ETV VERIFICATION PROTOCOL
STORMWATER SOURCE AREA TREATMENT TECHNOLOGIES

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For

US EPA Environmental Technology Verification Program
EPA/NSF Wet Weather Flow Technologies Pilot

NSF International
Ann Arbor, MI

And

US EPA National Risk Management Research Laboratory
Edison, NJ

FOREWORD

The U.S. Environmental Protection Agency (EPA) has instituted a program, the Environmental Technology Verification Program – or ETV – to verify the performance characteristics of commercial-ready environmental technologies through the evaluation of objective and quality-assured data. Managed by EPA's Office of Research and Development, ETV was created to substantially accelerate the entrance of innovative environmental technologies into the domestic and international marketplaces. ETV provides purchasers and permitters of technologies with an independent and credible assessment of the technology they are purchasing or permitting.

During a five-year pilot phase, the EPA has managed twelve ETV pilots in conjunction with partner organizations, including states, federal laboratories, associations, and private sector testing and standards organizations. Each pilot focuses on a different environmental sector and its relevant environmental technologies. Stakeholder Groups were established to represent customer groups for the particular technology sector, including buyers and users of technology, developers and vendors, state and federal regulatory personnel, and consulting engineers. All technology verification activities are based on testing and quality assurance protocols that have been developed with input from the major stakeholder groups.

The Wet Weather Flow Technologies Pilot was established to verify commercially available technologies used in the abatement and control of urban storm water runoff, combined sewer overflows, and sanitary sewer overflows. Untreated discharges that occur during wet weather events create significant chemical, physical, and biological stress to receiving waters. Early drainage plans contained no provisions to control the impacts from this type of pollution and physical stress from intensified flow rate and volume. Control of pollution associated with wet weather flows is a top environmental priority area at the Federal, State, and local level.

The Wet Weather Flow Technologies Pilot is operated under the direction of the USEPA National Risk Management Research Laboratory, Urban Watershed Management Branch, Edison, NJ, and its verification partner, NSF International (NSF). NSF International is an independent, not-for-profit organization, dedicated to public health, safety, and protection of the environment. NSF develops standards, provides educational services, and offers superior third-party conformity assessment services, while representing the interest of all stakeholders. In addition to well-established standards-development and certification programs, NSF specifically responds to and manages research projects, one-time evaluations and special studies. NSF is the verification partner organization for two additional ETV Pilots: the Drinking Water Treatment Systems Center and the Source Water Protection Technologies Pilot.

Verification of a technology under the ETV program does not constitute "certification" or "approval" by NSF or EPA. Rather it means that the technology has been evaluated in accordance with a recognized ETV Protocol and that the results are available in an approved Verification Report and Verification Statement.

ACKNOWLEDGMENTS

The U.S. EPA and NSF International would like to acknowledge those persons who participated in the preparation, review and approval of this Protocol. Without their hard work and dedication to the project, this document would not have been approved through the process which has been set forth for this ETV project.

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Representatives from several manufacturers of stormwater treatment technologies made valuable contributions to the development of this Protocol.

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1 Introduction

1.1 Purpose

This verification protocol establishes requirements and guidelines for verifying the performance of stormwater treatment technologies under Wet Weather Flow Technologies Pilot of the US EPA Environmental Technology Verification Program. This protocol describes the steps to be followed to ensure that verification activities are carried out in a consistent and objective manner that assesses the relevant performance characteristics of stormwater treatment technologies. It describes, in general terms, the process of selecting and documenting the verification tests to be conducted. The protocol also establishes requirements for sample collection and analysis and data reduction and reporting. The protocol provides guidelines for the preparation of verification test plans for specific technologies and test sites.

1.2 Scope

This protocol applies to pre-engineered, commercially-available, proprietary technologies that are used to treat stormwater runoff from urbanized or otherwise highly impervious catchment areas before it enters a stormwater collection system or receiving water. The evaluation procedures described in this protocol apply to devices that remove pollutants from stormwater through processes such as enhanced settling, hydrodynamic separation, filtration, adsorption or other means. This protocol may serve as the basis for verifying technologies referred to as “flow-through” or “in-line” devices, as well as catch-basin inserts and other commercial products

1.3 Verification Objectives

The testing prescribed by this protocol is intended to characterize a technology’s effectiveness in removing pollutants from stormwater runoff under an intended application. Verification testing conducted in accordance with this protocol will objectively measure the performance of a stormwater treatment technology in relation to the performance claims made by the manufacturer. This protocol is based on water quality constituent monitoring. It calls for monitoring the flow of stormwater into and out of a treatment technology for a minimum number of rainfall events and reporting the concentration and loading of pollutants of concern. Pollutant reduction data will be reported for each rainfall event that is sampled.

1.4 Verification Process

The verification process for the ETV Program consists of three primary phases, as described below:

Planning – The planning phase involves establishing and documenting the procedures to be followed during the verification of a specific technology. This includes identifying a field testing organization and personnel responsible for performance and oversight of the testing. The planning phase culminates in the preparation of a product-specific Verification Test Plan by the designated field testing organization. Guidelines for this phase are described in Section 2 of this protocol.

Verification Testing – This phase involves establishing the required test conditions, conducting the required tests, and the collection of the relevant data. Guidelines for this phase are described in Section 3 of this protocol.

Data Assessment and Reporting – This last phase includes all data analysis and the preparation and dissemination of a Verification Report and Verification Statement. Guidelines for this phase are described in Section 4 of this protocol.

Verification Testing may be conducted in cooperation with other monitoring and evaluation efforts sponsored by other organizations or government agencies. It is acceptable to include additional elements related to the planning, implementation, and reporting to satisfy those organizations provided the objectives of verification under the ETV Program are not compromised.

2 Development of a Verification Test Plan

A Verification Test Plan that clearly describes how testing is to be conducted shall be developed before verification testing of a stormwater treatment technology can begin. In most cases, the Test Plan will be developed by the designated field testing organization. An adequate Test Plan will help to ensure that testing and the reporting of results is conducted in a manner consistent the requirements specified in this protocol. An acceptable Test Plan also ensures that sufficient information about a vendor's product will be available for incorporation into the Verification Report upon the completion of testing. An individual Test Plan should be developed for each technology undergoing verification testing.

At a minimum a Verification Test Plan shall include:

- An introduction that describes the objectives of the testing to be conducted;
- Roles and responsibilities of participants in the verification testing of the technology;
- A complete description of the technology and its intended functions and capabilities;
- A description of the site(s) where verification testing is to take place;
- A description of the experimental design that includes the specific test procedures to be followed and identifies any necessary deviations from the requirements established in this protocol;
- A Quality Assurance Project Plan (QAPP) that describes the quality control procedures to be employed to ensure data and results are of sufficient quality;
- A description of how data are to be analyzed, managed, and reported;
- Health and safety procedures.

Guidelines and requirements for the content and scope of each of these required Test Plan elements are provided in this Protocol.

2.1 Roles and Responsibilities of Involved Organizations

The Test Plan shall specify the names and addresses of each organization having a role in the verification of a treatment technology. Where possible, the Test Plan should include the names, titles, and contact information for specific individuals with designated roles in the verification of the technology. General guidelines on the roles and responsibilities for the primary participants are listed below.

2.1.1 NSF International

NSF International is the US EPA's verification partner on the Wet Weather Flow Technologies Pilot. In the context of this Verification Protocol, NSF will select a qualified Field Testing Organization to develop and implement a Test Plan. In addition, NSF International has the following responsibilities:

- Review and approval of the Verification Test Plan;
- Oversight of Quality Assurance, including the performance of technical system and data quality audits, as prescribed in the Quality Management Plan for the Wet Weather Flow Technologies ETV Pilot;
- Coordination of Verification Report peer reviews, including review by the Stakeholder Advisory Group and Technology Panel;
- Approval of a Verification Report; and
- Preparation and dissemination of a Verification Statement.

2.1.2 US Environmental Protection Agency (USEPA)

The USEPA National Risk Management Research Laboratory provides administrative, technical, and quality assurance guidance and oversight on all WWF Pilot activities. EPA personnel are responsible for the following:

- Review and approval of the Verification Test Plan;
- Review and approval of Verification Report;
- Review and approval of Verification Statement; and
- Posting of Verification Report and Statement on EPA Website.

2.1.3 Field Testing Organization

The Test Plan shall identify the Field Testing Organization (FTO), including the personnel with important roles in the testing. The FTO shall have experience with the sampling of stormwater and monitoring of stormwater treatment technologies. The FTO will have primary responsibility for developing and implementing the Test Plan. The Test Plan shall designate responsibility for the following tasks:

- Coordinating testing with the vendor;
- Contracting with the analytical laboratories, contractors, and any other sub-consultants necessary for implementation of the approved Test Plan;
- Providing needed logistical support to the sub-consultants, as well as establishing a communication network, and scheduling and coordinating the activities for the verification testing;
- Overseeing or conducting the testing in accordance the approved Test Plan;
- Managing, evaluating, interpreting and reporting on data generated during the verification testing;
- Preparation and review of a Draft Verification Report.

2.1.4 Vendor

The Test Plan shall identify the vendor, manufacturer, or other entity responsible for the development of the technology to be verified. The Test Plan shall include the main vendor contact and the roles that all vendor personnel will have in the testing. The vendor's responsibilities may include but are not limited to the following:

- Providing, and possibly installing, the technology and ancillary equipment required for the verification testing,
- Providing technical support during the installation and operation of the technology. This should include the designation of a staff person or representative that will conduct at least one on-site inspection during monitoring to ensure the technology is functioning as intended;
- Providing descriptive details about the capabilities and intended function of the technology;
- Review and approval of the Verification Test Plan prior to the start of testing;
- Review and comment on the Draft Verification Report and Draft Verification Statement.

2.1.5 Analytical Laboratories

The Test Plan shall identify and describe all laboratories conducting analytical work on influent and effluent samples. Important considerations in selecting an analytical laboratory include proximity to the test site, the ability to achieve desired reporting limits, and experience with the types of samples that will be generated during verification testing. It may be necessary to contract with more than one laboratory to meet the analytical requirements.

Analytical laboratories selected shall be accredited by:

- The state in which the laboratory operates, if an accreditation program is offered;
- American Association of Laboratory Accreditation;
- National Environmental Laboratory Accreditation Program;
- NSF International; or
- An equivalent accreditation program deemed acceptable by NSF International.

2.1.6 General Contractors

One or more general contractors may be needed to install and/or maintain the stormwater treatment technology and ancillary equipment. Any subcontractors involved in sample collection or monitoring the test site shall also be described fully. The Test Plan shall identify the contractors to be used, a statement of their qualifications, and their responsibilities.

2.1.7 Site Owner

The owner of the site and facility where testing is to occur may have particular responsibilities during testing or site set-up and breakdown. The Test Plan shall describe any special requirements established by the site owner that may affect the test, including those related to site access, safety, and equipment needs.

2.1.8 Technology Panel on Storm Water Treatment Technologies

The ETV Technology Panel on Storm Water Treatment Technologies will serve as a technical and professional resource during all phases of the verification of a technology, including the review of test plans and the issuance of verification reports.

2.2 Technology Description

The Test Plan shall fully describe the technology being verified. This description and the related performance claims will provide the basis for the verification testing. The product description shall address the elements identified here.

2.2.1 Principles of operation

The Test Plan shall describe the engineering and scientific principles upon which the technology is based. This may include physical or chemical processes used to treat stormwater and remove pollutants (e.g. filtration, adsorption, settling, inertial separation, etc.). Any necessary or recommended pre- and post-treatment processes and the necessary influent water quality characteristics, if any, shall also be identified.

2.2.2 Physical description

The Test Plan shall describe the components of the equipment and how they function together as a system. This section shall describe the specific unit being tested but may also describe how the unit being tested relates to other models offered by the vendor. Drawings and diagrams should be included. Product manuals should be included as appendices or referenced. Among the items to include in this description:

- The materials of construction, including structural and functional components;
- Equipment dimensions including the equipment “footprint”;
- How and where the equipment is typically installed and whether installation is intended to be permanent;
- Geologic requirements and limitations (e.g., minimum depth to groundwater, soil characteristics)
- Physical requirements for proper installation and operation, such as: the required drop, if any, from influent to effluent; the physical clearance needed around the site for installation or maintenance of the equipment; required proximity to utility connections; type and/or level of upstream stormwater pretreatment recommended by the vendor;
- Unique or innovative features of the equipment;
- Sediment storage capacity (if applicable);

- Floatables/debris storage capacity (if applicable).

2.2.3 Technology applications and limitations

The Test Plan shall describe the applications for which the vendor claims the product is suited, including, but not limited to the size and nature of the drainage area or watershed that the unit is intended to treat. This should be supported by descriptions of existing installations.

Verification or determination of the head loss associated with a given technology is not within the scope of this Protocol. However, a vendors' claims related to head loss may be included in the Test Plan and the Verification Report, provided it is clear that no attempt was made to verify such claims.

2.2.4 Performance claims

The Test Plan shall clearly identify the vendor's performance claims related to the removal or reduction of pollutants from stormwater runoff. The vendor's pollutant reduction claims shall provide the basis for establishing a sampling plan and determine the list of pollutant constituents that will be used to characterize the unit's performance. Claims made for the purpose of verification may be qualitative or quantitative, and shall be consistent with product literature distributed by the vendor. Performance claims may relate to expected load reductions or removal efficiencies for specific pollutants or categories of pollutants. Performance claims should be based on performance under the design storm conditions and may be differentiated according to the intended application (i.e., anticipated flows, anticipated loadings, size or nature of drainage area, climatic conditions). Claims documented in the Test Plan should be relevant to the site and flow conditions expected during the test period.

2.2.5 Operation and maintenance

The Test Plan shall describe the manufacturer's recommended operation and maintenance procedures. The Test Plan should address preventative and corrective maintenance procedures expected during the testing period as well as over the anticipated lifetime of the equipment. The Vendor shall provide the FTO with any Operation and Maintenance manuals. These manuals may be included as an appendix or attachment to the Test Plan. The Test Plan shall address the availability of replacement materials or parts, if any (e.g., suppliers of filter media).

The Test Plan shall describe the recommended schedule and procedure for removal and disposal of any waste captured or generated by the device such as sediment, trash and debris, spent filter media and chemical adsorbents, filter backwash water, and other emissions. Depending on the Test site and the chemicals contained in the treated runoff, collected sediment and other wastes may need to be managed in accordance with special procedures identified in Federal, state or local regulations. The Test Plan should specify whether collected sediment and/or debris are to be tested to determine if special handling and disposal requirements apply.

Estimates shall be provided on the personnel, supplies and equipment needs associated with installing, operating, and maintaining the unit.

2.3 Test site selection and description

The selection of a suitable test site is critical to successful verification of a technology. To the extent possible, stormwater flows and pollutant loads should allow for a complete evaluation of a treatment technology's performance.

The Test Plan shall fully describe the test site and the rationale for selecting the site with respect to vendor's technology and its performance claims. The Test Plan shall identify and characterize site conditions that affect the flows and pollutant loadings to the equipment under test.

2.3.1 Sizing Methodology

The Test Plan shall fully describe the sizing methodology, if any, recommended by the vendor for selecting or designing the technology for a site. The Test Plan shall describe the actual sizing methodology used in selecting/designing the treatment technology for the specific test site, including any deviations from sizing methods recommended by the vendor. The Test Plan shall indicate how the anticipated flows at the test site relate to the range of design flow rates for the technology being verified. The Test Plan shall specify the hydraulic loading, if any, that will result in runoff by-passing the treatment technology.

The Test Plan shall address impact that state or local regulations enforced at the test site have on sizing and selection of the technology to be verified.

2.3.2 Site description

At a minimum, the description of the Test Site shall include the following information:

- Complete address of the technology monitoring location, along with latitude and longitude (degree, minutes, seconds);
- Property ownership;
- A description and a scaled plan view of the drainage area treated by the technology, to include:
- Location of the technology within the stormwater conveyance system;
- Storm drainage system information (e.g., size of drainage area, location of catch basins, open ditches, storm sewers, detention areas);
- A description of pollutant source areas (e.g., parking lot, landscaped, rooftop);
- Any pretreatment of stormwater runoff prior to treatment technology under test (e.g., structural and non-structural BMPs, floatables removal);
- Land use characterization for the drainage area, such as traffic volume, material storage, chemical usage, and other potential pollutant sources. Include a description of any on-going or planned maintenance activities or stormwater BMPs relevant to the quantity or quality of stormwater runoff upstream of the treatment device (e.g., erosion control measures, street sweeping, catch basin cleaning);
- Aerial photograph (if available);
- General meteorological conditions including summaries of long term annual, seasonal, and monthly rainfall, snowfall, and air temperature (min, max, average). To provide a general picture of the climatic conditions of test site, the depths of design rainfalls for the durations and frequencies shown in Table 2.1 shall also be provided.
- Location of the nearest named receiving water and the route of treated stormwater and stormwater that is bypassed, from the treatment device to the receiving water. Any subsequent stormwater best management practices between the treatment device and the receiving water should be noted.
- Summary of previous water quality and/or flow data collected in the study area or relevant nearby sites.
- Summary of local ordinances that may affect stormwater management or pollutant removal requirements.

Table 2.1 Rainfall Depth (inches)

Duration	2-mo.*	6-mo.	1-year	2-year	10-year
30 min					
1 hr					
2 hr					
12 hr					
24hr					

*- if available

2.3.3 Peak Flow Calculation

To ensure proper flow measurement techniques are employed, it may be necessary to determine the capacities of the conveyance system at the monitored points and the peak flows from the drainage area under various storm events. The Test Plan should include the calculated peak flows under the conditions shown in Table 2.2. Peak flow should also be calculated for the time of concentration of the drainage area to be treated by the device. The data requested in Table 2.2 is not intended to suggest that that a flow measurement device is required to be fully calibrated over the range of peak flows shown.

Table 2.2 Example Peak Flow Calculations (cfs)

Duration	2-mo.	6-mo.	1-year	2-year	10-year
30 min					
1 hr					
2 hr					
12 hr					
24hr					

2.4 Sampling and Analysis Plan

The Test Plan shall include a sampling and analysis plan to be followed during the course of verification testing. The methods and procedures described in the Test Plan shall be consistent with the requirements and guidelines established in Section 3 of this Verification Protocol. The Test Plan shall provide detailed procedures for the following:

- Initial set-up and shake-down testing;
- Influent and effluent sample collection;
- Flow measurement;
- Precipitation measurement;
- Sample analysis;
- Documenting operation and maintenance requirements;
- Data acquisition, storage, and management.

2.5 Quality Assurance Project Plan

2.5.1 General Requirements

The Test Plan shall include a quality assurance project plan (QAPP) that specifies the procedures to be followed to ensure the validity of test data and their use as the basis for equipment performance verification. A person or persons with a good understanding of chemical analytical methods, field sampling procedures, and data validation procedures should develop the QAPP in consultation with the analytical laboratory.

This protocol establishes minimum requirements for the collection and analysis of certain QA/QC samples. In the absence of specific recommendations or requirements, the following documents should be consulted during the preparation of the QAPP:

- California Department of Transportation Guidance Manual: Stormwater Monitoring Protocols, July 2000
- EPA QA/G5 Guidance for Quality Assurance Project Plans*;*
- ASTM D5612-94 Standard Guide for Quality Planning and Field Implementation of a Water Quality Measurement Program.

The QAPP shall address the activities of all organizations involved in verification testing, including the field testing organization and the analytical laboratories. The Field Testing Organization will have primary responsibility for ensuring that testing is conducted in accordance with QA/QC procedures in the Test Plan.

The QAPP shall address how data quality will be assured for each of the following:

- Water quality sample collection and analysis;
- Flow measurement;
- Precipitation measurement.

The objective of QA/QC is to ensure that strict methods and procedures are followed during sampling and analysis so that the data obtained are valid for use in the verification of a technology. In addition, QA/QC ensures that the conditions under which data is obtained will be properly recorded so as to be directly linked to the data, should a question arise as to its validity.

The following QA/QC measures shall be addressed in the QAPP:

- Description of the methodology for measurement of accuracy and precision, including the establishment of criteria based on the data quality objectives for the project;
- Description of the methodology for use of blanks, the materials used, the frequency, the criteria for acceptable method blanks and the actions to be taken if criteria are not met;
- Outline of the procedure for determining samples to be analyzed in duplicate, the frequency and approximate number;
- Outline of the frequency, format, and content of self-assessments (audits) of the FTO's or analytical laboratory's technical systems;
- Outline of the frequency, format, and content of assessment reports to be submitted to the Verification Organization (NSF International);
- Development of a corrective action plan for responding to audit findings;
- Format for providing all QC information, such as calibrations, blanks and reference samples, in an appendix to the report.

2.5.2 Field Quality Assurance

The QAPP shall address the following quality control elements:

- Frequency and methods for calibration of sampling and flow measurement equipment;
- Decontamination of sampling equipment;
- Sample labeling,
- Sample preservation, storage, and transportation
- Sample chain of custody.

A sample logbook shall be maintained for recording relevant information about all water quality samples.

2.5.2.1 Field Blanks

Field blanks are necessary to evaluate whether contamination is introduced during field sampling activities. The QAPP shall include the methods for preparing field blanks and specify the frequency at which field blanks will be collected. A minimum of two rounds of field blanks should be conducted. Field blanks should be collected before the initial runoff event, or at the earliest time possible. The second set of field blanks should be conducted at or near the mid-point of the testing (e.g., between event numbers 7 and 8).

Blanks should be collected by passing deionized water through the sampling equipment and collecting and delivering the samples as "blinds" to the analytical laboratory in the same manner as normal samples. For automated samplers, the manufacturer's recommended procedures should be followed.

2.5.2.2 Duplicates

Field duplicates are used to assess variability attributable to collection handling, shipping, storage and/or laboratory handling and analysis. The QAPP shall include a description of techniques used to collect duplicate samples and specify the frequency of collection. Duplicates for composite sampling may be obtained by splitting a composite sample of adequate volume into two separate samples, using an acceptable sample splitting technique. Duplicates for grab samples should be collected by filling two grab sample bottles at the same location.

A minimum of three rounds of field duplicates should be conducted. Field duplicates shall be obtained:

- During the initial runoff event, or at the earliest time possible;
- At or near the mid point of the testing (e.g., between event numbers 7 and 8); and
- During one of the last three sampling events.

2.5.2.3 Equipment maintenance and calibration

The QAPP shall describe the quality control for measurements of water level, velocity, precipitation, and other parameters that are measured and recorded in the field. Procedures and schedule for calibration, inspection, and cleaning of all equipment shall be included.

2.5.3 Laboratory QA

The QAPP shall describe the laboratory methodologies, limit of quantification for each constituent, lab certifications, constituent reporting units, and internal quality control procedures. The laboratory quality assurance /quality control procedures shall address, as applicable, the frequency and methods for conducting method blanks, duplicates (splits), matrix spikes, and external reference or laboratory control standards.

The Test Plan should specify the content and format of the hard copy and electronic data packages to be submitted by the laboratory to the FTO. The Test Plan shall describe the role of the analytical laboratory in conducting any data review and reduction.

2.5.4 Quality Assurance Reports

The findings, results, and corrective measures conducted in relation to QA/QC procedures shall be included in the Verification Report

2.6 Data Management and Reporting

The Test Plan shall establish the data storage, retrieval and transfer methods that make up a reliable data management system.

2.6.1 Data Storage Systems

The Test Plan shall describe initial data storage systems (field level data), data retrieval protocol, preliminary archival, and final data storage systems. It is recommended that a database system be established that can accommodate digital information such as laboratory analytical data and recorded data logger measurements. Procedures for efficient data input, back-up, and retrieval shall be established. A single database should, at a minimum, include the following categories of data: sampling event description (e.g., event date and time, duration, rainfall depth); sample identification information; sample collection and flow data; analytical results and data qualifiers.

To prevent data entry errors electronic data transfer from the analytical laboratory directly to the database is recommended.

2.6.2 Data Reduction

Data reduction refers to the process of converting the raw results from the equipment test into a form that can be used to evaluate the performance and operating characteristics of the system. The procedures to be used will be equipment dependent. The purpose of this step is to provide data that shall be used to verify the statement of performance capabilities. These data shall be obtained from logbooks, instrument outputs, and computer outputs as appropriate.

2.6.3 Data Evaluation

The Testing Organization shall verify the completeness of the appropriate data forms and the completeness and correctness of data acquisition and reduction. In addition, calculations and laboratory logbooks and data sheets will be reviewed to verify accuracy and completeness. The individual operators and the laboratory supervisor shall examine calibration and QC data. Laboratory and project managers shall verify that all instrument systems are in control and those QA objectives for accuracy, completeness, and method detection limits have been met.

Analytical outlier data are defined as those QC data lying outside a specific QC objective window for precision and accuracy for a given analytical method. Should QC data be outside of control limits, the analytical laboratory or field team supervisor shall investigate the cause of the problem. If the problem involves an analytical problem, the sample shall be reanalyzed.

If the problem can be attributed to the sample matrix, the result shall be flagged with a data qualifier. This data qualifier shall be included and explained in the final analytical report.

Guidance on Data Quality Evaluation is provided in Section 13 of the California Department of Transportation Guidance Manual: Stormwater Monitoring Protocols, July 2000.

2.6.4 Data Reporting

This section contains a list of the water quality and equipment operation data to be reported. At minimum, the data tabulation shall list the results for influent and effluent water quality analyses and equipment operating data. All QA/QC data and calculations shall be included in an appendix. All raw analytical data shall also be reported in an appendix. All data shall be reported in hard copy and electronically in a common spreadsheet or database format. The FTO shall periodically submit reports to NSF International that provides a summary of laboratory analytical and field data. The Test Plan shall specify the frequency with which reports will be submitted describe how data will be made available to NSF International.

2.7 Health and safety plan

Field verification of stormwater treatment technologies may involve activities that have the potential to adversely affect the health and safety of field personnel. The Test Plan shall include health and safety procedures for ensuring the safety of all personnel associated with testing and the security of the test site. Individuals responsible for oversight of health and safety activities and minimum safety training required for on-site staff shall be designated. It is the responsibility of the FTO to ensure that testing is performed in accordance with rules and regulations pertaining to worker safety and materials handling.

At a minimum, the Test Plan shall include:

- A description of the potential hazards associated with the monitoring activities and measures to be taken to reduce the risks associated with those hazards;
- The confined space entry protocol to be followed (if applicable);
- A description of the First Aid equipment available at the site;
- How the site is to be protected from vandalism;
- A description of the notification process in case of personal injury, including local appropriate emergency personnel to be contacted.

3 Requirements and Guidelines for Sampling and Analysis

For the purposes of this verification, performance of a stormwater treatment technology shall be characterized by how effective it is in removing targeted stormwater runoff constituents, pollutants, and contaminants. Technologies differ with respect to the types and amount of pollutants that they are designed to remove. Verification testing requires monitoring the influent to and effluent from a device and characterizing the pollutant concentration and loadings in each.

Verification testing shall be conducted in the field under actual stormwater runoff conditions. This Protocol establishes minimum requirements and guidelines for the following:

- the collection and analysis of influent and effluent samples,
- the monitoring of flow through the treatment device,
- the measurement of precipitation; and
- the evaluation of operation and maintenance procedures.

This Protocol was developed to cover a variety of stormwater technologies under a range of applications. The intent is to afford a fair level of flexibility to the Field Testing Organization in determining the most appropriate monitoring techniques for a given technology and the selected test site. In situations where this Protocol fails to provide sufficient guidance or recommendations for conducting a specific aspect of verification testing, it is incumbent upon the Field Testing Organization to refer to one or more of the many guidance documents available concerning stormwater monitoring and equipment testing. Recommended guidance documents to be used in developing a sampling and analysis plan include:

- California Department of Transportation Guidance Manual: Stormwater Monitoring Protocols, July 2000
- Methodology for the Study of Urban Storm Generated Pollution and Control, USEPA Environmental Protection Technology Series EPA-600/2-76-145
- Test Plan for the Verification of Arkal Filtration Systems, ,Inc. Pressurized Stormwater Filtration System, St. Mary's Hospital, Green Bay,WI , January 5, 2001, prepared by Earth Tech, USGS, and WI DNR (available from Jim Bachhuber, Earth Tech, 608-828-8121)
- Automatic Stormwater Sampling Made Easy by Cindy Thrush and Dana B. DeLeon, published by Water Environment Federation
- Methods for Collection and Processing of Surface-Water and Bed-Material Samples for Physical and Chemical Analyses by USGS, Open -File report 90-140
- Precision of a Splitting Device for Water Samples by USGS Open –File Report 95-293
- Selected Laboratory Tests of the Whole-Water Sample Splitting Capabilities of the 14-Liter Churn and the Teflon Cone Splitters by Arthur J. Horowitz, Timothy S.Hayes, John R.Gray, and Paul D. Capel

3.1 Sampling Events

3.1.1 Minimum number of events

Performance verification shall be based on data from a minimum of fifteen (15) rainfall events that meet the minimum criteria for qualified sampling event listed in 3.1.2. The field testing organization shall attempt to collect the required samples from consecutive rainfall events. Precipitation and flow measurement records should be maintained for all events that occur during the study period. If an event fails to meet one to more of the criteria for a qualified sampling event, the influent and effluent samples collected should not be analyzed. If an event fails to meet the qualification criteria, the reasons for such shall be documented. Only data from qualified sampling events shall be used in the calculation of pollutant removal efficiency.

Rainfall events that include significant snowmelt runoff shall not be included in the required number of qualified sampling events (15). If desired, data and results for snowmelt runoff events may be collected and reported upon in addition to the required qualified monitoring events.

Before the start of testing, a "shakedown" period may be required during which influent and effluent is observed and measured to ensure the device is functioning properly. Water samples may be collected to ensure proper operation of the sampling device, but these should not be included in the performance verification. In addition, field blanks may be collected and analyzed during this period (see Section 2.5.2.1).

3.1.2 Criteria for qualified sampling event

For an event to be considered a qualified sampling event, the following conditions shall be met:

- The total rainfall depth for the event, measured at the site, shall be 0.2 inches (5 mm) or greater;
- Flow through the treatment device shall be successfully measured and recorded over the duration of the runoff period;
- A flow-proportional composite sample shall be successfully collected for both the influent and effluent over the duration of the runoff event;
- Each composite sample collected shall comprised of a minimum of five (5) aliquots including at least two (2) aliquots on the rising limb of the runoff hydrograph, at least one aliquot near the peak, and at least two aliquots on the falling limb of the runoff hydrograph; and
- There shall be a minimum of six hours between qualified sampling events. That is, there shall be a minimum of six hours between the termination of measured effluent during one event and the start of measured influent to the stormwater technology during the subsequent rainfall event.

For the purposes of verification, there is no minimum required antecedent dry weather period.

3.2 Constituent selection

The selection of pollutant constituents for which the treatment technology is to be verified shall be based on the vendor's pollutant reduction claims, as specified in the Test Plan and supported by the product literature. Verification shall encompass performance claims that are quantitative (e.g., technology A has a load reduction efficiency of 50% for total phosphorus) or qualitative (e.g., technology A is effective in reducing nutrient loads in stormwater runoff).

The pollutant reduction performance of a technology shall be evaluated in relation to one or more of the following pollutant categories:

- sediment / particulates;
- nutrients;
- heavy metals;
- petroleum hydrocarbons; and
- bacteria.

Table 3.1 establishes a list of water quality constituents to be monitored within each of the five primary pollutant categories. If a vendor's claims include the reduction of one or more pollutants within a category, then sampling and analysis shall encompass each of the required constituents within that category, as specified in Table 3.1. For example, if the performance claims for a given technology include the removal of heavy metals, then influent and effluent samples shall be analyzed for, at a minimum, zinc, lead, cadmium and copper. If performance claims relate to the reduction of constituents in both the particulate and dissolved phases, then the concentrations in both phases shall be measured and the results reported accordingly.

The Test Plan may propose that supplemental constituents be included in verification testing if necessary to verify a performance claim made by the manufacturer or to satisfy regulatory or legal requirements for the test site.

Monitoring of conventional constituents such as COD, BOD, turbidity, specific conductance, temperature, and pH may also be considered if relevant to the performance of the technology at the test site location. The Test Plan may propose that supplemental particle size distribution analyses be conducted on some or all influent and effluent samples if the vendor's performance claims are differentiated based on particle size. The Test Plan shall fully describe the proposed method of conducting the particle size determination.

Table 3.1 –Water Quality Constituent List

Pollutant Category	Required Constituents	Target Detection Limits
Sediment / Particulates	Total Suspended Solids	5 mg/l
	Suspended Sediment Concentration (SSC)	>62µm,<62µm
Nutrients	Total Phosphorus	0.008 mg/l as P
	Dissolved Phosphorus*	0.002 mg/l as P
	Total Kjeldahl Nitrogen	0.14 mg/l
	Nitrate and Nitrite Nitrogen (NO_3-N +NO_2-N)	0.02 mg/l as N
Metals	Total Recoverable Zinc	19 ug/l
	Dissolved Zinc*	8 ug/l
	Total Recoverable Lead	1.0 ug/l
	Dissolved Lead*	0.4 ug/l
	Total Recoverable Copper	1 ug/l
	Dissolved Copper*	0.7 ug/l
	Total Recoverable Cadmium	0.04 ug/l
	Dissolved Cadmium*	0.02 ug/l
Petroleum Hydrocarbons	Total Petroleum Hydrocarbon (TPH)	1.0 mg/L
	Polycyclic Aromatic Hydrocarbons (PAHs):	
	Acenaphthene	0.048 ug/l
	Acenaphthylene	0.044 ug/l
	Anthracene	0.015 ug/l
	Benz(a)anthracene	0.059 ug/l
	Benzo(a)pyrene	0.041 ug/l
	Benzo(b)fluoranthene	0.073 ug/l
	Benzo(g,h,i)perylene	0.05 ug/l
	Benzo(k)fluoranthene	0.059 ug/l
	Chrysene	0.03 ug/l
	Dibenz(a,h)anthracene	0.019 ug/l
	Fluoranthene	0.098 ug/l
	Fluorene	0.12 ug/l
	Indeno(1,2,3-c,d)pyrene	0.078 ug/l
	Naphthalene	0.054 ug/l
	Phenanthrene	0.035 ug/l
	Pyrene	0.063 ug/l
Bacteria	Fecal Coliform	NA
	E. Coli or Enterococci	NA

* Analysis and reporting of dissolved constituents is required only if the vendor claims that the technology can remove dissolved species/fractions.

3.3 Sampling

The Test Plan shall fully describe the sampling procedures and techniques to be used to sample influent to and effluent from the treatment technology.

3.3.1 Sampling methods

3.3.1.1 Automated sampling

Except as noted in 3.3.1.2, influent and effluent samples shall be collected using automated sampling equipment that is programmable to collect composite samples on a flow-weighted basis. The automated sampler shall be programmed to ensure that a minimum of five (5) aliquots is collected over the period of runoff to the device. Aliquots shall be composited sited to obtain a single sample per qualified sampling event. The sampler should be programmed to maximize the number of aliquots collected given the projected rainfall depth for a storm. This requires that sample capacity of the automated sampler be sufficient to sample flows associated with the anticipated maximum rainfall depth or that a plan be established for changing out the sampling containers after a certain volume of flow has been recorded. The Test Plan shall describe the steps to be followed for proper composite bottle changing. Guidance on proper programming of automated samplers is available in Section 9 of the Caltrans Guidance Manual: Stormwater Monitoring Protocols.

3.3.1.2 Manual sampling

Manual grab sampling shall be conducted when sampling for constituents that transform rapidly, require special preservation or adhere to bottles. Samples for Total Petroleum Hydrocarbons and other hydrocarbons must be collected directly into the bottle that will be used in the laboratory. Samples for bacteriological analyses must be collected into sterile bottles using appropriate clean sampling and equipment handling techniques. Manual sampling may be considered as an alternative to automated sampling under other special conditions where automated sampling is not possible or reliable.

If samples are to be collected manually, the Test Plan shall describe how the criteria for a qualified sampling event in 3.1.2 will be met. The Test Plan shall demonstrate the availability and preparedness of sampling personnel and equipment so that runoff can be monitored over the duration of the event. A minimum of five samples shall be collected for each event. A Test Plan may propose that the collection of grab samples for hydrocarbons be suspended after a specific minimum rainfall depth or flow volume is reached if it can demonstrated that the hydrocarbon load at the site is typically reduced to levels below the reporting limit after the specified rainfall or runoff volume has passed. This is intended to reduce unnecessary sampling and analysis costs associated with the collection of grab samples beyond the period during which a pollutant load is expected.

3.3.2 Sampling location

The Test Plan shall describe how sampling is to be conducted to ensure the samples are representative of the total flow. The concentration of solids and the related bound pollutants may become stratified across the flow column in the absence of adequate mixing. Samples should be collected at a location that maximizes the mixing of the flow and the sample intake tube or device located accordingly.

3.3.2.1 Influent

Influent to the treatment technology shall be sampled as close as possible to the inlet of the treatment device. Samples collected should be representative of the total runoff of the drainage area. To ensure the collection of representative samples, the test site shall be designed so that influent samples may be collected from a pipe that conveys the total influent to the unit. This may require that the treatment technology be installed in a manner that is not typical for the unit, particularly for catch basin inserts that capture sheet or non-pipe flow across a wide sewer opening.

To prevent the skewing of influent pollutant concentrations, influent samples shall be taken at a location that is unaffected by the accumulation or storage of pollutants in or adjacent to the treatment device.

3.3.2.2 Effluent and bypass

Effluent from the treatment technology shall be sampled at a location that captures the total treated effluent from the device. If treated effluent is recombined with untreated or partially-treated bypass flows before its discharge to a sewer or receiving water, then effluent samples shall be taken downstream of the where the flows are recombined. If the design of the system is such that the untreated or partially-treated bypass flows are not recombined with the treated effluent prior to its discharge, then:
a) the bypass flow shall be sampled in accordance with 3.3.1; or b) it shall be assumed that the constituent concentrations in the bypass are equivalent to the upstream (influent) concentrations. For purposes of calculating overall pollutant reduction efficiency of the unit, the bypass load shall be incorporated as part of the effluent load.

3.3.3 Sample volume

The volume of samples collected shall be based on the type and number of analyses needed, as reflected in the parameters to be measured. The volume of the sample obtained shall be sufficient for all the required analyses plus an additional amount for any split or duplicate analyses required by the QAPP. The Test Plan shall specify the minimum sample volumes to be collected. Specific recommended minimum sample volumes for the required analytical constituents can be found in EPA's Methods for Chemical Analysis of Water and Wastes (USEPA1983) and Standard Methods for the Examination of Water and Wastewater (APHA 1999).

3.3.4 Sample containers

Sample containers shall be made of a chemically resistant material that is unaffected by the concentrations of pollutants measured. Most samples should be collected in polyethylene containers. Glass bottles shall be used when sampling for petroleum hydrocarbons and other organic compounds. The Test Plan shall describe the appropriate procedures for cleaning all sample containers and equipment before and during sample collection and storage.

3.3.5 Selection of sampling methods

3.3.5.1 Equipment selection

The Verification Test Plan shall describe all equipment to be used for the collection of water quality samples. Identical sampling devices shall be used to collect influent and effluent samples. At a minimum, the description of sampling equipment shall including:

- Manufacturer and model number of automated samplers
- Type and number of sample collection container bottle(s) (material and volume)
- Type of sample intake tubing and the maximum length and vertical lift
- Datalogger model.

Section 5 of Caltrans Guidance Manual: Stormwater Monitoring Protocols contains useful guidance on the selection and operation of sampling equipment.

3.3.5.2 Sampler Installation and Operation

The automated sampler shall be installed and calibrated according to manufacturer's specifications.

The Test Plan shall describe:

- How the sampler will be triggered to collect the flow-weighted samples, including its compatibility with and connection to external flow meters, if applicable;
- How the proper sample port intake velocity will be established to ensure the collection of representative samples; and
- How the sampler will be programmed to purge and rinse the sample tubing before collecting a new sample.

3.3.5.3 Sampler Maintenance

The Test Plan shall describe the procedures for cleaning the sampling equipment between runoff events and maintaining the equipment to ensure proper sampling.

3.3.6 Sample splitting, preservation, and holding

Stormwater samples require immediate preservation and/or analysis. Proper handling and preservation of samples is critical to obtaining quality data. The Test Plan shall describe the procedures to be used for splitting the flow weighted composite samples into appropriate sample bottles for laboratory analyses. It is recommended that composite sample splitting be conducted by the analytical laboratory to minimize the chance for sample contamination. The Test Plan shall describe the procedures for preserving samples, which may include cooling, pH adjustment, and chemical treatment. Sample preservation shall be provided during compositing of samples, as well as during transport. If ice or ice substitute is used in an automatic sampler to cool samples, the ice shall be replaced as necessary to maintain low temperatures.

All samples shall be properly labeled and entered in a sample collection log. The Test Plan shall describe the field procedures for recording, storing, and transporting samples from the time of collection until delivered to the analytical laboratory.

Maximum sample holding times for all samples shall be specified in the Test Plan and shall not exceed those specified for wastewater samples in 40 CFR Part 136 or in the selected analytical test method. The holding time starts when sample collection is complete and is counted until the extraction, preparation or analysis of the sample. For composite samples, the time of the initial sample aliquot is considered the "sample collection time" for determining sample holding time. Prompt delivery and analysis is important and allows the laboratory time to review that data and, if analytical problems are found, re-analyze the affected samples. Holding times should be considered in deciding whether laboratory services need to be available on evenings and weekends (Caltrans, 2000).

3.3.7 Sample chain of custody

The Test Plan shall describe the procedures to be followed to ensure that all samples are traceable from the time of collection to analysis. A chain-of-custody record shall accompany each sample. The form to be used for sample tracking shall be included in the Test Plan.

3.4 Analytical Methods

Laboratory analysis of samples shall be conducted in accordance with US EPA-approved methods or Standard Methods as contained in most recent editions of the EPA's *Methods and Guidance for the Analysis of Water* and the American Public Health Association's *Standard Methods for the Examination of Water and Wastewater,* respectively. If an EPA or Standard method is not available for a selected constituent, the Test Plan shall document the selected method and the basis for its selection. Suspended Sediment Concentration shall be conducted by ASTM Method D 3977-97 Method C which is a test that gives the sand/silt split above and below 62 microns.

For each constituent the Test Plan shall identify:

- the name of the analytical methodology;
- the approved Method Number;
- the method detection limit established by the analytical laboratory with appropriate units;
- sample preservation technique;
- container type; and
- maximum holding time.

It is important that the analytical methods used are sensitive enough to provide useful data. For each constituent, the analytical laboratories are responsible for determining the reporting limit (i.e., the minimum concentration at which the laboratory can accurately report detectable values). The laboratory may specify its reporting limit as a method detection limit (MDL) for the required analyses. The laboratory may also specify its minimum quantification limit (MQL), which is generally 3 to 5 times higher the MDL and typically matches the lowest calibration standard used. Every effort should be made to ensure that the MDL and MQL are below the level expected to be present in influent and effluent samples. Table 3.1 contains target method detection limits for most of the analyses to be conducted under this protocol. The actual reporting limits (by type and value) shall be indicated in the Test Plan.

The QAPP shall establish the quality control procedures to be followed for all analytical work to be performed. This may be done, in whole or in part, by way of reference to the quality assurance manual of the approved analytical laboratory.

3.5 Flow Measurement

Accurate measurement of volumetric flow rate at the inlet, outlet, and bypass, if applicable, of the treatment device is required to verify the load reduction capabilities of the device. The use of depth measurement devices and area/velocity measurement devices are common approaches to flow measurement when collecting flow-weighted stormwater samples. The appropriate method for flow measurement will depend on the nature of the test site and the conveyance system available. The appropriate method of flow measurement at the inlet to a treatment device may be different from that at the outlet. Methods that measure and record flow on a continuous basis over the duration of the sampling event and the expected range of flows shall be used.

Flow monitoring equipment shall be installed, maintained, and calibrated according to the manufacturer's specifications. Responsibility for inspection and maintenance of the flowmeter shall be assigned. Moisture indicators, sensors, and connections should be inspected before each sampling event. The expected frequency and method of calibration methods shall be described in the Test Plan.

The Test Plan shall describe the methods to be used to determine flow rates through the treatment technology. Equipment to be used to measure flow, level and velocity shall be described, including manufacturer and model number.

3.6 Precipitation Measurement

3.6.1 Methods

An automatic recording rain gauge shall be used to record rainfall depths at intervals of 15 minutes or less. The use of an electronic rain gauge (e.g. a tipping bucket) connected to a datalogger is recommended. The rainfall gauge shall record rainfall depths in increments of no greater than .01 inches.

3.6.2 Field Procedures

The Test Plan shall describe the location of the rain gauge in relation to the test site and shall specify the data recording forms and documentation procedures. At a minimum, the rain gauge should be inspected and cleared of debris between sampling events. The rain gauge shall be calibrated in accordance with the manufacturer's instructions. Calibrations should be conducted at least twice during the verification period.

3.7 Operation and Maintenance Parameters

The FTO shall maintain a record of activities associated with operating and maintaining the equipment during the testing period. Such activities shall be consistent with the manufacturer's recommended procedures. These may include, but are not limited to: the addition, removal, disposal, replacement and/or cleaning of media, chemicals, or treatment aids; removal of sediment or waste by-products from the device; planned and unplanned repairs; and periodic inspections.

The Test Plan shall describe any measurements to be made with respect to O & M procedures, such as:

- chemical or media usage;
- quality or quantity of waste by-products generated by the device;
- quality or quantity of sediment or other residuals trapped in the device;
- volume and nature of gross debris and trash captured by the device.

4 Data Analysis and Reporting

4.1 Performance Data

Performance indicators to be used to characterize the pollutant removal efficiency of the stormwater treatment technology shall include, at a minimum: (1) a load reduction based on the percentage of the total amount of pollutant that was removed from the flow through the device; and (2) an efficiency ratio based on reduction in event mean concentration (EMC) of the pollutant in the flow for the individual storm events. These indicators shall be developed for each pollutant constituent monitored.

Sediment analysis may also be determined for devices where is sediment capture and retrieval is possible.

This protocol does not require that pollutant removal efficiency be correlated to specific flow rates or range of flow rates through the technology. The performance indicators are intended to describe how the unit performed under the conditions of the types of sampling events that occurred during the sampling period.

Constituent concentration data are to be reported as event mean concentrations (EMCs) for influent and effluent samples. Data shall be reported as shown in Table 4.1. In addition, the occurrence of bypass flows during any sampling event shall be reported along with the total volume of bypass flow.

Table 4.1 Example of Data Summary- Event Mean Concentration

Event	Start Date/ Time	End Date/ Time	Event Rainfall Depth (in)	Maximum Hourly Rainfall Intensity (in/hr)	Runoff Volume Through Device (ft^3)	Runoff Volume Bypassing Device (ft^3)	EMC: Constituent 1 (mg/l unless otherwise noted)		EMC: Constituent 2 (mg/l unless otherwise noted)	
							Influent	Effluent	Influent	Effluent
Event 1										
Event 2										
Event 3										
Event 4										
Event 5...15										

NOTE: Event numbering will be 1-15; Pollutant Constituents will include entire monitored list.

4.1.1 Load Reduction

For each pollutant constituent a summation of the loads calculation shall be made. The load reduction efficiency of the device shall be based on relating the sum of the total outlet loads to the sum of the total inlet loads as follows:

$$\textbf{\% Load Reduction Efficiency} = 100\times(1-(A/B))$$

Where:
A = Sum of Effluent Load =(Effluent EMC_1)(Flow $Volume_1$)+(Effluent EMC_2)(Flow $Volume_2$)+ … (Effluent EMC_n)(Flow $Volume_n$)
B = Sum of Influent Load = (Influent EMC_1)(Flow $Volume_1$) +(Effluent EMC_2)(Flow $Volume_2$) + … (Effluent EMC_n)(Flow $Volume_n$)
n= number of qualified sampling events

Table 4.2 Sum of Loads Example Reporting Table

Event	Inlet Load	Outlet Load
Event $_{1}$	IL_1	OL_1
Event $_{2}$	IL_2	OL_2
Event $_{3}$	IL_3	OL_3
Event $_{4}$	IL_4	OL_4
Event $_{5..15}$	IL_{5-15}	OL_{5-15}
Total	Sum (IL_1 . IL_{15})	Sum(OL_1 .. OL_{15})

NOTE: Events 1-15 will be tabulated and summed.

4.1.2 Concentration Efficiency Ratio

For each pollutant constituent and storm event, an efficiency ratio (ER) shall be calculated based on the reduction in the event mean concentration (EMC) from the influent to the effluent. The efficiency ratio shall be calculated and reported for each storm event as follows:

Efficiency Ratio = 100× (1-(effluent EMC)/(influent EMC))

The influent concentrations of a pollutant constituent can vary widely from storm to storm. If the influent concentration is very low and approaches the limit below which a technology is not effective in further reducing the concentration, this may be reflected in a low efficiency ratio. It is important, therefore, that the influent and effluent concentration be clearly indicated when reporting the efficiency ratio for each storm event. This is also the reason why the efficiency ratios for each storm event should not be combined statistically to generate an overall efficiency ratio for the full test duration.

4.1.3 Flow Data

For each qualified sampling event, a runoff hydrograph (flow (cfs) vs. time) shall developed using the flow data collected at the inlet of the treatment technology over the duration of the sampling event. In addition to the flow, the hydrograph shall show the starting and ending point of the rainfall event and the points at which water quality sample collection started and ended. These hydrographs shall be presented in the Verification Report to provide a more complete picture of how the device functioned under various flow conditions.

4.1.4 Rainfall Data

In addition to the rainfall data requested in Table 4.1, the Verification Report shall include rainfall hyetographs for each measured rainfall during the monitoring period. The hyetographs shall show rainfall amounts for the minimum increment of time recorded by the gauge and a cumulative rainfall curve.

4.2 Verification Report

The FTO shall prepare a draft Verification Report describing the verification testing that was carried out and the results of that testing. The draft Verification Report shall undergo a complete review by NSF International and the EPA. The vendor shall be given the opportunity to review the draft Verification Report and to provide input on its content. This report should fully describe the technology and the verification of its performance characteristics and the required operation and maintenance procedures as specified in the Test Plan.

At a minimum, the Verification Report shall include the following items:

- Introduction

At a minimum, the Verification Report shall include the following items:

- Introduction
- Description and Identification of the Stormwater Treatment Technology (as required for inclusion in the Test Plan)
- Test Site Description (as required for inclusion in the Test Plan)
- Sampling Procedures and Analytical Methods
- Results and Discussion of Performance Indicators
- QA/QC Results
- Record of Operation and Maintenance Procedures Performed during Monitoring Period
- References
- Appendices, to include raw and analyzed test data.

4.3 Verification Statement

NSF and EPA shall prepare a Verification Statement that briefly summarizes the Verification Report for issuance to the vendor. The Verification Statement shall provide a brief description of the testing conducted and a synopsis of the performance results. The Statement is intended to provide verified vendors a tool by which to promote the strengths and benefits of their product.

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