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

Although new products continue to be added to the marketplace list of stormwater best management practices, the availability of good data and information on most of these technologies is still scarce. To address this problem, forward thinking states, including CA, MA, MD, NJ, PA, VA, and WA, banded together to form the Technology Acceptance and Reciprocity Partnership (TARP) Stormwater Work Group to layout a cost-effective path for evaluating innovative stormwater technologies by producing scientifically credible data, as well as useful information, which demonstrates how to apply the technology on real sites to manage stormwater runoff.

To support responsible use of stormwater technologies, the TARP Stormwater Work Group developed two Internet-based training courses. This training is the first of two modules covering aspects of stormwater technology evaluation and is supported by the TARP Protocol for Stormwater Best Management Practice Demonstrations. The purpose of the Protocol is to provide a uniform method for demonstrating stormwater technologies and developing test quality assurance (QA) plans for certification or verification of performance claims. In this training course you will learn:

- to use the Protocol to identify gaps and inconsistencies in a test plan for evaluation of a stormwater technology and understand differences in state requirements;
- to recognize data deficiencies;
- to develop, implement, and review a test plan;
- to understand, evaluate, and implement statistical methods.

The goal of this training course is to encourage collaboration, data sharing and reciprocal review amongst states and practitioners, while providing a uniform method for demonstrating stormwater technologies and developing Test Quality Assurance (QA) Plans. As a result of these efforts there will be an increase in expertise for assessment of stormwater technology performance and a reduction decision-making timeframes for technology implementation.

For more information on TARP and to download a copy of the TARP Protocol for Stormwater Best Management Practice Demonstrations, please visit: [http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/](http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/).
Instructor Biographies:

**Nancy Baker** is an environmental analyst in the Massachusetts Department of Environmental Protection, Northeast Regional Office, where she provides oversight and commentary on stormwater issues and coordinates the region’s reviews of development projects that require permits from the Department. Nancy has chaired the Technology Acceptance Reciprocity Partnership Stormwater Work Group since its inception in 1999 and has assisted with the Massachusetts Strategic Envirotechnology Partnership (STEP) evaluation of stormwater technologies, including the preparation of fact sheets, which complement the STEP verification reports.

Previously, Nancy supervised the Department’s staff in Outreach Services, which produced publications and training materials, including the Massachusetts Stormwater Management Handbooks. She formerly was an analyst with the Massachusetts DEP Drinking Water Program and the Massachusetts Environmental Policy Act (MEPA) Unit in the Executive Office of Environmental Affairs. Nancy has a B.S. degree in biology, an M.S. degree in marine biology, and enjoys landscape gardening and gourmet cooking.

**Eric Winkler, Ph.D.** is Director of Technical Services in the Center for Energy Efficiency and Renewable Energy (CEERE) at the University of Massachusetts Amherst. He is primarily responsible for outreach and technical support services on energy and environmental systems to public and private sector clients. He is also Director of the Massachusetts Energy Efficiency Partnership leading state and region wide initiatives with industry, public utilities and state agencies on energy and resource conservation. Dr. Winkler is part of the implementation team for two other DOE funded programs at CEERE, the Industrial Assessment Center and the Northeast CHP Application Center.

Dr. Winkler also directs a university based research and development program for innovative energy and environmental technologies. He was technical lead for the Massachusetts Executive Office of Environmental Affairs/UMass Strategic Envirotechnology Partnership focusing on technology validation of environmental and energy technologies. Dr. Winkler has served on state and federal environmental advisory review panels, including the MA DEP Storm Water Advisory Panel and the EPA ETV Washington DOT Project Review Panel. Dr. Winkler has been Principal Investigator on a number of US EPA S319 projects, most recently leading a project to develop a clearing house of information on proprietary stormwater technologies and a prioritization process for investment in technology demonstrations and testing. He has published numerous reports and journal articles on innovative wastewater and stormwater technologies. Dr. Winkler received his Doctorate in Environmental Chemistry from the University of Massachusetts Amherst in 1995 and holds Masters Degrees in Public Health and Soil Science.
Meet the Sponsors

TARP Stormwater Work Group

- California
- Maryland
- Massachusetts
- New Jersey
- Pennsylvania
- Virginia

State of Washington, Illinois, New York, and ETV are collaborating with TARP

No associated notes. For more information on TARP and to download a copy of the TARP Protocol for Stormwater Best Management Practice Demonstrations, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
Goals of TARP Stormwater Work Group

► Use protocol to test new BMPs
► Approve effective new stormwater BMPs
► Get credible data on BMP effectiveness
► Share information and data
► Increase expertise on new BMPs
► Use protocol for appropriate state initiatives

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

- Build TARP states’ capacity for use of protocol
- Expedite states’ approval times for tested BMPs
- Promote technology effectiveness testing
- Assure success for TARP reciprocity
- Attract new states to join TARP

Nancy:
Protocol is accessible in the links page at the end of the training course at no cost.
### Value of Protocol and Training

<table>
<thead>
<tr>
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<tr>
<td>Designed to get credible data</td>
<td>Learn to recognize good data</td>
</tr>
<tr>
<td>Predictable process</td>
<td>Consistency among states</td>
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<td>Rigorous</td>
<td>Build confidence and support for reciprocity</td>
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<td>Flexible</td>
<td>States can meet specific needs</td>
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Evaluating Stormwater Technology Performance

**Learning Objectives**
- Use the TARP Stormwater Demonstration Protocol to review a test plan and a technology evaluation
- Recognize data gaps and deficiencies
- Develop, implement, and review a test plan
- Understand, evaluate, and use statistical methods

**Logistical Reminders**
- Phone audience
  - Keep phone on mute
  - * 6 to mute your phone and again to un-mute
  - Do NOT put call on hold
- Simulcast audience
  - Use ❓ at top of each slide to submit questions
- Course time = 2 hours
- 2 question & answer periods
- Links to additional resources
- Your feedback

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Module I: Planning for A Stormwater BMP Demonstration

1. Factors Affecting Stormwater Sampling
2. Data Quality Objectives and the Test QA Plan

Module II: Collecting and Analyzing Stormwater BMP Data

3. Sampling Design
4. Statistical Analyses
5. Data Adequacy: Case Study

No associated notes. For more information on TARP and to download a copy of the TARP Protocol for Stormwater Best Management Practice Demonstrations, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
1. Factors Affecting Stormwater Sampling

- Rainfall and pollutants
- Sampling challenges
- Site-related issues
- Solids sampling
- Particle size issues
- Technology design limits

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Inherent variability in rainfall characteristics create unique challenges to understanding generalized performance of BMPs
Rainfall Variability

- To understand the full capabilities of a technology, a range of storms must be considered, including:
  - Common and extreme events
  - Seasonal variation
  - Regional variation

• Extreme events may provide useful information.
• However, sampling all extreme events, for example 2 years and up, may not be practical physically or financially feasible.
• Maximum event depth for sampling varies regionally.
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*Summer includes June, July, August and September

**Interval between rainfall midpoints

- There are significant variations in rainfall in the different regions of the United States.
- Each State may opt to utilize a different standard for representative rainfall event depth and number of events based on practical limitations for implementation of a qualified test plan.
- For example, the southwest region may not be able to sample as many events during a test duration due to rainfall inter event periods.
- In addition, sample size and flow weighted compositing (sample volume or flow through volume per unit time of event) may vary regionally.
Storms less than 1.5 inches make up 97% of rainfall events – Boston, MA 1920-1999.
Graph illustrates that storms less than 1.5 inches constitute 80% of rainfall data, for Boston region.
Rainfall Volume

- Sampling scheme varies based on the rainfall conditions, including volume, duration and intensity
- Need to consider minimum rainfall depth to ensure that washoff occurs (e.g., storms less than 0.1” of total depth may not produce certain pollutants in influent) and pollutants that may be low in concentration
- Consider issues around volume based regulatory criteria and flow rate based performance

• What is the importance of a <0.1” storm if drainage area is small and impervious area is large (i.e. urban land use)?
• Consider the ability to evaluate pollutants in runoff when concentrations are low. Need to size sample volumes based on flows.
Rainfall Volume
Sampling the “Right” Amount of Runoff

- Pollutant load decreases as storm lengthens
- Relation between loading and site stability (construction zones)
- As load decreases with storm duration, most load is associated with rainfall volume occurring during the beginning of the storm “First Flush”
- Volume is important, but intensity may be a better measure of system performance as flow rate is affected

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Rainfall Intensity and Duration

► Rainfall intensity and duration varies greatly from storm to storm and regionally
  ▪ With the majority of rainfall events less than 1.5” in depth, the range in storm duration dictates the average intensity of the storm
  ▪ It is critical to sample a range of storm intensities rather then a range of storm durations

Regional differences are important.
Average storm depth in the NE and SW are not too different, but in the SW the storm duration is 3 times longer.
Intensity, inter-event periods and pollutant buildup will vary regionally.
Graph illustrates frequency of rainfall intensity.
Sampling design should account for capturing representative sample over the range of intensities.
A large percentage (>90 of storm events) comprise a subset of the range of intensities.
This means that the full capacity of the treatment technology, if its treatment capability is strongly flow rate dependent, may not be tested in a limited set of storms.
Hydrographs Characterize Rainfall Runoff
Pattern and Sampling Adequacy

• Hydrographs are different for each storm, and clearly identify the most important time period for sampling.
• Maximum intensities identify key sampling regions, e.g. areas to sample include the rising limb, peak and falling limb of hydrograph.
• Second peak is not likely to contain significant pollutant load
• Hydrographs are determined by an instantaneous discharge minus some lag time, divided by watershed area (peak discharges represent a rough estimate for peak intensity).
• The falling limb of the Pollutograph may not follow the storm event hydrograph exactly.
• It is therefore important to sample the rising and falling limb and over a time period that adequately represents load.
• The slide illustrates that 95% of the cumulative load to the system and peak pollutant concentration occur early in the storm.
• In this case sampling beyond 2 hours yields little useful information.
• Other notable concern is variation in pollutant temporal issues.
Inter-Event Pollutant Issues

- Seasonal buildup and pollutant washoff, in relation to rainfall runoff, define a sampling window that should be considered.
- Seasonal buildup can vary greatly by region.
- Consider climatic conditions in arid and semi-arid regions.

- Seasonal buildup of pollutants, for example during the winter sanding season is likely to produce very different loads to the system.
- Know your site and be sure not to include base flow as event sampling.
- Considerations that take into account regional rainfall characteristics are tied to frequency and volume of rainfall events.
Sampling Approach for Storm Event Depth

Decision to sample up to a maximum rainfall depth is based on two competing factors:
- Cost of testing
- Desire to acquire representative sample set

The study designer does not have knowledge of the rainfall characteristics and load to the system prior to implementation.

Consider the following conditions:
- 97% of rainfall events are less than 1.5 inches, and
- 80% of pollutant loading is in the first 0.5 inch.

For some regions sampling up to 2 inches of the rainfall event is enough to represent the majority of load to the system.

However, it may not reflect the impacts that rainfall intensity or long duration storms have on overall performance.
Sample Composition

Want samples to reflect the load in all flow

- Sampling location is key
  - Avoid bed load sampling - sampling at the bottom of the collection or piping network
  - Ensure sample is mixed by sampling one or more locations along pipe cross section that best represent all of the flow
  - Potential bias in performance efficiency

- Pollutant specific sampling techniques
  - Solids sampling may be affected by inlet velocity of sampling equipment

• Bed load does not reflect incoming pollutant load. However, if bed load in the treatment unit is resuspended you want to sample that in the outlet.
• Sampler placement should be considered to avoid bed load and reflect overall rainfall load.
• Sampling in turbulent parts of treatment train can ensure mixed sample.
• Understand limitations of sampling devices and potential to miss parts of pollutant load (e.g. large particles moving quickly past a sample tube with low velocity inlet flow).
Considerations - Nature of Pollutants

- Seasonal variations - sand/salt used during winter months greatly increases pollutant levels during winter and spring snow melt
- Rainfall variations - loading rates (concentration) vary with storm intensity and duration
- Site specific - nature of impervious area and land uses
- Tidal influences

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Seasonal Variation of Pollutant Load

Annual variations of street accumulation of particulate pollutants in snowbelt urban areas (Data from Wisconsin Department of Natural Resources)

Sand/salt used during winter months greatly increases particulate pollutants in snowbelt urban areas.
Sample Heterogeneity

- Comparisons between sites are difficult due to variations in load characteristics and design parameters.
- Inability to replicate sample event conditions (e.g., flow, concentration, bed load) introduces error variance that cannot be quantified.

• Site to site comparisons are complicated by the fact that individual tests result in a single efficiency value.
• Replication of all parameters of an event is difficult, including: pollutant load, bed load, and event hydraulic conditions.
• Question: do we ever arrive at an event efficiency value with a variance?
Site-related Issues

▶ Land use
  ▪ Amount of impervious area, roads, parking lots, rooftops
  ▪ Rural vs. urban
  ▪ Stabilized vs. construction
  ▪ Topography, soils

▶ Other BMPs
  ▪ Catch basins
  ▪ Street sweeping
  ▪ Sand vs. CaCO$_3$ or CaCl$_2$

Generally as part of understanding the behavior of a particular system, other related site conditions, practices, and structural controls should be considered.
## Typical Pollutant Loading from Runoff Urban Land Use

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<tr>
<th>Land Use</th>
<th>TSS</th>
<th>TP</th>
<th>TKN</th>
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<th>NO₂+NO₃-N</th>
<th>BOD</th>
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<td>NA</td>
<td>NA</td>
<td>2</td>
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<td>NA</td>
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Concentration in mg/L, Data from Nationwide Urban Runoff Program, USGS

*Data from NURP study does not include pathogens.*

*Bacterial concentrations vary greatly in concentration and can vary in types, e.g. Fecal Coliform, F. Streptococci, depending on setting.*
### Site Information

Information that assists in comparability among sites

- Site drainage area
- Percent impervious area
- Percent area directly connected to BMP
- Path of stormwater flow to BMP
- Type of activities conducted
- Pollutant sources
- Percent stabilized vs. disturbed
- Drainage area inflow/outflow points
- Geological and hydrological conditions
- Soil type
- Existing control structures
- Site Drainage Plan

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Solids Sampling Issues

- Total Suspended Solids (TSS) method becomes less accurate when sand-size particles exceed 25% of the sample mass
- USGS considers TSS data for open channel flow not appropriate
- It is recommended that both TSS and Suspended Sediment Concentration (SSC) be considered due to potential bias in TSS tests
- Sampling both TSS and SSC highlights importance of particle size distributions (PSD) and the ability of BMPs to treat solids
- Sample size can affect concentration measures and representative sample

What factors can influence the relevance of either TSS or SSC analysis?
When is it most crucial to consider both?
USGS study comparing TSS and SSC values suggest that TSS is inappropriate for stormwater analysis
Some states have interest in particle size ranges.
Reference: 1) (Gray et. al. 2000)
Reference: 2) (USGS, 2001)
Particle Size Issues

- Removal efficiencies can vary greatly with particle size distribution (PSD)
- Poorly graded solids scheme can exaggerate performance claims
- Well-graded distributions present the most accurate performance data
- Sample volume must be considered in order to collect for PSD

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### Example of Representative PSD

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<td>2 (150-250 mm)</td>
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<td>4 (75-100 mm)</td>
<td>9%</td>
<td>1.53</td>
</tr>
<tr>
<td>5 (63-75 mm)</td>
<td>4%</td>
<td>0.68</td>
</tr>
<tr>
<td>6 (&lt;63 mm)</td>
<td>42%</td>
<td>7.14</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100%</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

Example PSD from laboratory test study on proprietary technology.
The illustration does not reflect mass removal of sediment by particle size only relative percents of size fractions.

It is possible that this system is effective at removing a large percentage of TSS, provided the distribution is skewed towards particles greater than 60 µm.
Particle Size Distribution Analysis

PSD Methods (USGS 2001)
- Dry / wet sieve
- Coulter counter
- Pipette method
- Laser diffraction spectroscopy
- Visual accumulation tube (VA)
- Bottom withdrawal tube
- Microscopy
- Sedigraph (x-ray sedimentation)
- Brinkman particle size analyzer
- Light-based image analysis

There are numerous methods proposed for PSD.
Method choice is dependent on sensitivity and detail requirements.
It is important to be sure to report particle size in standard nomenclature, e.g. ASTM, AASHTO, USDA.
Issues Around TSS Removal Rates - Irreducible Concentrations

- 80% TSS mass load reduction standard from the Coastal Zone Act Reauthorization Amendments of 1990 for all storms less than the 2-year event
- BMPs may fail to meet this standard, such as constructed wetlands, wet ponds, infiltration basins and trenches, grass swales, filter strips, and innovative systems
- Removal efficiencies have been directly related to the influent concentration - the higher the influent concentration, greater the removal rate
- Conversely, low concentration of solids in sediment cannot be reduced, hence the concept of “irreducible” effluent concentration limit proposed by Schueler (1996)

No associated notes. For more information on TARP and to download a copy of the TARP Protocol for Stormwater Best Management Practice Demonstrations, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
TSS: Implications for Performance Testing

- Comparisons of tests between regions based on “a removal rate” may not be valid because influent concentrations will vary
- Consider expected or required efficiency related to the concentration of TSS in the influent
- Consider comparison of data from different sites with varying influent concentrations and distributions (solids)

No associated notes. For more information on TARP and to download a copy of the *TARP Protocol for Stormwater Best Management Practice Demonstrations*, please visit: [http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/](http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/).
Evaluating TSS Removal Rates Based on Concentration

Figure illustrates wide variation in performance at low TSS concentration. Performance based on SSC concentration may have similar characteristic. These data do not illustrate efficiency based on PSD. Data including SSC may be better at approximating such a factor since it may be more representative of actual solids. In either case efficiency increases with concentration.
TARP Water Quality Parameters

- Consider
  - Permit requirements
  - Land uses in the catchment area – helpful to compile a list of common pollutants associated with a given land use
  - Existing monitoring data – use discretion when there is uncertainty about the previous methods and/or data quality

- At a minimum, analyze
  - Total suspended solids (TSS)
  - Suspended sediment concentration (SSC)
  - Other parameters to support performance claims

As the states and federal agencies develop new standards or change existing standards other sample constituents may be required for testing.
Questions and Answers

No associated notes. For more information on TARP and to download a copy of the *TARP Protocol for Stormwater Best Management Practice Demonstrations*, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
Module I: Planning for A Stormwater BMP Demonstration

1. Factors Affecting Stormwater Sampling
2. Data Quality Objectives and the Test QA Plan

Module II: Collecting and Analyzing Stormwater BMP Data

3. Sampling Design
4. Statistical Analyses
5. Data Adequacy: Case Study

No associated notes. For more information on TARP and to download a copy of the TARP Protocol for Stormwater Best Management Practice Demonstrations, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
2. Data Quality Objectives and Test QA Plan

- Understanding the DQO process
- The test QA plan scope
- Test QA plan contents
- Quality assurance project plan review

No associated notes. For more information on TARP and to download a copy of the *TARP Protocol for Stormwater Best Management Practice Demonstrations*, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
### Quality Management

<table>
<thead>
<tr>
<th>Data Life Cycle</th>
<th>Quality System Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning</td>
<td>Data Quality Objectives (DQOs)</td>
</tr>
<tr>
<td></td>
<td>Quality Assurance Project Plans (QAPPs)</td>
</tr>
<tr>
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<td>Standard Operating Procedures (SOPs)</td>
</tr>
<tr>
<td>Implementation</td>
<td>QAPPs</td>
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<tr>
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<td>SOPs</td>
</tr>
<tr>
<td></td>
<td>Data collection</td>
</tr>
<tr>
<td></td>
<td>Assessments and audits</td>
</tr>
<tr>
<td>Assessment</td>
<td>Data validation and verification</td>
</tr>
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<td>Data Quality Assessment (DQA)</td>
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</table>

No associated notes. For more information on TARP and to download a copy of the *TARP Protocol for Stormwater Best Management Practice Demonstrations*, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
Quality Assurance/Quality Control

- The **goal of quality assurance and quality control (QA/QC)** is to identify and implement sampling and analytical methodologies which limit the introduction of error into analytical data.

- **Quality Assurance (QA)** - an integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.

- **Quality Control (QC)** - the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality.

No associated notes. For more information on TARP and to download a copy of the *TARP Protocol for Stormwater Best Management Practice Demonstrations*, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
Understanding the Data Quality Objectives Process

- Determine the type, quality, and quantity of data needed to support BMP validity and review
- Provide the framework for a Test Plan, relating the goal of the demonstration, the most appropriate conditions to collect data and data types, and the rationale behind gaining approval

No associated notes. For more information on TARP and to download a copy of the TARP Protocol for Stormwater Best Management Practice Demonstrations, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
Elements of Test Plan Scope

- Identification of the members of the planning team
- Definition of each member’s role and responsibility as well as the primary decision maker
- Development of a concise problem description
- Specification of available resources and deadlines
- Previous studies and their outcomes
- Stakeholder issues surrounding the study
- Identification of test objectives
- Use of standardized test methods and procedures
- A data quality assurance and control plan
- Statistical testing of the data

Scope ensures “that the procedures for collecting, handling, and analyzing samples and data will be accurate, precise, representative, complete, and comparable.” – TARP Protocol Section II.E.
Test Plan Preparation for Protocol Developers
(Section 2, TARP Protocol)

- Research and comparison of current stormwater BMP developments
- Required financial assistance if necessary
- The availability and adequacy of pre-existing lab and/or field studies to support claims
- An understanding of the test plan and field demonstration review process (flowchart)

No associated notes. For more information on TARP and to download a copy of the TARP Protocol for Stormwater Best Management Practice Demonstrations, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
Validation Criteria for BMP Screening
(Section 2.2, TARP Protocol)

- Environmental benefits
- Commercial availability
- Adequate field testing
- Quality control
- Specification descriptions
- Performance claim
- Maintenance requirements

No associated notes. For more information on TARP and to download a copy of the
TARP Protocol for Stormwater Best Management Practice Demonstrations,
please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
Required Technology Specifications

(Section 2.3, TARP Protocol)

- Physical, chemical, and biological processes
- Operation and maintenance requirements
- Process flow diagrams and algorithms
- Equipment drawings and specs
- Existing test plans
- Performance data
- Other certifications
- Maintenance issues

No associated notes. For more information on TARP and to download a copy of the TARP Protocol for Stormwater Best Management Practice Demonstrations, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
Technology Performance Claims
(Section 2.4, TARP Protocol)

► Identify the intended use of the technology
► Predict capabilities to remove pollutants or control runoff quantity and quality
► Be objective, quantifiable, replicable, and defensible
► Be realistic – not overstated

Who sets the performance criteria? Should regulators see this in the test plan?
States should share test plans, when possible, prior to implementation, to allow for reciprocity consideration.

This process may allow for differences and exceptions between states.
Required Contents of the TARP Test QA Plan
(Section 3, TARP Protocol)

- Standardized test methods and procedures
- Data quality assurance project plan (QAPP)
- Stormwater data collection guidance
- Statistical testing of data and data reduction
- Health and safety plan
- Cost information

No associated notes. For more information on TARP and to download a copy of the *TARP Protocol for Stormwater Best Management Practice Demonstrations*, please visit: [http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/](http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/).
Quality Assurance Project Planning QAPP

1. Project management
2. Data generation and acquisition
3. Assessment and oversight
4. Data validation and usability

No associated notes. For more information on TARP and to download a copy of the TARP Protocol for Stormwater Best Management Practice Demonstrations, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
Project Management

- This QAPP section should indicate proper management of the entire project
- That the project has a defined goal
- That the study participants understand the goals and the approach to be used
- That the planning outputs have been defined

No associated notes. For more information on TARP and to download a copy of the *TARP Protocol for Stormwater Best Management Practice Demonstrations*, please visit: [http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/](http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/).
Specific Elements for Project Management

1. Title and approval sheet
2. Table of contents and document control format
3. Distribution list
4. Project/task organization schedule
5. Problem definition/background
6. Project/task description
7. Quality objectives and criteria for measurement data
8. Special training requirements/certification
9. Documentation and records

This is an itemized list of the major elements of the QAPP
Data Generation and Acquisition for the QAPP

- Appropriate methods for sampling, measurement and analysis
- Data collection and storage
- Data handling and custody
- Documented QC activities

No associated notes. For more information on TARP and to download a copy of the TARP Protocol for Stormwater Best Management Practice Demonstrations, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
Detail of Data Generation and Acquisition Requirements

1. Sampling process design (experimental design)
2. Sampling method requirements
3. Sample handling and custody requirements
4. Analytical methods requirements
5. Quality control requirements
6. Instrument/equipment testing, inspection, and maintenance requirements
7. Instrument calibration and frequency
8. Inspection/acceptance requirements for supplies and consumables
9. Data acquisition requirements (non-direct measurements)
10. Data management

These are the key elements of a QAPP.
Project Management Considerations
Assessment and Oversight

- QAPP should address the management activities for assessing the effectiveness of project
- Implementation and associated QA/QC activities
- Vendors and regulators should ensure that the QAPP is implemented as prescribed (assessments and response actions, reports to management)

Following what is specified in the QAPP can ensure that data meets the objectives of the test design and further ensures that data quality meets the standards established by the TARP protocol.
Data Validation and Usability

- Assuring the quality of the data collected
- Determining conformity of the data to specified criteria
- Ensure data reconciles with project objectives
  - Data review, validation, and verification methods
  - Reconciliation and DQOs

No associated notes. For more information on TARP and to download a copy of the *TARP Protocol for Stormwater Best Management Practice Demonstrations*, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
**SUMMARY: Stormwater Factors**

- Environmental and engineering factors profoundly influence the test plan design for sampling a stormwater technology.
- Developing and reviewing a test plan requires an understanding of complex weather and site conditions, properties and load variability of pollutants, and desired test criteria.
- Knowledge of testing goals, water quality parameters, and testing capabilities can assist in producing credible data which satisfies local, state and federal requirements.

No associated notes. For more information on TARP and to download a copy of the *TARP Protocol for Stormwater Best Management Practice Demonstrations*, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
**SUMMARY: Data Quality Objectives**

- Adoption of a testing protocol with standard testing methods provides consistency and limits bias in technology demonstrations.
- QA/QC process is well documented. Use of standard quality management techniques provides assurance of data quality for regulatory compliance.
- Ensuring that quality management is adhered to reduces uncertainty through data quality control, laboratory control and reporting analysis; and can reduce overall cost for testing.

No associated notes. For more information on TARP and to download a copy of the *TARP Protocol for Stormwater Best Management Practice Demonstrations*, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
Preview: Module II

- Using knowledge of environmental and engineering factors to develop and evaluate a sampling plan for a stormwater BMP
- Application of QA/QC to sampling and lab testing of the desired pollutant parameters
- Working with stormwater data and statistical analyses
- Case Study – Diagnosing, analyzing and addressing problems with stormwater demonstration test plans

No associated notes. For more information on TARP and to download a copy of the TARP Protocol for Stormwater Best Management Practice Demonstrations, please visit: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/.
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Evaluating Stormwater Technology Performance

Links to Additional Resources

TARP: http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/

For more information on TARP go to:
http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/

For links to additional resources for this presentation go to: http://www.clu-in.org/conf/tarp/stormwater/resource.cfm