# Massachusetts Stormwater Technology Evaluation Project

**Interdepartmental Service Agreement number BRP 2003-02**
**Massachusetts Department of Environmental Protection and**
**University of Massachusetts Amherst**

**Final Project Report**

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## Introduction

Municipalities in Massachusetts are becoming the first line of defense against nonpoint source pollution. To address this ubiquitous environmental problem, communities need cost-effective stormwater pollution control measures that can treat a range of environmental pollutants, including nutrients, pathogens, organic contaminants, and sediment. Municipal officials are also looking for ways to preserve land for other municipal purposes and improve the quality of their environmental resources through open space preservation. Stormwater best management practices (BMPs) that can effectively treat stormwater runoff with limited land area requirements are highly sought after by communities because the technologies support both of these goals.

In April 2004 The Massachusetts Department of Environmental Protection (Mass DEP) contracted with the University of Massachusetts Center for Energy Efficiency and Renewable Energy (CEERE) to provide technology transfer information about innovative stormwater BMPs to Mass DEP, conservation commissions, local officials, and other BMP Users. The Massachusetts Stormwater Technology Evaluation Project was initiated to develop a validated source of technical information on stormwater BMPs, providing end users with qualified information to make appropriate technology implementation decisions. The goal was to assist communities to maximize environmental benefits of grant programs by focusing efforts on technologies that have the most promising potential to reach specific water quality objectives. By increasing the availability of independently verified information specifically related to design requirements and pollutant removal efficiencies the project was intended to lead to more informed decision-making at the local level.

This report describes and evaluates the activities and accomplishments of the Massachusetts Stormwater Technology Evaluation Project conducted by the University of Massachusetts in collaboration with the Department of Environmental Protection. The tasks and deliverables listed are those described in the project scope of work. Included in this report are a number of appendices which extensively detail actual work product related to survey data and results, web based information and analysis and metrics. Reference to the web site (www.mastep.net) is made throughout the report and is the live version of the primary work product for this project. This report does include print versions of the web site. However, it is recommended that the electronic version be referenced to fully appreciate the final product.

This final report summarizes the work completed through June 2006. At the time of submitting this report, the site remains live and is managed by UMass Amherst. On-going support for the site is dependant upon continued funding which has been requested by the University.

## Project Timeline

The Project start date was May 1, 2004. The general project tasks and timeline are listed below.

1. Develop and Promote a Web-Based Technology Transfer Clearinghouse for Innovative Stormwater Technologies
2. Perform a Critical Assessment of Stormwater Technology Development Needs
3. Identify and Assess Available Information on Stormwater Best Management Practices (BMPs)
4. Develop metrics and evaluate project.
5. Project reporting.

| Project Schedule | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Task Description** | | Duration (Months) | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| **1** | **Develop and Promote a Web-Based Technology Transfer Clearinghouse for Innovative Stormwater Technologies** | | | | | | | | | | | | | | | | | | | | | | | | |
| A | Construct and update website | | | | | | | | | | | | | | | | | | | | | | | | |
| B | Conference presentations | | | | | | | | | | | | | | | | | | | | | | | | |
| C | DEP briefing | | | | | | | | | | | | | | | | | | | | | | | | |
| **2** | **Perform a Critical Assessment of Stormwater Technology Development Needs** | | | | | | | | | | | | | | | | | | | | | | | | |
| A | Engage User and DEP group | | | | | | | | | | | | | | | | | | | | | | | | |
| B | Develop needs survey | | | | | | | | | | | | | | | | | | | | | | | | |
| C | Survey User and DEP group | | | | | | | | | | | | | | | | | | | | | | | | |
| **3** | **Identify and Assess Available Information on Stormwater Best Management Practices (BMPs)** | | | | | | | | | | | | | | | | | | | | | | | | |
| A | Compile list of technology vendors | | | | | | | | | | | | | | | | | | | | | | | | |
| B | Develop technical screening tool | | | | | | | | | | | | | | | | | | | | | | | | |
| C | Develop cost-benefit tool | | | | | | | | | | | | | | | | | | | | | | | | |
| D | Screen technologies | | | | | | | | | | | | | | | | | | | | | | | | |
| E | Develop documentation for Category 1 technologies | | | | | | | | | | | | | | | | | | | | | | | | |
| F | Track Category 2 Technologies | | | | | | | | | | | | | | | | | | | | | | | | |
| G | Prioritize Category 3 technologies | | | | | | | | | | | | | | | | | | | | | | | | |
| **4** | **Develop Metrics and Evaluate Project** | | | | | | | | | | | | | | | | | | | | | | | | |
| A | Develop assessment criteria and survey users | | | | | | | | | | | | | | | | | | | | | | | | |
| B | Develop web-based survey | | | | | | | | | | | | | | | | | | | | | | | | |
| C | Collect and compile data | | | | | | | | | | | | | | | | | | | | | | | | |
| **5** | **Project Reporting** | | | | | | | | | | | | | | | | | | | | | | | | |
| A | Prepare quarterly reports | | | | | | | | | | | | | | | | | | | | | | | | |
| B | Prepare draft project report | | | | | | | | | | | | | | | | | | | | | | | | |
| C | Prepare final project report | | | | | | | | | | | | | | | | | | | | | | | | |

## Project Deliverables

### *Task 1: Develop, Maintain and Promote a Web-Based Technology Transfer Clearinghouse for Innovative Stormwater Technologies and Provide Technology Transfer to the Public through an Organized Distribution Plan*

***Deliverable 1A:*** *Construct and Update Website, A searchable website containing the project deliverables to facilitate technology transfer.*

During the initial quarter of the project it was determined that a database driven website was the optimal structure for the project deliverable. A number of database/hypertext markup language (HTML) structures were analyzed to determine the most cost effective and efficient method given that the database was to be designed and constructed to support a web based information resource on stormwater technologies. The design of the MASTEP web site (www.mastep.net) and collecting and compiling material to be presented on the site was conducted through a collaborative process with project partners including Mass DEP and EOEA staff as well as private sector stakeholder groups. The database structure

and web site design were in part based on input received from a user needs survey developed under Task 2. The mastep.net web site became operational in March 2005.

The database was initially designed in Microsoft Access and then converted to Microsoft SQL database. MSSQL was utilized since it has a robust management studio suite and is easily supported by multiple html based database querying tools including ASP, PHP and CF. Ultimately, the web site HTML was built using Macromedia ColdFusion programming language which is robust, well supported by its developers and is well integrated with website management software such as Macromedia Dreamweaver. Although MS SQL, ColdFusion Server, and Dreamweaver are not open source software packages (free) it was determined that proprietary software was the best option for managing the project. The database and web site are hosted on a Dedicated Dell Pentium 4 server physically located in the Department of Mechanical and Industrial Engineering in the College of Engineering at the University of Massachusetts - Amherst. The server has standard levels of hardware protection, data backup, and security. It is in a secure location on campus and is protected from internet attacks.

The web site is organized into five sections:

- Project Information – project history, sponsor information, guidance on site navigation and on interpreting BMP information contained on the site.
- Stormwater Library – downloadable documents and presentations containing background information on nonpoint pollution, stormwater management and policy, best management practices, and a glossary.
- The Database – vendor, product and performance information for innovative stormwater BMPs, a data entry utility for product vendors and/or Project staff to enter information for the BMPs, a map of Massachusetts installations of technologies, and documentation of the database.
- External Links to stormwater and Low Impact Development sites maintained by EOEA, other government agencies, academic institutions, stormwater testing and educational institutions, nonprofit organizations, etc.
- Contact Information for project staff and Feedback Form.

A representative sample of documents found on the site is enclosed with this report.

***Data Entry Process***

A key component of the project information structure includes a rapid process for collecting data to be evaluated. This was accomplished by developing a web based data entry screening tool (DEST). The data entry screening tool, accessed from The Database menu, allows site users, including: project staff or individuals who are granted data entry rights by the site administrator (product vendors, independent testing agencies) to create and update technology profiles. Once data is entered, project staff screen and evaluate the data, make appropriate changes, and translate the data to a display profile that is posted on the web site. Project staff also reviewed studies either provided by product manufacturers or obtained through research that project staff conducted. These data were then posted on the web site and used to create performance evaluation information as described below. The final decision on all information listed about a product rests with MASTEP and where input from project partners was required, that was solicited.

To develop the data entry screening tool, project staff first identified the information that was to be displayed on the web site – see task 2 for a description of that process – then organized the desired information into sections approximating the eventual display profiles for individual technologies. This information was then reformatted into a series of questions that would be asked of anyone filling out a technology profile. A draft data entry tool was vetted with EOEA and Mass DEP and several

representatives of technology providers and one individual with extensive experience evaluating technologies. Once the project staff analyzed input from the aforementioned and based on a number of iterations including further feedback from Mass DEP and EOEA, the draft tool was modified and translated into HTML and ColdFusion coded pages, which allows data entry to occur via the project web site.

Project staff initially anticipated that a large percentage of technology profiles would be entered by product manufacturers or vendors using the DEST, with a lesser number originating from independent testing agencies or Project staff. However, as of this writing, no profiles have been created by testing agencies, approximately half a dozen were created by vendors, and a majority of the technology profiles were generated by project staff. Although the DEST is a useful and comprehensive tool for data collection, project staff expended more effort in data entry than was anticipated. A potential issue related to project staff data entry is missing information specifically related to product specifications, costs, and site considerations. Project staff were required to interpret information provided in manufacturers' brochures, web sites, and third party test reports. These information sources do not always covers details required for the MASTEP technology profile. In all cases where project staff entered data, the product manufacturers / vendors were contacted after profiles were created and requested to recommend changes. This procedure worked satisfactorily in several instances where manufacturers provided supporting information to strengthen the technology profile. In some cases, manufacturers did not reply to project staff requests and the data was posted as originally entered by project staff.

***Database General Sections***

The stormwater database currently lists thirty-two technologies. The database is sortable by several search methods – e.g. by BMP type, product name, vendor, technology rating category, etc. Summary information is provided for each technology, as is more detailed information organized into five sections:

1) **General description of the product**. Type of BMP, pollutants addressed, applications for which the product is designed, and suitability for new or retrofit installations.

2) **Cost.** This information is presented according to any of three methods: cost per unit, cost per CFS, and cost per pound of pollutant treated. Cost information is provided for installation and maintenance costs. To date, it has proved somewhat difficult to supply adequate, accurate and up to date information for this section. In most cases, vendors have been reluctant to provide this information directly. Some cost information has been provided by 3rd party studies. However, several factors contribute to both the general scarcity of information and limited utility of information supplied either by vendors or via third parties. Many technologies come in multiple models and configurations, and/or are scaleable in size, making it difficult to specify costs with any degree of accuracy. For performance-related costs, the wide range of performance efficiency under different flow and pollutant loading conditions, as well as the uncertainty of performance claims (discussed in the performance section) introduce a great deal of imprecision in either average or high/low cost estimates. Installation and maintenance costs are similarly highly variable according to prevailing labor costs in different locations, site constraints, etc. Finally, all cost information is subject to inflation, rendering it out of date in short order. Much of the cost information that has been provided comes without a date. In summary, it is difficult to meaningfully adjust cost estimates to date- or site-specific needs of a give web site user.

3) **Design Considerations**. This describes installation and maintenance requirements, pre- and post-treatment requirements, sizing methodology, and specifications such as capacity flow, required depth to bedrock, load bearing capacity, etc. Many of the technology profiles created by Project staff have incomplete information in this section, due to lack of available information.

4) **Site and Environmental Consideration**. This describes suitable storm and soil types, any concerns over disposal of waste materials, vector control issues, etc. Again, this information is not always complete when Project staff had to glean it from brochures and web sites.

5) **Performance evaluation**. This section is the critical value added component of the database. It provides manufacturer-supplied pollution removal performance claims for each pollutant the system is designed to treat; results obtained from performance studies; and a quality of data rating system (1 = sufficient credible data to be able to evaluate pollution removal efficiency claims. 2 = promising studies are underway. 3 = insufficient credible data be able to evaluate claims. 0 = data review not yet conducted). For any studies reviewed, this section also contains a summary of the study and a link to a downloadable copy of the full study, if available. As of this writing, none of the technologies have achieved a category "1" rating, six are rated "2", and the remaining are category "3." This situation is discussed later in this document.

***Web Site Administration***

The site also contains an administrative section, open only to Project staff and others (e.g. DEP project manager) who are granted administrative status by the primary site administrator. This section allows administrators to perform a variety of site maintenance functions:

- Review information on registered members; name, address, email, and affiliation. Administrators can change status of any member and authorize that member to modify associated technology profiles.
- Review project status, including progress reports not viewable by the general public.
- Review and update technology profiles. This section is patterned after the Data Entry Screening Tool that is used to initiate technology profiles. Administrators can change any field entered in the original profile. There are also additional fields in sections II (Pollutants, Performance Claims) and VI (Performance Evaluation) for Project staff to add evaluation information (e.g. validated performance claims, quality of data category rating) to the profiles.
- Translate technology profiles into display profiles. Once a profile is completed, it is reformatted to appear as displayed on the public portion of the web site.
- Toggle display profiles on/off. This allows archiving of outdated display profiles, temporarily suspending display of profiles and overall management of displayed profiles.
- Copy profiles via the Manager function. This function is used to allow authorized data entry users to modify profiles that were created by others. It is used when a manufacturer wishes to update information on a profile initiated by Project staff. This functionality is only active once a data entry user has been granted permission by project staff and ensures that a valid authorized copy of the profile in maintained. In this process, a data entry user is issued a password authorizing updates to that profile. In this manner, if the updated profile contains unverified information, project staff can easily restore and redisplay information included in the copied profile.

***Website User Tracking***

The web site was originally designed to include a feature requiring site users to register and provide email and other information such as user category. This provided a means of characterizing site use and of surveying site users for feedback. Data has been collected on users for the project period to date. However, after receiving some comments by users and after a user email survey revealed some dissatisfaction with the registration feature. After consultation with project partners, Mass DEP and EOEA, the registration requirement was removed in May 2006. This change removes some ability to

track site use and user satisfaction. Individuals who wish to enter data (i.e. technology profiles) or to receive user surveys or progress updates on the web site are still required to register. As of the time of the removal of the general registration requirement, 313 user registrations were entered on the site. A complete listing of existing registered users is attached.

***Installation Tracking Functionality***

All features of the web site are functioning as designed. The technology installation map has limited data entries; despite several requests to vendors for installation, only two have yet replied affirmatively. Their information has been posted on the map. Of the other manufacturers queried, representative stated that it was against company policy to release such information. Others agreed to provide the information but have not yet produced it, and several did not respond. Project staff continue to request this information in communications with product representatives.

***Deliverable 1B:*** *Conference presentations, A report describing a minimum of six conference presentations at appropriate venues such as the annual meetings of the Massachusetts Association of Conservation Commissions, Massachusetts Municipal Association, Massachusetts Health Officers, NEIWPCC conferences, and Bay State Roads training sessions, including date, time location, attendance, presentation and handout materials, and a general report of audience feedback at each presentation.*

Technology Transfer was provided through a variety of means. MASTEP and EOEA staff distributed a description and the URL of the MASTEP site web to managers of other government, academic, corporate and nonprofit web sites for posting as a link from these MASTEP and DEP staff passed the word directly to colleagues and other stormwater professionals at meetings, conferences and other venues.

Eleven presentations on MASTEP were made at conferences and similar venues during the project period. A review of member registration file reveals the # of registrations that occurred around the time of these presentations. In some cases, the arbitrary 10 – day period consisted of the 10 days including and following the presentation. In other cases, where pre-conference communications described the site to prospective attendees, the 10-day period covered approximately 3 days before and 7 after the presentation. No attempt was made to filter any registrants from distant locations, nor to cross-reference with any surveys sent out by MASTEP, notices of MASTEP site in other publications, etc.

A listing of the presentations and site activity resulting from outreach are listed below:

1. February 22, 2005 eastern Massachusetts presentation to twenty-five consultants and engineers. *2 MASTEP website registrations w/in next 10 days*
2. March 23, 2005 Web seminar presented to EOEA and MassDEP employees, demonstrating web site. *13 MASTEP website registrations within 10 day period including prior 2 days (advance notice of demo sent to attendees).*.
3. June 14, 2005 Auburn presentation to 40-50 municipal officials, consultants and engineers. *18 MASTEP website registrations within 10 day period*
4. July 12, 2005 Boston presentation to 30 members of Low Impact Development working group and Coastal Zone Management stormwater advisory group. *6 MASTEP website registrations within 6 day period*
5. October 22, 2005 Amherst poster presentation at UMass Water Resources Research Center conference – direct contact with approximately 40 people during poster sessions; poster and handouts available to approximately 200 conference participants. *2 MASTEP website registrations within 10 day period*

6. November 17, 2005 Milford presentation to 20 engineers and municipal representatives. *14 MASTEP website registrations within 10 day period*
7. January 13, 2006 Boston presentation given at Massachusetts Municipal Association trade show. Direct contact with approximately 10 individuals during poster session, handouts available to over 600 trade show attendees. *6 MASTEP website registrations within 10 day period*
8. January 21, 2006 Worcester presentation to 25-30 lake associations, other nonprofit associations, government agency and municipal personnel at annual meeting of Congress of Lakes and Ponds. *9 MASTEP website registrations within 10 day period*
9. March 4, 2006 Worcester: DEP personnel exhibited MASTEP materials at Massachusetts Association of Conservation Commission annual conference and demonstrated the MASTEP web site during a conference presentation. *18 MASTEP website registrations within 10 day period (4 Conservation Commission officials registered day of/after conf.)*
10. April 11, 2006 Mansfield presentation to over 100 state agency, municipal, engineering personnel at stormwater forum hosted by Rinker Materials. *8 MASTEP website registrations within 10 day period*
11. April 18, Boxborough exhibit at Massachusetts Office of Technical Assistance Water Resources Conference. Direct contact with approximately 20 individuals, materials available to over 100 attendees. *9 MASTEP website registrations within 10 day period*

Power point slide show presentations were utilized for most presentations and distribution of a two-page handout describing the MASTEP web site was distributed at all presentations. A poster (approximately 3'x 4') describing the web site was used at several of the presentations. Several presentations are enclosed in the appendices.

Audience feedback was universally positive. As no evaluation forms were passed out for these presentations, feedback was given orally. The most common comment was that there is a need for this type of objective, user-friendly description of BMP technologies and related performance analyses. In-depth feedback was not expected from these presentations, because attendees would not have actually used the site themselves, other than a quick run-through some may have done during poster sessions. More involved feedback was obtained through user surveys, discussed later in this document.

In addition to the above-mentioned presentations, the site was promoted during two 2-hour Internet-based trainings (May 2004) hosted by US EPA and ECOS to 200 professionals from more than 35 states across the nation. The training covered the details for developing stormwater technology evaluations suitable for submission to the database.

***Deliverable 1C**: Technical briefings to MADEP on evaluated technologies, one to two briefings of two hours each.*

The above-mentioned March 23 2005 presentation to agency staff group served as a technical briefing on evaluated technologies. The July 12 2005 presentation to agency staff and LID working group served a similar function.

## Task 2: Perform a Critical Assessment of Stormwater Technology User Needs and Demonstration Needs

***Deliverable 2A, 2B, 2C**: Engage User and Mass DEP group, Develop needs survey, Survey user and Mass DEP groups.*

Project staff developed a user needs survey in consultation with Mass DEP and EOEA. The survey was delivered by email to 30 individuals representing the stormwater BMP industry, federal and Massachusetts environmental agency personnel, conservation commissioners, and municipal health

departments. Fourteen responses were received – most by email. Additional comments were also collected through phone conversations. In addition to the survey, project staff reviewed other web sites and stormwater management documents. Other related databases that were identified included: the International Stormwater Best Management Practices Database (http://www.bmpdatabase.org/ ), the US EPA Stormwater Program web site (http://cfpub.epa.gov/npdes/home.cfm?program_id=6) and the MA DEP and Coastal Zone Management Stormwater Management Handbook (http://www.mass.gov/dep/water/laws/swmpolv1.pdf ). Project staff relied particularly on the Handbook when categorizing BMP types and in developing the glossary for the web site. All of these sources were used to construct a weighted list of preferred data elements and navigational features. This analysis was then used to construct the database as described in the Task 1 report section. The needs survey, a list of survey recipients and respondents, and a summary of user responses are all included in the appendices accompanying this report.

**Task 3: Identify, Assess, and Prioritize Available Information on Stormwater BMPs.**

***Deliverable 3A**: A comprehensive list of stormwater BMPs, updated annually for the term of the project.*

Project staff received a list of prospective stormwater technologies from Mass DEP staff and EOEA – at project start. This list was undated and provided to the project staff again in late 2005. The updated list included additional technologies and was expanded to include expected study completion dates through project staff research. The appendices of this report includes the most current list as of June 30, 2006.

***Deliverable 3B:** A "quality of performance data" screening tool. The screening tool will screen the technologies based on availability of performance data and will provide a mechanism to assess the market status of current and developing stormwater BMPs.*

As described under tasks 1 and 2 above, Project staff developed a quality of data screening tool consisting of the 0-3 category displayed on the web site's technology performance evaluation pages. Staff assign a rating according to the following procedure: Performance studies for a given technology are located through direct communication with product representatives or searching manufacturers' web sites, similar communication and web site searches of testing agencies (e.g. ETV, NSF, US EPA, NJCAT, Caltrans, UNH Stormwater Center, etc.), and internet search engines. Each study is compared with TARP Tier II protocol requirements – the summary list of TARP requirements that project staff uses for this comparison is included with report enclosures. The review is generally a two-stage process. During the first phase, a check is made to determine whether major TARP requirements are met; e.g. is it a field study, were the required 15 storms, 50% of annual precipitation monitored, etc. Studies that fail these criteria are given a "3" rating. A more comprehensive review is then conducted to evaluate study design, sampling and analysis methods, quality control procedures and results, what range of conditions were studied/documented (e.g. flow rates, particle size distribution, pollutant loadings, etc.). Based on this detailed review, those studies that met the major TARP requirements are given a rating. All such studies evaluated to date have received a "3" rating – i.e. none have met the full TARP Tier II requirements. Project staff produced a summary evaluation of the study and posted it on the web site in the performance evaluation section for the given technology. This summary evaluation lists information such as project start and end date, pollutants and performance claims that were tested, methods used, whether a QAPP was written, etc. (when available – study reports do not all include this information). Project staff also prepared brief narrative evaluations of the study (where possible), indicating the salient reasons for the rating received. In cases where sufficient information is available in the report to warrant such an evaluation, Project staff will give a qualitative evaluation of the study's conformance to sound scientific methodology, irrespective of the study's TARP compliancy. Part-way through the project, MASTEP began using a standard template with which to report this evaluation. To date, only a few technologies

display this standard evaluation format. Plans for phase two of this project include reformatting all study evaluations to conform to this template. An example of the template can be found in the Arkal Pressurized Stormwater Filtration System profile and among the enclosed files. If in the judgment of Project staff the study results appear credible for the conditions under which they were performed (either lab or field tests), the pollution removal efficiencies will be reported alongside performance claims. These will generally be reported with attribution to the study in question and with some caveats advising against extrapolation of study results for any reason.

For technologies with more than one study, the category rating given is based on Project staff evaluation of all studies reviewed. If in communication with product manufacturers, vendors, or testing agencies it is learned that TARP-compliant studies have a good likelihood of appearing within the next 12-24 months, the technology is given a rating of "2."

The category rating is seen in two places on the web site. On the technology summary page, which lists all technology profiles, each technology is given an overall product rating. This rating is usually based on a technology's performance with respect to Total Suspended Solids. However, for some technologies that either were not tested for TSS or for which the more credible information pertains to other pollutants, the rating is displayed for those other pollutant(s), and the pollutants are listed next to the rating. In the detailed listing for each technology's pollutant removal claims and performance evaluation, a rating is displayed for each pollutant for which a claim exists and/or for which a test was performed. This means that several technologies will have ratings for nutrients, metals, bacteria, etc. in addition to or instead of a TSS rating.

***Deliverable 3C:*** *A cost-benefit analytical tool that will evaluate cost and non-cost factors such as socioeconomic and environmental impacts of the technologies currently available.*

The cost-benefit analytical tool, which reports cost per unit, per CFS, or per pound of pollutant removed, and which reports installation and maintenance costs, is described under task 1 of this report. As described above, environmental impacts are reported separately, in the technology profile section listing site and environmental considerations.

### ***Deliverable 3D:*** *Screen technologies.*

This system of evaluating technologies was used with few changes for the duration of the project. The appendices contain the screened technologies which total 32 to date. An electronic version of the screened technologies is also searchable on the mastep.net website. What follows in this section are Project staff observations and recommendations regarding performance evaluation studies, the TARP protocol, and related matters.

To date, no single study has been found that meets all Tier II protocol requirements. As a result, there are currently no category 1 technologies in the database. Of the thirty-two technologies included in the MASTEP database, six technologies have a rating of "2" because new field studies are underway that may meet TARP protocols. The rest of the technologies are rated "3." This is due to a number of factors. Some technologies simply lack performance studies. Several studies were reviewed that had poor or undocumented quality control, and several others were extremely limited in scope, measuring only one or a few storm events. There were also a number of studies with reasonable to good quality control but which did not meet all or most Tier II requirements.

*Laboratory vs. Field testing.* To date, more laboratory studies exist than do field studies. Product manufacturers and testing agency personnel we spoke with over the course of the project were divided in their opinions of the relative merit of the two approaches. On the one hand, laboratory studies allow a more precise control of variables, leading to more reproducible results and allowing one to evaluate systems for specific conditions, such as a precise range of flow rates and pollutant mix. On the other

hand, many voiced the opinion that laboratory studies do not always translate well to the field; natural variations in any number of test factors are hard to predict or simulate in the laboratory. A commonly-voiced complaint was that the cost of extensive field testing as required by TARP is prohibitively high. According to interviews with several agencies and manufacturers, several studies currently under way have set up to conform to TARP protocols. These should start appearing in 2006 and 2007. However, given the dearth of compliant studies to date and continuing concerns about costs of tests, it may be worthwhile for TARP to consider giving greater weight to lab studies in the certification process.

***BMP types***. Some BMP types are not particularly suited to the TARP Tier II protocol.

- Trash and debris collectors (e.g. Netting Trash Trap by Fresh Creek Technologies, FloGard Trash & Debris Guard by Kristar Enterprises) would not require water quality testing, nor are the preferred performance calculation methods (efficiency ratio, summation of loads) well suited for these systems. It is unclear whether other TARP protocol requirements such as number of samples per storm, timing of sampling within a storm, minimum 15 storms sampled, etc. are appropriate for trash and debris collectors.
- Groundwater recharge systems are primarily designed to redirect storm runoff back into groundwater; therefore performance analyses should focus on water quantity rather than quality. These systems may require water quality sampling in order to determine whether groundwater is being contaminated, but the TARP protocol sheds little light either on preferred methods for measuring recharge performance (i.e. quantity), sampling groundwater for pollutant concentrations, or whether "pollution avoidance" estimates could reliably be provided by sampling input loadings and assuming that these loads did not reach receiving surface waters.

***Capturing required storm events.*** Sampling frequency, duration, and number of storms sampled were all common reasons why the TARP protocol was not met. Some studies sampled fewer than 15 storms. One of the most frequent deficiencies was the percent of annual rainfall sampled. In many cases, even though 15 or more storms were sampled, the total amounted to 10% or less of average annual precipitation, instead of the TARP-required 50%. It was common for studies to avoid winter sampling. It was also common for study reports to neglect to mention whether storm events sampled were consecutive or not.

***Reporting of sampling procedures.*** Many reports that were reviewed either neglected to mention important factors such as particle size distribution, flow rates, and storm intensity; or sampled a narrow range of these attributes. This can make it difficult to either compare different technologies or to evaluate a product for its suitability for conditions found at a particular site needing stormwater mitigation. It may also lead to misinterpretation of results. For instance, the testing site used at the University of New Hampshire's Stormwater Center drains a parking lot situated on top of a hill. The incoming sediments uniformly tend to be of small particle size. This may lead to what appears to be poor performance results for systems tested there. However, it is widely reported in stormwater control literature that treatment efficiency declines as particle size diminishes. Thus it is important when reporting results to accurately characterize the sediments treated. Similarly, flow rate and influent pollutant concentrations can affect system performance, and similar care should be taken when interpreting and reporting results. It might be advisable for the TARP protocols to be revised to either require a specific set of ranges for particle size, flow and pollutant concentration, or to allow a provisional, partial or narrowly-defined certification of technologies that have been reliably tested, but under a narrow range of conditions. Another possible approach would be to replace single uniform standards (e.g. 80% TSS removal for new development) with a range of standards that require highest practical treatment efficiency based on site characteristics. These standards would be coupled with a permit application process involving a preliminary site visit wherein a visual survey would be conducted to ascertain site type. Factors such as watershed size, % impervious surface, topography, traffic, site use, etc. would be documented. In addition, an analysis of local soil types would be conducted to estimate particle size distribution expected in runoff. Based on these characteristics, the site would be assigned a score. All sites within a similar scoring range would be

assigned the same pollutant removal requirements and/or be required to install certain types of treatment. For instance, sites that are found to produce very fine particles might be required to install filtration systems or large settling ponds if possible. Alternatively, they might be required to remove somewhat less than 80% TSS. This approach might avoid or minimize those situations where well-meaning standards are impossible to attain. From a testing perspective, it might also yield a larger and more useful data set from field studies. Field studies are by their nature dependent on site characteristics; particle sizes, storm intensities, and pollutant loads may can significantly from one site to another. This contributes to the present situation where one study may appear to rate a particular technology poorly while a different study documents much better performance. This may be due more to site differences rather than variations in sampling and analysis methodology. If study sites are rated by their characteristics as suggested above, it may be possible to build a database that correlates particle size and other significant factors with performance efficiency, giving a more accurate estimate of a given technology's performance. With proper documentation, such a database of studies, study site characteristics and system performance might help stormwater managers/decisionmakers locate and evaluate systems that have been tested under conditions similar to those encountered at the local site.

***Total Suspended Solids vs. Suspended Sediment Concentration.*** Massachusetts Stormwater Management Policy uses Total Suspended Solids (TSS) as the target pollutant constituent for a removal standard, citing its "widespread contribution to water quality and aquatic habitat degradation", the readiness to which other pollutant constituents sorb to sediment particles, and availability of studies and data sets for TSS removal efficiency. However, there have recently been a number of studies conducted and papers written that propose Suspended Sediment Concentration (SSC) as a more accurate test, due to an under-representation of sand-sized and larger particles in TSS tests. This sampling error is said to be introduced in the process of extracting aliquots from the original sample. If the TSS test is indeed inaccurate, the Stormwater Policy's TSS standard may be undermining the goal of protecting water resources. Furthermore, the discrepancy between SSC and TSS tests can lead to confusing or misleading information on BMP performance. Some BMP manufacturers and vendors seem to prefer the SSC test, apparently on the belief that larger particles being easier to treat, an SSC test would show higher removal rates than would a TSS test. In fact, we have seen some claims made of a given TSS removal rate, "using the SSC method" for measurement of TSS. It is important for anyone reviewing TSS removal claims to verify the method used in making or testing the claim. Apart from this, the Commonwealth might do well to reconsider its reliance on TSS as the target pollutant, or at least to consider adding an SSC standard that could be used as an alternate to TSS.

### ***Deliverable 3E:*** *Develop documentation for Category 1 technologies.*

As previously described, no technologies reviewed to date meet all Tier II protocol requirements. As a result, there are currently no category 1 technologies in the database.

### ***Deliverable 3F:*** *Track category 2 technologies*

The status of category 2 technologies listed in the web site and potential candidates for screening are provided in the appendices. These data include technology name and model, type of technology, 3rd party evaluation identity, study status, projected date of completion, project notes, and reference source. Blow is a table describing several technologies which remain in Category 2 and are pending evaluation.

| Category 2 technologies | Reason/study comp. date |
|---|---|
| Baysaver Separation System | NJCAT lab studies. Says field studies coming. ETV underway, and EvTec 2? |
| Downstream Defender | Field studies said to be underway (NJCAT, MCZM, ETV) |
| FloGard+Plus | Hawaii study nearing publication |
| Inline Stormceptor. | NJCat promises later field study |
| Stormwater management Stormfilter | "final certification by NJCAT is in progress for an installation in Greenville Yards, Jersey City, NJ, maybe TARP compliant |
| UltraUrban Filter Smart Sponge AntiMicrobial | Rhode Island DOT is currently testing this product, may be available in November 2005 |

***Deliverable 3G:*** *Prioritize Category 3 technologies.*

Recommendations for types and prioritization of further testing for category 3 technologies is provided in the discussion under Task 3 deliverable 3A section of this report and is included in the appendices of this report.

## Task #4: Develop Metrics and Evaluate Project

***Deliverable 4A and 4B:*** *Project assessment criteria and survey forms to properly evaluate the costs and benefits of this project throughout the duration of the project and; A web-based survey to continuously monitor visitor satisfaction with the information being posted on the technologies for the term of the grant.*

Project assessment criteria were developed to answer the fundamental questions of how well this project provides *"…technology transfer information about innovative stormwater BMPs to MADEP, conservation commissions, local officials, and other BMP Users"*, and how well end users are provided with *"…qualified information to make appropriate technology implementation decisions.."* and how well this will *"…lead to more informed decision-making at the local level."*. These project goals (excerpted from the scope of work) were translated and reworded by project staff into the following questions that were used to guide development of surveys at different times throughout the project:

- Does the project web site contain credible, useful, understandable information?
- Is the information easily accessible? Is the web site designed in a user-friendly manner? I.e. is navigation efficient and uncomplicated, is information displayed in easy-to-read formats that help users satisfy their information needs?
- Is the web site being used by target audiences, and are they obtaining the information they seek?
- Does the web site contribute to informed decision making?

Feedback was sought on several occasions and via several methods during the course of the project. These include:

- The user needs survey discussed above.
- The data entry tool survey discussed above.
- A web site feedback form placed on the project web site, allowing site users the opportunity to comment on any aspect of the site. This did not seem to be a particularly useful feature. Only two or three direct replies were received via this method; however, several other otherwise unsolicited emails were received over the course of the project, suggesting changes in site function or display. It is unknown whether these were prompted by the feedback survey, or whether users were simply inspired to submit a comment because of a particular experience while using the site.

- A user survey sent to all registered site members in February 2006. Results from this survey were compiled into a single file, included with enclosures accompanying this report. The web feedback form is also included with the enclosures.
- A Vendor-tester survey, the primary intent of which was to obtain information on upcoming performance tests on any given product. However, recipients were also encouraged to review technology profiles, make recommendations to change any erroneous or confusing information, and to offer any other suggestions they wish concerning the site. Forms are included with enclosures.

In addition to these surveys, web site use has been tracked since mid October 2005 Those monthly statistical reports of site use have been sent to Mass DEP The final site statistics report is included with the enclosures.

Feedback received from these several sources has led to several changes in the web site, database, and project activities, including but not limited to:

- Elimination of the registration requirement
- Wording changes to clarify the quality of data categorization system
- Addition o f sorting capabilities to the technology summary listing
- Improvements to the glossary
- Layout of the installation map
- Addition of some technology profiles, addition of studies for existing profiles, changes to existing information for various fields of various technologies
- More aggressive outreach for the web site (note number of presentations is nearly double amount required in scope of services).

***Deliverable 4C:*** *Compilation of data and information from assessment, to be included in the Project Final Report.*

Based on review of all sources of feedback and site tracking data, it is the belief of project staff that the project goals are largely being met:

The site receives heavy use from a variety of BMP user categories. Site tracking offers only a rough analysis of user type (by tracking domain name suffix), and the discontinuance of the registration process no longer allows staff to directly review user affiliation. However, based on the limited analysis available through these methods, it is clear that a wide variety of user types frequent the site – engineers and other corporate entities, product manufacturers and vendors, municipalities, academics, federal, state and local government agencies, and nonprofit organizations. There seems to be a preponderance of corporate users. While Project staff welcomes these users, the tracking and membership information does suggest that improvement is still possible in the area of attracting municipal users. More aggressive outreach strategies might be employed to reach these audiences, such as direct mailings, more frequent presentations at local and statewide workshops and conferences targeting these audiences, and more prominent mention of the web site in agency newsletters, publications, grant announcements, etc. These will be explored more fully should the project extend to a second phase. However, even without additional outreach measures, it is expected that site use among target audiences will grow, as more users hear about the site through existing channels, and as users who may have visited the site only during its early operational phase when few listings were on display recognize the value of the information contained therein.

Users report finding the site easy to use and they appreciate the objective analysis of performance. Users are accessing and downloading a large number of documents, both those created in this project and those created by other agencies that are referenced on the site. Only a few users report making decisions based

on the information found on the web site, but several indicate that they are likely to do so as the occasion arises. Given the progress of the project- with initial phase devoted to site design, a gradual increase in the amount of information on the site, and a gradual increase in site use, it was never expected that it would be easy to document the last project goal – i.e. that the site leads to more informed decision making - within the 2-year life of this project. It is likely that this goal is just beginning to be realized.

### Task 5: Project Reporting

***Deliverables 5A, 5B, and 5C:*** *Prepare quarterly reports, prepare draft final report, prepare Final report.*

All quarterly reports have been submitted to the Mass DEP project manager. The Draft and Final report are encompassed in this final report.

## PROJECT SUMMARY

Overall, project activities met the proposed project deliverables and goals with few deviations. Project administration had no upsets and reports and deliverables were competed and submitted in a timely manner. One area of deviation that was unexpected was the complexity of the website with respect to the difficulty and amount of programming required to manage both data input and presentation. The project staff invested more time into this task in anticipation of long term use of the site and to aid in data collection and management. It is the project staffs view that this added work was worth the effort as evidenced by our ability to easily collect and process technology data meeting our project goals. Furthermore, the project team had intended early on to collect data by soliciting contributions from technology proponents, testing agencies and other resources. By in large, this was not the case for the majority of technologies that are in the current database. In this regard, there were benefits to having project staff collect and evaluate data versus simply evaluating data entered by a third party. The down side of this was that project staff used more time resources than was planned.

Project participation by Mass DEP and EOEA was excellent and truly added value to the project. Interactions related to specified deliverables requiring agency input was always timely and consensus was reached at each critical point. The Project staff were able to respond to suggestions and requests for information or materials without exception. Participation in project deliverables requiring outside input was also successful and without notable challenges, including contributions from private sector, state and federal agencies.

The value of MASTEP is evidenced as follows:

- Increasing number of registered users.
- Heavy use by a variety of BMP user categories, including state and local regulatory officials.
- Positive verbal feedback from conference presentation and interest in improving contents of website to enhance its value
- Evidence of high web site traffic and downloads of technology reports, presentation materials, and diversity of page hits.
- Website search engine placement is also evidence of excellent linkage to other high use sites and general high use activity.
- General acceptance, strong interest and positive response to neutrality of site from technology vendor group.

- Overall surveys of user groups suggest high user satisfaction, repeat use of the site, and expressed willingness to refer other users to the site.

A second phase of the project will build off of the extensive structure of the project web site, enhance and expand the information contained in the website and further support the work of MassDEP as it updates its Stormwater Policies, works with other states to implement the TARP protocol and moves towards its continued goal of improved water quality in the Commonwealth.

## APPENDICES

### Task 1

A. MASTEP description Two Page Information Sheet
B. COLAP MASTEP Presentation January 2006
C. Rinker Presentation 6-14-05
D. Rinker Presentation 1-13-06
E. MASTEP Poster Power Point Slide
F. Date Entry Screening Tool
G. DEST Introduction Letter Sample

### Task 2

H. Stormwater Tech Needs Survey
I. Needs Survey distribution list
J. Survey responses

### Task 3

K. TARP Requirements
L. MASTEP Review Template
M. MASTEP Arkal Technology Evaluation Sample Document
N. Category 2 Technology Report

### Task 4

O. Final Web Site Statistics
P. User Survey and Response Compilation
Q. Testing Agency Survey Form
R. Vendor Survey Form

### Database Technology Website

S. Stormwater BMP Technology Database Web Page Data Output