Summary of BMP Development Process – for STAC's Review

Summary:

In 2008 the University of Maryland/Mid-Atlantic Water Program (UMD/MAWP) conducted year two of the best management practice (BMP) Project by developing definitions and effectiveness estimates for 'new' BMPs. The purpose of the project was to develop definitions and effectiveness estimates reflective of average, watershed wide, operational conditions. Thus, research scale effectiveness estimates should be adjusted to account for differences upon scaling up to operational conditions. While there is peer reviewed to gray literature available on the BMP definition and components, these BMPs are 'new' and either do not have data, or very limited data, that directly analyzes the effectiveness of the practice. This was the biggest challenge and affected the process by putting more weight onto the best professional judgment (BPJ) aspect of the project.

For a more transparent use of BPJ and to provide more structure to estimating efficiencies the process used in year two was refined. As this process differed from year one UMD/MAWP and the CBP would like STAC to review how the new process was applied in year two. We need final comments and suggestions by October 22, 2008 so the Water Quality Steering Committee (WQSC) can consult STAC's comments if there are any unresolved issues impeding approval of definitions or effectiveness estimates. Currently, the definitions and effectiveness estimates are still under review by the CBP's Agricultural, Stormwater, Sediment, and Watershed Technical Workgroups, the Nutrient Subcommittee and the WQSC. The final BMP report will be approved for use by the CBP in mid-November and UMD/MAWP will then host a forum to present their findings and discuss next steps for further refinement.

Changes Made to Process Based on STAC's Review of Year 1

The process used to develop the BMP definition and effectiveness estimates for year two, 'new' practices, differed from year one, existing practices. The biggest process change was the use of a panel to develop BMP reports versus one expert per practice. For all practices, except ammonia emissions reductions, a panel of scientists with specific BMP expertise was convened and consulted when developing the BMP definitions and effectiveness estimates.

UMD/MAWP encouraged panel members to be conservative when estimating effectiveness and UMD/MAWP and panelists strived to recommend effectiveness estimates reflective of operational conditions. Panel members were sometimes reluctant to recommended percent removal values because of data gaps, but when this occurred they were conservative in their estimation. When developing BMP definitions, parameters from the study sites were used by the panel to capture the characteristics of the BMP present during effectiveness testing or monitoring. Meaning, if something influenced the effectiveness of the BMP, these parameters were incorporated into the definition to capture that factor determining effectiveness (i.e. for the infiltration bioretention BMP a soil P-index range was included in the definition because it will determine phosphorus removal rates).

While literature was reviewed and experts were recruited to suggest BMP effectiveness estimates for all year 2 practices in the BMP project, there were several cases where it was necessary to use BPJ. The most common reason for the application of BPJ was to account for the lack of data regarding the pollution reduction performance for these 'new' practices. Where data was available it was necessary to employ BPJ to adjust for spatial, temporal and management variability and resulting change in practice effectiveness at widespread "average" implementation across the Chesapeake Bay watershed.

The STAC review of the year 1 process cited the lack of a consistent approach or explanation for the application of BPJ as an area of concern. The year 2 process utilized a panel of scientists to develop BMP definitions and effectiveness estimates so more scientists were involved in applying BPJ. UMD/MAWP and panel members considered the need to use BPJ for effectiveness estimate modification on a practice by practice basis, depending on availability of literature, field scale implementation data, and other factors influencing implementation. This resulted in variable application of BPJ to different practices which we felt was warranted based the factors above and our experience from year one. The STAC review of the process used in year one of the BMP cited the lack of a consistent approach or explanation for the application of BPJ as an area of concern. To address this in year two, UMD/MAWP developed, and the CBP approved a decision matrix to use when considering literature values and incorporating BPJ for effectiveness estimation (see Appendix A). The decision matrix was a valuable tool, but unfortunately the decision matrix was not useable for practices where direct data on performance was not available. For some practices where effectiveness estimates were available the number of studies was too low, sometimes one, to determine a range and incorporate the decision matrix rules. It was useful when a large number of data were available to develop a range. We feel the decision matrix is a great tool and should be tested on a group of BMPs where numerous direct data on effectiveness values is available to determine its applicability and usefulness.

The STAC review of year 1 endorsed the guidelines set by UMD/MAWP but recommended they be developed and distributed to scientists earlier in the process so they could be employed from the beginning of effectiveness estimate development. To address this UMD/MAWP provided the guidelines, endorsed and approved by UMD/MAWP, STAC, and CBP, to all panelists in the first email or phone call soliciting assistance. A list of the guidelines is available in Appendix B. STAC also criticized the year 1 process for a lack of direct questions used to determine data applicability of the literature consulted to estimate effectiveness. UMD/MAWP incorporated this recommendation into the year 2 process and a list of questions used by UMD/MAWP when conducting its literature search, and used by panelists when considering papers to be included in the data set, is available in Appendix C.

It must also be recognized that practice effectiveness estimates are being developed using an adaptive management approach that recognizes that our knowledge is incomplete but proposes a science-based but conservative approach to effectiveness estimates that will be reviewed and updated at recurring intervals based on new research, monitoring and

experience. The conservative approach is always advisable in adaptive management and is particularly warranted here since there is little if any data that suggests actual widespread implementation performance as high as those in the research literature and several recent small watershed studies have indicated considerably lower reductions when groups of practices are applied than would have been expected based on current effectiveness estimates.

While there is peer reviewed to gray literature available on the BMP definition and components, these BMPs are 'new' and either do not have data, or very limited data, that directly analyzes the effectiveness of the practice. No direct effectiveness data was available for either livestock or horse pasture management, mortality composting, and Nutrient Use Efficiency (NUE). Data was available for ammonia emission reductions, dairy feeding management, infiltration and filtration practices, and dirt and gravel road erosion and sediment control. The reasons for adjusting the efficiency for specific practices based on BPJ are described below.

Explanation of how process was applied to each BMP:

For each year two BMP an explanation of how the process was applied is provided to assist in STAC's review. Each explanation will state if a panel was used, how much data was available, and how BPJ was used. We'd like STAC to react to the process. Do you agree with the process used to estimate effectiveness?

<u>Nutrient Use Efficiency (NUE)</u>
Was panel used? Yes, we consulted industry, academic and state agency staff.

How much data was available? No public data available on the relationship between reduced application rates, or plant uptake due to decision agriculture, and pollution reductions.

How BPJ was used? The panel consulted information from industry, state agency, and university extension to develop subdivisions of NUE. No effectiveness estimate is proposed as the CBP Watershed Model (WSM) can alter fertilizer application rates and plant uptake values to simulate the nutrient reduction associated with reduced application and decision agriculture.

<u>Dairy Precision Feeding</u>
Was panel used? Yes, nutritionists and feed specialists were utilized.

How much data was available? Results from direct fecal testing and tools that correlate manure nutrient content to feed (Milk Urea Nitrogen for N and Total Mixed Rations for P) will be utilized to estimate performance. A great deal of data was available on using feed and fecal testing to determine pollution reductions and no professional judgment is needed when these results are used to estimate pollution reductions. If a jurisdiction cannot provide testing results, average literature values for N and P will be used as effectiveness estimates. A value slightly below the average literature value was used, in accordance with the decision matrix.

How BPJ was used? The amount of data available provided all the guidance needed to develop the definition and effectiveness estimate.

Livestock Pasture Management

Was a panel used? Yes, pasture experts along with livestock and horse experts were both consulted.

How much data was available? Indirect data on properly managing pastures to be productive and high quality feed sources is available from peer reviewed published literature and also state agency and university extension publications. The benefits of rotational grazing to animal health from composting manure, selecting desirable pasture plant species, grazing management, controlling weeds, liming and fertilization, clipping and dragging pastures provided the information necessary to develop a definition of pasture management. However, no direct data on nutrient and sediment reduction benefits of rotational grazing was available so BPJ was used. The panel prefers to utilize RUSLE2 to determine phosphorus and sediment reductions. UMD/MAWP recommends an independent review of the applicability of utilizing RUSLE2 for pasture lands. RUSLE2 experts outside of the BMP project will be consulted to evaluate the RUSLE2 pasture results. RUSLE2, however, is not available at this time so the panel recommended an interim effectiveness estimate based on knowledge of pasture systems and phosphorous and sediment movement.

How BPJ was used? The definition of livestock pasture management is recommended to include an improvement to pasture through grass height and cover requirements and uniform grazing management, along with high traffic area management. This means the increase in pasture quality and reduction in erosion from heavy use areas provides the pollution reduction benefits associated with pasture management, as defined here. As no direct data was available BPJ was used to estimate the reduction in loadings from pasture and heavy use area management.

To estimate performance the panel assumed the benefits of pasture improvement (grass height and density) results in a 20% reduction in loadings, and pasture grasses contribute 25% of the pasture load, then 25 multiplied by 20% is 5%. Adding the benefit from high traffic management (35%) and pasture improvement (5%) equals a total sediment effectiveness estimate of 40%. With pasture management manure is intentionally managed and phosphorous is distributed across the pasture, resulting in higher phosphorous levels compared to the pre BMP condition. As sediment is reduced sediment-bound phosphorous runoff will also be reduced to some degree. We assume phosphorus reductions are half as much as the sediment reduction, thus pasture management reduces 20% of all phosphorous from the average pasture load in the WSM (40% sediment reduction divided in half equals 20%).

Horse Pasture Management

Was a panel used? Yes, horse and livestock experts along with pasture experts were both consulted.

How much data was available? Just like livestock pasture management, indirect data is available from published peer reviewed literature and state agency and university publications on the benefits of pasture improvements and heavy use area management. Again no data on nutrient and sediment reduction benefits of pasture and heavy use area management is available so BPJ was used. It was also recommended RUSLE2 be used to determine phosphorus and sediment reductions associated with horse pasture management. These runs, however, are not currently available and interim effectiveness estimates were recommended based on BPJ.

How BPJ was used? The definition of horse pasture management is: Horse pasture management includes maintaining a 50% pasture cover with managed species (desirable inherent) and managing high traffic areas. The effectiveness estimates for livestock pasture management are also used for horse pasture management (see livestock pasture management for an explanation of how BPJ was used to estimate effectiveness). Horse behavior will result in a heavier impact to pasture lands when compared to the degradation caused by dairy or beef operations. Horses tend to spot (graze pasture to inconsistent heights). Some areas will have grass heights of 1-3 ft, others ½-1 inch. Horse grazing behavior is not uniform. There are areas in pastures that are grazed, others where horses lay down, and others where they defecate. With cattle all of these activities are mutually exclusive. With unmanaged grazing, horses also tend to selectively graze certain species of grass. Furthermore, movement behavior is highly variable and depends on the number of horses, housing facility, the presence of neighboring horses, and other factors. To account for these behavior differences horse pasture management effectiveness estimates will be applied against 1.5 times the average pasture load in the CBP's Watershed Model. Dairy and beef effectiveness estimates are applied against 1.0 times the average pasture load in the Watershed Model.

<u>Mortality Composting</u>
Was a panel used? Yes, composting and animal experts were used.

How much data was available? No direct data on the water quality benefits of mortality composting was available. Extension publications and other sources of information address the procedures used for mortality composting or discuss the human and animal health benefits of the practice.

How BPJ was used? The effectiveness estimate is calculated using knowledge of septic systems, nitrification, denitrification, and composting operations. No direct data is available on the pollution reduction benefits of mortality compositing, and one value for nitrogen and one value for phosphorus reduction is assigned for all animal types. In addition, a method was developed to estimate total pounds available for loss based on direct data available on the average mortality weight, nitrogen and phosphorus composition, percent mortality, the number of animals each year, and an effectiveness estimate.

To determine effectiveness the loss of N and P prior to composting is needed. With burial the majority of phosphorus is bound in the soil, comparable to a septic system, but oozing to the surface and overland flow negates a 0% P loss. Panel members estimated available P loss from burial is between 10 and 15%, and 12% is assigned. Composting operations will result in some loss of P so the effectiveness of mortality composting for available P is rounded down to 10%. When burying carcasses 80% of the N is potentially available for loss. After composting only 60% of that 80% remains, as 40% is lost to the air as ammonia. 60% of 80 is 48%, however, some additional N is lost during composting operation (handling, storage, etc.) so 48% is reduced to 40%.

Dirt and gravel road

Was a panel used? The panel consisted of the director of the Dirt and Gravel Road Center and a PA DEP employee (the only agency in the watershed that implements this BMP).

How much data was available? Only one study is available that evaluates the sediment reduction of erosion and sediment controls on dirt and gravel roads.

How was BPJ used? The Center for Dirt and Gravel Road Studies (Center) conducted the research and after considering the data applicability to questions (see Appendix C) an issue arose with the Center's report. The Center monitored performance of various techniques that reduce erosion from dirt and gravel roads. Timing of pre-BMP and post-BMP sampling occurred one minute after the wetting front initially reached the sampling point. This reduced the infiltration rate on the initial run, but also eliminated the first flush of dried road sediment. During the first flush, the majority of sediment is transported. If the Center's procedure did not capture the sediment in the first flush then sediment reduction calculations are erroneous.

To account for sediment movement during the first flush, UMD/MAWP recommends discounting the Center's sediment reduction estimates by a relative 60%. Data is unavailable to determine the exact portion of sediment carried off dirt and gravel roads during the beginning of a precipitation event, but research from other land uses suggests first flush volumes carry the majority of sediment load in the runoff. 60% is selected as it is a high value to represent the majority, but not too high as first flush sediment transport is highly variable. First flush is related to factors such as the distribution of intensities during a storm, percent impervious cover, the number of dry days, and watershed area.

Solid-phase pollutants typically exhibit a first flush effect. Barbosa and Hvitved-Jacobsen (1999) observed a first flush effect for TSS. Extensive work in Florida has defined the first flush as the first 25 mm of runoff and determined it carries 90% of the pollution load from a storm. Yousef et al (1985) and Miller (1985) observed first flush for many pollutants, especially particulates. Sansalone and Cristina (2004) shows most of the pollutants in the first flush are associated with large particles.

Infiltration and filtration

Was a panel used? Yes, a researcher from UMD and staff from the Low Impact Development Center and Center for Watershed Protection (CWP) were consulted.

How much data was available? There are many data sources available that address the pollution reduction benefits of urban stormwater. The CWP recently conducted a literature synthesis on the infiltration and filtration techniques used in the BMP report and this data analysis was used to estimate effectiveness.

How BPJ was used? A literature review from the Center for Watershed Protection was concluded in April 2008 and used to determine effectiveness estimates. Average literature values were used as the baseline as more than 6 sources of data were available for each infiltration and filtration technique. The panel stated, however, that the values were not representative of operational conditions so discounts were assigned, consistent with the decision matrix. Strict definitions and breakouts by drainage structures and soil type provided a representative effectiveness estimate as they reflect the conditions and engineering used in the sites where performance values were monitored.

Ammonia emission reduction

Was a panel used? No, Jack Meisinger, a soil scientist with ARS who has studied ammonia emission reduction techniques counseled and provided advice on the definition and effectiveness estimate recommended by UMD/MAWP. UMD/MAWP contacted numerous people to serve on a panel and got commitments from three people. Due to schedule conflicts, however, this group never got together. Time ran out so UMD/MAWP drafted a report using literature provided by panel members and used Jack Meisinger to answer questions.

How much data was available? This BMP had a great deal of peer reviewed literature that directly addresses the ammonia reduction performance of biofilters, textile covers, and alum, the three subdivisions used to define ammonia emissions reductions. After reviewing the literature on covers (5 studies), alum (6 studies) and biofilters (8 studies) UMD/MAWP identified some issues with the study design and effectiveness calculations for alum treatment.

How BPJ was used? In the alum studies the effectiveness was calculated using a timeframe not proportional to the time scale when the majority of ammonia is emitted. Studies typically averaged the effectiveness during 0-35 days of flocklife when alum is highly effective, averaged the effectiveness of the alum during the last seven days of flock life when alum is moderately effective, and would then average those two values to determine overall effectiveness. For example, Meisinger (unpublished) found over 42 day grow-out the alum treated litter reduced the ammonia concentrated in the exhaust air by 75% compared to the untreated control, with excellent control over the 0-35 day period (82% lower ammonia compared to the control) and moderate control (50% reduction) during the last 7 days when excretions were largest. This is not reflective of the time when the majority of ammonia emissions occur, during the last seven days of flocklife (Carr, 2004). This increase in emissions correlates to an increase in pH observed over flocklife (Carr, 2004), and as the pH increases the ammonia emissions also

increase exponentially. Overall, alum is highly effective early on in flocklife, but is less efficient over the total flocklife (Carr, 2004). Thus, UMD/MAWP averaged the literature values and then discounted the value as these values do not account for cumulative emissions over time.

For biofilters eight studies were available and in accordance with the decision matrix the average value was used. There were 5 studies on the effectiveness of covers thus UMD/MAWP rounded down slightly from the average.

RUSLE2 Evaluation:
For the pasture management BMPs the panel recommended using RUSLE2 to determine the sediment reductions associated with pasture and heavy use area management. RUSLE2 has not historically been used for pasture lands and an evaluation of its applicability to and response on pasturelands is needed before results are used as pasture management efficiencies. RUSLE2 has been modified for pastures, how should RUSLE2 runs be analyzed for applicability to pasture systems? Are there general guidelines that should be followed when evaluating any tool being applied to landuses it has not historically analyzed? UMD/MAWP will be using independent RUSLE2 experts and the pasture panel to evaluate results. We would like STAC to help formulate a set of guidelines or questions to ask when conducting this review. STAC will also have the opportunity to analyze the RUSLE2 data if they desire.

Specific Questions to Assist in STAC Review:

Overall, is the process for developing BMP definitions and effectiveness estimates sound and applied appropriately? Are there recommendations for further refining the process in subsequent reviews and development of BMPs?

How can the decision matrix be modified to develop effectiveness estimates for 'new' BMPs?

Reference:

Barbosa, A.E., and T. Hvitved-Jacobsen. 1999. Highway Runoff and Potential for Removal of Heavy Metals in an Infiltration Pond in Portugal. *Science of Total Environment*, vol. 235, no. 1-3, pp. 151-159.

Carr, L. "In-House Treatments to Reduce Ammonia Emissions in Broiler Production." Power Point Presentation. Wye, Mills, MD. 21 May 2004.

Miller, R.A. 1985. Percentage Entrainment of Constituent Loads in Urban Runoff, South Florida. USGS WRI 84-4329.

Sansalone, J.J. and C.M. Cristina. 2004. First flush concepts for suspended and dissolved solids in small impervious watersheds. Journal of environmental engineering, vol 130, no 11, pp. 1301-1314.

Yousef, Y.A., M.P. Wanielista, H.H. Harper, D.B. Pearce and R.D. Tolbert. 1985. Best Management Practices – Removal of Highway Contaminants by Roadside Swales. Final Report, Submitted to the Florida Dept. of Transportation, Tallahassee, FL.

Appendix A: Decision Matrix for Development of Year Two BMPs

The following matrix was used to determine what effectiveness should be assigned to a specific best management practice based on the amount of data, variability of data, quality of the data, applicability of the data, and location of the studies used in the data set. The matrix was used to assist in the thought process for assigning an effectiveness estimate; it is not designed to be used as a rigid structure. While each BMP will be analyzed using this matrix, there will be flexibility in how the matrix is used. There will be interactions and differences between the parameters below that will have to be considered in developing effectiveness estimates. For example, a limited number of research scale studies that are consistent, have low variability and are highly applicable may be given a somewhat higher effectiveness estimate than it would be solely based on the research scale or number of studies.

The matrix is below, followed by an explanation and rationale of its components:

Effectiveness Estimates Assigned	**Average (median)**	**Below average (between average and 1st quartile)**	**Low end of range (within 1st quartile)**	**Conservative estimate with maximum of 30%**
Applicability	Within State TS definition and NRCS codes; Match Stormwater Manual Design Specifications	Generally representative of specifications	Somewhat representative of specifications	n/a
Location	Within Chesapeake Bay Watershed – representative soils and hydrology	Generally representative	Somewhat representative	n/a
Range	Low variability	Medium variability	High variability	n/a
Amount of Data	High	Medium	Low/limited	None

Scientific Basis*	Operational scale research (peer reviewed)	Research (peer reviewed)	Research ("gray" literature)	Best professional judgment, observation and/or extrapolation

*Information in all categories will be evaluated using the matrix above, but when there is information available that has undergone different levels of scientific review, it will be weighted as shown in this row.

1) Amount of data

Less than or equal to 3 studies: use low end of reported range or more conservative effectiveness estimate

4-6 studies: use value below the average of range reported

Greater than 6: use the average within the range

2) Variability

Wide range of data variability: use a conservative estimate

Low data variability: use the average of the range

3) Applicability
Completely consistent within jurisdiction and NRCS codes or Stormwater manual design standards: use average of the range of data

Generally representative: use a value below the average. Generally is defined as representing 67% or greater of the standards and specifications within state tributary strategy definitions, NRCS codes or Stormwater manual design standards.

Somewhat representative: use value at the low end of range

4) Location of studies used in data set

Location is defined as the average soil conditions and hydrologic regime associated with the landuse the BMP is typically applied to. When all studies are representative of the conditions within the Chesapeake Bay watershed the average of the range will be selected. When the natural conditions of the research area are generally representative of those in the Chesapeake Bay watershed, use a value below the average of the range. When the location of the studies used in the data set are somewhat representative of the soil and hydrologic conditions in the Chesapeake Bay watershed, select an effectiveness estimate at the low end of the range. Here generally is defined as the study being similar to, but not exactly the same as the soils and hydrology of the Chesapeake Bay watershed.

5) Scientific Basis

The quality of data will be used to assist in the process of effectiveness assignment. When all forms of data (peer reviewed operational scale studies, peer reviewed research plot studies, and 'gray' literature) are represented there is higher confidence in the data, and the average of the data range is selected. However, as year two BMPs are new practices, there was limited peer reviewed operational scale projects to use in effectiveness estimation development. When only 'gray' literature, or peer reviewed research, is available, it will not restrict the use of assigning the average effectiveness estimate within the data range. In this situation, the other factors (variability, location, applicability, and amount of data) will have more weight in selecting the effectiveness estimate of the practice. A BMP will not be assigned an effectiveness estimate at the low end of the range, when based solely on the lack of peer reviewed operational data, and the other factors do not indicate an estimate at the low end of the range should be assigned.

When all forms of data are available the following structure is used:

Peer reviewed studies that analyze practices in an operational setting on local watersheds that are applicable to expected conditions throughout watershed: average effectiveness estimate found in data range will be used

Studies that investigate practices on research plots on local watersheds that are applicable to expected conditions throughout watershed: values below the average of the range found in the data will be used

White paper, or limited research scale type publications, regardless of location: low end of the data range will be used

Best professional judgment, observation, and extrapolation: conservative effectiveness estimate below 30% will be used

Rationale for selecting a 30% effectiveness estimate when best professional judgment is used is justified because most watershed studies show that when applying a suite of BMPs to a watershed, maximum reductions are about 30%. As such, no effectiveness estimate for a single practice recommendation based primarily on best professional judgment, extrapolation or observation should be more than 30%.

Appendix B. Guidelines

The following guidelines were used when selecting data to include in the data set:

- Effectiveness estimates should reflect operational conditions, defined as the average watershed wide condition. Research scale effectiveness estimates should be adjusted to account for differences upon scaling up to operational conditions.
- Where studies with negative pollution reduction data (the BMP acted as a source, not a sink for pollution) are found, they should be included in the effectiveness development process as they reflect operational conditions.
- Peer reviewed literature has been subject to stringent evaluation and results from that literature are given more weight than literature that has not undergone the same review process by independent scientists. As such, peer reviewed literature should be given more weight than design standards and manuals. For this BMP, however, no peer reviewed literature was available and gray literature, or limited research scale type publications, and best professional judgment was used.
- Data from individual BMP project sites are to be utilized over median or average values calculated from multi-site analysis (meta-analysis). Single site studies evaluate individual BMP projects, while multi-site analyses are a collection of BMP projects.

Appendix C. Data applicability.

As with any literature review, data should be evaluated for its applicability. Before selecting a study for use in developing a BMP effectiveness estimate and definition, the panel considered the questions below at its April 2008 meeting. Data used to develop effectiveness estimates was selected based on its applicability to the natural conditions of the Chesapeake Bay watershed, such as, soil type, hydrologic flow paths, and species composition. The studies were evaluated for their BMP design and implementation compatibility to those in the Chesapeake Bay watershed. The timing of monitoring in relation to BMP implementation, rates and timing of fertilizer applications, and the relationship between cultivation, planting, and farming methods and dates, need to be evaluated to determine if the study duration is critical to the reported effectiveness results.

- Are natural characteristics (soil type, climate, flow paths, geology, vegetation, etc.) of the research site similar to conditions in the Chesapeake Bay watershed?
- Is the practice consistent with NRCS codes, jurisdictional stormwater design manuals? If not, how would effectiveness estimates be different?
- How critical is the duration of the experiment to the reported effectiveness results?
- Do results reflect changes in pollution reduction benefits over the lifetime of the BMP?
- Briefly explain the study method used?
- What parameters were sampled and monitored?
- Who conducted the research?
- How was the effectiveness estimate calculated?
- What was the scale of the study?
- What assumptions, outside of experimental results, were made in reaching the conclusions?