Center for Environmental Excellence by AASHTO
Stormwater Management Community of Practice (CoP)

STATE-OF-THE-PRACTICE REPORT:
Stormwater BMP Maintenance and Operations

August 2018

AMERICAN ASSOCIATION OF
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Susan Jones of the Federal Highway Administration (FHWA) and Melissa Savage of the AASHTO Center for Environmental Excellence (CEE) are also Community of Practice members and contributed to this work.

DISCLAIMER

This State-of-the-Practice Report summarizes the discussions of Stormwater Management Community of Practice members who spoke as individual members of the community and did not necessarily represent their agency's views or positions. In addition, the contents of the report do not necessarily represent the views or positions of AASHTO or the CEE.

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Executive Summary

This Community of Practice (CoP) report includes an overview of the State-of-the-Practice for maintenance and operation of stormwater Best Management Practices (BMPs) to comply with MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) National Pollutant Discharge Elimination System (NPDES) Permits for State Departments of Transportation (DOTs). BMPs are designed to reduce the discharge of pollutants from all regulated activities undertaken by the DOTs within their highway right-of-way and related facilities. Some BMPs also mitigate changes in hydrology associated with the development of highways and ancillary facilities. The objective of this report is to provide information on the state of the practice of stormwater BMP maintenance and operation for DOTs and provide information on the elements of an idealized DOT stormwater BMP maintenance and operation program.

Information in this report was developed based on an internet survey sent to each of the state DOTs in the U.S. The survey investigated DOT practices for maintenance of stormwater assets, specifically treatment BMPs installed pursuant to compliance with the DOT's NPDES Permit. This report provides an overview of the state of practice for stormwater BMP maintenance and recommends areas of future research to improve the stormwater maintenance program.

The survey found that in general, DOT maintenance programs are based on regular inspections and correction of identified deficiencies. DOTs are challenged with available tools to prioritize maintenance and rate performance of BMPs in the field. Therefore, DOTs can consider varying inspection frequency to coincide with estimated need.

Asset management planning is increasing as a tool among DOTs, including planning for stormwater assets. However, stormwater asset management plans are generally in the early stages of development, and maintenance cost information, particularly by BMP type, is generally not captured. Indeed, few DOTs are tracking maintenances costs for their stormwater programs. This information needs to be collected to allow DOTs to report NPDES compliance costs and forecast this rapidly increasing portion of the DOT budget. BMP maintenance costs also represent a substantial portion of the whole life cost for the BMP. Accurate maintenance costs will allow practitioners to select the least-cost, permit-compliant practice for each project, as well as reduce long term costs through design refinements.

INTRODUCTION

The Center for Environmental Excellence by AASHTO has established a Stormwater Management Community of Practice (CoP). The purpose of the Stormwater Management CoP is to create a forum where State Department of Transportation (DOT) practitioners can engage in facilitated discussions on emerging issues, research needs, and innovative stormwater quality compliance solutions. The CoP has two primary goals: the first is to extend each state DOT's network and contacts, enabling them to share experiences and engage in technology transfer. The

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second goal is to develop a State-of-the-Practice Report (this document) on a selected focus topic. The Stormwater Management CoP consists of representatives from 27 state DOTs, and the Federal Highway Administration (FHWA). The Stormwater Management CoP members agreed that stormwater BMP maintenance and operations should be the top priority for this report of the CoP.

Stormwater BMP Maintenance and Operations is a major element of a DOT NPDES stormwater program. This report provides a current state-of-practice summary for this important program area.

CURRENT STORMWATER BMP MAINTENANCE AND OPERATIONS PRACTICES

The use of stormwater treatment Best Management Practices (BMPs) has increased over time due to DOT NPDES permit requirements. These permits also require DOTs to develop a systematic approach for ongoing BMP inspection and maintenance to ensure that they are performing as designed and protecting receiving water quality.

This report provides an assessment of the current state of practice for the maintenance and operation of treatment BMPs by DOTs. A survey made up of 44 questions explored DOT practices in eight general areas. These questions were sent to all DOTs in the US in the form of a survey:

1. General Criteria:
   - What is your DOT's maintenance and operations based on?
   - How are your maintenance and operations criteria determined?
   - How many water quality and/or quantity treatment/flow control BMPs does your DOT own, operate, and maintain statewide?
   - Does your DOT have specific maintenance criteria for individual BMPs or BMP types?
   - Has your DOT conducted an internal audit to assess the adequacy and performance of the BMP Inspection and Maintenance program?
   - Are you aware of, or have you seen or used the AASHTO Maintenance Stormwater flip guide?

2. Training:
   - What BMP maintenance training do you perform for staff, how is it performed, how often, and by whom?
   - Does training occur at the District or Statewide level or both?

3. Tracking:
   - How do you track the completion of maintenance activities?
   - Does your DOT have automated or manual procedures for identifying BMPs which have not been inspected and/or maintained at the required frequency?
   - Do you track maintenance effort by individual BMP?
   - How does your DOT track or estimate BMP maintenance costs?

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4. Inspection:
   - Does your DOT designate a specific person as the point of contact within a given geographic region as the individual responsible for "day-today" BMP inspection and maintenance operations?
   - Do you use a software/database (such as an asset management system) for inspections and maintenance activities? If yes, what do you use?
   - How does an inspection result in a maintenance activity?
   - Does your DOT outsource to private vendors the BMP inspection and/or maintenance activities?
   - Does your DOT's inspection program generate a functional assessment rating (such as a Level of Service rating) for each BMP?
   - Does your DOT separate inspection workflows from maintenance workflows?
   - What determines inspection frequency (such as permit provision, internal experience or needs, etc.)?
   - Is frequency of inspection, maintenance and repair static or adjusted as inspected?
   - How frequently do you inspect BMPs?
   - How much time is spent inspecting and maintaining BMPs per year?

5. Design Considerations:
   - Do you have design criteria requirements (safety and accessibility, R/W, lane closures, etc.) or other activities that drive BMP maintenance and operation?
   - Is BMP design documentation accessible to determine how BMPs should be maintained (as necessary)?
   - Is there a communication process between hydraulic engineers and maintenance staff to address BMP maintenance and operational failures?
   - Is there a design standard for dewatering BMPs to prevent standing water?
   - Are you required to employ a Vector Control Plan?
   - Do you have a protocol for BMP handoff from construction to maintenance?

6. BMP Maintenance
   - Does your regulator allow (via permit provision) the repair schedule be adjusted based on experience?
   - Does repair frequency vary by location and/or type of BMP?
   - Do you have guidance on what triggers BMP maintenance?
   - Do you track maintenance effort by individual BMP?
   - If tracked, are costs used for future maintenance needs?
   - Do you have a protocol for BMP handoff from construction to maintenance?

7. Funding Resources
   - Do you have a dedicated funding source (earmarked) or is it comingled with other maintenance funds?
   - What is your annual maintenance budget for stormwater BMPs?
   - Was a specific DOT agency budget request initially made for maintenance and operations of stormwater BMPs?

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- Were appropriations provided by the legislature for this purpose?
- If appropriations are provided by the legislature, are they ongoing or do agency requests need to be made every biennium or fiscal year?
- How does your DOT structure these funds compared to other maintenance needs?
- Are actual or estimated maintenance and operations expenditures reported to regulators?
- How did your DOT determine the amount of funds needed for these activities?
- If funding is limited, are all BMPs still maintained?
- If per BMP cost or FTEs/Year is available, please provide this information as well.

8. Asset Management:
   - Does your DOT use an Asset Management Plan?
   - Do you input the maintenance and inspection records in your asset management system (if you have one)?

The seven general categories were further consolidated into four categories for discussion in this report. The four categories are:

1. **Treatment BMP Maintenance Basics**. This portion of the survey explored the basic criteria for BMP maintenance and other criteria such as safety and accessibility, mainly consisting of survey areas 1, 4 and 5.

2. **Training and Personnel.** Training requirements, training aides, programs, personnel authorities and chain of command, along with reporting and tracking tools were examined. This category explicitly assessed the use of asset management by DOTs for stormwater controls. This category generally consisted of questions from survey areas 2 and 3.

3. **Tools for Tracking and Reporting.** Maintenance inspections and follow-on actions should be documented. This portion of the survey investigated how DOTs perform these functions. This category generally consisted of questions from survey area 6.

4. **Program Administration**. This category of questions reviewed budgeting of maintenance, how maintenance resources are appropriated by the DOT, expended, and issues created from resource shortfalls. Program funding by the DOT is provided and assessed as a ratio per number of BMPs the DOT maintains. This category generally consisted of questions from survey areas 7 and 8.

Survey Results

The objective of the survey was to determine the level of resources DOTs are investing in BMP maintenance, the methods used and the tools, such as asset management systems, they are using to facilitate the work.

This section provides an overview of the survey results and discusses some of the important take-aways from the data. Stormwater professionals from 27 DOTs responded to the survey, making it one of the most comprehensive assessments of BMP maintenance practices to date.

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Discussion of Survey Results

BMP Maintenance Basics

Treatment BMP maintenance is performed to ensure that the BMP functions as designed to remove pollutants from stormwater runoff, and in the case of flow control BMPs, to regulate discharges to water bodies to minimize harm from excessive flows. Maintenance protocols tend to be site-specific, depending on such variables as the annual quantity of rainfall, length of growing season, public expectations for aesthetics, and traffic volume. Accordingly, DOTs develop their maintenance strategies over time to balance performance, cost and disruption to highway operations while ensuring NPDES permit compliance.

Survey questions that made up this category included questions: 2, 3, 4, 8, 13, 16, 17, 30, 32, 33, 34, 35 and 36 (see Appendix for compilation of actual survey responses).

Twenty-four DOTs responded to the question of how many treatment BMPs are formally maintained. The responses ranged from none (4 DOTs) to 6,000 (1 DOT), with an average value of about 830 BMPs maintained. The median value is relatively low however at 96, indicating the average value is skewed by a few DOTs that have relatively large numbers of treatment BMPs.

The primary driver for the maintenance of treatment BMPs is the DOT's NPDES permit (over 87% indicated such). Maintenance frequency was reported as provided at timed intervals (66.7%) and on a statewide basis (50%). Fewer DOTs based maintenance frequency on geography or level of service.

Most DOTs (79%) have specific maintenance criteria for types of treatment BMPs (such as infiltration basins or vegetated swales). The criteria are generally developed by the DOT to support their approach (timing, equipment, crew skills) to maintenance. Common themes in how BMP maintenance criteria was developed included consultation with the design engineer, development of guidance based on other DOT maintenance manuals, experience and through site inspections.

About half of the DOTs responded that safety and accessibility were 'drivers' of BMP maintenance. Most noted that standard design protocols were employed that intrinsically include safety and accessibility.

Relative to specific issues such as dewatering, most DOTs (58%) do not have a protocol to eliminate standing water. This may be a reflection of the importance of vector control in the state that the DOT operates, since almost 92% of DOTs are not required to develop or deploy a vector control plan. However, in states where vectors are an issue, DOT BMP selection processes likely eliminate vector prone designs.

One of the more prominent issues the survey attempted to answer is how an inspection results in a maintenance activity – i.e., what is the maintenance trigger. The survey respondents noted that most often, an inspection that identifies a deficiency triggers a maintenance work order. How this work order is prioritized and completed varies from state to state. It appears many DOTs are

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working on automated maintenance tracking systems, but prioritization of the work remains a human-based decision.

Inspection frequency is also based on a variety of approaches. Some DOTs specified inspection frequency in their maintenance manual, others referenced the MS4 Permit and some based the frequency on experience. The DOT MS4 Permit appears to be the primary driver, with 9 out of 20 DOTs reporting a required inspection frequency in their NPDES permit.

A corollary to the inspection driver is an adaptive approach to BMP inspection frequency. Fully 85% of DOTs do not adjust the inspection frequency based on the results of the inspection program. This would logically appear to be due to NPDES Permits specifying the frequency in almost 50% of the respondents reporting. However, 80% of the respondents indicated that their Permit does allow the DOT to adjust maintenance frequency based on observed BMP operation in the field. Apparently, DOTs are not widely exercising the flexibility in their MS4 Permit to vary maintenance frequency, or perhaps they have not maintained BMPs for the minimum numbers of years required before adjusting the frequency. Ironically, about 95% of survey respondents indicated that maintenance frequency varies by location and type of BMP. There would appear to be the potential to better adapt inspection programs to reflect maintenance needs in the field.

Reported BMP inspection frequency varied widely. Of the twenty respondents, inspection frequencies ranged from once every five years to weekly. However, the most common response was annually (over 50%). It is likely that maintenance forces feel that annual inspection is a practical minimum that is also sufficient to correct BMPs with chronic issues.

Summary and Recommendations
DOT maintenance programs are generally characterized by a regular inspection schedule, written inspection criteria, and an affirmative response to identified deficiencies. Based on the survey responses, areas for future consideration include refining inspection frequency to better match BMP maintenance requirements and streamlining (automating) the identification of a maintenance need in the field, along with the generation of a work order to correct the identified deficiency. DOTs should also consider providing input to regulatory agencies regarding BMP inspection frequency in their renewal application of their NPDES Permit. Since many survey respondents indicated that maintenance frequencies are indicated in their Permit, the maintenance program would benefit from feedback to the regulatory agency in this area.

Training and Personnel

Personnel training is an important element of the maintenance process to ensure that maintenance is performed correctly and consistently. Personnel in maintenance functions have a broad array of duties that include specialized skills. Maintenance of BMPs is an example of a maintenance operation that requires specialized skills to ensure permit obligations are met.

Survey questions that made up this category included questions: 5, 6, 7, 14, 15, 18, 31, 37, and 44.

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Most DOTs have a formalized training program for maintenance personnel, although about 1/3 of respondents indicated they did not. Training frequency ranges from 'as-needed' to annually, and as personnel are hired. Most training was noted as completed at the statewide level (over 70%). Just over half of DOTs responding reported that a specific person is designated as responsible for BMP inspection and maintenance.

Almost 80% of DOTs responded that maintenance personnel have access to design documentation for the BMP when performing maintenance operations, and over 70% indicated that there was communication between the design engineers and maintenance staff to address unusual situations or BMP failures.

AASHTO recently (2015) published a flipbook-style Maintenance Stormwater Field Guide specifically for field maintenance personnel. This field guide was designed to be kept in field vehicles and provide basic maintenance protocols for treatment BMPs. About 70% of respondents were aware of this publication and 63% had seen it, but less than 20% had used it in day to day operations. Almost 13% of respondents were not aware of the guide.

Fully 80% of respondents indicated that inspection workflows were separate from maintenance workflows, indicating that these are treated widely as independent operations. About 85% of DOTs have guidance for inspectors on what should trigger a maintenance action, but only about 74% of respondents have a protocol for handoff from inspection to maintenance forces.

Summary and Recommendations

DOT training programs for maintenance personnel appear to be widely used. BMP maintenance and operation procedures are generally DOT specific, resulting in the need for DOT specific training programs. The frequency of training is generally tied to staff turnover, program size, and most importantly, program performance.

The AASHTO field maintenance publication has broad recognition but modest use, indicating that generalized guidance material may have limited industry appeal. Based on this conclusion, it may be best for future efforts should be directed at specific industry-identified issues rather than generic manuals.

Tools for Tracking and Reporting

Tracking and reporting of BMP maintenance is moving to automated systems for improved efficiency and to improve annual reporting to the state or federal environmental agency. Tracking and reporting systems are generally customized to reflect the practices at the DOT, making them expensive to develop and deploy, but beneficial once they are in operation.

Survey questions 9, 10, 11, 12, 29, 38, 39, 40, 41, 42, 43 and 45 were included in this category.

The overarching question in this category was to determine if the DOT used a database or other software to record and report on inspection and maintenance activities. Fully 83% of respondents indicated they used some sort of software to help track inspections and maintenance of BMPs. Responses ranged from commercial (off the shelf) database applications to custom-built ones

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utilizing GIS. Many reported that their department was currently undergoing modernization in this area.

Tracking completion of maintenance activities was generally accomplished using the inspection and reporting software. About two thirds of respondents indicated that there was a procedure (either automated or manual) to determine if a BMP had been inspected and maintained as required by the DOTs standard operating procedure (SOP), although only about 38% of DOTs had conducted an audit to assure BMP maintenance and/or inspection and verify protocols were being implemented as required.

The survey also recorded more nuanced information about DOT inspection and maintenance programs. Less than half of DOTs reporting (45%) indicated that their inspection program generated an assessment or level of service rating for the BMP. This type of information is important if the DOT has a performance dashboard or similar system for informing the public regarding DOT operations.

Another important area of interest for the survey was operation and maintenance (O&M) cost. Most DOTs track maintenance costs (63%), and many other DOTs are currently moving to track this data. It is interesting to note however, that fewer DOTs (about 25%) track the time spent inspecting and maintaining individual BMPs, indicating that costs that DOTs track for BMP maintenance and operation are aggregated and include equipment, overhead and materials. Only 37% of DOTs use effort or costs tracked to inform future maintenance budgets.

It is positive that 79% of DOTs responding indicated that they are using an asset management plan for stormwater infrastructure. These plans tend to be general in nature, however, since only 37% of those responding indicate that maintenance and inspection records are input to the asset management plan.

Summary and Recommendations
The use of asset management plans (Plans) by DOTs for stormwater programs will assist states in tracking, budgeting and forecasting costs for drainage infrastructure and NPDES program compliance. A traditional Plan includes information on the asset type, location, condition, remaining useful life and O&M costs. However, most Plans appear to be basic in application and lacking important data inputs to extract maximum value.

There appears to be a need for more internal audits by DOTs to assure BMP inspection and maintenance. There is also a need for more and improved level of service data for drainage and water quality infrastructure to allow DOTs to report the condition of assets to the public. Finally, there is a need to improve tracking of individual maintenance cost by BMP type to allow the industry to refine whole life costs for BMPs and refine maintenance procedures to reduce maintenance cost.

Program Administration

Program administration includes budgeting, obtaining and managing resources to operate and maintain BMPs. DOT stormwater program budgets have generally been increasing in recent

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years in response to new requirements in NPDES permits. Tracking and reporting program implementation costs, and accurately articulating future program needs is important to ensure permit compliance. This portion of the survey examined resource issues for DOT stormwater maintenance and operation programs.

Survey questions 19, 20, 21, 22, 23, 24, 25, 26, 27, and 28 were included in this category.

Most of the DOTs responding to the survey reported that they did not have a dedicated funding allocation for maintenance and operation of the stormwater program; rather, for over 85% of DOTs, it is combined or comingled with other (maintenance) programs. Seven DOTs tracked their stormwater maintenance budget. The average budget is about $2.6 million annually, and the median budget is $100,000 – the relatively high average figure reflecting the fact that one DOT has relatively large maintenance budget compared to other reported values (see Appendix A, Question 20).

Tracking the stormwater program maintenance and operation budget is important to understand the portion of O&M funds dedicated to this area, as well as the escalation of these costs year over year. Most DOTs (over 80%) have not made specific appropriations requests for the stormwater program O&M budget from their state legislature. This is consistent with the finding that most DOTs do not track the stormwater maintenance budget independently.

The funds for stormwater program O&M generally appear to be allocated on an ad-hoc basis within each DOT from the general maintenance fund. It is unclear how maintenance needs (between general maintenance and stormwater BMP maintenance) are prioritized based on the survey results. Since stormwater-only costs are not generally tracked, DOTs that report program expenditures to regulatory agencies must either estimate the costs, or over 60% of DOTs do not report such information.

The general lack of budget tracking for stormwater program O&M can result in deferred maintenance for BMPs if there are more than 'average' needs in a given year. About 52% of respondents indicated that BMP maintenance can be deferred if funding is not available. Generally, maintenance staff prioritize maintenance projects based on available funding. Emergency repairs and public safety are given the highest priority. About 35% of DOTs outsource (to an independent contractor) BMP maintenance and inspection activities. About 60% of DOTs outsource one or the other of these functions.

Summary and Recommendations

Based on the survey, it appears that costs for the operation and maintenance of stormwater BMPs at DOTs are not generally tracked independently from the overall maintenance and operations budget. This may be problematic for several reasons. First, it is important for the industry to understand the total cost of NPDES permit compliance. Maintenance of BMPs is a sizable portion of this compliance cost. Second, tracking maintenance costs by BMP type allows for a whole life cost to be computed for the BMP. This is useful in that it allows practitioners to specify the BMP with the lowest whole life cost for a given project. Finally, tracking operation and maintenance cost provides information that can be used to request appropriations to fund stormwater maintenance and operation programs, and to reduce future cost by identifying the large cost items and refining the BMP design or maintenance protocols.

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It is recommended that DOTs consider separating BMP maintenance costs in their budgeting process and include costs to maintain individual BMPs in their asset management program. This will allow practitioners to focus on BMPs that have the highest return on investment, and target practices that cannot be implemented efficiently.

FUTURE RESEARCH AND INFORMATION NEEDS

Listed below are synopses of suggested research and information needs to improve the implementation and performance of DOT stormwater BMP maintenance and operations. These suggested research needs were developed based on a review of the survey findings and discussion within the Community of Practice participants.

Inspections

The survey responses indicated that most DOT NPDES Permits allow flexibility in the scheduling of BMP inspections and maintenance, but that few DOTs take advantage of this option, preferring instead to assess all sites on a fixed schedule (usually annually). Future research should consider:
- Determine if a fixed maintenance schedule is efficient and effective.
- Determine how to refine inspection frequency to better match BMP maintenance requirements.
- Develop criteria to determine inspection frequency, and adaptive methods.
- Develop methods to prioritize identified maintenance deficiencies and automate the work order generation process.
- Explore BMP inspection 1) methods (e.g., drones, staff gages), 2) constraints (e.g., traffic, safety), 3) criteria (e.g., sediment depth in sump, percolation rate), and 4) the consequences of poor BMP O&M (e.g., flooding, failure, sediment resuspension, vector habitat, aesthetics).

Training

DOT training programs appear to be widely implemented, though some DOTs still need to develop their programs. Currently, there do not appear to be good metrics to help guide training frequency. Investigation would be useful to:
- Establish a schedule for basic maintenance training for personnel.
- Develop metrics tying BMP performance to maintenance training.
- Identify the most efficient methods for training delivery.

Program Administration and Asset Management

The use of asset management plans by DOTs will assist them in tracking, budgeting and forecasting costs for drainage infrastructure and NPDES program compliance. However, most states have not fully developed such plans, and assistance would be beneficial in the following areas:
- Define asset management plan structure and features for stormwater infrastructure.
- Develop tools for 1) predicting BMP inspection and/or clean-out frequencies, and 2) tracking stormwater maintenance costs.
- Develop cost estimates for maintenance by BMP type.

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ACRONYMS AND ABBREVIATIONS

The following acronyms and abbreviations are used in this report:

AASHTO	American Association of State Highway and Transportation Officials
ACWA	Association of Clean Water Agencies
ADT	Average Daily Traffic
ALDOT	Alabama Department of Transportation
BMP	Best Management Practice
Caltrans	California Department of Transportation
CDOT	Colorado Department of Transportation
CoP	Community of Practice
DelDOT	Delaware Department of Transportation
DEP	Department of Environmental Protection
DES	Department of Environmental Services
DNR	Department of Natural Resources
DOT	Department of Transportation,
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
IDDE	Illicit Discharge Detection and Elimination
MOU	Memorandum of Understanding
MS4	Municipal Separate Storm Sewer System
NEDC	Northwest Environmental Defense Council
NEPA	National Environmental Policy Act
NHDOT	New Hampshire Department of Transportation,
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Units
NYSDOT	New York State Department of Transportation
ODOT	Oregon Department of Transportation
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
pH	A measure of acidity/alkalinity
ROW	Right-of-Way
SR	State Route
TAPE	Technology Assessment Protocol – Ecology
TMDL	Total Maximum Daily Load
WisDOT	Wisconsin Department of Transportation
WLA	Waste Load Allocation
WSDOT	Washington State Department of Transportation

APPENDIX A: SURVEY RESULTS

BMP Maintenance Basics

Question 2. What is your DOT's maintenance and operations based on?

- Geographic: 29.17%
- Statewide: 50.00%
- Level of service: 37.50%
- Performance thresholds: 41.67%
- Timed intervals: 66.67%
- Stormwater permitting: 87.50%

Question 3. How many water quality and/or quantity treatment BMPs does your DOT own, operate, and maintain statewide?

- 0
- 10
- 22
- 53
- 56
- 58
- 59
- 75
- 92
- 100
- 534
- 800
- 840
- 1000
- 1854
- 2000
- 2100
- 6000

Question 4. Does your DOT have specific maintenance criteria for individual BMPs or BMP types?

- Yes: 79.17%
- No: 20.83%

Question 8. How are your maintenance and operations criteria determined?

- Performance, time interval, and permit requirements.
- The DOT maintains written procedures outlining BMP inspection and maintenance criteria. As modifications are needed, the DOT updates these procedures to address any needed changes.
- Time intervals and performance.
- The DOT has developed a publication for inspection and maintenance of our stormwater control measures. The standards and criteria are based on reviews of various other state manuals and guidelines.
- Based on needs determined by asset management tools.
- Standard criteria were developed cooperatively between hydraulics and maintenance staff.
- The DOT has guidance that it developed based mainly on the state stormwater manual.
- As needed. The area superintendent conducts the weekly surveillance and an annual review.
- Maintenance of BMPs is prioritized based on safety concerns and by available funding.

Question 8. How are your maintenance and operations criteria determined?

- In consultation with a BMP design engineer, key inspection and maintenance criteria by BMP type are identified, with the goal of keeping the device type functioning as intended.
- Based on visual inspection.
- By BMP inspection ratings for functionality and by action ratings.
- Visually.
- They are defined in the DOT's highway runoff manual
- Per the BMP and benchmarks after installation.
- Under the DOT specification for plant warranty.
- Standards are in the BMP operation and maintenance manual.

- From design and operation literature with evaluation by the senior environmental engineer.
- The DOT has a consultant inspect them annually. Transitioning to regional operation and maintenance staff taking over, but it has not happened yet. My unit reviews the consultant's report and determines whether maintenance is required.
- Fiscal year budget and on regulatory frequency required.
- Annual inspection and case-by-case.
- Ratings system based on a condition inspection and assessment.
- The DOT is still working on completing operation and maintenance criteria, based out of our headquarters unit.
- By inspection every other year.

Question 13. Do you have design criteria requirements (safety and accessibility, right-of-way, lane closures, etc.) or other activities that drive BMP maintenance and operation?

- Yes: 50.00%
- No: 50.00%

Question 16. Is there a design standard for dewatering BMPs to prevent standing water?

- Yes: 41.67%
- No: 58.33%

Question 17. Are you required to employ a vector control plan?

- Yes: 8.33%
- No: 91.67%

Question 30. How does an inspection result in a maintenance activity?

- Los rating and/or maintenance need reports filed during an inspection.
- The DOT is starting a pilot program with view works software.
- If the inspection identifies a corrective maintenance need, a designated person at the district office creates a notification in SAP, which is used by the county maintenance manager (or designee) to create a work order and schedule the work.

- Assets rated as poor are reported to maintenance to schedule work. The DOT is currently developing an automated inspection and work order program.
- After inspection, any deficiencies are noted in the inspection report, and then the stormwater staff works with maintenance staff to complete needed maintenance.
- Unknown.
- Inspections generate work orders for maintenance activities.

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Question 30. How does an inspection result in a maintenance activity?

- The inspection report identifies the needed maintenance, and this is recorded in the stormwater control management system database.
- Inspector coordinates with local maintenance staff.
- Work orders are developed and provided to the contractor.
- Inspection shows need. Maintenance staff or contractors then can perform the task.
- If a deficiency is noted in the highway activity tracking system database, a maintenance activity is generated.
- Inspection happens. If there is funding, maintenance follows.
- Crew determination based on priorities.

- Maintenance activity is initiated when maintenance work is identified.
- The inspection and maintenance databases are linked, so that a query produces a list of maintenance needs.
- Review by our unit and assignment to operation and maintenance.
- Example – if a sediment pond has too much sediment accumulation, or vegetation is growing in the pond, the DOT requests maintenance.
- Condition assessment and rating.
- The DOT is trying out a new system, where the inspector can write a work order for maintenance.
- If the inspection "fails" the BMP due to functional issues like drainage, trash, trees, sediment, etc.

Question 32. What determines inspection frequency (such as Permit provision, internal experience or needs, etc.)?

- Experience and needs.
- Internal experience.
- Other than a startup period following construction, most are on a regular triennial (every three years) inspection cycle. If experience with the specific BMP indicates that more frequent inspection is needed, the cycle is changed for that BMP.
- Inspection frequencies are defined in the implementation and maintenance manual. Development and maintenance of the implementation and maintenance manual is an NPDES permit requirement.
- Internal program requirements.
- MS4 permit.
- Permit requirement, which can be adjusted based on experience.
- NPDES municipal stormwater permit.
- Warranty period.
- Recommend annual inspection.

- Permit provisions at a minimum and internal experience for more frequent inspections as needed.
- Prescribed maintenance schedules.
- Default inspection frequency is per the BMP operation and maintenance manual. Can be revised by the designer or maintenance staff.
- Permit provision internal experience.
- Inspections are conducted annually, as required by stormwater permit requirements.
- Currently, the DOT has a consultant do it annually but is transitioning to be done by assigned and trained operation and maintenance staff.
- Permit provision, internal experience.
- State stormwater regulations.
- Permit requirements.

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Question 33. Is frequency of inspection, maintenance and repair static or adjusted as inspected?

- Repair frequency is static: 15.00%
- Repair frequency is adjusted as inspected: 85.00%

Question 34. Does your regulator allow (via permit provision) the repair schedule be adjusted based on experience?

- Yes: 80.00%
- No: 20.00%

Question 35. Does repair frequency vary by location and/or type of BMP?

- Yes: 95%
- No: 5.00%

Question 36. How frequently do you inspect BMPs?

- It varies, but at least annually.
- Once every 1–5 years.
- After the initial startup period following construction (which varies by BMP), most are on triennial cycles.
- Most BMP types are scheduled to be inspected annually.
- Annually.
- Every three years.
- It varies, ranging from annual to one to five years.
- Twice a year.
- At least annually, or more frequently as warranted.
- It varies. Most are at least annually.
- Daily informal inspections and weekly formal inspections.
- Varies depending on the BMP.
- Annually or once per permit term, depending.
- Once every five years is maximum; usually more like every two to three years.

Training and Personnel

Question 5. What BMP maintenance training do you perform for staff, how is it performed, how often, and by whom?

- Annually by district stormwater certification every for years by central office.
- It varies. Our roadside environmental unit staff perform individual training, regional training sessions, workshops, and annual refreshers. Some staff also take certified BMP inspection and maintenance courses.
- BMP operation and maintenance trainings are not yet formalized.
- The DOT started offering inspection training in 2017. Maintenance training for
- Annual training is instructed by maintenance environmental coordinators in each region, and annual statewide training by the office of environment.
- The DOT has not held a training in some time. Our environmental agency offers maintenance training from time to time.
- Developed a post-construction BMP operation and maintenance manual. No scheduled training.
- Annual training provided by the construction bureau. There is a two-hour

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Question 5. What BMP maintenance training do you perform for staff, how is it performed, how often, and by whom?

county maintenance staff is planned for development in 2018.

- Instructor-led, classroom-based training is held about once a year. Roadside environmental unit staff within the NPDES program perform the training. Individualized training is also available upon request.
- BMP maintenance guides have been developed and are currently discussed with staff as BMPs come online.
- The only type of training offered is an annual presentation at a maintenance seminar by the engineers that have developed maintenance manuals.
- Training for inspectors.
- Headquarters maintenance staff provide statewide training as needed based on a developed curriculum.
- Training is outsourced and has not been done in a long time.
- No training has been done other than on-the-job drainage maintenance training.
- Annual and as-needed training is performed by our stormwater technical staff and given to maintenance staff at various levels.

classroom session, as well as a two-hour field training.

- DOT maintenance staff are trained to maintain temporary BMPs.
- The DOT does not. Of the 53 BMPs, 42 are filter buffers with level lip spreaders and sediment retention-routine operation and maintenance. The other 11 are structures are maintained with onsite direction by our unit.
- District-specific training with guidance from the state regulatory agency.
- None. The DOT has only seven that it maintains that require anything other than vac truck, mowing or excavation. Those are as directed by our unit staff.
- Most are simple filter buffers with and without level lip spreaders. For the seven that are either commercial structures or biofiltration structures, there is direct oversight of maintenance by our office.
- As needed, typically performed by central office and consultants.
- Starting a new training program by the state university extension service.
- No specific maintenance BMP training is offered. Meetings with staff and discussions on needs of certain BMPs occur following inspections.

Question 6. Does training occur at the district or statewide level or both?

- District level: 29.17%
- Statewide level: 29.17%
- Both district and statewide levels: 41.67%

Question 7. Does your DOT designate a specific person as the point of contact within a given geographic region as the individual responsible for "day-today" BMP inspection and maintenance operations?

- Yes: 58.33%
- No: 41.67%

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Question 14. Is BMP design documentation accessible to determine how BMPs should be maintained (as necessary)?

- Yes: 79.17%
- No: 20.83%

Question 15. Is there a communication process between hydraulic engineers and maintenance staff to address BMP maintenance and operational failures?

- Yes: 70.83%
- No: 29.17%

Question 18. Are you aware of, seen or used the AASHTO Maintenance Stormwater Flip Guide?

- Yes, I am only aware of the flip guide: 8.33%
- Yes, I am aware of and seen the flip guide: 62.50%
- Yes, I am aware of, seen, and used the flip guide: 16.67%
- No: 12.50%

Question 31. Does your DOT separate inspection workflows from maintenance workflows?

- Yes: 80.00%
- No: 20.00%

Question 37. Do you have guidance on what triggers BMP maintenance?

- Yes: 85.00%
- No: 15.00%

Question 44. Do you have a protocol for BMP handoff from construction to maintenance?

- Yes: 73.68%
- No: 26.32%

Tools for Tracking and Reporting

Question 9. Do you use a software/database (such as an asset management system) for inspections and maintenance activities? If yes, what do you use?

- Yes: 83.33%
  - Microsoft Excel.
  - SCMS, MMS.
  - It is a customized application called Maintenance-IQ. It runs on an ESRI platform with an SQL database.
  - Custom developed, web-based application specific to the BMP I&M program.
  - ArcMap with the Collector and Survey 123 mobile apps.
  - RoadMap.
  - Currently, the DOT uses a Microsoft Access database but will be converting to an ESRI asset management software.
  - AIMS/MATS proprietary database.

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Question 9. Do you use a software/database (such as an asset management system) for inspections and maintenance activities? If yes, what do you use?

- o Internally developed ECO-Database.
- o NPDES SWM and drainage inventory database.
- o For some parts, but not all.
- o Highway Activity Tracking System database.
- o City Works, and this is only after two years of BMP installation.
- o Microsoft Access database for tracking inspections and maintenance.
- o Currently use a combination of Excel and GIS for inspection/compliance tracking; will be starting to use GIS for inspections, a combination of Excel, and a daily work reporting software for maintenance activities.

- o MATS (not sure if that is a ME maintenance and operations program or used in other states).
- o MATS is our maintenance and operations database.
- o ArcGIS Online (considering integration with the Department's AMS).
- o Transportation Management System (TMS).
- No: 16.67%

Question 10. How do you track the completion of maintenance activities?

- Each district keeps its own records.
- Existing database, management systems, contracts, as appropriate.
- The DOT uses asset tracking software called Maximo.
- A work order is created in SAP. When the work is completed, the work order is closed. It is not very efficient or completely accurate, but it is a start.
- Maintenance activities for each BMP are recorded in the database application – "stormwater control management system."
- Our eco-database software.
- Routine maintenance is not well tracked; only major remediation, separately and linked to the database (much of this under development).
- Database.
- In our highway activity tracking system database.
- City works.
- Using a geographic information system (GIS) database that records the inspection

- Inspection and maintenance logs.
- A combination of Microsoft Excel and daily work reporting software.
- Not very effectively.
- Once the activities are completed, they are entered in a roadmap.
- Weekly work reports.
- The area offices maintain the weekly work logs.
- Maintenance activities are tracked in the Microsoft Access database and in a management of asset maintenance software.
- In a MATS database system.
- Statewide database and district-specific spreadsheets if they are maintained for regulatory compliance requirements.
- Database.
- SAP software database system.
- The DOT has one point of contact to tell when they are finished.

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Question 10. How do you track the completion of maintenance activities?

information using a mobile app interface,
like Collector or Survey 123.

Question 11. Does your DOT have automated or manual procedures for identifying BMPs which have not been inspected and/or maintained at the required frequency?

- Yes: 66.67%
- No: 33.33%

Question 12. Has your DOT conducted an internal audit to assess the adequacy and performance of the BMP inspection and maintenance program?

- Yes: 37.50%
- No: 62.50%

Question 29. Does your DOT's inspection program generate a functional assessment rating (such as a level of service rating) for each BMP?

- Yes: 45.00%
- No: 55.00%

Question 38. How much time is spent inspecting and maintaining BMPs per year? If per BMP cost or FTEs/year is available, please provide this information as well.

- Varies.
- Information not available.
- The DOT does not have data on this yet.
- Work time function codes specific for BMP maintenance are generally not available.
- Minimal due to small number of BMPs currently online.
- This information is not easily available.
- Varies by district.
- The DOT does not track this.
- Unknown.
- In 2016, there were 997 labor hours; $56,991 was spent on labor and equipment costs.
- There are for FTEs that oversee inspection and maintenance of BMPs as part of their job duties.
- Unknown.
- Unknown; over 2000 hours.
- 105 hours. Of consultant, approximately $10,000 per year; 20 hours of staff time.
- It is not tracked separately, so have no idea.
- Do not know.
- Not yet tracked well.
- One intern inspects during the summer every two to three years.

Question 39. How does your DOT track or estimate BMP maintenance costs?

- MMS.
- The DOT is just starting to roll out an asset management program for this.
- The DOT does not currently track maintenance costs but plans to in the future. If a contractor is doing the work, BMP maintenance costs are estimated
- BMP maintenance, including inspection, is tracked as an activity in teams (transportation environment accounting and management system). Inspection cost versus maintenance cost is estimated by data analysis.
- Spreadsheets.

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Question 39. How does your DOT track or estimate BMP maintenance costs?

- similarly to construction costs. Costs are generally not estimated if done by county forces.
- BMP maintenance costs are generally not tracked separate from other roadside maintenance activities.
- To be determined as more are developed.
- In the database.
- Varies by district.
- Develop a work unit cost based on past biennial expenditures.
- Time and materials.
- Developing a new enterprise asset management system (EAMS) to track these costs.
- Database tracks cost history of each item.
- The DOT has not tracked the cost.
- Costs are tracked through a maintenance of asset management software.
- Based on experience and previous budgets
- Currently not done. Moving forward with database enhancements to allow for this.
- By work orders.

Question 40. Do you track maintenance effort by individual BMP?

- Yes: 68.42%
- No: 31.58%

Question 41. If tracked, are costs used for future maintenance needs?

- Yes: 36.84%
- No: 31.58%
- No, maintenance efforts are not tracked: 31.58%

Question 42. Does your DOT use an asset management plan?

- Yes: 78.95%
- No: 21.05%

Question 43. Do you input the maintenance and inspection records in your asset management system (if you have one)?

- Yes: 36.84%
- No: 42.11%
- No, I do not have an asset management plan: 21.05%

Question 45. Do you track maintenance effort by individual BMP?

- Yes: 68.42%
- No: 31.58%

Program Administration

Question 19. Do you have a dedicated funding source (earmarked) or is it comingled with other maintenance funds?

- Dedicated funding (earmarked) source: 14.29%
- Co-mingled with other maintenance funds: 85.71%

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Question 20. What is your annual maintenance budget for stormwater BMPs?

- 0
- 25000
- 30,000
- 46,000

- 100,000
- 1,500,000
- 1,900,000
- 15,000,000

Question 21. Was a specific DOT agency budget request initially made for maintenance and operations of stormwater BMPs?

- Yes: 19.05%

- No: 80.95%

Question 22. Were appropriations provided by the legislature for this purpose?

- Yes: 14.29%

- No: 85.71%

Question 23. If appropriations are provided by the legislature, are they ongoing or do agency requests need to be made every biennium or fiscal year?

- They are ongoing: 4.76%
- Requests need to be made every biennium or fiscal year: 9.52%

- Appropriations are not provided by the legislature for this purpose: 85.71%

Question 24. How does your DOT structure these funds compared to other maintenance needs?

- It varies.
- Maintenance needs are prioritized from year to year.
- Funds used to maintain BMPs are comingled with other roadside environmental maintenance funds.
- No differentiation of funds for stormwater BMP maintenance.
- They are often secondary.
- Varies by district.
- Separate funding allotment for NPDES needs.
- A certain amount is awarded, and once the contractor runs out, maintenance is over until more funding is available.
- Districts and regions set priorities for maintenance funds and needs.
- These funds are kept separate from other maintenance needs.

- Unknown.
- Initial funding is by the legislature for only equipment and personnel to start the program. Stormwater maintenance is currently part of the overall maintenance budget.
- From the maintenance fund.
- It varies by region; some have dedicated funds, while others do not.
- Out of our general state fund.
- The same.
- Commingled.
- This is up to our maintenance department.
- All maintenance needs are comingled, and Maintenance determines which needs to be done first and when equipment is available.

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Question 25. Are actual or estimated maintenance and operations expenditures reported to regulators?

- No: 61.90%
- Yes, actual expenditures are reported: 9.52%
- Yes, estimated expenditures are reported: 28.57%

Question 26. How did your DOT determine the amount of funds needed for these activities?

- Experience.
- Estimated from maintenance contracts.
- Annual estimates are made based on experience in each division.
- Undetermined at this point in our program.
- Based on the BMP rating functionality and historical cost of the certain activities.
- Varies by district.
- Inventory and unit costs.
- Unknown.
- Funds come directly out of the operations budgets. Crews projections based on prior years.
- Based on past maintenance done.
- Does not determine.
- Based on experience, personnel and equipment were identified and added to each district's budget.
- Roadmap.
- Regions use rate charts and prior contracts to determine maintenance costs.
- Past use of the same or similar BMPs and anticipated costs.
- Condition assessment and rating.
- It is based on the previous year's amounts, but the DOT is improving our tracking to obtain more funds.
- Work is done; no budget.

Question 27. If funding is limited, are all BMPs still maintained?

- Yes: 52.38%
- No: 47.62%

Question 28. Does your DOT outsource to private vendors the BMP inspection and/or maintenance activities?

- Yes, inspection activities: 10.00%
- Yes, the maintenance activities: 15.00%
- Yes, both activities: 35.00%
- No: 40.00%

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