

Eastern Washington Stormwater Effectiveness Studies

Quality Assurance Project Plan:

BMP Inspection and Maintenance Responsibilities for Privately Owned Facilities

Study Classification:

Structural BMP Operational BMP Education & Outreach

Study Objective(s):

Evaluate Effectiveness Compare Effectiveness



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Quality Assurance Project Plan Publication Information

This Quality Assurance Project Plan (QAPP) will be available to the public on the Yakima County Public Service webpage: <http://www.yakimacounty.us/1732/Stormwater-Management>
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Document History

Due to the nature of this study, this document was developed using a combination of the Eastern Washington (EWA) Detailed Study Design Proposal and Quality Assurance Project Plan Templates for Operational Best Management Practices (BMPs) and Education and Outreach BMPs. A copy of the template is located at wastormwatercenter.org/ew-effectiveness-studies/.

The Detailed Study Design Proposal (Proposal) was submitted to the Washington State Department of Ecology (Ecology) on June 30, 2017. Ecology approved the Proposal via email to Yakima County on November 9th, 2017. Appendix A contains a copy of the email along with Ecology's comments on the Proposal.

Yakima County submitted a draft Quality Assurance Project Plan (QAPP) to Ecology on May 8, 2018. Ecology responded with comments on June 27, 2018, which include revisions that are necessary for approval of the QAPP. Appendix B contains a summary of Osborn Consulting, Inc. (OCI) responses to Ecology's comments including how the comments are incorporated into the QAPP. The QAPP was reviewed by members of the Technical Advisory Group (TAG) in November 2019. Appendix C contains a summary of the TAG's comments along with the responses to those comments, including how the comments were addressed in this document. The second draft of the QAPP was submitted to Ecology in December of 2019. The QAPP was then updated in December 2020.

Signature Page

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2.0 Executive Summary

Under the National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit for discharges from Municipal Separate Storm Sewer Systems (MS4s), municipalities and other jurisdictions designated by Washington State Department of Ecology (Ecology) in Eastern Washington (EWA) that manage discharges from their MS4s are regulated by the Eastern Washington Phase II Municipal Stormwater Permit program. One of the ways that Permittees are required to manage stormwater is to limit the amount of pollutants that discharge from the MS4s by implementing operational and structural Best Management Practices (BMPs) for publicly owned and privately-owned drainage systems. Over time, the effectiveness of structural BMPs can become compromised unless the BMP is properly maintained. Permittees are required to ensure maintenance is performed as required by the NPDES permit so that structural BMPs operate and provide the intended runoff treatment and flow control functions.

Difficulties can arise for Permittees when they try to identify and correct operational and maintenance problems with structural BMPs on private property. While this problem is clearly documented in related literature, few studies were located that describe strategies related to inspection, maintenance, and enforcement of structural BMPs on private property. Of the studies located, none reported on the effectiveness of those strategies.

The goals of this study are to identify commonly used inspection, maintenance, and enforcement strategies for privately owned stormwater BMPs and evaluate the effectiveness of those practices. These goals will be achieved by gathering information from EWA Permittees and other jurisdictions with similar inspection, maintenance, and enforcement (O&M) NPDES MS4 requirements, preferably in semi-arid regions. The information will be gathered using an online survey, followed by conducting interviews with some of the survey respondents to gain additional insight on responses.

The results from this study will inform municipalities of effective strategies for executing O&M plans in their jurisdictions to support permit compliance of privately-owned structural BMPs. This could lead to the development of recommendations for a prototype O&M program or draft O&M manual that individual jurisdictions could adopt when appropriate. Alternatively, findings from the project could be used to inform an Education and Outreach (E&O) program that would improve the decision-making of municipal stormwater operators, increase the effectiveness of their programs, and reduce municipal O&M expenses.

3.0 Background

3.1 *Introduction to the Operation & Maintenance Program*

This study will identify and evaluate procedures developed by other jurisdictions to meet inspection, maintenance, and enforcement (O&M) permit requirements for structural best management practices (BMPs) on privately-owned property. According to the 2007, 2014, and 2019 versions of the EWA Phase II Municipal Stormwater Permit (Washington State Department of Ecology, 2019), permittees are required to implement procedures for site inspection and enforcement of post-construction control measures. Specifically, permittees must implement mechanisms that allow access for permittees to inspect stormwater BMPs on private properties that discharge to the MS4. In lieu of requiring continued access, the mechanisms may require private property owners to provide annual certification by a qualified third party that adequate maintenance has been performed and the facilities are operating as designed to protect water quality (S5.B.5.b.iii). Additionally, permittees are required to implement an ordinance or other regulatory mechanisms to ensure adequate on-going long-term O&M of BMPs is approved by the permittee (S5.B.5.b.iii.c).

As a permittee, Yakima County is subject to the above-mentioned requirements of the 2019 EWA Phase II Municipal Stormwater Permit. According to Yakima County's ordinances (Yakima County, 2019) and the Yakima County Regional Stormwater Manual (Yakima County, 2010), the County's primary approach to meeting requirements for BMPs on private properties is to delegate responsibility of O&Ms to the private property owner. The owner is required to create a County-approved O&M Plan in accordance with the provisions in the Yakima County Regional Stormwater Manual. This manual further outlines the required components of the O&M plan for all structural BMPs on private property including that the private property owner must maintain a copy of the O&M plan on site and follow the practices in the plan. Yakima County then conducts inspections of the structural BMPs on the property and takes enforcement actions as necessary to ensure BMPs are operated and maintained as required.

In addition to the method used by Yakima County, there are multiple strategies currently employed by other permittees for inspection and maintenance of privately owned BMPs involving combinations of third-party inspectors, contractors, and municipal staff. Commonly, the private party that owns the BMP is responsible for all maintenance; however, there may be other strategies or models, such as public ownership and maintenance responsibility, which could support better long-term performance of BMPs. The following five potential strategies were identified during a preliminary investigation conducted by Yakima County which involved discussions with multiple other permittees in Washington State as well as input from members of the study technical advisory group (TAG).

- 1. Permittee or Non-Permitted Jurisdiction Inspection/Contractor Maintenance -** Permittee on non-permitted jurisdiction performs inspection of structural BMPs but requires the property owner to hire a qualified contractor to conduct necessary maintenance and provide proof that the maintenance has been completed.
- 2. Third Party Inspector/Contractor Maintenance -** Permittee or non-permitted jurisdiction requires structural BMP owners to contract with a third-party inspector and

provide an inspection certification letter to the Permittee or non-permitted jurisdiction, as well as proof that any required maintenance has been completed.

3. **Permittee or Non-Permitted Jurisdiction Inspection/Permittee or Non-Permitted Maintenance** - Permittee or non-permitted jurisdiction performs maintenance but the BMP remains under private ownership and the property owner pays the Permittee or non-permitted jurisdiction for the service.
4. **Property Owner Inspects/Property Owner Maintains** – Property owner both inspects and maintains the BMP on their property.
5. **Variable Inspection/Variable Maintenance** - Property owner is given the option to provide access to the Permittee or non-permitted jurisdiction for inspection or to hire a third party or contractor to inspect BMP(s). Property owner is given the option to provide access to the Permittee or non-permitted jurisdiction for maintenance or to hire a third party or contractor to maintain BMP(s)

.

These five potential strategies as well as others that may be identified during this study will be evaluated as part of this Effectiveness Study.

3.2 Problem Description

Structural stormwater BMPs can mimic the natural hydrology and reduce discharge of pollutants (Blecken, Hunt, Al-Rubaei, Viklander, & Lord, 2015). However, when stormwater BMPs are not maintained properly, the benefits of implementation are reduced or are nonexistent if the BMP has failed. Stormwater volumes and pollutants that were otherwise captured by the BMP can pass through BMPs with reduced function. The financial investment made for the stormwater BMP is wasted when the BMP does not function as designed or paid for. Additionally, Erickson et al. (2013) reported that maintenance of structural BMPs (primarily detention facilities and pipe networks) occurs too infrequently to ensure performance and that improved inspection protocols could lead to an overall reduction in maintenance costs.

It is clear from discussions with the EWA Stormwater Coordinators' Group, as well as guidance documents published by municipalities in other states, that the challenge of long-term BMP inspection and maintenance is not unique to EWA. The Environmental and Water Resources Institute (EWRI) of the American Society of Civil Engineers founded the Stormwater BMP Task Committee in 2010 *"to further the current state of knowledge pertaining to operation and maintenance of structural stormwater BMPs"* (Environmental & Water Resources Institute, 2012). Privately owned structural BMPs represent a unique problem for ensuring long-term design-based performance because of O&M issues. Results from the EWRI Stormwater BMP Task Committee indicate that there is no consensus on the best approach for designating responsibility for maintaining privately owned BMPs. Specific complications identified in other studies (Blecken, Hunt, Al-Rubaei, Viklander, & Lord, 2015) include the following:

1. Lack of access for inspection, either due to lack of permission to enter private property or difficulty accessing the location of the BMP
2. Lack of understanding of how to inspect and maintain the BMP

3. Unclear and/or changing ownership of the property and BMP
4. Lack of incentive or sense of responsibility for the private property owner
5. Limited funding, either for the municipality or the private property owner

3.3 *Results of Prior Studies*

Few studies have been conducted relating to inspection and enforcement of O&M requirements for stormwater BMPs, particularly BMPs located on private properties. Further, no studies were found that evaluate effectiveness of inspection, maintenance, and enforcement strategies for stormwater BMPs on private properties. Studies and information that were found identified two categories of approaches that may support a successful O&M program for BMPs on private property: 1) education or communication between parties and 2) incentives proposed to private property owners or developers. In addition, a study was located that identifies differences in O&M programs between jurisdictions. This section provides a summary of the information that was located regarding inspection and enforcement of O&M requirements.

3.1.1 Education or Communication Between Parties

- In Baton Rouge, communication of inspection and maintenance requirements is fostered in the form of a covenant (City of Baton Rouge, 2012). The covenant includes a schedule of maintenance proposed by the developer or owner that is consistent with local maintenance requirements and is submitted to the local municipal inspection division prior to final occupancy of the property.
- Rafter (2000), also discusses communication between developers and municipalities during the design process. In Lake County, Illinois, the agreement between the developer or owner is created before the developer qualifies for a permit, and “should point out an adequate source of funding to implement maintenance tasks in perpetuity”. Communication following the design process is also discussed: Lake County inspectors invite people who represent the private owner responsible for maintaining the BMP to perform joint inspections of the BMPs. This method allows the County to resolve any issues that arise with the party responsible for the BMP on-site or provide guidance to the party if necessary.
- Rafter (2000) and Richardson (2019) discuss education and public outreach programs to provide private owners with the knowledge necessary to perform maintenance. Educational programs in Lake County consist of workshops held two to three times per year which are geared towards homeowners’ associations. Manufacturers of proprietary BMPs also provide workshops for County or other local maintenance staff. Richardson (2019) also identifies workshops and hands-on training for local maintenance staff as key elements of municipal programs for stormwater BMPs to ensure structural BMPs are inspected and maintained properly.

3.1.2 Incentives Proposed to The Private Property Owner or Developer

Doll (1998) provides examples of credits towards stormwater or utility fees if private property owners maintain the BMPs on their property. The municipalities which implement the credit

system continue to inspect the BMPs on private property to ensure proper maintenance is performed by the private owner. These credits have been observed as one of the most common policy trends amongst developed countries with complex regulations related to urban stormwater and may improve O&M compliance with BMP owners (Aldous & Buys, 2009).

3.1.3 Differences in O&M Programs Between Jurisdictions

An article from the State of North Carolina surveyed local governments regarding inspection, maintenance, and enforcement practices for stormwater BMPs within the jurisdictional limits (Bruce & Barnes, 2008). Bruce and Barnes (2008) found that local municipalities differed in the way they oversaw the planning, installation, and monitoring of BMPs. However, the majority left maintenance responsibilities to the landowner – either private or public. With respect to conducting studies, the researchers cautioned on limited response rates from an electronic survey sent via email invitation. Researchers found they needed to personally contact (via phone) and recruit to get response rates of 36% (of 164 jurisdictional stormwater managers) of North Carolina jurisdictions ultimately participating.

3.4 Regulatory Requirements

This study is being conducted to meet the requirements of the 2014 EWA Phase II Municipal Stormwater Permit issued to Yakima County by the Washington State Department of Ecology (Ecology). According to Section S8.A of the permit, each city and county permittee covered by the permit is required to collaborate with other permittees to select, propose, develop, and conduct Ecology-approved studies to assess, on a regional or sub-regional basis, effectiveness of permit-required stormwater management program activities and best management practices. Yakima County is proposing to be the lead entity for the following effectiveness study: BMP Inspection and Maintenance Responsibilities Study. The following sections of the permit (Washington State Department of Ecology, 2019) are specifically addressed by this investigation:

- S5.B.5 Public and Private Projects Review, Inspection, & Compliance – Permittees are required to provide “provisions for both construction-phase and post-construction access for Permittees to inspect stormwater BMPs on private properties that discharge to the MS4”. Additionally, Permittees may “require private property owners to provide annual certification by a qualified third party that adequate maintenance has been performed and the facilities are operating as designed to protect water quality” instead of requiring continued access onto private properties.
- S5.B.6 Municipal Operations and Maintenance - According to the permit, “permittees shall implement an operation and maintenance program that includes a training component and has the ultimate goal of preventing or reducing pollutant runoff from municipal operations” (Washington State Department of Ecology, 2019).

4.0 Project Overview

4.1 Study Goal

The goals of this effectiveness study are to identify commonly used inspection, maintenance, and enforcement strategies for privately owned stormwater BMPs and evaluate the effectiveness of those strategies. The effectiveness will be evaluated based on comparing elements of the jurisdictions strategy to elements identified through a literature search that appear to support a successful program. The results from this study will inform municipalities of effective strategies for executing O&M programs that support compliance with the jurisdictions requirements for privately-owned structural BMPs. This could lead to the development of recommendations for a prototype O&M program or draft O&M manual that individual jurisdictions could adopt when appropriate. Alternatively, findings from the project could be used to inform an Education and Outreach (E&O) program that would improve the decision-making of municipal stormwater operators, increase the effectiveness of their programs, and reduce municipal O&M expenses.

4.2 Study Description and Objectives

The study will identify jurisdictions in Washington and other areas with similar O&M NPDES MS4 permit requirements. Study participants will preferably be from areas with similar semi-arid climates as well and the targeted number of participants who complete the survey is thirty. The participating jurisdictions will take a survey regarding their inspection, maintenance, and enforcement practices for structural BMPs located on private property. The survey questions are intended to identify the breadth of strategies applied by the participating jurisdiction, collect information needed to identify which strategies are more effective, and identify participants for interviews. Specifically, participants will be asked to provide a self-assessment of their jurisdiction's performance related to specific elements of their strategy and their responses will be compared to elements, identified in the literature, that appear to support a successful program (Table 8.1). These elements include cost, ease of access to BMPs, the jurisdictions staff understanding of O&M protocol, private property owner's understanding of responsibilities and compliance, etc. In addition, questions are included in the survey that may identify unique components of a jurisdictions O&M strategy including benefits, challenges, and improvements the jurisdiction identifies for their strategy. Finally, the responses given in the survey will guide the selection of participants to interview and the development of interview questions.

Ten to fifteen of the surveyed participants will be selected to interview in order to gather additional data, develop a better understanding of the jurisdictions strategies for inspection, maintenance, and enforcement procedures, and to evaluate the effectiveness of the strategy. Effectiveness of the strategy will be evaluated by comparing the combined participants responses to elements identified as part of a successful program from the literature (Table 8.1) to the actual elements of the strategy implemented by the jurisdiction. Additionally, the interviews will be used to develop a better understanding of the advantages and disadvantages of the jurisdiction's strategies described in their survey. The interviews will last approximately 30-60 minutes and will be conducted via phone. The responses will be coded and combined with the answers from the surveys to determine the breadth and most effective strategies.

The objectives of this investigation are:

- Identify which O&M BMP strategies are more commonly being implemented by jurisdictions
- Identify which O&M BMP strategy is overall most effective
- Identify which elements of different O&M strategies are more effective
- Develop recommendations for O&M strategies based on the results of this study

4.3 Study Location and/or Target Population

The target population is NPDES MS4 permittees in Washington and other jurisdictions who have similar O&M requirements for owner-operators of privately owned structural BMPs. Preference will be given to potential jurisdictions located in semi-arid areas, particularly the Columbia Basin (Oregon and Idaho). The target population consists of permittees or non-permitted jurisdictions, specifically stormwater managers, who are required to inspect and enforce maintenance of privately owned structural BMPs. Participants within the target population will be identified through the US Environmental Protection Agency (US EPA), Ecology, or other regulatory agency contacts as well as recommendations from stormwater managers and practitioners.

4.4 Data Needed to Meet Objectives

The data listed in Table 4.1 is required to meet the objectives of the study.

Table 4.1 Data Needed to Meet Objectives

Data Type	How Data Will Be Collected	Purpose
List of Jurisdictions	Department of Ecology, US EPA list of contacts, stormwater managers & practitioners	Identifies potential jurisdictions who may participate in the survey and interviews
Contact information for Study Participants	Contact through jurisdictions	Will be used to track potential participants, response rate, and identify potential interviewees; identification codes for participants
Jurisdictions' O&M requirements	Survey Question	Compare requirements of participants for consistency
Survey Responses	Online survey of participants	Provide breadth of approaches to inspection, maintenance, enforcement; ratings from self-evaluation of jurisdictions O&M strategy which will be used to select participants to interview and develop interview questions
Interview Responses	Responses provided in phone interviews will be coded	Gather additional data regarding breadth of strategies and evaluate effectiveness

4.5 Tasks Required to Conduct Study

Table 4.2 provides a summary of the tasks required to conduct the study and the corresponding project deliverables.

Table 4.2 Tasks Required to Conduct Study

Task Title and Description	Deliverable
1.0 Experimental Design <ul style="list-style-type: none"> • Proposal Development • Ecology Proposal Review 	<ul style="list-style-type: none"> • Final Proposal
2.0 QAPP <ul style="list-style-type: none"> • QAPP Development • Ecology QAPP Review • QAPP Revisions • Ecology Review 	<ul style="list-style-type: none"> • Draft QAPP • Ecology QAPP Comments • Responses to Ecology Comments • Final QAPP
3.0 Technical Advisory Group Convene a technical advisory group (TAG) which will consist of EWA stormwater managers, Ecology, and interested parties. This includes scheduling meetings with TAG to discuss the project status and soliciting comments from the TAG on the study documents.	<ul style="list-style-type: none"> • Meetings Agendas and Notes • Responses to TAG Comments
4.0 Data Collection & Analysis <ul style="list-style-type: none"> • <u>Participant Recruitment</u> – gather names of stormwater managers from jurisdictions with similar requirements to complete the survey. • <u>Survey Deployment</u> – disseminate survey to participants. • <u>Analyze Survey Results</u> – use survey results to identify participants for interviews and priority O&M program elements through rating results. • <u>Interview Protocol Development</u> – develop interview questions and standard operating procedures (SOPs) for contacting participants • <u>Interviews</u> – conduct interviews over the phone with 10-15 of the survey participants and document responses • <u>Synthesize Interview Findings w/ Survey Results</u> – code interview responses and use combined survey and interview results to fulfill study objectives 	<ul style="list-style-type: none"> • List of Survey Participants • Permit Requirements • Survey Results • List of Interview Participants • Document Interview Responses • Coded Interview Responses
5.0 Technical Report Develop annual reports, study fact sheet, and a final technical report as defined in the QAPP Section 14.0. This will include analyzing and interpreting the data collected during the study.	<ul style="list-style-type: none"> • Annual Reports • Study Fact Sheet • Draft Technical Report • Final Technical Report • Responses to Ecology Comments

4.6 Potential Constraints

Potential constraints are defined as conditions which may impact the project schedule, budget, and scope. Table 4.3 lists potential constraints as well as the actions to be taken to mitigate the impact of the conditions. Strategies for mitigating these constraints are discussed in Sections 6.0, 8.0, and 9.0 are part of the study design and implementation.

Table 4.3 Potential Constraints

Potential Constraint	Mitigation Approach
Low survey response rate ¹	Describe benefits of study results to participants and potential outcomes of study; follow-up with participants during survey process
Unable or unwilling participants due to fear of negative perception of their program	Communicate up front that survey and interview responses documented in reports will not identify respondents; instead, respondent's information will be replaced with an identification code.
Difficulty of identifying out-of-state jurisdictions with similar programs	Utilize list of contacts from Ecology, EPA as well as suggestions from stormwater managers and practitioners
Inconsistent responses	Utilize multiple choice, carefully worded questions to guide survey responses; validate surveys and interview questions before sending them to participants (through pilot testing); interview responses will be coded using a consistent process and verified
Electronic communication issues, such as filtering of emails to spam folder	Follow-up with phone call to notify participants of email dissemination

¹Market researchers report an average response rate to an email survey invitation is approximately 25%, but it will vary depending on motivation (Fluid Surveys, 2014).

5.0 Organization and Schedule

5.1 Key Project Team Members: Roles and Responsibilities

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1. Lead Entity Project Manager (PM) – The primary point of contact for the lead entity. Responsible for:
 - Conducting the study as defined in the Ecology approved QAPP
 - Ensuring staff working on this project are trained and have adequate experience to complete their assigned tasks
 - Submitting the study documents to Ecology including: QAPP and final report
 - Recruiting study participants, deploying surveys, and conducting interviews
 - Collecting data per the standard operating procedures (SOPs) section of this QAPP, analyzing data, data management
 - Scheduling audits, verify and assess the usability of data, and execute corrective actions
 - Developing reports: interim reports, the final report including data analysis, interpretation of results, and summarizing the study findings
 - Responding to Ecology comments on the final report
 - Organize TAG meetings (after the first meeting)
2. Consultant Project Manager (PM) – The consultant primary point of contact. Responsible for:
 - Develop an Ecology approved Proposal and QAPP and respond to Ecology comments
 - Developing survey and interview questions; validate survey and interview questions
 - Provide a peer review of the final report
 - Assemble the TAG and organizing the first TAG meeting
 - Providing the Lead Entity PM with technical support
3. Lead Entity Researcher - Responsible for assisting the Lead Entity PM.
4. Consultant Researcher - Responsible for assisting the Consultant PM.
5. Technical Advisory Group (TAG) Member - The goal of the TAG is to provide insight, suggestions, and professional opinions to the Lead Entity Project Manager throughout the study. The primary responsibilities of TAG members include: attending project meetings (by webinar or in person) and participating in the meeting discussion; review/comment on research materials (i.e. QAPP, data collected, data analyzed, final report, etc.) prior to the lead entity submitting the documents to Ecology.
6. Technical Advisory Group (TAG) Lead – Responsible for organizing/scheduling meetings with the TAG members and distributing the project/meeting documents prior to the meeting. During meetings the TAG lead is responsible for ensuring that the TAG member's comments are heard and addressed as well as developing/distributing meeting notes of any action items from the meeting.
7. Data Verifiers - Data verifiers will review the analyzed data and verify the analysis is correct and that the data being analyzed matches the data collected. *See Section 12.0 of this document.*
8. Financial Support – Responsible for providing the lead entity with some level of financial support toward the cost of the study.
9. Auditor - Responsible for conducting audits to verify the study conforms to the plan and procedures as defined in *Section 11.0* of this document. This may include: verifying staff collecting the data are trained and follow SOPs for data collection; verifying data management procedures are followed including reviewing data records to ensure they are consistent, correct and complete, with no errors or omissions; and traveling where the data is stored to review the data records compared to the QAPP Data Management Plan. Auditors will report their findings directly to the Lead Entity PM.
10. Ecology Reviewer – Responsible for reviewing and approving the study documents: the Proposal, QAPP, and Final Report.

5.2 Project Schedule

An overview of the project timeline as depicted during the public commentary period is shown in Figure 5.2.1. A task timeline based on quarterly activities is shown in Table 5.2.1.

Table 5.2.1 Proposed Study Timeline

Task Name	2017			2018			2019		2020		2021				2022		
	Q2: Apr-Jun		Q3: Jul-Sept	Q4: Oct-Dec	Q1: Jan-Mar		Q2: Apr-Jun	Q3: Jul-Aug	Q4: Aug-Sep		Q3: Oct-Dec	Q4: Aug-Sep	Q1: Oct-Dec	Q2: Jan-Mar	Q3: Apr-Jun	Q4: Jul-Sept	Q1: Oct-Dec
Experimental Design																	
Proposal Development																	
Ecology Proposal Review																	
QAPP																	
QAPP Development																	
Ecology QAPP Review																	
QAPP Revisions																	
Ecology Review																	
TAG Meetings									1-2						*3		*4
Data Collection & Analysis																	
Participant Recruitment																	
Survey Development & Pilot Testing																	
TAG conducts audit																	
Survey Deployment																	
Synthesize Survey Results															*		
TAG - Data Verification & Audit															*		
Develop Interview Questions & Pilot Test															*		
Email Participants Information List															*		
TAG Conducts Audit															*		
Conduct Interviews															*		
Synthesize Interview Findings w/ Survey Results															*	*	
TAG - Data Verification & Audit															*		
Technical Reports																	
Annual Reports																	
Final Report															*	*	*
Study Fact Sheet															*		
Ecology Review															*	*	*
Respond to Ecology Comments																	*

*Denotes schedule changes made in November 2020.

5.3 Budget and Funding Sources

Per Yakima County, funding for the project will come from primarily Yakima County with additional support from the City of Yakima as part of their role as a participating entity.

Table 5.3.1 Estimated Study Budget

Task	Hours	Cost Per Hour	Work Performed by	Total
QAPP Development & Technical Support	120	\$160	Consultant	\$21,607
Manage TAG	15	\$160	Consultant	\$2,448
	60	\$60	Lead Entity	\$3,600
Participant Recruitment	40 ¹	\$60 ²	Lead Entity	\$2,400
Survey Deployment	40 ³	\$60	Lead Entity	\$2,400
Survey Results	40 ⁴	\$60	Lead Entity	\$2,400
Interview Development	30 ⁵	\$160	Consultant	\$4,787
Interviews	60 ⁶	\$60	Lead Entity	\$3,600
Interview Results	40 ⁷	\$60	Lead Entity	\$2,400
Final Report	60 ⁸	\$60	Lead Entity	\$3,600
	12 ⁹	\$160	Consultant	\$1,958
Total				\$51,200

¹ It is estimated the lead entity will spend 40 hours compiling the names and contact information for survey recipients.

² Estimated hourly rate for work performed by lead entity is \$60/hour.

³ It is estimated the lead entity will spend 40 hours recruiting participants to complete the survey including phone calls, targeted emails etc. as part of low response mitigation.

⁴ It is estimated the lead entity will spend 40 hours generating an interim report and tables with survey results.

⁵ It is estimated a consultant will spend 30 hours generating an interview based on survey results.

⁶ It is estimated the lead entity will spend approximately 48 hours (4 hours per interviewee) recruiting, conducting and summarizing individual interviewees.

⁷ It is estimated the lead entity will spend 40 hours generating a report based on interview results.

⁸ It is estimated the lead entity will spend 60 hours compiling individual project components and generating a final report.

⁹ Consultant hours are to provide a QC review of the TER before the document is submitted to Ecology for review.

6.0 Quality Objectives

This section of the QAPP provides a roadmap of the quality assurance and quality control (QA/QC) plan that will be implemented in the experimental design and employed throughout the study.

The purpose of a QAPP is to ensure that the data collected during the study is scientifically and legally defensible (Washington State Department of Ecology, 2011). The QAPP documents how quality assurance (QA) and quality control (QC) will be applied to a research project to assure that the results obtained are of the type and quality needed and expected. The QA/QC plan for this study is embedded throughout the QAPP and emphasizes how the data quality indicators (DQIs) and respective measurement performance criteria (MPCs) are addressed during the study.

DQIs are qualitative and quantitative measures that characterize the aspects of quality data (EPA, 2006). DQIs are goals for data quality that are specific to each study. DQIs are intended to minimize error and improve the accuracy of the data. DQIs guide the development of the experimental design as well as the process of creating and analyzing data. The seven principle DQIs for this study are:

- Validity
- Reliability
- Objectivity
- Credibility
- Transferability
- Completeness
- Integrity.

Once established, the DQIs provide the basis for the MPCs which are the acceptance criteria for the DQIs that specifies how good the data must be to meet the project objectives. Table 6.1 first defines each DQI, then the approach for addressing DQIs and the respective MPCs for this study are described.

Reference Section 12.0 for details regarding the process that will be employed to evaluate the quality and usability of the data for meeting the project objectives which is based primarily on whether the MPCs were met for the applicable DQIs.

Table 6.1 Summary of the Seven Principle Data Quality Indicators (DQIs) for E&O Studies

Data Quality Indicator (DQI)	DQIs for this Study	Measurement Performance Criteria (MPCs) for this Study
Validity - Closeness between the measured value and the true value. An instrument is considered valid when it measures what it is purported to measure (Radhakrishna, 2012) (Biddix, 2016).	<ul style="list-style-type: none"> The survey designed for this study was developed (Section 8.1) using literature regarding inspection, maintenance, and enforcement strategies for structural BMPs on private property and permit requirements for WA jurisdictions. Survey and interview questions (Section 8.1 and Appendix E) were/will be written in language that is accessible to the target audience (i.e. Permittees or Stormwater Managers) Survey and interview questions will be pilot tested by Consultant staff and Yakima County personnel as well as comments from TAG members to validate instruments before broad application (Section 8.3) 	<ul style="list-style-type: none"> Pilot testing survey and interview questions were/will be used to validate the instruments (Section 8.3). The MPC for this DQI is that the group pilot testing mutually agrees on the interpretation of the survey and interview questions.
Reliability - The degree to which an instrument produces stable and consistent results on repeated measurements (Radhakrishna, 2012). The level of precision or reliability, also called sampling error, is the range in which the true value of the population is estimated to be.	<ul style="list-style-type: none"> SOPs are defined and will be consistently followed for collecting data (Section 8.2) Multiple instruments are used to collect data: the entire target audience will be surveyed, and a small portion interviewed to compare and better understand responses (Section 8.0) The survey and interview questions will be pilot tested using Consultant staff and Yakima County personnel as well as comments from TAG members to validate the instruments (Section 8.3) For rating/ranking questions, response options (i.e., high, medium, low) will be defined to improve consistency between respondents. To support survey responses that represent a jurisdictions practices, respondents will be asked to acknowledge whether they are knowledgeable in their jurisdictions practices to provide representative responses to questions or if needed they will consult the appropriate personnel before responding to questions. To support interview responses that represent a jurisdictions practices, respondents will be provided with a list of information that is needed to answer questions prior to the interview. In addition, participants will be asked how they certain they are regarding the responses they provide. 	<ul style="list-style-type: none"> Audits will be used to verify procedures are being followed. Data will be considered acceptable if it is being collected in accordance with SOPs (Section 11.0) See description of pilot testing MPCs for Validity Response from survey and interview will be compared for consistency. The MPC for this DQI is that the responses are consistent Respondent acknowledges they are knowledgeable regarding their jurisdictions practices and has provided response representative of the jurisdiction's practices A list of information needed to respond to interview questions is provided to participants prior to the interview and participants indicate they are certain about their responses.

<p>Objectivity - Attempt to diminish or eliminate the investigators bias (Clark, 1994). An objective investigator is neutral and open all sides of the argument without imposing their own bias, motivations, interested or perspectives (Guba, 1981) (Radhakrishna, 2012)).</p>	<ul style="list-style-type: none"> Those performing interviews will avoid the use of prompts and will ask a prepared list of questions to each participant being interviewed (Section 8.2) Data analysis procedures and methods are used that are appropriate for the types of data collected (Section 13.0) Data coding will be used to provide evidence that conclusions are based on findings (Section 13.0) SOPs are defined and will be consistently followed during the survey and interview process (Section 8.2) 	<ul style="list-style-type: none"> The survey and interview SOPs will be followed for all participants Peer debriefing will be used to validate coding and the group will mutually agree on the interpretation of the coding which may include adding codes (Section 13.0)
<p>Completeness - The amount of valid data needed to be obtained from the measurement system (Lombard & Kirchmer, 2004). Data is considered complete when: the sample size is representative of the target population.</p>	<ul style="list-style-type: none"> The sample size was selected based on a review of literature (Section 8.1) and having enough of participants to ensure the sample size is representative of the target population. Procedures for handling missing data are defined in Section 10.3 Missing data will be reported with appropriate coding Results will include consideration for how missing data from the survey or interview could limit the transferability of the data set 	<ul style="list-style-type: none"> Procedures for handling missing data and coding are defined in Section 10.3 The sample size identified for the study is consistent with the number who participated in the study
<p>Credibility – Credibility is often referred to as social desirability bias. This describes a type of response bias where survey respondents answer questions in a manner they believe will be viewed favorably by others. It can take the form of over-reporting "good behavior" or under-reporting "bad" or undesirable behavior (Grimm, 2010).</p>	<ul style="list-style-type: none"> Careful consideration of social desirability bias in the selection of how questions are worded. Questions will also be validated prior to completing the survey or interview questions. Measures, such as identification codes for respondents and response coding, will be taken to ensure confidentiality and those measures will be communicated to participants. Multiple types of instruments will be used (survey and interviews) to collect and cross-check responses. This can assist the investigator in understanding and interpreting the responses. 	<ul style="list-style-type: none"> Use mixed methods to collect data including surveys with multiple choice and open-ended questions as well as interviewing participants. The MPCs with respect to this DQI is that responses provided by each participant are consistent (survey compared to interview). Response from survey and interview will be compared for consistency. The MPC for this DQI is that the responses are consistent
<p>Transferability – The extent to which sample data can be transferred from a sample to a population. Datasets are considered transferable if the instruments, data sources, data collection procedures, sample selection procedures, and reporting are equivalent (Washington State Department of Ecology, 2011).</p>	<ul style="list-style-type: none"> Permittees with similar permit requirements for O&M of BMPs on private property are the target audience. Preference will be given to participants in a similar climate to EWA (Columbia Basin) (Section 7.2) The sample size was selected based on recommendations from literature specifically selecting the sample size that is representative of the population(s) (Section 7.2 and 8.0) Follow-up procedures according to the SOPs in Section 8.2 will be used for non-respondents 	<ul style="list-style-type: none"> Participants have similar O&M requirements for BMPs on private property (Section 13.0) Respondent acknowledges they are knowledgeable regarding their jurisdictions practices and has provided response representative of the jurisdiction's practices Data will be considered transferable if the participants have similar permit requirements

Integrity - Integrity is concerned with minimizing errors through the process of collecting, recording, and analyzing data (Radhakrishna, 2012).	<ul style="list-style-type: none">• SOPs will be consistently followed during data collection (Section 8.2)• Data recording and reporting procedures were developed (Section 10.2 and 8.2). Data will be reviewed to ensure it has been properly recorded and coded.• A standard survey will be issued to each participant and interview questions will be consistent for each interviewee.• Those involved in data collection will be properly trained to follow the SOPs.• Identification codes for respondents will be provided to ensure confidentiality during the study.• Compare responses to similar survey and interview questions from the same respondent to determine if they are consistent	<ul style="list-style-type: none">• Audits will be used to verify that procedures are being followed. Data will be considered acceptable if it is being collected in accordance with SOPs (Section 11.0)• All those involved in data collection will collect data according to the SOPs and be trained prior to data collection.• The identify of all respondents will be replaced with an identification code.• If the survey and interview responses are found to be similar, it will be assumed that their responses accurately reflect their opinions and/or understanding of their jurisdictions O&M BMP program for BMPs on private property.
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7.0 Experimental Design

7.1 Study Design

This study will utilize a survey and interview questions to gather information from permittees regarding practices used to meet inspection, maintenance, and enforcement requirements for BMPs on private property. The following paragraphs provide an overview of the study design; specifically, the primary components of the study, the approach to evaluating effectiveness, and the justification for selecting this approach. The subsequent sections provide more details about the study design.

The target population is NPDES MS4 permittees in Washington and other jurisdictions who have similar requirement for owner-operators of privately owned structural BMPs. Preference will be given to jurisdictions located in the Pacific Northwest, particularly those within the Columbia Basin (Oregon and Idaho). Reasoning for selection of the target population is provided in Section 7.2. The permittees or non-permitted jurisdiction will be contacted and interested parties will be identified as participants in the study (Section 8.2). To gather information, an online survey will be developed and administered to the permittees via email. The survey questions are targeted at defining the breadth of strategies applied by jurisdictions, rating elements of the strategy compared to common references in the literature (Table 8.1) of elements that appear define a successful O&M program, and information that may influence responses (i.e., number of privately owned BMPs within the jurisdiction, jurisdictions population, etc.). Information that will be requested in the survey includes the following items.

- Requirements related to BMPs on private property
- Number of privately owned BMPs in the jurisdiction
- Strategy taken by the jurisdiction to inspect and maintain structural BMPs on private property
- Existing source of funding for inspection and maintenance of structural BMPs on private property
- Self-assessment of BMP inspection and maintenance elements (high, medium, or low) that are part of the jurisdiction's strategy such as:
 - Ease of access to BMPs
 - Cost effectiveness for conducting approach
 - Inspection approach successfully identifies whether required maintenance was conducted
 - Staff understanding of how to conduct inspection and/or maintenance
 - Sufficient jurisdiction funding available to provide O&M activities
 - Providing incentives to BMP owners
 - Jurisdictions implements penalties to non-compliant property owners
 - Private property owner's demonstration of compliance with requirements
 - Communication provided to property owner

- Process for communicating BMP O&M responsibilities to new property owners
- Availability of proper maintenance equipment
- Complete documentation of inspections and maintenance
- Ability to demonstrate compliance with requirements
- Challenge with the existing approach used to inspect and maintain structural BMPs on private property
- Benefit to using the existing approach for inspecting and maintaining structural BMPs on private property
- How (or if) the permittee would change the program for inspecting and maintaining structural BMPs on private property
- Whether the jurisdiction offers incentives to private property owners to inspect or maintain structural BMPs on their property, and if so, what those incentives are.

Whether the jurisdiction has mechanisms in place to penalize or fine a BMP owner for not demonstrating they are compliant with the requirements. The survey will consist of multiple choice, open-ended, and rating questions. The survey is designed to last approximately 30 minutes. Participants will be assigned identification codes to maintain confidentiality of results. Additional information regarding the survey design can be found in Section 8.1 and information about pilot testing (validating) the survey questions is located in Section 8.3, and a copy of the survey can be found in Appendix E.

After the surveys have been administered, responses will be analyzed (Section 13.0). A group of participants will be identified for interviewing based on selecting participants who appear to have the most effective strategies and who are willing to be interviewed. Interview questions will be developed after the survey data has been analyzed to gather additional information regarding how inspection, maintenance, and enforcement of O&M is performed at each jurisdiction and identify anything that jurisdictions would change to improve their programs. Reference Section 8.1.2 for a list information that is anticipated to be collected as part of the interview questions. Effectiveness will be determined based on how the jurisdictions strategies compare to the elements of a successful program identified from the literature (Table 8.1). Information needed to respond to interview questions will likely require some research on the participants part before they can answer the questions. As such, a list of information needed to answer the questions will be provided to the participant prior to the interview. This list of information and interview questions will pilot-tested prior to the sending information to participants or conducting interviews (Section 8.3).

Ten to fifteen permittees will be selected for interviews which will be conducted via phone and will last approximately 30 minutes. This number of permittees to interview was targeted in order to gather a wider range of responses and is a recommended number for reaching saturation of responses. Additional information regarding saturation and validation of responses can be found in Section 8.3. The interview process is further described in Sections 8.1 and 8.2. Following the interview process, the responses will be transcribed, coded, and analyzed (Section 13.0).

7.2 *Process for Selecting the Test-Site and Target Population*

The study area consists of all jurisdictions from Washington and the Pacific Northwest who have similar requirements for inspection and maintenance of privately-owned structural BMPs. Preference will be given to participants located within semi-arid climate areas, specifically the Columbia Basin in Oregon and Idaho. The reason preference is given to these areas is because variables such as climatic conditions are known to influence the effectiveness of stormwater management BMPs (Caraco, 2000). As such there may be strategies that support successful O&M programs in EWA that are unique to jurisdictions in these climates. The target population for participating in the study consists of managers and lead staff, specifically stormwater managers in the previously identified jurisdictions, who are required as part of their job duties to understand their jurisdiction's approach to inspect and maintain privately owned structural BMPs. A list of contacts will be obtained through the EPA, Ecology, as well as other stormwater practitioners. Once a list of stormwater operators is generated with a number of participants equal to or greater than the target sample size (n=30), they will be contacted to participate in the survey.

The study area was selected in order to achieve the largest population while maintaining comparability between jurisdictions. For example, jurisdictions with similar requirements for inspection, maintenance, and enforcement of structural BMPs on private property are expected to be more comparable as they are more likely to use similar strategies that other jurisdictions in the study area to meet their permit requirements. Additionally, those jurisdictions are likely to have faced similar challenges with BMPs on private property, such as those listed in Section 3.2 of this document. The preference given to jurisdictions within semi-arid regions is expected to increase the transferability of the data collected, as their BMPs, rainfall and runoff patterns, and populations are expected to be more comparable.

The target population was also selected to achieve comparability between jurisdictions as well as achieve a higher level of validity for the data collected. It is expected that stormwater managers or other lead staff identified by their jurisdiction have the best understanding of a jurisdiction's inspection, maintenance, and enforcement of BMPs on private property, and will know which personnel to contact to respond to the survey and interview questions (if needed). The stormwater managers or lead staff are also likely to communicate and understand similar stormwater terminology. As such, results gathered from the survey and interview processes (which will be written in language for the target audience) are expected to be easily comparable to other jurisdictions.

7.3 *Operational BMP Function*

According to the 2019 and previous versions of the EWA Phase II Municipal Stormwater Permit (Washington State Department of Ecology, 2019), permittees are required to implement procedures for site inspection and enforcement of post-construction control measures.

Specifically, permittees must implement mechanisms that allow access for permittees to inspect stormwater BMPs on private properties that discharge to the MS4 (S5.B.5.iii). In lieu of requiring continued access, the mechanisms may require private property owners to provide annual certification by a qualified third party that the required maintenance has been performed and the facilities are operating as designed to protect water quality. Additionally, permittees are required to implement regulatory mechanisms that ensure adequate on-going O&M of BMPs is occurring on public and private properties (S5.B.5.b.ii.c).

Permittees follow different approaches or strategies for meeting this requirement. Based on a preliminary investigation of permittees conducted by Yakima County as well as input from members of the TAG, the following appear to be the most common strategies in Washington for meeting the above-mentioned permit requirements.

- **Permittee or Non-Permitted Jurisdiction Inspection/Contractor Maintenance** - Permittee or non-permitted jurisdiction performs inspection of structural BMPs but requires the property owner to hire a qualified contractor to conduct necessary maintenance and provide proof that the maintenance has been completed.
- **Third Party Inspector/Contractor Maintenance** - Permittee or non-permitted jurisdiction requires structural BMP owners to contract with a third-party inspector and provide an inspection certification letter to the Permittee or non-permitted jurisdiction, as well as proof that any required maintenance has been completed.
- **Permittee or Non-Permitted Jurisdiction Inspection/Permittee or Non-Permitted Maintenance** - Permittee or non-permitted jurisdiction performs maintenance but the BMP remains under private ownership and the property owner pays the Permittee or non-permitted jurisdiction for the service.
- **Property Owner Inspects/Property Owner Maintains** – Property owner both inspects and maintains the BMP on their property.
- **Variable Inspection/Variable Maintenance** - Property owner is given the option to provide access to the Permittee or non-permitted jurisdiction for inspection or to hire a third party or contractor to inspect BMP(s). Property owner is given the option to provide access to the Permittee or non-permitted jurisdiction for maintenance or to hire a third party or contractor to maintain BMP(s).

7.4 *Type of Data to be Collected*

The data required to meet the objectives of this study are described in Table 7.1.

Table 7.1: Summary of data being collected.

Data Type	Purpose
List of Jurisdictions	A comprehensive list of all jurisdictions that could participate in the study will be developed to recruit potential jurisdictions to participate in the study.
List of Participants (stormwater managers and/or lead staff)	Developed a coded list of all participants who agree to participate in the study including contact information. The list will be used to track the survey response rate and identify/contact potential interviewees.
Survey Responses from Participants	Survey responses will be used to gather information regarding common strategies jurisdictions use to meet requirements related to inspection, maintenance, and enforcement of structural BMPs on private property. Additionally, survey responses will be used to identify strategies are more successful, identify variables the may influence the jurisdictions responses (i.e., number of BMPs located within the jurisdiction), and identify participants to interview.
Interview Transcripts and Coded Interview Responses	The purpose of interviews is to validate the findings from the survey and better understand approaches/strategies to inspection, maintenance, and enforcement of BMPs on private property as well as confirm the jurisdictions self-assessment from the survey. This information will be analyzed and combined with survey responses to evaluate and compare the effectiveness of the various strategies as well as specific elements that appear to support a successful program.

8.0 Instrument Design and Development

This section describes the instruments that will be used during the study, the procedures used to collect data, and the process used validate the instruments. The instruments for this study will be the survey and interview questions. The survey can be found in Appendix E. The interview questions will be developed following analysis of the survey results.

8.1 *Instrument Design*

The instruments utilized for this study will include a survey, which will be distributed to all participants, followed by interviews with selected participants. These instruments were designed to meet the overall objectives of the study as well as the QA/QC objectives (Section 6.0). The following paragraphs describe the survey and interviews in detail.

8.1.1 Survey

Participants in the study will be issued an online survey using SurveyMonkey® or other similar online survey app. A copy of the survey can be found in Appendix E. The survey consists of ten questions related to the jurisdictions' approaches/strategies to inspecting, maintaining, and enforcing maintenance of BMPs on private property. The development of the questions was guided by identifying elements of O&M program that are likely to support meeting requirements defined in the 2019 EWA Phase II Permit as well as common related issues/challenges identified in literature, particularly in (Blecken, Hunt, Al-Rubaei, Viklander, & Lord, 2015). The questions are worded using language accessible to the target audience (stormwater managers) to improve validity. Additionally, the questions were pilot tested by the consultant team (that wrote the QAPP), Yakima County, and the TAG members during the development of this document to verify the interpretation of questions which supports the reliability of responses. The surveys are expected to last 30 minutes, and contain multiple-choice, rating, and open answer-style questions. Confidentiality will be maintained by assigning identification code to each respondent which will be used (if needed) to identify participants in reports produced from this study. The development of identification code is described in more detail in Section 10.1.

The survey question were selected specifically to meet some of the objectives of the study including identifying: the breadth of strategies applied by jurisdictions, the most commonly applied strategies, identify the most effective elements and strategies, and identify variables that may influence the participants response (jurisdictions strategy). The questions included in the survey were designed to collect this information as well as address the QA/QC requirements in Section 6.0. Specifically:

- **Question 1** – Requests general information about the jurisdiction and the person responding to the questions including: name, title, and contact information of person completing the survey; jurisdictions name; applicable permit requirements; number of privately owned BMPs located within the jurisdiction that discharge to an MS4; and the jurisdiction 2019 population. The permit requirements will be compared to verify the jurisdictions programs are transferable and comparable. Questions about the number of BMPs maybe be used to identify possible reasons for differences in responses. Reasons maybe further explored as part of the interview process.

- **Question 2** – Asks the respondent to acknowledge they are appropriate person to respond to questions that are representative of their jurisdictions O&M program and that if they are uncertain of answers, they will consult other jurisdictional staff who are knowledgeable before responding. This question addresses Section 6.0 DQI/MPC related to Transferability/Comparability and Reliability.
- **Question 3** - Identifies the jurisdictions strategy for addressing permit requirements related to inspect, maintenance, and enforcement of BMPs on private property. Responses are provided as multiple-choice answers with the option to provide an open ended responses for an “other” strategy or to provide more details about the jurisdictions strategy. The multiple-choice options were identified by Yakima County as described in Section 3.1 and 7.3. Responses to this question will be used to identify the breadth of strategies used to inspect, maintain, and enforce BMPs on private property. The data collected will also be used to determine the most commonly applied strategy by responding jurisdictions.
- **Question 4** – This question asks participants to conduct a self-assessment of their strategy based on common elements identified in the literature that appear to support a successful O&M program for private property owners. Elements include access to BMPs, cost to conduct inspection and/or maintenance, private property owner’s understanding and willingness to follow requirements, available funding sources, etc. The elements were identified based on EWA permit requirements (Washington State Department of Ecology, 2019) and priorities identified in the literature (see Table 8.1). Each participant will rate (high, medium, or low) their jurisdiction strategy for how they perform related to each element. Response from all participants will be combined (averaged as described in Section 13.0) to identify the most effective strategies and identify the jurisdictions with the most effective elements. For example, specific element may rate higher for strategies that are not identified as the most effective.
- **Questions 5 to 10** – Are open ended questions that identify items such as the jurisdictions funding source for implement the strategy/approach defined in question 3; challenges, benefits, and improvements the jurisdiction identifies for their strategy; and whether the jurisdiction provides incentives for property owners for complying with requirement or mechanisms to penalize or fine the BMP owner for not complying with requirements. This question is intended to provide additional information about the strategy that maybe be used to identify possible reasons for differences in responses and develop interview questions.

In order to understand the breadth of approaches and make accurate comparisons between jurisdictions, it is important to attain enough responses. The goal is to obtain at least 30 survey responses since 30 is considered a large sample size in quantitative research (Statistics Solutions, n.d.). However, there is no specific rule requiring a minimum of 30 responses. Poor response rates from initial online recruitment could cause the need for targeted communication including phone calls to potential respondents.

There are several strategies that will be employed to improve response rate including survey design, value proposition, confidentiality, and targeted reminders. The survey was designed

using language that is clear and concise for those participating and should take respondents less than 30 minutes to complete. The survey was validated by pilot testing the survey as described in Section 8.3. In addition, the value proposition for why they should participate should be clearly stated in the recruitment email since messaging can improve response rates (Qualtrics XM, 2019). While the responses to the survey might not be considered sensitive to everyone, some respondents might not want their thoughts broadly disseminated. As such, confidentiality through the use of coded identities should improve response rates, as well as the credibility of the data (Section 6.0). Finally, for those not responding initially, reminder emails will be sent at a different day and time than the initial email recruitment or any previous email contact. Further information on the survey process can be found in the SOPs in Section 8.2.

Table 8.1 Summary of Literature: Elements that Appear to Support a Successful O&M Program

Element	Justification & Source
Ease of jurisdictions access to BMPs (for inspection or maintenance)	Lack of access for jurisdictions to inspect or maintain BMPs has been identified as a barrier to conducting O&M requirements either due to lack of permission to enter private property or difficulty accessing the location of the BMP (Blecken, Hunt, Al-Rubaei, Viklander, & Lord, 2015).
Jurisdiction has sufficient funding available to perform the required inspection, maintenance, and enforcement activities.	Limited funding for the jurisdiction has been identified as a barrier to performing required O&M activities (Blecken, Hunt, Al-Rubaei, Viklander, & Lord, 2015; Rafter , 2000).
The jurisdiction provides training for all staff that perform inspection, maintenance, and enforcement of BMPs on private property.	Lack of understanding of how to inspect and maintain BMPs has been identified as a barrier to correctly performing these activities (Blecken, Hunt, Al-Rubaei, Viklander, & Lord, 2015; Buys & Aldous, 2009). Recommendations for successfully performing these activities include a robust training program (Flynn, Linkous, & Buechler, 2012).
The jurisdiction has a written plan that defines the required O&M protocol for all BMPs such as a guidance manual.	Improper or incomplete BMP O&M guidance has been identified as a barrier to correctly performing these activities either because staff do not understand how to maintain BMPs or appropriate equipment for O&M activities is not available to the jurisdiction (Flynn, Linkous, & Buechler, 2012; Blecken, Hunt, Al-Rubaei, Viklander, & Lord, 2015). Recommendations for improving staffs understanding include developing a written O&M plan for each BMP that includes a punch list of required O&M activities as well as photos of failing BMPs (Richardson, 2019).
Jurisdiction has appropriate equipment available to conduct maintenance for all BMPs	Researchers have reported that barriers to the public understanding the impact of stormwater and relevant policies may relate to the public not understanding the education materials either because the written material is too technical, or they speak languages other than English.
The jurisdiction provides O&M protocol and/or education materials to BMP owners in languages other than English	Recommendations or addressing this issue include providing material in languages besides English, including photos and illustrations in materials, face to face meetings with the public, and developing written materials using technical terms that can be understood by the general public (Herron, Stepenuck, & Green , 2009)
BMP owners can demonstrate compliance with the jurisdiction's requirements	Researchers have reported that barriers for BMP owners to perform required O&M activities include: lack of funding as well as a lack of incentive or sense of responsibility
Jurisdiction provides incentives to BMP owners to encourage them to conduct requirement maintenance	Researchers have reported that barriers for BMP owners to perform required O&M activities include: lack of funding as well as a lack of incentive or sense of responsibility

Jurisdiction has mechanisms in place to penalize or fine BMP owner for not demonstrating the owner is compliant with requirements	(Blecken, Hunt, Al-Rubaei, Viklander, & Lord, 2015; Doll & Lindsey, 1999; Rafter, 2000; Aldous & Buys, 2009)
BMP owners are willing to pay for required maintenance.	
When ownership changes, the jurisdiction has a process for communicating all BMP responsibilities to the new property owner	Unclear and/or changing ownership of the property and BMP has been identified as a barrier to BMP owners conducting the required O&M activities (Blecken, Hunt, Al-Rubaei, Viklander, & Lord, 2015; Aldous & Buys, 2009).
Documentation of inspections and maintenance is up to date and complete for all BMPs on private property	A defined maintenance tracking program & data base for storing information appears to support success of the jurisdictions staff understanding and completing required documentation as well as provided required BMP O&M activities (Flynn, Linkous, & Buechter, 2012; Flynn, Linkous, & Buechter, 2012). Apps with a punch list of required activities have also been successful at improving jurisdictions tracking program (Richardson, 2019).
The jurisdiction has a documentation process for tracking inspection and maintenance activities that is consistent, complete, and easy to use.	
The jurisdiction's documentation and inspection records are up to date and complete for all BMPs on private property.	

8.1.2 Interviews

The purpose of interviews for this study is to address questions that may have arisen from the survey responses; to develop a deeper understanding of the strategy used to inspect, maintain, and enforce BMPs on private property; and collect data needed to evaluate the effectiveness of strategies. The interviews will provide a narrative for the responses given during the surveys and the responses will be coded and grouped into themes that as described in Section 13. Since information is needed from the survey responses to develop interview questions, the interview questions will be developed following the surveys. Example questions related to clarifying survey responses and developing a deeper understanding of the participant's approach may address some of the following topics:

- Provide an overview of the strategy that is implemented by the jurisdiction
- Time spent (hours per year) by the jurisdictions staff on inspection, maintenance, and enforcement activities related to privately owned BMPs
- Estimated number of privately owned structural BMPs in the jurisdiction
- Type, size, age, and area managed with privately owned BMPs
- Number of structural BMPs inspected and maintained each year
- Number of enforcement actions taken as a result of those inspections
- Funds spent annually on inspection, maintenance, and enforcement activities by jurisdiction related to privately owned BMPs
- Process for tracking BMP O&M (paper forms, Excel or Access Database, GIS Database, other software package)
- Details regarding the funding mechanisms (e.g., cost share or fee programs for implementing the selected strategy if applicable)

- Potential inspection or enforcement cost savings through implementation of the selected strategy.
- Issues related to access or other private property legalities
- Issues of local traditions or “culture” that could affect O&M
- Ask participants to provide additional details regarding the benefits, challenges, and improvements they identified related to their strategy in the survey

Following the survey, respondents will be selected for interviews. The group of participants for interviews will be identified based on:

- Participants who indicated they were willing to be interviewed on the survey
- Participants who selected the strategies that were identified as the most effective based on responses to the self-assessment. Ideally participants will be selected who provided different ratings to elements or responses to questions. For example, participants identified the same strategy however responses to survey questions 7-10 (benefits, challenges, and improvements) appeared to be different and/or conflict. The intent is to capture the opinions of jurisdictions that are and are not experiencing problems with their O&M strategy in order to provide a comprehensive evaluation of the strategy. Interview questions will be designed to develop an understanding of the similarities and differences in responses between jurisdictions with similar strategies. For example, determine whether there is a unique aspect about the jurisdictions program that makes it less or more effective.
- Participants who rates specific elements of their strategy high for strategies that were not identified as the most effective. This information will be used to recommend approaches for addressing specific elements of a program that appear to support success.

The general rule when conducting qualitative research involving interviews is that once a researcher reaches “saturation” of responses (i.e. no additional themes are emerging and no new insight is being gained), then the researcher should stop interviewing participants. Guest, Bunce and Johnson (2006) reported that typically saturation occurs at about 15 to 20 respondents but could be fewer than 10 depending on the questions being asked and the sample size. Jabbar (2015) indicated that 15 to 25 interviews should provide sufficient qualitative data. Galvin performed a review of 54 investigations in “six prominent building and energy journals” where interviews were conducted on people’s beliefs, practices, and attitudes towards building energy consumption. He found that most investigations reported between 6 and 15 interviews were used to make conclusions about the population. Based on this literature, it is recommended that ten to fifteen interviews be conducted.

Interviews will be conducted over the phone by the Lead Entity PM and are targeted for 30 minutes. Interviews will not be recorded. Instead, notes will be taken during the interview to capture a record of the responses. Because some interview questions will require the participant to conduct research on their jurisdictions program, participants will be provided with interview questions prior to the interview. Providing the list of information ahead of the interview also addresses the reliability DQI in Section 6.0. Interviews will begin with a brief description of this

study, the purpose of the interview, and logistics of the interview. After the introduction, all interviewees will be asked the same prepared list of questions about their approach to inspection, maintenance, and enforcement in order to limit potential for interviewer bias and to support comparable responses. The last question the Lead Entity PM will ask the participant is how certain they are that their responses represent their jurisdictions program. Responses to this question will be used to evaluate the reliability of the participants responses (Section 6.0).

At the conclusion of the interview, interviewees will be given a chance to clarify any of their statements, provide any closing thoughts, and ask questions of the interviewer (questions will be limited to the future of this project and sharing of project information). The actual interview responses will remain anonymous using response coding and all identifying information will be redacted (see Sections 10.1 and 10.2). The confidentiality of the interview will be communicated to the participant upfront to limit the potential for any social desirability bias (Section 6.0). Further information regarding the interview process can be found in the SOPs in Section 8.2.

Following the use of these instruments, responses from the interviews and the survey will be coded and analyzed. Information regarding data analysis and presentation can be found in Section 13.0.

8.2 Procedures for Collecting Data

Standard operating procedures (SOPs) will be used during this study to describe how data should be collected. The use of SOPs also addresses Section 6.0 DQIs for Reliability, Objectivity, and Integrity. The standard operating procedures (SOPs) that will be followed during this study include:

- Survey Dissemination & Follow-Up
- Interview Administration

8.2.1 Survey Distribution and Follow-Up

This section describes the procedures for distributing the survey and following up with participants to encourage response. The Lead Entity PM is responsible for administering surveys and collecting results.

- Step 1: Stormwater managers identified as participants for the study will be assigned identification codes, in accordance with the procedures described in Section 10.1.
- Step 2: A link to the SurveyMonkey® survey will be sent to each stormwater manager via email. The email will also include:
 - A due date three weeks out from the date the survey was sent will be provided with the link.
 - The stormwater managers should be informed that while their email address will be associated with their responses in SurveyMonkey®, the responses will be associated with their identification code when recorded in Excel to maintain confidentiality.
 - Email reminders will be sent by the Lead PM to jurisdictions that have not responded each week after the initial survey is sent out. The last week, the Lead

PM may also call and remind their contact at the jurisdictions of the survey deadline and/or extend the deadline as needed to increase participation.

- Step 3: As responses are provided, the data will be recorded in Excel with the associated identification code assigned to the respondent. Data will be recorded as described in Section 10.2.
- Step 4: Participants will be given three weeks to respond to the survey. An email reminder will be sent two weeks after the link to the survey has been sent. Two to three days prior to the deadline, participants will be contacted via phone to provide a final reminder and answer any questions or concerns the participant may have.
- Step 5: After the due date, responses will be recorded in Excel for analysis. The number of participants who agreed to participate in the study but did not respond will be noted in Excel with the other data.
- Step 6: The specific permit requirements for each respondent related to O&M of privately owned BMPs will be compared to verify they have similar permit requirements.
 - Differences between respondents will be recorded in Excel.

8.2.2 Interview Administration

This section describes the procedures for selecting participants to interview and conducting interviews. The Lead Entity PM is responsible for administering interviews. Since the interview questions will be developed after the survey is completed, the SOPs may be revised to provide more specific details when the interview questions are developed.

Summary of procedures prior to the interview:

- Step 1: Using the survey responses, select 10-15 respondents who provided a variety of responses to similar strategies and are willing to participate in the interviews.
- Step 2: Contact selected participants to request an interview. Schedule a date and time for the interview if the participant agrees to an interview.
 - The Lead Entity PM may elect to share the following information with the participant to provide additional detail about the interview:
 - Why interviews are being conducted
 - Expected length of interview
 - Expected number of questions
 - Time at the end of the interview will be provided for any final clarification of responses, closing statements, or questions regarding reporting of the interview results
 - Because interview questions may require some research on the participants part before they can answer the question, a list of information needed to answer the questions will be provided to the participant prior to the interview.

- Interview responses will remain confidential through the use of the identification codes and coded responses
- Step 3: Develop a list of questions to ask each of the participants who agree to an interview and follow the procedures (Section 8.3) for validating the interview questions. The same list of questions must be provided to each interviewee. These questions will be developed to provide additional insight into the survey responses collected and understand whether the strategy includes priority elements identified from question 4 of the survey. The questions will focus on details regarding their approach with an emphasis on noting any unique items that may not have been included in the survey response and justification for their selected rating of the approach.

Summary of procedures during the interview:

- Step 4: On the scheduled date and time, the interviewer will contact the participant to conduct the interview by phone. The Lead Entity PM will provide the following information prior to the interview:
 - A brief description of the study
 - Why interviews are being conducted
 - Expected length of interview
 - Expected number of questions
 - Time at the end of the interview will be provided for any final clarification of responses, closing statements, or questions regarding reporting of the interview results
 - Interview responses will remain confidential through the use of the identification codes and coded responses
- Step 5: The interviewer will read a prepared list of questions developed in Step 3. No prompts will be used to help the participant respond to the question.
 - The interviewer will take detailed notes to capture the responses.
- Step 6: Once the interviewer has received responses for each of the questions, the interviewer will ask the participant if they wish to clarify any statements, provide any additional information, or if they have any questions regarding the future of the study or how the data will be reported.
- Step 7: Following the completion of the interview, the interviewer will record the responses provided according to Section 10.0.

8.3 Instrument Validation

Validation is the process to verify the instrument measures what it was intended to measure and produces stable results. Both the survey questions and interview questions will be validated using pilot testing. Pilot testing includes staff from Osborn Consulting and Yakima County taking the survey. Then these groups met to compare their interpretation of the questions. Where there are differences in the interpretation of the questions, the group discussed their interpretation and modified the questions until they mutually agree on the interpretation of the wording. In addition, input from the TAG members was also used to refine survey questions and will be used to refine interview questions.

9.0 Quality Control

The purpose of this section is to describe the QC procedures that will be employed during the study to minimize errors and support the integrity of the data through the process of collecting, recording, and analyzing data. This section describes the procedure for addressing Section 6.0 DQI/MPC for Completeness.

9.1 Study QC Procedures

For all the data that will be created during this study, the following quality control procedures will be implemented:

- SOPs were developed (Section 8.2) that define procedures for collecting data. Prior to the start of data collection, all staff who collect data will be trained on the SOPs to ensure consistent responses.
- Data recording and reporting procedures were developed and will be consistently followed (Refer to Section 10.0 Data Management Plan Procedures).
- Standard forms for data collection during interviews will be developed and consistently used to collect interview responses (see section 10.0)
- Audits will be performed to verify that QAPP is being followed (Section 11.0)

9.2 Corrective Action

Correction actions are developed when it is found (through audits for example) that part of the QAPP is not being followed. If a problem is identified each issue will need to be evaluated to determine the potential impact on the project which may include flagging data, rejecting data, and developing a corrective action plan to prevent these issues from occurring again. If problems arise during the study a corrective action plan will be developed that includes procedures that will be followed to correct or compensate for problems. All corrective actions will be summarized in the table located in Appendix G and included in the final report. Examples of a corrective action include:

- Responses to survey and/or interview questions suggest that the respondents may have had varying interpretations of questions. Corrective action may include asking participants during the interview to explain how they interpreted the question. If it is found that respondents had different interpretations, the survey question may be rejected, or a follow up survey will be conducted to verify responses.
- SOPs not followed during the interview process. For this example, the issue would be documented, the data collected would be flagged, and the person leading the interviews would be retrained or replaced.

10.0 Data Management Plan Procedures

This section defines the data management plan, specifically how the data collected, and other important project documents will be managed, stored, and archived during the study. The purpose of the data management plans is to reduce the potential for errors during the data collection and analysis phases of the project; it also ensures that should an unanticipated change in Key Team Members take place, the project can be more easily continued by a new team member. This section describes the procedure for addressing Section 6.0 DQI/MPC for Completeness and Integrity.

10.1 Data Identification

The recorded responses of the survey and interviews conducted for this study will remain confidential in order to encourage participation in the study and improve credibility of the data. Data collected during the study will therefore be coded. Specifically, participants will be assigned an identification code, which will allow the Lead Entity PM to identify the participant while maintaining their privacy. The identification codes and associated participant information will be stored in a spreadsheet separate from the data mentioned in Section 10.2. The identification code will consistently incorporate the following items, in order:

- Indication of which Phase municipal permit the participant is subject to
 - Example: P2 for Phase II permittee
- Area in which the permittee is subject to the municipal permit
 - Example: “EW” for Eastern Washington, “WW” for Western Washington, “NW” for permittees located outside of Washington, etc.
- A three-digit number which is unique to that participant
 - Example: 001, 002, 003, etc.

10.2 Data Recording & Reporting Requirements

This section describes the procedures for recording data and compiling the data collected during the survey and interview process. Data recorded during the study will follow the data identification protocols listed in Section 10.1 and will be associated with an identification code in lieu of participant contact information.

Responses to the survey will be collected in SurveyMonkey® and will be exported to Microsoft Excel for further analysis. Responses to interview questions will transcribed into Excel. All responses will be compiled by data source (survey or interview) and question. Open ended questions will be reviewed and coded by common themes (reference Section 13.0 for more details about the analysis methods).

Data that will be compiled in Excel includes:

- Participant Identification Number
- List of Jurisdictions in Study Area (Columbia Basin for example)
- List of Participants who have agreed to participate in the study area

- Identification code of Respondents to the Survey
- Survey Responses organized by question and respondent ID
- List of Respondents to Interview
- Interview Responses and ID code
- Summary of requirements related to O&M on private property

The Lead Entity PM is responsible for saving notes detailing interview responses (as applicable) within one week of receiving the responses and ensuring that the data is archived until after the Final Technical Report has been approved by Ecology. The Lead Entity PM is also responsible for transferring data from SurveyMonkey® and interview transcripts or notes to Excel Spreadsheets for analysis. The data verifiers (see Section 5.0) are responsible for verifying that the data collected in from survey monkey or interview notes has been correctly transferred in the Excel format.

10.3 Procedures for Missing Data

Any data missing on the data collection forms will be documented in the Excel Spreadsheet by coding the data as M (for missing). In addition, a note will be added to the spreadsheet explaining the reasons why the data is missing (if known). Missing data will be reported in the final technical report along with a description of how the data set was analyzed without the missing data.

10.4 Acceptance Criteria for Existing Data

This section is not applicable to this study.

10.5 Revisions to the QAPP

If significant changes are made to the QAPP after the QAPP is approved and prior to the completion of the study, the QAPP will be revised and submitted to Ecology for review and approval. For example, revisions to the QAPP will be made when the interview questions are developed if needed when the interview SOPs are updated to reflect the interview questions. After the revised QAPP is approved, the document will be submitted (by the lead entity) to the all persons on the Distribution List in this document. In addition, revisions to the QAPP will be documented using the Summary of QAPP Revisions Table located in Appendix F. A completed copy of this table will be included in the final technical report.

11.0 Audits

This section identifies the audits that will be conducted during the study and defines the procedures for conducting the audit. The auditor(s) as defined in Section 5.1 is responsible for conducting each audit. Qualitative audits will be performed to verify that the study is conducted in conformance to the QAPP. For the Eastern Washington Effectiveness studies, audits will be conducted by the auditors defined in Section 5.0. A copy of the Audit Checklist for this study can be found in Appendix H.

Audits that will be conducted include:

- Verify that the SOPs are followed for data collection and data recording in Section 8.2
- Verify the data management procedures defined in Section 10.0 are followed
- Each audit will include:
 - Interviewing the Lead Entity PM (and anyone else who is participating in conducting interviews) regarding the SOPs they are following during data collection and comparing their responses to the SOPs
 - Interviewing the Lead Entity PM (and anyone else who is participating in data management) regarding their data management procedures and comparing interview responses to the Data Management Plan in Section 10.0
 - Reviewing the electronic files to verify that the data management procedures are followed
 - Where a discrepancy is found, reference Section 9.2 for the process of developing a corrective action plan

Audits will be conducted four times according to the following schedule:

- Prior to deploying the survey
- Following the completion of the survey
- Prior to conducting interviews
- Following the completion of 2 or 3 interviews

12.0 Data Verification and Usability Assessment

This section defines the process that the project will employ to verify the instruments, evaluate the quality of the data, and evaluate the usability of the data for meeting the project objectives. The process for validation of the instruments (survey and interview questions) is provided in Section 8.3. This section defines the process to determine if the Section 6.0 MPCs are met for the relevant DQIs.

12.1 Data Verification

This section describes the process that will be employed to evaluate the quality of the data created during the study and identify responsible party for verifying the data. Verification of the data will be performed by a person other than the one collecting and analyzing the data. For example, the Data Verifiers listed in Table 5.1.

The data verification process will include:

- Review all the data records to ensure they are consistent, correct and complete, with no errors or omissions
- Review the results from the QC section
- Review the results from the audit section
- Examine data to determine if MPC's listed in Table 6.1 were met
- Participant responses will also be verified for consistency. This will include comparing the survey responses to the interview responses for the same person to determine if there are any anomalies between similar responses. In addition, the final interview question will include asking the participant how certain they are that their responses represent their jurisdictions program. If responses between the survey and interview questions are found to be similar and/or the interviewee indicates they are certain of their responses, it will be assumed that their responses accurately reflect their opinions and/or understanding of their jurisdictions O&M BMP program for BMPs on private property. If the responses are different or the interviewee indicates they are uncertain of their responses, the participant will be asked to explain their uncertainty or the reason for the discrepancy. The level of uncertainty, differences, and explanation will be considered to determine how differences in their responses may affect the quality of the data. The data maybe flagged or thrown out.
- Peer debriefing will be used to validate coding: the lead researcher will code the data and provide two other researchers with their coding which they will use to code a portion of the data. The researchers will meet to compare their results until they mutually agree on the interpretation of the coding including adding additional codes. Reference Section 13.3 for more details.

12.2 *Data Usability Assessment*

This section describes the process and procedures that will be used to establish the usability of the data for meeting the project objectives. This should include:

- Results from the data verification (Section 10.2)
- Results from the audit (Section 11.0)
- Requirements related to inspection, maintenance, and enforcement are similar between all participants (Section 13.3.2)
- Whether responses from the same person on the survey and interview to similar questions are the consistent
- Whether the interviewee is certain that their responses represent their jurisdictions program
- Whether the MPCs for the project have been met as defined in Table 6.1. Generally, if the MPCs have been met, then data should be of sufficient quality to be usable for meeting project objectives. If the MPCs have not been met for data, the user will need to decide if the data is still usable or reject the data.

13.0 Data Analysis Methods

The survey and interview questions being developed for this Effectiveness Study include both open-ended and multiple-choice questions. This will result in analyzing the data using qualitative methods (data from open ended questions) and quantitative methods (data from multiple choice, ranking, and ratings questions). The methods described in this section apply to the survey (Appendix E). The proposed methods for analyzing interview questions are described in this section. When the interview questions are developed, this section maybe be revised if additional analysis methods (other than those described in this section) are needed to analyze the interview questions. Any revisions to the QAPP will follow the process outlined in Section 10.5.

13.1 *Hypothesis Testing*

Not Applicable. No data collected from this study that will be statistically compared. This is because the sample size is either too small or the data is not in a form that can readily be analyzed through a statistical analysis (i.e., qualitative data).

13.2 *Quantitative Data Analysis Methods*

13.2.1 Multiple-Choice and Rating Questions

Quantitative methods will be used to analyze responses to multiple choice and rating questions. For multiple choice questions (survey questions 1, 3, and 5), the percent of response to each question will be calculated to determine the distribution of responses for each option including the highest distribution of responses. For example, the highest distribution of responses to a multiple-choice option will indicate the most common strategy used by jurisdictions for survey Question 3. Equation 1 will be used to calculate the distribution of responses for each option. Figure 14.1 and 14.2 as well as Table 14.1 provides examples of how the data maybe presented in the final report.

$$R_{\text{Distribution}} = \frac{n_{\text{response}}}{n_{\text{total}}} \times 100\% \quad \text{Equation 1}$$

Where:

$R_{\text{Distribution}}$ = distribution of responses to option selected
 n_{response} = number of responses to an option
 n_{total} = total number of responses to the question

13.2.2 Open-Ended Questions - Part of Multiple-Choice Question

Responses to open ended questions (in the survey comment box) that are part of a multiple-choice question (Questions 1, 3, and 5) will be coded and organized into themes as described in Section 13.3. Then the distribution of responses to each theme will be calculated using Equation 1. The total number of responses (n_{total}) will be calculated by summing the total number of responses to each question including responses to the open-ended questions.

13.2.3 Combined Multiple-Choice and Open-Ended Questions

Responses to a question that include both a response to the multiple-choice option and open-ended question (in the comment box) will count as one response (toward the total number of

responses to the multiple-choice question). In this case the distribution calculation will be calculated for only the multiple-choice option selected. Then unique components of the strategy noted in the comment box will be coded and organized into themes as described in Section 13.3 and reported separately. For example, 40% of the participants selected option C for Question 3 and of those responses 30% of participants identified differences in their jurisdiction's strategy compared to the multiple-choice options provided. Differences reported included 50% indicate their jurisdiction adds component X to their strategy and 50% indicates that their jurisdiction removes component Y from their strategy.

13.2.4 Rating Questions

For questions in which the respondent will rate options (survey question 4), responses to high, medium, and low will be converted to a numerical scale (high=3, medium=2, and low=1). For each strategy selected, the ratings for each option (element) will be averaged using the numerical value that corresponds to their response and Equation 2. For example, 8 participants select the same strategy from survey question 2 of those participants 4 rate an element as high whereas 3 rate the same element as medium and 1 rates the element as low. Using Equation 2 the sum of the element ratings = high: 3x4 + medium: 2x3 + low: 1x1 = 19. The average ($R_{element}$) = 19/(8 participants) = 2.4 (average rating for an element). This process will be repeated for each of the elements in Question 3. Table 14.2 provides an example of how the data maybe presented in the final report.

$$R_{element} = \frac{\sum \text{sum of element ratings}}{n_{total}} \quad \text{Equation 2}$$

Where:

$R_{element}$ = average rating for the element
 n_{total} = total number of ratings to the element

13.3 Qualitative Data Analysis Methods

13.3.1 Open-Ended Questions

Qualitative analysis for the open-ended questions (survey questions 6 to 10 and responses provided in the comment boxes to all questions) will follow these steps:

1. Transcribe the data from each source (i.e. typing up responses from survey comment boxes or from interview questions)
2. Responses will be organized by source (i.e., survey or interviews) and by each question
3. Review and code the responses into themes. Themes will be identified based on the responses that emerge from the data (Gibbs, 2008). A starting place for coding will be to use the elements identified in the survey (question 4). For data that fit into two or more codes, the data was assigned all applicable codes. Each code assigned will count as one response toward the total response count (n_{total}).
4. After the lead entity project manager has identified codes and coded the data, a peer debriefing process will follow to verify the selected codes. This will include having two or three other researchers (i.e., data verifiers) review the codes and separately code 30%

of the data. Then the data verifiers will compare their results and where they do not have similar responses, they will discuss their interpretation of the codes until they mutually agreed on the coding. This may include modifying or adding themes to define responses. This process is part of the MPC for Objectivity defined in Section 6.0.

5. Then the distribution of responses provided for each theme will be calculated using Equation 1. The most common response(s) to each question will be identified based on the highest distribution of responses related to a specific theme.

13.3.2 Permit Requirements and Overview of Jurisdictions Strategy

Responses provided to survey question 1 relate to the specific requirements that apply to the jurisdiction. If all participants are permitted under the NPDES MS4 permit in Washington and no comments are provided in the comment box, no additional work is needed except to determine the distribution of responses described in Section 13.2.1. If participants are from areas outside of Washington or Washington participants provide comments in the comment box that indicate differences in requirements (i.e., more stringent local ordinances), then the requirements that apply to that participant will need to be compared to determine if the requirements are similar to the requirements defined in the EWA NPDES MS4 permit. This will include:

1. Locate the applicable requirements and transcribe the requirements for each participant (i.e. typing up responses) into an Excel spreadsheet
2. Compare the requirements to the EWA NPDES Phase II MS4 permit to determine if they are similar. If there are differences, they should be noted in the final report. For example, if a jurisdiction has additional or different requirements, they may influence the effectiveness of the jurisdiction's strategy. This may occur if the requirements are more stringent and/or connected to issuance of building permits or property titles. For this example, the property owner maybe more likely to comply with the requirements.

During the interview the participant will be asked to provide an overview of their strategy. The information provided will be compared to other participants to determine if there are any unique components that may influence the effectiveness of the strategy. Unique components will be documented in the final report.

13.4 Interview Question Analysis Methods

It is anticipated that interview questions will primarily be open-ended questions as such responses will be analyzed using the qualitative analysis methods described in Section 13.3. In addition, responses will be calculated on a per unit basis to improve the comparability of responses between participants. Examples of a per unit responses include:

- Annual cost per number of BMPs inspected and/or maintained each year
- The number of full time equivalent (FTE) employees per number of BMPs inspected and/or maintained each year
- Cost per sqft of impervious area managed by BMPs
- Average cft of runoff volume that BMPs are designed to manage

For interview questions that are multiple-choice, the responses will be evaluated using the quantitative methods described in Section 13.2.

13.5 Effectiveness Determination

The effectiveness of the strategies will be evaluated using the methods described in this section.

13.5.1 Survey Effectiveness Assessment

The goal of identifying the most effective strategies from surveys responses is to identify which participants to interview. In addition, responses to the self-assessment (survey question 4) will also be used to meet the Section 6.0 MPC for Reliability, Credibility, and Integrity. Specifically, responses from the survey self-assessment will be compared to the interview responses to determine if the responses are similar as described in Section 12.1. The process of assessing effectiveness from survey responses is as follows:

1. For participants that selected the same strategy, the average ratings for each element (question 4) will be calculated as described in Section 13.2.4.
2. A total score will be calculated for each strategy by summing the average ratings from each element. The strategy with the highest overall score will be identified as the most effective.
3. Participants from the strategies with the highest overall scores will be a top choice for interviews. The purpose of interviewing these participants is to develop a better understanding of the jurisdictions strategy and confirm the participants self-assessment of their jurisdictions program.
4. Participants from strategies that did not have the highest scores but had elements that on average rated higher than the strategies identified as the most effective may also be selected for interviews. The purpose of interviewing these participants is to better understand why specific elements were rated higher.

13.5.2 Interview Effectiveness Evaluation

The goal of the interview evaluation is to identify the most effective strategy and recommend approaches for addressing specific elements of O&M program. The proposed process for assessing effectiveness from interview responses is as follows:

1. Responses to interview questions will be compared to elements identified from the literature as being a component of a successful BMP inspection, maintenance, and enforcement program. These elements are summarized in Table 8.1.
2. For each strategy selected responses from participants will be combined to determine an average or most common response to each question. This will include:
 - a. Responses will be converted to a per unit basis and averaged (using Equation 2)
 - b. Responses to open ended questions will be coded (per Section 13.3) and the distribution of responses will be calculated (equation 1) to determine the most common response to the question (highest distribution of responses).

3. For each strategy, the most common (highest distribution of responses) or average response to each question will be compared to determine which best align with the elements defined in Table 8.1. This is expected to include:
 - a. Responses provided on a per unit basis - For example, the following element, *Strategy is cost effective for jurisdiction to conduct required inspection and/or maintenance*, responses with the lowest average per unit cost will be identified as the most effective for this question. Whereas the strategy with the second lowest cost per unit would be identified as the second most effective and the third lowest cost would be identified as the third most effective, etc.
 - b. Responses to open ended questions - For example, the following element, *BMP owners demonstrate compliance the jurisdiction's requirements*, the highest distribution of responses to this question that indicate property owners demonstrate compliance would be identified as the most effective for this question. Whereas the strategy with the second highest distribution of responses would be identified as the second most effective and the third highest distribution would be identified as the third most effective, etc.
4. After step 3, the strategy for each question identified as the most effective, second most effective, etc. will be converted to a numerical scale. For example, if there are 3 strategies that are being compared during the interview, the strategy with the most effective response to a question will be assigned a numerical value of 3, the second most effective a value of 2, and the third most effective a value of 1. For strategies with the same average response or distribution of responses, each strategy will be given the same score. For example, if the two strategies have the same value for the lowest cost per unit both will be considered the equally effective and assigned a score of 3.
5. The process described in steps 1 to 4 will be repeated for each of the interview questions.
6. An overall score for each strategy will be calculated by summing the numerical value for each question. The strategy with the highest overall score will be identified as the most effective strategy.
7. For similar questions provided in the interview and the survey, responses will be compared for consistency as described in Section 12.1. If the responses are similar, results from the survey may be combined with the interview responses to determine the most effective strategies and/or elements of strategies.
8. The final report will provide a summary of the most effective strategy as well as the most effective elements of different strategies. Depending on the results, the study recommendations may include developing a new strategy that combines the most effective elements from different strategies.

13.5 Data Presentation Methods

The purpose of this section is to describe how the data will be presented (i.e. tables, charts, and/or graphs) in the final reports to illustrate trends, relationships, and anomalies. Data collected during this study will be presented primarily in tables and bar-chart or pie style graphics to illustrate key findings.

Data will be depicted in graphics if the responses to certain questions warrant visual representation. For example, Figure 14.1 is a pie graph that illustrates the breakdown of applicable permits that apply to the study participants and Figure 14.2 is a bar graph that illustrates the distribution of responses to survey question 3.

Responses will also be depicted in tables that summarize participants responses. For example, Table 14.1 summarizes the number of study participants that selected a specific strategy based on the type of permit and state in which the jurisdiction is located as well as the total sample size and distribution of responses ($R_{Distribution}$). Table 14.2 provides a summary of average ratings to survey question 3. Table 14.3 provides a summary of responses to open ended questions 6-9 including identifying the distribution of responses to major themes (from coding data) and examples of how coding was applied to responses.

Table 14.1 Summary of Respondents by Permit Type and State

O&M BMP on Private Property Strategy	WWA		EWA	Other State		$R_{Distribution}$
	Phase 1	Phase 2	Phase 2	Phase 1	Phase 2	
a. Permittee Inspection & Contractor Maintenance	1	1	2	2	2	27%
b. Third Party Inspection & Contractor Maintenance	0	2	1	2	1	17%
c. Permittee Inspection & Permittee Maintenance	1	3	2	3	2	37%
d. Property Owner Inspects & Property Owner Maintains	0	1	2	0	0	10%
e. Variable Inspection/Variable Maintenance	0	1	1	1	0	10%
Total Responses					30	

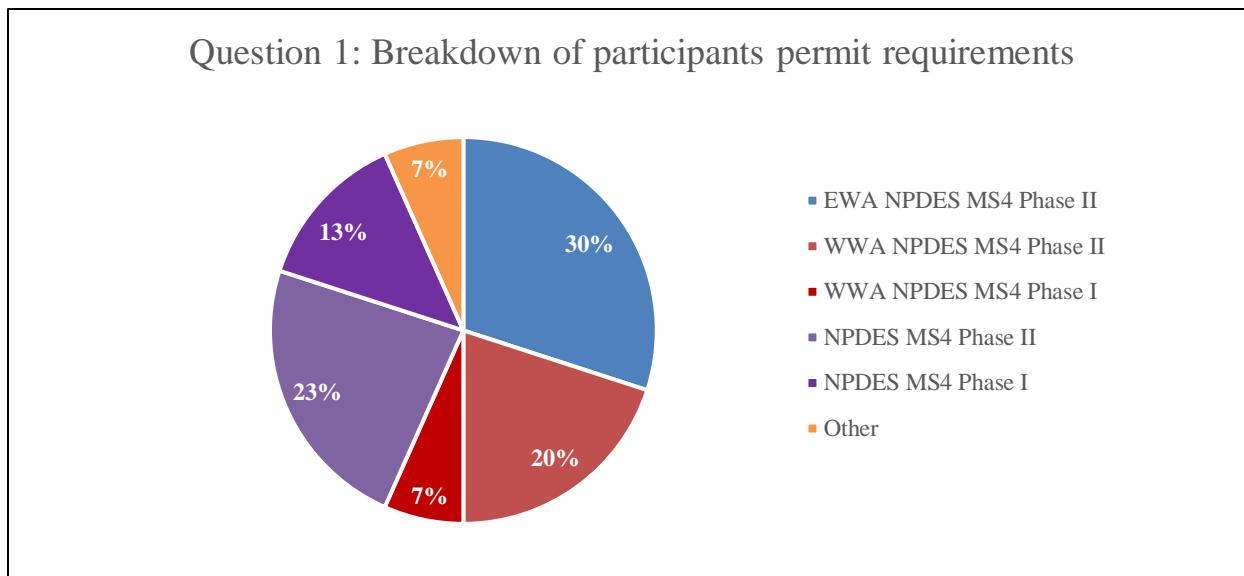
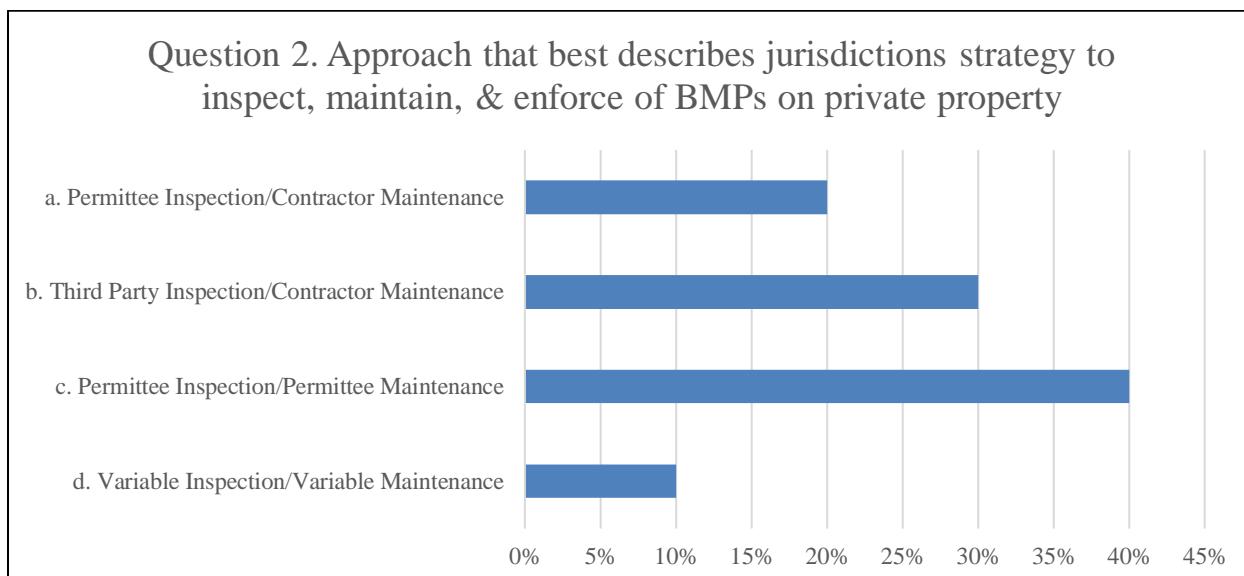
**Figure 14.1: Responses to Question 1****Figure 14.2: Responses to Question 2**

Table 14.2 Responses to Question 4 - Average Rating of Elements for Question 2 Option C: Permittee Inspection & Permittee Maintenance

Element	Average Score
Access to BMPs on private property	3
Does our jurisdiction have funding to perform the required inspection, maintenance, and enforcement activities?	2
Is training provided for staff performing inspection, maintenance, and enforcement activities?	2.5
Does your jurisdiction have a written plan that defines the O&M protocol for BMPs?	3
Does the jurisdiction provide O&M protocol to BMP owners in language that can be understood by the general public and/or does the jurisdiction have a program to educate BMP owners about their O&M responsibilities?	3
Is O&M protocol and/or education materials provided in languages other than English?	2
When ownership changes, does your jurisdiction have a process for communicating all O&M responsibilities to the new BMP owner?	1.5
Does your jurisdiction have the appropriate equipment available to conduct maintenance of BMPs on private property?	3
Are BMP owners able to demonstrate compliance with your jurisdiction's requirements?	2.75
Are BMP owners in your jurisdiction willing to pay for required maintenance?	3
Jurisdiction has a documentation process for tracking inspection and maintenance activities	2
Are your jurisdiction's documentation and inspection record up to date and complete for BMPs on private property?	2.5

Table 14.3 Summary of Responses to Open Ended Questions

Q #	Third Party Inspection/Contractor Maintenance	% of Responses	Codes Applied: Example Responses
Q6	Primary challenges with strategy	56% Compliance 37% Documentation	Documentation: Insufficient documentation from BMP owner
Q7	Primary benefit to strategy	54% Access 28% BMP Owner Understanding of Requirements	Access: this strategy provides easy access to BMPs
Q8	Improvements or changes recommended	75% Documentation	Documentation: need to develop an easier process for BMP owners to document maintenance records and send to jurisdiction

14.0 Reporting

The purpose of this section is to describe how the study findings will be reported and disseminated.

14.1 *Final Reporting*

The following provides a summary of the reports that will be produced for this study as well as the party responsible for preparing the reports.

- Annual Reports (Permit Section S8.B8) – the Lead Entity PM will develop the annual reports which will describe the interim results and status of the study
- Final Report (Permit Section S8.B10) – the Lead Entity will produce the final technical report which will summarize the final results of the study and recommend future actions based on the study findings. Table 14.1 provides an outline of the final technical report.
- Study Fact Sheet - the Lead Entity will develop a fact sheet which summarizes the key points of the study along with the study findings.

Table 14.1 Proposed Effectiveness Study Report Content

Final Report Sections	Effectiveness Studies
0.0 Cover Letter	✓
1.0 Executive Summary	✓
2.0 Introduction	See Note 1
3.0 Description of the Operation & Maintenance Program	See Note 1
4.0 Data Collection Procedures	See Note 1
5.0 Data Summaries and Analysis	✓
6.0 Discussion	✓
7.0 Conclusions	✓
8.0 Future Action Recommendations	✓
9.0 Appendices	

1. The Final Technical Report will reference these sections in the approved QAPP (in lieu of rewriting these sections in the Final Report). Any applicable changes made since the QAPP was approved will be noted in these sections.

14.2 *Dissemination of Project Documents*

Upon completion of the project, the Final Report will be sent to the Ecology Municipal Stormwater Permit Manager, along with a spreadsheet containing the coded data collected during the study. Any unused data will be noted in the spreadsheet and a reason will be provided for the rejection of the data. The Final Report and Fact Sheet will be available to the public on the Yakima County webpage at the following link:

<http://www.yakimacounty.us/1732/Stormwater-Management>

15.0 References

Aldous, M., & Buys, F. (2009). The perceived economic impact of the City of Johannesburg's storm water attenuation policy on private property developers: research article. *Acta Structilia, 16*(2), 18-45.

Biddix, P. J. (2016). *Uncomplicated Reviews of Educational Research Methods: Instrument, Validity, Reliability*. Retrieved November 20, 2016, from Research Rundowns: <https://researchrundowns.com/quantitative-methods/instrument-validity-reliability/>

Blecken, G.-T., Hunt, W. F., Al-Rubaei, A. M., Viklander, M., & Lord, W. G. (2015). Stormwater control measure (SCM) maintenance considerations to ensure designed functionality. *Urban Water Journal, 14*(3), 278-290.

Bruce, S., & Barnes, G. (2008). *Survey of Local Government Post Construction BMP Maintenance and Enforcement in North Carolina: Report FIndings, Best Management Practices (BMP) Maintenance & Enforcement Survey Report*. Raleigh, NC: State of North Carolina.

Buyss, F., & Aldous, M. (2009). The perceived economic impact of the City of Johannesburg's storm water attenuation policy on private property developers. *Acta Structilia: Journal for the Physical and Development Sciences*, 18-45.

Caraco, D. (2000). Stormwater Strategies for Arid and Semi-Arid Watersheds. *Watershed Protection Techniques, 3*(3), 695-706.

City of Baton Rouge. (2012, July). *Private Stormwater Quality Best Management Practices Maintenance Covenant*. Retrieved from City of Baton Rouge: <https://www.brla.gov/DocumentCenter/View/1678/Stormwater-Quality-BMP-Maintenance-Covenant-PDF>

Clark, J. A. (1994). Objectivity, Subjectivity, and relativism in educational research. *Curriculum Inquiry, 24*(1), 81-94.

Doll, A., & Lindsey, G. (1999, January). Credits bring economic incentives for onsite stormwater management. *Watershed & Wet Weather Technical Bulletin*. Water Environment Federation.

Environmental & Water Resources Institute. (2012, July 4). *Stormwater BMP Maintenance Task Committee*. Retrieved from Environmental & Water Resources Institute Stormwater Infrastructure Committee: http://www.ewri-swi.org/stormwater_bmp_task.html

EPA. (2006). *Guidance on Systematic Planning Using the Data Quality Objectives Process*. Washington, D.C.

Erickson, A., Weiss, P., & Gulliver, J. (2013). *Optimizing Stormwater Treatment Practices: A Handbook of Assessment and Maintenance*. New York, New York: Springer Publishing Company.

FluidSurveys. (2014, October 8). *Response Rate Statistics for Online Surveys - What Numbers Should You Be Aiming For?* Retrieved from FluidSurveys University: <http://fluidsurveys.com/university/response-rate-statistics-online-surveys-aiming/>

Flynn, K. M., Linkous, B. W., & Buechter, M. T. (2012). Operation and Maintenance Assessment for Structural Stormwater BMPs. *World Environmental and Water Resources Congress 2012: Crossing Boundaries* (pp. 3662-3673). Albuquerque, New Mexico: ASCE.

Flynn, K., Likous, B., & Buechter, M. (2012). Operation and Maintenance Assessment for Structural Stormwater BMPs. *Proceedings of the World Environmental and Water Resources Congress*. Albuquerque, NM.

Fryrear, A. (2015, 7 27). *What's a Good Survey Response Rate?* Retrieved from Survey Gizmo: <https://www.surveygizmo.com/resources/blog/survey-response-rates/>

Galvin, R. (2015). How many interviews are enough? Do qualitative interviews in building energy consumption research produce reliable knowledge? *The Journal of Building Engineering*.

Gibbs, G. R. (2008). *Analysing Qualitative Data*. Sage Publications Inc. .

Grimm, P. (2010). Social desirability bias. *Wiley International Encyclopedia of Marketing*.

Guba, E. G. (1981). Criteria for assessing the trustworthiness of naturalistic inquiries. *ECTJ*, 29(2), 75-91.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough?: An experiment with data saturation and variability. *Field Methods*, 18(1), 59-82.

Herron, E., Stepenuck, K., & Green , L. (2009). *Tools for Effective Outreach* . University of Rhode Island and University of Wisconsin.

Jabbar, A. (2015, March 20). *Sample size for qualitative interviews*. Retrieved from The Academic Triangle: https://researchcholic.wordpress.com/2015/03/20/sample_size_interviews/

Lombard, S., & Kirchmer, C. (2004). *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies*. Manchester: Environmental Assessment Program.

Qualtrics XM. (2019). *How to Increase Online Survey Response Rates*. Retrieved 10 2019, from Qualtrics XM: <https://www.qualtrics.com/experience-management/research/tools-increase-response-rate/>

Radhakrishna, R. (2012, June). Ensuring Data Quality in Extension Research and Evaluation Studies. *Journal of Extension*, 50(3), 3.

Rafter, D. (2000, 3 17). *Forester Media*. Retrieved from The Messy Business of Maintaining BMPs: <https://www.foresternetwork.com/stormwater/stormwater-management/article/13000375/the-messy-business-of-maintaining-bmps>

Richardson, D. C. (2019, 7 26). *Forester Media*. Retrieved from Keeping Pace with Maintenance: <https://www.foresternetwork.com/stormwater/stormwater-management/article/21089239/keeping-pace-with-maintenance>

Statistics Solutions. (n.d.). *Qualitative Sample Size*. Retrieved 11 2019, from Statistics Solutions: <https://www.statisticssolutions.com/qualitative-sample-size/>

University of Minnesota. (2010). *Stormwater Treatment: Assessment and Maintenance - Field Data Sheet for Level 1 Assessment: Visual Inspection of Permeable Pavements*. Minneapolis, MN.

Washington State Department of Ecology. (2011). *Technical Guidance Manual for Evaluating Emerging Stormwater Treatment Technologies*. Olympia: Washington State Department of Ecology.

Washington State Department of Ecology. (2013). *Eastern Washington Low Impact Development Guidane Manual*. Olympia, WA: Department of Ecology.

Washington State Department of Ecology. (2018). *Technical Guidance Manual for Evaluating Stormwater Treatment Technologies - Technology Assessment Protocol - Ecology (TAPE)*. Olympia, WA: Department of Ecology.

Washington State Department of Ecology. (2019). *Eastern Washington Phase II Municipal Stormwater Permit*. Olympia, WA: Department of Ecology.

Washington State Department of Ecology. (2019). *Stormwater Management Manual for Eastern Washington*. Olympia, WA: Department of Ecology.

Washington State Department of Ecology. (2019). *Stormwater Management Manual for Western Washington*. Olympia, WA: Department of Ecology.

Yakima County. (2010). *Yakima County Regional Stormwater Manual*. Water Resources Division, Stormwater Management. Yakima, WA: Yakima County Public Services. Retrieved October 1, 2019, from <https://www.yakimacounty.us/1740/Stormwater-Manual>

Yakima County. (2019, September). *Yakima County Code*. Retrieved 10 2019, from Code Publishing Company: <https://www.codepublishing.com/WA/YakimaCounty#!/YakimaCounty12/YakimaCounty1210.html#12.10.330>

16.0 Appendices

Appendix A. Proposal: Ecology Approval Letter and Comments



To: Karen Dinicola, Department of Ecology
From: Douglas C. Howie, P.E., Department of Ecology
Cc: Abbey Stockwell, Department of Ecology
Date: July 20, 2017
Subject: Comments on Eastern Washington Effectiveness Study Proposals

Here are my comments on the eight Eastern Washington Effectiveness Studies submitted to Ecology on July 11 and following days. The proposals follow a common format with significant portions of the documents left for later completion. There is still adequate information in each proposal to identify what the author intends to complete.

Documents Reviewed:

1. *Detailed Study Design Proposal: Elementary School Stormwater Education*, by HDR, Inc. June 30, 2017
2. *Detailed Study Design Proposal: BMP Inspection and Maintenance Responsibilities*, by HDR, Inc. and Drummond Carpenter, PLLC, June 30, 2017
3. *Detailed Study Design Proposal: Bioretention Soil Media Study*, by HDR, Inc. and D&H Technology Solutions, LLC, June 30, 2017
4. *Detailed Study Design Proposal: Sharp Avenue Porous Pavement*, by City of Spokane, June 2017
5. *Detailed Study Design Proposal: Garland Stormwater Gardens with Biochar Amended Soil*, by City of Spokane, June 2017
6. *Detailed Study Design Proposal: Mobile Contractor Illicit Discharge Education & Outreach Effectiveness Study*, by City of Wenatchee, June 28, 2017
7. *Detailed Study Design Proposal: Sand Filter Sidewalk Vault BMP*, by Spokane County, June 30, 2017
8. *Detailed Study Design Proposal: Street Sweeping and Catch Basin Cleaning Comparison*, by City of Ellensburg, June 30, 2017

General Comments on Proposals

1. There are still a number of significant issues left to fill in when producing the QAPP for these studies. I will probably have more comments when they submit the QAPP.

Comments on Elementary School Stormwater Education

1. It's a small thing, but they sometimes italicize *Drain Rangers* and sometimes not.
2. How will they adapt the WWA program to EWA students? There are no specifics identified, particularly when they include "engineering design processes" in the curriculum. In Section 4.1, they describe the study goals. These are universal issues, not a WWA or EWA specific issue.

3. Will the report on the WWA Drain Rangers project contain before and after information that they could use to help in the development of the before and after evaluations?
4. There is a reference to “See Section 4.5 for more information about IRB’s”. This reference is in Section 4.5 and there is no further information about IRB’s in the document. There is a detailed discussion of IRBs in the BMP Inspection and Maintenance Responsibilities Proposal.
5. In Section 13, they discuss using the Likert Scale. What is the Likert Scale and how do they apply it to data from this study?
6. The information shown in Table 13.3 is quite limited. I think they should include gender in the data as well as age.
7. It would be good to include some thinking about following-up with the student in another 2 or 3 years to see what they retained and if they applied any of the lessons learned to their life.

Comments on BMP Inspection and Maintenance Responsibilities

1. I’m not seeing a lot in the way of evaluating the information they collect for effectiveness. As I read the Project Overview section, my final thought was that I still didn’t know exactly what they plan to evaluate and compare.
2. Early in the text, they refer to “similar semi-arid jurisdictions”, but in Section 7.0, the scope is limited to “Washington and Columbia River Basin”. What happened to using information from eastern Oregon and southern Idaho?
3. Add two additional questions for the survey: What benefits do they derive from the inspections and what do they use to determine the need for maintenance?
4. I think the survey will take more than 10 minutes if they include all the bulleted items listed. There are some questions, which will take research on the part of the responder, such as funds spend, number of privately owned BMPs, and number inspected each year.
5. The proposed report information does not include information on the effectiveness of the inspections, it just reports on the information gathered.

Comments on Bioretention Soil Media Study

1. Please do not call bioretention facilities “ponds”. They are “Swales” or “cells”, but not ponds. While water does collect in the facility before passing through the media, they are not a pond.
2. In Section 4.2, they refer to the “TAPE Board of External Reviewers” as someone who will review the QAPP and TER. They also mention this elsewhere in the proposal. This is not necessary for this study. They need to create an advisory/review panel that will independently review the results of the monitoring, but it doesn’t have to be the TAPE BER. This is a modification to an existing BMP that has already received a lot of study. This work doesn’t need to go through the full TAPE process. The study should still follow the TAPE protocol, but not to the extent of bringing in members of the BER for review.
3. In Section 5.0, they list Brad Daly multiple times. There may be a conflict between his tasks if he is both an Advisory Board lead/member and a reviewer. They also list Art Jenkins twice in the table.

4. I would expect to see the Bioretention sizing calculations in the QAPP.
5. There are several sections left to be completed, which have a bearing on the success of this study.
6. What happens if the grass proposed for the vegetated swale doesn't grow, or show sparse growth? When do they determine that they have adequate vegetation to compare the two cells accurately? Will they perform any analysis on the amount of vegetation in the cell?

Comments on Sharp Avenue Porous Pavement

1. They need to follow much of the protocol described in the TAPE Guidance Manual if they want to have permeable pavement approved for treatment. They don't need to use the TAPE Board of External Reviewers (BER), but they do need to develop a technical review panel that will independently review the results of the monitoring. They also need to collect water quality samples from a suite of pollutants, as described in the TAPE guidance. They haven't identified what pollutants they want to monitor in the document yet.
2. They need to evaluate the removal percentages for the various pollutants. They need to follow the statistical analysis described in the TAPE guidance manual for this analysis.
3. They should probably add Ray Latham, CRO Municipal Stormwater Permit Manager (rlat461@ecy.wa.gov) to the distribution list.
4. They will need to describe the basins that receive rainfall and direct runoff to the sampling stations better. Will there be run-on to the permeable pavement? Will runoff occur from lands other than the street?
5. The minimum rainfall for a qualifying event in TAPE is 0.15 inches, not 0.2 inches.
6. The statement at the start of Section 5.3 is confusing. Are they collecting only one sample per quarter, or will they attempt to collect samples from all potentially qualifying rainfall events throughout the year.
7. Will they want to collect grab samples during the monitoring? If so, they need to describe the process for collecting.

Comments on Garland Stormwater Gardens with Biochar Amended Soil

1. They should probably add Ray Latham, CRO Municipal Stormwater Permit Manager (rlat461@ecy.wa.gov) to the distribution list.
2. I'm confused about just what a Storm Garden is. I thought it is an Eastern Washington version of a Bioretention facility. In this proposal, they speak of it as a bio-infiltration swale. Bio-infiltration swales don't include engineered soil, so the BMP discussed this proposal is not a bio-infiltration swale. If they want to test a Bioretention Soil Mix that uses biochar instead of compost, they need to remove references to bio-infiltration swales, and say that Storm Gardens are equivalent to Bioretention.
3. The previous laboratory study that found biochar could remove pollutants is important and they should include summary data from the study as an appendix to the QAPP.
4. Based on the text in Section 3.5 they will use grab samples to get their data. The effluent grab sampler does produce a pseudo-composite sample, but the influent sampler does not. The number of samples is very small and probably the calculations won't produce statistically significant data unless the level of treatment is very high. It is also very

difficult to accept data as paired when one is a single grab and the other is a composite over time.

5. Section 5.3 appears to say that there will be only one sample per quarter. They should collect samples from all potentially qualifying rainfall events throughout the year, particularly if they have a limited volume of sample to work with and a large number of pollutants to sample. They could select some pollutants for testing and some to skip, knowing that they can reverse the pollutants tested after the next storm.
6. What pollutants do they propose to test for in this project. They list pollutants tested in the lab study on biochar, but they don't list anything for this study.
7. The minimum rainfall for a qualifying event in TAPE is 0.15 inches, not 0.2 inches.

Comments on Mobile Contractor Illicit Discharge Education & Outreach

1. They need to develop a distribution list by name along with specifying particular people for signatures.
2. In the first paragraph, they say there were two programs in eastern Washington and then mention Snohomish County as one of the programs. They explain this later, but it is confusing at the start. Maybe leave out the "eastern" at the first mention.
3. The text for the pledge in the third bullet should stand out as italics or in quote marks.
4. In Section 4.5, they have language that implies they will go for consultant selection twice, once for data collection preparation and once for data collection. Couldn't they combine the two pieces into a single project and save some time, money and effort?
5. In Table 4.1, they could include as a constraint the thought that the mobile business owner may fear some sort of penalty if they admit they discharge incorrectly. This may limit the number of responses you get from those who are not obeying the Dump Smart Program.

Comments on Sand Filter Sidewalk Vault BMP

1. Page 4: They identify an initial mix that meets Ecology's requirements for treatment of dissolved Cu and Zn and total phosphorus, but not TSS. All BMPs must meet the minimum level of TSS treatment before they perform any evaluation for other pollutants.
2. For TAPE approval, there is no maximum number of samples to collect. You need to collect a minimum of 12 samples and you need to meet the statistical requirements for confidence. If that takes more than 36 samples, you need to collect more than 36 samples. Typically, if someone needs to collect more than 25 samples to show treatment, they realize the existing device doesn't work and they stop sampling. They might change the treatment technology and start the process again, or they move out of the TAPE program.
3. You need to add a goal of establishing a design flow rate in gallons per minute per square foot of the sand filter surface.
4. Highlight the location of the vault on Figure 4.1.
5. Section 4.4, you need to collect continuous flow measurements and water quality samples must include event mean concentrations, not just grab samples.
6. Section 4.5, Ecology must review and approve the QAPP.

7. Section 7.2, do you have values for the current influent concentrations? You might want to collect samples to get a feel for the influent pollutants.
8. Table 7.2, you should include an analysis of the organic content of the soils and possibly other parameters, such as carbon: nitrogen ratio.

Comments on Street Sweeping and Catch Basin Cleaning Comparison

1. There are a several places where sentences suddenly end, there are missing words, or text doesn't make sense. The proposal is still understandable and I assume the next edit will correct these issues.
2. Section 3.3, add a bullet that discusses the potential that sediment in the catch basin could resuspend and flow out of the catch basin during a large storm. A catch basin could catch some sediment, at least for a short time, and then discharge to the swale. The sediment bags should catch this sediment.
3. You are vacuuming the street with a hand held vacuum to collect samples. How will this work with the street sweeper volumes of sediment removed?

If you have any further questions, please contact me by email at douglas.howie@ecy.wa.gov or by phone at (360) 407-6444.

Appendix B. QAPP: Ecology Response to Submittals



To: Ray Latham, Department of Ecology, Municipal Stormwater Permit Manager
 From: Brandi Lubliner, P.E., Department of Ecology, QA Coordinator
 Date: June 27, 2018
 Subject: Eastern Washington Stormwater Effectiveness Study QAPP Review Comments

I reviewed the *Eastern Washington Stormwater Effectiveness Studies Quality Assurance Project Plan: BMP Inspection and Maintenance Responsibilities*, draft dated May 8, 2018. This QAPP is not complete but it is close. The following revisions are necessary for approval.

1. Signature Page and Table in Section 5.1: Specify both Ray Latham Ecology permit/project manager and Brandi Lubliner as Ecology QA Coordinator.
2. Section 3.2 mentions Zoomerang, but Section 4.5 mentions SurveyMonkey. Which?
3. Sections 2, 3, and 4: This project has two distinct goals that are sometimes presented as only one. Thru the survey they want to learn both the breadth of approaches/strategies **and** quantify 'best' using a series of value statements (costs, efficiencies, clean water, completeness, etc.).
 - a. Section 4 opens with...The purpose is to determine the "best" strategy... Other places there is "most successful". Section 4.6 says 'preferred strategy'. Is the best strategy the one chosen by the most jurisdictions? Is best the strategy that yields the most permissions or the most inspections? Or is best made of up several component parts? If so the component metrics/parts that define what best or successful mean are missing from this QAPP, or are they the bulleted list in Section 7? Without the rubric or ranking system being explained in this QAPP, 'best' remains vague and the success of the project is limited.
 - b. Revise to add and define in more specific terms. Such as a survey questions will aim to rank BMPs and return on maintenance for ease of maintenance, hours maintained per visit, visits per year per unit BMP, etc.
 - c. Appendix A (the survey) was not included, reference in Section 8. Unclear to this reviewer what the survey questions will actually measure.
4. Section 7.1: it is somewhat unclear to me how confidentiality will be maintained if all the surveys will be stored by the jurisdiction. Not sure they should promise it. It might be good just to not collect the names of the responded or code-out identifying data to the subjects.
5. Section 2, 6, and 7:
 - a. Because there were 8 or so actual BMPs listed in the Background (Section2), I thought for a while this was a BMP specific survey, but the other parts of the QAPP are clearly more programmatic level questions. Maybe the list of BMPs that make up the category of structural BMPs should be brought from Background down to Section 7.3, where it currently says Not Applicable.
 - b. Section 7.1: the bulleted list of survey info gathered doesn't look like only a 10 minute interview. My own lessons learned for surveys is to ask for what is really

desired. Some of these are in-depth especially the BMP specific ones: age, area managed, size, funds per BMP.

6. Section 4 Quality Objectives is a little lean with regard to how the surveys is devised or will be implemented to prevent bias. I suspect there will be great care given to how the questions are phrased, trying to not be leading questions. Also, what is the target completeness goal 90% of how many of the total population? How many surveys will be too little? Who will do the coding?
7. Section 9.1: first bullet is a carry-over from another QAPP. Delete.
8. Section 10: much of the necessary information for this section is missing.
9. Section 12:
 - a. Move the first paragraph (except the last sentence) of Section 12 into this section 8.3. This is instrument verification.

The survey instrument will be verified by having several (approximately three to five) stormwater (managers) operators serve as beta-testers of both the instrument and the administration protocols. These individuals can be selected from participating jurisdictions in Yakima County. These individuals can suggest revisions of the questions and confirm the online data collection interface is functioning. Finally, the beta-testers can verify their online responses were accurate before broad survey administration.
 - b. Move the third paragraph from Section 12 to Section 9.1. This describes QC
 - c. Move the second paragraph from Section 12 to Section 9.2. This is corrective action.
 - d. With the exception of one sentence this section is now empty. This section is usually describes how the lead entity determines the data are useable: the QC steps are verified and were followed, the dataset represents a minimum # of surveys. Audits were completed, findings okay. Systematic bias isn't evident. Corrective actions were taken as needed. If some of the data are found to be too bias, incomplete, failed QC, etc they won't be used. Usability statement is made in the final report.
10. Section 13: This whole section needs to move to become a new Section 10. It is currently out of place.
 - a. Section 13.2: I would replace the word 'trends' with 'themes' as is mentioned in other locations of the QAPP.
11. Section 14.2: The final report must also go to the Ecology project and permit manager, along with a spreadsheet of all the study data. This means all the useable quality assured data used for the analysis, and the rejected or un-useable data gathered as part of the study. The rejected data can be included in a separate file or a different tab and the reasons for its failure described.

My role as QA Coordinator for municipal stormwater monitoring is relatively new, and was not yet established in the earlier drafts of this QAPP. Please send the final PDF for signature when ready. If you have any further questions, please contact me by email at brandi.lubliner@ecy.wa.gov or by phone at (360) 407-7140.

QAPP Comments from Ray Latham on first QAPP Submittal

ii. Signature Page.

Please include a line for both Brandi Lubliner and I on the signature page.

3.1 Background Introduction

(Break up sentence.) “*This study will investigate procedures developed by other jurisdictions related to inspection and enforcement of operation and maintenance requirements. for all structural best management practices (BMPs). BMPs installed on privately owned property include ~~ing~~, but are not limited to, detention ponds, tanks and vaults; infiltration facilities; detention facilities; storm treatment wetlands and wet ponds; and mechanical separators.*”

Brandi addresses a dichotomy of goals in her comment 3.

The last paragraph of 3.1 only mentions the potential for disseminating information. The final report and data should be available for electronic or hardcopy publication, web distribution or as a workshop. Please provide details in 7.5.

3.2 Problem Description;

The literature review is 8-10 years old, which is sufficient for support of the problem statement. But, it is suggested that more current surveys on stormwater BMP O&M practices and the inspection procedures be reviewed in building the survey and interview questionnaire.

4.1 Study Goal:

... “to determine the best O&M strategy”, is not the same goal as (4.2)...Study Objective: “to learn novel and effective ways that municipalities are meeting the challenge of ensuring ongoing maintenance of structural BMPs on private property”. But, evaluating the first question is a necessary step to reach the study objective of determining effectiveness of an inspection strategy.

4.2 Study Description and Objectives:

Is the focus on assessing management strategies by jurisdictions to ensure ongoing maintenance or O&M procedures for privately owned BMPs? This needs to be better defined because it drives the focus of the survey and the analysis.

The inspection protocols and identified O&M practices codified by participating respondents in their Storm Water Management Plans (SWMP) will identify common practices. The survey may then evaluate the success or shortcomings of those strategies.

Add a 4th bullet “Provide the constraints or triggers to gage the success of a given inspection strategy.” One of the outcomes of the study is to provide an analytical tool for jurisdictions to evaluate and revise their SWMP.

6.0 Quality Objectives;

There is value in learning about impediments to success. A strategy or project may have a critical element that needs tweaking in order to be successful.

7.1 Study Design:

Interviews: Who will screen responses, conduct interviews and analyze data? Core team, Lead or contractor?

I would suggest not making an assurance of anonymity during certain portions of the data collection. Survey responses may be relatively easy. But, maintaining claims of confidentiality of interviews may be very difficult given specific information that is being collected.

7.2 Process for Selecting the Test-Site and Target Population:

Clarify who the 'target population' is for each segment of the survey. The stormwater (Public Works) managers, the owners of private facilities or both?

Owners could be queried about their own method of BMP management (familiarity with BMP, presence/absence of O&M manual, their evaluation method, inspection frequency, types of repair, interactions with jurisdiction.)

MS4 managers would be asked about code requirements, inspections/complaints procedures, technical assistance, resolution mechanisms...etc.

7.6 Other E&O Programs:

This project is designed to be helpful during discussions on improving stormwater management planning. How will this information be disseminated; publications, presentation, workshops?

8.1 Instrument Design:

This needs specificity on the scope of the questions. The ability to discern what triggers success/failure of a program may decrease with the number of variables. Review the objective statement for reference during formulation of the survey.

9.1 Study QC Procedures:

Redo 1st bullet and make it pertinent to this study. This statement is pulled from another study.

9.2 Corrective Action:

What is the acceptable level of consistency? Provide specific criteria on how is this determined.

What procedures are used to amend survey questions without introducing bias, while maintaining anonymous entries?

10.0 Data Management Plan Procedures;

This needs to have specific SOP's provided to assure consistency with protocols and provide guidance for Section 11.0.

12.0 Data Verification and Usability Assessment;

To maintain veracity, the verification needs to be conducted by an individual not involved in interviewing or collecting data.

13.0 Data Presentation Methods:

There are many options for visually presenting the data. I would suggest you be clear about the point you wish to illustrate and then choose the graphic method for presentation.

14.0 Reporting:

Ecology needs an electronic copy of both the usable and unused data, with footnote explanations for rejection. The analysis, discussion, conclusions and recommendations are included in a final report and presentation materials provided to Ecology.

Appendix C. QAPP: Responses to Ecology's Comments

Comment #	Reviewer	Ecology's Comment	OCI's Response
1	BL	Signature Page and Table in Section 5.1: Specify both Ray Latham Ecology permit/project manager and Brandi Lubliner as Ecology QA Coordinator.	Ray Latham has been added as Municipal Stormwater Permit Manager; Brandi Lubliner has been added as Ecology QA Coordinator.
2	BL	Section 3.2 mentions Zoomerang, but Section 4.5 mentions SurveyMonkey. Which?	Sections 3.2 and 4.5 have been revised; this information has been moved to Section 8.0. SurveyMonkey will be used.
3	BL	<p>Sections 2, 3, and 4: This project has two distinct goals that are sometimes presented as only one. Thru the survey they want to learn both the breadth of approaches/strategies and quantify 'best' using a series of value statements (costs, efficiencies, clean water, completeness, etc.).</p> <p>a. Section 4 opens with...The purpose is to determine the "best" strategy... Other places there is "most successful". Section 4.6 says 'preferred strategy'. Is the best strategy the one chosen by the most jurisdictions? Is best the strategy that yields the most permissions or the most inspections? Or is best made of up several component parts? If so the component metrics/parts that define what best or successful mean are missing from this QAPP, or are they the bulleted list in Section 7? Without the rubric or ranking system being explained in this QAPP, 'best' remains vague and the success of the project is limited.</p> <p>b. Revise to add and define in more specific terms. Such as a survey questions will aim to rank BMPs and return on maintenance for ease of maintenance, hours maintained per visit, visits per year per unit BMP, etc.</p> <p>c. Appendix A (the survey) was not included, reference in Section 8. Unclear to this reviewer what the survey questions will actually measure.</p>	<p>The goal and objectives for the study have been rewritten to capture the two distinct goals in the previous submittal. The goal is now to identify commonly used inspection, maintenance, and enforcement strategies for privately owned stormwater BMPs in the Pacific Northwest and evaluate the effectiveness of those practices.</p> <p>a. The effectiveness of the strategies will be assessed in terms of aspects of an inspection, maintenance, and enforcement strategy, such as access to BMPs, cost, private property owners' understanding of responsibilities, etc. These metrics are defined in the QAPP, will be assessed using the survey, and are based on priorities identified in the literature, the permit requirements, and identified by permittees during this study.</p> <p>b. This study will focus on the effectiveness of inspection, maintenance, and enforcement strategies for BMPs on private properties. Specific BMPs will not be assessed in this study.</p> <p>c. A copy of the survey is included in Appendix E.</p>
4	BL	Section 7.1: it is somewhat unclear to me how confidentiality will be maintained if all the surveys will be stored by the jurisdiction. Not sure they should promise it. It might be good just to not collect the names of the responded or code-out identifying data to the subjects.	Respondents will be assigned an identification code, which will be used to identify their responses throughout the study. Information regarding the identification code has been included in Sections 8.0 and 10.0.

5	BL	<p>Section 2, 6, and 7:</p> <ul style="list-style-type: none"> a. Because there were 8 or so actual BMPs listed in the Background (Section2), I thought for a while this was a BMP specific survey, but the other parts of the QAPP are clearly more programmatic level questions. Maybe the list of BMPs that make up the category of structural BMPs should be brought from Background down to Section 7.3, where it currently says Not Applicable. b. Section 7.1: the bulleted list of survey info gathered doesn't look like only a 10 minute interview. My own lessons learned for surveys is to ask for what is really desired. Some of these are in-depth especially the BMP specific ones: age, area managed, size, funds per BMP. 	<p>The QAPP will focus on the breadth of programs used by jurisdictions to inspect and enforce maintenance of BMPs on private properties and the effectiveness of those programs. Sections 2, 6, and 7 have been revised to clarify the goal of the study.</p> <p>The bulleted list in Section 7.1 has been revised to reflect the contents of the survey. The survey length has also been updated to a duration of 20-30 minutes.</p>
6	BL	Section 4 Quality Objectives is a little lean with regard to how the surveys is devised or will be implemented to prevent bias. I suspect there will be great care given to how the questions are phrased, trying to not be leading questions. Also, what is the target completeness goal 90% of how many of the total population? How many surveys will be too little? Who will do the coding?	Section 6.0 has been updated to address DQIs and MPCs for the study. The section includes measures that will be taken during the study to limit bias and targets for response rates during the survey/interview.
7	BL	Section 9.1: first bullet is a carry-over from another QAPP. Delete.	Will delete.
8	BL	Section 10: much of the necessary information for this section is missing.	Will add.
9	BL	<p>Section 12:</p> <ul style="list-style-type: none"> a. Move the first paragraph (except the last sentence) of Section 12 into this section 8.3. This is instrument verification. <p><i>The survey instrument will be verified by having several (approximately three to five) stormwater (managers) operators serve as beta-testers of both the instrument and the administration protocols. These individuals can be selected from participating jurisdictions in Yakima County. These individuals can suggest revisions of the questions and confirm the online data collection interface is functioning. Finally, the beta-testers can verify their online responses were accurate before broad survey administration.</i></p> <ul style="list-style-type: none"> b. Move the third paragraph from Section 12 to Section 9.1. This describes QC 	The section has been completely rewritten and the new section addressed your comments.

		<p>c. Move the second paragraph from Section 12 to Section 9.2. This is corrective action.</p> <p>d. With the exception of one sentence this section is now empty. This section is usually describes how the lead entity determines the data are useable: the QC steps are verified and were followed, the dataset represents a minimum # of surveys. Audits were completed, findings okay. Systematic bias isn't evident. Corrective actions were taken as needed. If some of the data are found to be too bias, incomplete, failed QC, etc they won't be used. Usability statement is made in the final report.</p>	
10	BL	<p>Section 13: This whole section needs to move to become a new Section 10. It is currently out of place.</p> <p>a. Section 13.2: I would replace the word 'trends' with 'themes' as is mentioned in other locations of the QAPP.</p>	Section has been updated and reorganized as suggested
11	BL	Section 14.2: The final report must also go to the Ecology project and permit manager, along with a spreadsheet of all the study data. This means all the useable quality assured data used for the analysis, and the rejected or un-useable data gathered as part of the study. The rejected data can be included in a separate file or a different tab and the reasons for its failure described.	Added text to Section 14.2.
12	RL	<p>ii. Signature Page.</p> <p>Please include a line for both Brandi Lubliner and I on the signature page.</p>	Added, see response to Comment #1.
13	RL	<p>3.1 Background Introduction (Break up sentence.) "This study will investigate procedures developed by other jurisdictions related to inspection and enforcement of operation and maintenance requirements. for all structural best management practices (BMPs). BMPs installed on privately owned property include ing, but are not limited to, detention ponds, tanks and vaults; infiltration facilities; detention facilities; storm treatment wetlands and wet ponds; and mechanical separators." Brandi addresses a dichotomy of goals in her comment 3. The last paragraph of 3.1 only mentions the potential for disseminating information. The final report and data should be available for electronic or hardcopy publication, web distribution or as a workshop. Please provide details in 7.5.</p>	<ul style="list-style-type: none"> Section 3.1 has been revised. Please see Comment #3 for additional information. Details regarding dissemination of the study are provided in Section 14.2 (Dissemination of Project Documents).

14	RL	3.2 Problem Description; The literature review is 8-10 years old, which is sufficient for support of the problem statement. But, it is suggested that more current surveys on stormwater BMP O&M practices and the inspection procedures be reviewed in building the survey and interview questionnaire.	Noted.
15	RL	4.1 Study Goal: ... “to determine the best O&M strategy”, is not the same goal as (4.2)...Study Objective: “to learn novel and effective ways that municipalities are meeting the challenge of ensuring ongoing maintenance of structural BMPs on private property”. But, evaluating the first question is a necessary step to reach the study objective of determining effectiveness of an inspection strategy.	The study goal has been revised to combine the two question, as both are desired results of the study.
16	RL	4.2 Study Description and Objectives: Is the focus on assessing management strategies by jurisdictions to ensure ongoing maintenance or O&M procedures for privately owned BMPs? This needs to be better defined because it drives the focus of the survey and the analysis. The inspection protocols and identified O&M practices codified by participating respondents in their Storm Water Management Plans (SWMP) will identify common practices. The survey may then evaluate the success or shortcomings of those strategies. Add a 4th bullet “Provide the constraints or triggers to gage the success of a given inspection strategy.” One of the outcomes of the study is to provide an analytical tool for jurisdictions to evaluate and revise their SWMP.	See response to Comment #3. This will not be an outcome of the study. The findings of the study may be used to inform jurisdictions regarding effectiveness of different approaches to inspection and enforcement of maintenance of BMPs on private property.
17	RL	6.0 Quality Objectives; There is value in learning about impediments to success. A strategy or project may have a critical element that needs tweaking in order to be successful.	See response to Comment #6.
18	RL	7.1 Study Design: Interviews: Who will screen responses, conduct interviews and analyze data? Core team, Lead or contractor? I would suggest not making an assurance of anonymity during certain portions of the data collection. Survey responses may be relatively easy. But, maintaining claims of confidentiality of interviews may be very difficult given specific information that being collected.	<ul style="list-style-type: none"> • Reference section 5.1 for the roles and responsibilities of the project team. • Comment noted

19	RL	<p>7.2 Process for Selecting the Test-Site and Target Population: Clarify who the 'target population' is for each segment of the survey. The stormwater (Public Works) managers, the owners of private facilities or both?</p> <p>Owners could be queried about their own method of BMP management (familiarity with BMP, presence/absence of O&M manual, their evaluation method, inspection frequency, types of repair, interactions with jurisdiction.)</p> <p>MS4 managers would be asked about code requirements, inspections/complaints procedures, technical assistance, resolution mechanisms...etc.</p>	<p>The target population was clarified in the QAPP as stormwater managers.</p> <p>The survey is the only instrument developed for the QAPP and it is intended to be short to support the higher response rate. Additional questions such as the ones you have listed maybe added to the interview questions if they are needed to achieve the study goals.</p>
20	RL	<p>7.6 Other E&O Programs: This project is designed to be helpful during discussions on improving stormwater management planning. How will this information be disseminated; publications, presentation, workshops?</p>	Dissemination of project documents is included in Section 14.2.
21	RL	<p>8.1 Instrument Design: This needs specificity on the scope of the questions. The ability to discern what triggers success/failure of a program may decrease with the number of variables. Review the objective statement for reference during formulation of the survey.</p>	Section was updated.
22	RL	<p>9.1 Study QC Procedures: Redo 1st bullet and make it pertinent to this study. This statement is pulled from another study.</p>	Text was revised.
23	RL	<p>9.2 Corrective Action: What is the acceptable level of consistency? Provide specific criteria on how is this determined. What procedures are used to amend survey questions without introducing bias, while maintaining anonymous entries?</p>	<p>This section was updated.</p> <p>It is not possible to define a level of consistency related to every item in the QAPP except to state that correction plans may be developed if the QAPP is not followed and if the QAPP is not followed, each items will need to evaluated to determine the potential impact on the project.</p>
24	RL	<p>10.0 Data Management Plan Procedures; This needs to have specific SOP's provided to assure consistency with protocols and provide guidance for Section 11.0.</p>	This section has been updated.
25	RL	<p>12.0 Data Verification and Usability Assessment; To maintain veracity, the verification needs to be conducted by an individual not involved in interviewing or collecting data.</p>	Comment noted in the section.

26	RL	13.0 Data Presentation Methods: There are many options for visually presenting the data. I would suggest you be clear about the point you wish to illustrate and then choose the graphic method for presentation.	Comment noted
27	RL	14.0 Reporting: Ecology needs an electronic copy of both the usable and unused data, with footnote explanations for rejection. The analysis, discussion, conclusions and recommendations are included in a final report and presentation materials provided to Ecology.	See response to Comment #11.

Appendix D. QAPP: Summary of TAG Comments and Responses to Comments

Comment #	Commenter Initials	Section & Page	Comment	Response to Comment
1	WWCo	Title Page	clearly state in the title this effectiveness study applies to privately owned facilities	Title updated to include <i>Privately Owned Facilities</i>
2	WWCo	ii	Why wasn't the TAG part of the initial QAPP review conducted in 2018?	The TAG was not included in the review of the first version of the QAPP due to insufficient time prior to the deadline.
3	cp	iv	Chad Phillips - Stormwater Engineer	Updated
4	WWCo	iv	Chuck Geissel's title should be changed to Public Works Technician III	Updated
5	WWCo	general	This document needs further editing. Passive voice, text duplications and omissions, and inconsistencies in terminology between sections limit readability	<ul style="list-style-type: none"> • Passive voice is a common voice used in technical papers. • The QAPP was written following the EWA QAPP template for effectiveness studies which was developed with Ecology. Per the template there are duplications in sections. For example, section 4 provides an overview of other QAPP sections and with other sections including duplication with additional information. • QAPP was reviewed and further updated to address inconsistencies in the terminology.
6	WWCo	general	numbered lines would've made it much easier to comment	Comment noted
7	WWCo	2.0; pg. 7	"Over time, the effectiveness of structural BMPs can become compromised unless the BMP is properly maintained" -- Cite source	The executive summary should does not contain citations unless they are absolutely necessary to understand the work. For example, if the main purpose of the paper is to follow up someone else's work.
8	WWCo	2.0; pg. 7	"Difficulties can arise for Permittees when that try to identify and correct operational and maintenance problems with structural BMPs on private property" -- what sort of difficulties? This needs concrete examples.	The executive summary is meant to provide a summary of the entire QAPP. Examples for this item can be found in Section 3.2 Problem Description.
9	WWCo	2.0; pg. 7	3rd paragraph - first sentence refers to goals, second paragraph switches to a single goal.	Updated
10	cp	8	Requirements were also effective in the 2007 permit. Suggested Revision: According to the 2007, 2014 and 2019 Phase II permit....	Updated to include 2007, 2014, and 2019.

11	cp	8	I don't see that there is any language pertaining to 3rd party requirements	Added reference to permit section that mentions the use of a third party to inspect and maintain BMPs on private property
12	WWCo	3.1; pg. 8	2nd paragraph, last sentence: does Yakima County inspect just one time?	The 2 nd paragraph states that <i>Yakima County conducts inspections</i> which implies more than one inspection is occurring.
13	WWCo	3.1; pg. 8	3rd paragraph: "In addition to the method used by Yakima County, there are multiple strategies" -- how was this established? Anecdotally? I know you explain it later but clarity will improve readability. Same comment applies to the list of 4 potential strategies - how was this list developed?	Added text that elaborates on the approach Yakima County followed to identify the strategies listed.
14	RL	3.1 pg.8/ 4.2 pg 12	Include non-permitted jurisdictions in effectiveness survey for managing stormwater structures. Suggested Revision: Non-Permitted/Private Ownership Evaluate effectiveness of using jurisdiction's regulations without Permit requirement to assess private owned, maintained and functioning facilities.	For the summary of strategies in section 3.1, this list was developed from discussions with permittees as such the reference to permitted was not revised. Other references through the QAPP and survey were updated to expand the target audience to non-permitted jurisdictions.
15	WWCo	3.2; pg. 9	First sentence: This is a strange reference. Does this imply that individual BMPs are ineffective? It might be more meaningful to discuss Ecology's presumptive reduction of pollutants assumption, and to reference the stormwater management manual for eastern Washington.	Text revised
16	WWCo	3.3; pg. 10	entire section - the previous section used the abbreviation O&M but this section spells it out.	Text updated to use abbreviation throughout document
17	WWCo	3.4; pg. 11	Bulleted list - Also include education and outreach citation? It sounds like the effectiveness study will likely result in recommendations for targeted outreach strategies.	Section 3.4 of the QAPP identifies the conditions in the NPDES permit that the study will evaluate as part of the effectiveness study requirements defined in Section 5.8 of the permit. The goal of this study is to identifying common strategies for O&M of BMPs on private property and evaluating the effectiveness of those strategies. While an outcome of this may include recommendations for a targeted E&O program that supports a successful O&M program, this study will not evaluate the effectiveness of the E&O program. As such a section of the permit pertaining to E&O was noted added.
18	WWCo	4.2; pg. 12	First sentence - confusing language. Rephrase?	Removed "from" to clarify

19	WWCo	4.2; pg. 12	"The survey questions are intended to capture the breadth of approaches applied by the participating jurisdiction as well as the perceived effectiveness of the approach" -- How will this study tie perception to reality? Is there any ground-truthing? I may think I have a very effective program but how do we know? My incorrect understanding could skew results.	The intent of asking questions related to the respondent's perception of their program was to keep the survey questions short to increase the response rate. As discussed during the TAG meeting, question #4 from the survey. A similar question will be asked in the interview instead and the rating system will be defined for each element to reduce subjectivity. In addition, the term perception was removed from the QAPP.
20	WWCo	4.2; pg. 12	Are jurisdiction demographics considered? Percent of residents who don't speak English as their primary language? Rural vs. urban? I think we need this info upfront so a spectrum can be selected for interview.	Questions about the population and number of BMPs on private property were added. Questions related to primary language of the BMP owner and whether the BMP is located in a rural or urban area were not added to the survey as it is unlikely that this information is readily available and the survey is intended to be short to encourage a higher response rate. Evaluating whether the language of the BMP owner influences the effectiveness of the strategy would be a good follow up study.
21	WWCo	4.2; pg. 12	"The objectives of this investigation are:" -- So basically, we're just asking if O&M is being done, and if it is that's a success? What if it's being done incorrectly?	The study is meant to identify: <i>the most common strategies</i> municipalities use for O&M of BMPs on private properties, what elements are most important to creating an effective strategy, and which BMPs strategies are more effective based on the jurisdictions rating of the elements. The study is not investigating whether the jurisdiction strategy is compliant with the permit. Will delete "demonstration of permit compliance" in the second bullet.
22	WWCo	4.3; pg. 12	First sentence -- MS4 is written twice	Removed second "MS4"
23	WWCo	4.6; pg. 15	Potential constraints -- How about responder bias? They may think their program is a success but there's no external validation of the participant's perception.	Validation is discussed in Section 6.0 and Section 8.3 describes pilot testing the survey and instruments which is the process of validating these instruments. Specifically, pilot testing assesses the interpretations of the survey and interview questions. Additionally, the interview questions will be used to better understand the participant's perception.
24	cp	17	Is there any way to clarify throughout the report when the role members are specifically incorporated into process?	Specific role names have been added where required in the QAPP.
25	TAJ	Section 5.1, Page 16	Brian Ollie is no longer with the City of Pasco. Suggested Revision: Please supplement with Tyler Johnson.	Updated
26	TAJ	Section 5.1, Page 17	TAG Member - Reviewer does not have a section indicating responsibilities. Suggested Revision: Please provide TAG - Reviewer responsibilities.	Per discussion during TAG Meeting, the description of responsibilities for TAG Members who are reviewers is

				combined with TAG Members following Table 5.1. Additional information is located in Section 12.0
27	WWCo	5.1; pg. 15	For Walla Walla County, financial support was a possibility. We would like to be consulted and given an estimate before we are added as a financial supporter. We are a very small permittee and perhaps financial contribution should be proportional to the size/population of the permitted area?	Reference to Walla Walla County providing financial support was removed.
28	WWCo	5.3; pg. 18	For Walla Walla County, financial support was a possibility. We would like to be consulted and given an estimate before we are added as a financial supporter. We are a very small permittee and perhaps financial contribution should be proportional to the size/population of the permitted area?	Duplicate comment. See response to comment #27
29	WWCo	6.0; pg. 20	First sentence - define QA/QC before abbreviating	Definition for QA/QC added before acronym is used
30	WWCo	6.0; pg. 20	Again, how do we ground-truth responders Credibility and the Validity of their responses? They may answer truthfully but if they have incorrect or incomplete understanding of BMP maintenance best practices, they will misreport the success of their program.	Practices for addressing credibility, validity, and reliability (defined in Section 6) are commonly accepted practices in qualitative research. Consistency in responses is addressed between interviews and surveys will be the measured along with asking the person in the survey if they have the knowledge (or if they can find the appropriate knowledgeable person) to answer the question. In addition, references to specific DQI/MPCs identified in Section 6.0 were included in Sections 8-13 to identify how QA/QC was applied to the project.
31	WWCo	7.1; pg. 22	survey should also consider the number of private BMPs under a jurisdiction's permitted area - it's much easier to have a compliant program when you are responsible for two ponds than 50. But it's maybe much more cost effective to run a larger program	A question related to the number of BMPs on private property within the jurisdiction has been added to the survey. The study is not meant to assess compliance, rather identify common strategies and evaluate how effective those strategies are based on how respondents' rate/prioritize specific elements of an O&M program.
32	WWCo	7.1; pg. 22	Bulleted list, "Rating of elements related to the inspection and maintenance approach used by the jurisdiction, such as:" - some of these are very subjective questions and it will be difficult to meaningfully compare responses.	The rating question has been removed from the survey. A similar question will be included in the interview questions with a definition for the ratings range provided for each element to improve consistency of responses. It is also anticipated that participants will be provided with a list of information they need to answer prior to the interview.

33	WWCo	7.1; pg. 23	"Once the surveys have been administered, responses will be analyzed to identify the programs with the highest rating as well as which participants to interview" -- The interview forms an important piece of quality control - the interview questions can help validate the success of a stormwater program - an interviewee might score highly on the questionnaire if they incorrectly perceive their program to be better than it actually is... it might be better to have an intermediary step to validate/ground-truth questionnaires before scheduling the full interview.	See response to comment #32. Interviewees will be selected to represent a variety of responses.
34	WWCo	7.2; pg. 23	"It is expected that stormwater managers are the most knowledgeable regarding a jurisdiction's approach to inspection and enforcement of maintenance of BMPs on private property' - - How will you ground-truth, or validate this assumption?	Question #2 in the survey is expected to validate the assumption. Revised text to "have the best understanding of a jurisdiction's stormwater program and will know which personnel to contact to fully respond to the survey and interview questions"
35	cp	25	same as comment # 10 (page 8 - Requirements were also effective in the 2007 permit)	Will update to "According to the 2019 and previous versions of the Phase II permit"
36	RL	7.3 pg.25	Non-Permitted jurisdictions require owner responsibility for O&M. Suggested Revision: Jurisdictions typically include code regulations for compliance with cost reimbursement for inspection and maintenance w/ subsequent lean and forfeiture where jurisdiction assumes O&M.	Question related to penalties and fines for non-compliance BMP owners was added to question 4 of the survey.
37	WWCo	8.1.1; pg. 27	"The development of the questions was guided by permit requirements in the 2019 EWA Phase II Permit and common issues identified in literature, particularly in (Blecken, Hunt, Al-Rubaei, Viklander, & Lord, 2015)." -- Is this the most current, trusted source? Why are they cited as the expert?	This journal article was written by some of the top stormwater researchers in the nation. Furthermore, journal articles are reviewed by other stormwater researchers (peer reviewed) before they are published. Typically publishing articles in peer reviewed journals indicates that someone is an expert in their field.
38	WWCo	8.1.2; pg. 29	public records request is a very real threat and may be enough of a disincentive to limit participation	Comment noted

39	RL	8.1.2 pg.29	Evaluating respondents by scores (low, med., high) may lead to identifying effective methods with limited resources. Suggested Revision: Maintain ratio of interviewing respondents by scores provides equal distribution of responses, and greater confidence in assessing BMP effectiveness by capabilities with available resources.	The survey includes questions that are designed to identify variables that may influence the success of strategies applied by different jurisdictions. The interview questions will expand upon these questions to identify more variables. However, the study is not designed to identify whether specific strategies/approaches are more effective for certain populations. Variable identified during this study could be the focus on a future effectiveness study.
40	RL	8.2.2 pg 31 Step 2	Bullet 5 - The list of information provided to respondents needs reviewed.	The list of information will be included during pilot testing of the interview. Text was added in Section 8.3 to reflect this
41	AE	11.0, p. 36	There isn't set schedule for when audits are conducted during the course of the study, only suggestions on when these should be completed. Suggested Revision: A table or schedule listing times to complete audits. I think we need to audit 4 times: once prior to survey deployment, once following the end of the survey, once prior to interviews, once following end of interviews.	Added audit schedule to Section 11.0
42	WWCo	12.1; pg. 36	"Participant responses will also be verified for consistency. This will include comparing the survey responses to the interview responses for the same person to determine if there are any anomalies between similar responses. If the responses are found to be similar, it will be assumed that their responses accurately reflect their opinions and/or understanding...public records request is a very real threat and may be enough of a disincentive to limit participation -- but what if their opinions/understanding is flawed? Consistently flawed? This at least needs to be addressed as a potential study limitation.	Reference response to comment 30.
43	WWCo	pg. 55 Ecology comments	I agree the study definition of "Best", or "most successful" is vague. This needs further refinement.	Ecology's comment was made on the previous version of the QAPP (submitted to Ecology on May 8, 2018). The study definition has been revised in the most recent QAPP.
44	WWCo	pg. 73, survey question 4	This is very subjective. My 5 may be your 3. How do you compare the two?	See response to Comment #32

45	WWCo	pg. 74, survey question 5	Again, very subjective. Difficult to compare across jurisdictions.	Question 5 has been revised following removal of Question 4 (see Comment #32). Question 5 is now question 4. New question 4 asks for participants to identify the most important elements of an O&M program.
46	RL	Survey pg. 73	Sometimes difficult to gauge how to evaluate answer. Suggested Revision: Add a metric for each question. See below	
47	RL	Survey	Took me much longer to go through survey to determine how Poor/Low - Exc./High meant in context of question. Suggested Revision: Access to BMPs (impossible --> easy)	
48	RL	Survey	Most jurisdictions will be all over the board, from Poor to High on each category. Suggested Revision: <ul style="list-style-type: none"> • Cost for labor and materials (\$, \$\$, \$\$\$, \$\$\$\$, >\$\$\$\$) • Time required for inspect w/report - repair (<1 hr., 1-4 hr., 4-8 hr., 1- 3 days, > 3 days) 	
49	RL	Survey	How will these questions be scored? Some desirable characteristics are Low (e.g. Cost for approach) others are High (e.g. Funding) Suggested Revision: <ul style="list-style-type: none"> • Staff required - Depends on resources available. (Crew 1-5) • Property owners compliance (Follow up - timeliness for compliance) or (not compliant --> full compliance) • Sufficient funding (None - adequate - No problem) • Documentation of insp. And maintenance (Owner or Staff?) • Enforcement approach Process?, Effectiveness?, (Used most often Easy - Hard) • Overall Approach (What do you mean) • ADD - Jurisdictions Priority (Low -->High) 	Question #4 has been removed from the survey. See response to Comment #32. Comments 46 to 49 will be used to develop the metrics for a similar question that will be added to the interview questions.

Appendix E. Copy of Survey for Study Participants

Yakima County Effectiveness Study

BMP Inspection and Maintenance Responsibilities Survey

Instructions: This survey is being conducted as part of Yakima County's NPDES MS4 Phase II Permit requirements for evaluating the effectiveness of a permit required stormwater management practices (S8. Monitoring). Information collected from this survey will be used to assist Yakima County with understanding the breadth of inspection, maintenance, and enforcement practices used by other permittees or non-permitted jurisdictions for structural stormwater best management practices (BMPs) on private property as well as identify practices that are more effective. *Note: This information will be stored with Yakima County and any reports or data released from this study will not identify respondents; instead, respondent's information will be replaced with an identification code.*

1. General Information

Note: This information is only being collected to contact you for future interviews.

- Name of Person Completing the Survey:
- Title:
- Jurisdiction:
- Email:
- Phone Number:
- Select the permit that applies to your jurisdiction. For permits other than Washington State, please provide a weblink to your permit and note the section numbers of the permit or requirements that apply to inspection, maintenance, and enforcement of BMPs on private property.
 - Eastern Washington NPDES MS4 Phase II
 - Western Washington NPDES MS4 Phase II
 - Western Washington NPDES MS4 Phase I
 - NPDES MS4 Phase II
 - NPDES MS4 Phase I
 - Non-Permitted Jurisdiction
 - Other

- Provide the estimated number of BMPs located on private properties within the limits of your jurisdiction that discharge to a municipal separate storm sewer system (MS4). For non-permitted jurisdictions, note the number of BMPs located on private property.

- Provide the estimated 2019 population within the limits of your jurisdiction:

2. **Question 2 is intended to confirm that you are knowledgeable about the inspection, operation, and maintenance practices for BMPs on private property used by your organization. Please check the box to confirm.**

I am knowledgeable regarding the practices used by my jurisdiction to inspect, maintain, and enforce maintenance of BMPs on private property. If I am uncertain of answers to any of the questions, I will seek out the appropriate knowledgeable personnel within my jurisdiction to provide the necessary information.

3. Select the method that best describes your jurisdiction's strategy to inspect and maintain structural stormwater BMPs on private property. Use the comment box following the question as needed to clarify your response.

- a. **Permittee or Non-Permitted Jurisdiction Inspection/Contractor Maintenance:**
Inspection: Permittee or non-permitted jurisdiction inspects BMP(s);
Maintenance: Property owner is required by permittee or non-permitted jurisdiction to hire a third party or contractor to maintain BMP(s) and provide proof of maintenance
- b. **Third Party Inspection/Contractor Maintenance:**
Inspection: Property owner is required by permittee or non-permitted jurisdiction to hire third party or contractor to inspect BMP(s);
Maintenance: Property owner is required by permittee or non-permitted jurisdiction to hire third party or contractor to maintain BMP(s). Permittee or non-permitted jurisdiction requires proof of inspection and maintenance.
- c. **Permittee or Non-Permitted Jurisdiction Inspection/Permittee Maintenance:**
Inspection: Permittee or non-permitted jurisdiction inspects BMP(s)
Maintenance: Permittee or non-permitted jurisdiction maintains BMP(s)
- d. **Property Owner Inspects/Property Owner Maintains**
Inspection: Property owner inspects BMP(s)
Maintenance: Property owner maintains BMP(s)
- e. **Variable Inspection/Variable Maintenance:**
Inspection: Property owner is given the option to provide access to the permittee or non-permitted jurisdiction for inspection or to hire a third party or contractor to inspect BMP(s)
Maintenance: Property owner is given the option to provide access to the permittee or non-permitted jurisdiction for maintenance or to hire a third party or contractor to maintain BMP(s)
- f. Other, please describe in the box provided below.

If you have additional comments or responded with option e. *Other*, please use the box below.

4. This question is intended to be a self-assessment of your jurisdiction's strategy identified in Question 3. A list of elements is included in the table below that was identified through a literature search as being a component of some jurisdictions' strategies for inspection, maintenance, and enforcement of BMPs on private property. For each element, circle the rating description that best represents your jurisdiction's program, defined as either high, medium, or low. A rating of NA indicates the element is not applicable or not part of your jurisdiction's program. If element(s) not listed are part of your jurisdiction's strategy, please describe the element(s) in the comment box including how the element(s) rates (high, medium, or low). Alternatively, the comment box maybe used to explain the effectiveness rating for specific elements.

Element	High	Medium	Low	N/A
Does your jurisdiction have access to BMPs on private property?	BMPs are easily accessible	About half of the BMPs are accessible	The majority to none of the BMPs are accessible	
Does your jurisdiction have funding to perform the required inspection, maintenance, and enforcement activities?	Sufficient funding is available	Some funding is available	No funding is available	
Is training provided for staff performing inspection, maintenance, and enforcement activities?	All staff are trained	Some staff are trained	No training is provided	
Does your jurisdiction have a written plan that defines the O&M protocol for BMPs?	An O&M protocol has been developed for all BMPs	An O&M protocol has been developed for some BMPs	No O&M protocol has been developed for any BMPs	
Does the jurisdiction provide O&M protocol to BMP owners in language that can be understood by the general public and/or does the jurisdiction have a program to educate BMP owners about their O&M responsibilities?	Protocol is revised for individuals without a technical background or jurisdiction has program to educate BMP owners	Somewhere between a High and Low rating	Protocol is the same as what is provided to the jurisdiction's staff and/or the jurisdiction does not have an education program	
Is O&M protocol and/or education materials provided in languages other than English?	Protocol and/or education materials are provided in multiple languages	Somewhere between a High and Low rating	Protocol and/or education materials are only provided in English	

Element	High	Medium	Low	N/A
When ownership changes, does your jurisdiction have a process for communicating all O&M responsibilities to the new BMP owner?	Communication provided to all new BMP owners	Communication provided to some new BMP owners	No communication is provided to new BMP owners	
Does your jurisdiction have the appropriate equipment available to conduct maintenance of BMPs on private property?	Jurisdiction has the appropriate equipment needed to maintain all BMPs	Jurisdiction has the appropriate equipment to maintain some BMPs but not all BMPs	Jurisdiction does not have appropriate equipment to maintain any BMPs	
Are BMP owners able to demonstrate compliance with your jurisdiction's requirements?	All BMP owners demonstrate compliance	Some BMP owners demonstrate compliance	No BMP owners demonstrate compliance	
Are BMP owners in your jurisdiction willing to pay for required maintenance?	All BMP owners are willing to pay for required maintenance	Some BMP owners are willing to pay for required maintenance	No BMP owners are willing to pay for required maintenance	
Does your jurisdiction have a documentation process for tracking inspection and maintenance activities?	Documentation process is consistent, complete, and easy to use	Somewhere between a High and Low rating	No jurisdictional documentation process	
Are your jurisdiction's documentation and inspection records up to date and complete for BMPs on private property?	Documentation of inspections and maintenance activities is up to date and complete for all BMPs	Somewhere between a High and Low rating	Documentation of inspections and maintenance is neither up to date nor complete for BMPs	

Please write any additional comments for Question 4 here:

5. Define the existing source of funding for inspection and maintenance of BMPs on private property:

- a. Property owner pays third party
- b. Property owner pays permittee
- c. Mix of options a & b
- d. Stormwater fee for private properties
- e. Other

If you have additional comments or responded with option *e. Other*, please use the box below.

Questions 6-10 are open-answer questions. Please provide responses in the boxes below.

6. Describe a primary challenge with using the strategy selected in Question 3.

7. Describe a primary benefit to the strategy selected in Question 3.

8. How would your jurisdiction improve or change your program?

9. Does your jurisdiction offer incentives to private property owners to inspect or maintain structural BMPs on their property? If so, please describe the incentive. If not applicable, please write N/A.

10. Does your jurisdiction have mechanisms in place to penalize or fine a BMP owner for not demonstrating they are compliant with the requirements? If so, please describe the mechanism. If not applicable, please write N/A.

Appendix F. Summary of QAPP Revisions

Revision #	Revision By	Section and Page	Status of Revision (Draft/Approved)	Summary of Revision
1	THB	Distribution List, p. iv	Draft	Removed City of Spokane Valley from Distribution List; Updated personnel for Yakima County
2	THB	5.1, p. 16	Draft	Removed City of Spokane Valley from Key Project Team Members; Updated personnel from Yakima County
3	THB	5.2, p. 18	Draft	Updated schedule

Appendix G. Corrective Action Plan

#	Date Need for Corrective Action was Identified	Issue Identified	Summary of Corrective Action	Implementation Data of Corrective Action

Appendix H. Audit Checklist

Auditor name:	Date/Time:	
Name(s) of personnel conducting data collection, data recording, interviews, data management:		
Standard Operating Procedure (SOP)	Actions Compliant with SOPs?	Comments:
Survey Distribution & Follow-Up		
Participants referred to by identification code (see Section 10.1)		
Survey administered to each participant via SurveyMonkey®		
Participants informed that responses associated with identification code to maintain confidentiality		
Final reminder provided to participant via phone two to three days prior to deadline for survey		
Number of participants who agreed to participate but did not respond recorded in Excel		
Permit requirements of each respondent related to O&M of privately owned BMPs compared		
Interview Administration		
10-15 survey respondents selected reflect variety of responses		
Interview conducted by phone on scheduled date and time		
Information listed in Section 8.2.2, Step 4 provided to the interviewee at beginning of interview		
Interviewer reads same list of questions to each interviewee		
No prompts used to help interviewee respond to interview questions		
Following interview, allow participant to clarify statements or provide more information		
Overall SOP audit notes:		

Data Management Procedures	Actions Compliant with Procedures?	Comments:
Data Identification		Overall data management procedures audit notes:
Each participant assigned a code following the procedures outlined in 10.1		
Participant information and identification codes stored in a spreadsheet separate from reported data		
Data Recording & Reporting Requirements		Overall data management procedures audit notes:
Recorded data uses identification code to identify participants		
Survey responses exported or recorded in Excel following		
Responses to interview questions transcribed into Excel within one business day of interview		
Responses sorted by data source (survey or interview) and question		
Responses to open-ended questions are coded by common themes		
All data listed in Section 10.2 compiled in Excel		
All data recorded is archived until after the Final Technical Report has been approved by Ecology		
Data verifiers have verified data collected during survey or interview has been correctly transferred		
Procedures for Missing Data		Overall data management procedures audit notes:
Missing data is coded with "M" in Excel and note explaining why data is missing (if known)		