FINAL REPORT

Business Inspection Stormwater Source Control Effectiveness Study

Prepared for:

City of Lakewood and the Washington State Department of Ecology

Project No. 160384-005 • September 30, 2017

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CONSULTING

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Aspect Consulting, LLC

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Executive Summary

This report provides the results of the Business Inspection Stormwater Source Control Effectiveness Study (the Study). The Study is part of the Stormwater Action Monitoring (SAM) program led by the Washington State Department of Ecology (Ecology), which is one component of the Puget Sound Ecosystem Monitoring Program (PSEMP). The Stormwater Work Group oversees the effectiveness studies, which are being coordinated by Ecology and led by municipal stormwater permittees and other natural resource agencies. The Study was led by the City of Lakewood and implemented by Aspect Consulting, LLC and Cardno, Inc. Technical guidance and review of the project were provided by a Technical Advisory Committee comprised of representatives from municipal jurisdictions and other stakeholders in stormwater management in western Washington.

Six Effectiveness Questions related to stormwater source control were identified by permittees and stakeholders of the municipal stormwater permits of the National Pollutant Discharge Elimination System (NPDES). These questions were the motivating and guiding impetus for the Study. Two questions were related to the frequency of inspections at businesses and four questions were related to source control best management practices (BMPs) at businesses. The answers to the questions are intended to assist NPDES stormwater permittees with the effectiveness and efficiency of source control efforts and help refine the permit requirements for source control. Aspects about BMPs in each of the original effectiveness questions could be not be addressed due to limited data about BMPs in the source data. Alternative related effectiveness questions based on BMP status and repeat occurrence were identified that could be addressed based on the data available.

Data of municipal business inspections were obtained from two sources: directly from municipal NPDES permittees in western Washington (both Phase I and Phase II permittees), and also from the statewide Local Source Control Partnership (LSCP). The data were combined into a relational database by standardizing responses to 13 key fields. A total of 39 fields were used to populate the database comprised of 47,338 inspection records, with 25,256 records coming from permittees and 22,082 records coming from the LSCP. A total of 24,496 records represent Phase I jurisdictions and 21,479 records represent Phase II jurisdictions. In addition, the LSCP data included 1,363 inspection records collected by Ecology, which were conducted under Ecology's Urban Waters Initiative.

The first effectiveness question (Question 1) inquired about inspection frequency of stormwater treatment and flow control BMPs on private property. Data on property ownership were not available; therefore, a surrogate of commercial versus non-commercial land use was used. Commercial land uses were based on six individual types of land use related to commercial or business properties, and non-commercial land uses were based on seven non-business land uses. Data for evaluating this question came just from what was sent by permittees, but was not available in the LSCP dataset as treatment and flow control BMPs were not distinguished in LSCP data. Inspection frequencies for treatment and flow control BMPs were approximately 1.0 time per year on average, though Phase I jurisdictions had a frequency slightly higher than 1 and Phase II jurisdictions had a frequency slightly lower than 1. Commercial properties had a slightly higher inspection frequency than non-commercial for

both Phase Is and Phase IIs indicating that the emphasis of municipal inspection programs is slightly greater for commercial properties than non-commercial.

Statistical comparisons for inspection frequency of treatment and flow control BMPs grouped by land use indicated highly significant differences in the three comparisons tested: for Phase Is, for Phase IIs, and for permittee data. While the statistical results showed significant differences for the commercial versus non-commercial land use comparison (thanks to large sample sizes), the differences may not be of practical importance. The closeness of all inspection frequencies to 1.0 time per year and the slight differences in average inspection frequencies (differences of 0.03 to 0.15 inspections per year on average between business categories) do not indicate large practical differences among data grouped by land use categories. The closeness of the inspection frequencies to 1.0 times per year in the data grouped by commercial and non-commercial land uses did not support performing additional statistical tests to determine which individual land uses had significantly different inspection frequencies.

The second effectiveness question (Question 2) inquired about inspection frequency of operational BMPs and structural BMPs (other than treatment and flow control BMPs) at businesses. Data were assessed by business category for this question. For Phase Is, businesses related to automobiles, boats, their repair and maintenance, and fueling (Auto/Boat category) had the highest mean inspection frequencies for both structural and operational BMPs (1.5 and 1.4 times per year, respectively). Businesses related to food stores, restaurants, food production, and hotels (Food/Retail category) also had a relatively high inspection frequency for structural BMPs for Phase Is (1.4 times per year). For Phase IIs, the Auto/Boat category and businesses related to construction, recreation, and landscaping (Land Usage category) were relatively high for both BMP categories with an average inspection frequency of 1.2 times per year.

Statistical comparisons of inspection frequencies for structural versus operational BMPs indicated significant differences among business categories for Phase IIs at the 8.4 percent significance level but not for Phase Is or permittee data at a significance level of less than 21 percent. For the LSCP data, a highly significant result was found indicating a strong difference in inspection frequency among business categories. But as with the statistical comparison for Effectiveness Question 1, the statistical results may not be of practical importance due to the closeness of the mean inspection frequencies to between 1 and 2 times per year. But the differences in inspection frequencies were greater for Question 2 than Question 1, and a finer grained analysis could be done to evaluate inspection frequencies among smaller groups to look for larger differences. This includes evaluation among the 27 business types that were grouped into the six business categories evaluated here or among the 40 jurisdictions with data that were grouped into two permittee phases.

The third effectiveness question (Question 2A) inquired about contact roles at businesses and cooperativeness during inspections. The question was addressed by inspection counts per business category for the five possible contact roles. Relatively few data were available for if the business was cooperative. Only 81 records indicated non-cooperative businesses and just one of these records also included a contact role. Among the cooperative businesses where contact role was indicated, the vast majority were Business Owners; however, businesses related to industrial fabrication, utilities, and waste reclaim (Industrial business category) and the Land Usage category had a higher number of Other Staff as the contact role. Businesses

related to offices, education, personal services, and warehousing (the Indoor/Office business category) represented the most records with contact role information. But very few records that met the criteria of this question had Property Owners as the contact role; therefore, comparison of business owners to property owners was not possible.

The fourth effectiveness question (Question 2B) inquired about follow-up inspections and BMPs. The question was addressed by inspection counts based on the status of the BMPs over repeat inspections. The great majority of records noted the status of BMPs as Resolved. Among all four possible BMP statuses, BMPs related to spills (Spill Planning and Response BMP type), were the most numerous across business categories with the exception of BMP issues related to prohibited discharges (Discharge/Illicit Connection BMP type) for the BMP status of Referred (to another agency for follow-up). The business category of Auto/Boat was the most common with Indoor/Office and Food/Retail business categories not far behind. Because the data analyzed for the fourth effectiveness question is from the LSCP program only, it is possible that the high presence of spill-related BMPs being called out during inspections is an outcome of the spill kit program the LSCP promotes.

The fifth effectiveness question (Question 2C) inquired about what barriers may exist to BMP implementation. The question was addressed by analyzing the median percentage of mentions of BMPs being called out as issues on a reoccurring basis over repeat inspections at each business. This is intended to serve as an indication of chronic BMP barriers and may point to the need for follow-up on these issues. For Phase Is, several BMP types were always called out as issues during the majority of repeat inspections (median percentages of 100 percent) across all business categories. These include the BMP types of Cleaning/Washing, Housekeeping, Maintenance/Repair/Access, Spill Planning and Response, and Storage and Cover. The business category of Auto/Boat had the greatest number of BMPs called out followed by the Indoor/Office business category, though the Land Usage category had the most types of BMP issues always called out on average (100 percent median).

The sixth effectiveness question (Question 2D) inquired about technical assistance and BMPs. The original question proposed to include "situations where technical assistance and/or follow-up inspections are needed to ensure required BMPs are implemented." The proposed approach to address this question and comment would apply to businesses with repeat non-compliant follow-up inspections and the type of technical assistance provided as related to BMPs. But the parsing of data by the necessary fields (especially Technical Assistance Type and Inspection Type) to address the questions resulted in no records.

The municipal NPDES stormwater permit sections related to source control focus on the program requirements and inspection of certain types of BMPs at set frequencies. The permit does not, however, specify the type of data to be collected for municipal source control efforts and how those data should be stored or managed. While this non-prescriptive approach provides flexibility to the permittees, the lack of source control data collection standards creates variability in the type and breadth of data collected. Notwithstanding the limitations of the data available, a large database of over 47,300 records was able to be assembled due to efforts to parse data records into the desired data fields and to standardize and categorize responses for comparability. This required a significant effort that would be have been reduced if data were collected by individual municipalities following regional data standards.

Many of the original source control effectiveness questions could not be answered as originally articulated. This was the result of the questions being identified by the Stormwater Work Group and the Effectiveness Studies Subgroup prior to assessing what data were available. In addition, the questions were not always connected to specific municipal stormwater permit conditions. Alternative source control effectiveness questions were identified based on data available after data were compiled.

Data-driven evaluations of municipal stormwater permit implementation such as this Study have great potential to benefit adaptive management of stormwater both locally and regionally. Evaluating data collected under source control programs is necessary to learn from past efforts and improve future source control efforts, and identifying relevant questions is a vital starting point. Therefore, a primary recommendation is to identify additional source control questions of interest based on evolving permit requirements, on available data, and on how the data are related per the database structure.

Basic data parameters are recommended to be collected during municipal inspections at businesses for evaluation of stormwater source control activities and BMPs. Having consistent source control data parameters in the municipal permits would support Ecology in evaluating permit effectiveness and would support permittees with providing a database template and clarity on what information is to be recorded. It would also support effectiveness analyses and regional evaluations of municipal stormwater source control efforts. Basic data parameters recommended to collect during business inspections include, among others:

- Date of inspection

- Type of inspection to indicate if full inspection or abbreviated for screening or follow-up purposes

- Specific types of BMPs in use

- Type of technical assistance provided

- Date and type of BMP maintenance

- Percentage "in compliance" based on the use of appropriate BMPs. This could be done by grading the effective use of each BMP on a numeric scale, such as 1 to 5, based on performance criteria specific to the BMP.

- Reasons for lack of BMP implementation, including such standard responses as financial burden, lack of technical assistance for identifying appropriate BMPs, or lack of BMP maintenance.

Data for this evaluation were grouped into a manageable number of groupings (such as 6 business categories to represent 27 business types). But this resulted in large sample sizes for some groups, which supported statistically significant differences in inspection frequencies that may not be effectively different (such as 1.1 versus 1.3 inspections per year on average within a given business category). A finer-grain analysis could be done to determine which of the 27 specific business types have different inspection frequencies:

- regardless of what BMPs were inspected;

- for businesses that received a range of repeat visits, such as 2 to 3, 4 to 6, and 7 or more;

- for the range of BMPs inspected and BMP issues that were called out;

- on a subset of the highest quality data from jurisdictions with comparable programs;

- on just LSCP data based on what BMP issues were present (since the LSCP dataset includes information on what BMPs were called out during inspections); and

- on data grouped by municipality or region for a geographic comparison.

For municipal stormwater permittees, recommendations include:

- If inspection frequencies of some business types exceed their relative representation within a jurisdiction and the likelihood (or risk) to pollute, evaluate the reasons why they might be inspected more in your jurisdiction. Consider reducing inspection frequencies where possible while meeting permit requirements. For Phase Is, an example is businesses related to industrial manufacturing, utilities, and waste reclaim, which had a relatively high inspection frequency for operational BMPs. For Phase IIs, an example is businesses related to food, retail, and personal services, which had a relatively high inspection frequency for operational BMPs.

- Consider the types of BMPs that have been called out the most frequently in context of their required versus optional use and for their ability to manage sources of stormwater pollution. Spill planning and response BMPs were almost always the most numerous for both single and repeat inspections across most business categories. Spill preparedness is important, but other BMPs may deserve more attention that were called out less frequently, such as how wastes are stored and the maintenance of BMPs, both of which were prevalent the data evaluated for this study.

- Implement or adjust municipal business inspection programs to align with the efforts to evaluate source control efforts on a regional basis. Collect basic data parameters using consistent terminology to record them.

- Provide data when requested by effectiveness studies proponents. Data evaluations such as this are only as good as the data that goes into them.

Finally, one recommendation for the LSCP program is to stay abreast of what changes may come to the NPDES municipal stormwater permits and try to align LSCP data collection requirements with those in the updated NPDES permits.

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ACKNOWLEDGMENTS

1 Introduction and Background

This report provides the summary of the data, analysis, and results of the City of Lakewood's Business Inspection Stormwater Source Control Effectiveness Study (the Study). The focus of the Study is an evaluation of data from municipal inspections of businesses and private stormwater flow control and treatment facilities. The Study is one of several effectiveness studies of the Western Washington Stormwater Action Monitoring (SAM) program, administered by the Washington State Department of Ecology (Ecology). The City of Lakewood is the municipal agency sponsor of the Study, and a consultant team implemented the Study from Aspect Consulting and Cardno, Inc. Originally, Cardno was the lead and only consultant, but the project shifted to Aspect with the move of key project staff to Aspect in late 2016. Project work is being guided and reviewed by a Technical Advisory Committee with representatives from municipalities and the Washington Stormwater Center.

This report represents Deliverable 5.2 (final report) in the project scope of work. In addition, the database for the Study is provided separately as Deliverable 3.2. The data presented in this report includes information about the sources of data, how data were acquired, the data standardization process, and the creation of the project database. The data analysis and results provide information about the procedures used to analyze data, summaries of records, and analysis of results.

2 Source Control and Effectiveness Questions

This section provides a definition of stormwater source control and presents the questions driving the study. The definition is in context of stormwater management in western Washington, and both the definition and questions are based on the municipal stormwater discharge permits (Ecology 2013a, Ecology 2013b) of the National Pollutant Discharge Elimination System (NPDES).

2.1 Definition of Source Control

Source control in a stormwater context refers to the idea of preventing pollutants from entering stormwater runoff. Stormwater, as defined by the NPDES permit, refers to, "runoff during and following precipitation and snowmelt events, including surface runoff, drainage or interflow" that, "travels across the land surface and discharges to water bodies either directly or through a collection and conveyance system" (Ecology, 2013b). A pollutant in this context is defined as any undesirable substance in stormwater runoff, including chemical, physical, or biological constituents.

Source control of stormwater pollution is achieved by a variety of practices, techniques, and activities, collectively termed as best management practices (BMPs). A source control BMP is defined by the NPDES municipal permits as, "a structure or operation that is intended to prevent pollutants from coming into contact with stormwater through physical separation of area or careful management of activities that are sources or pollutants" (Ecology, 2013a).

These BMPs serve to prevent the generation of potential pollutants or manage and treat them at the source once generated. Source control BMPs are not intended to prevent all stormwater impacts, but rather a combination of BMPs is typically required in practice to minimize impacts.

2.2 Source Control Effectiveness Questions

Seven Effectiveness Questions related to stormwater source control and municipal inspections of businesses were articulated by the Effectiveness Subgroup of the Stormwater Work Group (SWG). An extensive process was undertaken by the Subgroup for this and the other effectiveness studies to identify questions and solicit proposals to address the questions. Each effectiveness study and associated questions focus on a different aspect of the municipal stormwater NPDES permits. The history of the SWG and the subgroups that contribute to the SAM program can be found on Ecology's website of the Puget Sound Ecosystem Monitoring Program (PSEMP, 2017).

The questions were identified by the Effectiveness Subgroup and approved by the SWG prior to knowing exactly what data were available from municipal business inspections; therefore, the questions were refined over the course of the Study based on the data available and what analysis was thought could be done. The original Effectiveness Questions are provided in Table 1, and questions 1 through 6 are addressed in this Study. Question 7 is not addressed as part of the present Study but is expected to be addressed as a separate effectiveness study intended to develop a coordinated inspection framework.

Table 1. Source Control Effectiveness Questions

1. What is the optimum frequency of inspections to maintain the functionality of structural BMPs for treatment and flow control at stormwater facilities on commercial property?

2. What is the optimum frequency of inspections to ensure the proper use of structural and operational source control BMPs at businesses?

3. Which is more effective for specific high value BMPs: focusing on the property owners or focusing on the business owners, or a combination of the two?

    Comment: Target both structural and operational BMP types, and situations where a business owner is and is not cooperative and willing.

4. Which required BMPs were implemented based upon follow up inspection? Which optional BMPs were installed based upon follow up inspection?

5. What were the primary barriers to not adopting or installing BMPs?

6. Address the connection between in-person visits and source control BMPs, and identify situations where technical assistance and/or follow-up inspections are needed to ensure required BMPs are implemented.

    Comment: Gather data about percent compliance. Partner with Ecology Local Source Control program to do this study.

7. Are stormwater source control inspections more effective if combined with other types of inspections? How can coordination of inspections be improved or better organized regionally for referral of issues to the correct entity?

As the data assembly occurred, it became apparent that most of the questions could not be addressed exactly as worded due to lack of data. Therefore, based on the type of data

available, alternative questions were identified to address the topic of each original question as possible. The alternative Effectiveness Questions are presented in Section 4 with the results of the data analysis.

3 Data Sources and Data Acquisition

The source control requirements come from the municipal stormwater NPDES permits. This section provides a summary of the business inspection requirements in those permits and what data were obtained and used for the Study. Permittees are required to report information about their source control efforts in NPDES permit annual reports. But because of the limited information that could be gained from the annual reports, the Study sought data directly from permittees. Thus, two primary sources of data were identified and obtained for the Study:

1. Data provided directly from NPDES permittees (cities, counties, and ports); and

2. Data obtained from the statewide Local Source Control Partnership (LSCP) program, which is administered by Ecology.

As summarized below, a total of 47,338 inspection records were obtained, with 25,256 coming directly from permittees and 22,082 coming from the statewide LSCP program.

3.1 Source Control Requirements in NPDES Municipal Permits

The NPDES municipal stormwater permit is primarily intended to reduce the discharge of pollutants to the municipal separated stormwater sewer system (MS4). All permittees are required to develop a Stormwater Management Plan (SWMP) for this purpose, but differences exist among the Phase I permit (for larger jurisdictions) and Phase II permit (for smaller jurisdictions) for stormwater source control activities. The Phase I permit SWMP is required to describe how compliance is met for the source control program for existing sites (Ecology, 2013a, section S5.C.7). The Phase II permit is absent of a source control program; however, the section on illicit discharge detection and elimination (IDDE) in both permits contain requirements for controlling, managing, and treating stormwater runoff in permit section S5.C.3 for Phase II permittees (Ecology, 2013b) and section S5.C.8 for Phase I permittees (Ecology, 2013a).

The permits dictate the elements of the source control and IDDE programs that need to be implemented by permittees and set targets for the number of sites or outfalls to be inspected. However, the data reporting requirements are minimal. For Phase I source control programs, the data required to be reported relevant to this Study are primarily the number of sites inspected. For both Phase I and Phase II IDDE programs, the data required to be collected relevant to this Study are primarily the number of illicit discharges and illicit connections eliminated.

The data acquisition process included a survey of permittees to find out what data are collected by cities, counties, and ports for business inspections related to stormwater source control (Cardno, 2015). The survey is included in this report as Appendix A. Following

review of the survey results, a list of 20 data fields was assembled, and a data request memo was sent to each permittee through Ecology regional permit managers (Cardno, 2016). The data request memo is included in this report as Appendix B.

3.2 Data from Permittees

Data directly from NPDES permittees were acquired from a data request that was sent to every western Washington primary municipal stormwater permittee via Ecology permit managers (Cardno, 2016). The data request included a spreadsheet database template, list of desired data fields, data field definitions, and instructions. Source control data provided by permittees are from various environmental inspection programs of businesses and private commercial properties and include: general environmental compliance inspections; source control and/or IDDE inspections; fats, oils, and grease (FOG) program inspections; private drainage inspections; health department inspections; and industrial pretreatment program inspections. Table 2 shows a summary of the number of permittees from whom data were requested, the number who responded, and the total number of records provided.

Table 2. Data provided from stormwater permittees

	W. WA Permittees	Provided Data	Declined or Unable	No Response	No. Inspection Records
Phase I Municipalities	6	1	3	2	16,149
Phase I Large Ports	2	0	0	2	0
Phase II Municipalities	85	17	7	59	9,107
TOTAL	93	18	10	63	25,256

Although relatively few municipalities responded to the data request and provided data (16.8 percent), the 18 who did respond with useable data provided a sizeable number of inspection records. The majority of inspection records came from one Phase I, the City of Seattle, who submitted over 16,100 records. Other permittees submitted from 3 to over 3,600 records per jurisdiction.

Most permittees used the spreadsheet template that was provided in the data request. A few permittees either customized the template to match their data fields or provided data with unique data fields specific to their database. Two data sets (from the cities of Everett and Lakewood) provided only general inspection dates as sometime during a quarter or a year, which reflects the minimum requirements in the NPDES permit regarding annual or semiannual inspections. When importing records with nonspecific dates into the database, dates were assigned as the first day of the first month of the period, which were effectively the beginning of the year or quarter (e.g., January 1, March 1, etc.). Also, two cities (Everett and Seattle) submitted multiple data sets from different inspection programs in those jurisdictions. Everett submitted data for their industrial pre-treatment and surface water inspection programs (includes inspections of private stormwater facilities and sewer dye testing), and Seattle submitted data for their inspection programs for private stormwater facilities and business inspections.

Figure 1 below shows the distribution of records received from each permittee and that could be used in the database. Data in 6 of the 18 datasets received directly from permittees contained the same data as the LSCP datasets for those jurisdictions. Therefore, the datasets received from the cities of Bellingham, Marysville, Shoreline, and Sumner, and from Kitsap County and Snohomish Health District, were not used as provided but rather were included via the LSCP data.
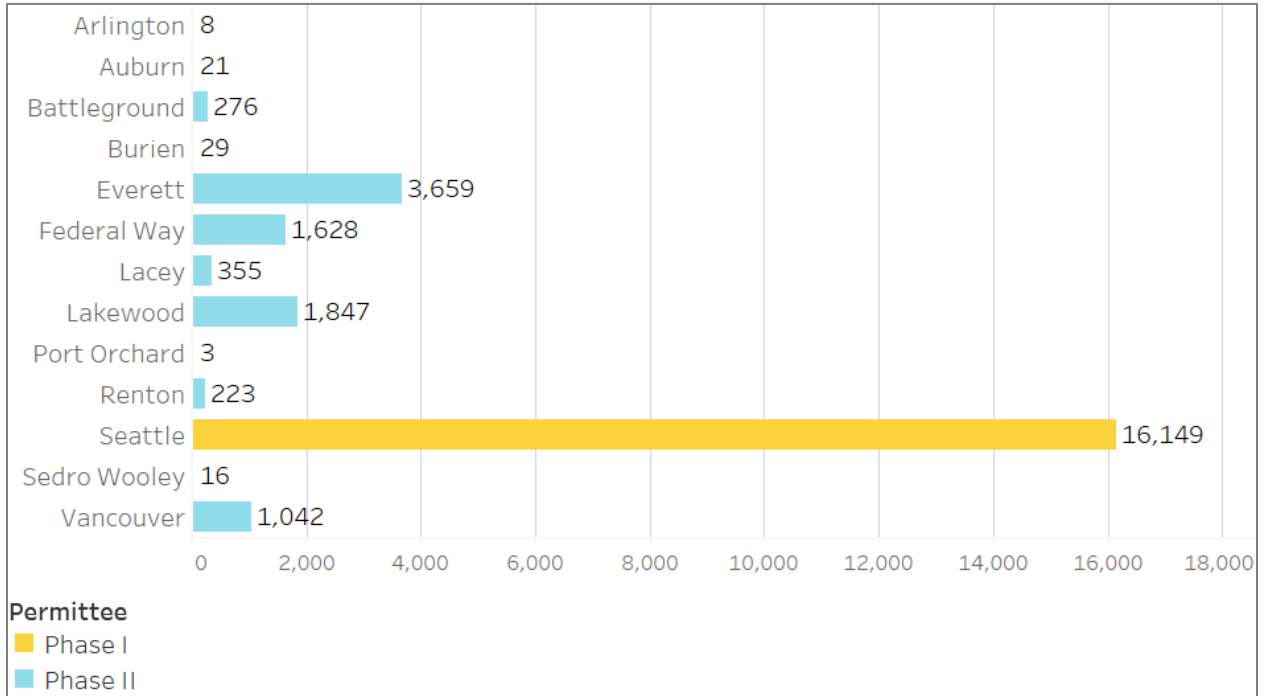
Figure 1. Distribution of inspection records provided by NPDES permittees

3.3 Data from the Local Source Control Partnership

The second major source of data used for the Study came from the LSCP program. The LSCP is administered by Ecology, implemented by individual jurisdictions, and oriented around inspections of small businesses. The LSCP is a technical assistance program and, unlike the permit-driven programs, does not include enforcement actions. In addition, it is acknowledged here that the LSCP generally prefers the terminology of "site visit" rather than "inspection" to differentiate the program from other municipal onsite activities that could potentially include enforcement actions. Data from the LSCP were acquired from the program's database via the Secure Access Washington portal (with permission from Ecology).

LSCP inspections typically focus on operational BMPs and provide technical assistance to businesses for pollution prevention. At its inception in 2008, the LSCP had 14 participating municipal agencies in Washington. In the most recent biennium (2015-2017), 22 participating agencies from 20 municipal jurisdictions participated in the program. Most LSCP participants were a single agency within a jurisdiction; however, two jurisdictions (Kitsap County and Clark County) in the most recent biennium have two agencies each that are LSCP participants. All available LSCP data were used for this Study.

The LSCP program is primarily focused in the Puget Sound region in western Washington; however, two jurisdictions outside this region, the City of Spokane in eastern Washington and Clark County in southwest Washington, also participate. Table 3 provides a summary of LSCP participating agencies for whom data are included in the Study database. It also shows the breakdown of inspection record numbers by NPDES permit phase for comparison to the data received directly from permittees.

Table 3. Data available from the LSCP program

	Participating Jurisdictions	No. Agencies with Data	No. Inspection Records
Phase I Municipalities	5	7	8,259
Phase I Large Ports	1	1	88
Phase II Municipalities	20	16	12,372
Ecology	1	1	1,363
TOTAL	27	25	22,082

In addition to participating municipal jurisdictions, Ecology also performs source control inspections across multiple regions in the state, the data from which are included in the LSCP database. Of the 22,082 statewide LSCP records obtained, 1,363 were from Ecology Urban Waters Initiative, as noted in Table 3. Figure 2 on the next page shows the distribution of LSCP records for each participating jurisdiction.
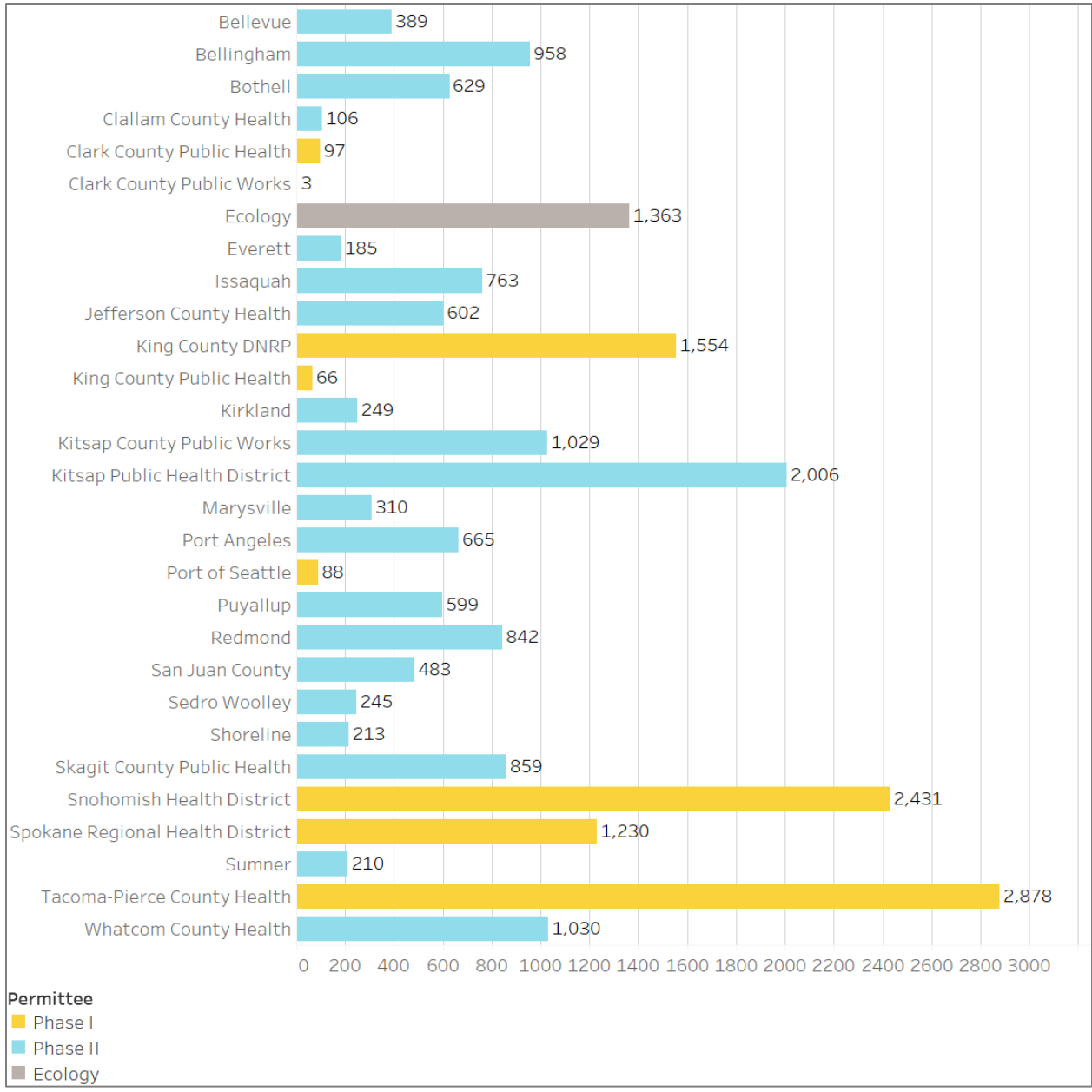
Figure 2. Distribution of inspection records among LSCP participants

4 Database

All of the source control data were assembled into a relational database using Access®. A total of 39 fields were populated with 47,338 inspection records at 25,956 businesses from 40 municipal jurisdictions.

The 20 fields identified in the data request to permittees were included in the database, along with 19 additional fields to capture information as available. The fields were organized into four database tables that were linked in the database:

1. **The File table** includes five fields with information on the municipality, permittee type, file name, and how data were provided.
2. **The Business table** includes 13 fields about the business that was inspected, such as business type, land use, and location. The Business table is linked to the File table by a File ID field.
3. **The Inspection table** includes 15 fields with information about inspections, including date and type, compliance status and cooperativeness, which BMPs were inspected, and the technical assistance provided. The Inspection table is linked to the Business table by a Business ID field.
4. **The New BMP table** includes six fields with information about the BMP corrections that were called out in the inspection or new BMPs that were added. The New BMP table is linked to the Inspection table by an Inspection ID field.

Table 4 provides the list of data fields and their definitions sorted by which of the four database tables they are assigned.

Table 4. Data fields and their definitions

Table	Field Name	Format	Definition
File	File Name	text	Name of file with original data
	Municipality	text	Name of agency who collected data
	Type	text	Type of municipality: City or County
	Permit	text	Phase I, Phase II, or Port NPDES permittee, or Ecology (for data collected by Ecology)
	Data Source	text	Permittee or LSCP indicating provider data
Business	FILE ID	numeric	<> unique number for record in FILE table
	Business Name	text	Name of business where inspection occurred
	DBA Name	text	"Doing business as" name of business
	Business Type	text	Grouped type of business
	Business Category	text	Categorized Business Type
	NAICS code	numeric	6-digit business type code assigned by North American Industry Classification System
	SIC code	numeric	4-digit business type code assigned by the Standard Industrial Classification
	Land Use	text	Categorized land use type based on 2010 Washington State Land Use
	Address	numeric/text	Street address of business inspected
	Notes	numeric/text	Notes from the land use spatial join performed in ArcGIS
	Tax Parcel	numeric	Tax parcel number
	Original Business Type	text	Reference field from LSCP database
	ZIP code	numeric	5-digit zip code of inspected business or property
Inspection	BUSINESS ID	numeric	<> unique number for business or property inspected in BUSINESS table
	Cycle	numeric	number of site visits to business distinguished by date
	Inspection Date	MMDDYYYY	Date of inspection
	Inspection Type	text	Categorized type of inspection
	In Compliance	Yes or No	Compliance status as provided in original record
	Cooperative	Yes or No	Was contact at business cooperative?
	Inspected Flow Treatment BMP	Yes or No	Were flow control or treatment BMPs inspected?
	Inspected Structural BMP	Yes or No	Were structural BMPs inspected (other than ones for flow control or treatment)?
	Inspected Operational BMP	Yes or No	Were operational BMPs inspected?
	New BMPs	Yes or No	Were issues noted that resulted in BMP usage correction or new BMPs to be used?
	Technical Assistance	Yes or No	Was technical assistance provided?
	Technical Assistance Type	text	Categorized type of technical assistance provided
	Contact Role	text	Categorized role of contact person
	Inspection Data Entry Notes	text	Notes field from LSCP inspection record
	Permittee Notes	text	Notes field from Permittee inspection record

Table	Field Name	Format	Definition
New BMP	INSPECTION ID	numeric	<> unique number for inspection record in INSPECTION table
	BMP Category	text	Categorized BMP general type: structural or operational
	BMP Type	text	Categorized field of the specific type of BMP
	BMP Notes	text	Inspection of BMP deficiency, status, or type added
	BMP Data Entry Notes	text	LSCP field of BMP compliance and contact method contact
	BMP Status	text	LSCP field with status of BMP correction

4.1 Data Standardization

The process for combining datasets was oriented around developing controlled lists of valid values for several fields. This was done in order to standardize responses for summary and comparison between the data provided directly from NPDES permittees and that obtained from the LSCP. In a designed experiment, the controlled value lists would be specified up front. In this *post hoc* data evaluation, the lists were determined in reverse based on the permittee and LSCP data. When populating the database, the raw responses were mapped to the lists of valid values. The following 13 fields were developed with standardized responses:

1. Business Type

2. Business Category

3. Land Use

4. Inspection Type

5. Inspection Cycle (site visits)

6. Cooperative?

7. Treatment and Flow Control BMPs Inspected?

8. Structural BMPs Inspected?

9. Operational BMPs Inspected?

10. Technical Assistance Type

11. Contact Role

12. New BMPs?

13. New BMP Type

The fields with standardized responses (i.e. valid values) are discussed below, and Table 5 provides the standardized responses for seven key fields that require more than just a yes or no response.

Table 5. Standardized responses for categorized fields

Business Type	Land Use	Inspection Type	BMP Category	BMP Type	Technical Assistance	Contact Role
Agriculture / Forestry / Landscaping	Commercial	Annual / Routine	Operational	Activity / Location	BMP-specific	Manager
Automotive / Autobody / Auto Detail	Forestry / Mining / Agriculture	Follow-up	Structural	Cleaning / Washing	Educational	No Contact
Boats / Boatyards / Marinas	Industrial	Initial		Discharge / Illicit Connection	Spill Kit	Other Staff
Business / Offices / Government	Institutional	Source Control / LSCP		Disposal	Training	Owner
Commercial food production	Mixed	Private drainage / FOG		Housekeeping		Prop. owner or rep.
Construction	Open	Screening		Labeling		Indeterminate
Education	Park	Spill / IDDE / IC		Maintenance / Repair / Access		
Engineering / Architecture / Consulting	Recreation			Mapping		
Gas / Fuel Station	Residential Multi			Material transfer		
Grocery / Food Retail	Residential Single			Pretreatment and treatment		
Health Services / Medical / Dental / Veterinary	Road / Rail / Air / Parking			Records		
Housing Services	Utility			Secondary containment		
Indeterminate	Water Body			Spill planning and response		
Industrial Fabrication / Repair / Manufacturing				Storage and cover		
Laboratory				Sweeping		
Other				Training		
Personal Services						
Recreation						
Restaurant / Bar / Hotel						
Transportation						
Utilities / Yards						
Warehousing / Storage						
Waste / Recycling / Reclaim						

The five standardized fields that require a yes or no response are:

- Cooperative, to indicate if a business was cooperative during the inspection;

- Treatment and Flow Control BMP Inspected, to indicate if those BMPs were inspected;

- Structural BMPs Inspected, to indicate if BMPs based on physical structures, devices, or equipment were inspected;

- Operational BMPs Inspected, to indicate if BMPs based on non-structural activities or methods were inspected; and

- New BMPs, to indicate what new or different BMPs were called out during an inspection.

For the Business Type field, a list of 27 standardized responses was developed. The business types were based on common business classifications, especially the North American Industry Classification System (NAICS) definitions and tax types on businesses from the Washington Department of Revenue (WA DOR, 2017). In addition to a text description for the field of business type in the source data, the NAICS and also Standard Industrial Classification (SIC) numbers were requested in the data from permittees and were included in some of the LSCP records. The text description of business types was far more complete (82 percent or 21,189 out of 25,956 businesses) than the NAICS data field (56 percent or 14,633 businesses) and SIC data field (16 percent or 4,106 businesses, of which 3,976 also had NAICS numbers). Therefore, the text description of business type was used for data analysis. The NAICS and SIC numbers are included where available in the project database, but it was beyond the scope of this study to manually enter the numbers for records that did not originally include them.

More than 8,100 unique business types were reported in the source data and were grouped into standardized responses by similar characteristics of the nature of the business. For a few of the business types, the name used does not obviously indicate the types of businesses associated with those types. Explanations for those types are provided here:

- Personal Services refers to a selection of retail businesses related to personal care and customer service.

- Other refers to additional personal care businesses not included under Personal Services.

- Indeterminate was used when reviewing records that did not have business types assigned in the source data. For these records, the business name was reviewed and Indeterminate was assigned to businesses types that could not be determined based on business name.

For the Business Category field, a list of six standardized responses was developed based on the Business Type field and reflect a further reduction in the number of unique

business types. See Table 6 below for additional explanation of the Business Category field. Figure 3 shows the distribution of Business Category and Business Type records.
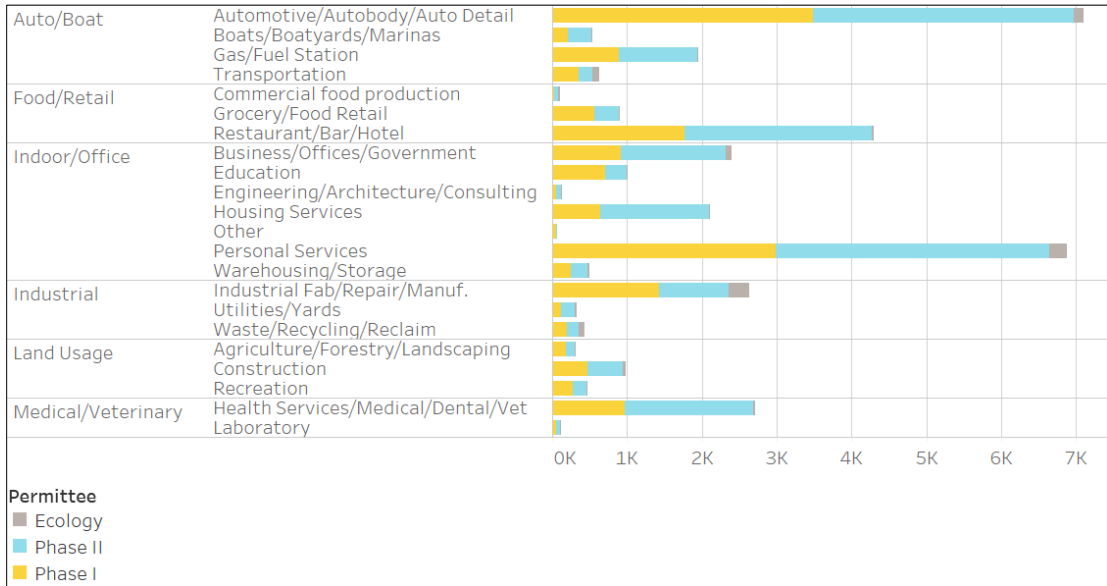
Figure 3. Distribution of Business Category and Business Type

For the Land Use field, 167 unique land uses in the source data were assigned to 14 standardized land uses. The field of Land Use was desired both because it is typically available in municipal data and it can be an indicator of the types and risk levels of potential stormwater pollutants. For this assessment, Land Use was used as a surrogate parameter for property ownership, which was not included in the source data. Figure 4 shows the distribution of Land Use records.

Land use data were available in some permittee files, but it was not included in the LSCP data. Tax parcel numbers were provided with some LSCP data and were considered for converting to land use. But the variable formats for tax parcel numbers from each jurisdiction did not support an efficient or accurate process for determining land use. Instead, land uses from the LSCP data were spatially geolocated in ArcGIS based on business address and joined to a layer of statewide land use classification from 2010 (Ecology, 2010).

Some error is expected from the geolocating process, such as inspections at 56 businesses being closest to the land use of "water body." The geolocating procedure provides a percent confidence of accuracy and nearly records all reported 100 percent confidence. All but 67 records were at 90 percent confidence or higher. Notwithstanding the high confidence reported in the geolocation process, 1,074 records were located on "undeveloped" land use. The great majority of these records were revised by going through the business names and picking a more appropriate land use (based on Ecology, 2010 land uses) where possible.
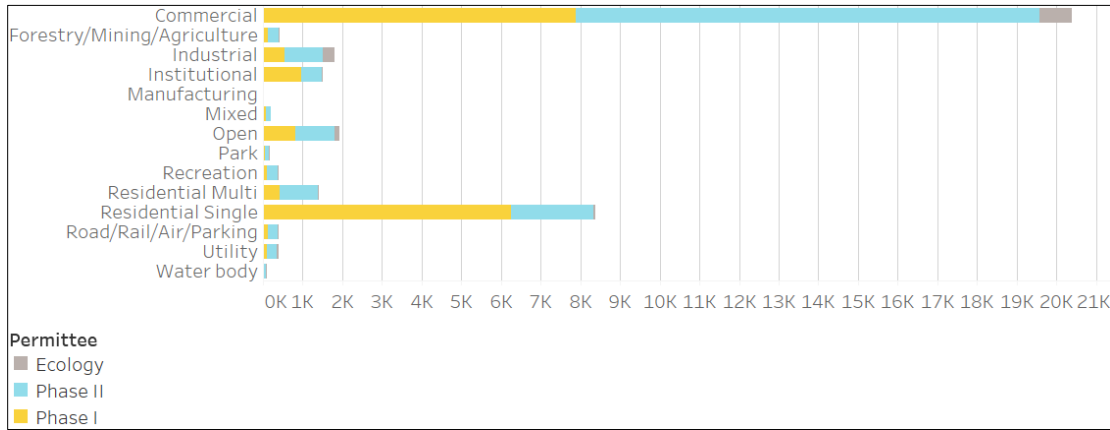
Figure 4. Distribution Within the Land Use Field

For the Inspection Type field, 28 unique inspection types in the source data were assigned to 6 standardized inspection types. Common inspection types were included (such as screening, initial, and follow-up), and others were added based on survey information about permittees' inspection programs. The LSCP data uses consistent terminology for inspection type; however, variability in terminology for inspection type is present in the permittee data. This was especially the case for indicating an initial or follow-up inspection, since some records indicated that the inspection just for source control, for the LSCP program, for spill response, or routine. Figure 5 shows the distribution of Inspection Type records. Because of the inconsistency in inspection type terminology, the definitions of inspection types are provided here:

- Annual / Routine: a once per year or scheduled inspection performed as a routine check-up.

- Screening: an abbreviated inspection done to screen a business to check for the presence of materials or practices of concern for source control or pollution prevention.

- Initial: the first full inspection done at a business.

- Follow-up: an inspection done following a an initial or previous follow-up inspection with the purpose of following up on issues found.

- LSCP / Source Control: an inspection done as part of the LSCP program or to specifically check on source control BMPs. Used for very few LSCP records that did not indicate another Inspection Type.

- Private drainage / FOG: an inspection done on private property to check for management of fats, oils, and grease. Usually done at restaurants and are not part of NPDES permit compliance.

- Spill / IDDE / IC: an inspection done as part of a jurisdiction's illicit discharge detection and elimination (IDDE) program that is oriented to spill prevention or spill response and eliminating illicit connections (IC).
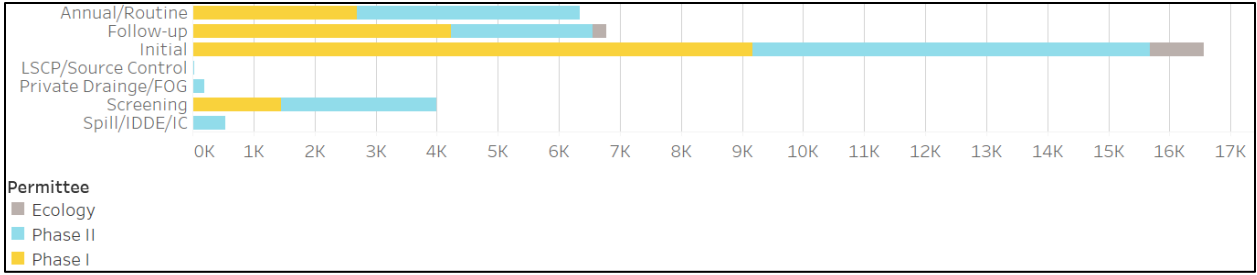
Figure 5. Distribution of Inspection Type

The field of Inspection Cycle was initially intended to capture a set of inspections that begin with a screening inspection and end with one or more follow-up inspections. Multiple inspections within a year were attempted to be coded with the same cycle number differentiated by Inspection Type. But due to the inconsistency of the use of the Inspection Type "follow-up," a consistent method for assigning cycle number could not be determined. Inspection Cycle was ultimately used to indicate simply the sequential visits to a business by date regardless of Inspection Type or the time period since the previous inspection. While this does not allow an explicit evaluation of follow-up efforts, Inspection Cycle can instead be used to determine basic inspection frequencies and track BMP issues over time. Figure 6 shows the distribution of Inspection Cycle records. Cycles greater than 10 have less than 12 records each, though the histogram bars are not visible due to the scale of the graph.
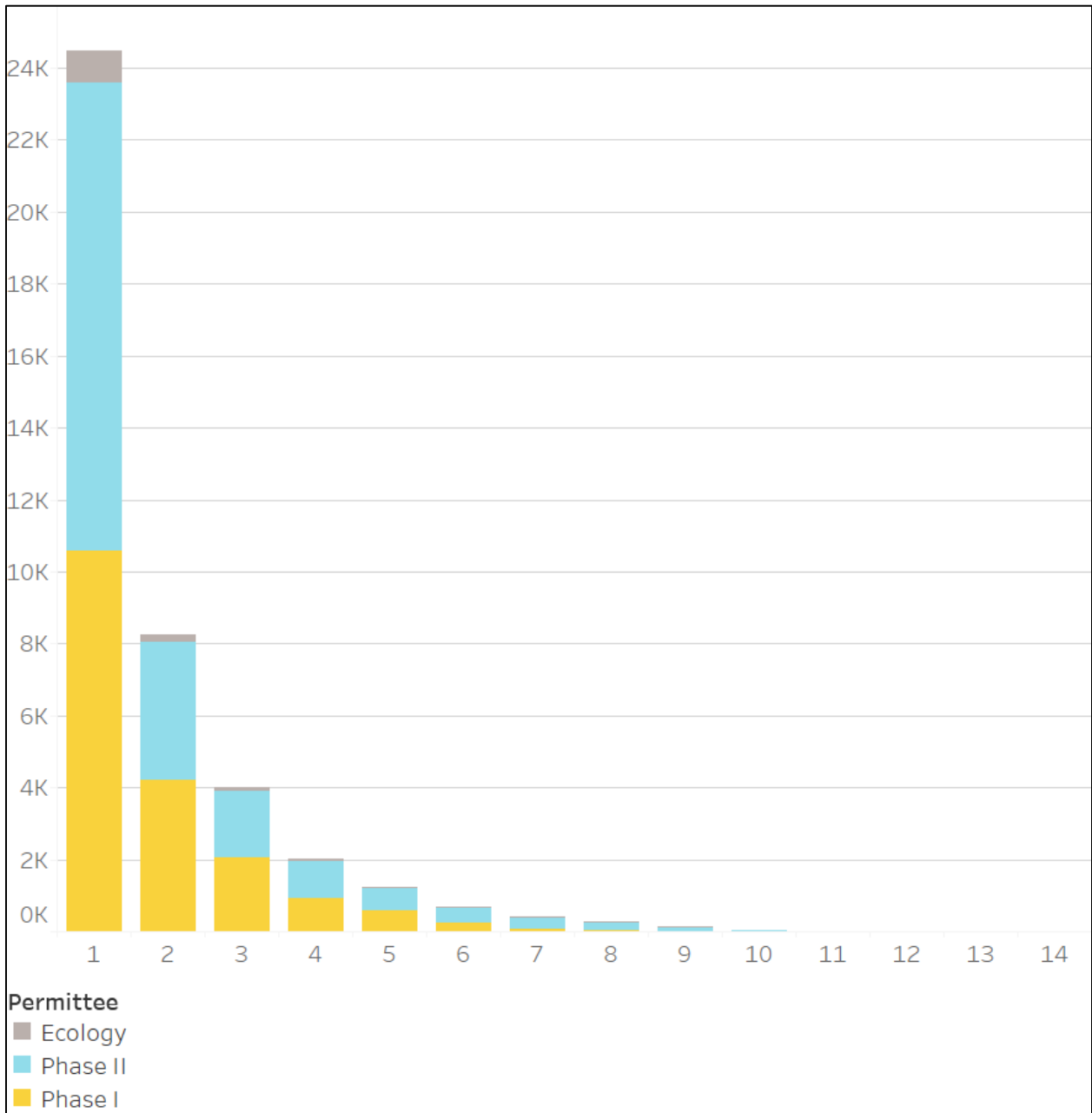
Figure 6. Distribution of Inspection Cycle (number of site visits per business)

For Technical Assistance, 27 unique values in the source data were assigned to 4 standardized values. The standardized values represented if assistance was provided for BMPs, for general education, for training, or for spill kits, which is a commonly reported type of technical assistance, especially for the LSCP program. Figure 7 shows the distribution of Technical Assistance records, which were only available for Phase IIs.
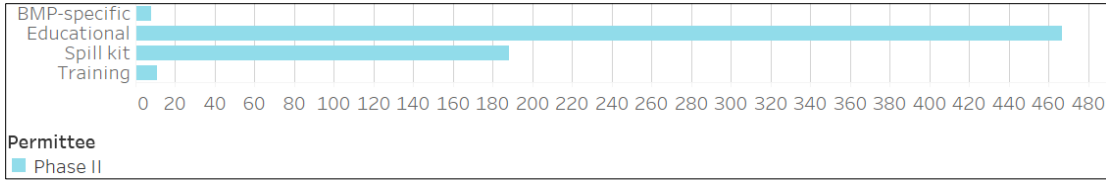
Figure 7. Distribution of Technical Assistance Type

For Contact Role, 776 unique values in the source data were assigned to 6 standardized roles. The standardized roles were identified to represent property owners, business owners, business managers, and other business staff. Figure 8 shows the distribution of Contact Role records.
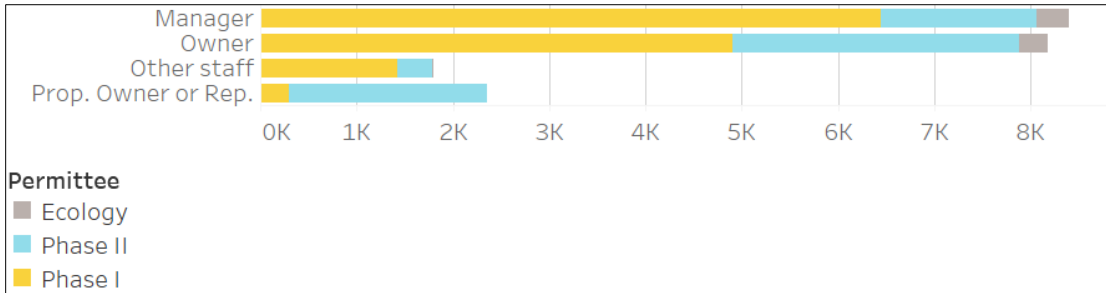
Figure 8. Distribution of Contact Role

For the BMP Category and BMP Type fields, 226 unique BMPs in the source data were assigned to two standardized BMP categories (operational or structural) and to 17 standardized specific BMP types. BMP types were identified based on the level of detail in the raw records, along with the types of source control BMPs in the Stormwater Management Manual for Western Washington (Ecology, 2012). Some BMP Types could be both operational and structural depending on the context, and the individual BMPs mentioned in the records were reviewed to decide how to code them. Relatively little information was provided for BMP Type in the permittee data. The LSCP data included BMP Type information sporadically noting if certain BMPs were provided to a business (such as spill kits) and or were called out as deficient. The LSCP data also included a brief description of the issue and the corrective action needed. The definitions for the BMP Types are as follows.

- Activity / Location: structural BMPs related to location and/or activity used by a business that may be a risk for pollution generation.

- Cleaning/Washing: operational or structural BMPs for cleaning activities or equipment that either occur outside or have the potential to discharge outside.

- Discharge/Illicit Connection: operational or structural BMPs related to prohibited discharges or illicit connections in existing plumbing.

- Disposal: operational or structural BMPs related to the method of disposal or recycling, including how waste materials are stored.

- Housekeeping: operational BMPs for general cleanup of business or site.

- Labeling: operational BMPs for labeling of hazardous materials and wastes.

- Maintenance / Repair / Access: operational or structural BMPs related to the activities or equipment used to maintain, repair, or access BMPs.

- Mapping: operational BMPs related to meeting the site-specific storm sewer and drainage mapping requirement in the NPDES permits.

- Material transfer: operational or structural BMPs related to the techniques and devices used to transfer potential pollutants between storage and usage containers. Does not refer to transportation (e.g. shipping) of materials.

- Pretreatment and Treatment: operational or structural BMPs related to activities and devices used to remove pollutants from discharge or runoff, such as catch basin filter inserts for sediment or coalescing plates for metals.

- Records: operational BMPs related to the record-keeping requirements for using and storing hazardous materials and wastes and BMP maintenance.

- Secondary Containment: operational or structural BMPs that are secondary devices, containers, structures, and methods for containing leaks and spills from primary storage containers.

- Spill Planning and Response: operational BMPs for cleaning up spills, including the presence of spill kits.

- Storage and Cover: operational BMPs related to how materials are stored or covered to prevent leakage and contact with precipitation and runoff.

- Sweeping: operational BMPs related to sweeping ground surfaces to remove pollutants prior to coming into contact with precipitation or runoff.

- Training: operational BMPs related to the training requirements for managing potential pollutants and cleanup up spills.

Figure 9 shows the distribution of BMP Category and BMP Type records.
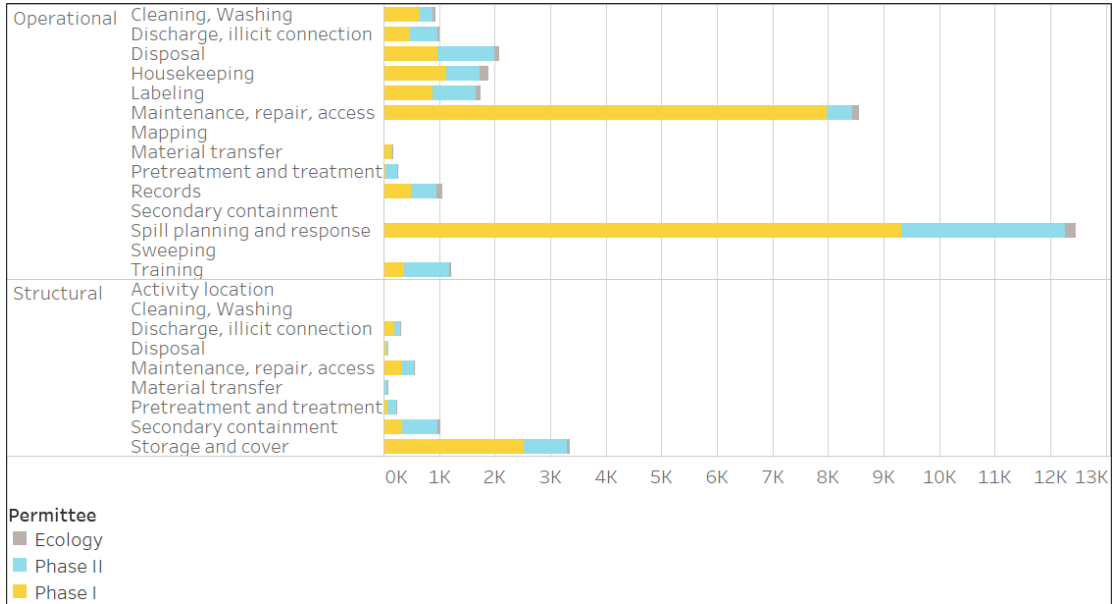
Figure 9. Distribution of BMP Category and BMP Type

In addition to the standardized fields described above and listed in Table 5, the field of Business Category was developed to reduce the number of business description options. This was done to make data analysis more manageable with fewer categories with which to work. The business categories were chosen to correspond to the general type of potential pollution-generating activities associated with the business type. Table 6 provides the list of business types and the matching business categories to which they were assigned.

Table 6. Grouping of business type by business category

Business Category	Business Type
Industrial	Industrial Fabrication /Repair / Manufacturing
	Utilities/yards
	Waste/Recycling/Reclaim
Land Usage	Agriculture/Forestry/Landscaping
	Construction
	Recreation
Auto/Boat	Automotive/Autobody/Auto Detail
	Boats/Boatyards/Marinas
	Gas/Fuel Station
	Transportation

Business Category	Business Type
Indoor/Office	Business/Offices/Government
	Education
	Engineering/Architecture/Consulting
	Housing Services
	Other
	Personal Services
	Warehousing/Storage
Medical/Veterinary	Health Services/ Medical/Dental/Veterinary
	Laboratory
Food/Retail	Commercial food production
	Grocery/Food Retail
	Restaurant/Bar/Hotel

4.2 Data Completeness and Alternative Effectiveness Questions

Through the process of surveying jurisdictions and reviewing data submitted or obtained, it was found that only some data are available to address the source control Effectiveness Questions as worded. The questions (see Table 1) driving the Study were developed prior to the assessment of what inspection data are available. The Effectiveness Subgroup of the Stormwater Work Group (SWG) developed the Effectiveness Questions with input from NPDES municipal permittees and other agencies, organizations, and individuals interested in participating in the regional stormwater management program.

Evaluation of what data are available included assessment of the completeness of the inspection records. Not every jurisdiction's dataset included responses for all variables. The main reasons for incomplete records is that the data are either not collected during inspections or not routinely transferred from field notes to the jurisdiction's or the LSCP's inspection databases. In addition, some jurisdictions declined providing data due to the staff effort required to assemble the data, the lack of electronic records (i.e., paper files only), or the fact that submitting data is not a permit requirement. Notably, two large Phase Is, King County and Snohomish County, declined to provide data, which resulted in fewer than expected records from well-established business inspection programs.

In the *Data Analysis Plan* (Cardno, 2015), the data variables needed to address the source control Effectiveness Questions were envisioned. Tables 7 through 12 summarize the percentage of records available for each type of data envisioned to address each source control Effectiveness Question. As indicated below, none of the Effectiveness Questions could be answered exactly as asked. Therefore, following each table is a brief explanation of what related questions can be answered based on the database fields and data (if available).

Table 7. Comparison of data needs to data available for Question 1

Effectiveness Question	Data Needed	Percentage Records
1. What is the optimum frequency of inspections to maintain the functionality of structural BMPs for treatment and flow control at stormwater treatment and control facilities on private property?	Date of inspection	99.7
	Type of BMPs inspected	64.0
	Date of follow-up activities	42.8
	Functionality and/or usage of BMP	0
	Dates of BMP maintenance	0

For Effectiveness Question 1 (Table 7), the completeness of the data available is moderate to high for the fields of inspection date, follow-up date, and type of BMPs inspected. But because data are not available for two desired fields—BMP functionality and dates of BMP maintenance—the question is not answerable exactly as stated. Similar alternative questions that can be addressed with the available data are:

- What are the inspection frequencies of treatment and flow control BMPs on commercial versus non-commercial property as indicated by land use?
- Among commercial vs. non-commercial properties, how are inspection frequencies different in the following groups?
    - Phase I versus Phase II jurisdictions (Permittee Type)
    - Permittee data versus LSCP data (Data Source)

Treatment and flow control facilities on private property are understood to refer to systems other than catch basins that are used for treatment of stormwater coming from private (not municipal) property. The systems are typically needed due to a potential pollution-generating or flood-causing activity on the property. Typical systems include oil-water separators, wetpools, and filtration (Ecology, 2012).

Data were not available on property ownership; therefore, instead of assessing Question 1 for private versus non-private property, the designation of commercial versus non-commercial land use was used as a related surrogate distinction. Land uses were grouped into commercial and non-commercial land uses as follows:

Land uses for commercial property
- Commercial
- Industrial
- Mixed
- Institutional
- Road/Rail/Air/Parking
- Forestry/Mining/Agriculture

Land use categories for non-commercial property
- Residential multi
- Residential single

- Park

- Open

- Water body

- Recreation

- Utility

Table 8. Comparison of data needs to data available for Question 2

Effectiveness Question	Data Needed	Percentage Records
2. What is the optimum frequency of inspections to ensure the proper use of structural and operational source control BMPs at businesses?	Date of inspection	99.7
	Type of inspection	99.6
	Type of business	79.6
	Type of BMPs inspected	64.0
	Date of follow-up activities	42.8
	Date of compliance	28.6
	Functionality and/or usage of BMP	0
	Dates of BMP maintenance	0

For Effectiveness Question 2 (Table 8), the completeness of the data available is moderate to high for the fields of inspection date, follow-up date, type of inspection, type of business, and type of BMPs inspected, and completeness is low to moderate of the compliance date field. Because data are not available for two desired fields—BMP functionality and dates of BMP maintenance—the question is not answerable exactly as stated. Similar alternative questions that can be addressed with the available data are:

- What are the inspection frequencies of operational and structural BMPs among Business Categories?
- How are the inspection frequencies different in the following groups?
    - Phase I versus Phase II jurisdictions
    - Permittee data versus LSCP data
    - Business Categories with a single inspection versus repeat inspection (based on Cycle)

The aspect of proper use of BMPs is related to the concept of barriers to BMPs use, which is asked about in Question 2C. Therefore, analysis to address BMP usage is covered under Question 2C.

Table 9. Comparison of data needs to data available for Question 2A

Effectiveness Question	Data Needed	Percentage Records
2A Which is more effective for specific high value structural and operational BMPs: focusing on the property owner or business owner or both? Use cooperativeness as indicator.	Inspection frequency variables from no. 2	see Table 8
	Role of the contact person at the business	40.4
	Information on cooperativeness level	8.8
	High-value BMPs noted	0

For Effectiveness Question 2A (Table 9), the completeness of the data available is moderate to high for the fields from Question 2, moderate for the role of the contact person at the business, and low for if the business was cooperative during the inspection. Because data are not available for one desired field—indicating if BMPs are "high-value,"—the question is not answerable exactly as stated. To address the cooperativeness aspect of the question, the data request to permittees included a "yes or no" cooperativeness field for inspections. Some permittee data included cooperativeness information, but LSCP data did not, which resulted in very few records with cooperativeness indicated. In addition, the concept of cooperativeness is subjective, and because it is generally not recorded during inspections, it did not provide a useful basis for the effectiveness question. Alternative questions are identified here that can be addressed in a limited way with the available data.

- What are the inspection counts among Business Categories that reflect contact roles separated among cooperative and non-cooperative inspections?
- Among the inspection counts from the preceding question, how do the inspection counts vary in the following groups?
  - Phase I versus Phase II jurisdictions
  - Permittee data versus LSCP data
  - In compliance versus not in compliance after follow-up inspections
  - Inspection included Operational BMPs versus Structural BMPs

Table 10. Comparison of data needs to data available for Question 2B

Effectiveness Question	Data Needed	Percentage Records
2B Which required BMPs were implemented based upon follow-up inspection? Which optional BMPs were installed based upon follow-up inspection?	Inspection frequency variables from no. 2	see Table 8
	The BMP requirements for each situation	0

For Effectiveness Question 2B (Table 10), the same variables used for Question 2 can be used, the completeness of which is moderate to high. Because data are not available for the desired field indicating what BMPs are required or optional in each situation, the question is not answerable exactly as stated. A similar alternative question that can be addressed with the available data is:

- What are the counts of inspections among Business Categories that reflect:
  - inspection types?
  - single versus repeat inspections (based on Cycle)?
  - the categories and types of new BMPs?
  - the BMP status?

Table 11. Comparison of data needs to data available for Question 2C

Effectiveness Question	Data Needed	Percentage Records
2C What were the primary barriers to not adopting or installing BMPs?	Type of inspection	99.6
	Type of stormwater BMP	93.5
	Date of follow-up activities	42.8
	Date of non-compliance	6.7
	Reasons or barriers noted	0

For Effectiveness Question 2C (Table 11), the completeness of the data available is moderate to high for the fields of type of inspection, type of BMPs inspected, and the date of follow-up activities. Percent completeness was low for date of non-compliance. Similar alternative questions that can be addressed with available data are:

- Among Phase I and Phase jurisdictions, what are the percentages of BMP Types called out in repeat inspections to the same business?
- How do the percentages vary among Business Categories?

The assumption in the alternative question for Effectiveness Question 2C is that if BMPs are called out more than once, then it may be due to barriers for using the BMPs. The data do not include information on what the barriers may be.

Table 12. Comparison of data needs to data available for Question 2D

Effectiveness Question	Data Needed	Percentage Records
2D Address the connection between site visits and required source control BMPs. Identify situations where technical assistance and/or follow-up inspections are needed. Use percent compliance data.	Date of initial inspection	57.2
	BMP usage status	43.5
	Date of follow-up inspection	42.8
	Type of technical assistance	1.3
	Type of BMPs required	0

For Effectiveness Question 2D (Table 12), the completeness of the data available is moderate for the fields of initial inspection date, BMP usage, follow-up date, and type of technical assistance. Percent completeness is very low for the type of technical assistance. Because data are not available for the type of BMPs required, the question is not answerable exactly as stated.

This Effectiveness Question focuses on the usefulness of site visits, especially where follow-up inspections are needed. The ideal dataset to evaluate this would include businesses whose status changed from non-compliance to compliance due to follow-ups and/or technical assistance. Thus, similar alternative questions that could be addressed are:

- What are the counts of inspections by type of Technical Assistance provided during repeat inspections at businesses that are considered not in compliance?

- How are these inspections distributed among Business Categories and Types and among BMP Types for both Phase I and Phase II permittees?

5 Data Analysis and Results

The source control data were analyzed to address the alternative Effectiveness Questions identified above in Section 4.2. The results are presented below in order of the questions and are summarized from the full data analysis. Results of the full data analysis are provided in Appendix C, which includes the specific methods and groupings of data that were used to summarize records for each question.

5.1 Question 1: Inspection Frequency of Treatment and Flow Control BMPs

The first Effectiveness Question inquires about inspection frequency of treatment and flow control BMPs. Two alternative questions were identified, which are listed below followed by tables of results with summary statistics.

Alternative questions for Effectiveness Question 1:

> *What are the inspection frequencies of treatment and flow control BMPs on commercial versus non-commercial property as indicated by land use?*

> *Among commercial vs. non-commercial land uses, how are the inspection frequencies different between permittee phases and data sources?*

The results for the alternative questions for Effectiveness Question 1 are presented in Tables 13 through 15 with inspection counts grouped by commercial versus non-commercial land uses. Table 13 provides results for all data grouped together by land use, Table 14 provides results for data separated by permittee type (Phase I or Phase II) and land use, and Table 15 provides results for data separated by the data source (Permittee or LSCP) and land use. Because this question is asking about inspection frequency, only businesses with more than one inspection (Cycle>1) were used since a frequency cannot be calculated on single values for businesses that have had just one inspection.

Table 13. Inspection frequencies for treatment and flow control BMPs by Land Use

Land Use Group	No. Inspections	No. Businesses	Mean Number of Inspections (Cycle)	Mean Days Between Inspections	Inspection Frequency (per yr)
Commercial	6,831	3,590	4.8	1,042	1.0
Non-Commercial	7,069	2,493	4.1	1,177	1.0

For all data grouped together (Table 13), inspection frequency was the same among commercial versus non-commercial properties at 1.0 times per year on average. The number of inspections between commercial and non-commercial land use groups was similar, but the number of businesses was higher for commercial properties. Mean cycle number is also provided and is greater for commercial than non-commercial.

Table 14. Inspection frequencies for treatment and flow control BMPs by permittee phase

Permittee Phase	Land Use Group	No. Inspections	No. Businesses	Mean Inspection Cycle	Mean Days Between Inspections	Inspection Frequency (per yr)
Phase I	Commercial	2,558	748	4.1	1,010	1.19
	Non-Commercial	5,466	1,723	3.8	1,184	1.04
Phase II	Commercial	4,273	2,842	6.1	1,109	0.97
	Non-Commercial	1,603	770	7.0	1,109	0.91

For data grouped by permittee phase (Table 14), inspection frequency was slightly greater for both Phase I and Phase II commercial than non-commercial land uses. Phase IIs had a higher number of businesses than Phase Is, but Phase Is had a higher number of inspections.

Table 15. Inspection frequencies for treatment and flow control BMPs by data source

Data Source	Land Use Group	No. Inspections	No. Businesses	Mean Number of Inspections (Cycle)	Mean Days Between Inspections	Inspection Frequency (per yr)
Permittee	Commercial	6,831	3,590	4.8	1,042	1.02
	Non-Commercial	7,069	2,493	4.1	1,177	0.99
LSCP	Commercial			*no data*		
	Non-Commercial					

For data grouped by data source (Table 15), only permittee data (but not LSCP data) included inspections of treatment and flow control BMPs. In the permittee data, inspection frequencies were slightly greater for commercial properties than non-commercial. The number of businesses in the commercial land use group is higher than in the non-commercial group, but the non-commercial had slightly more inspections.

Statistical analysis was done on mean inspection frequencies of treatment and flow BMPs for data grouped by land use. A non-parametric test was chosen because the number of inspections per year were not normally distributed. The Wilcoxon rank sum test (a nonparametric t-test equivalent) was used to test whether or not the number of inspections per year for commercial and non-commercial flow treatment BMPs had statistically significant differences.

The Wilcoxon rank sum test is used to look for statistically significant shifts between two distributions. Hypothesis tests were conducted separately for inspection frequencies among commercial versus non-commercial property for Phase Is, Phase IIs, and data from permittees (LSCP data did not include inspection of treatment and flow control BMPs). Specifically, the statistical hypotheses are *H_0 (null hypothesis): the shift in distribution is equal to 0* and *H_a (alternative hypothesis): the shift in distribution is not equal to 0*.

Results of the three hypothesis tests are shown in Table 16. There were highly statistically significant differences in all three commercial versus non-commercial comparisons indicating distribution shifts (reject H_0).

Table 16. Statistical results for inspection frequencies of treatment and flow control BMPs

Comparison	Test statistic value	Probability value
Among Phase I Permittees	746,390	1.979×10^{-10}
Among Phase II Permittees	1,213,100	$< 2.2 \times 10^{-16}$
Among Permittee data	5,261,500	$< 2.2 \times 10^{-16}$

Although the statistical results are significant, the results should be interpreted with caution because the sample sizes are quite large and the effective difference in inspections per year is not very different. The largest difference is 1.039 to 1.193 inspections per year on average between commercial and non-commercial properties for Phase Is. The smallest difference is 0.999 to 1.015 mean inspection frequency between commercial and non-commercial properties within the permittee data. The significant difference between means so close to each other is due to the large sample sizes. These results indicate that small but significant differences exist in these three groups, but the statistics don't necessarily indicate a difference in the effective number of inspections per year since inspections occur in whole number increments. Thus, at this coarse level of analysis with all data grouped by just a couple of parameters, significant and small differences in inspection frequencies of treatment and flow control BMPs exist but this may not translate to effective differences in discrete inspections.

Additional results for Effectiveness Question 1 with data grouped by commercial and non-commercial land use are provided in Appendix C. Those results include inspection frequencies for structural and operational BMPs as well as by business category.

5.2 Question 2: Inspection Frequency of Structural and Operational BMPs

The second Effectiveness Question inquires about inspection frequency of structural BMPs (other than treatment and flow control) and operational BMPs. Two alternative questions were identified, which are listed below followed by tables of results with summary statistics.

Alternative questions for Effectiveness Question 2:

What are the inspection frequencies of operational and structural BMPs among Business Categories?

How are the inspection frequencies different between: permittees (Phase I and Phase II jurisdictions) and data sources (Permittee or LSCP)?

The results for the alternative questions for Effectiveness Question 2 are presented in Table 17 and Table 18 with inspection counts grouped by permittee phase and by data source, respectively. Because this question is asking about inspection frequency, only businesses with more than one inspection (Cycle>1) were used since a frequency cannot be calculated on single values for businesses that have had just one inspection.

Table 17. Inspection frequencies, structural and operational BMPs by permittee phase

Permittee Phase	Business Categories	For Structural BMPs				For Operational BMPs			
		No. Inspections	Mean Number of Inspections (Cycle)	Mean Days Between Inspections	Inspection Frequency (per yr)	No. Inspections	Mean Number of Inspections (Cycle)	Mean Days Between Inspections	Inspection Frequency (per yr)
Phase I	Auto/Boat	3,050	3.4	891	1.5	4,696	3.4	1,489	1.4
	Food/Retail	481	2.9	209	1.4	2,183	3.1	1,138	1.1
	Indoor/Office	2,320	2.8	450	1.2	4,817	3.1	1,165	1.2
	Industrial	584	3.0	655	1.3	1635	3.3	1,351	1.3
	Land Usage	491	2.8	352	1.3	863	3.1	1,357	1.2
	Medical/Veterinary	774	2.5	180	1.3	949	2.6	1,276	1.3
Phase II	Auto/Boat	4,160	3.4	1,367	1.2	3,745	3.2	1,312	1.2
	Food/Retail	2,485	3.2	1,002	1.1	2,173	3.1	972	1.2
	Indoor/Office	6,279	4.5	1,468	1.0	3,326	3.1	1,401	1.1
	Industrial	1,157	3.5	1,427	1.1	904	3.1	1,306	1.2
	Land Usage	699	3.1	1,121	1.2	650	3.1	1,062	1.2
	Medical/Veterinary	1,701	3.1	2,052	1.0	1,439	2.9	1,943	1.0

For results grouped by permittee phase (Table 17), the key results for inspection of structural BMPs are:

- For Phase I permittees, the business category of Auto/Boat had the highest mean inspection frequency of 1.5 times per year and also the highest average number of repeat inspections of 3.4.

- For Phase I permittees, the business category of Indoor/Office had the lowest mean inspection frequency of 1.2 times per year. The category of Medical/Veterinary had the lowest average number of repeat inspections of 2.5

- For Phase II permittees, the business categories of Auto/Boat and Land Usage had the same highest mean inspection frequency of 1.2 times per year. The category of Indoor/Office had the highest average number of repeat inspections of 4.5.

- For Phase II permittees, the business categories of Indoor/Office and Medical/Veterinary had the same lowest mean inspection frequency of 1.0 times per year. The categories of Land Usage and Medical/Veterinary had the lowest average number of repeat inspections of 3.1.

The key results for inspection of operational BMPs for results grouped by permittee phase (Table 17) are:

- For Phase I permittees, the business category of Auto/Boat had the highest mean inspection frequency of 1.4 times per year and also the highest average number of repeat inspections of 3.4.

- For Phase I permittees, the business category of Food/Retail had the lowest mean inspection frequency of 1.1 times per year. The category of Medical/Veterinary had the lowest average number of repeat inspections of 2.6.

- For Phase II permittees, the business categories of Auto/Boat, Food/Retail, Industrial, and Land Usage had the same highest mean inspection frequency of 1.2 times per year. The category of Auto/Boat had the highest average number of repeat inspections of 3.2.

- For Phase II permittees, the business category of Medical/Veterinary had the lowest mean inspection frequency of 1.0 times per year had the lowest average number of repeat inspections of 2.9.

Table 18. Inspection frequencies, structural and operational BMPs by data source

Data Source	Business Categories	For Structural BMPs				For Operational BMPs			
		No. Inspections	Mean Number of Inspections (Cycle)	Mean Days Between Inspections	Inspection Frequency (per yr)	No. Inspections	Mean Number of Inspections (Cycle)	Mean Days Between Inspections	Inspection Frequency (per yr)
Permittee	Auto/Boat	452	6.0	1,427	0.9	1,683	3.4	2,129	1.2
	Food/Retail	356	6.9	1,156	0.9	1,746	3.1	1,435	1.0
	Indoor/Office	3,208	7.3	1,197	0.9	2,752	3.3	2,103	1.1
	Industrial	259	5.8	1,592	1.0	1,057	3.4	1,809	1.3
	Land Usage	53	7.0	1,274	1.0	376	3.5	2,328	1.2
	Medical/Veterinary	292	8.4	1,100	1.0	205	3.2	3,758	1.0
LSCP	Auto/Boat	7,000	3.3	1,154	1.3	7,000	3.3	1,154	1.3
	Food/Retail	2,664	3.1	853	1.2	2,664	3.1	853	1.2
	Indoor/Office	5,739	3.0	1,124	1.2	5,739	3.0	1,124	1.2
	Industrial	1,852	3.1	1,099	1.2	1,852	3.1	1,099	1.2
	Land Usage	1,180	2.9	913	1.2	1,180	2.9	913	1.2
	Medical/Veterinary	2,212	2.8	1,496	1.1	2,212	2.8	1,496	1.1

For results grouped by data source (Table 18), the key results for inspection of structural BMPs are:

- For permittee data, the business categories of Industrial, Land Usage, and Medical Veterinary had the highest mean inspection frequency of 1.0 times per year. The category of Medical/Veterinary had the highest average number of repeat inspections of 8.4.

- For permittee data, the business categories of Auto/Boat, Food/Retail, and Indoor/Office had the lowest mean inspection frequency of 0.9 times per year. The category of Industrial had the lowest average number of repeat inspections of 5.8.

- For LSCP data, the business category of Auto/Boat had the highest mean inspection frequency of 1.3 times per year and also the highest average number of repeat inspections of 3.3.

- For LSCP data, the business categories of Medical/Veterinary had the lowest mean inspection frequency of 1.1 times per year and also the lowest average number of repeat inspections of 2.8.

The key results for inspection of operational BMPs for results grouped by data source (Table 18) are:

- For permittee data, the business category of Industrial had the highest mean inspection frequency of 1.3 times per year. The category of Land Usage had the highest average number of repeat inspections of 3.5.

- For permittee data, the business categories of Food/Retail and Medical/Veterinary had the lowest mean inspection frequency of 1.0 times per year. The category of Food/Retail had the lowest average number of repeat inspections of 3.1.

- For LSCP data, the business category of Auto/Boat had the highest mean inspection frequency of 1.3 times per year and also the highest average number of repeat inspections of 3.3.

- For LSCP data, the business category of Medical/Veterinary had the lowest mean inspection frequency of 1.1 times per year and also the lowest average number of repeat inspections of 2.8.

- Results for LSCP structural and operational BMPs are identical as all LSCP records have only Yes values for the fields of both InspectedStructuralBMP and InspectedOperationalBMP.

Statistical analysis was done on mean inspection frequency results for Question 2. A non-parametric test was chosen because the distributions for number of inspections per year were not normally distributed. Multiple comparisons were required to test differences among the business categories and BMP categories by permittee phase and data source. The Friedman rank sum test (a nonparametric two-way analysis of variance (ANOVA) equivalent) was deemed the most applicable given the unreplicated randomized block

design of the data; however, it's worth noting that the data for this Study are observational and not from a randomized experiment designed to test the difference in inspection frequencies. The Friedman rank sum was used to test whether or not the mean number of inspections per year varied between business category type (6 levels) and BMP type (2 levels). Hypothesis tests using the Friedman rank sum statistic were conducted separately for Phase I permittees, Phase II permittees, and the data source. The statistical hypotheses are *H_0: there is no difference between the variables* versus *H_a: at least two of the variables are different from each other*.

The results of the three hypothesis tests are shown in Table 19. The statistical results show that a significant difference (reject H_0) among the Phase II permittees was present at the 8.4 percent significant level. But comparisons of inspection frequencies among Phase I permittees and among just the permittee data set were not significant at the 21 percent significance level or greater. As with any ANOVA for multiple comparisons, rejection of the null hypothesis does not indicate which variables are different. Further statistical testing would have to be done to determine differences among specific combinations of business and BMP categories.

Table 19. Statistical results for inspection frequencies of structural versus operational BMPs

Comparison	χ^2 (chi-square)[1]	Degrees freedom	Probability value
Among Phase I Permittees	7.1429	5	0.210
Among Phase II Permittees	9.7143	5	0.084
Among permittee data	5.7143	5	0.335
Among LSCP data[2]	H=74.645	5	1.105×10^{-14}

[1] Chi-square test statistic is used instead of Friedman rank sum test statistic when degrees of freedom are greater than four (Zar 1996).

[2] Results for Kruskal-Wallis rank sum test statistic (H).

The data from just the LSCP data set was tested with a different test than the Friedman rank sum because the values of mean number of inspection per year are identical for both structural and operational BMP categories. Instead, a Kruskal-Wallis rank sum test (nonparametric one-way ANOVA equivalent) was used to look for differences in the number of inspections per year among the business categories. The statistical hypotheses for the Kruskal-Wallis test are *H_0: the business category inspections per year are identical populations* versus *H_a: the populations for at least two of the business categories are different*. The results of this hypothesis test are shown in the last row of Table 19.

The Kruskal-Wallis test on LSCP data was highly statistically significant (reject H_0), meaning the population of inspections per year for at least two business categories are different. Rejection of the null hypothesis, however, does not indicate which categories are different. Since the sample size is so large (n = 12,299), it is not surprising to see significant differences even though the means are quite similar.

Although the mean inspection frequencies are similar (between 1.0 and 1.5 times per year) further statistical testing could be done to determine which of the 27 business types may have large differences. Additional results for Effectiveness Question 2 are provided in Appendix C and include histograms of the distributions of inspection frequencies grouped by business categories. These histograms would be a good starting point for considering which inspection frequencies that may translate to more relevant practical results for how many times a year different business types are inspected. The results in Appendix C also include inspection frequencies for treatment and flow BMPs and for all data together without distinction of permittee type.

5.3 Question 2A: Contact Roles and Cooperativeness

Effectiveness Question 2A inquires about whether the business was cooperative during the inspection process, and seeks a link between cooperativeness and contact roles at the business. Analysis of the data was done to address the alternative questions identified above.

Alternative questions for Effectiveness Question 2A:

> *What are the counts of inspections among Business Categories that reflect cooperative and uncooperative contact roles, including property owners, business owners, managers, and other employees?*

> *How do the inspection counts vary among: permittee phase, data source, cooperative or not, in compliance or not, and BMP Category?*

The results for the alternative questions for Effectiveness Question 2A are presented in Table 20 through Table 22 with inspection counts grouped, respectively, by permittee phase, data source, and what category of BMPs (structural or operational) was inspected. Relatively few records (4,170) were available that included data on whether or not a business was cooperative and almost all were "yes" (4,089). Of the records that indicated a business was not cooperative (81), these were only from Phase IIs (Table 20) and from the permittee data source (Table 21). When parsing inspections by the role of the contact person at the business, only 1 record was populated that contained all of this information for a non-cooperative business. Also, among the records that indicate cooperative or not, none had compliance status noted. Because of the very limited data records that fit the criteria needed to address this Effectiveness Question, a comparison of cooperative versus non-cooperative businesses is not possible.

Table 20. Contact roles and Cooperativeness by permittee phase

Permittee Phase	Business Categories	Cooperative				Not Cooperative			
		Bus. Owner	Bus. Manager	Prop. Owner or Rep.	Other Staff	Bus. Owner	Bus. Manager	Prop. Owner or Rep.	Other Staff
Phase I	Auto/Boat								
	Food/Retail								
	Indoor/Office	no data				no data			
	Industrial								
	Land Usage								
	Medical/Veterinary								
Phase II	Auto/Boat	33	5						
	Food/Retail	38	7	1					
	Indoor/Office	256	2	1	12				1
	Industrial	4	4	1	12				
	Land Usage	1	2	1	2				
	Medical/Veterinary	31			1				

For results grouped by permittee phase (Table 20), just Phase IIs had information on cooperativeness of the business during inspections. Of these, the *business owner* was the most common contact role across business categories except for the *other staff* role in Industrial and Land Usage business categories. The Indoor/Office business category represented the highest proportion with contact role information.

Only 1 record was found among Phase IIs with a non-cooperative business that had business category noted, which was in the Indoor/Office category. The contact role at the one non-cooperative business was for *other staff*.

Table 21. Contact roles and Cooperativeness by data source

Data Source	Business Categories	Cooperative				Not Cooperative			
		Bus. Owner	Bus. Manager	Prop. Owner or Rep.	Other Staff	Bus. Owner	Bus. Manager	Prop. Owner or Rep.	Other Staff
Permittee	Auto/Boat	33	5						
	Food/Retail	38	7	1					
	Indoor/Office	256	2	1	12				1
	Industrial	4	4	1	12				
	Land Usage	1	2	1	2				
	Medical/Veterinary	31			1				
LSCP	Auto/Boat	no data				no data			
	Food/Retail								
	Indoor/Office								
	Industrial								
	Land Usage								
	Medical/Veterinary								

For results grouped by data source (Table 21), only data provided by permittees (but not LSCP data) contained information on the cooperativeness associated with contact roles. Table 21 has identical distribution of records among the contract roles and business categories as for Table 20 that parses data by permittee phase. Thus, among permittee data that includes data on cooperativeness of businesses during inspections, the most numerous records were for Indoor/Office businesses where the *business owner* was the contact.

Table 22. Contact roles and Cooperativeness by BMP Category

BMP Category	Business Categories	Cooperative				Not Cooperative			
		Bus. Owner	Bus. Manager	Prop. Owner or Rep.	Other Staff	Bus. Owner	Bus. Manager	Prop. Owner or Rep.	Other Staff
Structural	Auto/Boat		2			*no data*			
	Food/Retail	1	3						
	Indoor/Office	2	1	1					
	Industrial		1						
	Land Usage		1						
	Medical/Veterinary								
Operational	Auto/Boat					*no data*			
	Food/Retail		2	1					
	Indoor/Office	6							
	Industrial		1	1					
	Land Usage								
	Medical/Veterinary								

For results grouped by BMP Category to indicate if structural or operational BMPs were inspected (Table 22), few records were present that also had the contact role and cooperativeness noted. Among these, the Indoor/Office business category had the most records with *business owner* being the sole contact role. The contact role of *business manager* was the most numerous among business categories.

The lack of data available for cooperativeness and contact roles limits the analysis that can be done to address Effectiveness Question 2A. The main culprit for this is that contact roles are either not collected during inspections or were not widely reported in the data.

Additional results for Effectiveness Question 2A are provided in Appendix C and also include inspection counts by business category for the records without cooperativeness data. Due to the relatively few numbers of records that meet the criteria to address Effectiveness Question 2A, it is not recommended to do statistical analysis on these results.

5.4 Question 2B: BMPs and Follow-up Inspections

Effectiveness Question 2B inquires about follow-up inspections and seeks a link between follow-ups and BMPs. One alternative question was identified, which is listed below followed by tables of results with summary statistics.

Alternative question for Effectiveness Question 2B: What are the counts of inspections among Business Categories that reflect: Inspection Type; single vs. repeat inspections; Category and Type of new BMPs; and BMP status?

To address the aspect of this question that deals with follow-up inspections, data were summarized by cycle count greater than 1 to indicate repeat inspections. While the field of Inspection Type has "follow-up" as one of the answer options, this field was primarily

populated in the LSCP data but not in the Permittee data and is represented in just under 25 percent of the records (11,666). Using Cycle instead of Inspection Type orients the question toward repeat inspections rather than follow-ups based on issues found at an initial inspection. The BMP Type field indicates what BMPs were called out during an inspection.

The results for Alternative Question 2B are provided in Table 23 through Table 26 with inspection counts grouped by BMP Status in each table (respectively, *In Process, No Further Action, Refer to Agency, or Resolved*). The BMP Status field was identified and added to the list of database fields during review of the LSCP data, which included a field for this. The data request to permittees did not include information on the status of BMPs; therefore, the data analyzed for this question come solely from the LSCP program. Results are provided for single and repeat inspections across the range of business categories in Tables 21 through 24. The total number of inspections (n) per business category is also provided in each table associated with the four BMP statuses.

The BMP Status of *In Process* refers to BMPs that have begun to be addressed but need more work. The status of *No Further Action* refers to issues that were called out but do not require further action and is commonly used for optional BMPs. The status of *Refer to Agency* indicates a significant issue that needed to be escalated for possible enforcement action. The status of *Resolved* refers to BMP issues that reached a state of improvement that was satisfactory to the inspector.

Table 23. BMP Percent Status=In Process for single versus repeat inspections

BMP Type	Inspection Count (Cycle) = 1 Percent of total per business category						Inspection Count (Cycle) >1 Percent of total per business category					
	Auto Boat (n=176)	Food Retail (n=58)	Indoor Office (n=154)	Industrial (n=65)	Land Usage (n=61)	Medical Veterinary (n=25)	Auto Boat (n=102)	Food Retail (n=30)	Indoor Office (n=79)	Industrial (n=15)	Land Usage (n=5)	Medical Veterinary (n=12)
Cleaning / Washing	4%		1%	6%	8%		2%		1%			
Discharge / Illicit Connection	3%	14%	2%	3%	10%	8%	6%	10%	6%			17%
Disposal	11%	12%	12%	11%	8%	20%	5%	7%	10%	13%		8%
Housekeeping	3%	12%	3%	6%	3%		6%	13%	5%	7%	20%	
Labeling	13%	2%	12%	12%	15%	16%	7%	3%	3%			8%
Maintenance / Repair / Access	11%	17%	5%	11%	7%	8%	9%	10%	10%	7%		17%
Material Transfer	3%	5%	1%	3%			1%					
Pretreatment and Treatment	3%	12%	2%	2%	5%		4%	17%	4%			8%
Records	11%		9%	11%	11%	24%	4%	3%	1%			
Secondary Containment	5%	7%	6%	5%	7%		11%	3%	5%	20%	20%	
Spill Planning and Response	24%	16%	27%	23%	23%	20%	24%	33%	39%	27%	40%	42%
Storage and Cover	6%	3%	9%	8%	3%	4%	23%		15%	27%	20%	
Training	3%	16%	7%	2%	3%		4%	10%	4%			

Note: total number of inspections per business category is provided in parentheses in the header row

For BMPs with a status of *In Process* (Table 23), all BMP types are represented, but the most and least prevalent BMPs were different for single versus repeat inspections. For single visits (cycle=1 for 544 inspections), the most prevalent BMP type called out as being in process was Spill Planning and Response representing the most followed by Labeling, Disposal, Records, and Maintenance. These BMPs tended to be called out across business categories consistently with the Auto/Boat and Indoor/Office categories representing the most and the Medical/Veterinary category the least. The least prevalent BMP issues for single inspections were Material Transfer and Cleaning/Washing, which were present in just four out of six business categories each.

For repeat inspections (cycle>1 for 253 inspections), the Spill Planning and Response BMP type was the most prevalent as being in process, which is similar to single inspections. Spill Planning and Response, however, is the only BMP type represented in all business categories with repeat inspections. Also, the next most numerous BMP types called out as in process for repeat inspections were mostly different than for single inspections and included Secondary Containment, Storage and Cover, Housekeeping, and Maintenance. These BMPs were represented at four to five business categories each and all included the Auto/Boat, Food/Retail (except for Storage and Cover), and Indoor/Office categories. The business categories of Land Usage and Medical/Veterinary had the fewest BMPs noted in process.

Table 24. BMP Percent Status=No Further Action for single versus repeat inspections

	Inspection Count (Cycle) = 1						Inspection Count (Cycle) >1					
	Percent of total per business category						Percent of total per business category					
BMP Type	Auto Boat (n=65)	Food Retail (n=89)	Indoor Office (n=121)	Industrial (n=12)	Land Usage (n=82)	Medical Veterinary (n=10)	Auto Boat (n=90)	Food Retail (n=64)	Indoor Office (n=95)	Industrial (n=14)	Land Usage (n=61)	Medical Veterinary (n=9)
Cleaning / Washing	2%					10%	4%					
Discharge / Illicit Connection	6%	6%	2%			20%	10%	6%				11%
Disposal	14%	42%	6%	25%	1%	10%	14%	20%	12%		2%	11%
Housekeeping	5%	8%	4%		1%			8%	4%			
Labeling	8%		21%	17%	4%		12%	3%	6%	14%		
Maintenance / Repair / Access	9%	8%	2%	8%	9%		2%	6%	2%	21%	2%	
Material Transfer		2%	1%				1%	5%				
Pretreatment and Treatment		2%	4%				1%	17%				
Records	11%	8%	5%		4%		6%	3%	4%			11%
Secondary Containment	9%	3%	4%		0%	20%	2%					
Spill Planning and Response	22%	1	37%	42%	68%	10%	34%	27%	65%	57%	97%	22%
Storage and Cover	9%	7%	10%	8%	10%	30%	8%	3%	6%	7%		33%
Training	6%	4%	3%		4%		4%	2%				11%

Note: total number of inspections per business category is provided in parentheses in the header row

For BMPs with a status of *No Further Action* (Table 24), all BMP types are represented, but the most and least prevalent BMPs were somewhat different for single versus repeat inspections. For single visits (cycle=1 for 379 inspections), the most prevalent BMP type called out as requiring no further action was Spill Planning and Response by far followed by Disposal and Storage/Cover. These BMPs were called out consistently across business categories with the Indoor/Office and Food/Retail categories representing the most and the Industrial and Medical/Veterinary categories representing the fewest BMPs requiring no further action. The least prevalent BMPs with no further action needed for single inspections were Material Transfer and Pretreatment/Treatment, which were present for just two out of six business categories each.

For repeat inspections (cycle>1 for 333 inspections), the same most prevalent BMPs as for single inspections were reported as requiring no further action, including Spill Response and Planning, Disposal, and Storage/Cover. Spill Response and Planning, however, is the only BMP type represented by all business categories with repeat inspections. Also, the next most numerous BMP types called out as requiring no further action for repeat inspections were mostly different than for single inspections and included Material Transfer, Cleaning/Washing, and Secondary Containment. These BMPs were represented at one or two business categories each and all included the Auto/Boat category. The business categories of Indoor/Office and Auto/Boat has the most numerous overall BMPs requiring no further action. In addition, the business categories of Industrial and Land Usage had the fewest BMPs noted as requiring no further action.

Table 25. BMP Percent Status=Refer to Agency for single versus repeat inspections

BMP Type	Inspection Count (Cycle) = 1						Inspection Count (Cycle) >1					
	Percent of total per business category						Percent of total per business category					
	Auto Boat (n=139)	Food Retail (n=97)	Indoor Office (n=147)	Industrial (n=59)	Land Usage (n=48)	Medical Veterinary (n=21)	Auto Boat (n=173)	Food Retail (n=55)	Indoor Office (n=80)	Industrial (n=34)	Land Usage (n=27)	Medical Veterinary (n=17)
Cleaning / Washing	3%		4%	10%	2%	5%	2%			6%	7%	
Discharge / Illicit Connection	26%	31%	27%	14%	25%	19%	13%	11%	11%	9%	22%	
Disposal	15%	29%	27%	7%	19%	24%	9%		6%	3%		18%
Housekeeping	4%	3%	5%	12%	8%	14%	6%	2%		9%		
Labeling	9%	1%	1%	14%	8%		6%		1%	15%		
Maintenance / Repair / Access	13%	8%	13%	7%	8%	10%	7%	4%	4%	9%		12%
Material Transfer	5%	4%	1%	3%	2%	5%				6%	4%	
Pretreatment and Treatment	6%	2%	9%	7%	6%	5%	4%	9%	3%	3%	4%	6%
Records	4%	3%	3%	14%	6%	5%	5%	2%	1%	6%	7%	12%
Secondary Containment	3%	11%	2%			5%	4%	9%	1%	9%	4%	
Spill Planning and Response	4%	5%	5%	5%	10%	10%	23%	53%	59%	15%	41%	41%
Storage and Cover	8%	1%	1%	3%	4%		8%	2%	3%	12%	7%	
Training		1%	1%	3%			12%	9%	11%		4%	12%

Note: total number of inspections per business category is provided in parentheses in the header row

For BMPs with a status of *Refer to Agency* (Table 25), all BMP types are represented, but the most and least prevalent BMPs were different for single versus repeat inspections. For single visits (cycle=1 for 510 inspections), the most prevalent BMP types referred for follow up were Discharge/Illicit Connection and Disposal by far representing the most followed by Maintenance. These BMPs were called out consistently across business categories with the Auto/Boat and Indoor/Office categories representing the most and the Land Usage and Medical/Veterinary categories the least. In addition, the BMP types of Housekeeping, Material Transfer, Pretreatment/Treatment, Records, and Spill Planning and Response were also referred for follow-up among all business categories. The least prevalent BMPs referred for single inspections was Training, which was present for only three business categories.

For repeat inspections (cycle>1 for 386 inspections), the most prevalent BMP type referred was Spill Planning and Response, which was represented in all business categories along with Pretreatment/Treatment and Records BMP types. The BMP type of Discharge/Illicit Connection was also prevalent but only represented by five business categories (all except Medical/Veterinary). The Auto/Boat and Industrial business categories were represented by all but one BMP type each that was referred (Material Transfer and Industrial, respectively). The business category of Medical/Veterinary had the fewest BMPs noted for referral.

Table 26. BMP Percent Status=Resolved for single versus repeat inspections

BMP Type	Inspection Count (Cycle) = 1						Inspection Count (Cycle) >1					
	Percent of total per business category						Percent of total per business category					
	Auto Boat (n=3,076)	Food Retail (n=980)	Indoor Office (n=2,520)	Industrial (n=513)	Land Usage (n=507)	Medical Veterinary (n=648)	Auto Boat (n=2,452)	Food Retail (n=730)	Indoor Office (n=1,567)	Industrial (n=320)	Land Usage (n=231)	Medical Veterinary (n=340)
Cleaning / Washing	3%	3%	2%	3%	4%	1%	2%	3%	1%	0%	0.4%	1%
Discharge / Illicit Connection	5%	8%	4%	4%	4%	4%	4%	7%	3%	4%	3%	5%
Disposal	11%	14%	8%	8%	13%	33%	7%	6%	6%	10%	10%	36%
Housekeeping	5%	9%	6%	6%	6%	2%	8%	8%	4%	8%	7%	4%
Labeling	14%	3%	9%	13%	13%	7%	12%	4%	5%	10%	7%	6%
Maintenance / Repair / Access	10%	12%	6%	5%	7%	13%	8%	10%	5%	7%	4%	11%
Material Transfer	0.3%	2%	1%	1%	1%	0.3%	0.2%	1%	0.4%	1%	1%	1%
Pretreatment and Treatment	1%	8%	2%	2%	1%	4%	1%	10%	2%	0.3%	0.4%	3%
Records	5%	2%	5%	9%	6%	9%	4%	2%	4%	8%	3%	9%
Secondary Containment	7%	7%	5%	10%	5%	4%	8%	7%	4%	10%	10%	5%
Spill Planning and Response	25%	20%	27%	22%	23%	14%	28%	29%	41%	24%	33%	31%
Storage and Cover	8%	5%	17%	12%	10%	3%	13%	7%	18%	13%	12%	6%
Training	6%	7%	9%	6%	7%	5%	5%	7%	7%	4%	8%	9%

Note: total number of inspections per business category is provided in parentheses in the header row

The BMPs with a status of *Resolved* (Table 26) were by far the most numerous across all BMP types. All BMP types are represented for both single and repeat inspections. For single visits (cycle=1 for 8,244 inspections), the most prevalent BMP type called out as resolved was Spill Planning and Response followed by Disposal, Labeling, Storage/Cover, and Maintenance. These BMPs were resolved the most in the Auto/Boat and Indoor/Office business categories and the least in the Land Usage and Industrial categories. The least prevalent BMP type noted as resolved for single inspections was Material Transfer.

For repeat inspections (cycle>1 for 5,730 inspections), Spill Planning and Response was by far the most numerous as being resolved as with single inspections. Some of the same BMP types were also the most frequently resolved in repeat inspections as with single inspections, including Disposal and Storage/Cover. The Auto/Boat business category had the most number of BMPs considered resolved for repeat inspections followed by Indoor/Office. In addition, the business categories of Industrial and Land Usage had the fewest BMPs noted as requiring no further action.

Due to the relatively few numbers of records that meet the criteria to address Effectiveness Question 2B, it is not recommended to do statistical analysis on these results.

5.5 Question 2C: Barriers to BMPs

Effectiveness Question 2C inquires about barriers to BMP usage. One alternative question was identified, which is listed below followed by tables of summary statistics.

Alternative question for Effectiveness Question 2C: Among Phase I and Phase II jurisdictions, what are the percentages of BMP Types that are called out repeatedly among Business Categories for businesses that have repeat inspections?

The results for Alternative Question 2C are provided in Table 27 and Table 28 with median percent occurrences across Business Categories of BMPs being called out during repeat inspections for permittee types (Table 27) and data source (Table 28). While data were not available that directly address barriers to BMP use, the presence of repeated issues with the same types of BMPs is used here as a surrogate to indicate potential barriers to BMP use. The same data are summarized for this question as for Effectiveness Question 2B with BMP Type distributed by Business Category. But for Question 2C, the analysis focuses on repeat inspections (17,057 records) at individual businesses where issues with the same types of BMPs reoccur.

The median percent of times was calculated for the number of times that each BMP type was called out as an issue for each business category. Thus, values in Table 27 and Table 28 are percentages, with 100 indicating that a BMP of that type was always called out on a per-business basis. In addition, each of these values has a sample size, which is reported in parentheses in each cell of the tables below. Results with any sample size are reported; however, results are greyed out for cases where the sample size was less than 3 since medians reported for samples of just 1 or 2 are not very meaningful. Still, these results are useful to include to represent the full range of BMPs and business categories that had BMP issue reoccurrences. See Figure 6 for the distribution of records by number of site visits (cycle number).

Table 27. Median relative percentages of BMP issues for repeat visits, Phase Is.

BMP Type	Business Category					
	Auto Boat	Food Retail	Indoor Office	Industrial	Land Usage	Medical Veterinary
Cleaning / Washing	100 (n=76)	100 (n=41)	100 (n=61)	100 (n=15)	100 (n=6)	100 (n=4)
Discharge / Illicit Connection	80 (n=63)	100 (n=22)	75 (n=41)	80 (n=15)	100 (n=10)	100 (n=4)
Disposal	66.7 (n=74)	100 (n=9)	100 (n=59)	100 (n=33)	100 (n=10)	100 (n=8)
Housekeeping	100 (n=144)	100 (n=37)	100 (n=76)	100 (n=57)	100 (n=26)	100 (n=8)
Labeling	66.7 (n=124)	100 (n=6)	75 (n=37)	75 (n=31)	75 (n=7)	100 (n=2)
Maintenance / Repair / Access	100 (n=238)	100 (n=92)	100 (n=263)	100 (n=64)	100 (n=33)	100 (n=24)
Mapping	100 (n=2)		100 (n=2)			
Material Transfer	100 (n=23)	100 (n=4)	100 (n=11)	100 (n=15)	100 (n=11)	
Pretreatment and Treatment	83.3 (n=13)	100 (n=6)	83.3 (n=2)	100 (n=3)	100 (n=1)	28.6 (n=1)
Records	70.8 (n=38)	83.3 (n=2)	75 (n=35)	100 (n=19)	70.8 (n=6)	100 (n=6)
Secondary Containment	80 (n=46)	66.7 (n=5)	87.5 (n=6)	66.7 (n=7)	66.7 (n=5)	100 (n=1)
Spill planning and Response	100 (n=309)	100 (n=154)	100 (n=219)	100 (n=84)	100 (n=41)	100 (n=15)
Storage and Cover	100 (n=210)	100 (n=55)	100 (n=124)	100 (n=75)	100 (n=35)	100 (n=16)
Training	66.7 (n=15)	100 (n=1)	100 (n=5)	40 (n=1)	100 (n=3)	100 (n=1)

For Phase Is, most combinations of business category and BMP type (57 out of 79) had 100 percent BMP issue reoccurrence (Table 27). In addition, several BMP types among Phase I jurisdictions had median percentages of 100 percent for all business category and BMP type combinations indicating consistent BMP issue reoccurrence over multiple inspections. These BMP types included: Cleaning/Washing, Housekeeping, Maintenance/Repair/Access, Spill Planning and Response, Storage and cover, Material Transfer, and Mapping. The BMP issue reoccurrences occurred across all business categories except for Material Transfer (all except Medical/Veterinary) and Mapping (only Auto/Boat and Indoor/Office). The relatively fewer business categories represented by the Material Transfer and Mapping businesses may reflect the more likely presence of outdoor activities at these businesses than at indoor businesses (offices, food/retail) or those where drainage may be treated or infiltrated rather than going to the MS4 (Land Usage). BMP types with less than 100 percent median reoccurrence for three or more business categories include: Discharge/Illicit Connection, Labeling, Pretreatment/Treatment, Records, and Secondary Containment.

The business categories of Food/Retail and Medical/Veterinary showed the most number of 100 percent median BMP issue reoccurrences (11 out of 14 BMP types) with

Auto/Boat businesses showing the fewest (7 out of 14 BMP types). Although the Auto/Boat category had the most BMP issue reoccurrences overall, the more frequent reoccurrence of issues among most BMP types was for the Medical/Veterinary category. Thus, businesses associated with medical, veterinary, and laboratory businesses along with food, retail, and hotels had the most chronic BMP issues reoccur.

The number of repeat inspections with issues was highly variable and ranged from one to 309 with Spill Response and Planning representing the most and Mapping representing the fewest. In addition, BMP Types of Activity/Location and Sweeping are not represented among Phase I jurisdictions.

Table 28. Median relative percentages of BMP issues for repeat visits, Phase IIs

BMP Type	Business Category					
	Auto Boat	**Food Retail**	**Indoor Office**	**Industrial**	**Land Usage**	**Medical Veterinary**
Cleaning / Washing	100 *(n=21)*	80 *(n=13)*	64.6 *(n=12)*	100 *(n=2)*	100 *(n=2)*	100 *(n=3)*
Discharge / Illicit Connection	80 *(n=76)*	100 *(n=44)*	100 *(n=42)*	70.8 *(n=10)*	100 *(n=6)*	100 *(n=10)*
Disposal	84.5 *(n=92)*	100 *(n=39)*	100 *(n=59)*	75 *(n=16)*	100 *(n=9)*	100 *(n=54)*
Housekeeping	75 *(n=70)*	100 *(n=49)*	100 *(n=26)*	63.3 *(n=16)*	100 *(n=9)*	100 *(n=7)*
Labeling	75 *(n=92)*	100 *(n=17)*	100 *(n=46)*	66.7 *(n=15)*	100 *(n=7)*	75 *(n=11)*
Maintenance / Repair / Access	91.7 *(n=66)*	100 *(n=41)*	100 *(n=44)*	66.7 *(n=16)*	100 *(n=5)*	100 *(n=17)*
Material Transfer	75 *(n=3)*	100 *(n=6)*	83.3 *(n=4)*	45 *(n=2)*	100 *(n=1)*	100 *(n=1)*
Pretreatment and Treatment	80 *(n=29)*	100 *(n=57)*	90 *(n=20)*	75 *(n=2)*	53.3 *(n=2)*	100 *(n=5)*
Records	91.7 *(n=42)*	66.7 *(n=17)*	90 *(n=24)*	100 *(n=13)*	66.7 *(n=3)*	75 *(n=13)*
Secondary Containment	75 *(n=109)*	100 *(n=29)*	66.7 *(n=41)*	66.7 *(n=16)*	100 *(n=10)*	77.5 *(n=12)*
Spill planning and Response	75 *(n=202)*	93.8 *(n=84)*	100 *(n=148)*	75 *(n=31)*	100 *(n=19)*	66.7 *(n=47)*
Storage and Cover	75 *(n=118)*	100 *(n=31)*	100 *(n=49)*	66.7 *(n=23)*	100 *(n=14)*	100 *(n=10)*
Training	75 *(n=80)*	80 *(n=39)*	100 *(n=46)*	100 *(n=9)*	100 *(n=9)*	82.9 *(n=26)*

As with Phase Is, Phase II data also showed that most combinations of business category and BMP type had 100 percent median BMP issue reoccurrence (Table 27). However, Mapping, Activity/Location, and Sweeping were not BMP types called out in the Phase II data, and fewer 100 percent combinations occurred (40 out of 78) than in Phase I data. No BMP types showed 100 percent median issue reoccurrence across all business categories, and all business categories are represented in Phase II data for the types of BMP issues represented. The number of repeat inspections with issues was highly variable and ranged from 1 to 202 with Spill Response and Planning representing the most and Material Transfer representing the fewest.

BMP types with the highest median of BMP issue reoccurrences included Cleaning/Washing, Discharge/Illicit Connection, Disposal, Housekeeping, Labeling, Maintenance/Repair/Access, Material Transfer, Storage and Cover, and Training. BMP types with the lowest number of BMP issue reoccurrences included: Pretreatment and Treatment, Records, Secondary Containment, and Spill Planning and Response. Businesses in the Auto/Boat category had the most number of types of BMP issues. But the business category of Land Usage had the most number of BMP types (11 out of 13) with 100 percent medians. This indicates businesses in that category (construction, agriculture, recreation) had the most often reoccurrence of BMP issues on average.

Additional results for Effectiveness Question 2C are provided in Appendix C and include mean percentages for BMP issue reoccurrence for all data grouped together without distinction of permittee type.

5.6 Question 2D: Follow-up Inspections and Technical Assistance

Effectiveness Question 2D inquires about follow-up inspections and technical assistance. Two alternative questions were identified, which are listed below.

Alternative questions for Effectiveness Question 2D:

> *What are the counts of inspections by type of Technical Assistance provided during repeat inspections at businesses that are considered not in compliance?*

> *How are these inspections distributed among Business Categories and Types and among BMP Types for both Phase I and Phase II permittees?*

The intent of the alternative questions for Effectiveness Question 2D is to see what types of technical assistance are the most successful for BMP implementation during repeat visits to the same business. This could provide insight into what technical assistance is repeatedly provided to businesses indicating the need for follow-up inspections. The combination of criteria needed to address this question, however, was too constraining for the limited data available. The field of Technical Assistance was barely populated with just 597 records (as shown in Figure 7). The majority of these (390) were for Educational Technical Assistance during Annual/Routine inspections. None of the 597 Technical Assistance records were coded as Follow-up inspections. Only 12 of the Technical Assistance records had data on both Inspection Type and BMP Type as shown in Figure 10. Technical assistance by Inspection Type and BMP Type. Of these 12 records, Educational Technical Assistance composed half. In addition, just three of four Technical Assistance types are represented (no records for *Training*).
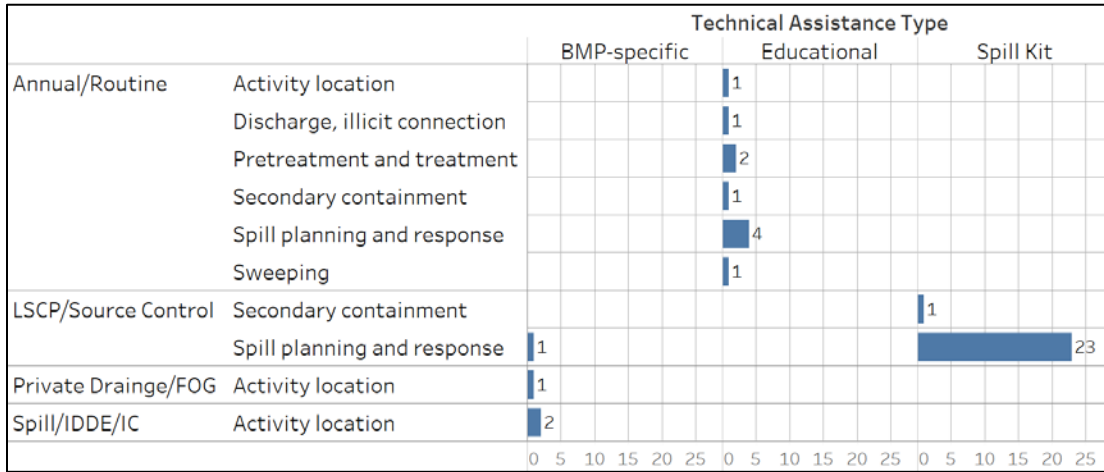
Figure 10. Technical assistance by Inspection Type and BMP Type

6 Discussion

The outcomes of this Source Control Effectiveness Study are discussed below. Conclusions from the data analysis are summarized by the two main topics of the Effectiveness Questions: inspection frequency and best management practices.

Recommendations are provided and include ideas for deeper analysis on the data assembled for this study. Also, suggestions for the municipal stormwater permits are provided to clarify and enhance source control permit conditions. This includes what data should be collected, how to organize and structure the data, what analysis is possible, and how it can inform adaptive management efforts for preventing stormwater pollution at or near its source.

These discussion points and the conclusions of this Study are intended primarily for Ecology and municipal stormwater permittees. Potential improvements or refinements can also be considered by the LSCP program based on this Study, although the LSCP program's focus is hazardous waste and pollution prevention, of which stormwater is a significant part for some businesses.

6.1 Inspection Frequency

Two Effectiveness Questions were related to frequency of inspections. One question inquired about inspection frequency of stormwater treatment and flow control facilities on private property. The second question inquired about inspection frequency of structural BMPs (other than treatment and flow control BMPs) and operational BMPs at businesses.

Effectiveness Question 1 originally inquired about private property, but data did not include property ownership. Instead, Question 1 was evaluated for commercial and non-commercial land uses as a surrogate. Inspection frequencies hovered around 1.0 times per year for treatment and flow control BMPs, which is consistent with NPDES permit requirements. Phase I jurisdictions had an inspection frequency slightly greater than 1 time per year but fewer total inspections on average than Phase IIs. Phase IIs had an inspection frequency slightly less than 1. Phase Is and Phase IIs both had slightly greater inspection frequencies for commercial than non-commercial properties.

The statistical comparisons for inspection frequency for treatment and flow control BMPs grouped by land use indicated highly significant differences in the three comparisons tested: for Phase Is, for Phase IIs, and for permittee data. While the statistical results showed significant differences for the commercial versus non-commercial land use comparison (thanks to large sample sizes), the differences may not be of practical importance. The closeness of all inspection frequencies to 1.0 time per year and the small differences in average inspection frequencies (0.03 to 0.15 times per year differences on average between business categories) apply best to longer term municipal inspection programs or ones that may have intentionally changed their inspection frequency at some point. Inspections are typically performed in whole number increments so that a difference of, for example, 1.04 to 1.19 inspections per year indicates only a small shift in inspection frequency across records.

These results indicate that Phase Is inspect treatment and flow control BMPs slightly more often than Phase IIs, but Phase IIs are inspecting them more repeatedly. The results also indicate that the emphasis of municipal inspection programs is slightly greater for commercial properties than non-commercial. Data for evaluating this question came just from what was sent by permittees; it was not available in the LSCP dataset, as that program typically does inspect treatment and flow control facilities.

Question 2 (and Question 1 also) originally asked about the optimum inspection frequency for various BMP categories. In order to evaluate optimum status, additional data fields about BMPs and compliance were required that were not available. Instead, Question 2 was evaluated for inspection frequencies for BMPs grouped by structural and operational. For Phase Is, businesses in the category of Auto/Boat had the highest inspection frequencies for both structural and operational BMPs (1.5 and 1.4 times per year, respectively). For Phase IIs, Auto/Boat and Land Usage business categories were relatively high for both BMP categories (1.2) and also Industrial and Food/Retail business categories (1.2) for operational BMPs.

The statistical comparisons of inspection frequency for structural versus operational BMPs indicated a significant difference for Phase IIs at the 8.4 percent significance level but not for Phase Is or permittee data below the 21 percent significance level. For the LSCP data, a highly significant result was found indicating that a strong difference in inspection frequency among business categories. But the distinction between the categories of operational and structural BMPs was not possible due to the data indicating that both BMP categories were always inspected in LSCP data.

While the data available did not allow for the evaluation of "optimum" frequency as stated in the original Effectiveness Questions, it did allow for a comparison of inspection frequencies of the major categories of BMPs and business types. The results indicate small but real differences in inspection frequencies for the groupings evaluated, including by permittee phase, by data source, by business category, and by BMP category. But the differences may not have a practical effect being at most a difference of 0.5 inspections per year on average across business categories.

6.2 Best Management Practices

Four Effectiveness Questions were related to best management practices. Question 2A inquired about contact roles at businesses and cooperativeness during inspections. Question 2B inquired about follow-up inspections and BMPs. Question 2C inquired about what barriers may exist to BMP implementation. Question 2D inquired about technical assistance and follow-up inspections.

Question 2A was addressed by looking at contact roles and cooperativeness in the context of the business category. Relatively few data were available for whether the business was cooperative, and only 81 records indicated non-cooperative businesses. Even fewer records with cooperativeness information also contained contact role data, and these data were only available from Phase II data submitted directly from permittees. Only 1 record was found among Phase IIs with a non-cooperative business that had business category noted, which was in the Indoor/Office category and had Other Staff as the contact role.

Among the cooperative businesses where contact role was indicated, the great majority were Business Owners; however, the Industrial and Land Usage business categories had a higher number of Other Staff as the contact role. The Indoor/Office business category represented the most records with contact role information. Very few records that met the criteria of this question had Property Owners as the contact role; therefore, comparison of business owners to property owners was not feasible with the data. In addition, an analysis of cooperativeness at businesses during inspections was not possible due to the dearth of data on business cooperativeness.

Question 2B was addressed for single and repeat inspections and the status of the BMPs. The great majority of BMPs were in the "Resolved" category followed by BMPs "In Process" and BMPs that were referred to other agencies for follow-up. BMPs requiring no further action represented the fewest inspections. For all BMP statuses for both single and repeat inspections (with one exception), the BMP type of Spill Planning and Response was the most prevalent. The exception was BMP issues related to Discharge/Illicit Connections that was the most prevalent for BMP referrals and single inspections at businesses. The business category of Auto/Boat was the most common for BMP issues of all statuses (except those referred to other agencies) with Indoor/Office and Food/Retail business categories not far behind. The business categories of Medical/Veterinary, Industrial, and Land Usage represented the least common BMP issues. Because the data analyzed for Questions 2B is from the LSCP program only, it is possible that the high presence of spill-related BMPs being called out during inspections is an outcome of the spill kit program the LSCP promotes.

Question 2C was addressed by analyzing the median percentage of times that BMPs were called out during repeat inspections on a per-business basis. This is intended to serve as an indication of chronic BMP issues and may point to the need for increased follow-up to resolve those issues. For Phase Is, several BMP types were always called out as issues during the majority of repeat inspections (median percentages of 100 percent) across all business categories. These include BMPs associated with Cleaning/Washing, Housekeeping, Maintenance/Repair/Access, Spill Planning and Response, and Storage and Cover. Businesses in or related to automobiles, boats, their repair and maintenance, and fueling (Auto/Boat category) had the greatest number of BMPs always called out (100 percent median) followed by office, personal services, and other indoor non-industrial businesses (Indoor/Office category).

For Phase IIs, a majority of BMPs per business category were always called out for most inspections (100 percent median). But unlike Phase Is, no Phase II businesses had BMP issues always called out across all business categories. BMP types at Phase II businesses with the highest median percent of issue reoccurrence included those associated with Cleaning/Washing, Discharge/Illicit Connection, Disposal, Housekeeping, Labeling, Maintenance/Repair/Access, Material Transfer, Storage and Cover, and Training. While businesses in the Auto/Boat category were the most numerous with all types of repeat BMP issues, businesses in or related to agriculture, construction, and recreation (Land Usage category) had the most types of BMP issues always called out on average (100 percent median).

For Question 2D, data on Technical Assistance and Inspection Type were lacking and no records were found for follow-up inspection types that fit the question's parameters. A mere 12 records had data on other Technical Assistance types that also noted what type of inspection and the type of BMP issues called out.

The results of the evaluation of BMP data for the Study indicated the following main conclusions:

- BMP types associated with spill planning and response were noted as issues the most frequently overall. This is thought to be largely due to spill kit programs that many jurisdictions have adopted, especially with support from the LSCP.

- For BMPs that were referred to another agency for follow-up, issues with prohibited (illicit) discharges and plumbing connections were the most prevalent.

- BMPs that were called out the most during repeat inspections included:

    o For Phase Is, BMPs that are associated with cleaning or washing activities, housekeeping, BMP maintenance, spill planning, and storage of waste materials.

    o For Phase IIs, BMPs that are associated with cleaning or washing activities, illicit discharges or connections, labeling and disposal of waste, housekeeping, BMP maintenance, fueling (and other transfer of potential pollution generating materials), and storage of waste materials.

- Businesses that had the most frequent BMP issues included:

    o For Phase Is, businesses in or related to automobiles, boats, their repair and maintenance, and fueling (Auto/Boat category) followed by office, personal services, and other indoor non-industrial businesses (Indoor/Office category)

    o For Phase IIs, businesses in the Auto/Boat category as well as in construction, recreation, and landscaping businesses (Land Usage category).

- Aspects about BMPs in each of the original effectiveness questions could not be addressed due to limited data about BMPs in the source data. Alternative related effectiveness questions based on BMP status and repeat occurrence were identified that could be addressed based on the data available.

6.3 Data Considerations and Recommendations

The municipal NPDES stormwater permits focus on the program requirements for source control and related activities; they do not, however, specify the type of data to be collected for municipal source control efforts and how those data should be stored or managed. While this non-prescriptive approach provides flexibility to the permittees, the lack of source control data collection standards creates variability in the type and breadth of data collected. This is reflected in this Study by the limited response from NPDES

permittees and the variable breadth, quality, and quantity of data provided directly by them.

The data from the LSCP were of consistent quality and completeness per the LSCP program requirements. Although some of the LSCP data did not explicitly include information needed to answer some of the Effectiveness Questions, the data available were readily standardized and mapped to desired data fields. This resulted in a high usability of the LSCP data.

Notwithstanding the limitations of the data available, a large database of over 47,300 records was able to be assembled due to efforts to parse data records into the desired data fields and to standardize and categorize responses for comparability. This required a significant effort that would be have been reduced if data were collected by individual municipalities following regional data standards.

Many of the original source control effectiveness questions could not be answered as originally articulated. This was the result of the questions being identified by the Stormwater Work Group and the Effectiveness Studies Subgroup prior to assessing what data were available and the questions being disconnected from specific NPDES permit requirements. One example is question 2A, which originally inquired about "high-value" BMPs and the cooperativeness of the business being inspected. Neither of these considerations (high-value BMPs and cooperativeness) are identified in the municipal stormwater permits nor recorded as such in municipal businesses inspections. Alternative source control effectiveness questions were identified after data were compiled for this Study that were related to the original questions and based on data available.

The lack of clear effectiveness questions hampered the data evaluation by constraining the analysis around issues that may not be of the most widespread benefit for an effectiveness evaluation of municipal source control via business inspections. Therefore, a primary recommendation is to identify additional questions of interest based on the available data and how the data are related per the database structure (what fields are fundamentally related to others). In addition, the value of data-driven adaptive management for the municipal stormwater permits cannot be overstated. Evaluating data collected under source control programs is necessary to learn from past efforts and improve future source control efforts, and identifying relevant questions is a vital starting point.

Different source control effectiveness questions should be developed in conjunction with identifying what data fields are required to be collected and the standard responses used. It is suspected that some of the data needed for this evaluation are collected or noted qualitatively during municipal inspections at businesses. But those data were not provided or not easily available in the format requested. Basic data parameters that are recommended to be collected during municipal inspections for evaluation of stormwater source control activities and BMPs at businesses include, among others:

- Date of inspection
- Type of inspection to indicate if full inspection or abbreviated for screening or follow-up purposes

- Specific types of BMPs in use

- Type of technical assistance provided.

- Date and type of BMP maintenance

- Percentage "in compliance" based on the use of appropriate BMPs. This could be done by grading the effective use of each BMP on a numeric scale, such as 1 to 5, based on performance criteria specific to the BMP.

- Reasons for lack of BMP implementation, including such standard responses as financial burden, lack of technical assistance for identifying appropriate BMPs, or lack of BMP maintenance.

Specifying basic source control data parameters in the municipal permits would support Ecology in evaluating permit effectiveness. It would support permittees with providing a database template and clarity on what information is to be recorded. It would also support effectiveness analysis and regional evaluation of municipal stormwater source control efforts.

For the data that were available and compiled for this Study, Phase II jurisdictions were well-represented in number but for relatively few jurisdictions (45 percent of inspection records from 29 out of 85 Phase IIs). Records from Phase Is were high in number (52 percent of records from 6 out of 6 jurisdictions) but were primarily from the City of Seattle (66 percent of the Phase I data). This skews the Phase I results toward Seattle's data and source control program. Although the City of Seattle was the only Phase I respondent to the data request to permittees, some of the other Phase I inspection data were captured in the LSCP dataset. The remainder of records (3 percent) were collected by Ecology.

Data for this evaluation were grouped into a manageable number of groupings (such as 6 business categories to represent 27 business types). But this resulted in large sample sizes for some groups, which supported statistically significant differences in inspection frequencies that may not be effectively different (such as 1.1 versus 1.3 inspections per year on average within a given business category). A finer-grain analysis could be done to determine which of the 27 specific business types have different inspection frequencies:

- regardless of what BMPs were inspected;

- for businesses that received a range of repeat visits, such as 2 to 3, 4 to 6, and 7 or more;

- for the range of BMPs inspected and BMP issues that were called out;

- on a subset of the highest quality data from jurisdictions with comparable programs;

- on just LSCP data based on what BMP issues were present (since the LSCP dataset includes information on what BMPs were called out during inspections); and

- on data grouped by municipality or region for a geographic comparison throughout western Washington.

Visual inspection of the distributions of the business categories can serve as a good starting point to qualitatively indicate which business types would be interesting to test for differences. Histograms for many of these BMP and business combinations are provided in Appendix A and could be assessed for additional analysis.

For municipal stormwater permittees, recommendations include:

- Consider the relatively higher inspection frequencies identified in this Study for certain business categories in context of the number of those businesses in your jurisdiction. If inspection frequencies of some businesses exceed their relative representation and likelihood (or risk) to pollute, evaluate the reasons why they might be inspected more in your jurisdiction. Consider reducing inspection frequencies where possible while meeting permit requirements. For Phase Is, a good candidate is businesses related to industrial manufacturing, utilities, and reclaim, which had a relatively high inspection frequency for operational BMPs. For Phase IIs, a good candidate is businesses related to food, retail, and personal services, which also had a relatively high inspection frequency for operational BMPs.

- Consider the types of BMPs that were called out the most frequently in context of their required versus optional use and for their ability to manage sources of stormwater pollution. A good candidate for this is BMPs related to spill planning and response, which were almost always the most numerous for both single and repeat inspections across most business categories. Being prepared for possible spills is important, but other BMPs may deserve more attention that were called out less frequently. This includes the effectiveness of how wastes are stored and the maintenance of BMPs, which span both structural and operational BMP categories.

- Implement or adjust municipal business inspection programs to align with the efforts to evaluate source control efforts on a regional basis. This means collecting basic data parameters (such as what is noted above) and using consistent terminology to record them. This will support adaptive management of stormwater by improving source control efforts.

- Provide data when requested by effectiveness studies. Data evaluations such as this are only as good as the data that goes into them.

Finally, one recommendation for the LSCP program is to stay abreast of what changes may come to the NPDES municipal stormwater permits and try to align LSCP data collection requirements with those in the updated NPDES permits.

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Limitations

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**APPENDIX A
SURVEY OF NPDES MUNICIPAL
STORMWATER PERMITTEES**

Survey of Municipal Stormwater Source Control Programs
1 March 2016
Stormwater Source Control Effectiveness Study

INTRODUCTION
The City of Lakewood and Cardno consultants are conducting a stormwater source control data assessment as an effectiveness study of the coordinated Regional Stormwater Monitoring Program (RSMP) funded by municipal stormwater permittees. The objective of the assessment is to provide information that can help NPDES municipal stormwater permittees improve their environmental inspection programs. Inspection programs to be evaluated are those targeting stormwater source control activities and related BMPs on commercial properties and at businesses. The study design includes first surveying permittees about the types of inspection data available starting with the previous permit cycle for western Washington (2007-2012) through the present. Based on the results of this survey we will seek to collect, analyze, and report on your collective experience to address the source control Effectiveness Questions (see below).

This document provides a brief description of the study, a survey, and a spreadsheet, each designed to help us better understand each jurisdiction's inspection programs. The survey (see pages 3-10) will gather information about the types of source control programs implemented by NPDES municipal stormwater permittees, the purpose and goals of the programs, and the types of data available for analysis. A request for your inspection data will be conducted after we review the survey results. These data will be analyzed to assess the effectiveness of both permit-required and non-permit-required actions and approaches. All study findings will be posted on the RSMP website[1].

EFFECTIVENESS QUESTIONS
Effectiveness studies were identified from a list of prioritized Effectiveness Questions, which included several questions on source control. A technical advisory committee established for this study comprised primarily of municipal stormwater permittees has reviewed and refined the source control Effectiveness Questions, which are listed below. A separate document entitled Source Control Study Data Analysis Plan (posted on the RSMP website) was also prepared to provide the methodology to assess and analyze the gathered data and how each Effectiveness Question will be addressed. The source control Effectiveness Questions are listed below and represent the refined questions after review by the technical advisory committee.

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[1] http://www.ecy.wa.gov/programs/wq/stormwater/municipal/rsmp/rsmp.html. Follow the link to Effectiveness Studies and click on the Source Control tab.

Source Control Effectiveness Questions
1. What is the optimum frequency of inspections to maintain the functionality of structural BMPs for treatment and flow control at stormwater facilities on commercial property?
2. What is the optimum frequency of inspections to ensure the proper use of structural and operational source control BMPs at businesses?
2a. Which is more effective for specific high value BMPs: focusing on the property owners or focusing on the business owners, or a combination of the two?
Comment: Target both structural and operational BMP types, and situations where a business owner is and is not cooperative and willing.
2b. Which required BMPs were implemented based upon follow up inspection? Which optional BMPs were installed based upon follow up inspection?
2c. What were the primary barriers to not adopting or installing BMPs?
2d. Address the connection between in-person visits and source control BMPs, and identify situations where technical assistance and/or follow-up inspections are needed to ensure required BMPs are implemented.
Comment: Gather data about percent compliance. Partner with Ecology Local Source Control program to do this study.
3. Are stormwater source control inspections more effective if combined with other types of inspections? How can coordination of inspections be improved or better organized regionally for referral of issues to the correct entity?

The final Effectiveness Question (number 3 above) related to combining inspection efforts will be addressed during a later phase of the project and is not included in this portion of the study.

SURVEY AND DATA REQUEST PROCESS

At this time, we are asking municipal stormwater permittees in western Washington to please complete the survey below. We want to minimize your valuable municipal staff time; therefore, we are first asking about your inspection programs via a survey in order to focus the data request that will follow.

Specifically, we are seeking information about municipal inspections on private commercial properties and at businesses that include a stormwater component and were done starting with the previous permit cycle (2007-2012) through the present. This information will inform us how best to acquire your data and will help us determine how to standardize data from multiple jurisdictions. We will review the survey responses and follow-up with a data request based on the type and format of data available from your jurisdiction as you indicate in the survey questions. Here are the four steps we envision for the survey and data request process:

Step 1   Complete the survey on the following pages. We want to learn more about your program since we anticipate there will be multiple program structures among permittees.

Step 2   Review the attached spreadsheet that contains a list of potential data fields. Indicate which ones are available from your jurisdiction and in what form those data are available. Please include information about electronically stored (computer) and hard copy (paper) inspection data.

Step 3. <u>Send the survey and spreadsheet back to us</u> and we will review it and determine which data variables we will request from your jurisdiction. Please include a contact email and phone number if we need to contact your jurisdiction to clarification of any survey responses.

Email the survey and spreadsheet by April 22 to: James Packman, Cardno consultants, james.packman@cardno-gs.com. For questions, call 206-267-1400, ext 8234.

Step 4. We will <u>follow-up</u> with your jurisdiction with a specific data request based on data available.

This study is also coordinating with the Ecology Local Source Control (LSC) program since it focuses on business inspections. However, LSC program staff has informed us that limited data are available that would help address the Effectiveness Questions, and there have been issues with the LSC databases over the years. Thus, we are seeking data directly from permittees first and will supplement as possible with LSC program data.

SURVEY - **Please complete and email to James Packman,**
james.packman@cardno-gs.com by April 22, 2016.

Permittee: _____

Contact name: _____

Contact email and phone: _____

1. **What are the drivers/purposes of your inspection programs? Check all that apply.**

❐	Meet the minimum requirements of the NPDES Municipal stormwater permit.
❐	Inspect sites above and beyond the NPDES permit requirements.
❐	Meet MTCA requirements for contaminated site clean-up.
❐	Meet local TMDL requirements.
❐	Assess small quantity hazardous waste generators (SQG).
❐	Assess medium or large quantity hazardous waste generators (MQG or LQG).
❐	Protect riparian, nearshore, or marine habitat, such as for fish or shellfish.
❐	Protect endangered species.
❐	Protect the municipal storm sewer system.
❐	Protect water quality in receiving water bodies.
❐	Other: *E.g. Other permits*

2. **Please describe your jurisdiction's working definition of a few terms in the context of stormwater management at businesses and on commercial properties:**

Inspection:

Compliance:

Source Control:

3. **Estimate the level of effort your jurisdiction spends inspecting annually among the three main types of best management practices (BMPs) described below. To do so, estimate the number of hours or percentage of FTE that your jurisdiction inspects each?**

BMP Type	% time inspected
Operational Source Control BMPs –non-structural practices implemented by the property or business owner that prevent or reduce pollutants. Examples include good housekeeping, spill prevention, employee training, technical assistance, etc.	
Structural Source Control BMPs – structural, mechanical devices, or facilities that prevent or treat stormwater pollution, such as cover, containment, diversion of water to sanitary sewer, capture and reuse devices (i.e. solvent sink), etc.	
Treatment and Flow Control BMPs –structures or facilities that remove or reduce pollutants in stormwater that discharge directly from the property, such as vaults, ponds, oil-water separators, or other engineered structures or systems.	
Other BMPs (optional) - industrial waste water, inspections not necessarily related to source control such as industrial wastewater.	

4. **For each BMP type from the three categories in question 3, please list the top 5 most valuable BMPs inspected by your program. BMP "value" is your jurisdiction's perception of the BMP's impact on improving stormwater runoff quality.**

5 Most Valuable BMPs	Operational	Structural	Treatment & Flow Control
1			
2			
3			
4			
5			

5. **Check yes or no for inspection programs and sources of data available from your jurisdiction that relate to stormwater source control.**

#	Inspection Program	Source Control-related Data Available	
		Yes	No
1	Environmental/stormwater/maintenance		
2	Hazardous material/waste management		
3	Fats/oils/grease (FOG) inspections		
4	Industrial pre-treatment		
5	Moderate Risk Waste program		
6	Incentive program (e.g. EnviroStars)		
7	Health/restaurant inspections		
8	Fire/Safety inspection		
9	other:		
10	other:		
11	other:		

6. **Check all programs that use inspections and describe the different types of inspections that contribute to your jurisdiction's data sources for stormwater source control.**

Types of Inspections	1. Envr/Stormwater	2. Haz/Waste	3. FOG	4. Indust. Pre-treat	5. MR Waste	6. Incentive	7. Health	8. Fire/Safety	9-11. Other	Description
Screening										
Initial										
Follow-up										
Emergency/Spill Response										
Illicit Discharge/Connection										
other:										
other:										

7. Check all programs in which inspection data are stored in various formats. If possible, please attach a sample page or report from your database(s) that have some of the same variables as on the attached spreadsheet list.

Data Storage Mode	1. Envr/Stormwater	2. Haz/Waste	3. FOG	4. Indust. Pre-treat	5. MR Waste	6. Incentive	7. Health	8. Fire/Safety	9-11. Other	Sample Page or Report Attached (Y/N)
Excel/spreadsheet										
Access/relational database										
City Works or other public works software										
other:										
Paper files										
Scanned files saved on computer (indicate approx. percentage of records)										
Other:										
Other:										
Other:										

8. **Please fill out the DATA AVAILABLE column in the attached spreadsheet to provide us with more specificity on data available from your jurisdiction. Your response will help us greatly to identify the initial list of variables for the assessment.**

9. **Describe how follow-up inspections are linked to specific issues related to compliance? For example, what percentage of out-of-compliance businesses or commercial properties receives follow-up inspections? Is there a set follow-up inspection schedule or expected number of follow-ups planned each year?**

10. **Has your jurisdiction performed data analysis on your own inspection data that may be relevant to the Effectiveness Questions being addressed in this study? If so, please describe. Are digital copies of those reports available? If so, we would appreciate receiving a copy (please send back with the survey).**

11. Please let us know how we can best work with your jurisdiction for the upcoming data request.

12. We welcome other comments or suggestions you may have for the study.

VARIABLES/DATA FIELDS	DATA TYPE				POTENTIAL VALUES	DATA AVAILABLE (Check all that apply)
	QUANTITATIVE	CATEGORICAL	DESCRIPTIVE	CALCULATED		
NPDES Permittee		x			City of …. or …. County	
INSPECTION TYPE OR FREQUENCY						
Type of inspection		x	x		initial, follow-up, spill, complaint, referral	
Initial inspection date		x				
Follow-up inspection date		x				
Date of follow-up activity (non-inspection)		x				
Frequency of initial inspection	x			x		
Frequency of follow-up inspection	x			x		
COMPLIANCE						
Date of compliance		x				
Date of non-compliance		x				
Compliance status		x			in/out	
Reason for inspection			x		routine, annual, spill, etc.	
Definition of compliance			x			
Number of inspections to achieve compliance	x			x		

VARIABLES/DATA FIELDS	DATA TYPE				POTENTIAL VALUES	DATA AVAILABLE (Check all that apply)
	QUANTITATIVE	CATEGORICAL	DESCRIPTIVE	CALCULATED		
BMPs						
BMP type		x			operation or structural	
BMP function		x			treatment, flow control, diversion, capture/reuse, etc.	
BMP name		x				
BMP size/volume	x					
Level of BMP evaluation			x		screening, functionality check, maintenance	
High value BMP?		x			Yes, No	
BMP required/optional		x			Required, Optional	
Inspection that BMP is associated with			x			
BARRIERS						
Technical assistance offered?		x			Yes, No	
Barriers to BMP implementation		x	x			
PROPERTY/BUSINESS INFORMATION						
Property or business name (DBA)			x			
Primary NAICS #		x				
Primary NAICS description		x				

VARIABLES/DATA FIELDS	DATA TYPE				POTENTIAL VALUES	DATA AVAILABLE (Check all that apply)
	QUANTITATIVE	CATEGORICAL	DESCRIPTIVE	CALCULATED		
Primary SIC #		x				
Primary SIC description		x				
Role of contact at business/property		x			business owner, business manager, property owner, other	
Business/Property address						
Generator status		x			SQG, MQG, LQG	
Individual discharge permit?		x			Yes, No	
Cooperation level of business		x			Cooperative, non-cooperative	
Risk level of business activity	x	x				
High risk business activity		x			Yes, No	
Non-English primary language		x	x			
Multiple tenant business?		x			Yes, No	
OTHER						

**APPENDIX B
DATA REQUEST MEMO TO NPDES
MUNICIPAL STORMWATER
PERMITTEES**

Memorandum

To: NDPES Municipal Stormwater Permittees in Western Washington

From: Greg Vigoren, City of Lakewood
James Packman, Cardno consultants

Date: 24 August 2016

Re: **Data Request for RSMP Source Control Effectiveness Study**

As a follow-up to the survey of municipal source control programs we sent to permittees this past spring, we are now requesting your jurisdiction's data from business inspections. The data will be analyzed to address the source control Effectiveness Questions of the Region Stormwater Monitoring Program (RSMP). The questions are listed at the end of this memo for your reference. As such, this study is intended to provide helpful information to western Washington NPDES municipal stormwater permittees to improve the quality and efficiency of environmental business inspection programs. At this time, we are requesting the following items by September 30:

1. Data from business inspections from 2007 to the present – see instructions below.
2. Table on page 3 of this memo indicating what data are being sent from your jurisdiction.

The response rate to the survey was less than desired with only 30 out of 89 permittees responding and only 12 of 30 providing database examples. We appreciate the efforts of those jurisdictions that responded to the survey and we hope many more of you will respond to this data request. Having a robust data set will facilitate a meaningful data analysis. As a project funded by permittees themselves, we hope your jurisdiction will participate by providing data.

We want to assure you that the data will be kept confidential and shared only among other permittees and Ecology. The data will not be made available to the public or to any private or non-profit entities more than it already is via a public records request. Data summaries will be grouped by general categories, including business type, land use, and BMPs without naming any specific businesses. While specific jurisdictions will be noted in the data summaries, the purpose is only for education and information-sharing and will not have any permit compliance implications.

For reference, project documents and deliverables can be found on the RSMP website; http://www.ecy.wa.gov/programs/wq/stormwater/municipal/rsmp/effective.html. Click the Source Control tab then click the deliverable numbers to view the project documents. Key documents at this stage of the project include the data analysis plan (D1.4) and the survey (D1.5).

WHAT DATA ARE BEING REQUESTED?

Refer to the attached spreadsheet for a database template you may use and the list of 19 data fields for which we are requesting data. The data fields are oriented around businesses and the dates of inspection. The (14) fields associated with each inspection at a business are repeated for up to six inspections at a given business. We recognize that some jurisdictions may not have data for all of the data fields being requested; however, we

ask that you provide data that matches as many variables as possible and which are feasible given your existing data records and staff resources.

The data being requested are from municipal inspections of businesses on private property to meet NPDES permit requirements under the previous and current NPDES municipal stormwater permits from February 2007 to the present. For Phase I permittees, the data are expected to be primarily from implementation of permit section S5.C.7 Source Control Program for Existing Development and also section S5.C.8 Illicit Connections and Illicit Discharges Detection and Elimination. For Phase II permittees, the data are expected to be primarily from implementation of permit section S5.C.3 Illicit Discharge Detection and Elimination (IDDE). For both Phase Is and Phase IIs, additional data may be available from implementation of permit sections on education and outreach (S5.C.10 Phase I; S5.C.1 Phase II).

Please note, we are not seeking data from every IDDE incident or from inspections on public or municipal property; rather, the focus of the Effectiveness Questions (and the data analysis) is on inspections at businesses on private properties. Depending on how your jurisdiction organizes its business inspections, your data may include some IDDE-focused inspections as well as local source control (LSC) inspections, private drainage inspections (PDI), and fats, oils, and grease (FOG) inspections. All of these data are welcome as long as they are associated with business inspections.

Please send us your data by September 30 or sooner. For files smaller than 10 MB, please email them directly to james.packman@cardno-gs.com. For files larger than 10 MB, please see below for file transfer instructions via the secure Cardno FTP site.

INSTRUCTIONS FOR DATA TRANSFER

Please send data files to Cardno consultants via their secure file transfer protocol (FTP) website. For files that are larger than 10 MB, we ask that you do not email the files to us as our email servers have a small size limit for file attachments. Instructions for transferring files via the Cardno FTP site are as follows:

- Prepare your files so that they conform to the following requirements:
  - Remove spaces and special characters from the filenames.
  - For multiple files, you MUST zip them into one zip archive. To do this on a Windows operating system, highlight the files, right-click, and select Send to: Compressed (zipped) folder.
- To access the Cardno FTP website, click on the link below:

  http://webftp.cardno-gs.com

  - **Username:** cardno-gs
  - **Password:** Tr4nsf3r
- Once you login to the site, you will be asked for your name and email address, as well as the email address(es) that you would like to receive the files. Use a semicolon to separate multiple email addresses. Click "Continue".

Please use the email address of james.packman@cardno-gs.com *for the recipient.*

- Next you will see the "Upload Files" section, click "Choose File" to add a single file. You may add additional files by clicking the "Add" button.

- Click "Upload File(s)" to finish the transfer process.

- The file(s) will be uploaded to the site and an email will be sent to the addresses you entered, including your own.

- The posted files will be available for 120 hours from the time of posting and will be automatically deleted after that time.

DATA PROVIDED FROM YOUR JURISDICTION

Please provide data in spreadsheet format, ASCII, or as text files delimited by commas, tabs, or paragraphs. Due to the limit of the scope of this project, we are only able to accept tabulated data that can easily be imported into a database. We are not able to accept hand-written or scanned records that are not already tabulated in digital format. Please transfer this page of the memo with your data file(s) and indicate Yes or No in the first three columns of the table below for what data fields your jurisdiction has available and is providing.

Jurisdiction name:

Contact name and email:

Data Transferred?	Data Not Available?*	Data Not Tabulated?*	FIELD NAME	DEFINITION
			Business Name (or DBA Name)	Name of business or property, legal name or "doing business as" name
			Business Type	General type of business, i.e. dry cleaners, auto repair, gas station, marina, etc.
			NAICS code	North American Industry Classification System number for business type (4 to 6 digit)
			SIC code	Standard Industrial Classification number for business type (4 to 6 digit)
			Land Use	Primary activity: commercial, industrial, residential, school, religious, parking lot, mixed use
			Inspection_Date	Date of 1st inspection starting 2007
			Inspection_Type	Type of inspection: screening, initial in cycle, follow-up, ongoing
			In Compliance?	Was business overall in compliance with inspection criteria?
			Treatment and Flow Control BMPs Inspected?	Were treatment or flow control BMPs inspected during the inspection?
			Structural BMPs Inspected?	Were structural BMPs inspected (other than treatment and flow control BMPs) during the inspection?
			Operational BMPs Inspected?	Were operational BMPs inspected during the inspection?
			New BMPs following inspection?	Did the inspection result in new BMPs being installed or used?
			New BMPs type_1	Type of BMP 1 that was installed or used after inspection
			New BMPs type_2	Type of BMP 2 that was installed or used after inspection

Data Transferred?	Data Not Available?*	Data Not Tabulated?*	FIELD NAME	DEFINITION
			New BMPs type_3	Type of BMP 3 that was installed or used after inspection
			Technical Assistance Provided?	Was technical assistance of any kind provided during or following the inspection?
			Technical Assistance type	Type of technical assistance provided, e.g. spill kits, incentive voucher, educational materials.
			Role of Main Contact at Business	Property owner, business owner, owner of both property and business, other employee.
			Business Cooperative?	Was the business generally cooperative during the inspection?

* Not available = not collected. Not tabulated = collected but not currently in a database.

**APPENDIX C
DATA ANALYSIS FULL RESULTS**

Data Analysis Appendix

Source Control Effectiveness Study

Document Information

Prepared for	Aspect Consulting
Project Number	E317500600
Project Manager	Tamre Cardoso
Date	September 25, 2017

Prepared by:

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Introduction

A post-hoc evaluation of existing data was conducted using R Studio (Version 1.0.153 with R Version 3.4.1 [Single Candle]) on Mac OS Sierra (Version 10.12.6). The methods and results are presented below by effectiveness question.

Effectiveness Questions

1. ***What is the optimum frequency of inspections to maintain the functionality of structural BMPs for treatment and flow control at stormwater facilities on private commercial property?***

No data were available on BMP functionality and maintenance to determine an optimum inspection frequency. Summaries were generated for some alternative effectiveness questions as indicated below.

1.1. What are the inspection frequencies of structural and operational BMPs on commercial versus non-commercial properties as indicated by land use?

Methods

The data were first split into two sets, commercial and non-commercial, based on the LandUse variable. Commercial properties had LandUse values of Commercial, Industrial, Manufacturing, mixed, Institutional, Road/Rail/Air/Parking, and Forestry/Mining/Agriculture. Non-commercial properties had LandUse values of Residential Multi, Residential Single, Park, Open, Water body, Recreation, and Utility. Records with LandUse values of Blank ("") or reject were omitted from this analysis.

The commercial and non-commercial sets were further split into smaller subsets using the InspectedStructuralBMP, InspectedOperationaBMP and InspectedFlowTreatmentBMP variables. Each of these variables had three possible outcomes: Blank (""), No, or Yes, giving up to nine combinations of the outcomes across the two variables. We created five subsets as follows: InspectedStructuralBMP = Yes or InspectedOperationalBMP = Yes that contained all records with (Yes, Blank), (Yes, No), (Yes, Yes), (Blank, Yes), or (No, Yes); InspectedStructuralBMP = Yes only that contained all records with (Yes, No), (Yes, Yes), or (Yes, Blank); InspectedOperationalBMP = Yes only that contained all records with (No, Yes), (Yes, Yes), or (Blank, Yes); one additional set consisting of InspectedStructuralBMP = Yes and InspectedOperationalBMP = Yes that only contained records with (Yes, Yes); and a flow treatment set consisting of InspectedFlowTreatmentBMP = Yes.

For each of the subsets of data, per commercial and non-commercial groups, we calculated some inspection summary statistics for each business within unique combinations of business/BMP type. These summaries included number of businesses, total number of inspections, mean number of inspections per year, number of businesses with one observed cycle, number of businesses with more than one observed cycle, mean number of cycles given more than one cycle per BMP type (BMPType variable), and mean frequency (in days) between inspections across all BMP types. Mean frequencies for days between inspections are means of means that were calculated by taking the grand mean across all individual means calculated for individual properties/BMP types. We also present the mean percentage of inspections that were designated In Compliance = Yes (InCompliance variable) for all inspections with a single visit or for inspections with repeat visits. The percentages for businesses with repeat visits were based on the value of InCompliance variable for the last reported cycle. These summaries were calculated based on all the data.

Results

The database has a total of 72,324 records that represent 47,338 unique inspections. Of these inspections, there are 24,650 (52.1%) unique commercial inspections and 12,704 (26.8%) unique non-commercial inspections. The remaining 9,984 (21.1%) inspections have LandUse values of "Blank" or "reject." Thus, the summaries for effectiveness question 1.1 are based on about 79% of the unique inspections in the database.

The summary statistics are shown in Table 1.1. In all cases, except for one, single cycle inspections exceed inspections with return visits. Only non-commercial flow treatment inspections have more return visits than single cycle visits. The mean number of inspections per year are similar for all subsets of commercial and non-commercial structural, operational or flow treatment inspections, varying from 1.0 to 1.2.

The mean number of inspection cycles for all properties/BMPs with more than one inspection varies between 3.7 and 4.8. The mean frequencies between inspections for BMPs with more than one visit vary between about 1042 days to 1210 days. In general, commercial properties appear to be inspected slightly more frequently than non-commercial properties.

Although presented, the mean designated In Compliance values may not be particularly meaningful because the field is often blank in the database. Of the 72,324 records in the database only 36.8% have a Yes or No for the InCompliance field, leaving 63.2% of records with blanks.

Table 1.1. Summary statistics related to frequencies of inspections for structural or operational inspections all phases and permittee/LSCP data sources separated by commercial and non-commercial land use types. Inspected Subset is defined as S = InspectedStructuralBMP Yes; O = InspectedOperationalBMP Yes; F = InspectedFlowTreatmentBMP Yes. Mean in compliance values for cycle = 1 are simple means across all businesses. For cycle > 1, percentages are means for the means per BMP type across all businesses with the last cycle in compliance.

Inspected Subset	Land Usage	Number of Businesses	Total # Inspections	Mean # Inspections Per Year	Num Cycle = 1	Num Cycles > 1	Mean Cycles	Mean Frequency Between Inspections (Days)	Mean % Designated In Compliance for Cycle = 1	Mean % Designated In Compliance on last Cycle for Cycle > 1
S or O	Commercial	12,745	21,514	1.2	8,527	4,218	4.0	1137.5	38.3	6.3
	Non-commercial	4,401	7,127	1.1	3,119	1,282	4.0	1209.4	31.9	7.1
S	Commercial	12,371	20,499	1.2	8,397	3,974	4.0	1068.3	40.4	6.2
	Non-commercial	4,364	7,076	1.1	3,090	1,274	4.0	1197.4	32.1	7.1
O	Commercial	10,274	17,764	1.2	6,276	3,998	3.8	1137.2	40.4	2.7
	Non-commercial	3,700	5,635	1.2	2,539	1,161	3.7	1218.6	35.2	1.1
S and O	Commercial	9,900	16,749	1.2	6,146	3,754	3.8	1062.5	42.8	2.3
	Non-commercial	3,663	5,584	1.2	2,510	1,153	3.7	1205.0	35.5	1.1
F	Commercial	3,590	6,831	1.0	2,731	859	4.8	1042.3	0.0	23.9
	Non-commercial	2,493	7,069	1.0	1,010	1,483	4.1	1176.8	0.0	6.3

1.2. Among commercial versus non-commercial properties, how are the inspection frequencies different between the following groups:

- o Phase I and Phase II jurisdictions?
- o business types with a single visit?
- o business types with repeat visits?

Methods

The commercial and non-commercial subsets from 1.1 were further split into Phase I and Phase II permits and the summaries were recalculated for all BMPs for the three subsets InspectedStructuralBMP = Yes, InspectedOperationalBMP = Yes, and InspectedFlowTreatmentBMP = Yes. Similarly, the commercial and non-commercial subsets from 1.1 were also further split by data source of permittee versus LSCP. Note that are no cases for LSCP with InspectedFlowTreatment = Yes. The same summaries as for question 1.1 are presented.

The database contains 24 unique business types (excluding blanks and reject), which was too many categories for calculating meaningful summaries for the many data subsets. The 24 business types were collapsed into 6 unique business categories. For commercial and non-commercial businesses, we examined percentages of single and repeat visits by business category for each of the following subsets:

- all commercial and non-commercial;
- all Phase I commercial and non-commercial;
- Phase I, InspectedStructuralBMP=Yes;
- Phase I, InspectedOperationalBMP=Yes;
- Phase I, InspectedFlowTreatmentBMP=Yes;
- all Phase II commercial and non-commercial;
- Phase II, InspectedStructuralBMP=Yes;
- Phase II, InspectedOperationalBMP=Yes;
- Phase II, InspectedFlowTreatmentBMP=Yes;
- All data source permittees;
- data source permittees, InspectedStructuralBMP=Yes;
- data source permittees, InspectedOperationalBMP=Yes;
- data source permittees, InspectedFlowTreatmentBMP=Yes;
- all data source LSCP;
- data source LSCP, InspectedStructuralBMP=Yes; and,
- data source LSCP, InspectedOperationalBMP=Yes.

Results

The summaries for effectiveness question 1.2 are initially based on about 97% of the unique inspections in the database. For all summaries parsed by permit Phase I or Phase II, there are 1,363 fewer inspections due to Permit values of "N/A." The new distribution for commercial versus non-commercial inspections when parsed by permit type are 45,975 total inspections of which 23,523 (51.2%) are commercial, 12,470 (27.1%) non-commercial. There are 9,982 (21.7%) of inspections under Phase 1 and Phase 2 permits that are not defined as commercial or non-commercial. All records in the database have a data source of either "Permittee" or "LSCP",

so the overall percentages from effectiveness question 1.1 apply when the data are parsed by data source.

The summaries for commercial versus non-commercial split by Phase I vs. Phase II permittees or by data source of permittee versus LSCP are shown in Tables 1.2 – 1.6. Table 1.2 provides summaries based on all businesses within each permit or data source category for all BMP types. Table 1.3 further breaks out the summaries for each inspected subset by inspection type (variables InspectedStructuralBMP = Yes, InspectedOperationalBMP = Yes or InspectedFlowTreatmentBMP = Yes) and by land usage (Commercial versus Non-commercial). Tables 1.4 – 1.6 provide further breakdowns by business categories for all data, permittee phase, and data source, respectively.

A Wilcoxon rank sum test (a nonparametric t-test equivalent), was used to test whether or not the number of inspections per year for commercial and non-commercial flow treatment BMPs had statistically significant differences in their location parameter. Hypothesis tests were conducted separately for Phase I and Phase II permittees, and Permittees. A non-parametric test was chosen because the distributions for number of inspections per year were far from normally distributed. Histograms showing the distributions are provided in Figures 1.1 – 1.3. Seven number summary statistics for number of inspections per year are shown in Table 1.7.

The Wilcoxon rank sum test is used to look for a statistically significant location shifts between two distributions. Specifically, the statistical hypotheses are H_0: the true location shift is equal to 0 versus H_a: the true location shift is not equal to 0. The results of the three hypothesis tests are shown in Table 1.8. There were statistically significant differences in the true locations for all three commercial versus non-commercial comparisons. The results should be interpreted with caution, however, because the sample sizes are quite large and the inspection frequencies in Table 1.7 are not really that different. There may not be any practical significance tied to these results.

Table 1.2. Summary statistics related to frequencies of inspections for each business for commercial versus non-commercial properties split out by Phase I and Phase II permittees or by data source permittee versus LSCP for all BMPs.

Inspected Subset	Land Usage	Number of Businesses	Total # Inspections	Mean # Inspections Per Year	Num Cycle = 1	Num Cycles > 1	Mean Cycles	Mean Frequency Between Inspections (Days)	Mean % Designated In Compliance for Cycle = 1	Mean % Designated In Compliance on last Cycle for Cycle > 1
Phase I	Commercial	4,905	9,675	1.3	2,744	2,161	3.8	880.5	41.2	2.4
	Non-commercial	3,323	7,729	1.1	1,547	1,776	3.7	1089.2	13.2	0.3
Phase II	Commercial	8,072	13,757	1.1	5,516	2,556	4.1	1360.7	27.4	10.2
	Non-commercial	2,674	4,698	1.0	1,843	831	4.2	1463.5	20.7	12.1
Permittee	Commercial	4,136	8,126	1.0	2,981	1,155	4.5	1297.6	1.0	19.7
	Non-commercial	2,532	7,125	1.0	1,039	1,493	4.1	1189.4	0.0	6.3
LSCP	Commercial	9,583	16,432	1.2	5,829	3,754	3.8	1062.5	42.8	2.3
	Non-commercial	3,615	5,536	1.2	2,462	1,153	3.7	1205.0	35.5	1.1

Table 1.3. Summary statistics related to frequencies of inspections for all businesses split out by land usage of commercial vs non-commercial and Phase I and Phase II permittees or by permittee versus LSCP for structural, operational, and flow treatment BMPs.

Land Usage	Inspect. Type	Inspected Subset	Number of Businesses	Total # Inspections	Mean # Inspections Per Year	Num Cycle = 1	Num Cycles > 1	Mean Cycles	Mean Frequency Between Inspections (Days)	Mean % Designated In Compliance for Cycle = 1	Mean % Designated In Compliance on last Cycle for Cycle > 1
Commercial	Structural	Phase I	3,783	6,102	1.4	2,445	1,338	3.7	536.0	65.7	2.3
		Phase II	7,836	13,271	1.1	5.402	2,444	4.1	1351.2	28.7	8.8
		Permittee	2,788	4,067	1.0	2,568	220	6.8	1141.3	0.0	72.7
		LSCP	9,583	16,432	1.2	5,829	3,754	3.8	1062.5	42.8	2.3
	Operational	Phase I	4,157	7,117	1.4	2,575	1,582	3.7	813.2	56.3	3.3
		Phase II	5,375	9,521	1.2	3,151	2,224	3.8	1379.4	31.5	2.5
		Permittee	691	1,332	1.0	447	244	4.0	2297.0	4.5	9.1
		LSCP	9,583	16,432	1.2	5,829	3,754	3.8	1062.5	42.8	2.3
	Flow Treatment	Phase I	748	2,558	1.2	169	579	4.1	1010.3	0.0	0.0
		Phase II	2,842	4,273	1.0	2,562	280	6.1	1108.8	0.0	73.2
		Permittee	3,590	6,831	1.0	2,731	859	4.8	1042.3	0.0	23.9
Non-Commercial	Structural	Phase I	1,563	2,212	1.3	1,139	424	3.6	617.6	55.4	1.3
		Phase II	2,651	4,630	1.0	1,840	811	4.2	1470.0	21.2	10.5
		Permittee	749	1,540	0.9	628	121	7.5	1144.0	0.0	64.5
		LSCP	3,615	5,536	1.2	2,462	1,153	3.7	1205.0	35.5	1.1
	Operational	Phase I	1,600	2,263	1.3	1,168	432	3.6	664.7	54.4	1.3
		Phase II	1,950	3,138	1.1	1,260	690	3.7	1544.7	25.0	1.0
		Permittee	85	99	0.6	77	8	2.6	4140.5	0.0	0.0
		LSCP	3,615	5,536	1.2	2,462	1,153	3.7	1205.0	35.5	1.1
	Flow Treatment	Phase I	1,723	5,466	1.0	378	1,344	3.8	1183.7	0.0	0.0
		Phase II	770	1,603	0.9	631	139	7.0	1109.5	0.0	67.6
		Permittee	2,493	7,069	1.0	1,010	1,483	4.1	1176.8	0.0	6.3

Table 1.4. Summary statistics related to frequencies of inspections for all businesses split out by land usage of commercial versus non-commercial, business categories and structural or operational BMPs.

Land Usage	Business Category	Structural BMPs					Operational BMPs				
		Total # of Inspections	Mean # Inspections Per Year	Num Cycles > 1	Mean Cycles	Mean Frequency Between Inspections (Days)	Total # of Inspections	Mean # Inspections Per Year	Num Cycles > 1	Mean Cycles	Mean Frequency Between Inspections (Days)
Commercial	Auto/Boat	6121	1.3	1477	3.5	1084.9	6007	1.4	1495	3.4	1130.4
	Food/Retail	2435	1.2	477	3.2	857.0	2304	1.2	495	3.1	918.4
	Indoor/ Office	5943	1.1	937	3.8	1083.0	4480	1.2	880	3.0	1160.4
	Industrial	1515	1.2	328	3.5	992.4	1457	1.2	331	3.2	1045.8
	Land Usage	548	1.2	115	3.1	856.6	594	1.2	133	3.1	1123.9
	Medical/ Veterinary	2036	1.1	414	2.9	1450.7	1822	1.1	419	2.8	1468.3
Non-Commercial	Auto/Boat	1258	1.2	322	3.0	1351.6	1251	1.2	322	3.0	1351.6
	Food/Retail	571	1.1	100	3.0	834.6	534	1.2	100	3.0	834.6
	Indoor/ Office	2855	1.1	417	4.7	1175.1	1807	1.1	305	3.0	1243.1
	Industrial	525	1.2	117	3.1	1488.9	515	1.2	116	3.0	1492.0
	Land Usage	679	1.2	135	2.9	768.7	672	1.2	135	2.9	768.7
	Medical/ Veterinary	466	1.1	110	3.0	1616.0	462	1.1	110	3.0	1616.0

Table 1.5. Summary statistics related to frequencies of inspections for all businesses for commercial and non-commercial land use split out by Phase I and Phase II permittees and by structural or operational BMPs for each business category.

Land Usage	Permit	Business Category	Structural BMPs					Operational BMPs				
			Total # of Inspec.	Mean # Inspec. Per Year	Num Cycles > 1	Mean Cycles	Mean Freq. Between Inspec. (Days)	Total # of Inspec.	Mean # Inspec. Per Year	Num Cycles > 1	Mean Cycles	Mean Freq. Between Inspec. (Days)
Commercial	Phase I	Auto/Boat	2493	1.5	601	3.5	809.0	2717	1.5	654	3.5	939.5
		Food/Retail	408	1.4	92	3.0	216.5	541	1.3	122	3.1	658.9
		Indoor/Office	1528	1.2	288	2.9	398.5	1778	1.2	350	2.9	738.9
		Industrial	423	1.3	90	3.0	639.6	538	1.3	113	3.1	902.5
		Land Usage	192	1.4	47	2.8	409.7	276	1.3	67	3.1	1089.1
		Medical/ Veterinary	632	1.3	127	2.4	138.4	674	1.3	137	2.5	276.0
	Phase II	Auto/Boat	3431	1.2	839	3.5	1290.6	3093	1.2	804	3.3	1296.1
		Food/Retail	1980	1.2	383	3.3	1006.4	1716	1.2	371	3.1	1002.0
		Indoor/Office	4124	1.1	619	4.2	1435.2	2411	1.1	500	3.1	1501.9
		Industrial	786	1.2	174	3.7	1257.1	613	1.2	154	3.1	1258.0
		Land Usage	321	1.1	60	3.4	1321.3	283	1.2	58	3.2	1322.9
		Medical/ Veterinary	1377	1.0	286	3.1	2045.3	1121	1.0	281	3.0	2061.9
Non-Commercial	Phase I	Auto/Boat	557	1.4	136	3.0	948.9	557	1.4	136	3.0	948.9
		Food/Retail	73	1.3	15	2.5	206.2	73	1.3	15	2.5	206.2
		Indoor/Office	792	1.2	118	2.8	426.5	837	1.2	125	2.8	591.5
		Industrial	161	1.3	33	3.0	509.5	161	1.3	33	3.0	442.7
		Land Usage	299	1.2	64	2.9	321.7	299	1.2	64	2.9	321.7
		Medical/ Veterinary	142	1.4	26	3.1	479.5	142	1.4	26	3.1	479.5
	Phase II	Auto/Boat	656	1.0	177	3.0	1672.4	649	1.1	177	3.0	1672.4
		Food/Retail	491	1.1	84	3.1	934.1	454	1.1	84	3.1	934.1
		Indoor/Office	2006	1.0	294	5.3	1492.2	913	1.0	175	3.1	1722.6
		Industrial	300	1.1	72	3.1	1855.3	290	1.1	71	3.0	1865.5
		Land Usage	372	1.2	71	3.0	1165.8	365	1.2	71	3.0	1165.8
		Medical/ Veterinary	322	1.0	84	2.9	1917.8	318	1.0	84	2.9	1917.8

Table 1.6. Summary statistics related to frequencies of inspections for all businesses for commercial and non-commercial land use split out by data

sources Permittee versus LSCP and by structural or operational BMPs for each business category.

Land Usage	Data Source	Business Category	Structural BMPs					Operational BMPs				
			Total # of Inspec.	Mean # Inspec. Per Year	Num Cycles > 1	Mean Cycles	Mean Freq. Between Inspec. (Days)	Total # of Inspec.	Mean # Inspec. Per Year	Num Cycles > 1	Mean Cycles	Mean Freq. Between Inspec. (Days)
Commercial	Permittee	Auto/Boat	372	0.9	35	7.2	1164.4	258	1.0	53	3.3	2419.2
		Food/Retail	304	0.9	12	7.3	1193.4	173	0.9	30	3.3	2015.6
		Indoor/Office	1919	1.0	119	7.5	1146.6	456	1.0	62	3.3	2321.2
		Industrial	178	0.9	20	7.7	1188.9	120	1.2	23	3.5	2064.8
		Land Usage	40	1.0	2	7.0	1273.8	86	1.0	20	3.6	2710.8
		Medical/ Veterinary	286	1.0	5	8.4	1100.3	72	1.0	10	3.5	2156.7
	LSCSP	Auto/Boat	5749	1.4	1442	3.4	1083.0	5749	1.4	1442	3.4	1083.0
		Food/Retail	2131	1.2	465	3.1	846.5	2131	1.2	465	3.1	846.5
		Indoor/Office	4024	1.2	818	3.0	1072.3	4024	1.2	818	3.0	1078.3
		Industrial	1337	1.2	308	3.2	979.6	1337	1.2	308	3.2	979.6
		Land Usage	508	1.2	113	3.0	849.2	508	1.2	113	3.0	849.2
		Medical/ Veterinary	1750	1.1	409	2.8	1456.1	1750	1.1	409	2.8	1456.1
Non-Commercial	Permittee	Auto/Boat	7	0.3	0	NA	NA	--	--	--	--	--
		Food/Retail	38	0.9	0	NA	NA	1	1.0	0	NA	NA
		Indoor/Office	1140	0.8	119	7.6	1153.5	92	0.6	7	2.7	3373.0
		Industrial	10	0.5	1	9.0	1133.1	--	--	--	--	--
		Land Usage	7	1.0	0	NA	NA	--	--	--	--	--
		Medical/ Veterinary	4	1.0	0	NA	NA	--	--	--	--	--
	LSCSP	Auto/Boat	1251	1.2	322	3.0	1351.6	1251	1.2	322	3.0	1351.6
		Food/Retail	533	1.2	100	3.0	834.6	533	1.2	100	3.0	834.6
		Indoor/Office	1715	1.1	298	3.0	1183.7	1715	1.1	298	3.0	1183.7
		Industrial	515	1.2	116	3.0	1492.0	515	1.2	116	3.0	1492.0
		Land Usage	672	1.2	135	2.9	766.9	672	1.2	135	2.9	766.9
		Medical/ Veterinary	462	1.1	110	3.0	1616.0	462	1.1	110	3.0	1616.0

Table 1.7. Summary statistics for number of inspections per year for flow treatment BMPs. Alternating gray and white

shading delineate hypothesis test pairs.

Case	*n*	Min	Q1	Median	Q3	Max	Mean	Std. Dev.
Phase I, Commercial	748	0.250	0.750	1.000	1.250	6.000	1.193	0.757
Phase I, Non-commercial	1,723	0.2857	0.667	1.000	1.000	7.000	1.039	0.653
Phase II, Commercial	2,842	0	1.000	1.000	1.000	3.000	0.968	0.181
Phase II, Non-commercial	770	0	1.000	1.000	1.000	2.000	0.910	0.275
Permittee, Commercial	3,590	0	1.000	1.000	1.000	6.000	1.015	0.391
Permittee, Non-commercial	2,493	0	0.667	1.000	1.000	7.000	0.999	0.567

Table 1.8. Results for Wilcoxon rank sum hypothesis test for location shifts between commercial and non-commercial flow treatment BMPs for three comparisons. *W* is the test statistic.

Comparison	*W*	*p*-value
Phase I Permittees	746,390	1.979×10^{-10}
Phase II Permittees	1,213,100	$< 2.2 \times 10^{-16}$
Permittees	5,261,500	$< 2.2 \times 10^{-16}$
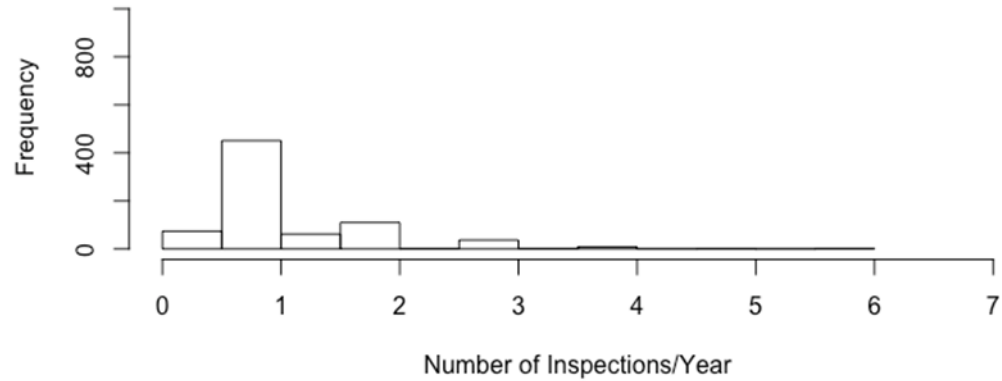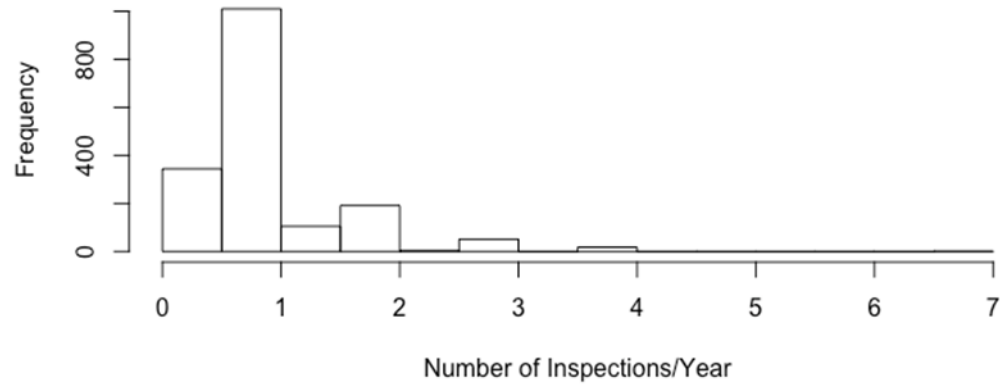
Figure 1.1. Histograms for the number of flow treatment inspections per year for commercial Phase I permittees (top) and non-commercial Phase I permittees (bottom). Histograms are plotted using the same axes to allow for direct comparisons of the distributions.
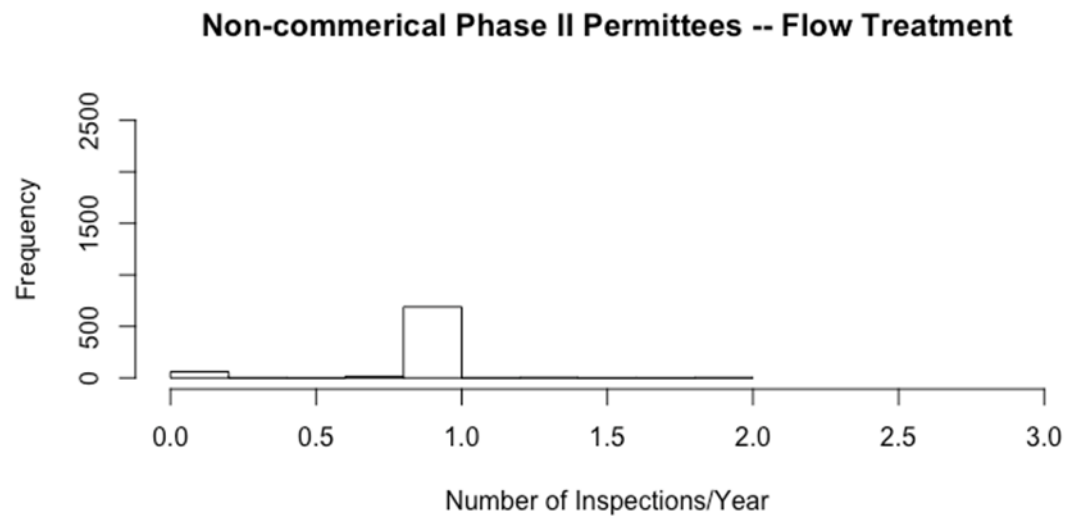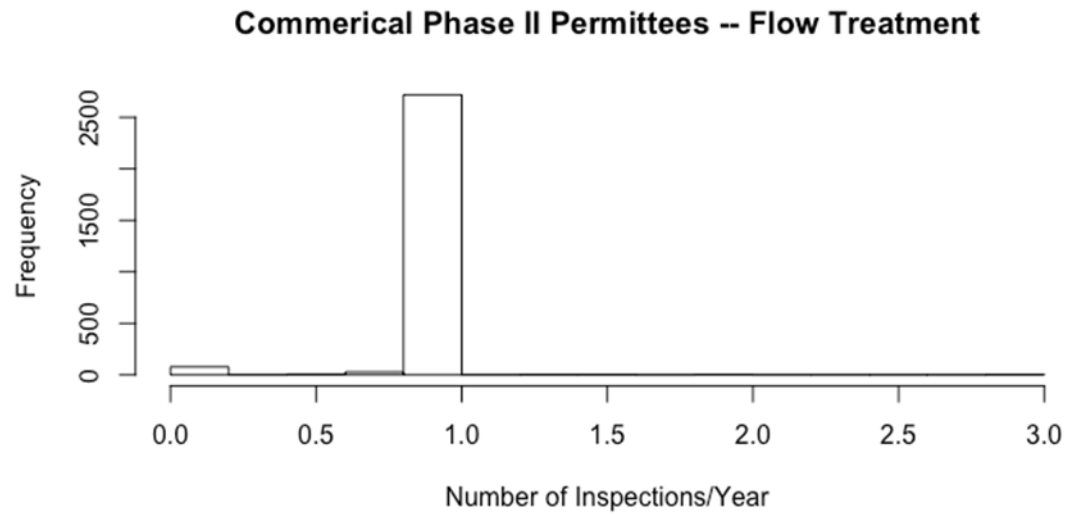
Figure 1.2. Histograms for the number of flow treatment inspections per year for commercial Phase II permittees (top) and non-commercial Phase II permittees (bottom). Histograms are plotted using the same axes to allow for direct comparisons of the distributions.
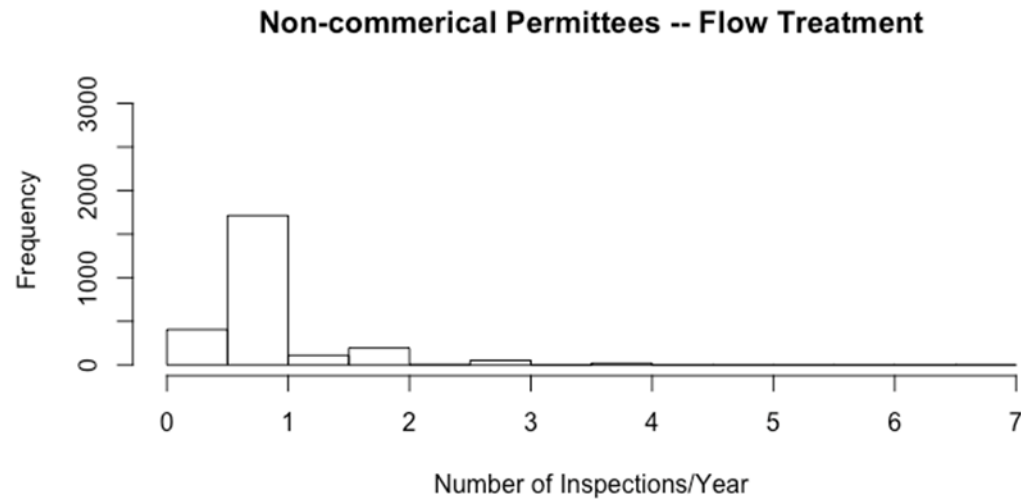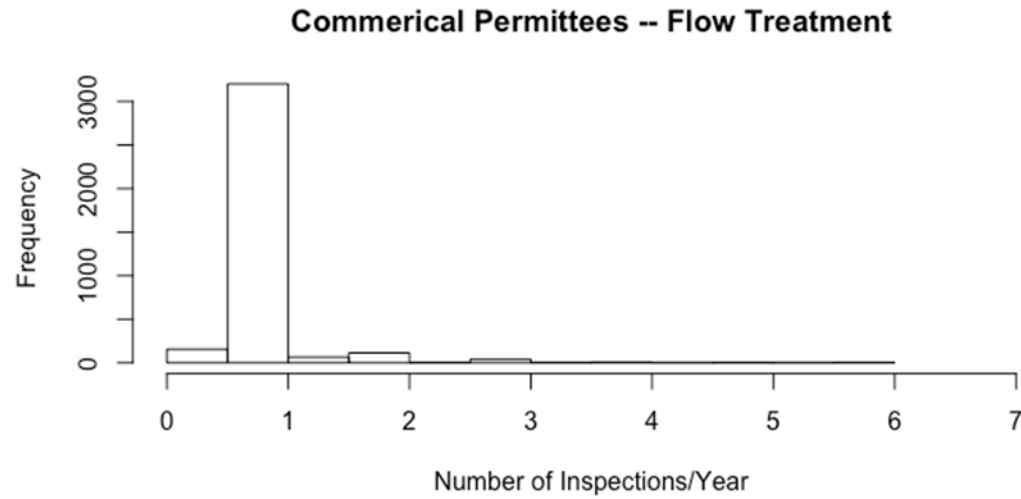
**Figure 1.3. Histograms for the number of flow treatment inspections per year for commercial Permittees (top) and non-commercial Permittees (bottom). Histograms are plotted using the same axes to allow for direct comparisons of the distributions.**

2. *What is the optimum frequency of inspections to ensure the proper use of structural and operational source control BMPs at businesses?*

No data available on proper vs. improper usage of BMPs. Alternative effectiveness questions that can be addressed:

2.1. What are the inspection frequencies of operational and structural BMPs among Business Categories?

2.2 How are the inspection frequencies different between the following groups:
- Phase I and Phase II jurisdictions?
- Business Categories with a single visit?
- Business Categories with repeat visits?

Methods

The calculated summaries for this effectiveness question are the same as those for effectiveness question 1 (1.1 and 1.2) except that the data are not split by commercial versus non-commercial land use. All summaries are based on all the categories of the LandUse variable (including values of "blank" and "reject").

Results

Summaries are presented in Tables 2.1 – 2.6. Table 2.1 provides summaries of all the data based on various combinations of structural and operational BMPs, as well as flow treatment BMPs. Table 2.2 summarizes all the data by Phase I vs. Phase II permittees or by data source of permittee versus LSCP. Table 2.3 splits out the summaries in table 2.2 by inspection type (structural, operational, or flow treatment). Table 2.4 shows summaries for structural and operational BMPs by business categories (all permit types and data sources). Tables 2.5 and 2.6 split the summaries in Table 2.4 by permit phase and data source, respectively.

Depending on the questions are of interest, there may be options to conduct some post-hoc statistical comparisons between various groups for mean number of inspections per year, mean cycles, or mean frequency between inspections.

A Friedman rank sum test (a nonparametric two-way ANOVA equivalent), was used to test whether or not the mean number of inspections per year varied between business category type (6 levels) and BMP type (2 levels). Hypothesis tests were conducted separately for Phase I permittees, Phase II permittees, and Permittees. A non-parametric test was chosen because the distributions for number of inspections per year were far from normally distributed. Histograms showing the distributions are provided in Figures 2.1 – 2.6.

There are not a lot of options for a nonparametric two-way ANOVA. The Friedman rank sum test is most applicable for un-replicated randomized block designs with one treatment variable and one blocking variable. To use the test in this case, the dependent variable was mean number of inspections per year (same numbers as in Tables 2.5 and 2.6 except values were not rounded) , the "treatment" was business category, and the "block" was BMP type. You must note that these data are observational and not from a randomized experiment.

The statistical hypotheses are H_0: there is no difference between the variables versus H_a: at least two of the variables are different from each other. As with any ANOVA, rejection of the null hypothesis does not tell you which variables are different. The results of the three hypothesis

tests are shown in Table 2.7. None of the tests were significant at a 5% significance level.

Since the mean number of inspection per year values are identical for both BMP types for LSCP, the Friedman test is not really applicable. Instead, we used a Kruskal-Wallis rank sum test (a nonparametric one-way ANOVA equivalent) on number of inspections per year to look for differences among the business categories. The distributions by business category are shown in Figure 2.7.

The statistical hypotheses are H_0: the business category inspections per year are identical populations versus H_a: the populations for at least two of the business categories are different. The results of this hypothesis test are shown in Table 2.7. The test was highly statistically significant, meaning the population of inspections per year for at least two business categories are different. As with any ANOVA, rejection of the null hypothesis does not tell you which categories are different. Since the sample size is so large ($n = 12,299$), it is not surprising to see significant differences even though the means are quite similar. It is recommended to use Figure 2.7 to qualitatively summarize differences, as opposed to using multiple formal comparisons (statistical tests). As with the tests for effectiveness question 1, the practical significance of the closeness of the mean number of inspection values needs to be considered in the interpretation of the results.

Table 2.1. Summary statistics related to frequencies of inspections for structural or operational inspections all phases and permittee/LSCP data sources. Inspected Subset is defined as S = InspectedStructuralBMP Yes; O = InspectedOperationalBMP Yes; F = InspectedFlowTreatmentBMP Yes. Mean in compliance values for cycle = 1 are simple means across all businesses. For cycle > 1, percentages are means for the means per BMP type across all businesses with the last cycle in compliance.

Inspected Subset	Number of Businesses	Total # Inspections	Mean # Inspections Per Year	Num Cycle = 1	Num Cycles > 1	Mean Cycles	Mean Frequency Between Inspections (Days)	Mean % Designated In Compliance for Cycle = 1	Mean % Designated In Compliance on last Cycle for Cycle > 1
S or O	21,216	35,958	1.2	14,209	7,007	3.9	1307.5	30.1	6.6
S	17,026	27,905	1.2	11,744	5,282	4.0	1110.7	38.1	6.4
O	17,765	30,399	1.2	11,132	6,633	3.8	1312.7	31.8	3.4
S and O	13,575	22,346	1.2	8,667	4,908	3.8	1097.1	41.1	2.0
F	6,300	14,150	1.0	3,930	2,370	4.3	1136.4	0.0	12.6

Table 2.2. Summary statistics related to frequencies of inspections for all businesses split out by Phase I and Phase II permittees or by permittee versus LSCP for all BMPs.

Inspected Subset	Number of Businesses (%)	Total # Inspections	Mean # Inspections Per Year	Num Cycle = 1	Num Cycles > 1	Mean Cycles	Mean Frequency Between Inspections (Days)	Mean % Designated In Compliance for Cycle = 1	Mean % Designated In Compliance on last Cycle for Cycle > 1
Phase I	12,011	24,398	1.2	6,598	5,413	3.8	1192.1	22.4	3.0
Phase II	13,028	21,394	1.1	9,218	3,810	3.9	1487.8	22.9	9.5
Permittee	12,733	25,184	1.1	8,186	4,547	4.0	1497.3	2.1	9.3
LSCP	13,199	21,970	1.2	8,291	4,908	3.8	1097.1	41.1	2.0

Table 2.3. Summary statistics related to frequencies of inspections for all businesses split out by Phase I and Phase II permittees or by permittee versus LSCP for structural, operational, and flow treatment BMPs.

Inspect. Type	Inspected Subset	Number of Businesses (%)	Total # Inspections	Mean # Inspections Per Year	Num Cycle = 1	Num Cycles > 1	Mean Cycles	Mean Frequency Between Inspections (Days)	Mean % Designated In Compliance for Cycle = 1	Mean % Designated In Compliance on last Cycle for Cycle > 1
Structural	Phase I	5,346	8,314	1.3	3,584	1,762	3.6	555.5	63.2	2.0
	Phase II	10,787	18,229	1.1	7,499	3,288	4.1	1393.8	26.6	9.1
	Permittee	3,827	5,935	1.0	3,453	374	6.6	1242.4	0.0	63.6
	LSCP	13,199	21,970	1.2	8,291	4,908	3.8	1097.1	41.1	2.0
Operational	Phase I	9,536	16,367	1.3	6,049	3,487	3.7	1243.3	34.7	4.6
	Phase II	7,336	12,670	1.1	4,422	2,914	3.8	1420.0	30.0	2.1
	Permittee	4,566	8,429	1.1	2,841	1,725	3.8	2013.3	5.6	7.3
	LSCP	13,199	21,970	1.2	8,291	4,908	3.8	1097.1	41.1	2.0
Flow Treatment	Phase I	2475	8,031	1.1	549	1926	3.9	1129.7	0.0	0.0
	Phase II	3,825	6,119	1.0	3,381	444	6.2	1165.1	0.0	67.3
	Permittee	6,300	14,150	1.0	3,930	2,370	4.3	1136.4	0.0	12.6

Table 2.4. Summary statistics related to frequencies of inspections for all businesses split out by business categories and structural or operational BMPs.

Business Category	Structural BMPs					Operational BMPs				
	Total # of Inspections	Mean # Inspections Per Year	Num Cycles > 1	Mean Cycles	Mean Frequency Between Inspections (Days)	Total # of Inspections	Mean # Inspections Per Year	Num Cycles > 1	Mean Cycles	Mean Frequency Between Inspections (Days)
Auto/Boat	7452	1.3	1809	3.4	1160.7	8683	1.3	2171	3.3	1336.7
Food/Retail	3020	1.2	578	3.2	860.1	4410	1.1	843	3.1	1048.5
Indoor/Office	8947	1.1	1364	4.0	1138.1	8491	1.1	1607	3.1	1421.7
Industrial	2111	1.2	457	3.4	1135.1	2909	1.2	687	3.2	1362.8
Land Usage	1233	1.2	250	3.0	916.2	1556	1.2	339	3.1	1288.4
Medical/Veterinary	2504	1.1	524	2.9	1492.6	2417	1.1	553	2.8	1639.6

Table 2.5. Summary statistics related to frequencies of inspections for all businesses split out by Phase I and Phase II permittees and by structural or operational BMPs for each business category.

Permit	Business Category	Structural BMPs					Operational BMPs				
		Total # of Inspections	Mean # Inspections Per Year	Num Cycles > 1	Mean Cycles	Mean Frequency Between Inspections (Days)	Total # of Inspections	Mean # Inspections Per Year	Num Cycles > 1	Mean Cycles	Mean Frequency Between Inspections (Days)
Phase I	Auto/Boat	3050	1.5	737	3.4	891.0	4696	1.4	1144	3.4	1331.5
	Food/Retail	481	1.4	107	2.9	209.4	2183	1.1	385	3.1	1094.0
	Indoor/ Office	2320	1.2	406	2.8	450.2	4817	1.2	897	3.1	1352.5
	Industrial	584	1.3	123	3.0	655.2	1635	1.3	386	3.3	1426.7
	Land Usage	491	1.3	111	2.8	352.2	863	1.2	202	3.1	1254.3
	Medical/ Veterinary	774	1.3	153	2.5	179.6	949	1.3	187	2.6	837.0
Phase II	Auto/Boat	4160	1.2	1026	3.4	1366.5	3745	1.2	981	3.2	1363.8
	Food/Retail	2485	1.1	468	3.2	1002.5	2173	1.2	455	3.1	998.0
	Indoor/ Office	6279	1.0	923	4.5	1468.3	3326	1.1	675	3.1	1566.3
	Industrial	1157	1.1	258	3.5	1426.5	904	1.2	225	3.1	1402.1
	Land Usage	699	1.2	131	3.1	1120.9	650	1.2	129	3.1	1118.5
	Medical/ Veterinary	1701	1.0	370	3.1	2052.1	1439	1.0	365	2.9	2065.0

Table 2.6. Summary statistics related to frequencies of inspections for all businesses split out by data source of permittee or LSC and by structural or operational BMPs for each business category. Results for LSCP structural and operational are identical as all LSCP records have only Yes values for the InspectedStructuralBMP and InspectedOperationalBMP variables.

Data Source	Business Category	Structural BMPs					Operational BMPs				
		Total # of Inspections	Mean # Inspections Per Year	Num Cycles > 1	Mean Cycles	Mean Frequency Between Inspections (Days)	Total # of Inspections	Mean # Inspections Per Year	Num Cycles > 1	Mean Cycles	Mean Frequency Between Inspections (Days)
Permittee	Auto/Boat	452	0.9	45	6.0	1426.8	1683	1.2	407	3.4	2129.0
	Food/Retail	356	0.9	13	6.9	1157.5	1746	1.0	278	3.1	1434.7
	Indoor/Office	3208	0.9	248	7.3	1197.0	2752	1.1	491	3.3	2102.7
	Industrial	259	1.0	33	5.8	1592.5	1057	1.3	263	3.4	1809.2
	Land Usage	53	1.0	2	7.0	1273.8	376	1.2	91	3.5	2328.2
	Medical/Veterinary	292	1.0	5	8.4	1100.3	205	1.0	34	3.2	3757.8
LSCP	Auto/Boat	7000	1.3	1764	3.3	1153.9	7000	1.3	1764	3.3	1153.9
	Food/Retail	2664	1.2	565	3.1	853.3	2664	1.2	565	3.1	853.3
	Indoor/Office	5739	1.2	1116	3.0	1123.9	5739	1.2	1116	3.0	1123.9
	Industrial	1852	1.2	424	3.1	1099.5	1852	1.2	424	3.1	1099.5
	Land Usage	1180	1.2	248	2.9	913.3	1180	1.2	248	2.9	913.3
	Medical/Veterinary	2212	1.1	519	2.8	1495.8	2212	1.1	519	2.8	1495.8
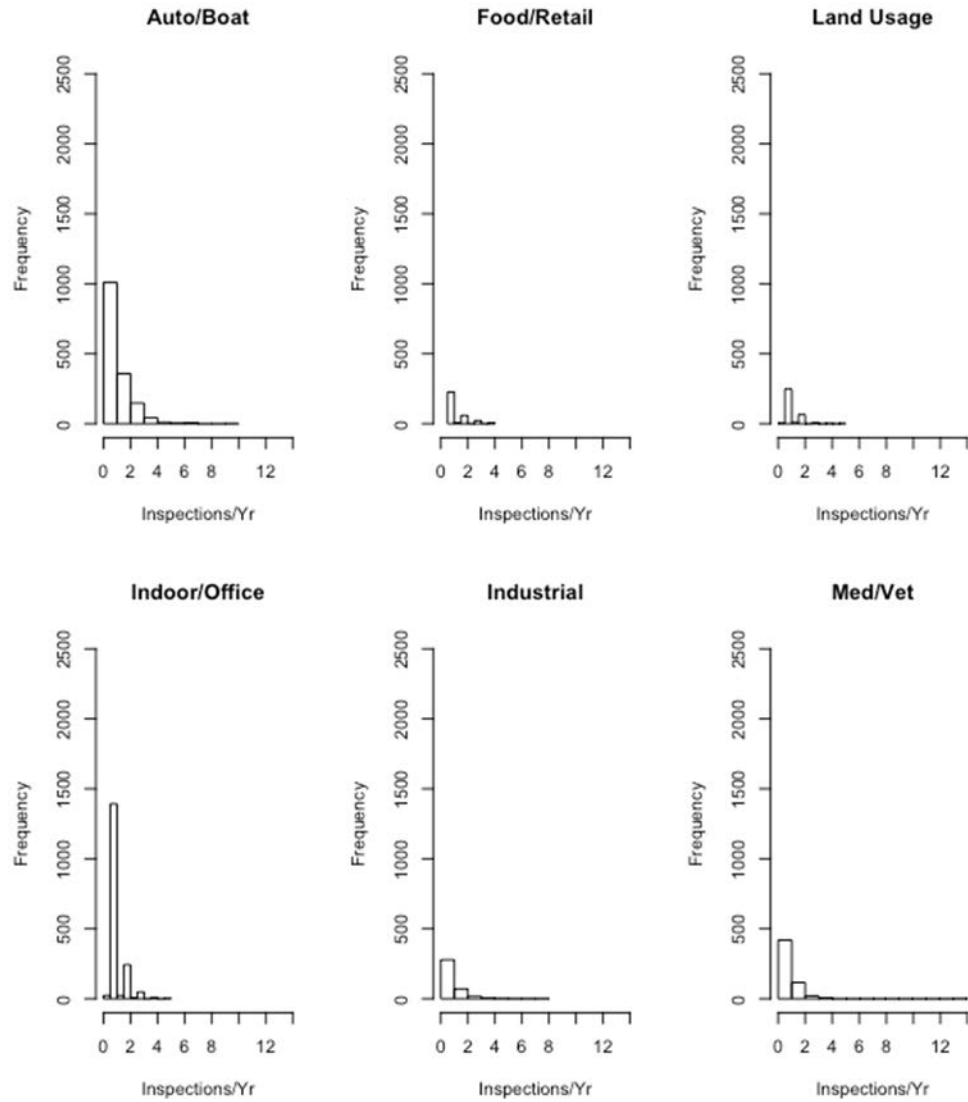
Figure 2.1. Distributions of number of inspections per year for Phase I permittees and structural BMPs, by business category.
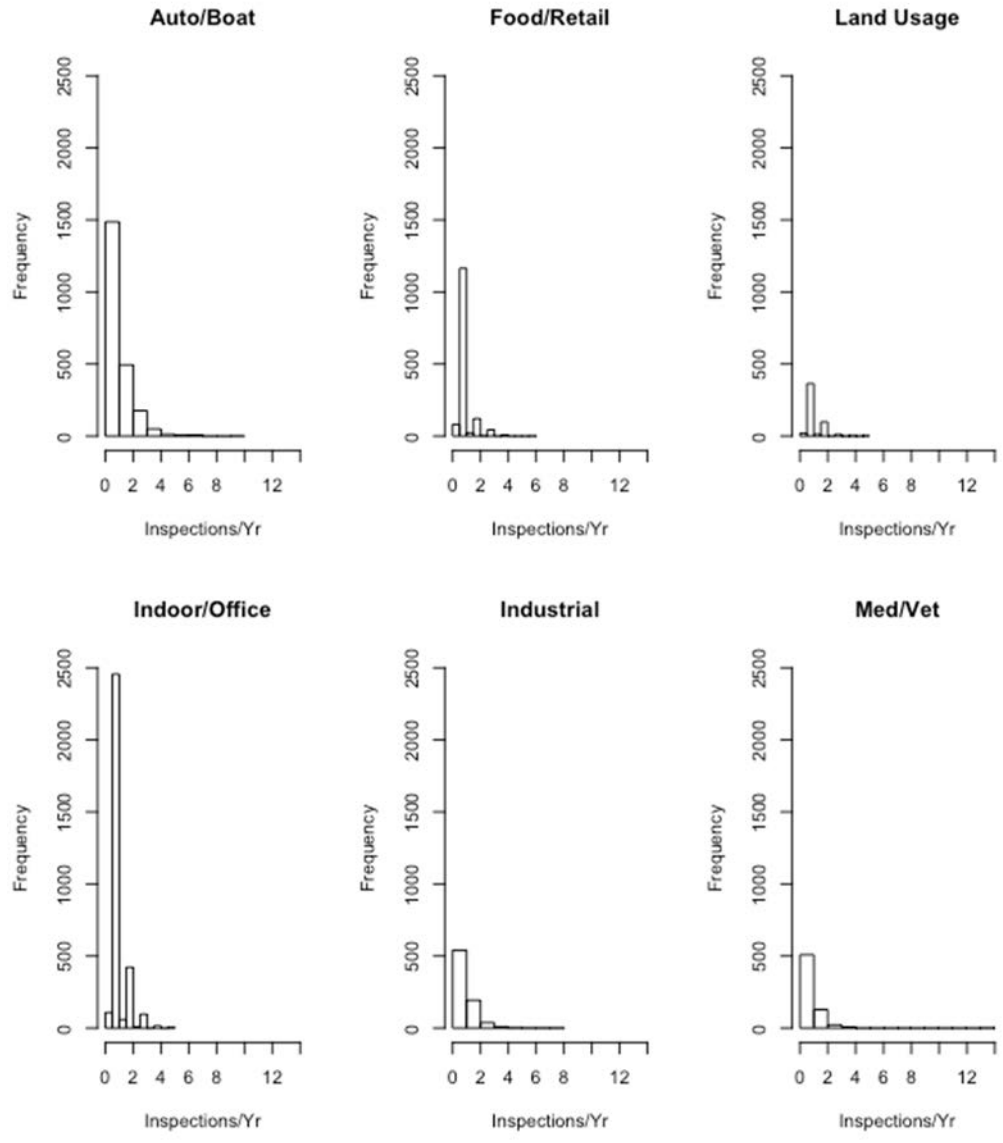
Figure 2.2. Distributions of number of inspections per year for Phase I permittees and operational BMPs, by business category.
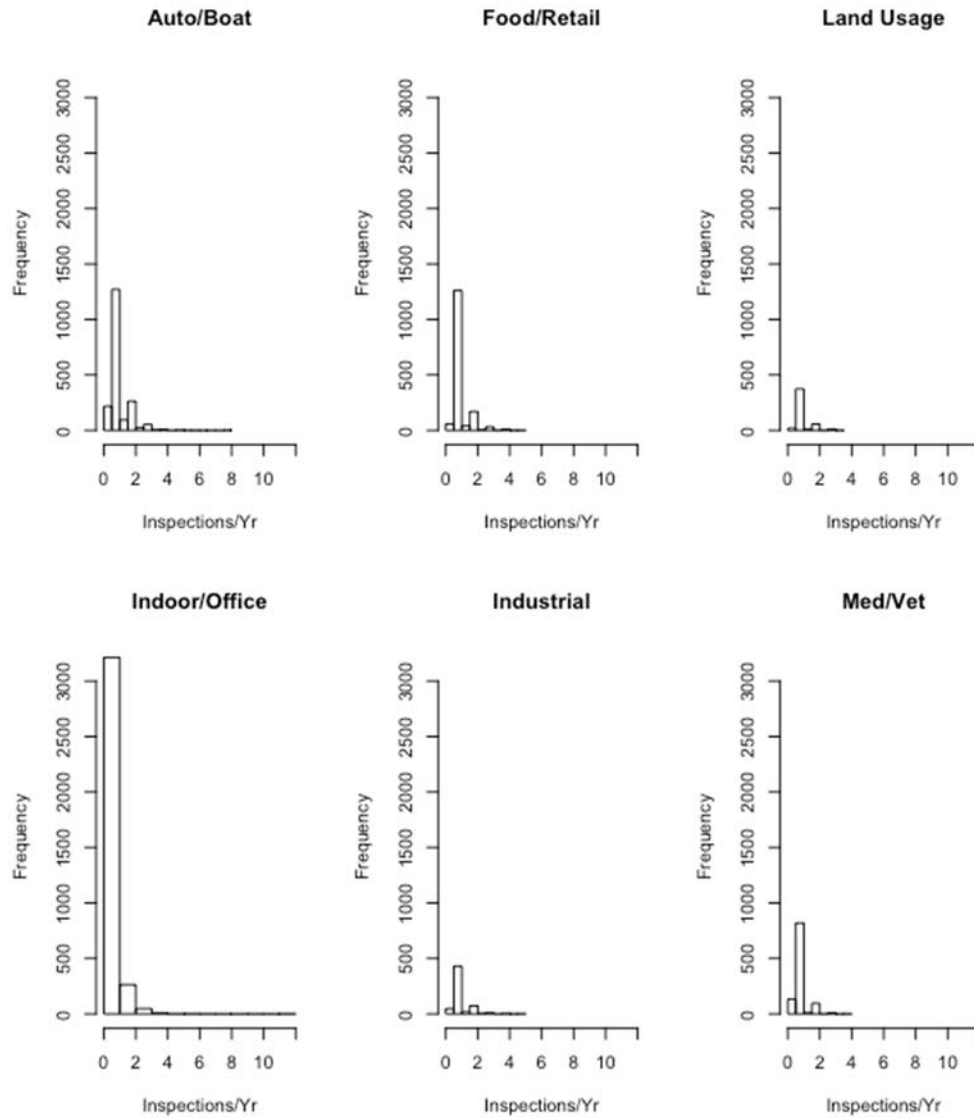
Figure 2.3. Distributions of number of inspections per year for Phase II permittees and structural BMPs, by business category.
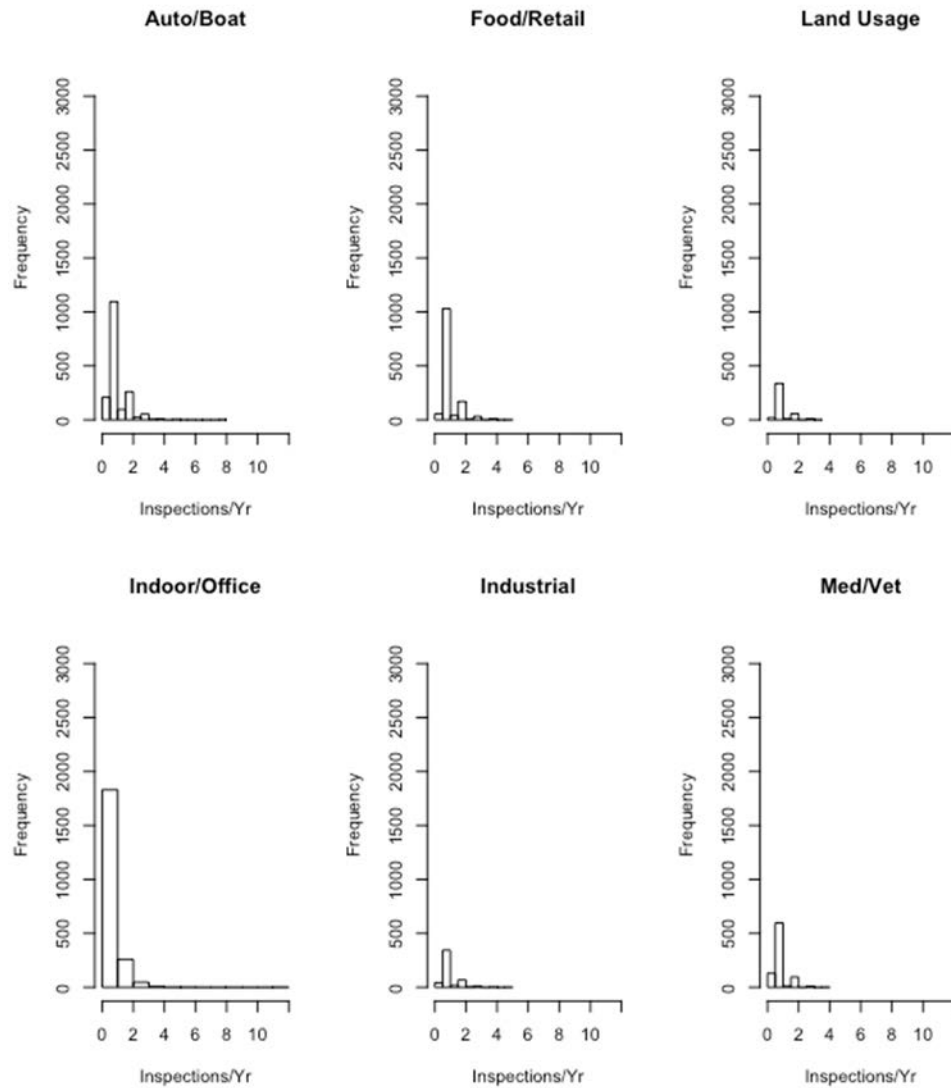
Figure 2.4. Distributions of number of inspections per year for Phase II permittees and operational BMPs, by business category.
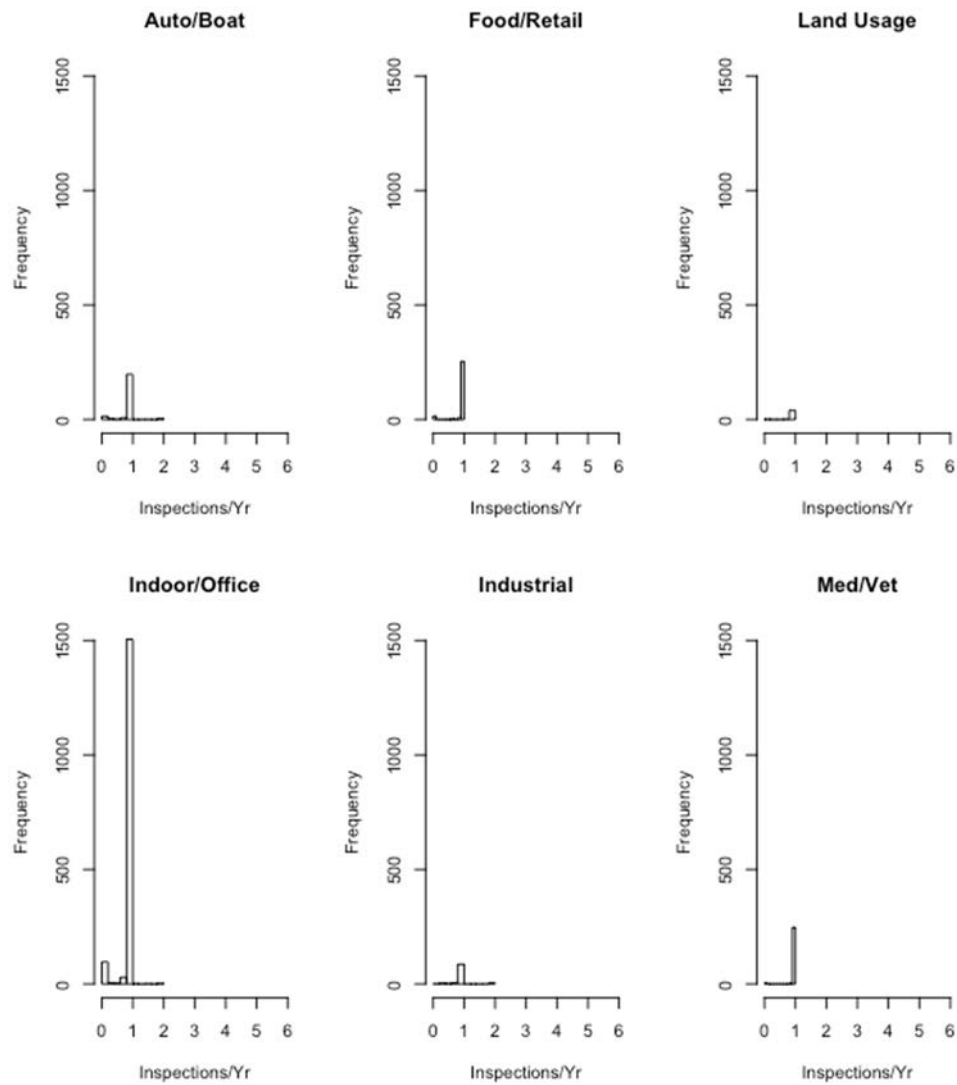
Figure 2.5. Distributions of number of inspections per year for permittees and structural BMPs, by business category.
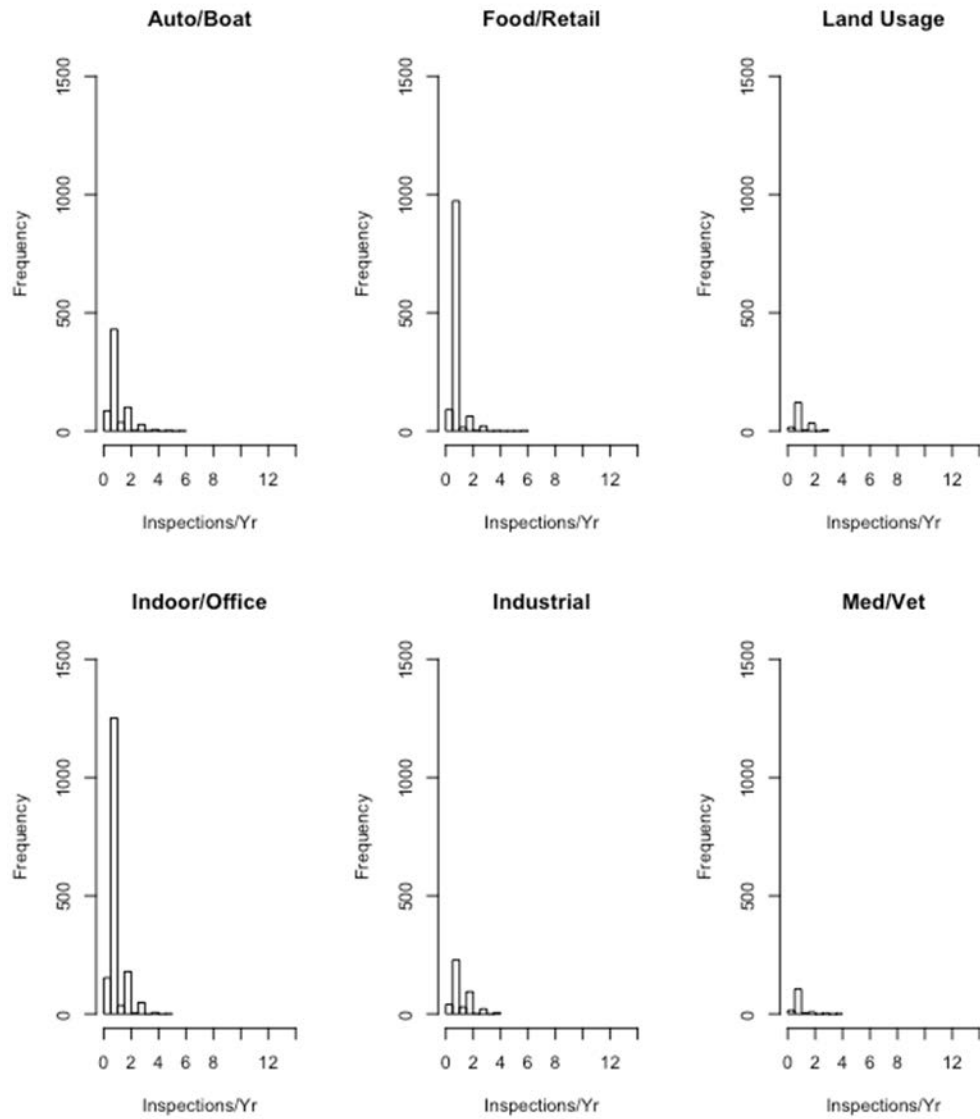
Figure 2.6. Distributions of number of inspections per year for permittees and operational BMPs, by business category.
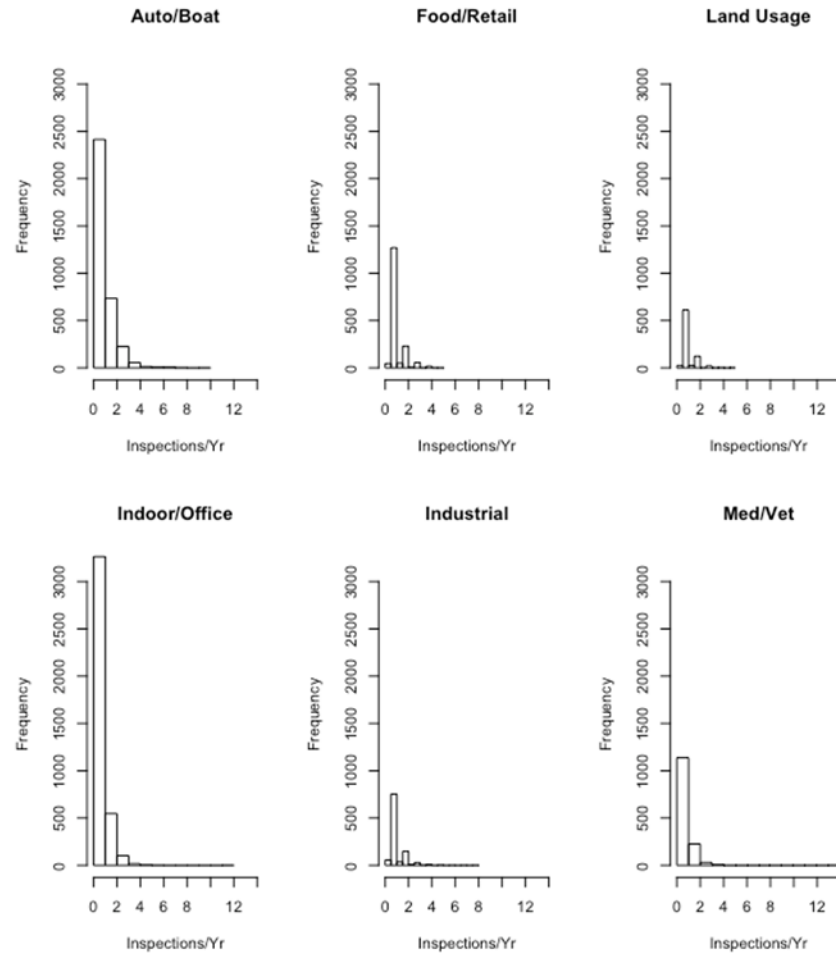
Figure 2.7. Distributions of number of inspections per year for LSCP and structural BMPs, by business category. Note that all LSCP records that had the InspectedStructuralBMP field = YES, also had InspectedOperationalBMP field = YES. Thus, the distributions for structural and operational BMPs are identical (as reflected in Table 2.6).

Table 2.7. Results for Friedman rank sum hypothesis tests for testing for differences between the variables. The dependent mean inspections per year is compared for "Treatment" of business category (6 levels), "Blocked" by type of BMP (structural or operational).

Comparison	χ^2	df	p-value
Phase I Permittees	7.1429	5	0.2102
Phase II Permittees	9.7143	5	0.0838
Permittees	5.7143	5	0.3350
LSCP[1]	74.645	5	1.105×10^{-14}

[1] This is results for a Kruskal-Wallis rank sum test.

2A   Which is more effective for specific high value BMPs: focusing on the property owners or focusing on the business owners, or a combination of the two?

  Comment: Target both situations where a business owner is and is not cooperative and willing.

No data available on the value of BMPs. Alternative effectiveness questions that can be addressed:

- What are the distributions of Business Categories that reflect contact roles, including property owners, business owners, managers, and other employees?
- Group results by:
  - Cooperativeness.
  - Compliance status after follow-up inspections.
  - Operational or structural BMPs.

Methods and Results

All summaries developed for question 2A are simple counts of cases for various combinations of the data for values of reported cooperation (Cooperative variable) and contact roles (ContactRole variable). Unfortunately, both of these variables have a large percentage of blanks in the database. The distribution of the Cooperative variable is 5.7% yes, 0.1% no, and 94.2% blank. The distributions of the ContactRole variable is 19.7% Owner, 21.8% Manager, 1.7% Property owner or representative, 4.0% Other Staff, 0.2% Indeterminate, 0.4% reject, and 52.3% blank.

The counts are summarized in Tables 2A.1 – 2A.6. The counts are based on all 72,324 records in the database as opposed to unique inspection records. Table 2A.1 gives counts by permit and business category for all records with Cooperative = blank. Table 2A.2 gives counts by permit and business category for all records with Cooperative = Yes or Cooperative = No. Table 2A.3 gives counts by data source and business category for all records with Cooperative = blank. Table 2A.4 gives counts by data source and business category for all records with Cooperative = Yes or Cooperative = No. Table 2A.5 separates counts by BMP category (BMPCategory variable = "Structural" or "Operational") and business category for all records with Cooperative = blank. Table 2A.6 separates counts by BMP category (BMPCategory variable = "Structural" or "Operational") and business category for all records with Cooperative = Yes or Cooperative = No.

Statistical tests for any of these data are not recommended due to low numbers of records with non-blank values for the Cooperative and ContactRole variables.

Table 2A.1. Counts of numbers of inspections for business category and contact roles by permittee phase and Cooperative variable = Blank.

Permit	Business Category	Cooperative = "Blank"			
		Bus. Owner	Bus. Manager	Prop. Owner or Rep.	Other Staff
Phase I	Auto/Boat	3754	2717	11	407
	Food/Retail	1428	2331	32	457
	Indoor/Office	1499	3581	205	748
	Industrial	877	1363	5	354
	Land Usage	437	456	2	123
	Medical/Veterinary	283	315	17	124
Phase II	Auto/Boat	1895	1010	87	22
	Food/Retail	532	538	33	29
	Indoor/Office	749	653	620	45
	Industrial	313	185	43	10
	Land Usage	263	122	0	2
	Medical/Veterinary	361	137	16	3

Table 2A.2. Counts of numbers of inspections for business category and contact roles by permittee phase and Cooperative variable = Yes or No.

Permit	Business Category	Cooperative				Not Cooperative			
		Bus. Owner	Bus. Manager	Prop. Owner or Rep.	Other Staff	Bus. Owner	Bus. Manager	Prop. Owner or Rep.	Other Staff
Phase I	Auto/Boat	0	0	0	0	0	0	0	0
	Food/Retail	0	0	0	0	0	0	0	0
	Indoor/Office	0	0	0	0	0	0	0	0
	Industrial	0	0	0	0	0	0	0	0
	Land Usage	0	0	0	0	0	0	0	0
	Medical/Veterinary	0	0	0	0	0	0	0	0
Phase II	Auto/Boat	33	5	0	3	0	0	0	0
	Food/Retail	38	7	1	0	0	0	0	0
	Indoor/Office	256	2	1	12	0	0	0	1
	Industrial	4	4	1	12	0	0	0	0
	Land Usage	1	2	1	2	0	0	0	0
	Medical/Veterinary	31	0	0	1	0	0	0	0

Table 2A.3. Counts of numbers of inspections for business category and contact roles by data source and Cooperative variable = Blank.

Data Source	Business Category	Cooperative = "Blank"			
		Bus. Owner	Bus. Manager	Prop. Owner or Rep.	Other Staff
Permittee	Auto/Boat	1554	1715	96	395
	Food/Retail	1340	2226	60	456
	Indoor/Office	934	3252	822	739
	Industrial	683	1289	46	353
	Land Usage	304	421	2	122
	Medical/Veterinary	73	202	33	124
LSCP	Auto/Boat	4241	2100	2	34
	Food/Retail	644	663	5	30
	Indoor/Office	1432	1133	3	56
	Industrial	598	461	2	11
	Land Usage	404	175	0	3
	Medical/Veterinary	577	267	0	3

Table 2A.4. Counts of numbers of inspections for business category and contact roles by data source and Cooperative variable = Yes or No.

Data Source	Business Category	Cooperative				Not Cooperative			
		Bus. Owner	Bus. Manager	Prop. Owner or Rep.	Other Staff	Bus. Owner	Bus. Manager	Prop. Owner or Rep.	Other Staff
Permittee	Auto/Boat	33	5	0	3	0	0	0	0
	Food/Retail	38	7	1	0	0	0	0	0
	Indoor/Office	256	2	1	12	0	0	0	1
	Industrial	4	4	1	12	0	0	0	0
	Land Usage	1	2	1	2	0	0	0	0
	Medical/Veterinary	31	0	0	1	0	0	0	0
LSCP	Auto/Boat	0	0	0	0	0	0	0	0
	Food/Retail	0	0	0	0	0	0	0	0
	Indoor/Office	0	0	0	0	0	0	0	0
	Industrial	0	0	0	0	0	0	0	0
	Land Usage	0	0	0	0	0	0	0	0
	Medical/Veterinary	0	0	0	0	0	0	0	0

Table 2A.5. Counts of numbers of inspections for business category and contact roles by BMP category and Cooperative variable = Blank.

BMP Category	Business Category	Cooperative = "Blank"			
		Bus. Owner	Bus. Manager	Prop. Owner or Rep.	Other Staff
Structural	Auto/Boat	538	368	0	54
	Food/Retail	117	149	0	25
	Indoor/Office	149	252	15	49
	Industrial	116	176	0	45
	Land Usage	50	75	0	12
	Medical/Veterinary	25	29	2	11
Operational	Auto/Boat	3013	2115	4	257
	Food/Retail	1329	2113	23	342
	Indoor/Office	1094	2730	118	470
	Industrial	631	920	0	185
	Land Usage	381	306	0	73
	Medical/Veterinary	317	236	12	82

Table 2A.6 Counts of numbers of inspections for business category and contact roles by BMP category and Cooperative variable = Yes or No.

BMP Category	Business Category	Cooperative				Not Cooperative			
		Bus. Owner	Bus. Manager	Prop. Owner or Rep.	Other Staff	Bus. Owner	Bus. Manager	Prop. Owner or Rep.	Other Staff
Structural	Auto/Boat	0	2	0	0	0	0	0	0
	Food/Retail	1	3	0	0	0	0	0	0
	Indoor/Office	2	1	1	0	0	0	0	0
	Industrial	0	1	0	0	0	0	0	0
	Land Usage	0	1	0	0	0	0	0	0
	Medical/Veterinary	0	0	0	0	0	0	0	0
Operational	Auto/Boat	0	0	0	0	0	0	0	0
	Food/Retail	0	2	1	0	0	0	0	0
	Indoor/Office	6	0	0	0	0	0	0	0
	Industrial	0	1	1	0	0	0	0	0
	Land Usage	0	0	0	0	0	0	0	0
	Medical/Veterinary	0	0	0	0	0	0	0	0

2B. Which required BMPs were implemented based upon follow up inspection? Which optional BMPs were installed based upon follow up inspection?

No data available on the required versus optional BMPs. Alternative effectiveness questions that can be addressed:

- What are the distributions of Business Category that reflect:
    - inspection types?
    - single versus repeat inspections?
    - if new BMPs were added after previous inspection?
    - the categories and types of BMPs?
    - the BMP status?

Data variables to use:

- Business Category (6 categories)
- Inspection type (7 types)
- New BMPs (Yes or No)
- BMP Category (Operational or Structural)
- BMP Type (17 types)
- BMP Status (4 statuses)

Methods and Results

All summaries developed for question 2B are simple counts of cases for various combinations of the data for values of reported BMP status (BMPStatus variable) by business category and BMP type for all inspections with one visit or with repeat visits. As with the variables used for effectiveness question 2A, the BMPStatus variable has a large percentage of blanks. The distribution of the BMPStatus variable is 1.7% "In Process", 1.6% "No Further Action", 1.4% "Refer to Agency", 23.7% "Resolved", and 71.5% blank.

The counts are summarized in Tables 2B.1 – 2B.4. The counts are based on all 72,324 records in the database as opposed to unique inspection records. Table 2B.1 gives counts by BMP type and business category split by single and repeat visits for all records with BMPStatus = "In Process". Table 2B.2 gives counts by BMP type and business category split by single and repeat visits for all records with BMPStatus = "No Further Action". Table 2B.3 gives counts by BMP type and business category split by single and repeat visits for all records with BMPStatus = "Refer to Agency". Table 2B.4 gives counts by BMP type and business category split by single and repeat visits for all records with BMPStatus = "Resolved".

Statistical tests for any of these data are not recommended due to low numbers of records with non-blank values for the BMPStatus variable.

Table 2B.1. For inspections with BMP status = "In Process", inspection counts for BMP type and business category separated by number of cycles.

BMP Type	Business Category											
	Cycle = 1						Cycle > 1					
	Auto/ Boat (*n*=176)	Food/ Retail (*n*=58)	Indoor /Office (*n*=154)	Industrial (*n*=65)	Land Usage (*n*=61)	Med/Vet (*n*=25)	Auto/ Boat (*n*=102)	Food/ Retail (*n*=30)	Indoor/ Office (*n*=79)	Industrial (*n*=15)	Land Usage (*n*=5)	Med/Vet (*n*=12)
Cleaning, Washing	7	0	1	4	5	0	2	0	1	0	0	0
Discharge, illicit	5	8	3	2	6	2	6	3	5	0	0	2
Disposal	19	7	19	7	5	5	5	2	8	2	0	1
Housekeeping	6	7	5	4	2	0	6	4	4	1	1	0
Labeling	23	1	18	8	9	4	7	1	2	0	0	1
Maintenance, repair,	19	10	8	7	4	2	9	3	8	1	0	2
Material transfer	5	3	1	2	0	0	1	0	0	0	0	0
Pretreatment and	6	7	3	1	3	0	4	5	3	0	0	1
Records	20	0	14	7	7	6	4	1	1	0	0	0
Secondary	8	4	9	3	4	0	11	1	4	3	1	0
Spill planning and	43	9	41	15	14	5	24	10	31	4	2	5
Storage and cover	10	2	14	5	2	1	23	0	12	4	1	0
Training	5	9	11	1	2	0	4	3	3	0	0	0

Table 2B.2. For inspections with BMP status = "No Further Action", inspection counts for BMP type and business category separated by number of cycles.

	Business Category											
	Cycle = 1						Cycle > 1					
BMP Type	Auto/ Boat (n=65)	Food/ Retail (n=89)	Indoor /Office (n=121)	Industrial (n=12)	Land Usage (n=82)	Med/Vet (n=10)	Auto/ Boat (n=90)	Food/ Retail (n=64)	Indoor/ Office (n=95)	Industrial (n=14)	Land Usage (n=61)	Med/Vet (n=9)
Cleaning, Washing	1	0	0	0	0	1	4	0	0	0	0	0
Discharge, illicit	4	5	3	0	0	2	9	4	0	0	0	1
Disposal	9	37	7	3	1	1	13	13	11	0	1	1
Housekeeping	3	7	5	0	1	0	0	5	4	0	0	0
Labeling	5	0	25	2	3	0	11	2	6	2	0	0
Maintenance, repair,	6	7	3	1	7	0	2	4	2	3	1	0
Material transfer	0	2	1	0	0	0	1	3	0	0	0	0
Pretreatment and	0	2	5	0	0	0	1	11	0	0	0	0
Records	7	7	6	0	3	0	5	2	4	0	0	1
Secondary	6	3	5	0	0	2	2	0	0	0	0	0
Spill planning and	14	9	45	5	56	1	31	17	62	8	59	2
Storage and cover	6	6	12	1	8	3	7	2	6	1	0	3
Training	4	4	4	0	3	0	4	1	0	0	0	1

Table 2B.3. For inspections with BMP status = "Refer to Agency", inspection counts for BMP type and business category separated by number of cycles.

BMP Type	Business Category											
	Cycle = 1						Cycle > 1					
	Auto/ Boat (*n*=139)	Food/ Retail (*n*=97)	Indoor /Office (*n*=147)	Industrial (*n*=59)	Land Usage (*n*=48)	Med/Vet (*n*=21)	Auto/ Boat (*n*=173)	Food/ Retail (*n*=55)	Indoor/ Office (*n*=80)	Industrial (*n*=34)	Land Usage (*n*=27)	Med/Vet (*n*=17)
Cleaning, Washing	4	0	6	6	1	1	3	0	0	2	2	0
Discharge, illicit	36	30	40	8	12	4	23	6	9	3	6	0
Disposal	21	28	39	4	9	5	16	0	5	1	0	3
Housekeeping	6	3	8	7	4	3	11	1	0	3	0	0
Labeling	12	1	2	8	4	0	11	0	1	5	0	0
Maintenance, repair,	18	8	19	4	4	2	12	2	3	3	0	2
Material transfer	7	4	2	2	1	1	0	0	0	2	1	0
Pretreatment and	9	2	13	4	3	1	7	5	2	1	1	1
Records	6	3	4	8	3	1	8	1	1	2	2	2
Secondary	4	11	3	0	0	1	7	5	1	3	1	0
Spill planning and	5	5	8	3	5	2	40	29	47	5	11	7
Storage and cover	11	1	2	2	2	0	14	1	2	4	2	0
Training	0	1	1	2	0	0	21	5	9	0	1	2

Table 2B.4. For inspections with BMP status = "Resolved", inspection counts for BMP type and business category separated by number of cycles.

	Business Category											
	Cycle = 1						Cycle > 1					
BMP Type	Auto/ Boat (*n*=3076)	Food/ Retail (*n*=980)	Indoor /Office (*n*=2520)	Industrial (*n*=513)	Land Usage (*n*=507)	Med/Vet (*n*=648)	Auto/ Boat (*n*=2452)	Food/ Retail (*n*=730)	Indoor /Office (*n*=1567)	Industrial (*n*=320)	Land Usage (*n*=231)	Med/Vet (*n*=340)
Cleaning, Washing	94	29	44	13	19	4	41	19	19	1	1	4
Discharge, illicit	156	77	99	19	21	27	108	52	53	13	7	17
Disposal	335	141	209	43	64	213	177	45	98	31	24	124
Housekeeping	166	87	148	30	30	16	189	59	64	25	16	13
Labeling	417	29	230	67	66	48	284	27	81	32	17	20
Maintenance, repair,	299	115	152	27	37	82	187	71	75	23	10	38
Material transfer	9	23	15	7	4	2	5	6	6	3	2	2
Pretreatment and	35	82	48	8	3	27	34	74	26	1	1	10
Records	160	19	131	44	28	59	96	18	56	27	8	29
Secondary	209	65	120	52	27	26	201	48	65	31	23	16
Spill planning and	761	200	668	113	119	92	686	212	644	76	76	104
Storage and cover	246	47	418	59	52	21	314	48	278	43	28	21
Training	189	66	238	31	37	31	130	51	102	14	18	32

2C   *What were the primary barriers to not adopting or installing BMPs?*

No data available on barriers to BMP use. Assessment of new BMPs adopted is included in question 2B. Alternative effectiveness questions that can be addressed: Among Business Categories, what BMP Types were called out repeatedly that may indicate BMP barriers?

Methods and Results

The summaries for effectiveness question 2C are mean percentages for inspections with repeat visits broken out by BMP type and business category. Percentages are calculated for individual businesses within a combination of BMP type and business category. The individual percentages for all businesses within a BMP type/business category combination are then averaged. Table 2C.1 shows mean percentages for all data. Tables 2C.2 and 2C.3 show mean percentages for data Phase I and Phase II permits, respectively. To account for possible skewed distributions of percentages due to a few businesses having a large number of inspection cycles, median relative percentages are also reported for all data, and Phase I and Phase II permittees in Tables C2.4 – C2.6, respectively. The sample sizes for each combination of BMP Type and Business Category were highly variable. The sample sizes for Phase I and Phase II permittees are shown in Tables 2C.7 and 2C.8, respectively. Sample sizes in 2C.7 correspond to means and medians in Tables 2C.2 and 2C.5. Sample sizes in 2C.8 correspond to means and medians reported in Tables 2C.3 and 2C.6.

Depending on the questions are of interest, there may be options to conduct some post-hoc tests to compare mean or median percentages across various groups.

Table 2C.1. Mean relative percentages for occurrences of repeat inspections for BMP types within business categories, all data. Entries of NA means that there were no records with Cycle > 1 for the given combinations of BMP Type and Business Category.

BMP Type	Business Category					
	Auto/Boat	Food/Retail	Land Usage	Indoor/Office	Industrial	Medical/Veterinary
Activity location	NA	NA	NA	NA	NA	NA
Cleaning, Washing	84.0	90.5	90.7	83.5	83.6	88.1
Discharge, illicit connection	79.1	88.3	92.2	81.9	78.8	86.2
Disposal	78.4	87.9	86.2	82.9	82.9	87.0
Housekeeping	80.9	89.3	90.9	88.3	85.3	93.3
Labeling	75.7	94.4	81.5	80.9	76.4	82.9
Maintenance, repair, access	87.7	90.2	91.6	94.5	85.8	94.1
Mapping	100.0	NA	NA	100.0	NA	NA
Material transfer	89.9	87.5	84.7	87.8	81.5	100.0
Pretreatment and treatment	81.4	83.4	68.3	82.4	86.2	74.2
Records	79.4	70.0	72.3	81.8	81.5	86.1
Secondary containment	77.7	85.5	84.8	76.2	76.4	78.6
Spill planning and response	84.1	91.9	89.4	88.0	85.5	79.0
Storage and cover	84.7	90.7	92.0	89.4	86.9	86.5
Sweeping	NA	NA	NA	NA	NA	NA
Training	77.9	78.1	89.4	83.4	81.8	79.6

Table 2C.2. Mean relative percentages for occurrences of repeat inspections for BMP types within business categories for Phase I permits. Entries of NA means that there were no records with Cycle > 1 for the given combinations of BMP Type and Business Category.

BMP Type[1]	Business Category					
	Auto/Boat	Food/Retail	Land Usage	Indoor/Office	Industrial	Medical/Veterinary
Cleaning, Washing	46.1	51.0	51.4	41.3	33.8	54.2
Discharge, illicit connection	36.4	45.5	36.7	39.8	35.8	75.0
Disposal	40.3	41.7	43.7	40.6	49.5	54.2
Housekeeping	44.4	53.2	47.4	47.0	54.8	53.1
Labeling	44.2	38.9	44.0	36.6	36.3	41.7
Maintenance, repair, access	55.3	61.8	58.6	55.3	48.8	61.3
Mapping	33.3	NA	NA	35.0	NA	NA
Material transfer	38.5	37.5	47.0	52.6	38.8	NA
Pretreatment and treatment	34.4	41.7	25.0	41.7	40.0	14.3
Records	38.2	58.3	29.2	40.3	37.8	61.1
Secondary containment	38.7	50.0	38.3	40.8	41.6	66.7
Spill planning and response	50.8	75.5	60.8	51.6	54.4	47.2
Storage and cover	46.7	48.3	52.6	46.9	51.2	41.7
Training	33.4	50.0	50.0	50.0	20.0	66.7

[1]There are no inspections for BMP Types of "Activity location" or "Sweeping" for Phase I permits.

Table 2C.3. Mean relative percentages for occurrences of repeat inspections for BMP types within business categories for Phase II permits. Entries of NA means that there were no records with Cycle > 1 for the given combinations of BMP Type and Business Category.

BMP Type	Business Category					
	Auto/Boat	Food/Retail	Land Usage	Indoor/Office	Industrial	Medical/Veterinary
Activity location	NA	NA	NA	NA	NA	NA
Cleaning, Washing	45.4	39.2	58.3	32.9	58.3	33.3
Discharge, illicit connection	35.9	41.9	45.8	37.5	37.8	41.2
Disposal	41.9	36.0	66.7	38.0	39.2	48.1
Housekeeping	36.0	38.6	57.6	33.7	33.7	42.9
Labeling	40.3	44.8	53.6	39.2	27.8	40.9
Maintenance, repair, access	40.6	39.5	47.3	36.4	33.8	51.5
Material transfer	29.8	30.6	25.0	32.1	32.5	25.0
Pretreatment and treatment	37.0	39.2	26.7	35.8	29.2	40.0
Records	40.9	32.9	26.1	37.8	37.6	34.5
Secondary containment	35.7	48.9	47.0	41.5	39.1	34.0
Spill planning and response	47.7	37.4	49.4	43.2	47.2	36.7
Storage and cover	33.0	41.5	45.4	38.8	39.2	34.5
Sweeping	NA	NA	NA	NA	NA	NA
Training	46.5	34.4	52.1	43.8	40.1	37.1

Table 2C.4. Median relative percentages for occurrences of repeat inspections for BMP types within business categories, all

data. Entries of NA means that there were no records with Cycle > 1 for the given combinations of BMP Type and Business Category.

BMP Type	Business Category					
	Auto/Boat	Food/Retail	Land Usage	Indoor/Office	Industrial	Medical/Veterinary
Activity location	NA	NA	NA	NA	NA	NA
Cleaning, Washing	100.0	100.0	100.0	100.0	100.0	100.0
Discharge, illicit connection	80.0	100.0	100.0	80.0	80.0	100.0
Disposal	75.0	100.0	100.0	100.0	100.0	100.0
Housekeeping	100.0	100.0	100.0	100.0	100.0	100.0
Labeling	73.2	100.0	75.0	100.0	75.0	100.0
Maintenance, repair, access	100.0	100.0	100.0	100.0	100.0	100.0
Mapping	100.0	NA	NA	100.0	NA	NA
Material transfer	100.0	100.0	100.0	100.0	100.0	100.0
Pretreatment and treatment	83.3	100.0	66.7	90.0	100.0	83.3
Records	80.0	66.7	66.7	80.0	100.0	100.0
Secondary containment	75.0	100.0	100.0	73.2	66.7	80.0
Spill planning and response	100.0	100.0	100.0	100.0	100.0	92.9
Storage and cover	100.0	100.0	100.0	100.0	100.0	100.0
Sweeping	NA	NA	NA	NA	NA	NA
Training	75.0	81.7	100.0	100.0	100.0	85.7

Table 2C.5. Median relative percentages for occurrences of repeat inspections for BMP types within business categories for

Phase I permits. Entries of NA means that there were no records with Cycle > 1 for the given combinations of BMP Type and Business Category.

BMP Type[1]	Business Category					
	Auto/Boat	Food/Retail	Land Usage	Indoor/Office	Industrial	Medical/Veterinary
Cleaning, Washing	100.0	100.0	100.0	100.0	100.0	100.0
Discharge, illicit connection	80.0	100.0	100.0	75.0	80.0	100.0
Disposal	66.7	100.0	100.0	100.0	100.0	100.0
Housekeeping	100.0	100.0	100.0	100.0	100.0	100.0
Labeling	66.7	100.0	75.0	75.0	75.0	100.0
Maintenance, repair, access	100.0	100.0	100.0	100.0	100.0	100.0
Mapping	100.0	NA	NA	100.0	NA	NA
Material transfer	100.0	100.0	100.0	100.0	100.0	NA
Pretreatment and treatment	83.3	100.0	100.0	83.3	100.0	28.6
Records	70.8	83.3	70.8	75.0	100.0	100.0
Secondary containment	80.0	66.7	66.7	87.5	66.7	100.0
Spill planning and response	100.0	100.0	100.0	100.0	100.0	100.0
Storage and cover	100.0	100.0	100.0	100.0	100.0	100.0
Training	66.7	100.0	100.0	100.0	40.0	100.0

[1]There are no inspections for BMP Types of "Activity location" or "Sweeping" for Phase I permits.

Table 2C.6. Median relative percentages for occurrences of repeat inspections for BMP types within business categories for

Phase II permits. Entries of NA means that there were no records with Cycle > 1 for the given combinations of BMP Type and Business Category.

BMP Type	Business Category					
	Auto/Boat	Food/Retail	Land Usage	Indoor/Office	Industrial	Medical/Veterinary
Activity location	NA	NA	NA	NA	NA	NA
Cleaning, Washing	100.0	80.0	100.0	64.6	100.0	100.0
Discharge, illicit connection	80.0	100.0	100.0	100.0	70.8	100.0
Disposal	84.5	100.0	100.0	100.0	75.0	100.0
Housekeeping	75.0	100.0	100.0	100.0	63.3	100.0
Labeling	75.0	100.0	100.0	100.0	66.7	75.0
Maintenance, repair, access	91.7	100.0	100.0	100.0	66.7	100.0
Material transfer	75.0	100.0	100.0	83.3	45.0	100.0
Pretreatment and treatment	80.0	100.0	53.3	90.0	75.0	100.0
Records	91.7	66.7	66.7	90.0	100.0	75.0
Secondary containment	75.0	100.0	100.0	66.7	66.7	77.5
Spill planning and response	75.0	93.8	100.0	100.0	75.0	66.7
Storage and cover	75.0	100.0	100.0	100.0	66.7	100.0
Sweeping	NA	NA	NA	NA	NA	NA
Training	75.0	80.0	100.0	100.0	100.0	82.9

Table 2C.7. Sample sizes for means and medians shown in Tables 2C.2 and 2C.5.

BMP Type[1]	Business Category					
	Auto/Boat	Food/Retail	Land Usage	Indoor/Office	Industrial	Medical/Veterinary
Cleaning, Washing	76	41	6	61	15	4
Discharge, illicit connection	63	22	10	41	15	4
Disposal	74	9	10	59	33	8
Housekeeping	144	37	26	76	57	8
Labeling	124	6	7	37	31	2
Maintenance, repair, access	238	92	33	263	64	24
Mapping	2	0	0	2	0	0
Material transfer	23	4	11	11	15	0
Pretreatment and treatment	13	6	1	2	3	1
Records	38	2	6	35	19	6
Secondary containment	46	5	5	6	7	1
Spill planning and response	309	154	41	219	84	15
Storage and cover	210	55	35	124	75	16
Training	15	1	3	5	1	1

[1]There are no inspections for BMP Types of "Activity location" or "Sweeping" for Phase I permits.

Table 2C.8. Sample sizes for means and medians shown in Tables 2C.3 and 2C.6.

BMP Type	Business Category					
	Auto/Boat	Food/Retail	Land Usage	Indoor/Office	Industrial	Medical/Veterinary
Activity location	0	0	0	0	0	0
Cleaning, Washing	21	13	2	12	2	3
Discharge, illicit connection	76	44	6	42	10	10
Disposal	92	39	9	59	16	54
Housekeeping	70	49	9	26	16	7
Labeling	92	17	7	46	15	11
Maintenance, repair, access	66	41	5	44	16	17
Material transfer	3	6	1	4	2	1
Pretreatment and treatment	29	57	2	20	2	5
Records	42	17	3	24	13	13
Secondary containment	109	29	10	41	16	12
Spill planning and response	202	84	19	148	31	47
Storage and cover	118	31	14	49	23	10
Sweeping	0	0	0	0	0	0
Training	80	39	9	46	9	26

2D *Address the connection between in-person visits and source control BMPs, and identify situations where technical assistance and/or follow-up inspections are needed to ensure required BMPs are implemented.*

Comment: Gather data about percent compliance. Partner with Ecology Local Source Control program to do this study.

No data available on the required versus optional BMPs. Alternative effectiveness questions that can be addressed:

- What are the distributions of Business Categories that reflect follow-up inspections?
- Group results by:
  - Summarize by Phase I and Phase II separately, but <u>not</u> by Permittee or LSCP data source.
  - Summarize by the 4 types of Technical Assistance
  - Out of compliance after initial inspection
  - if new BMPs were added after initial inspection
  - what type of BMPs were added

Data variables to use:

- Inspection Type (Follow-up only)
- Technical Assistance (Yes)
- Technical Assistance Type (4 types)
- In Compliance (No) after previous inspection
- New BMPs (Yes)
- BMP Type (17 types)

To answer the alternative effectiveness question, we had hoped to show counts for each of the main technical assistance types split by BMP type and business category by permit phase and also by BMP category of structural versus operational. In practice, however, there was inadequate data to address the alternative question(s). The entries in the database do not support an analysis. Of all the records in the database, the distribution for the TechnicalAssistanceType variable is 0.0% "BMP specific", 0.6% "Educational", 0.3% "Spill Kit", 0.0% "Training", 38.8% "reject", and 60.4% blank.

For BMPCategory = "Operational" there are only 24 records with technical assistance type of spill kits in Phase II (none in Phase 1) and only 6 records with technical assistance type of educational in Phase II (none in Phase 1). For BMPCategory = "Structural" there are 0 records with technical assistance type of spill kits in Phase I or Phase II, and only 4 records with technical assistance type of educational in Phase II (none in Phase 1). None of the total records mentioned above match on Cycle > 1, InspectionType = "Follow-up" and InCompliance = "No".