ILLICIT DISCHARGE DETECTION AND ELIMINATION (IDDE) REGIONAL DATA EVALUATION for WESTERN WASHINGTON

Prepared for: City of Lakewood and
Washington State Department of Ecology

Project No. 160384-07 • March 31, 2017 Final

Aspect CONSULTING

earth + water

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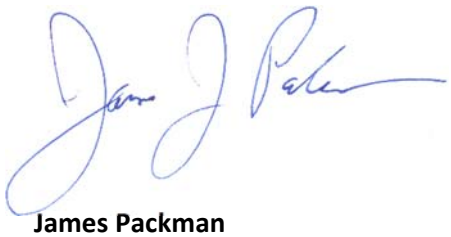

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SUMMARY

This assessment evaluated 2,913 data records for illicit discharge detection and elimination (IDDE) incidents reported for calendar year 2014 by permittees of the Western Washington NPDES Municipal Stormwater Permit. As part of the Stormwater Action Monitoring program (SAM, formerly known as the Regional Stormwater Monitoring Program or RSMP), the Stormwater Work Group's (SWG) Source Identification (Source ID) subgroup leads the effort on coordinating and directing the evaluation of IDDE data. Outcomes from this evaluation help the Source ID subgroup further its goals to provide information about source identification and elimination methods and identify opportunities for regional solutions to common stormwater pollution problems related to illicit discharges and illicit connections.

Data for this evaluation came from 78 Western Washington jurisdictions—this included seven Phase I permittees and 71 Phase II permittees. One Phase I permittee and 14 Phase II permittees reported zero illicit discharges or illicit connections. Among the seven reporting Phase I permittees, 1,269 records were submitted for mostly illicit discharges with only 26 illicit connections reported. About two-thirds of the Phase I records came from the City of Tacoma with the City of Seattle and Pierce County contributing about 10 percent of the records each. Data from the 71 reporting Phase II permittees provided 1,644 records and were mostly illicit discharges with only 33 illicit connections reported. About one fifth of the Phase II records came from the City of Bellevue. Because of the relatively high number of records from Tacoma and Bellevue, much of the data summary and analysis is weighted toward those programs.

Data were analyzed primarily by graphical distributions to compare counts of record types and incident characteristics. Statistical analysis of data was also done to quantitatively compare records. Because data were almost entirely descriptive, an appropriate statistical test for categorical data was chosen, which was the Maximum Likelihood Chi-Square statistic. The chi-square test was used to compare selected pairs of data fields to determine if their distributions are significantly different than random in relation to each other. The key results are summarized in the bullet points below.

- The most common types of pollutants recorded were hydrocarbons and vehicles fluids, sediment from construction and flooding, industrial-related discharges, and sewage. In addition, Phase II permittees had a significant number of records that were not IDDE incidents, such as allowable discharge, reports of solid waste dumping, or unconfirmed citizen complaints. The data analysis showed that the pollutants reported aligned with the sources in logical associations, including spills and accidents discharging hydrocarbons and vehicle fluids, construction activities discharging sediment, and industrial activities providing other chemical discharges.
- The most common source tracing methods used were visual and empirical methods, which included visual reconnaissance, field observations, and mapping analysis. Likewise, visual indicator testing methods were the most prevalent. These indicators included observation of the presence of discharge, the color, odor, or turbidity of discharge, and floatables and solid waste.
- The most common notification methods were direct reporting by the public. These include notification by pollution hotline calls, spills and emergency response, and other direct reports, such as via website or citizen complaints. The second most prevalent notification method was

inspection-related observations and included construction inspections, business inspections, and direct observations from spill response and driving through jurisdiction areas.

- The most common correction and elimination method was the use of best management practices (BMPs), which included adding or improving source control, cleaning up spills, and operational BMPs of education, technical assistance, and behavior or operational modification. Enforcement, another one of the correction and elimination methods, was used in relatively higher proportion for Phase Is than for Phase IIs, which correlates with the Phase I permit requirements to develop and implement an enforcement program of local ordinances for water quality protection. While the Phase II permit also requires "escalating enforcement" if a discharge is not eliminated, the use of enforcement methods by Phase IIs was significantly less than by Phase Is.
- Incident response times for all pollutant categories were mostly within one to three days on average. In addition, the vast majority of incidents were responded to within seven days per permit guidance. A fair amount of records (over 500) did not have enough date information to determine if a response had occurred within seven days for an illicit discharge or within 21 days for illicit connections.
- On average, resolution times for all pollutant categories were mostly under eight days for Phase Is and up to 53 days for Phase IIs for most pollutants. For resolution of the 59 illicit connections reported, the vast majority indicated they were resolved within six months (a permit-related period of interest). A few illicit connection records with long resolution times pulled the average high, especially for Phase II permittees.

To address the potential bias introduced by the relatively large number of records from the cities of Bellevue and Tacoma, the chi-square analysis was run on the data set with and without those cities' data. The analysis of just Bellevue's and Tacoma's data showed nearly identical results as analysis of the overall data set. The analysis without these cities' data, however, showed many significant comparisons but for a slightly different mix of responses in the fields that were compared. The results of the statistical analysis with and without Bellevue's and Tacoma's data supports having a robust regional dataset to represent the various IDDE incidents that occur and how permittees detect and handle them.

The entry of data from permittee submittals was a time-consuming process that would have been more efficient with standardization of IDDE information that permittees report. The Source ID subgroup has begun the standardization process for IDDE data reporting by creating a data entry form for reporting IDDE incidents. The form was sent to permittees in early 2014 for their optional use but few permittees used it. Based on the results of this data evaluation, the Source ID subgroup updated the data entry form with an expanded and improved list of standardized data entry options. The desire to not increase the data entry burden on permittees guided the revision of the form and the number of data fields remained the same at 16 but with expanded answer options. These expanded answer options, along with an improved data entry interface, should provide both consistent and richer data while not increasing the time needed for data entry.

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ACKNOWLEDGMENTS

The project team is composed of: Greg Vigoren from the City of Lakewood; James Packman and Brian Hite from Aspect Consulting; and Kristan Robbins from Cardno, Inc. Data entry was greatly assisted with the help of Garrett Starks, municipal stormwater intern at Washington State Department of Ecology (Ecology) Water Quality program, southwest regional office.

Project guidance and review of the project deliverables was provided by the Stormwater Work Group (SWG) Source Identification (ID) subgroup. The Source ID subgroup members are listed alphabetically below:

- Abby Barnes, Washington State Department of Natural Resources
- Kim Benedict, City of Lacey
- Karen Dinicola, Ecology, SWG staff
- Todd Hunsdorfer, formerly King County
- Nat Kale, formerly Ecology
- Brandi Lubliner, Ecology, SAM/RSMP Coordinator
- Ryaen-Marie Tuomisto, City of Kirkland
- Rick Moore, GeoEngineers
- Blair Scott, King County
- Greg Vigoren, City of Lakewood

Funding for this project was provided by NPDES municipal stormwater permittees in Western Washington through the Stormwater Action Monitoring program (SAM, previously referred to as the Regional Stormwater Monitoring Program), which is administered by Ecology. Grateful acknowledgement is provided to Ecology staff Brandi Lubliner and Karen Dinicola. The project team appreciates their dedication to the SAM program and adaptive stormwater management and for project guidance along the way.

ACRONYMS

BMPs	Best management practices
ERTS	Environmental Response Tracking System
G3	(Permit) General Condition number 3
IDDE	Illicit Discharge Detection and Elimination
MS4	Municipal Separate Storm Sewer System
N/A	Not applicable
NPDES	National Pollution Discharge Elimination System
PARIS	Permit and Reporting Information System
QC	Quality control
RSMP	Regional Stormwater Monitoring Program
SAM	Stormwater Action Monitoring
SWG	Stormwater Work Group
TPH	Total petroleum hydrocarbons
WDNR	Washington Dept. of Natural Resources
WSDOT	Washington State Department of Transportation

1 INTRODUCTION

This report provides the results of an evaluation of 2014 data from municipal illicit discharge detection and elimination (IDDE) stormwater programs in Western Washington. The data set was composed of 2,913 IDDE records from 78 Western Washington permittees who reported IDDE data in 2014—7 Phase I permittees and 71 Phase II permittees (see Appendix A for full list of permittees). The data analysis has been done to support the Stormwater Action Monitoring (SAM) program of the Stormwater Work Group for Puget Sound (SWG). The SAM program, previously known as the Regional Stormwater Monitoring Program (RSMP), was designed to meet the stormwater monitoring needs of municipal separate storm sewer systems (MS4) by permittees of the National Pollution Discharge Elimination System (NPDES) Municipal Stormwater permits for Western Washington (Ecology 2013a for Phase I permit, Ecology 2013b for Phase II permit).

This data analysis supports one of four strategic components of SAM, Source Identification and Diagnostic Monitoring (the others being Status and Trends in Receiving Waters, Effectiveness Studies, and Administration of Pooled Funds). The SWG Source Identification (Source ID) subgroup leads the effort on coordinating and directing the implementation of the Source Identification and Diagnostic Monitoring efforts and has overseen this data evaluation.

1.1 Source Identification Goal and Objectives

The goal of the Source ID subgroup is:

> *Provide information about source identification and elimination methods in use and identify opportunities for regional solutions to common illicit discharges and pollution problems.*

Objectives to achieve this goal were developed by the subgroup based on the SWG work plan for 2016-2017 (PSEMP 2016). The objectives are:

1. Move from anecdotes to data to set priorities on reducing sources of stormwater pollution, including:
    a. Consistent reporting of data to support desired regional analyses,
    b. Store data in a way that can be searched and downloaded,
2. Identify the best ways to solve (fix/reduce/eliminate) these pollution sources, and
3. Evaluate IDDE data to inform regional funding decisions to address common source control issues and reduce pollutants.

This evaluation of 2014 IDDE data is one task implemented by the Source ID subgroup to achieve these objectives.

1.2 2014 Data Evaluation Objectives and Tasks

Previously, a technical memo was prepared that summarized the metadata used in this evaluation and the data compilation process (Cardno 2015). The memo described the wide variety of data types, formats, and quality as submitted by MS4 permittees in 2014. In addition, the memo updated the data analysis approach to be used. Feedback and outcomes from the review of the metadata technical memo (by the Source ID subgroup and others) guided the data analysis. As described in the memo, the proposed objectives for the remaining IDDE data evaluation are:

1. Prepare a comprehensive database from the permittee-submitted IDDE data for the 2014 calendar year,
2. Evaluate and describe the data to address the Source ID subgroup's objectives,
3. Prepare a data summary report, and
4. Identify a list of updated data fields for consistent IDDE data reporting.

Tasks to achieve these objectives were also identified in the technical memo and include the following steps for completing the data compilation and evaluating the data:

1. Hand-enter data as needed to complete the database,
2. Coordinate with Ecology for data entry by a stormwater intern,
3. Contact a handful of permittees to request data in a more user-friendly format,
4. Tabulate the range and distribution of responses for data fields,
5. Review the response distributions and identify data analysis questions,
6. Analyze and summarize IDDE data, including statistical analysis as possible,
7. Write a draft report to present the findings, and
8. Revise report into a final version based on comments from the Source ID subgroup, the SAM Ecology staff, and others.

This report represents the culmination of the steps above and presents the final report for the 2014 IDDE data evaluation.

1.3 Data Submittal Requirements

The data and information used in this evaluation came from annual report submittals required by Phase I and Phase II permittees of the NPDES Municipal Stormwater permits for Western Washington (Ecology 2013a, Ecology 2013b). Entities whose data are included in this analysis are NPDES Phase I and Phase II cities and counties in Western Washington and Phase I Ports of Seattle and Tacoma.

The data came primarily from two questions in the appendices to the permits that specify the annual reporting requirements. For IDDE data submittal, the requirements are the same for both Phase I and Phase II permittees. Essentially, permittees need to submit the number of illicit discharges and connections eliminated during the reporting year or period and a summary of actions taken to eliminate the discharges. Table 1-1 summarizes the annual reporting questions for which IDDE data were submitted by permittees.

Table 1-1. IDDE annual report questions relevant to this evaluation.

Permit Topic	Phase I: Larger Cities and Counties	Phase I: Port of Seattle and Port of Tacoma	Phase II: Smaller Cities and Counties
Number of Illicit Discharges and Connections	Question 47. Number of illicit discharges, including illicit connections, eliminated during the reporting year (S5.C.8.d.iii and iv)?	Question 13. Number of illicit discharges, including illicit connections, eliminated during the reporting period (S6.E.3.d)?	Question 19. Number of illicit discharges, including illicit connections, eliminated during the reporting year (S5.C.3.d.iv)?

Permit Topic	Phase I: Larger Cities and Counties	Phase I: Port of Seattle and Port of Tacoma	Phase II: Smaller Cities and Counties
Summary of Actions	Question 48. Attach a summary of actions taken to characterize, trace and eliminate each illicit discharge found by or reported to the permittee. For each illicit discharge, include a description of actions according to required timelines (S5.C.8.d.iv)?	Question 13b. Attach a summary of illicit discharges discovered and actions taken to eliminate the discharges (S6.E.3.d)?	Question 20. Attach a summary of actions taken to characterize, trace and eliminate each illicit discharge found by or reported to the permittee. For each illicit discharge, include a description of actions according to required timeline (S5.C.3.d.iv)?

In addition to the IDDE submittal requirements as noted in Table 1-1, the Source ID subgroup created an "IDDE Incident Reporting Form" for submitting IDDE data in annual reports (Ecology 2015a). The form comprises a list of preferred data fields and anticipated potential answer options and was provided to permittees in early 2014 as an optional, albeit preferred, format (K. Dinicola, personal communication). During the review of this data evaluation, the Source ID subgroup updated the reporting form to reflect a broader range of data field answer options based on data submitted by permittees and analyzed here. The original and updated forms are provided in Appendix B.

1.4 Definitions: Illicit Discharge, Illicit Connection, Incident, and Event

The following definitions of illicit discharge and illicit connection were used in this evaluation as they are defined in the NPDES permits (Ecology 2013a, Ecology 2013b):

> *"Illicit connection" means any infrastructure connection to the MS4 that is not intended, permitted, or used for collecting and conveying stormwater or non-stormwater discharges allowed as specified in this permit. Examples include sanitary sewer connections, floor drains, channels, pipelines, conduits, inlets, or outlets that are connected directly to the MS4.*
>
> *"Illicit discharge" means any discharge to a MS4 that is not composed entirely of stormwater or of non-stormwater discharges allowed as specified in this Permit.*

Three quarters of the IDDE records reported by permittees were for IDDE events that fit these definitions (2,173 out of 2,913 total records, 74.6 percent). The remaining 25 percent of the records were for incidents that were non-IDDE incidents, which included other types of events, no events at all (after inspection), and a small number of inconclusive records. The non-IDDE records include a variety of incidents, including complaints that could not be confirmed, solid waste dumping, and allowable discharges, such as flooding, stormwater run-on, source tracing dye, and tides.

Many of the non-IDDE incidents were learned about by some form of public reporting. Because the permits require having a pollution hotline, it was decided to consider all data submitted by permittees rather than exclude those records that weren't IDDE-related. The database was prepared to represent the efforts by permittees to respond to all incidents reported. Thus, the term "incident" refers to a report of any type of event, be it IDDE in nature or not. When appropriate, the analysis and discussion is limited to just IDDE events; for overall data summaries, the non-IDDE events and records that could be resolved are included. Data that were deemed an IDDE indicate either pollution is occurring, has occurred, was prevented from occurring or minimized, and/or was contained, i.e., didn't necessarily reach the MS4.

2 METHODS

Methods are described below for how the database was created and the data analysis methods used. Ultimately, a database was created with 2,913 permittee submittal records among 78 reporting jurisdictions.

2.1 Data Sources and Formats

IDDE data were retrieved primarily from Ecology's Permit and Reporting Information System (PARIS) intended for permittees to submit permit-related data (Ecology 2015b). Data were also retrieved from an online database created by Ecology as an optional submittal format for permittees' IDDE incident data (Ecology 2015c). The online data submittal option was created by Ecology to provide a standardized set of data fields for reporting incidents; however, relatively few (seven) permittees used it.

Sources of the data in permittees' submittal came from a variety of municipal programs, including IDDE/spill response, environmental/stormwater inspections, fats/oils/grease (FOG) programs, private drainage inspection (PDI) programs, health department inspections, operations and maintenance programs, and all-inclusive municipal public works departments. All data were considered for this evaluation to reflect different organizational structures and programs to address the IDDE permit requirements.

Permittees submitted data in a variety of formats, including spreadsheets, text documents, portable document format, and scanned field forms and database output. A spreadsheet database was created to compile the comprehensive dataset from all permittees. Most submittals had data in a copyable format and some were copyable as-is (e.g., spreadsheet to spreadsheet). However, just under half of the total number of incidents needed to be hand-entered as they were from file formats that described IDDE incidents in descriptive terms or were from database output files that required copying and pasting line by line. Recommendations to reduce time-consuming data entry for future IDDE data collection are described in Section 4.1

2.2 Database and Data Fields

A spreadsheet database was created to organize the permittee submittal records. Most records could be copied into the database from the source files, but some required hand-entry. To populate many of the database fields, it was necessary to completely read through the information in each record and enter the best answer based on the field definitions and answer options. Data entry was done by project consultant staff with significant help by a stormwater intern at Ecology.

The data fields were decided based on the highest priority data fields from the Ecology online submittal form (see Appendix B) as well as desired fields to try to address the Source ID subgroup objectives. An initial set of data fields was proposed in the metadata technical memo (Cardno 2015) and refined based on comments and feedback. The data fields were further defined and a few additional fields were added during the final database population process. Table 2-1 provides the final data fields used, the data format, and the field definition.

Table 2-1. Data Fields Used to Populate IDDE Database.

	FIELD NO.	FIELD NAME	FORMAT	DEFINITION
Fields from or related to the online reporting form	1	Jurisdiction Name	text	Permittee name: "City of ", " County", or "Port of "
	2	Incident Found?	text	y/n per definition of incident: any pollutant or potential pollutant was found at the site, even if not a IDDE discharge or connection
	3	Incident Type	text	The type of event that occurred: Illicit discharge, Illicit connection, inconclusive, or N/A
	4	Incident ID	numeric and/or text	Unique ID as assigned by permittee
	5	Date reported	date	Date incident occurred (initial)
	6	Days to respond	numeric	Calculated number of days for permittee to respond to incident after notification
	7	Date begin response	date	Date response begun by permittee
	8	Days to End of Response	numeric	Calculated number of days for permittee to conclude incident
	9	Date end response	date	Date response ended by permittee
	10	Date Final Resolution	date	Date incident was resolved
	11	Days to Resolve Incident	numeric	Calculated number of days to resolve issue
	12	Final Resolution In Process	text	Description of incident resolution
	13	Location: address, intersection, or coordinates	numeric and/or text	incident address, intersection, or geo coordinates (except for zip code, see next field)
	14	Zip code	5-digit zip code	Incident location zip code
	15	Precipitation in previous 24hrs	numeric and/or text	Rainfall depth in 24 hrs prior to incident date or brief text description per permittee report
	16	Incident frequency	numeric	Continuous, Intermittent, One-time spill or discharge, short-term, N/A
	17	Investigated within 7 days per program procedures?	text	y/n to answer question
	18	If suspected illicit connection, investigated within 21 days?	text	y/n to answer question
	19	Final resolution of illicit connection within 6 months?	text	y/n to answer question
	20	How did you learn about the problem?	text	Description of how problem was identified
	21	How Learn Category	text	Assigned category of how the problem was learned about
	22	ERTS Number	numeric and/or text	ERTS case number or Yes if it was reported to ERTS but no number provided
	23	Source Tracing Methods Used?	text	were source tracing methods used to trace discharge?
	24	Source Tracing Methods: Visual Recon	text	x or blank
	25	Source Tracing Methods: Dye Testing	text	x or blank
	26	Source Tracing Methods: Video Inspection	text	x or blank
	27	Source Tracing Methods: Smoke Testing	text	x or blank
	28	Source Tracing Methods: Pressure Testing	text	x or blank
	29	Source Tracing Methods: Other	text	other types of source tracing methods used
	30	Source Tracing Category	text	Assigned category of source tracing method used
	31	Indicator Testing Done?	text	y/n was indicator testing done?
	32	Indicator Testing: Visual	text	x or blank
	33	Indicator Testing: Odor	text	x or blank
	34	Indicator Testing: Fecal Coliform	text	x or blank
	35	Indicator Testing: Flow	text	x or blank
	36	Indicator Testing: Color	text	x or blank
	37	Indicator Testing: Turbidity	text	x or blank

	FIELD NO.	FIELD NAME	FORMAT	DEFINITION
	38	Indicator Testing: Detergent/Surfactants	text	x or blank
	39	Indicator Testing: pH	text	x or blank
	40	Indicator Testing: Ammonia	text	x or blank
	41	Indicator Testing: TPH/Oil	text	x or blank
	42	Indicator Testing: Nitrates	text	x or blank
	43	Indicator Testing: Chlorine/Chloride	text	x or blank
	44	Indicator Testing: Other	text	other types of indicator testing methods used
	45	Indicator Category	text	Assigned category of indicator testing method used
	46	Type of discharge	text	general type of discharge
	47	Pollutant Identified	text	Name of pollutant (if identified)
	48	Pollutant Identified_2	text	Name of second pollutant (if identified)
	49	Pollutant Category	text	Assigned category of pollutants
	50	Pollutant Source or Cause	text	Description of source or cause of discharge
	51	Pollutant Source Category	text	Assigned category of source or cause
	52	Property Ownership	text	General ownership of property where incident occurred: commercial, municipal, or residential.
	53	Land Use	text	Specific land use description if provided. Leave blank if nothing specific noted.
	54	Correction/Elimination Method: Problem Not Abated	text	x or blank
	55	Correction/Elimination Method: Add or Improve Source Control	text	x or blank
	56	Correction/Elimination Method: Behavior/Operation Modification	text	x or blank
	57	Correction/Elimination Method: Educational/Technical Assistance	text	x or blank
	58	Correction/Elimination Method: Enforcement	text	x or blank
	59	Correction/Elimination Method: Clean up	text	x or blank
	60	Correction/Elimination Method: Other	text	x or blank
	61	Correction/Elimination Category	text	Assigned category of correction/elimination method
Additional fields that some permittees reported	62	Enforcement	text	Description of enforcement or corrective action
	63	Discharge quantity	text	description of volume or mass of discharge with units, if reported.
	64	Discharge quantity category	text	Assigned category of discharge quantity method
	65	Discharge frequency	text	Range of discharge frequency, if reported. See Field 8
	66	Discharge to MS4?	text	y/n does record indicate if discharge occurred to MS4?
	67	Record No.	numeric	unique ID for database
Other fields added for data analysis and completeness	68	Permittee type	text	Phase I or Phase II
	69	Original description	text	Copy/paste record notes and description exactly as permittee wrote
	70	Data Entry Notes	text	describe inconsistency or other problem with record data
	71	Conflicting information: resolved but ongoing	text	Lists a date for being resolved but the comments state the incident is on-going

2.3 Data Standardization

The data compilation included standardizing responses to fit the data fields for the project database. Lists of set answer options were developed and used that captured the range of information reported by permittees. This allows for comparability across jurisdictions and adapts the varying document formats, level of detail, and information reported to a consistent data format.

The data standardization process required some degree of subjective interpretation as many fields were populated based on the narrative descriptions, inspector notes, or mapped from other fields in the submittal. In order to minimize bias from this interpretive process, the lists of set answer options were updated throughout the data compilation as were the previously completed data entries.

2.4 Data Quality Control

The lists of standardized responses were developed as data were being entered, which sometimes required subjective judgment by the staff entering the data for what standardized term to use. Thus, a few quality control (QC) steps were incorporated into the data entry. One QC step included having project staff review the entries made by other staff for consistency both within a jurisdiction's incident descriptions and among jurisdictions data that was already entered. For some data, the standardized responses were discussed among project staff to determine the best fit for incident reports that were confusing, inconclusive, or short on detail. In addition, basic QC steps were done including checking dates for proper format, spelling checks, duplicates, and typos.

2.5 Data Analysis Methods

Methods used to analyze the IDDE data focused primarily on comparisons of count data. Data were evaluated in meaningful groups, such as comparing the use of different source tracing methods for different types of pollutants. Summaries of data were oriented around addressing the Source ID subgroup's objectives as noted above.

Statistical analysis was done to evaluate statistical differences in count data for fields including pollutant type, source tracing methods, and indicator testing used in comparison to permittee phase, pollutant sources, and quantity of discharge, among others. Statistical procedures included assembling count data into contingency tables and using the Maximum Likelihood Chi-squared statistic to identify significant differences. This method was selected due to its applicability to categorical data.

3 RESULTS

Summaries of the IDDE records are provided below. The summary includes what data are represented in the data set and continues through the range and number of responses for the data fields. Groupings and comparisons of data are provided to address the Source ID subgroup objective for prioritizing efforts to reduce common sources among jurisdictions.

3.1 Data Represented

In total, 2,913 records were obtained from the permittee submittals with 1,269 from Phase Is and 1,644 from Phase IIs as shown in Figure 3-1. Seven Phase I permittees and 71 Phase II permittees submitted data, and the alphabetical distribution of records from each jurisdiction is shown in Figure 3-2.

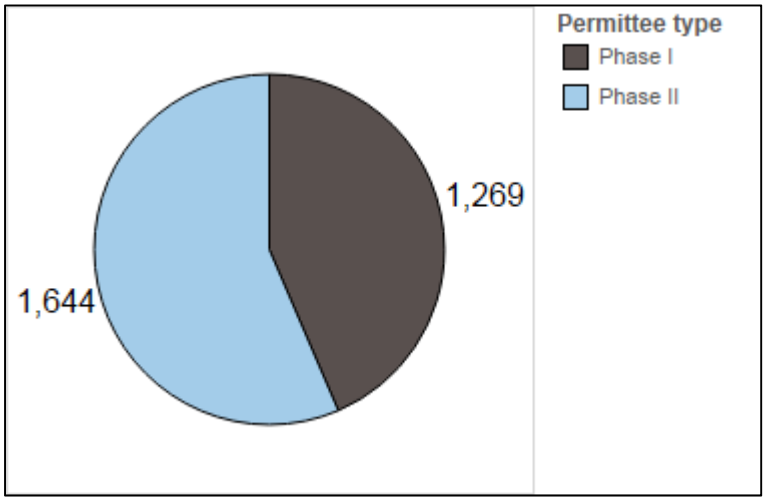

Figure 3-1. Number of records submitted.

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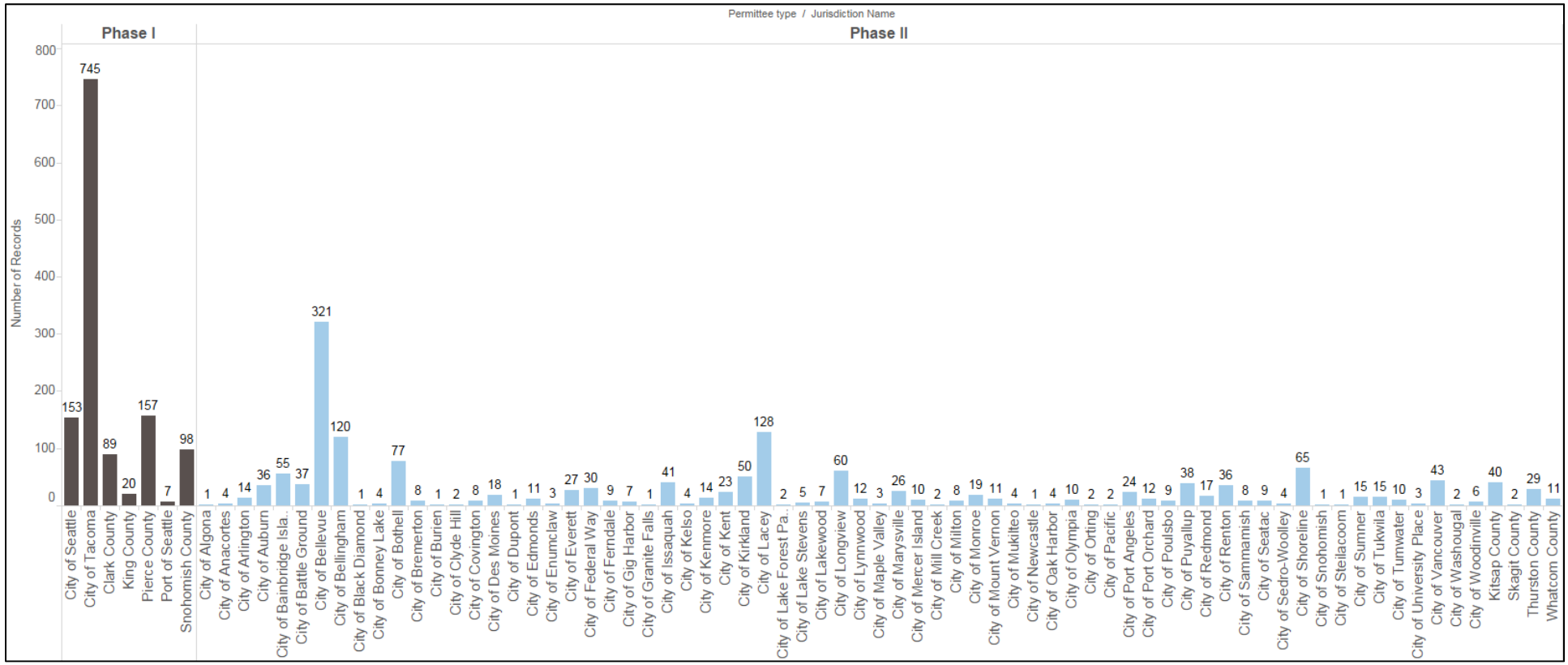

Figure 3-2. Number of records submitted by permittees alphabetically.

As noted in Section 1.4, about 25 percent of records were not IDDE events, but many of these records reported some type of pollution-related event. As the database was populated, the field of Incident Found (field 2) was used to indicate if an incident of any kind occurred. Among the 2,913 total records, 2,407 records were incidents, 351 records were coded as no incident, and 155 were coded as inconclusive. Figure 3-3 shows the distribution of total records by whether an incident of any kind occurred or if the information was inconclusive.

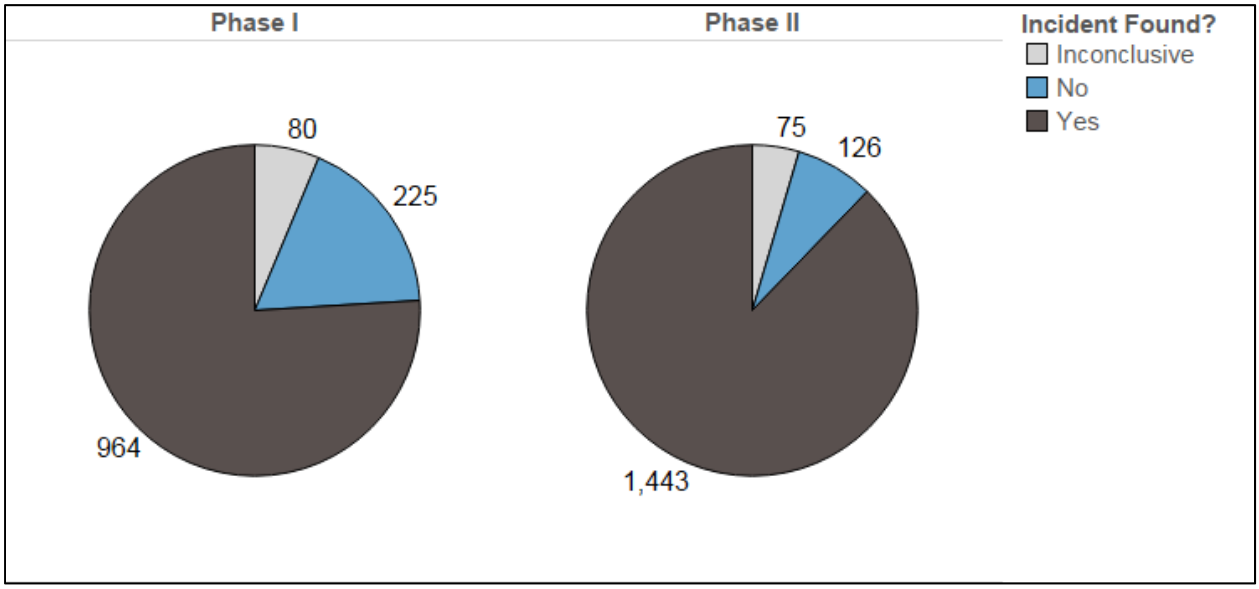

Figure 3-3. Occurrence of any type of incident.

Incidents were also coded by type as illicit discharge, illicit connection, inconclusive, or non-IDDE. Among 2,913 total records, 2,133 records were illicit discharges, 59 were illicit connections, 90 were inconclusive, and 631 records were non-IDDE in nature. Most of the non-IDDE events were allowable discharges (e.g., flooding, stormwater run-on, source tracing dye, and tides, clogged storm drains with natural objects) and included solid waste dumping, complaints that could not be confirmed, and no actual event upon inspection. Figure 3-4 shows the distribution of records by event type separated by permittee phase.

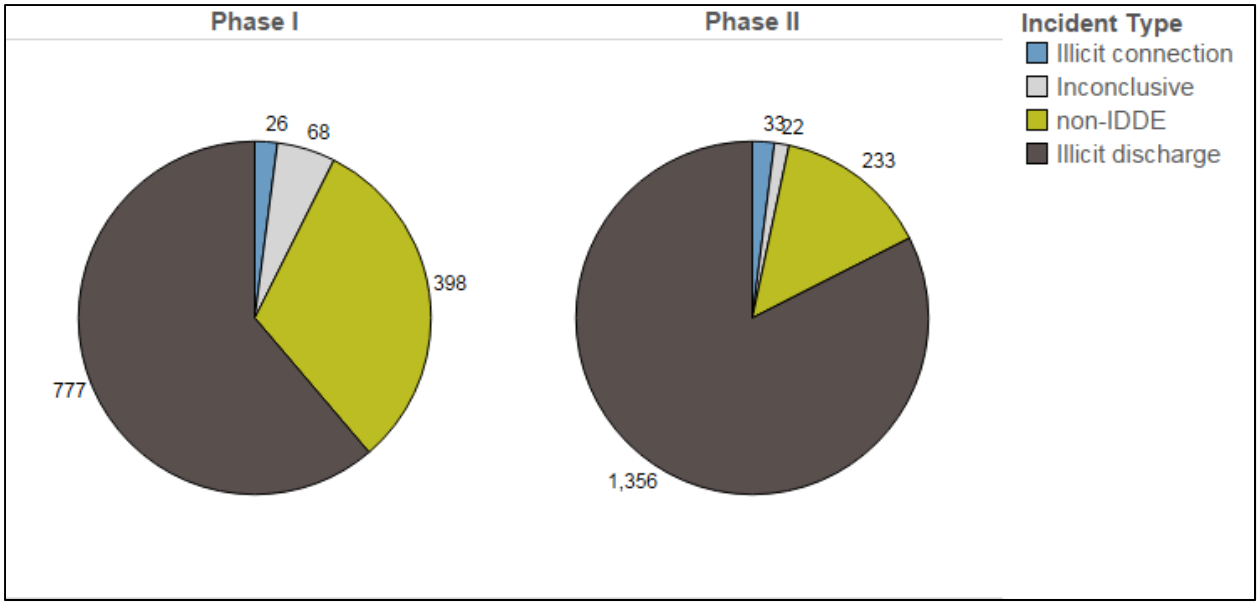

Figure 3-4. Incident type.

Figure 3-5 shows the distribution of records submitted by Phase I permittees with groupings that show if an incident occurred ("yes" or "no") or if the record was inconclusive. Records submitted by Phase I permittees ranged from 11 to 625 per permittee. One Phase I permittee, the City of Tacoma, submitted far more IDDE records than the other Phase Is. Another Phase I (Snohomish County) submitted a general statement that summarizes the investigation of incidents and the number of illicit discharges and connections but does not provide detail, such as pollutant type or correction method when illicit discharges occurred. For the purposes of this IDDE analysis, all-inclusive statements like this without supporting data were considered incomplete, and individual records were created and coded with as much information as possible based on the statement provided. Sometimes this meant only noting whether or not an incident occurred with no detail in the database record.

Figure 3-6, Figure 3-7, and Figure 3-8 show the distributions of records submitted by Phase II permittees. The figures show, respectively, incidents that occurred, no incidents, and inconclusive incidents. Incident numbers ranged from 1 to 300 per permittee. One Phase II permittee, the City of Bellevue, submitted far more IDDE records than the other Phase IIs.

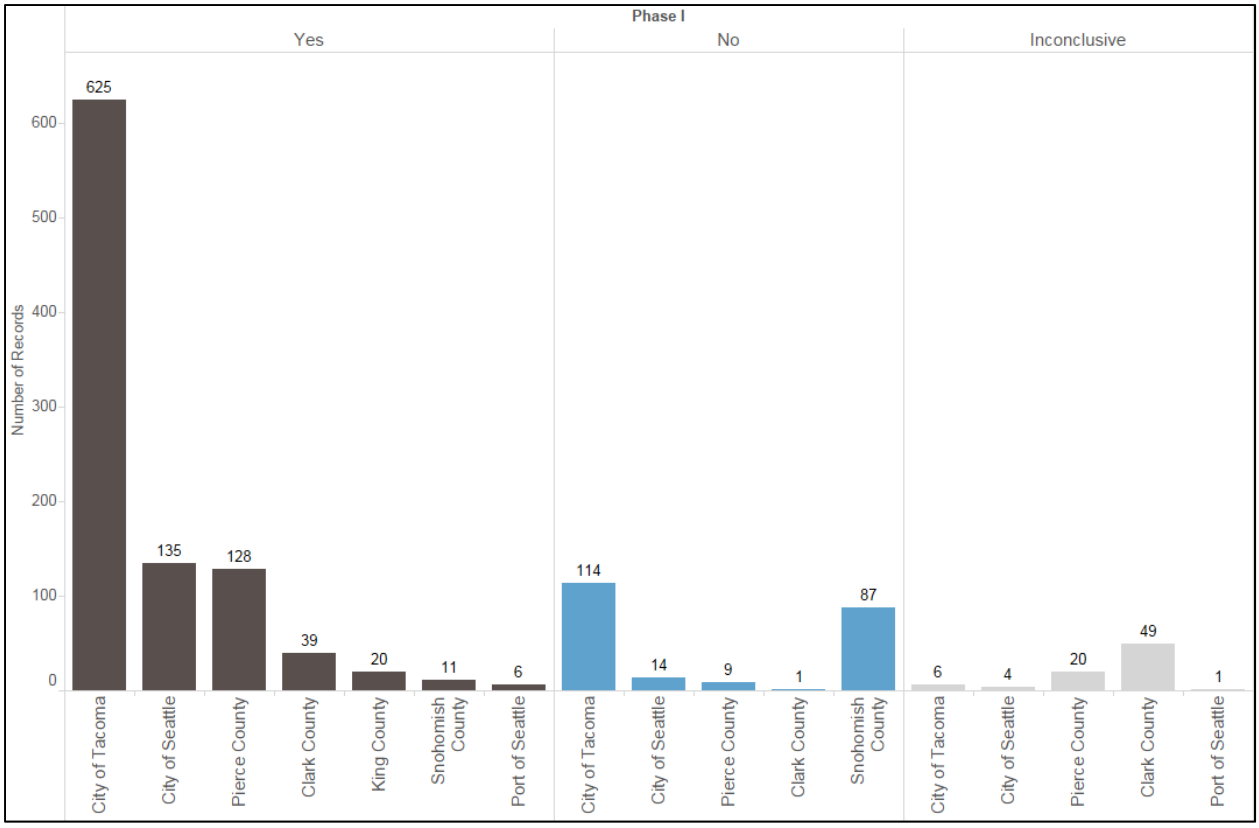

Figure 3-5. Records submitted by Phase I permittees for conclusive incidents, no incidents, and inconclusive incidents.

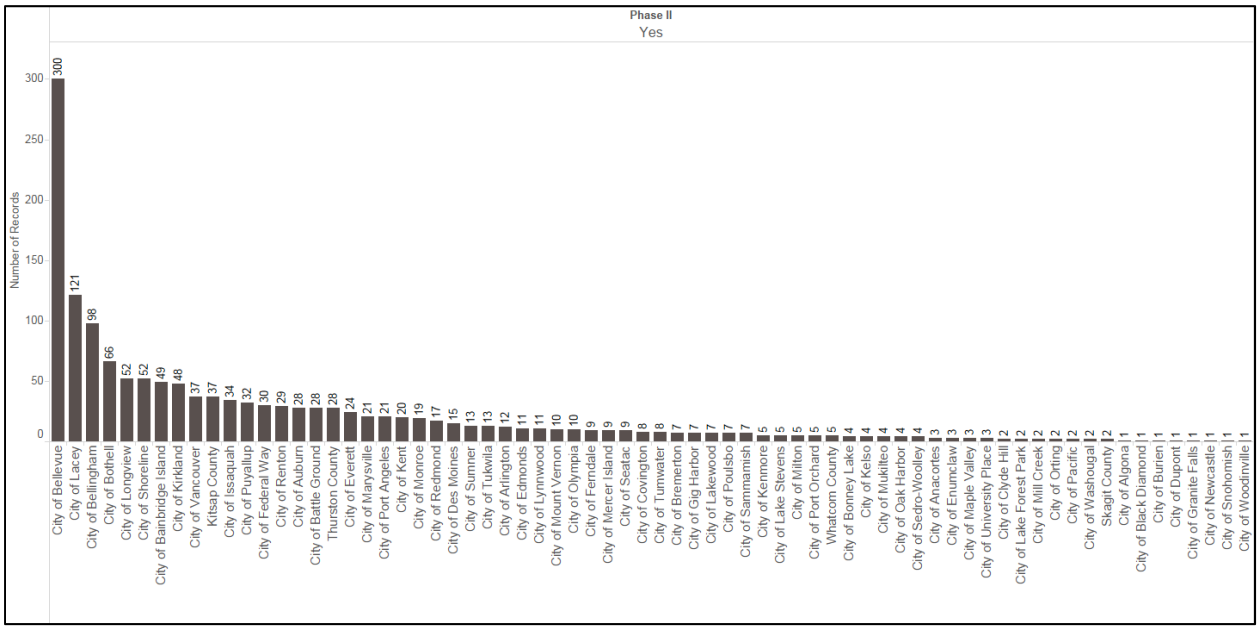

Figure 3-6. Records submitted by Phase II permittees for conclusive incidents.

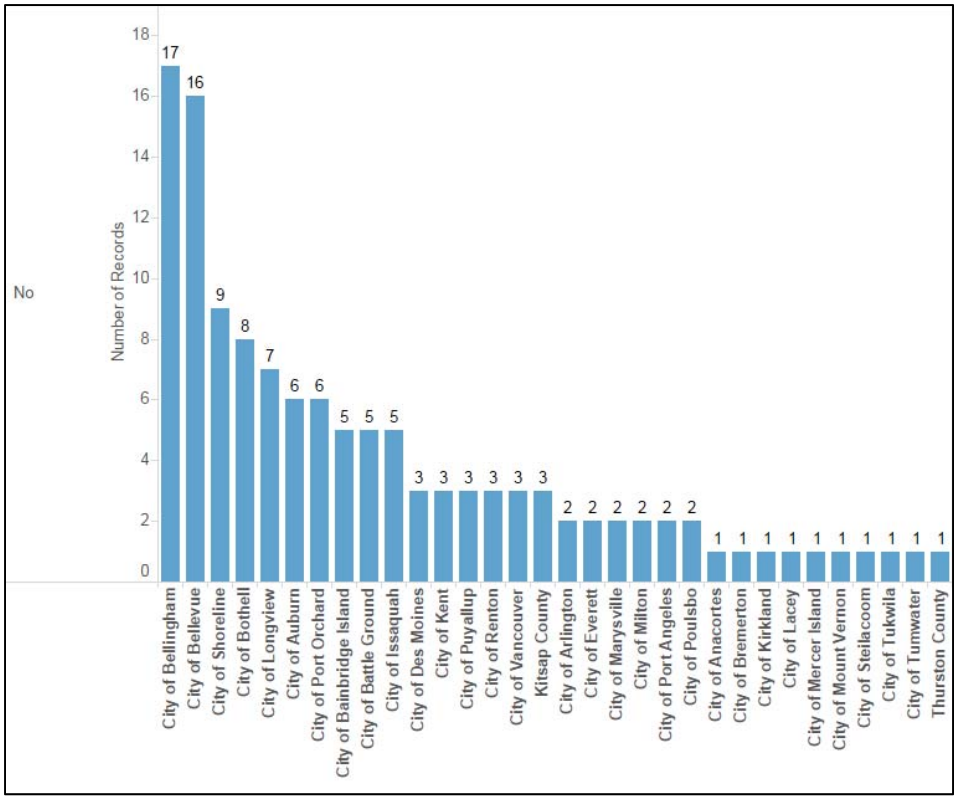

Figure 3-7. Records submitted by Phase II permittees for no incidents.

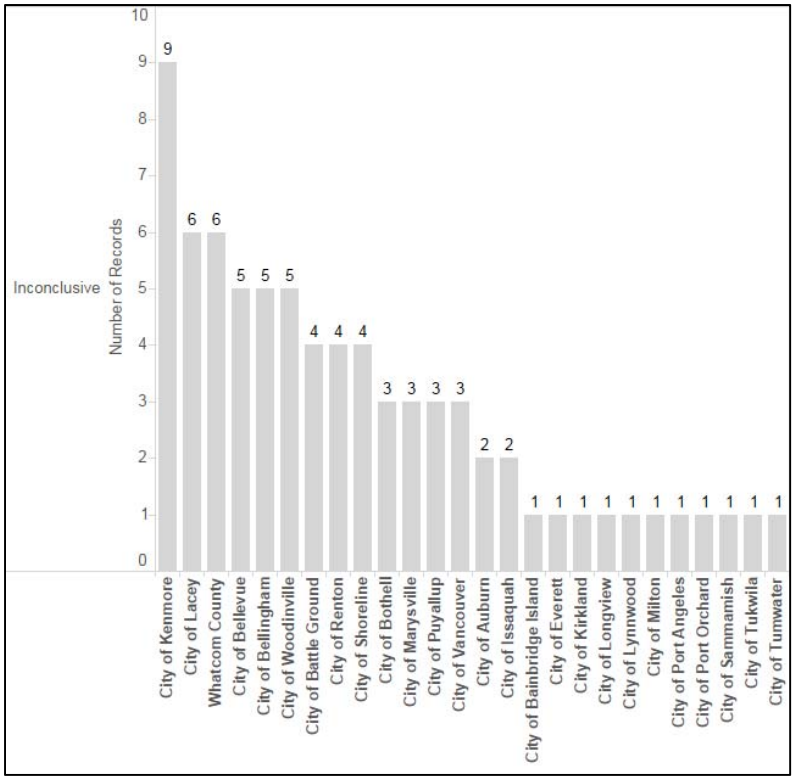

Figure 3-8. Records submitted by Phase II permittees for inconclusive incidents.

The dates represented by the records with any type of incident are almost entirely from 2014. Some records, however, were for incident dates in other years dating back to 2009 and into 2015. 2013 had the second highest number of dates (70 records) and other years besides 2014 had between four and 10 records each. Figure 3-9 shows the distribution of records by month across years submitted. A small number of records did not include incident date and are shown as null in Figure 3-9.

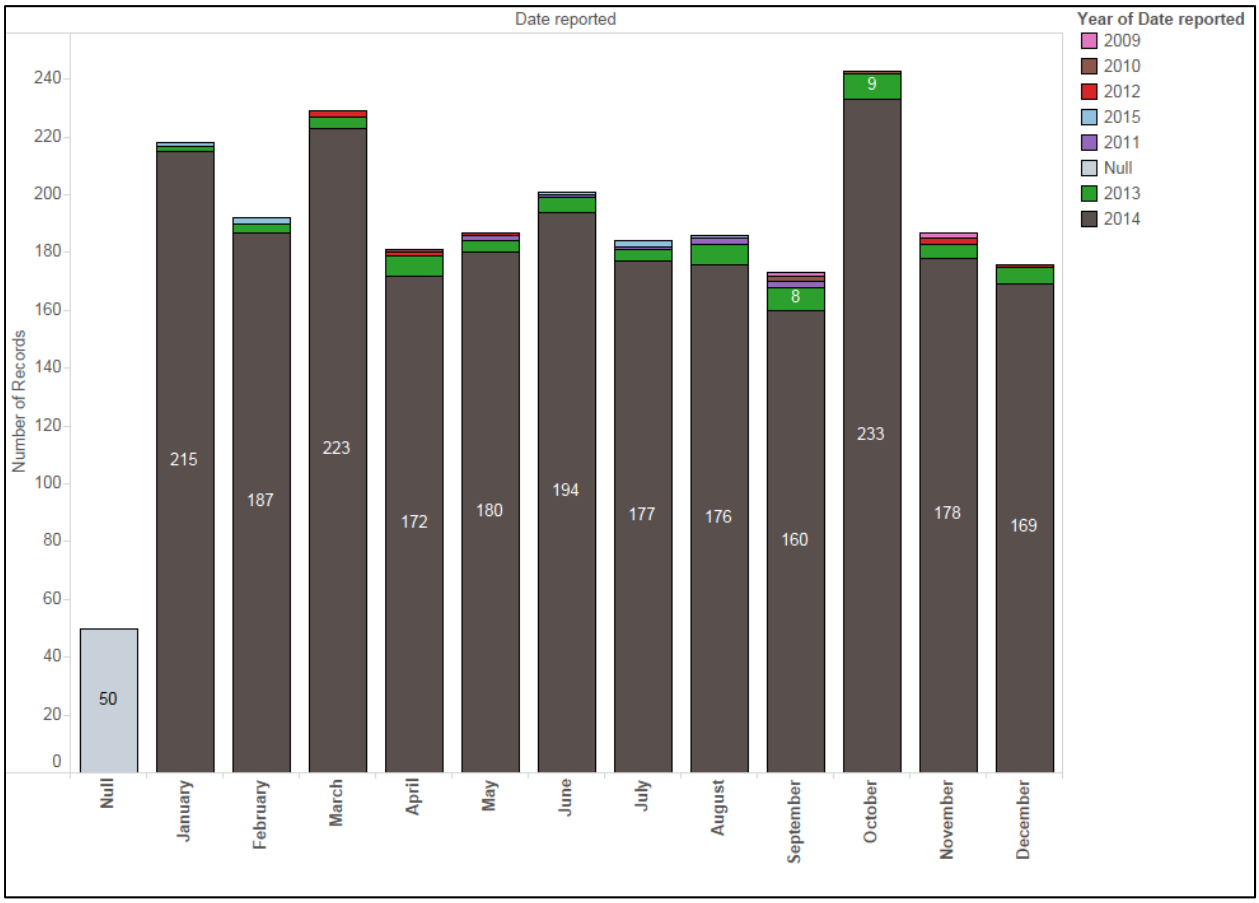

Figure 3-9. Distribution of incidents in months and years initially reported.

The wet season versus dry season distribution of incidents was also assessed per the NPDES permit definitions: wet season is October 1 to April 30 and dry season is May 1 through September 30. As shown in Figure 3-10, the majority of incidents occurred in the wet season for both permittee types in a similar percentage. In the wet season, 62.6 percent of incidents occur in Phase Is jurisdictions and 60.5 percent of incidents occurred in Phase II jurisdictions.

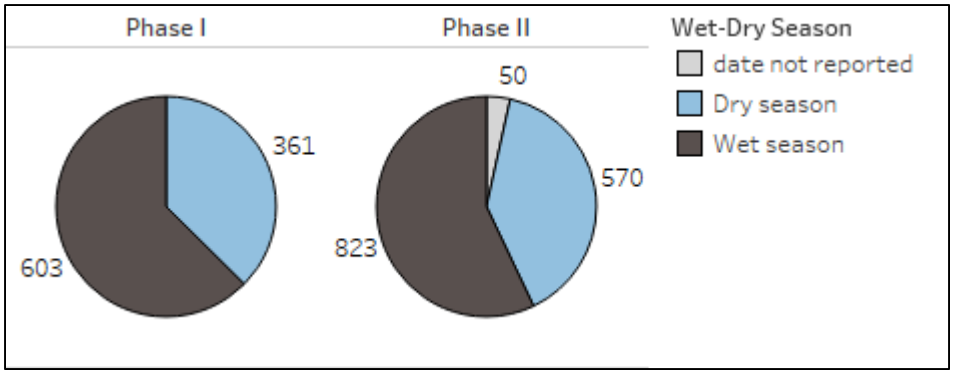

Figure 3-10. Distribution of incidents by wet vs. dry season.

A further breakdown by incident type across seasons is provided in Figure 3-11. Phase Is had a relatively larger proportion of non-IDDE incidents than Phase IIs--this was case during both the wet season and dry season. Among the relatively few records without dates reported (Phase IIs only), almost all incidents were illicit discharges.

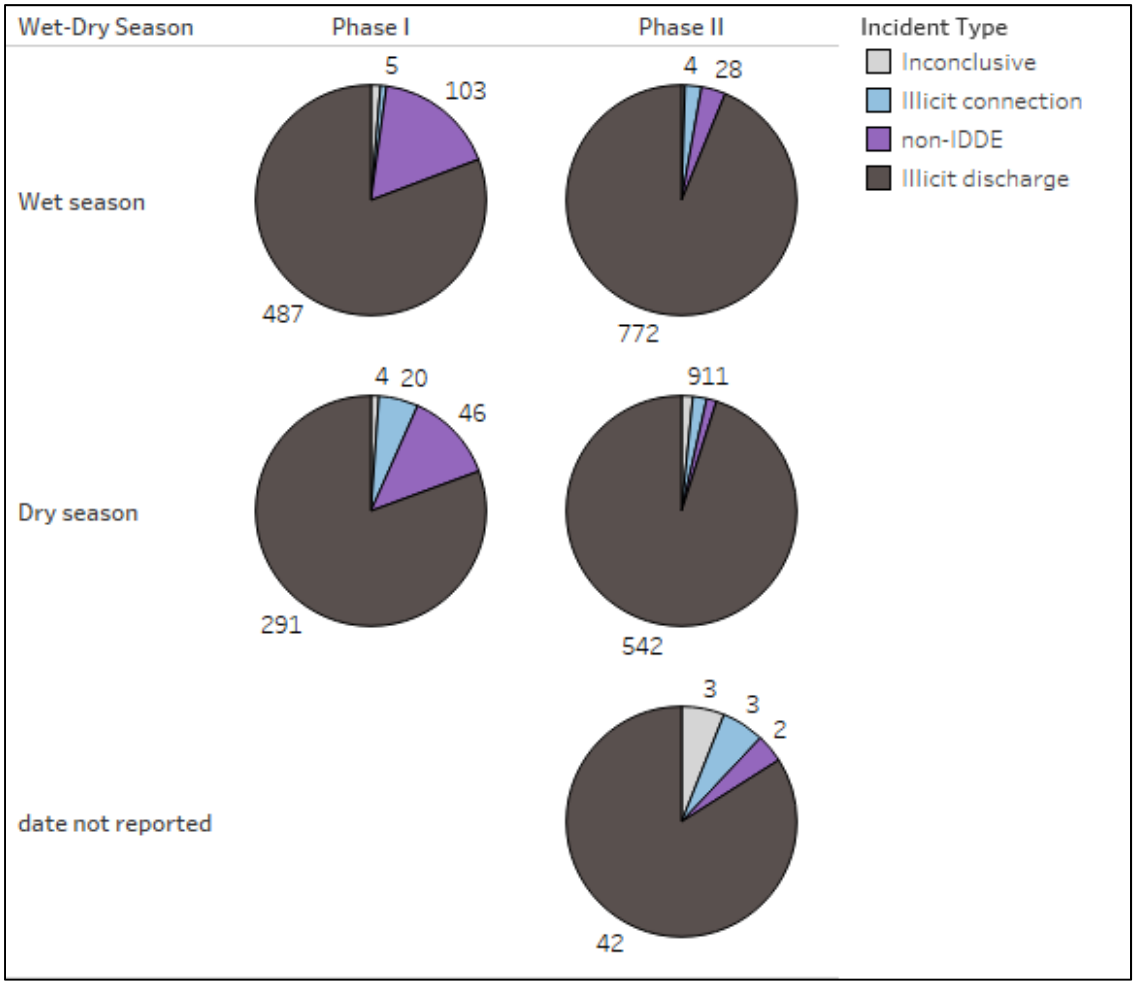

Figure 3-11. Incident type by season and permittee phase.

A comparison of proportions of incident types by wet versus dry season is provided in Table 3-1. Percentages in Table 3-1 were calculated based on all records where an incident of any type occurred but does not include records where no incident was found to have occurred. Phase II permittees reported a higher percentage of illicit discharges than Phase I permittees in both wet and dry seasons; however, Phase Is reported a higher percentage of non-IDDE incidents than Phase IIs for both seasonal periods.

Table 3-1. Percentages of incident type by season and permittee phase.

	Illicit Discharge		Illicit Connection		non-IDDE		Inconclusive	
Season	**Phase I**	**Phase II**	**Phase I**	**Phase II**	**Phase I**	**Phase II**	**Phase I**	**Phase II**
Wet Season	50.5%	53.5%	0.5%	1.3%	10.7%	1.9%	0.8%	0.3%
Dry Season	30.2%	37.6%	2.1%	0.8%	4.8%	0.6%	0.4%	0.6%
date not reported	-	2.9%	-	0.2%	-	0.1%	-	0.2%

3.2 Types of Pollutants

Many pollutant descriptions were provided in the permittee records, including similar pollutants that were described with various terms. Through the data standardization process, a total of 53 discrete pollutants were identified and used in the database for all records that indicated pollutant type. To make the summary of pollutant types manageable, the 53 pollutant types were grouped into eight categories. Table 3-2 lists the pollutant types and pollutant categories, and the assignment of pollutants to the eight categories is explained below.

Individual pollutant types were not always exclusive to just one pollutant category and this created crossover of some pollutants among multiple categories. The same pollutant may be part of multiple categories depending on the context and additional information in the record. Examples of this include: potable water, pool water, and fire suppression foam, which may or may not be allowable discharges; turbidity-causing substances, including soil, sediment, or concrete, which was either solid waste, construction discharge, or allowable discharge; and trash or refuse, which could be either solid waste or industrial waste. In addition, many records reported multiple wastes, which explains why some unexpected pollutants are grouped under some categories, for example pet waste listed under sewage and sediment/soil/construction, and paint listed under industrial discharge and solid waste. In the cases with multiple pollutants noted, the assigned pollutant category reflected the primary pollutant.

The pollutants identified were those reported by permittees, which explains some of the lumping of pollutant types in the database, such as oils with lubricants or sewage with septage. Pollutants were assigned to the pollutant categories based on the range of pollutants reported, similar characteristics in pollutant properties, potential effects on water quality, sources from similar pollution-generating activities, or consistency in terminology use by permittees. The category of Other was used to group pollutants that were either not identified, were unclear as the basic chemical composition and potential source (such as unspecified foam), and where the record was unclear if discharge was illicit (such as potable water).

Table 3-2. Pollutant types reported among the eight pollutant categories.

Allowable Discharge, Natural Cause	Cleaning Chemicals	Hydrocarbons, Vehicle Fluids	Industrial Discharge, Chemicals	Other	Sediment, Soil, Construction	Sewage	Solid Waste, Garbage
Allowable discharge	Bleach	Chemical waste	Acetone	Discolored/ Turbid water	Cement/ Concrete	Chlorinated pool water	Cement/ Concrete
Cement/ concrete	Carpet cleaning waste	Discolored/ Turbid water	Cement/ Concrete	Foam	Discolored/ Turbid Water	Discolored/ Turbid water	Corn starch
Fire fighting foam	Chemical waste	Ethylene glycol	Chlorinated pool water	N/A	Lime	Food waste/ Grease/Oil	Discolored/ Turbid Water
Fire fighting runoff	Chlorinated pool water	Fire fighting foam	copper azole	None found	Oil/lubricant/ unspecified	Pet waste	Food waste
Groundwater	Food waste	Fire fighting runoff	Fertilizer	Not identified	pet waste	Sediment/ Soil	metal
Iron bacteria	Food waste/ Grease/Oil	Food Waste/ Grease/Oil	Fire fighting foam	Potable water	Plaster	Sewage/ Septage	Not identified
Natural Source	Hydrochloric/ Muriatic acid	Gas/diesel	Herbicide	Sediment/Soil	Potable water	Soap/ Detergent	Paint
None found	Oil/lubricant/ unspecified	Heating oil	Hydrochloric/ Muriatic Acid		Sawdust	Stormwater	Sediment/ Soil
Potable water	Sediment/Soil	Kerosene	Lead		Sediment/Soil	Wastewater	Sewage/ Septage
Sediment/Soil	Soap/ Detergent	Mineral Oil	Paint		Sewage/ Septage		Trash/Refuse
Stormwater	Sodium Hypochlorite	not identified	Plaster		Stormwater		Vehicle fluids
Tide surcharge	Trash/refuse	Oil/lubricant/ unspecified	Potable water		Vactor decant fluid		wastewater
Trash/refuse	Vehicle fluids	Paint	Refrigerant		Vactor decant liquid		
Vehicle fluids	Wastewater	PCBs	Sediment/Soil		Vehicle fluids		
Yard waste		Potable Water	Soap/ Detergent		Wastewater		
		Roofing Tar	Sulfuric acid		Yard waste		
		Sediment/Soil	Trash/Refuse				
		Soap/Detergent	Vehicle fluids				
		Transformer Oil	Wastewater				
		Trash/Refuse	Wood Preservative				
		Vehicle fluids					
		Wastewater					

Figure 3-12 shows the distribution of incidents grouped by pollutant type category among the Phase I and Phase II permittees. Records where no incident occurred are not included in Figure 3-12. For each permittee type, the type of incident is indicated by stacked bars and includes illicit discharges, illicit connections, non-IDDE incidents, and inconclusive records. Hydrocarbons and vehicle-related substances were most often reported by both permittee types, followed by sediment, soil, and pollutants from construction activities. Incidents with pollutants in the hydrocarbon and vehicle fluids

category were the most numerous for both Phase I and Phase II permittees; however, pollutants in this category were relatively more numerous for Phase IIs.

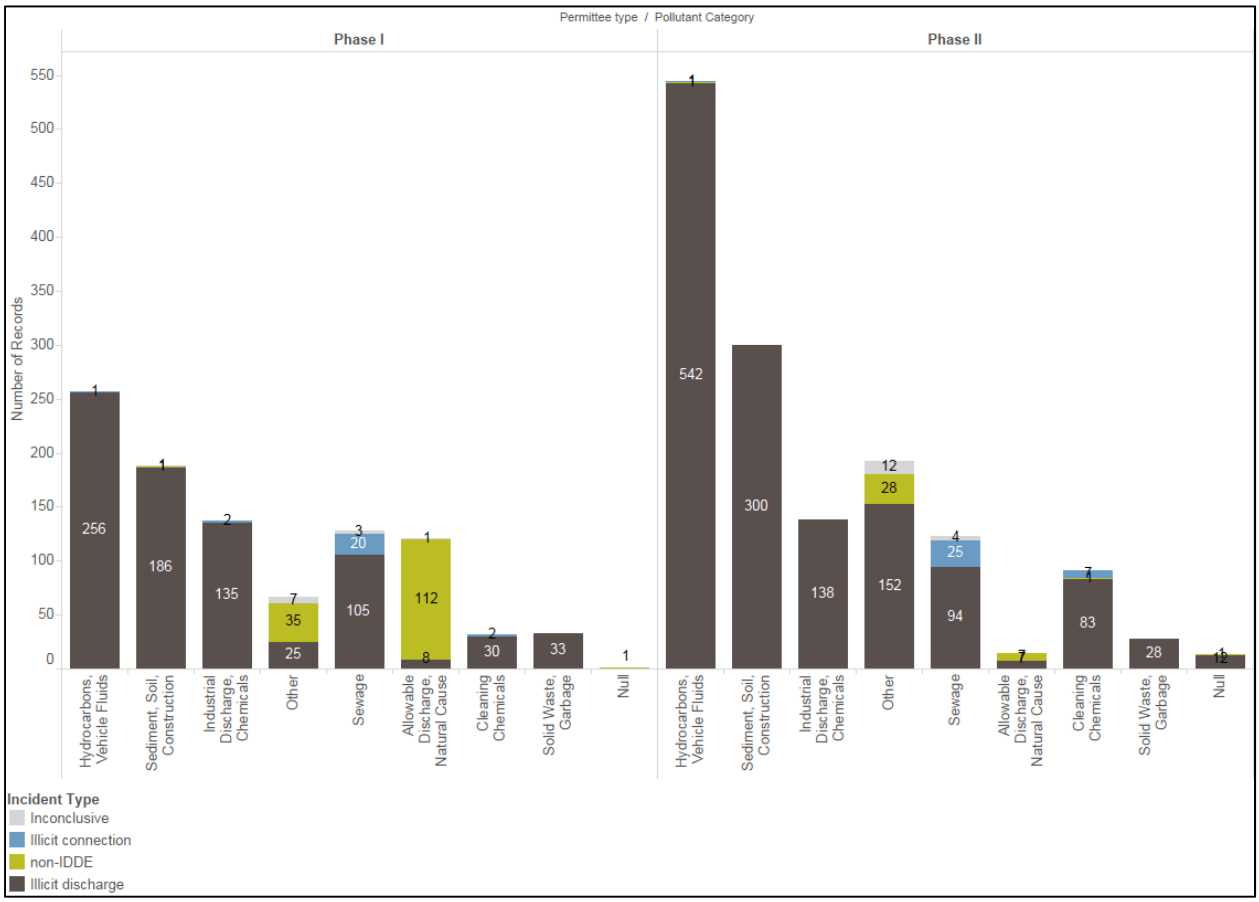

Figure 3-12. Incidents by pollutant type category.

3.3 Sources of Pollutants

The sources of pollutants were variably reported and identified primarily through review of record notes. Descriptions in the permittee records used inconsistent terms to describe the pollutant sources and not all terms used were related to the sources or the activities that caused the incident. A total of 58 discrete pollutant sources were used that referred to different activities or occurrences that caused the incident. To make the summary of pollutant sources manageable, the 58 sources were grouped into seven categories. Table 3-3 lists the pollutant sources and the categories they were grouped into.

The selection of which pollutant sources to group in the categories was made by best judgment and based on similar characteristics in either the activities attributed to the incidents or source areas where the discharge came from. The pollutant source category names into which pollutant sources were grouped indicate these common characteristics and are self-explanatory for the most part. The category of Natural Source includes incidents where the cause was due to non-anthropogenic activities and was often associated with non-IDDE records. The category of Other includes incidents where the source was

not identified, no source was found upon investigation, or a handful of causes that didn't fit the other categories, such as a few records where the incident was due to farming related sources like livestock activities.

Table 3-3. Pollutant sources reported among the eight pollutant source categories.

Auto Repair, Auto Body	Construction, Earthworks	Illicit Connection, Leaking Pipe	Industrial or Outdoor Activity	Natural Source	Other	Spill, Dumping, Runoff
Auto Body Activity	Allowable Discharge, Natural Cause	Broken water line	Broken water line	Drainage/ Grade	Boat in storm pond	Abandoned container
Auto Maintenance	Cleaning Chemicals	Broken/Clogged sewer main	Dumping	Groundwater pumping	Drainage/ Grade	BMP failure
	Hydrocarbons, Vehicle Fluids	Cracked storm line	Gun Firing Range	Natural cause	Farming related	Broken/Clogged sewer main
	Industrial Discharge, Chemicals	Illicit Connection	Industrial	Reservoir Discharge	N/A	Carpet Cleaning Waste
	Other	Sanitary Overflow	Junk yard activity	Sinkhole	None Found	Dumping
	Sediment, Soil, Construction		Landscaping activities		Source not identified	Equipment cleaning
	Sewage		Logging activities		Unconfirmed Report	Fire fighting related
	Solid Waste, Garbage		Manufacturing runoff			Leaking Container
			Painting related			Leaking dumpster
			Sandblasting waste			Painting related
						Pressure washing wastewater
						Recycling
						Roof cleaning runoff
						Source not identified
						Spill
						Stormwater
						Sump pump
						Swimming pool related
						Vehicle accident
						Vehicle Spill
						Vehicle Washing

Figure 3-13 shows the distribution of incidents grouped by pollutant source category among the Phase I and Phase II permittees. As shown, spills, dumping, and runoff were the most common pollutant sources in the permittee records, followed by construction activities and then pipe issues or illicit connections. The category of "null" reflects those records where a not enough information was provided to identify what the source was. Records where no incident occurred are not included in Figure 3-13.

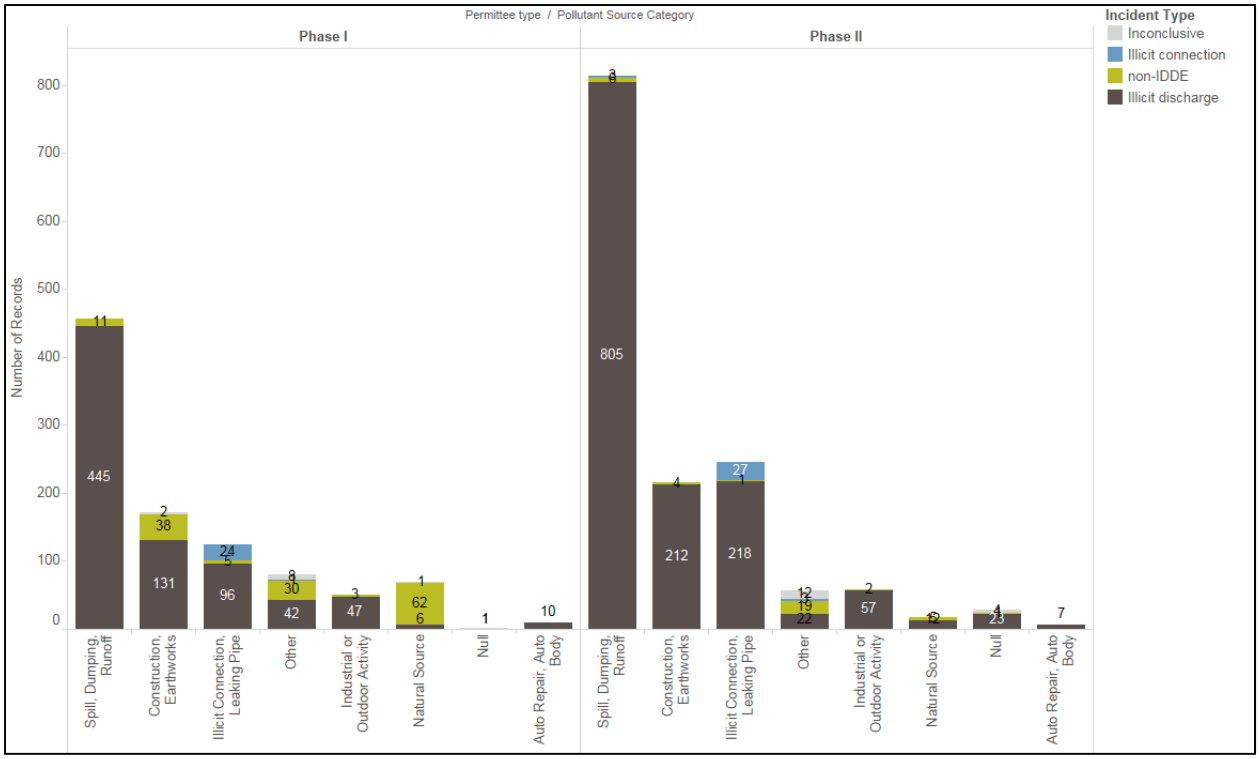

Figure 3-13. Incidents by pollutant source category.

3.4 Notification Methods

Three notification categories were created from a total of 19 methods reported. The categories include inspection or observation by municipal staff, hotline calls or other public notification, and referral from another agency or another person or department within a jurisdiction. In addition, there were some records that did not have enough information to determine the notification method and these are grouped into the null category. Table 3-4 lists the notification methods reported and the groupings by notification category.

Direct notification included by phone (hotline), email, website report, or complaint. Notification via inspections included field observation from IDDE staff, business inspections, catch basin or manhole inspections, and construction inspections. Referral from other agencies includes intra-jurisdiction staff referrals, Environmental Response Tracking System (ERTS) reports, and notification from other agencies, such as Washington State Department of Transportation (WSDOT).

Table 3-4. Notification methods reported among the three notification categories.

Hotline, Reported to Jurisdiction	Inspection or observation by staff	Intra- or Interagency referral	Null
Business Owner/Tenant Report	Business inspection	ERTS	N/A
Citizen report/complaint	Business Owner/Tenant report	Other Agency Referral	(blank)
IDDE field observation	catch basin or manhole inspection	Staff Referral	
Pollution Hotline	Construction inspection		
Property owner	Field screening		
Spill Response	IDDE field observation		
	outfall inspection		
	sanitary sewer inspection		
	Stormwater BMP inspection		

Figure 3-14 shows the distribution of incidents according to notification method categories among Phase I and Phase II permittees. All records are included in Figure 3-14 to reflect all types of incidents reported. The notification methods among Phase Is and Phase IIs had a similar distribution, with hotline calls and other third party notification being the most numerous, followed by inspections, and then referrals. For Phase Is, however, the number of incidents in these three top notification categories were about the same, whereas they varied considerably for Phase IIs. Records where no incident occurred are not included in Figure 3-14.

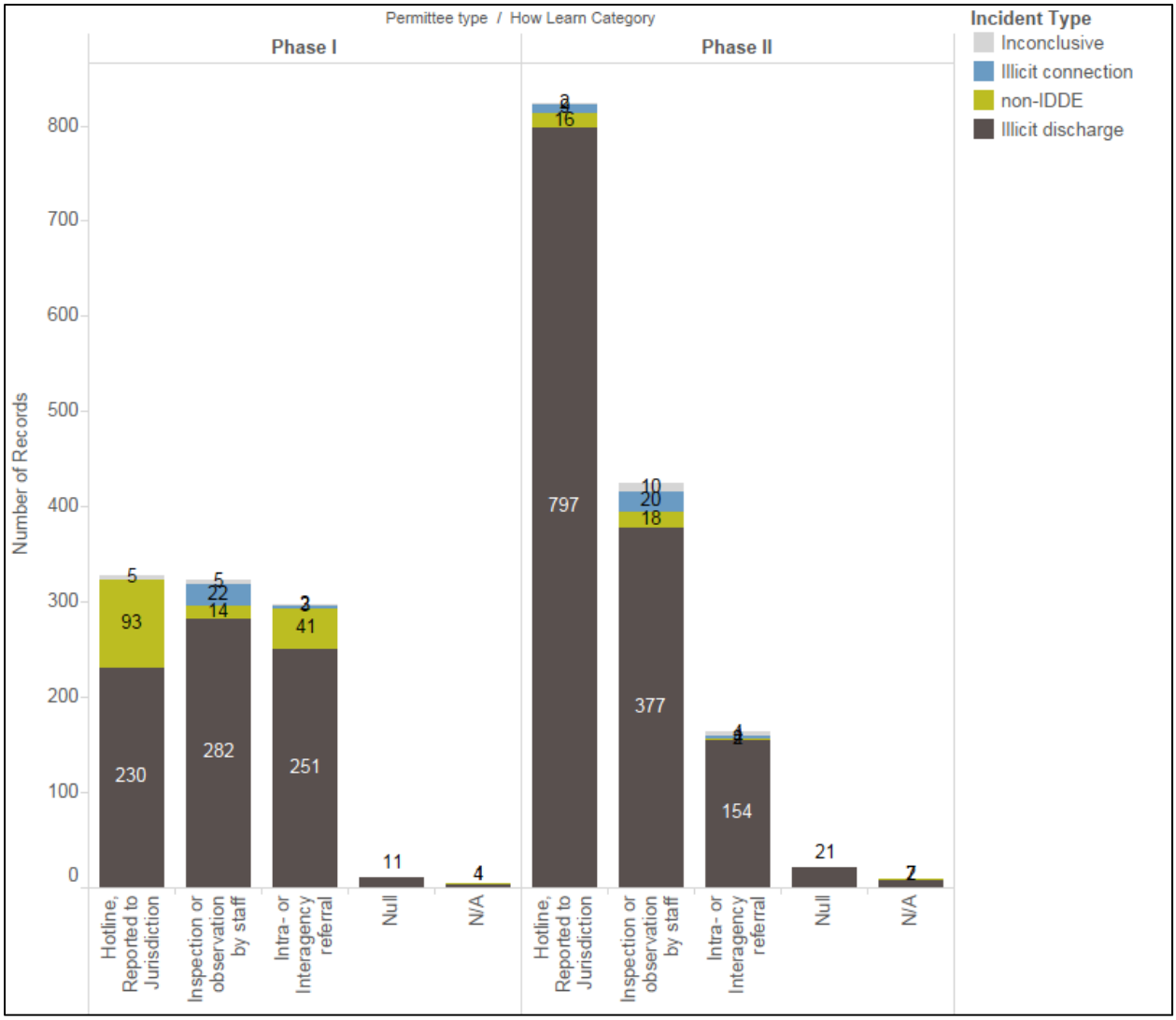

Figure 3-14. Incidents by notification method category.

3.5 Source Tracing Methods

Three source tracing categories were created from a total of 10 source tracing methods reported. The categories include in-pipe testing of any kind, visual or empirical source tracing, and other methods (Table 3-5). The category of Other was used for records that did not specify what methods were used, and the Null category represents records that had no source tracing method references. Some records included multiple methods and the source tracing category assigned to each record was based on the most complex method used. In-pipe testing methods were typically the most complex and involved the most effort by jurisdictions; thus, if a record used any in-pipe method for source tracing, it was assigned to the in-pipe category. The order of complexity of the categories matches how the groupings are presented in Table 3-5 with in-pipe methods first, visual and empirical methods second, and other or unspecified methods last.

Table 3-5. Source tracing methods reported among the three source tracing categories.

In pipe testing	Visual, Empirical	Other	Null
Dye testing	Conversation with Citizen	Canine detection	N/A
Indicator testing	Indicator testing	Unspecified investigation	(blank)
Pressure testing	Mapping		
Smoke testing	Visual recon		
Video inspection			
Visual recon			

Figure 3-15 shows the distribution of incidents according to source tracing method categories among Phase I and Phase II permittees. The number of incidents for each source tracing category varied among Phase I and Phase II permittees. But the relative prevalence of the categories was the same among permittee phases with visual or other empirical methods being the most prevalent followed by in-pipe testing and then other/unspecified method. Records where no incident occurred are not included in Figure 3-15.

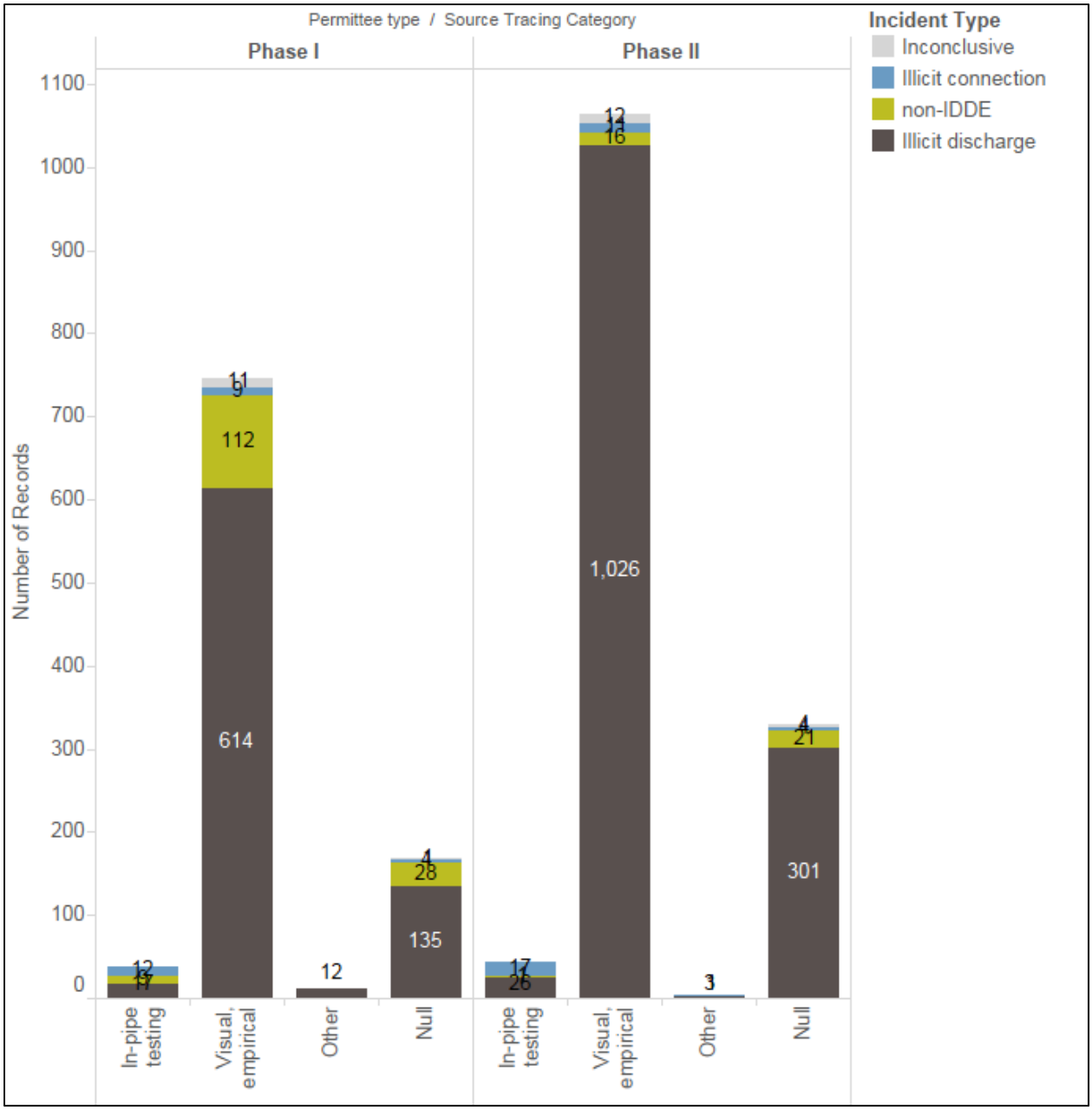

Figure 3-15. Incidents by source tracing method category.

3.6 Indicator Testing Methods

Four categories of indicator testing methods were created from a total of 18 methods reported. The categories include chemical testing, visual methods that include color, turbidity, and flow, odor/pH/fecals methods, and other for records that did not indicate what indicator methods were used (Table 3-6). Some records noted multiple indicator methods used, and the indicator method category assigned to those records was based on the most complex method used. The use of multiple indicator testing methods is reflected in the repetition of those methods under multiple categories. In-pipe

testing methods were typically the most complex and involved the most effort by jurisdictions; thus, if a record used any in-pipe method among methods, it was assigned to the chemical testing category. The order of complexity of the categories matches how the groupings are presented in Table 3-6 with chemical testing first, odor/pH/fecals testing methods second, and visual methods third.

Table 3-6. Indicator testing methods reported among four indicator testing categories.

Chemical testing	Odor, pH, fecals	Visual, turbidity, flow	Other
Ammonia	Flow	Color	Unspecified
Chlorine/Chloride	Hydrogen Sulfide / Carbon Monoxide	Floatables	
Color	pH	Flow	
Conductivity	Potassium	pH	
Detergent/Surfactant	Suspended Solids	Turbidity	
Flow		Color	
Fluoride			
Lead			
Nitrates			
pH			
Potassium			
Potassium / Conductivity			
TPH/Oil			
Turbidity			

Figure 3-16 shows the distribution of indicator testing method categories among Phase I and Phase II permittees by the type of incident reported. The number of incidents that used visual indicator testing was almost identical among Phase Is (742) and Phase IIs (756); however, this method represents a much larger proportion of records for Phase Is. For indicator methods based on chemical testing, Phase IIs used them more frequently than methods based on odor, pH, or fecals detection, and the opposite was true for Phase Is, who used odor, pH, or fecals detection more than chemical testing. Records where no incident occurred are not included in Figure 3-16.

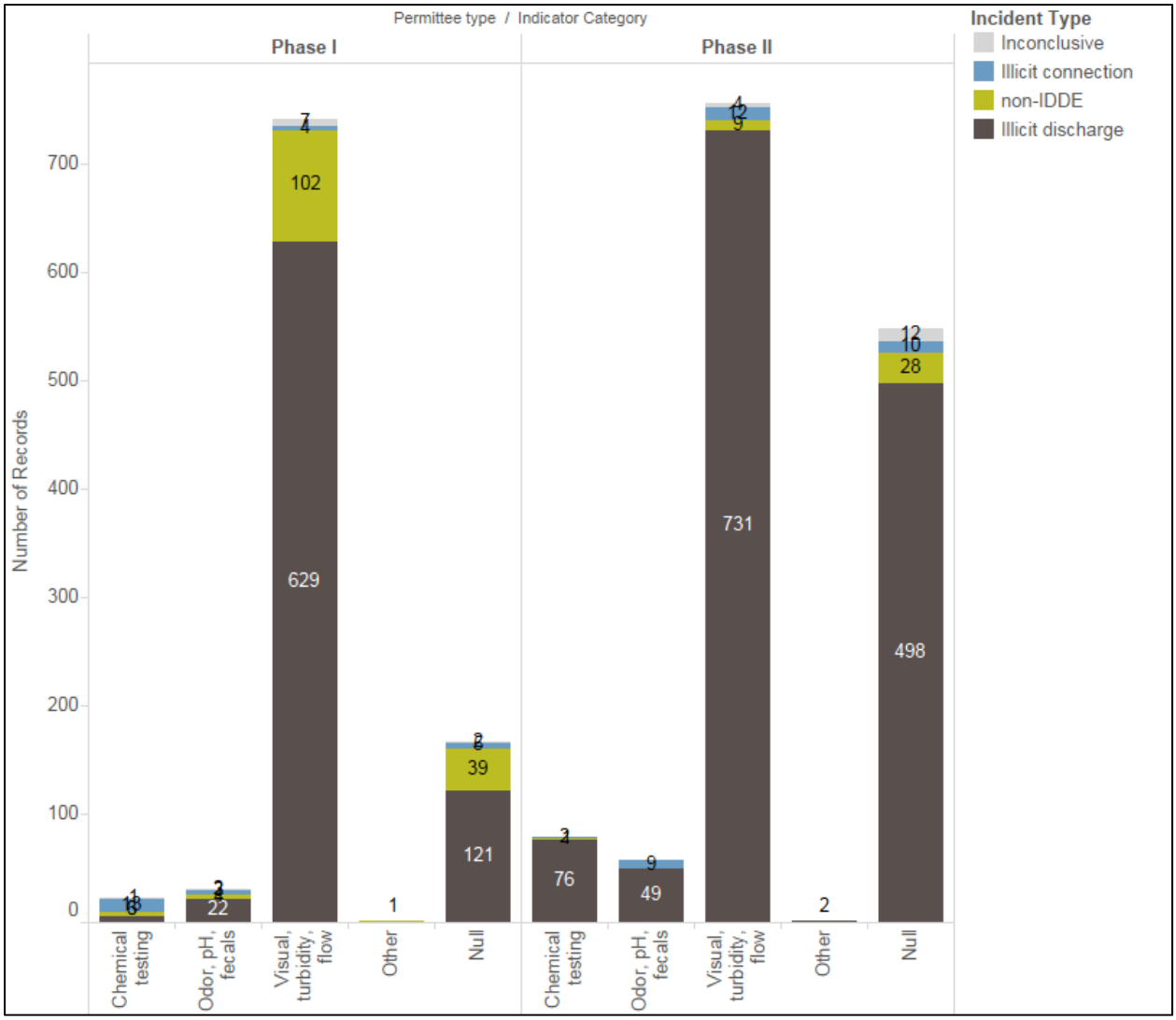

Figure 3-16. Incidents by indicator testing method category.

3.7 Correction and Elimination Methods

Five categories of correction and elimination methods were created from the 13 methods reported and are shown in Table 3-7. The categories include enforcement actions, the use of BMPs to prevent or cleanup discharges, referral to another agency or department within the jurisdiction, no further action needed, and a category of other for records that indicate further investigation was required, did not indicate what correction and elimination methods were used, or where just education was provided. Many records reported multiple correction and elimination methods and the primary category assigned to each record was based on the level of severity. Thus, if enforcement of any kind was used, it was assigned to the Enforcement category. Using BMPs was prioritized second for category assignment followed by referral to another agency. Some correction and elimination methods were used ubiquitously and often in combination with other methods, including behavior modification and education.

Table 3-7. Correction and elimination methods reported among five correction/elimination categories.

Enforcement	BMPs or Cleanup	Refer to Other Agency or Dept	Other	No Action Needed
Behavior/ Operation Modification	Behavior/ Operation Modification	Behavior/Operation Modification	Education	Behavior/Operation Modification
Education/ Technical Assistance	Education/ Technical Assistance	Education/Technical Assistance	Further investigation	Education/Technical Assistance
Enforcement	Enforcement	Enforcement	Unknown	Clean up
Clean up	Clean up	Clean up		No action needed
Code violation	Further investigation	Report to Ecology		
Verbal Notice	Verbal Notice	Refer to other dept or agency		
		Refer to Construction Inspector		

Figure 3-17 shows the distribution of incidents by the assigned correction and elimination method categories among Phase I and Phase II permittees for all types of incidents. The use of BMPs was the most prevalent among both types of permittees. Enforcement methods were used in similar numbers for Phase Is (128) and Phase IIs (109); however, enforcement represents a larger effort by Phase Is; this result is consistent with the enforcement program requirements in the Phase I permit. Records where no incident occurred are not included in Figure 3-17.

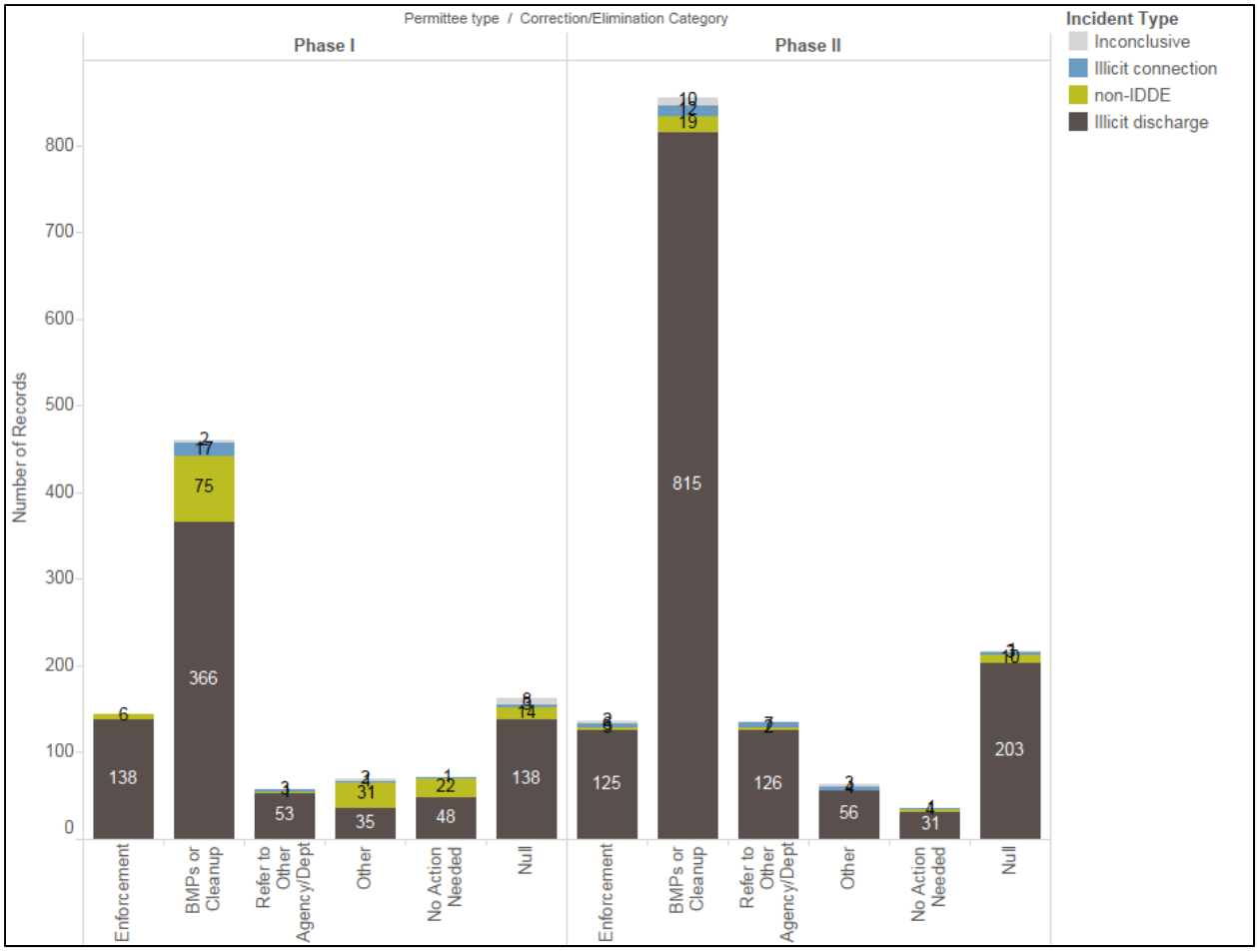

Figure 3-17. Incidents by correction and elimination method category.

3.8 Response and Resolution Times

The times for incident response and resolution were evaluated. Average response times were determined as well as the distributions of records for specific time periods relevant to permit reporting requirements: response within seven days for all incidents, response within 21 days for illicit connections, and resolution within six months for illicit connections. Response and resolution times are evaluated in the sections below for records with incidents by pollutant category (see Table 3-2) and incident type (illicit discharge, illicit connection, non-IDDE, and inconclusive).

3.8.1 Average Response Times

The average (arithmetic mean) response and resolution times were determined in days for incidents with date information to support such an analysis. Response times were calculated as the difference between the date of the initial response by the permittee and the date the incident was reported. Figure 3-18 shows, in the lower section, the average response times for pollutant category (alphabetically, see Table 3-2) by incident type. The upper section of Figure 3-18 provides the numbers of incidents with complete date information that was used to determine average response time.

Average response times for all pollutant types ranged from 0 to 7 days. The average times shown in Figure 3-18 are rounded to the nearest whole number to correspond to days as whole increments. Values of zero indicate the response date was the same as the notification date and effectively represent one day.

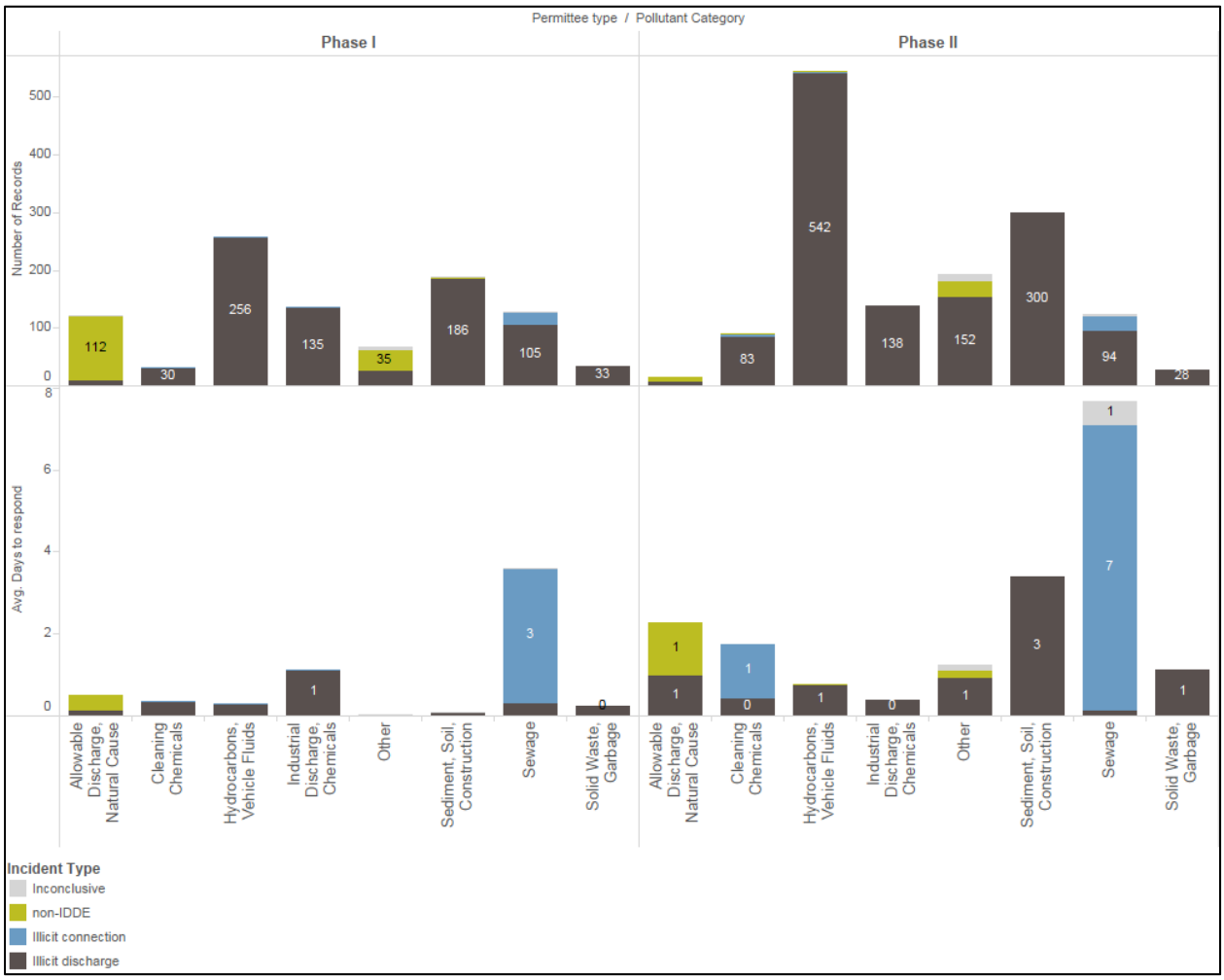

Figure 3-18. Average response time to incidents by pollutant type.

Figure 3-19 shows, in the lower section, the average resolution times in days by pollutant category (alphabetically) and incident type. Resolution times were calculated as the difference between the reported date the incident was resolved and the initial date the incident was reported. The upper section of Figure 3-19 provides the numbers of incidents with complete date information that was used to determine average resolution times.

Average resolution times ranged from one to over 240 days with most resolutions occurring in 53 days or less. Resolution times, on average, were much shorter for Phase Is than Phase IIs for all pollutant categories. The longest resolution times were for illicit connections, especially for Phase IIs. However, the illicit connection records with complete date information were few in number (17 Phase Is and 20 Phase IIs). A few records with long resolution times pulled the average high for illicit connections in

some Phase II jurisdictions, including individual records from: City of Anacortes (729 days), City of Federal Way (565 days), City of Port Angeles (531 days), and City of Tukwila (430 days).

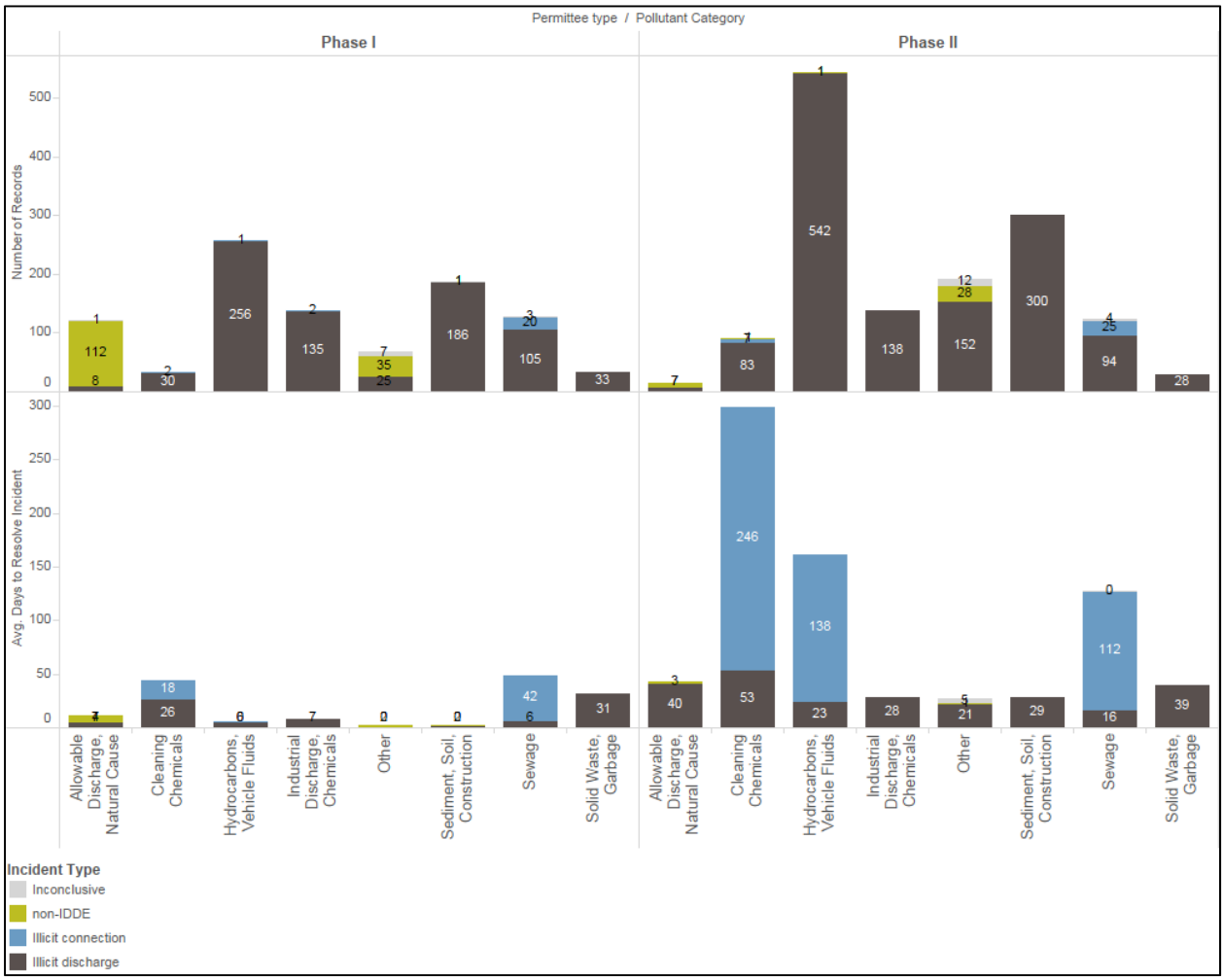

Figure 3-19. Average resolution time for incidents by incident type.

3.8.2 Investigated Within Seven Days

Figure 3-20 shows the number of incidents investigated within seven days, after more than seven days, and the number of records with insufficient date information (null). The vast majority (1,843) of incidents were investigated within seven days; only 24 incidents (less than 1 percent) were investigated after more than seven days. The number of records where an incident occurred but had incomplete date information was significant with 199 Phase I records and 302 Phase II records. Most records with insufficient date information lacked the date when the response was begun.

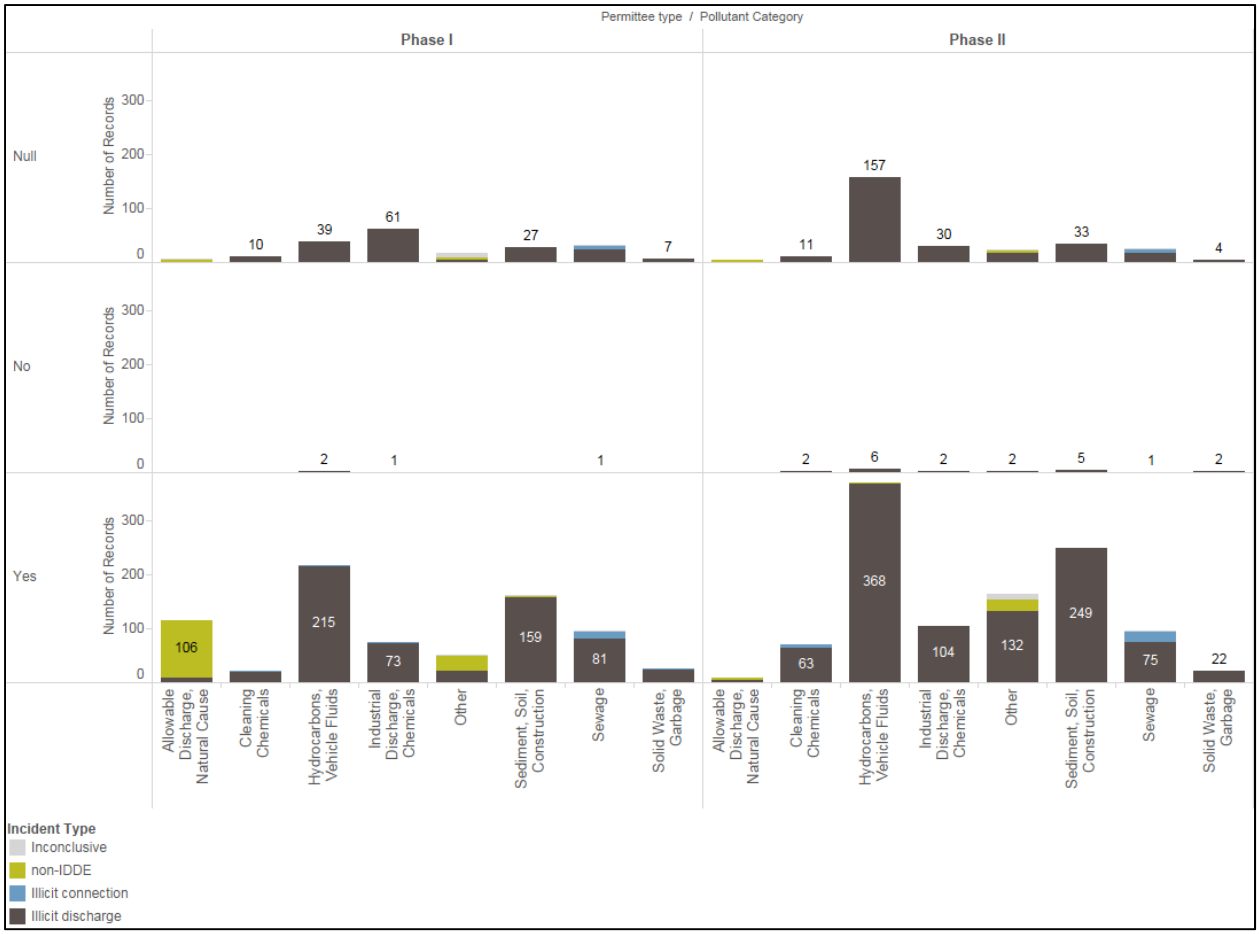

Figure 3-20. Incidents responded to within 7 days.

3.8.3 Illicit Connections Investigated Within 21 Days

Figure 3-21 shows the number of records of investigations begun within 21 days of the illicit connection reported or learned about. Relatively few (59) illicit connections records were submitted by permittees. For those records with dates of when an illicit connection was learned and when it was responded to, 42 incidents were investigated within 21 days and three incidents were not. Most illicit connections investigated within 21 days were of sewage and the ones not investigated in this time were from sewage and solid waste incidents. As with the response within seven days above, the number of records without complete date information is represented by the Null category in Figure 3-21, of which there were 18.

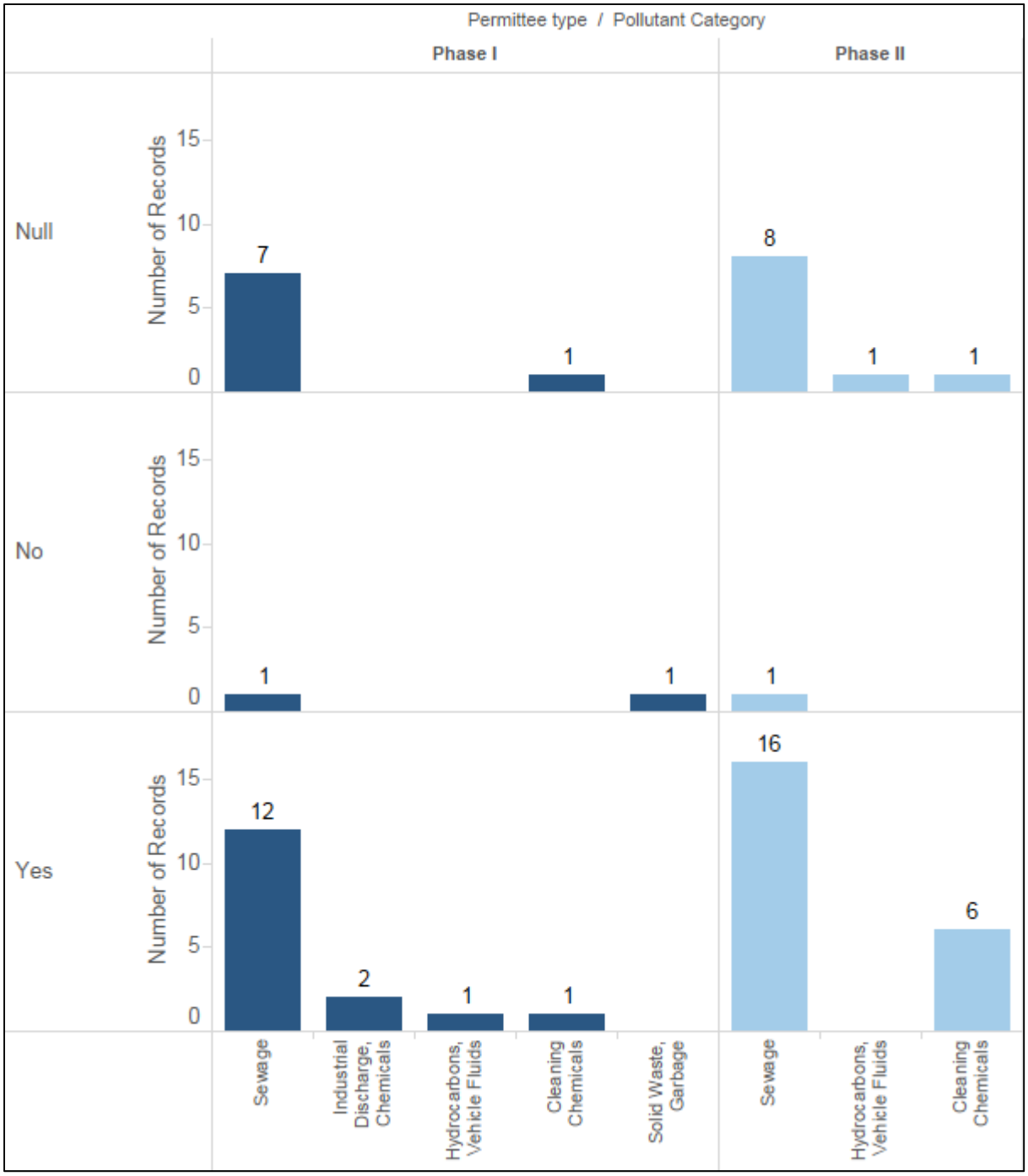

Figure 3-21. Illicit connections investigated within 21 days.

3.8.4 Illicit Connections Resolved Within Six Months

Figure 3-22 shows the number of illicit connections resolved within six months. Of the 59 illicit connections reported, 25 were resolved within six months and seven were not. Most illicit connections involved sewage, and the illicit connection incidents not resolved within six months (all by Phase IIs)

were half sewage-related and half chemical-related. 27 records did not have date resolution information and are represented by the Null category in Figure 3-22.

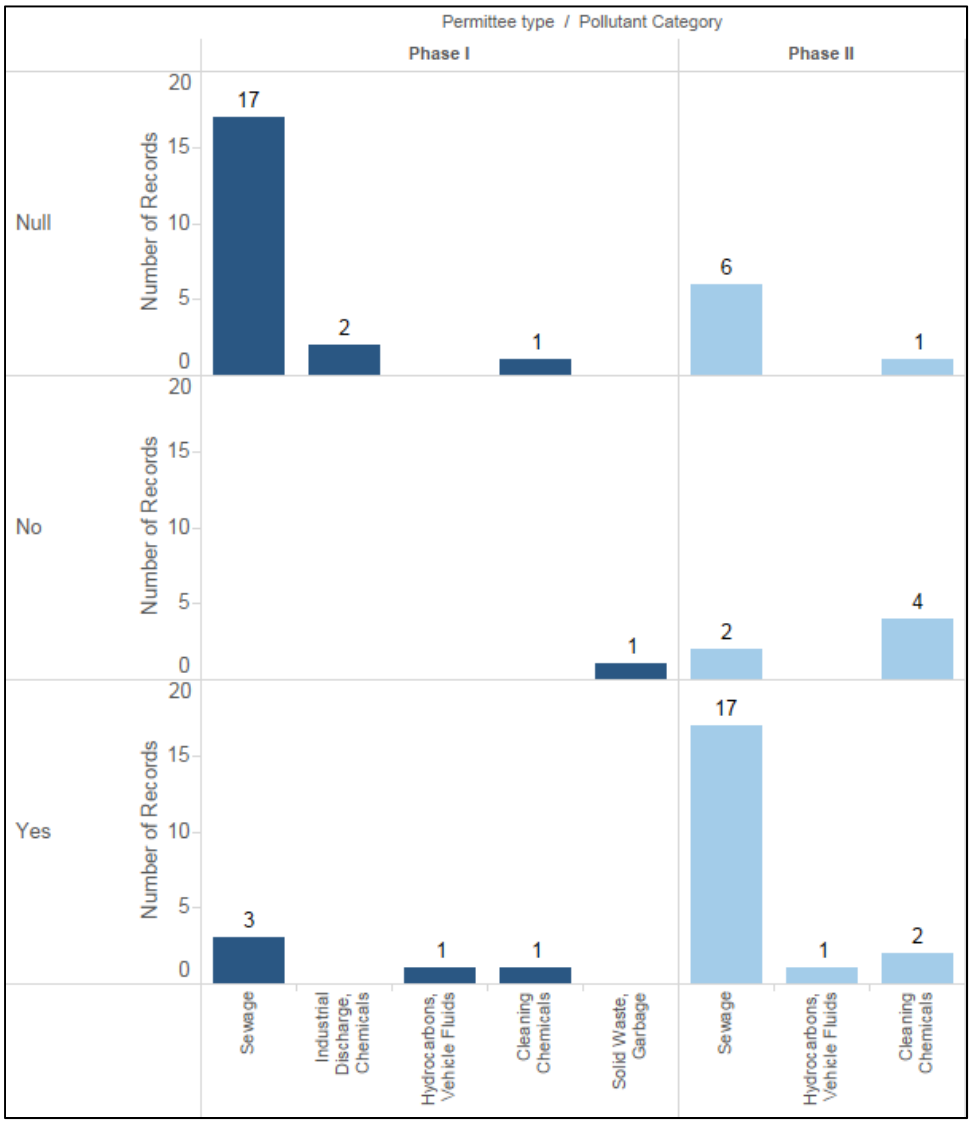

Figure 3-22. Final resolution of illicit connections within 6 months.

3.9 Statistical Analysis of Data

Statistical analysis of the data was done to evaluate differences among data parameters. The data were almost entirely descriptive and categorical; therefore, an appropriate statistical test was selected to compare counts of records and the frequency distributions of different type of incidents. For this analysis, the observed and expected frequency of records were compared using log-linear analysis of frequency (contingency) tables and tested with Maximum Likelihood Chi-squared statistics (chi-square)[1]. The chi-square test was chosen because it is suitable for use in contingency tables that are greater than

[1] Most contingency table data exceeded five records, but it's worth noting that the Maximum Likelihood Chi-squared statistic is not as sensitive to expected frequencies of less than five data points as some alternative.

two factors by two factors. The chi-square statistic tests the difference in observed and expected frequencies where the expected frequencies represent a random distribution of records. A statistically significant result indicates that the observed data are not randomly distributed for each contingency analysis comparison.

All statistical analyses were limited to those records where an incident was determined to occur (the "yes" records represented in Incident Found field, see Table 2-1 and Figure 3-3). The analysis was also limited to records with incident dates reported in 2014 (2264 out of 2407 conclusive incident records) since that was the intended period of data to be evaluated even though some permittee submittals included data from other years. The data fields of interest for the contingency analysis had either multiple answer options for individual records or the field had a list of answer options too numerous to evaluate effectively. Therefore, the contingency analysis used the "category fields," for example, instead of using the field of Pollutant Type, which has 53 discrete pollutant types, the field of Pollutant Category was used, which has the pollutant types grouped into eight categories.

The combinations of category data fields selected to be tested by contingency table analysis using the chi-squared statistic included the following comparisons:

- Pollutant type categories compared to:
    - Permittee phase
    - Categories of how the problem was learned about
    - Categories of pollutant source/cause
    - Categories of source tracing methods
    - Categories of correction/elimination actions
    - Categories of quantity of discharge
- Source tracing methods categories compared to:
    - Categories of how the problem was learned about
    - Categories of indicator testing
    - Categories of correction/elimination actions

The results of the analysis are summarized below and the contingency table analysis results themselves are provided in Appendix C in Table C-1 through Table C-9. In each comparison, if the observed and expected frequencies were significantly different, then the chi-square result had a probability value of less than 0.05 (95 percent significance level). All comparisons performed showed statistically significant differences except for the comparison of source tracing method and how the problem was learned. The following is a list of descriptions of the statistical results for the comparison of categories of pollutant type.

- When the frequency of pollutant types was compared by permittee phase (Table C-1), Phase Is had more records in the Allowable Discharge and Sewage categories than expected, while Phase IIs had more records in the Other pollutants, Cleaning Chemicals, Hydrocarbons, and Industrial Discharge Chemicals categories.
- When the frequency of pollutant types was compared by how the problem was learned (Table C-2), reported by Hotline category was a more common method for Allowable Discharge,

Hydrocarbons, and Other pollutant categories than expected by chance. Inspection methods were more common for Industrial Discharge, Cleaning Chemicals, and Sediment categories. Referral methods were more common for Sewage and Solid Waste categories.

- When the frequency of pollutant types was compared by source tracing methods (Table C-3), In-pipe testing methods were more common for Sewage and Other pollutant category than expected by chance. Also, Visual Empirical methods were more often used for Hydrocarbons and Sediment than expected by chance.
- When the frequency of pollutant types was compared by pollutant source (Table C-7), Construction sources were more common for Allowable Discharge and Sediment pollutant types than expected by chance. Additionally, the following comparisons by pollutant source were statistically significant:
    - Construction sources were less likely to be the source of Hydrocarbons and Other pollutant types;
    - Pollutant sources from Illicit Connections/Leaking Pipe was more likely to be a source of Sewage and Other pollutants than expected;
    - Illicit Connections/Leaking Pipe sources were less likely to be the cause of Hydrocarbons, Sediment, or Industrial Discharge pollutant types;
    - Spill/Dumping/Runoff was a more common source for Cleaning Chemicals, Hydrocarbons, and Industrial Discharge pollutants than expected and was less likely to be a source of Sediment or Sewage pollutants.
- When the frequency of pollutant types was compared by discharge quantity (Table C-8), Hydrocarbons were more likely to be associated with Very Small discharges than expected by chance, and Sediment, Sewage, and Solid Waste pollutants were more likely to be Small discharges. Medium, Large, and Very Large discharges were more likely to be Other pollutants. Records with discharge quantities noted were relatively few (159 of incidents, 26 percent), thus comparisons with that field were from a more limited dataset than the other statistical comparisons. For reference, discharges were grouped into the following categories.
    - Very Large, >100,000 gallons
    - Large, 10,000-100,000 gallons
    - Medium, 1,000-10,000 gallons
    - Small, 100 to 1000 gallons
    - Very Small, <100 gallons
- When the frequency of pollutant types was compared by corrective action (Table C-9), Enforcement actions were more common for Sediment and Solid Waste pollutants and less likely for Allowable Discharge and Other pollutants than expected by chance. Correction actions of Refer to Other Agency/Dept was more common for Hydrocarbons and Sewage pollutants. In addition, Source Control BMPs actions was more common for Industrial Discharge and Other pollutants and was less likely for Sediment and Sewage pollutants than expected.

The following is a list of descriptions of the statistical results for the categories of source tracing method compared to the categories of other data fields as noted above.

- When the frequency of source tracing method was compared by how the problem was learned (Table C-4), there was no significant difference between the distribution of incidents among categories and what was expected by chance.
- When the frequency of source tracing method was compared by indicator testing method (Table C-5), Visual indicator methods were more common for Visual Empirical source tracing methods than expected by chance. For Chemical Testing and Odor/pH indicator testing methods, In-pipe Testing source tracing methods were more common than expected by chance, and Visual Empirical source tracing methods were less common.
- When the frequency of source tracing method was compared by corrective action (Table C-6), Enforcement actions were more commonly associated with Visual Empirical source tracing methods than expected by chance. BMPs or Cleanup actions were more commonly associated with Visual Empirical or In-Pipe Testing source tracing methods than expected by chance. In addition, Refer to Other Agency/Dept corrective actions were more common with Other source tracing methods.

Due to the high number of records from the cities of Bellevue and Tacoma, the statistical analysis was also run on the data set without these cities' data and on just those cities' data to determine if the chi-square results were the same or different. The results for the analysis without Bellevue's and Tacoma's data were significant for five of the six comparisons based on pollutant type category (for all except pollutant type compared to source tracing method) and for all three comparisons based on source tracing method. The comparisons with significant differences excluding the Bellevue and Tacoma data were the same as with the analysis of the full data set; however, each comparison has a slightly different mix of significantly different categories in each field. The analysis based on pollutant type that was not significant for the dataset without Bellevue's and Tacoma's data was the comparison to discharge quantities, which was influenced by the lack of discharge quantity data available in the overall dataset.

The results of the contingency analysis on only Bellevue's and Tacoma's data had almost entirely the same results as the analysis on the full data set. For all comparisons based on pollutant type, the significant categories were the same as the analysis on the full data set. For comparisons based on source tracing method, the results were the same as the full data set except for the comparison to corrective action, which did not show a significant difference.

The differences in the analysis of the data set without Bellevue's and Tacoma's data and with just those data indicate the strong influence of those relatively large data sets. This is evident especially from the nearly identical results of the analysis run on the entire data set and on just Bellevue's and Tacoma's data. However, the results of the analysis on the data set without those two cities' data indicates that many significant associations exist among the fields compared but in a slightly different mix. The differences in the statistical results supports the importance of assessing data regionally to detect different approaches by permittees and to represent the range of IDDE incidents and solutions in use across the region.

4 DISCUSSION

Discussion of the results of the data evaluation are presented here. The discussion covers five topics for relevance to the objectives of the Source ID component of SAM:

1. Distribution of data among permittees
2. Pollutants and their sources
3. Source tracing and indicator testing methods
4. Notification methods and response times
5. Correction and elimination methods

4.1 Distribution of Incidents Among Permittees

Data evaluated were from all Phase I municipal stormwater permittees except the Port of Tacoma, which reported zero incidents in their 2014 annual report. Among the seven Phase Is who reported data, 1,269 records were submitted. Two-thirds (59 percent) of the Phase I records came from the City of Tacoma with City of Seattle and Pierce County contributing about 10 percent of the records each. The rest were from the remaining Phase I permittees and ranged from 7 to 157 records each. Of the Phase I records submitted, 964 conclusively reported some type of incident with 777 illicit discharges and 26 illicit connections; the remainder of Phase I records represented non-IDDE events or inconclusive as to what (if any) type of incident occurred.

For Phase II permittees, 1,644 records were submitted by 71 permittees and ranged from 1 to 321 records per each permittee. About one-fifth (19 percent) of the Phase II records came from the City of Bellevue. Of the Phase II records submitted, 1,356 illicit discharges and 33 illicit connections were reported; the remainder of Phase II records represented non-IDDE events or inconclusive as to what (if any) type of incident occurred.

Because of the relatively high number of records from the City of Bellevue and the City of Tacoma, much of the data summary and analysis is biased toward those programs. Evaluation of permittee IDDE programs was not part of this evaluation; however, some understanding of the programs was obtained simply by reviewing records and seeing how permittees reported information. Some of the variation in data due to how programs are implemented was eliminated with the review of records and standardization of data. Presuming that Bellevue's and Tacoma's programs represent a good implementation of the IDDE permit requirements, then having their large datasets will have ultimately helped this evaluation. In contrast, the low numbers of incidents reported by many larger jurisdictions may indicate room for improvement by some permittees for record-keeping and/or IDDE program implementation.

4.2 Pollutants and Pollutant Sources

The top three most common types of pollutants and their sources are discussed here. For all permittees, hydrocarbons and vehicle fluids represented the highest contributions of the IDDE records. This is due to the high number of automobile-related sources, including overwhelmingly spills from auto accidents and other auto-related activities. Sediment and construction-related pollutants were the second most prevalent and came from construction activities and sediment-related flooding issues, including leaking or broken pipes. For Phase I permittees, following the number one and two most common pollutant

source types described above, three pollutant types were represented similarly: industrial-related discharges, allowable discharges, and sewage, which came primarily from leaking or broken pipes. For Phase II permittees, the third most prevalent pollutant was "other" types of pollutants, which includes primarily records that were not IDDE incidents or where a pollutant or potential pollutant of concern was not found or identified.

The statistical analysis of pollutant types compared to pollutant sources confirm logical associations. These include the prevalence of pollutants coming from source activities that use or expose those pollutants, including sediment from construction sites, chemicals from industrial activities, and hydrocarbons from spills and dumping.

4.3 Source Tracing and Indicator Testing

The top source tracing methods used were visual and empirical methods, which included mostly visual reconnaissance, field observations, and mapping analysis. Likewise, visual indicator testing methods were the most prevalent. These indicators included observation of the presence of discharge, the color, odor, or turbidity of discharge, and floatables and solid waste.

The second most prevalent group of source tracing method records were those that did not indicate what method was used. A small number of incidents used in-pipe investigations (181), which included video inspection and testing with dye, smoke, pressure, or chemical indicators.

The statistical analysis of source tracing methods and indicator testing methods confirmed logical associations for what types of indicators are used to trace certain pollutants. Visual methods were associated with visual indicators like flow and turbidity, and chemical testing methods were associated with in-pipe source tracing.

4.4 Notification Methods and Response Times

Results indicate that hotline calls and other direct reporting by the public were the most common notification methods. These include notification by pollution hotline, spills and emergency response, and other direct ways such as reporting via website or citizen complaints. The second most prevalent notification method was inspection-related observations. These were primarily from construction inspections, business inspections (like Local Source Control program visits), and direct observations from other field activities like spill response and driving through jurisdiction areas. Notification from within the jurisdiction government or another agency like Ecology represented the third most prevalent method.

Response times for all pollutant categories were within one to three days on average with just one exception of illicit connections for Phase II permittees, which averaged seven days' response time. Only 24 incidents were not responded to within seven days (four by Phase Is and 20 by Phase IIs). A fair number of incidents did not have enough information to determine if a response had occurred within seven days, including 199 from Phase I and 302 from Phase II permittees. About half of the Phase II incidents that exceeded seven days' response time were from spills or dumping of hydrocarbons and other vehicle fluids.

4.5 Correction and Elimination Methods and Resolution Times

The use of BMPs was the most prevalent correction and elimination method used (1,316 records), which included adding or improving source control, cleaning up spills, and operational BMPs of education, technical assistance, and behavior or operational modification. For Phase I permittees, enforcement methods was the second most prevalent correction method followed by near equal numbers of incidents addressed by referral, no action needed, or other methods. For Phase II permittees, enforcement methods and referral to another agency or department both were the second most prevalent correction method.

Resolution times for most pollutant categories were seven days or less for Phase I permittees and under 30 days for Phase II permittees. Illicit connections often had long resolution times, and most were resolved with the permit-specified 6-month period. However, a few illicit connections in a few jurisdictions had resolution times of longer than six months and these few data points had a strong influence on the calculation of average resolution times for this incident type. For Phase I and Phase II permittees, illicit discharges in the pollutant categories of cleaning chemicals and solid waste had the longest resolution times. Average illicit discharge resolution times for these categories of pollutants ranged from 26 to 53 days.

5 CONCLUSIONS AND RECOMMENDATIONS

This evaluation of IDDE data submitted by 78 NPDES municipal stormwater permittees in western Washington resulted in an in-depth look at how permittees submitted data and the quality and distributions of those data. The data evaluation compared various information among Phase I and Phase II permittees to describe pollutant types and sources, how permittees learned about the incidents and how they responded to them, and the methods they used to trace and eliminate the pollutants.

The statistical tests performed on the comparisons of data categories confirmed many logical associations. These include pollutants coming from logical sources like hydrocarbons being associated with spills and sediment coming from construction areas. These statistical confirmations illustrate that most permittees are recording basic information to describe the incidents; however, significant variability was found in the detail of how incidents are described. Also, a significant number of non-IDDE incidents were reported, which represents the breadth of potential pollution events that are reported to municipal staff who deal with IDDE events.

5.1 Data Collection Recommendations

For this project, entry of data to create the database was a time-consuming process that would have been more efficient with standardized information reported by permittees. The various reporting formats and level of detail provided in permittee submittals created the need for a thorough review of data during the database creation process to ensure consistency and accuracy. Ecology began the data standardization process for IDDE reporting by creating an optional data entry form that was provided to Phase II permittees in February 2014 (K. Dinicola, personal communication). During the review of the present data evaluation, an updated list of incident fields for the data entry form was identified by the Source ID subgroup of the SWG. The original and updated data entry forms (lists of fields and

anticipated response options) are provided in Appendix B, and the data fields created for the database for this evaluation are listed in Table 2-1.

The changes to the IDDE reporting form included removing some fields, such as weather conditions, and adding other fields, such as if a discharge reached the MS4 system. Ultimately, the number of data fields remained the same at 16 but most fields have added detail to be reported for each incident, including the types and quantities of pollutants and additional answer options as relevant. The new data form is intended to be entirely formatted in drop-down selection format, will meet the NPDES municipal permits reporting needs, clarifies what information is required in permittee annual reports, and does not significantly add effort for data entry by permittees. In fact, the data entry effort by permittees reporting IDDE incidents may be lessened if the form revision will include an instant search feature based on typing key words. The revised draft data entry form is currently in discussion among the Source ID subgroup and Ecology, and the final form is likely to take effect with the next municipal stormwater permit cycle starting in 2018.

5.2 Potential Uses of Regional Evaluations

The results of this data evaluation support the development of a regional IDDE database that can be used to compare pollution reduction and response among jurisdictions and across the Western Washington region. By standardizing responses from a wide range of data formats and program types, this evaluation identified commonalities and differences in the distributions of the types of incidents, pollutants, sources, tracing methods, indicator methods, and the timing of handling IDDE incidents as reported in 2014. This information can be used by permittees generally to compare their IDDE programs' successes and challenges to other permittees' programs, and can be used specifically to look up successful methods for handling the multitude of incident types to which permittees are called on to respond. In this way, such a regional compilation and comparison of IDDE data has the potential to improve both the effectiveness and efficiency of municipal efforts to prevent and reduce stormwater pollution region-wide.

In addition to the potential specific uses noted above for the regional IDDE database prepared for this evaluation, regional evaluations of municipal stormwater data in general support a number of uses that can provide meaningful evaluation, updates, and information-sharing. Such uses include: focusing municipal inspection efforts on the most common or most high risk pollutants; fostering cross-jurisdiction coordination to share program and technical information; using data-driven information to highlight and update the most effective procedures and methods for pollutant reduction and issue correction; targeting public education and outreach efforts; supporting funding requests for improving regional pollution reduction efforts; expanding spill response programs and resources; tracking temporal and spatial trends in the number and locations of incidents; and quantifying and tracking pollutant entry to receiving waters as well as pollutant reduction over time. In this regard, regional evaluations can be an effective tool for NPDES permittees to implement permit requirements and ultimately protect water quality.

6 REFERENCES

Cardno 2015. Summary of Initial Review of Municipal NPDES IDDE Submittals. Memorandum to Dept. of Ecology and City of Lakewood, December 31, 2015.

Ecology 2013a. Phase I Municipal Stormwater Permit. National Pollution Discharge Elimination System and State Waste Discharge General Permit for discharges from Large and Medium Municipal Separate Storm Sewer Systems. Effective dates: August 1, 2013 to July 31, 2018. Reference includes associated appendices.

Ecology 2013b. Phase II Western Washington Phase II Municipal Stormwater Permit. National Pollution Discharge Elimination System and State Waste Discharge General Permit for discharges from Small Municipal Separate Storm Sewers in Western Washington. Effective dates: August 1, 2013 to July 31, 2018. Reference includes associated appendices.

Ecology 2015a. Western Washington IDDE Incident Tracking Form. Instructions for IDDE online reporting. http://www.ecy.wa.gov/programs/wq/stormwater/municipal/IDDEinctrkfrminstr.pdf.

Ecology 2015b. IDDE data submitted online via Ecology form. https://data.wa.gov/Natural-Resources-Environment/RSMP-Illicit-Discharge-Detection-and-Elimination-I/ikwr-f47z.

Ecology 2015c. Ecology Water Quality Permitting and Reporting System, Permit and Reporting Information System (PARIS). Website with filter developed by Ecology to obtain responses to individual questions. Phase I permittees: https://fortress.wa.gov/ecy/wqreports/public/f?p=110:302:773825931585507::NO:RP:P302_PERMIT_TYPE:15. Phase II permittees: https://fortress.wa.gov/ecy/wqreports/public/f?p=110:302:2522273609057873::NO:RP::.

K. Dinicola, personal communication. Email on 10/28/15 forwarding an email from February 2014 to Phase II permittees about the online IDDE incident tracking form.

PSEMP 2016. Stormwater Work Group 2016-2017 Work Plan. Puget Sound Ecosystem Monitoring Program. Available via Department of Ecology at http://www.ecy.wa.gov/programs/wq/psmonitoring/swgworkplans.html

A. APPENDIX A – PERMITTEES

Permittees of the Western Washington NPDES Municipal Stormwater permit

Phase Is
Clark County
King County
Pierce County
Port of Seattle
Port of Tacoma*
Seattle
Snohomish County
Tacoma

Phase IIs
Aberdeen*
Algona
Anacortes
Arlington
Auburn
Bainbridge Island
Battle Ground
Bellevue
Bellingham
Black Diamond
Bonney Lake
Bothell
Bremerton
Brier*
Buckley*
Burien
Burlington*
Camas*
Centralia*
Clyde Hill
Covington
Cowlitz County*
Des Moines
DuPont
Duvall*
Edgewood*
Edmonds
Enumclaw
Everett
Federal Way
Ferndale
Fife*
Fircrest*
Gig Harbor
Granite Falls
Issaquah
Kelso
Kenmore
Kent
Kirkland
Kitsap County
Lacey
Lake Sammamish
Lake Stevens
Lakewood
Longview
Lynnwood
Maple Valley
Marysville
Medina*

Phase IIs, continued
Mercer Island
Mill Creek
Milton
Monroe
Mount Vernon
Mountlake Terrace*
Mukilteo
Newcastle
Normandy Park*
Oak Harbor
Olympia
Orting
Pacific
Port Angeles
Port Orchard
Port Townsend
Poulsbo
Puyallup
Redmond
Renton
Sammamish
SeaTac
Sedro-Woolley
Shoreline
Skagit County
Snohomish
Steilacoom
Sumner
Thurston County
Tukwila
Tumwater
University Place
Vancouver
Washougal
Whatcom County
Woodinville

* Indicates permittees who reported zero IDDE incidents in 2014. The city of Aberdeen reported five incidents but no summary of actions or supporting information about the incidents.

B. APPENDIX B – IDDE INCIDENT TRACKING FORM

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ORIGINAL INCIDENT TRACKING FORM as developed by Ecology permit managers and Source ID subgroup, revision May 8, 2013. Fields in blue text indicate optional information for permit-required reporting during the current permit cycle.

<table>
<tr><td>1. Jurisdiction name:</td><td colspan="4">6. Constituted a threat to human health or the environment?
__ yes; immediate response: __ yes __ no (explain); __G3 notification
__ no</td><td colspan="3">7. Address, nearest intersection, or zip code (optional):</td></tr>
<tr><td>2. Unique identifier:
nnnnn</td><td colspan="4"></td><td colspan="3"></td></tr>
<tr><td>3. Date incident was reported:
mm/dd/yyyy</td><td rowspan="2">8. Response timeline (permit compliance information):
Investigated within 7 days?
__ yes
__ no (explain)
__ referred (explain)
If suspected illicit connection, investigated within 21 days?
__ yes
__ no (explain)
__N/A
Final resolution within six months?
__yes
__no (explain)</td><td rowspan="2">9. How did you learn about the problem? (optional)
__ business inspection
__ catch basin or manhole inspection
__ ditch inspection
__ outfall inspection
__ stormwater BMP inspection
__ video inspection
__ other field screening
__ pollution hotline
__ other public report
__ staff referral
__ referred by adjacent MS4
__ other agency referral
__ ERTS
__ other (explain)</td><td rowspan="2">10. Source tracing method(s):
__ further inspection
__ dye testing
__ optical brightener
__ sand bagging
__ septic system inspection
__ smoke testing
__ vehicle/foot recon
__ video inspection
__ other (explain)</td><td rowspan="2">11. Indicator testing (optional):
__ flow
__ ammonia
__ color
__ odor
__ pH
__temp
__turbidity
__visual indicators
__chloride & fluoride
__detergent/ surfactants
__ hardness
__ nitrate
__ potassium
__ specific conductivity
__ other (explain)</td><td rowspan="2">12. Pollutant(s) identified:
__ sediment/soil
__ pet waste
__ food waste/oil
__ vehicle fluids
__ soap/detergent
__ dumping/trash
__ cement/concrete
__ paint
__ yard waste
__ sewage/septage
__ other (explain)
__ natural source
__ none found</td><td rowspan="2">13. Source or cause:
__ construction
__ residential
__ multifamily
__ commercial
__ retail
__ fueling
__ restaurant
__ drive-thru
__ mobile business
__ other
__ industrial
__ vehicle
__ illicit connection
__ public entity
__ other (explain)
__ source not identified</td><td rowspan="2">14. Correction and elimination method(s):
__ add or improve source control BMP
__ education/technical assistance
__ verbal notice
__ written warning
__ legal notice
__ penalty or fine
__ other (explain)
__ problem not abated (explain)
__ no action needed</td></tr>
<tr><td>4. Weather condition at time of report (optional):
__ clear
__ fog
__ rain
__night</td></tr>
<tr><td>5. Is this a
__ spill
__ ongoing problem</td><td></td></tr>
<tr><td>15. Final resolution
mm/dd/yyyy</td><td colspan="6">16. Field notes, explanations, and other comments:</td></tr>
</table>

REVISED DRAFT INCIDENT TRACKING FORM per Source ID subgroup, revision March 15, 2017

1. Jurisdiction name *__permit number* 2. Incident ID assigned by jurisdiction 3. Date incident reported 4. Date to begin response 5. Date to end response 6. Date of final resolution *- transfer to another party?* *__specify* 7. Discharge to MS4? *yes/no/unknown* <u>If no:</u> *- Cleaned up?* *- Combined sewer?* *- Private or other storm sewer?* *- Other?* *__explain* <u>If yes:</u> estimated discharge quantity: *- unknown* *- sheen* *- <10 gallons* *- 10 to 100 gal* *- 100 to 1000 gal* *- 1,000-10,000 gal* *- >10,000 gallons* Discharge frequency: *- continuous/ongoing* *- intermittent* *- one-time* 8. G3 notification? *yes/no* *__ERTS no.*	9. Incident location (enter one): *- address* *- tax parcel* *- lat/long* *- nearest intersection* 10. How was the incident discovered? *- pollution hotline* *(includes phone and/or web and/or mobile app)* *- direct report to staff* *- staff referral* *- other agency referral* *- ERTS* *- IDDE field observation* *- inspection:* *__ business* *__ construction* *__ catch basin or manhole* *__ outfall or other MS4* *__ stormwater BMP* *__ other* *- other* *__explain*	11. Pollutants identified: *- none found* *- unconfirmed* *- not identified* *- unspecified* *- vehicle oil, fuel, or other lubricant* *- antifreeze or other coolant* *- sediment/soil* *- sewage/septage* *- solid waste/trash* *- food waste or oil* *- yard waste or other plant or wood waste* *- household or industrial chemical* *__specify* *- carpet cleaning waste* *- fertilizer* *- pesticide or herbicide* *- bacteria* *- pet waste* *- soap/detergent* *- fire-fighting foam* *- other or unknown foam* *- heating oil or kerosene* *- roofing or road tar* *- cement, concrete, lime, or plaster* *- paint (oil based)* *- paint (latex)* *- PCBs* *- refrigerant* *- chlorinated water* *- other* *__specify*	12. Source or cause: *- n/a* *- allowable discharge* *__[dropdown list]* *- not identified* *- illicit connection* *- dumping* *- spill* *- vehicle collision/accident* *- construction activity* *- construction BMP failure* *- structural BMP failure* *- runoff due to drainage or grade conditions* *- stormwater or flood water* *- groundwater pumping* *- broken or clogged water or sewer line* *- septic system* *- leaking or abandoned container/dumpster* *- non-emergency firefighting or training* *- fueling* *- auto repair* *- vehicle washing* *- vehicle leakage/fluids* *- equipment cleaning* *- pressure washing* *- drive-thru* *- mobile business* *- retail operations* *- restaurant* *- logging* *- livestock* *- other* *__specify*	13. Source tracing: *- n/a* *- visual observation* *- map analysis* *- further inspection or reconnaissance* *- indicator testing* *- dye testing* *- pressure testing* *- smoke testing* *- video inspection* *- canine detection* *- optical brightener* *- sand bagging* *- smell/odor* *- other* *__specify*	14. Indicator testing: *- n/a* *- flow/discharge* *- sheen/oil* *- floatables* *- detergent or surfactants* *- ammonia* *- color* *- odor* *- pH* *- temperature* *- turbidity* *- hardness* *- nitrates* *- potassium* *- specific conductivity* *- bacteria* *- chloride/chlorine* *- fluoride* *- carbon monoxide* *- hydrogen sulfide* *- other* *__specify*	15. Correction/elimination methods: *- no action needed* *__explain* *- clean-up* *- education/technical assistance* *- add or improve source control BMP* *focus on structural* *- behavioral or BMP operation modification (focus on operational)* *- enforcement:* *- verbal notice* *- written warning* *- correction notice* *- stop work order* *- legal notice* *- penalty or fine* *- referred to other agency or department* *- follow-up or further investigation* *- problem not abated* *__explain* *- other* *__specify*
				16. Field notes, explanations, and/or other comments: will be character limited		

C. APPENDIX C – CONTINGENCY TABLES AND MAXMIUM LIKELIHOOD CHI-SQUARED STATISTICAL RESULTS

Table C-1. Observed frequencies and residuals from expected frequencies for pollutant type by Phase type for 2014 incidents in all jurisdictions (Maximum Likelihood Chi-Square = 129, df=7, p<0.001).

	Observed		Row Total	Observed - Expected	
Factor	Phase 1	Phase 2		Phase 1	Phase 2
Allowable Discharge, Natural Cause	40	2	42	28	-28
Cleaning chemicals	5	27	32	-4	4
Hydrocarbons, Vehicle Fluids	26	119	145	-16	16
Industrial Discharge, Chemicals	11	47	58	-6	6
Other	17	112	129	-20	20
Sediment, Soil, Construction	37	86	123	2	-2
Sewage	30	35	65	11	-11
Solid Waste, Garbage	10	9	19	5	-5
Column Total	176	437	613		

Table C-2. Observed frequencies and residuals from expected frequencies for pollutant type by how the problem was learned for 2014 incidents in all jurisdictions (Maximum Likelihood Chi-Square = 151, df=14, p<0.001).

	Observed			Row Total	Observed - Expected		
Factor	Hotline, Reported to Agency	Inspection	Intra- or Interagency referral		Hotline, Reported to Agency	Inspection	Intra- or Interagency referral
Allowable Discharge, Natural Cause	33	1	8	42	11.8	-12.8	1.0
Cleaning chemicals	11	16	5	32	-5.2	5.5	-0.3
Hydrocarbons, Vehicle Fluids	81	38	25	144	9.0	-9.4	0.5
Industrial Discharge, Chemicals	14	33	10	57	-14.7	14.2	0.4
Other	95	12	11	118	35.9	-26.9	-9.1
Sediment, Soil, Construction	32	71	18	121	-28.5	31.1	-2.6
Sewage	32	17	16	65	-0.6	-4.4	5.1
Solid Waste, Garbage	2	9	8	19	-7.7	2.7	5.0
Column Total	300	197	101	598			

Table C-3. Observed frequencies and residuals from expected frequencies for pollutant type by source tracing method for 2014 incidents in all jurisdictions (Maximum Likelihood Chi-Square = 63, df=14, p<0.001).

	Observed			Row Total	Observed - Expected		
Factor	In pipe testing	Other	Visual, Empirical		In pipe testing	Other	Visual, Empirical
Allowable Discharge, Natural Cause	3	0	28	31	1.6	-0.3	-1.3
Cleaning chemicals	0	0	31	31	-1.4	-0.3	1.7
Hydrocarbons, Vehicle Fluids	0	0	140	140	-7.6	-3.1	10.7
Industrial Discharge, Chemicals	2	0	54	56	-0.8	-1.0	1.8
Other	9	11	107	127	2.1	8.2	-10.4
Sediment, Soil, Construction	2	0	117	119	-4.4	-2.5	7.0
Sewage	13	0	45	58	10.1	-1.0	-9.1
Solid Waste, Garbage	1	0	18	19	0.3	0.0	-0.3
Column Total	30	11	540	581			

Table C-4. Observed frequencies and residuals from expected frequencies for source tracing method by how the problem was learned for 2014 incidents in all jurisdictions (Maximum Likelihood Chi-Square = 0.44, df=4, p=0.98).

	Observed			Row Total	Observed - Expected		
Factor	Hotline, Reported to Agency	Inspection	Intra- or Interagency referral		Hotline, Reported to Agency	Inspection	Intra- or Interagency referral
In pipe testing	16	10	4	30	0.9	-0.2	-0.7
Other	0	0	0	0	-0.2	0.0	0.3
Visual, Empirical	266	183	88	537	-0.6	0.2	0.4
Column Total	18	4	9	31			

Table C-5. Observed frequencies and residuals from expected frequencies for source tracing method by indicator testing method for 2014 incidents in all jurisdictions (Maximum Likelihood Chi-Square = 10.8, df=2, p<0.004).

	Observed			Row Total	Observed - Expected		
Factor	Chemical testing	Odor, pH, fecals	Visual, turbidity, flow		Chemical testing	Odor, pH, fecals	Visual, turbidity, flow
In pipe testing	9	4	17	30	6	2	-8
Visual, Empirical	59	33	421	513	-6	-2	8
Column Total	68	37	438	543			

Table C-6. Observed frequencies and residuals from expected frequencies for source tracing method by corrective action for 2014 incidents in all jurisdictions (Maximum Likelihood Chi-Square = 45, df=8, p<0.001).

	Observed						Observed - Expected				
Factor	Enforcement	Other	Refer to Other Agency/ Dept	BMPs or Cleanup	No Action	Row Total	Enforcement	Other	Refer to Other Agency/ Dept	BMPs or Cleanup	No Action
In pipe testing	1	1	3	23	1	29	-1.4	-0.2	9.8	-8.3	0.1
Other	0	0	11	0	0	11	4.4	0.3	-9.3	5.4	-0.8
Visual, Empirical	78	27	56	345	13	519	-3.0	-0.1	-0.5	3.0	0.6
Column Total	80	29	71	391	17	588					

Table C-7. Observed frequencies and residuals from expected frequencies for pollutant type by pollutant source for 2014 incidents in all jurisdictions (Maximum Likelihood Chi-Square = 877, df=42, p<0.001).

	Observed							
Factor	Auto Repair, Auto Body	Construction, Earthworks	Illicit Connection, Leaking Pipe	Industrial or Outdoor Activity	Natural Source	Other	Spill, Dumping, Runoff	Total
Allowable Discharge, Natural Cause	0	12	3	1	24	0	2	42
Cleaning chemicals	0	0	2	1	0	1	28	32
Hydrocarbons, Vehicle Fluids	4	2	2	1	1	3	132	145
Industrial Discharge, Chemicals	1	3	0	11	0	1	42	58
Other	0	0	106	1	3	16	3	129
Sediment, Soil, Construction	0	81	10	3	2	2	25	123
Sewage	0	1	58	0	0	3	2	64
Solid Waste, Garbage	0	4	0	2	0	1	12	19
Column Total	5	103	181	20	30	27	246	612
	Observed - Expected							
	Auto Repair, Auto Body	Construction, Earthworks	Illicit Connection, Leaking Pipe	Industrial or Outdoor Activity	Natural Source	Other	Spill, Dumping, Runoff	
Allowable Discharge, Natural Cause	-0.1	4.9	-9.7	-0.2	22.1	-1.7	-15.3	
Cleaning chemicals	0.0	-5.4	-7.8	0.2	-1.4	-0.2	14.6	
Hydrocarbons, Vehicle Fluids	2.4	-22.3	-40.4	-4.1	-6.4	-3.7	74.5	
Industrial Discharge, Chemicals	0.6	-6.8	-17.3	9.2	-2.8	-1.5	18.5	
Other	-1.4	-21.7	68.2	-3.5	-3.5	10.1	-48.3	
Sediment, Soil, Construction	-1.3	60.4	-26.1	-1.2	-4.2	-3.6	-23.9	
Sewage	-0.4	-9.8	39.0	-2.0	-3.1	0.2	-23.9	
Solid Waste, Garbage	0.2	0.7	-6.0	1.7	-0.7	0.4	3.7	

Table C-8. Observed frequencies and residuals from expected frequencies for pollutant type discharge quantity for 2014 incidents in all jurisdictions (Maximum Likelihood Chi-Square = 99, df=28, p<0.001).

	Observed					Total
Factor	**Very Large**	**Large**	**Medium**	**Small**	**Very Small**	
Allowable Discharge, Natural Cause	0	0	0	7	0	7
Cleaning chemicals	0	0	1	1	2	4
Hydrocarbons, Vehicle Fluids	0	0	2	11	41	54
Industrial Discharge, Chemicals	0	0	0	5	7	12
Other	7	5	7	3	1	23
Sediment, Soil, Construction	0	0	0	15	9	24
Sewage	1	2	6	15	5	29
Solid Waste, Garbage	0	0	0	5	1	6
Column Total	8	7	16	62	66	159
	Observed - Expected					
	Very Large	**Large**	**Medium**	**Small**	**Very Small**	
Allowable Discharge, Natural Cause	-0.1	-0.1	-0.6	4.0	-3.2	
Cleaning chemicals	0.1	0.1	0.8	-0.9	0.0	
Hydrocarbons, Vehicle Fluids	-3.3	-3.0	-3.8	-9.3	19.4	
Industrial Discharge, Chemicals	-0.5	-0.4	-1.1	0.2	1.8	
Other	5.8	3.9	4.7	-5.9	-8.5	
Sediment, Soil, Construction	-1.3	-1.1	-2.5	5.7	-0.9	
Sewage	-0.6	0.6	3.0	3.9	-6.8	
Solid Waste, Garbage	-0.1	0.0	-0.4	2.4	-1.8	

Discharge groupings:

- Very Large, >100,000 gallons
- Large, 10,000-100,000 gallons
- Medium, 1,000-10,000 gallons
- Small, 100 to 1000 gallons
- Very Small, <100 gallons

Table C-9. Observed frequencies and residuals from expected frequencies for pollutant type by corrective action method for 2014 incidents in all jurisdictions (Maximum Likelihood Chi-Square = 140, df=28, p<0.001).

	Observed					Row Total
Factor	Enforcement	No Action	Other	Refer to Other Agency/Dept	BMPs or Cleanup	
Allowable Discharge, Natural Cause	0	8	7	0	26	41
Cleaning chemicals	5	0	1	2	22	30
Hydrocarbons, Vehicle Fluids	17	2	4	25	95	143
Industrial Discharge, Chemicals	8	1	4	0	44	57
Other	1	1	3	18	99	122
Sediment, Soil, Construction	36	2	6	9	62	115
Sewage	5	3	4	17	32	61
Solid Waste, Garbage	8	0	0	0	11	19
Column Total	80	17	29	71	391	588
	Observed - Expected					
	Enforcement	No Action	Other	Refer to Other Agency/Dept	BMPs or Cleanup	
Allowable Discharge, Natural Cause	-5.5	7.0	5.1	-4.9	-1.8	
Cleaning chemicals	1.0	-0.6	-0.3	-1.5	1.4	
Hydrocarbons, Vehicle Fluids	-2.6	-2.5	-3.4	7.6	1.0	
Industrial Discharge, Chemicals	0.3	-0.6	1.3	-6.8	5.8	
Other	-15.7	-2.8	-3.3	3.1	18.6	
Sediment, Soil, Construction	20.3	-1.6	0.1	-5.0	-13.8	
Sewage	-3.3	1.3	1.1	9.7	-8.8	
Solid Waste, Garbage	5.5	-0.2	-0.7	-2.2	-2.5	