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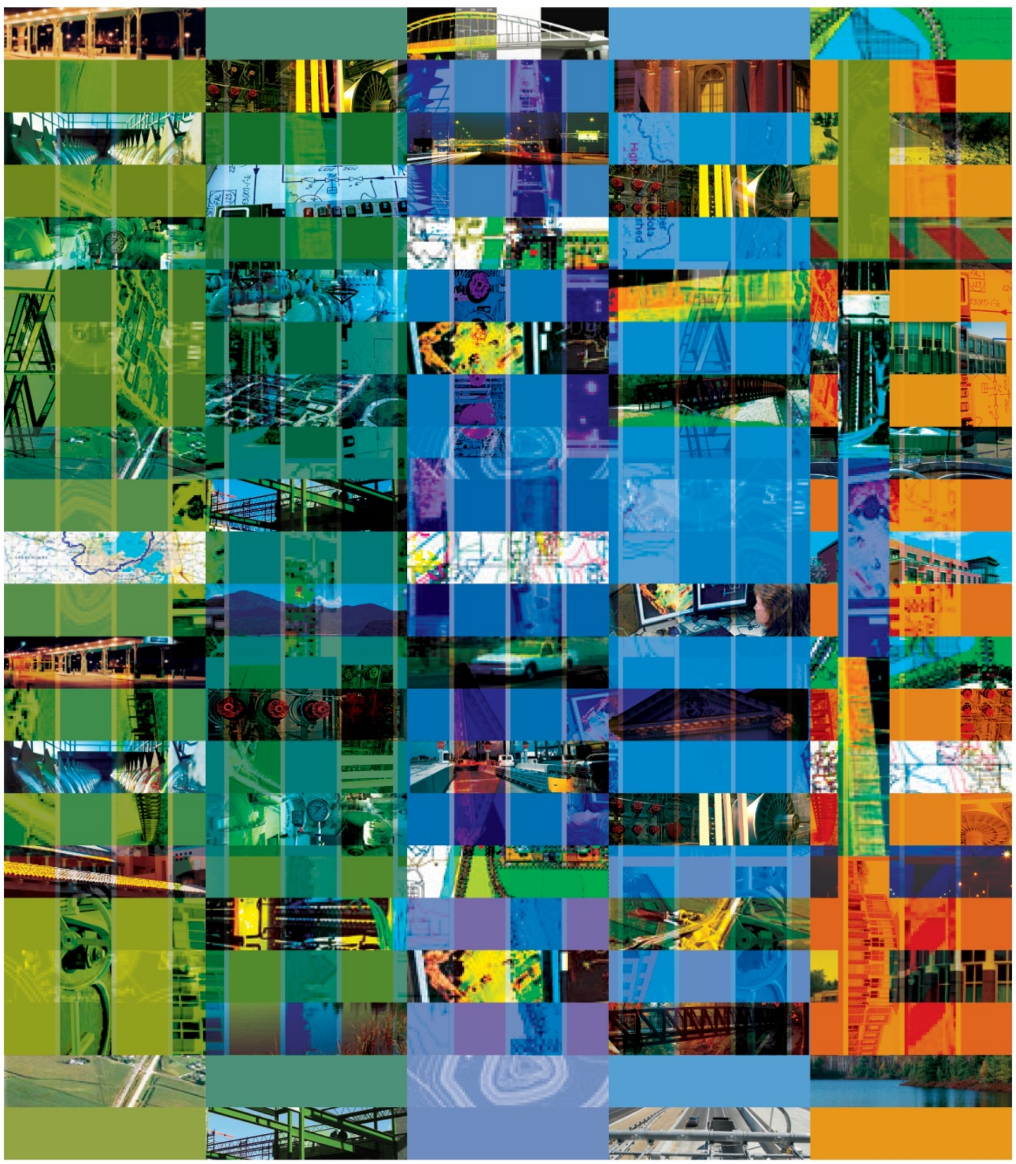
Illicit Discharge Detection and Elimination Plan



Report

Village of

Indian Head Park, IL

June 2020

STRAND ASSOCIATES®

Report for
Village of Indian Head Park, Illinois

Illicit Discharge Detection and Elimination Program

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SECTION 1 INTRODUCTION

The purpose of the Illicit Discharge Detection and Elimination (IDDE) Program is to identify potential illegal connections and discharges to the municipal separate storm sewer system (MS4) and eradicate them as quickly and with as little damage as possible. Illicit discharges, which can make up a large percentage of the pollutants found in MS4 discharges, derive from sanitary sewers, septic tank effluent, road spills, carwash wastewater, and improper disposal of household and automobile wastes. Untreated discharges can enter the storm sewer system directly from a sanitary sewer connection or indirectly from a sanitary sewer leak. The pollutants produced by direct and indirect untreated illicit discharges can vastly degrade water quality. Using geographic information system (GIS) tools and various field-testing methods performed by trained personnel, the Village of Indian Head Park's (Village) IDDE Program will help the Village avoid contributing to a violation of any applicable water quality standards outlined in Title 35 of the Illinois Administrative Code under Subtitle C, Chapter I, Part 302.

SECTION 2 STORM SEWER SYSTEM MAPPING

To better detect and eliminate illicit discharges, an MS4 permittee needs to know where its outfalls are located. The Village has already created a comprehensive map of its storm sewer system, which includes outfall locations and waterways (See Appendix B). Mapping will be continuously updated to include the locations of all MS4 outfalls and the names and location of all Waters of the United States (WOTUS) that receive discharges from those outfalls. The Village requires developers to provide GIS shapefiles of new sewer systems for incorporation into the mapping database.

A. Measurable Goal

Each year, the Village will update its mapping database with any new subdivision or applicable improvement projects. Field crews will monitor and verify the accuracy of the created outfall map each year after the first year of the permit cycle. The number of outfalls incorrectly included in the database, as well as the number of new outfalls identified each year, will determine the success of the outfall map.

B. Milestones

1. Year 1–Use publicly available contour mapping and previous record drawings to identify and map outfall locations discharging directly into WOTUS. Expand the current map to include all creeks and waterways and show land uses at the outfall locations.

2. Year 2–Incorporate new outfall and storm sewer information into the database. Field inspectors will verify the locations of the outfalls identified during the previous year as they monitor the outfalls for illicit discharges.

3. Years 3 to 5–Continue to incorporate new outfall and storm sewer information into the database. Field inspectors will continue to monitor and verify the locations of identified outfalls and attribute information of the outfalls within the database.

SECTION 3 REGULATORY CONTROL PROGRAM

The Village enforces the Metropolitan Water Reclamation District of Greater Chicago Watershed Management Ordinance (WMO), which provides for control of illicit discharges from soil erosion. It also has its own ordinances concerning illicit discharges.

A. Measurable Goal

The Village's Municipal Code (Chapter 40, Article III, Division 3–Use of Public Sewers) prohibits illicit discharges into any public sewers within the storm sewer system. As part of the IDDE, the Village will continuously review these prohibited discharges and consider whether to add any further items.

B. Milestones

Years 1 to 5–Continue to enforce the Village's Prohibited Discharges Ordinance and the WMO. Consider whether more items need to be added to the Prohibited Discharges Ordinance.

SECTION 4 DETECTION AND ELIMINATION PROGRAM

4.01 Detection and Elimination Prioritization Plan

The Village is required to proactively conduct field assessments to detect and monitor illicit discharges and connections to the Village's stormwater system and receiving waters. The Village will develop a prioritization plan to rank those areas most likely to contain illicit discharges based on land use, proximity of receiving waters to commercial and industrial areas, water quality data, age of the subwatershed development, and reported complaints. The initial prioritization procedure is listed in the following. The current mapping system (see Appendix B) identifies 22 outfalls located in the Village. The GIS database will display areas and waterbodies that are found to be at high risk for illicit discharges. Training protocols will be developed to keep staff safe during the field assessments.

Hierarchy for Developing Priority Areas:

1. Locations with known repeated problems in the past.
2. Particularly vulnerable waterbodies with potential illicit discharges.
3. Older communities with a high likelihood for illegal connections.
4. Commercial and industrial areas of the Village.
5. Routinely inspected outfalls.
6. Areas with numerous storage vessels of hazardous materials or large quantities of materials that could result in a spill.

In addition to developing and maintaining a detection and elimination prioritization plan, the Village provides its citizens a way to report potential illicit discharges via its stormwater management Web site.

A. Measurable Goal

The number of monitored outfalls and illicit discharge discoveries will be the measures of success of the detection and elimination prioritization plan. The prioritization plan is meant to anticipate areas with the highest expected number of illicit discharges which, in turn, will aid in locating major illicit discharges present within the system.

B. Milestones

1. Year 1–Develop and implement the detection and elimination prioritization plan for all MS4 outfalls within Village boundaries. Provide a comment portal on the Village's Web site to

report potential illicit discharges. Monitor the response times, inspection outcomes, and any enforcement taken from the online reports.

2. Year 2–Staff will begin conducting an Outfall Reconnaissance Inventory (ORI) of the Village's surface waters by walking streams to identify outfalls and potential discharge problems, taking site photos and recording observations on pipe sizes and type of discharge. Priority will be given to those outfalls initially listed as most likely to have water quality issues.

3. Years 3 to 5–Continue updating priority outfalls. Update the GIS database to include information attained from ongoing field assessments. Ask staff to evaluate the progression and efficacy of the plan and make revisions if needed. Eliminate any illicit discharges.

4.02 Illicit Discharge Tracing Procedures

Pollutant tracing is an essential component of the IDDE Program. Therefore, the Village will examine data regarding current procedures and obtain information regarding new techniques for tracing and detecting. Furthermore, the Village will perform a complete ORI throughout this permit cycle to confirm outfall locations, collect physical data, and identify potential areas with upstream illicit discharges. Appendix E contains details on the ORI, as well as an example form that staff can use. Updates and revisions will be made to the tracing procedures as needed.

A. Measurable Goal

Throughout the permit cycle, the Village will review the efficacy of its tracing procedures. As new illicit discharges are detected, Village staff will perform an annual review of all illicit discharges located and determine the most effective tracing methods. Tracing procedures will be modified as necessary.

B. Milestones

1. Year 1–Allow for the IDDE Program to commence. If necessary, provide a training session for Village staff involved in performing tracing tasks. Begin the ORI by first examining priority outfalls.

2. Year 2–Continue completing the ORI. If illicit discharges are detected, on-site investigations will be conducted to trace the illicit discharge to its source. Tracing procedures can include smoke testing, dye testing, and televising. Descriptions of some tracing procedures can be found in Appendix C.

3. Year 3–The Village will initiate any illicit discharge elimination necessary after collecting two years worth of tracing data. The Village will continually compile data for illicit discharge information. These data will determine which tracing methods are the most effective at each location.

4. Years 4 to 5–Continue tracing processes and monitoring outfalls. Once illicit discharges are detected, Village staff will follow the municipal protocol for illicit discharge removal. Make recommendations as to which tracing methods have proven to be the most effective.

4.03 Visual Dry Weather Screening

Dry weather screening is intended to detect and eliminate illicit discharges and illegal connections to the MS4 using dry weather discharge monitoring and follow-up investigations. The Village will use its MS4 outfall database as the basis for the monitoring program and its prioritization plan to create a screening schedule. Screening will first take place at outfalls that have been identified to have the greatest potential for illicit discharges.

A. General Field Assessment Procedures

Screening will take place at least 48 hours after a precipitation event. Staff will receive training on procedures for collecting, analyzing, and investigating dry weather flows before involvement in the program. Training sessions will include a review of safety protocols, field observation reporting, flow estimating, field sampling, calibration of field equipment, and the use of screening test kits. Table 1 contains equipment that staff will typically use during screening procedures.

Minimum two-person crew	Watch with second timer
Field book and pens	Tool tote with hammer, tape measure, pry bar
Digital camera	Cell phone
Safety vest, work boots, cones	Flashlight and headlamp
Manhole lid pick	Map of inspection area
Clear sample bottles	Wide mouth container

Table 1 Field Assessment Equipment

B. Physical Parameters of Dry Weather Screening

Dry weather screening will assess a variety of physical parameters at each outfall location, including outfall flow, odor, color, turbidity, and the presence of floatables. Staff will observe outfall flow both qualitatively (no flow, trickle, moderate, or substantial) and quantitatively. Quantitative flow rates include one of two calculations: recording the time it takes for the full flow to fill a known volume or multiplying the cross-sectional flow area by the flow velocity. Odor is defined as one of the following terms: sewage, rancid or sour, petroleum or gas, sulfide, or other. Color is a description of the type of color and its intensity. Turbidity measurements include qualitative descriptions (clear, slightly cloudy, cloudy, or opaque). Floatables provide the clearest physical indicator of an illicit discharge and can include oil sheens, sewage, and suds. Appendix F contains an example form that staff can use during outfall screening.

Observed flows are non-stormwater related during a dry weather screening but are not necessarily the result of an illicit discharge. Similarly, the absence of flow does not always equate to the absence of an illicit discharge, as these discharges can be sporadic.

C. Measurable Goal

Record annual implementation of the dry weather screening process and results of tracing illicit discharges. Record the details of each process and its results and include in the annual report. The dry weather screening process will change as problem areas are discovered. The goal is to eventually visit all MS4 outfalls within the Village.

D. Milestones

1. Year 1–Begin training staff responsible for collecting, analyzing, and investigating dry weather flows. Training sessions will include a review of safety protocols, field observations reporting, flow estimating, field sampling, and the sampling and analytical methods used to obtain different physical parameters.

2. Year 2–Begin dry weather screening of the MS4 outfalls. Screening will start at the outfalls that have been identified to have the highest potential for illicit discharges and will be performed in dry summer months. Record results and include in the annual report.

3. Years 3 to 5–Continue dry weather screening annually during the summer months and record results to be included in the annual report.

4.04 Pollutant Field Testing

If need be, staff will test for pollutants at select locations based on historical tracing and field visualization. As referenced in Section 4.05, pollutant field testing might occur once dry weather flows have been detected. Staff will use the Flow Chart Method described in "Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments" (Brown Caraco, and Pitt, 2004 a, b) to interpret indicator data and incidentally identify causes of the discharge (refer to Appendix D). Appendix D provides benchmarks for various pollutants that can be used as starting points for both trigger levels and subsequent classification of illicit discharges.

Surfactants, boron, fluoride, ammonia, and potassium are the most common pollutants of interest for *residential* outfalls. Testing helps aid in classifying and consequently removing illicit discharges. There are also manufacturing zones located in the Village. Appendix D contains benchmark concentrations for a handful of industrial indicator parameters, including ammonia and potassium, allowing for possibly synergistic testing with residential parameters. Additional data can lead to adjustments to trigger levels.

A. Measurable Goal

Pollutant tracing might only occur when certain trigger levels are met. The number of illicit discharges located after testing has been completed will determine the success of this practice. Should field testing continually result in staff investigations without discovering the source of the discharge, trigger levels will be adjusted. The annual report will include the results and assessments.

B. Milestones

1. Year 1–Begin training staff responsible for field testing. Training sessions will include a review of safety protocols, field sampling, calibration of field equipment, and proper test procedures for each pollutant.

2. Year 2–Begin dry weather screening of the MS4 outfalls. If discharges are discovered during such dry weather screenings, staff will complete further testing of pollutants as part of the illicit discharge investigation and complete a brief report.

3. Years 3 to 5–Review the results of the pollutant field tests and make recommendations as to which chemicals pose the greatest threat to the Village. Include results in the annual report and continue to test for pollutants following discovery of discharges during the dry weather survey.

4.05 Illicit Discharge Source Removal Procedures

When an illicit discharge is located, the Village will initiate procedures to work with the property owner to eliminate the connection as soon as possible. Typically, illicit discharges fall into one of two categories; operational missteps or structural problems. Educating the property owner committing an operation misstep can usually eliminate the illicit discharge. For property owners with structural problems like an illegal sewer connection, responsibility to eradicate the problem lies with the property owner; however, the Village can provide technical guidance.

If the Village locates an illicit discharge within Village boundaries that discharges directly to a neighboring municipality's MS4, the Village will notify the affected municipality within 24 hours of confirming the location of the illicit discharge. If the Village locates an illicit discharge in an unincorporated area, staff will contact Cook County within 24 hours of confirming the location of the illicit discharge. The goal of this Best Management Practice is to ensure that the permit holder has the authority to remove the illicit discharges when detected.

A. <u>Measurable Goal</u>

Village staff will measure the success by how many illicit discharges are detected and removed. If there are instances when an illicit discharge is detected but the property owner is not legally able to treat or remove the discharge, the removal procedure process will be modified. The Village will use education, enforcement, and fines to eliminate illicit discharges.

B. <u>Milestones</u>

1. Year 1–Allow the IDDE Program to commence.
2. Year 2–Begin monitoring MS4 outfalls based on outfall priority.
3. Year 3–Begin procedures to identify sources of detected illicit discharges.
4. Year 4–Begin the process of removing illicit discharges. Compile an annual report to summarize the data concerning detection and treatment of illicit discharges. Include the procedures used for subsequent analysis on the most efficient methods.
5. Year 5–Continue monitoring detected illicit discharge and pursue elimination. Review status of the detected illicit discharges and success of removal. Compile annual report.

4.06 Program Evaluation and Assessment

The Village will review the efficacy of the IDDE Program on an annual basis and will provide recommendations when staff believe changes should be made to the program. The review will focus on the effectiveness of the program, budget, staff required, and potential integration with other programs. Any modifications to the plan will be made at the start of each permit year in April.

A. Measurable Goal

The Village will annually assess the IDDE Program using the following criteria;

- Updated mapping to display outfalls located during an ORI.
- Surveyed stream reaches with instances of obvious or potential illicit discharges, as well as locations of dumping sites.
- Pollutant indicator sampling results for stream reaches, outfalls, and storm drains.
- Frequency of online comments and associated number of confirmed illicit discharges.
- Costs for each segment of the IDDE Program.
- Number of discharges corrected.
- Status of elimination and enforcement actions.

B. Milestones

1. Year 1–Maintain measurable goals for evaluating the effectiveness of the IDDE Program. Compile the annual report in March and adopt modifications, if necessary.

2. Years 2 to 5–Review the IDDE Program for the previous year, analyzing staff hours, budgeted and used dollars, and effectiveness in detecting and eliminating illicit discharges. Compile the annual report in March and adopt modifications, if necessary.

SECTION 5 PUBLIC EDUCATION AND OUTREACH

To encourage community awareness and involvement, the Village will post the IDDE Program on the stormwater Web site alongside copies of annual IEPA reports and the overall MS4 Program. The Village will continue to maintain the online comment portal on the Web site for citizens to report spills or illicit discharges.

A. Measurable Goal

Response times, inspection outcomes, and enforcement actions taken based on public concerns and complaints will determine the success of public education and outreach efforts. Furthermore, the Village will post the annual IDDE Program report on the stormwater Web site.

B. Milestones

1. Year 1–Establish an online comment portal on the Village’s Web site. Monitor the response times, inspection outcomes, and any enforcement taken from the Action Line. Post the IDDE Program and Notice of Intent on the Village’s stormwater Web site.

2. Years 2 to 5–Continue to monitor the online portal and post the annual IDDE Program reports in June for the previous year. Use education as the first method to eliminating illicit discharges (i.e., inform the property owner regarding responsibly taking care of stormwater leaving the property).

SECTION 6 OTHER ILLICIT DISCHARGE CONTROLS

The Village will consider updating its development ordinances to include the requirement that all new grated storm inlets be marked “Dump No Waste.”

A. Measurable Goal

Update current Village development ordinances.

B. Milestones

1. Years 1 to 2–Propose amendments of the development ordinances to the Planning Department.

2. Years 3 to 5–Maintain the updated ordinances.

APPENDIX A
IDDE ITEMS SUMMARY

IDDE ITEMS SUMMARY

The following section summarizes the items to be completed before the next permit period.

Year 1 (2020)

1. Update GIS system with new storm sewer information within the last year.
2. Develop a prioritization plan to rank areas most likely to contain illicit discharges.
3. Establish an online comment portal on the Village's Web site. Monitor the response times, inspection outcomes, and any enforcement taken.
4. Post the IDDE Program and a copy of previous Annual Reports on the stormwater Web site.
5. Update the development ordinance to require all new grated storm inlets to provide a warning against dumping waste into the storm sewer.
6. Develop a procedure for evaluating the effectiveness of each component of the IDDE Program.

Year 2 (2021)

1. Incorporate new outfall and storm sewer information into the GIS database.
2. Forward proposed modifications of the Prohibited Discharges and development ordinances to Village Board for approval and implementation.
3. Begin monitoring outfalls that have been identified and surveyed the previous year.
4. Continue to monitor response times and enforcement action taken from online comments.
5. Begin dry weather screening of the MS4 outfalls. Pollutant field testing will be done when warranted by discovery of potential illicit discharges.
6. Review the IDDE Program from the previous year. Compile the annual report and adopt modifications, if necessary.

Year 3 (2022)

1. Continue to incorporate new outfall and storm sewer information into the GIS database.
2. Continue to enforce applicable stormwater discharge ordinances.
3. Continue to update and monitor priority outfalls and the online comments.
4. Continue dry weather screening annually during the summer months.
5. Begin tracing procedures if illicit discharges have been detected.
6. Review the results of the pollutant field tests and make recommendations as to which chemicals pose as the greatest threats to the Village. Include the results in the annual report and continue to test for pollutants during the dry weather survey when warranted.
7. Review the IDDE Program for the previous year. Compile the annual report and adopt modifications, if necessary.

Year 4 (2023)

1. Continue to incorporate new outfall and storm sewer information into the GIS database.
2. Continue to enforce applicable stormwater discharge ordinances.
3. Continue to update and monitor priority outfalls and the online comments.
4. Review the results of the first two years of monitoring. The procedures laid out for the prioritization plan will be repeated on any new outfalls added to the database since the last prioritization was developed.
5. Review the results of the pollutant field tests and make recommendations as to which chemicals pose as the greatest threats to the Village.

6. Continue dry weather screening annually during the summer months and continue to test for pollutants when warranted.
7. Make recommendations as to which tracing procedures are the most effective.
8. Remove any illicit discharges.
9. Review the IDDE Program for the previous year. Compile the annual report and adopt modifications if necessary. Include in the annual report data of the illicit discharges that were detected and treated.

Year 5 (2024)

1. Continue to incorporate new outfall and storm sewer information into the GIS database.
2. Continue to enforce applicable stormwater discharge ordinances.
3. Continue to update and monitor priority outfalls and the Action Line.
4. Review the results of the pollutant field tests and make recommendations as to which chemicals pose as the greatest threats to the Village.
5. Continue dry weather screening annually during the summer months and continue to test for pollutants when warranted.
6. Review the IDDE Program for the previous year. Compile the annual report in December and adopt modifications, if necessary. Include in the annual report data of the illicit discharges that were detected and treated.

ANNUAL CALENDAR OF ACTIVITIES

The following section details the regular activities to be performed on an annual basis.

January

1. Post the IDDE program and a copy of the annual report from the previous year on the stormwater Web site.
2. Review the Village's Prohibited Discharges ordinance and identify possible updates.
3. Update the GIS database with new outfall and storm sewer information.
4. Monitor stormwater Web site.

February

1. Update the GIS database with new outfall and storm sewer information.
2. Monitor stormwater Web site.

March

1. Update the GIS database with new outfall and storm sewer information.
2. Monitor stormwater Web site.

April

1. Update the GIS database with new outfall and storm sewer information.
2. Prioritize critical outfalls most likely to contain illicit discharges.
3. Monitor stormwater Web site.

May

1. Update the GIS database with new outfall and storm sewer information.
2. Conduct training session for Village staff involved in field testing.
3. Perform testing for pollutants at critical locations.
4. Monitor stormwater Web site.

June

1. Update the GIS database with new outfall and storm sewer information.
2. Perform dry weather screening and continue to test for pollutants when warranted.
3. Remove illicit discharges once detected and traced back to the source.
4. Monitor stormwater Web site.

July

1. Update the GIS database with new outfall and storm sewer information.
2. Perform dry weather screening and continue to test for pollutants when warranted.
3. Remove illicit discharge once detected and traced back to the source.
4. Monitor stormwater Web site.

August

1. Update the GIS database with new outfall and storm sewer information.
2. Perform dry weather screening and continue to test for pollutants when warranted.
3. Remove illicit discharges once detected and traced back to the source.
4. Monitor stormwater Web site.

September

1. Update the GIS database with new outfall and storm sewer information.
2. Evaluate prioritization, detecting, tracing, and elimination procedures based on field data. Review which procedures were the most effective. Include evaluation in the annual report.
3. Monitor stormwater Web site.

October

1. Update the GIS database with new outfall and storm sewer information.
2. Monitor stormwater Web site.

November

1. Update the GIS database with new outfall and storm sewer information.
2. Monitor stormwater Web site.

December

1. Update the GIS database with new outfall and storm sewer information.
2. Compile data from the Web site including response times, inspection outcomes, and any enforcement taken. Include data in annual report.

3. Review the IDDE program for the previous year. Compile the annual report and adopt modifications, if necessary.
4. Monitor stormwater Web site.

APPENDIX B
STORM SEWER OUTFALL MAP

1335.001

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VILLAGE OF INDIAN HEAD PARK

STORM SEWER ATLAS

NO.	REVISIONS	BY:	DATE:
1	VILLAGE REVIEW	ERS	3/8/16

APPENDIX C
EXAMPLE ON-SITE INVESTIGATION PROCEDURES

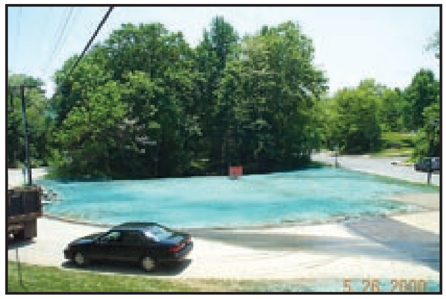


Figure 61: Symptom (left): Discoloration of stream; Diagnosis: Extra hydroseed leftover from an upstream application (middle) was dumped into a storm drain by municipal officials (right).

A third example of the windshield survey approach is shown in Figure 62, where a very thick, sudsy and fragrant discharge was noted at a small outfall. The discharge appeared to consist of wash water, and the only commercial laundromat found upstream was confirmed to be the source. On-site testing may still be needed to identify the specific plumbing or connection generating the discharge.

Detailed Drainage Area Investigations

In larger or more complex drainage areas, GIS data can be analyzed to pinpoint the source of a discharge. If only general land use data exist, maps can at least highlight suspected industrial areas. If more detailed SIC code data are available digitally, the GIS can be used to pull up specific hotspot operations or generating sites that could be potential dischargers. Some of the key discharge indicators that are associated with hotspots and specific industries are reviewed in Appendix K.

13.3 On-site Investigations

On-site investigations are used to pinpoint the exact source or connection producing a discharge within the storm drain network. The three basic approaches are dye, video and smoke testing. While each approach can determine the actual source of a discharge, each needs to be applied under the right conditions and test limitations (see Table 56). It should be noted that on-site investigations are not particularly effective in finding *indirect* discharges to the storm drain network.

Figure 62: The sudsy, fragrant discharge (left) indicates that the laundromat is the more likely culprit than the florist (right).

Table 56: Techniques to Locate the Discharge		
Technique	**Best Applications**	**Limitations**
Dye Testing	• Discharge limited to a very small drainage area (<10 properties is ideal) • Discharge probably caused by a connection from an individual property • Commercial or industrial land use	• May be difficult to gain access to some properties
Video Testing	• Continuous discharges • Discharge limited to a single pipe segment • Communities who own equipment for other investigations	• Relatively expensive equipment • Cannot capture non-flowing discharges • Often cannot capture discharges from pipes submerged in the storm drain
Smoke Testing	• Cross-connection with the sanitary sewer • Identifying other underground sources (e.g., leaking storage techniques) caused by damage to the storm drain	• Poor notification to public can cause alarm • Cannot detect all illicit discharges

TIP
The Wayne County Department of the Environment provides excellent training materials on on-site investigations, as well as other illicit discharge techniques. More information about this training can be accessed from their website: http://www.wcdoe.org/Watershed/Programs___Srvcs_/IDEP/idep.htm.

Figure 63: Dye Testing Plumbing (NEIWPCC, 2003)

Dye Testing

Dye testing is an excellent indicator of illicit connections and is conducted by introducing non-toxic dye into toilets, sinks, shop drains and other plumbing fixtures (see Figure 63). The discovery of dye in the storm drain, rather than the sanitary sewer, conclusively determines that the illicit connection exists.

Before commencing dye tests, crews should review storm drain and sewer maps to identify lateral sewer connections and how they can be accessed. In addition, property owners must be notified to obtain entry permission. For industrial or commercial properties, crews should carry a letter to document their legal authority to gain access to the property. If time permits, the letter can be sent in advance of the dye testing. For residential properties, communication can be more challenging. Unlike commercial properties, crews are not guaranteed access to homes, and should call ahead to ensure that the owner will be home on the day of testing.

Communication with other local agencies is also important since any dye released to the storm drain could be mistaken for a spill or pollution episode. To avoid a costly and embarrassing response to a false alarm, crews should contact key spill response agencies using a "quick fax" that describes when and where dye testing is occurring (Tuomari and Thomson, 2002). In addition, crews should carry a list of phone numbers to call spill response agencies in the event dye is released to a stream.

At least two staff are needed to conduct dye tests – one to flush dye down the plumbing fixtures and one to look for dye in the downstream manhole(s). In some cases, three staff may be preferred, with two staff entering the private residence or building for both safety and liability purposes.

The basic equipment to conduct dye tests is listed in Table 57 and is not highly specialized. Often, the key choice is the type of dye to use for testing. Several options are profiled in Table 58. In most cases, liquid dye is used, although solid dye tablets can also be placed in a mesh bag and lowered into the manhole on a rope (Figure 64). If a

Table 57: Key Field Equipment for Dye Testing
(Source: Wayne County, MI, 2000)

Maps, Documents
- Sewer and storm drain maps (sufficient detail to locate manholes)
- Site plan and building diagram
- Letter describing the investigation
- Identification (e.g., badge or ID card)
- Educational materials (to supplement pollution prevention efforts)
- List of agencies to contact if the dye discharges to a stream.
- Name of contact at the facility

Equipment to Find and Lift the Manhole Safely (small manhole often in a lawn)
- Probe
- Metal detector
- Crow bar
- Safety equipment (hard hats, eye protection, gloves, safety vests, steel-toed boots, traffic control equipment, protective clothing, gas monitor)

Equipment for Actual Dye Testing and Communications
- 2-way radio
- Dye (liquid or "test strips")
- High powered lamps or flashlights
- Water hoses
- Camera


Figure 64: Dye in a mesh bag is placed into an upstream manhole (left); Dye observed at a downstream manhole traces the path of the storm drain (right)

longer pipe network is being tested, and dye is not expected to appear for several hours, charcoal packets can be used to detect the dye (GCHD, 2002). Charcoal packets can be secured and left in place for a week or two, and then analyzed for the presence of dye. Instructions for using charcoal packets in dye testing can be accessed at the following website: http://bayinfo.tamug.tamu.edu/gbeppubs/ms4.pdf.

The basic drill for dye tests consists of three simple steps. First, flush or wash dye down the drain, fixture or manhole. Second, pop open downgradient sanitary sewer manholes and check to see if any dye appears. If none is detected in the sewer manhole after an hour or so, check downgradient storm drain manholes or outfalls for the presence of dye. Although dye testing is fairly straightforward, some tips to make testing go more smoothly are offered in Table 59.

Table 58: Dye Testing Options

Product	Applications
Dye Tablets	• Compressed powder, useful for releasing dye over time • Less messy than powder form • Easy to handle, no mess, quick dissolve • Flow mapping and tracing in storm and sewer drains • Plumbing system tracing • Septic system analysis • Leak detection
Liquid Concentrate	• Very concentrated, disperses quickly • Works well in all volumes of flow • Recommended when metering of input is required • Flow mapping and tracing in storm and sewer drains • Plumbing system tracing • Septic system analysis • Leak detection
Dye Strips	• Similar to liquid but less messy
Powder	• Can be very messy and must dissolve in liquid to reach full potential • Recommended for very small applications or for very large applications where liquid is undesirable • Leak detection
Dye Wax Cakes	• Recommended for moderate-sized bodies of water • Flow mapping and tracing in storm and sewer drains
Dye Wax Donuts	• Recommended for large sized bodies of water (lakes, rivers, ponds) • Flow mapping and tracing in storm and sewer drains • Leak detection

Table 59: Tips for Successful Dye Testing
(Adapted from Tuomari and Thompson, 2002)

Dye Selection
- Green and liquid dyes are the easiest to see.
- Dye test strips can be a good alternative for residential or some commercial applications. (Liquid can leave a permanent stain).
- Check the sanitary sewer before using dyes to get a "base color." In some cases, (e.g., a print shop with a permitted discharge to the sanitary sewer), the sewage may have an existing color that would mask a dye.
- Choose two dye colors, and alternate between them when testing multiple fixtures.

Selecting Fixtures to Test
- Check the plumbing plan for the site to isolate fixtures that are separately connected.
- For industrial facilities, check most floor drains (these are often misdirected).
- For plumbing fixtures, test a representative fixture (e.g., a bathroom sink).
- Test some locations separately (e.g., washing machines and floor drains), which may be misdirected.
- If conducting dye investigations on multiple floors, start from the basement and work your way up.
- At all fixtures, make sure to flush with plenty of water to ensure that the dye moves through the system.

Selecting a Sewer Manhole for Observations
- Pick the closest manhole possible to make observations (typically a sewer lateral).
- If this is not possible, choose the nearest downstream manhole.

Communications Between Crew Members
- The individual conducting the dye testing calls in to the field person to report the color dye used, and when it is dropped into the system.
- The field person then calls back when dye is observed in the manhole.
- If dye is not observed (e.g., after two separate flushes have occurred), dye testing is halted until the dye appears.

Locating Missing Dye
- The investigation is not complete until the dye is found. Some reasons for dye not appearing include:
- The building is actually hooked up to a septic system.
- The sewer line is clogged.
- There is a leak in the sewer line or lateral pipe.

Video Testing

Video testing works by guiding a mobile video camera through the storm drain pipe to locate the actual connection producing an illicit discharge. Video testing shows flows and leaks within the pipe that may indicate an illicit discharge, and can show cracks and other pipe damage that enable sewage or contaminated water to flow into the storm drain pipe.

Video testing is useful when access to properties is constrained, such as residential neighborhoods. Video testing can also be expensive, unless the community already owns and uses the equipment for sewer inspections. This technique will not detect all types of discharges, particularly when the illicit connection is not flowing at the time of the video survey.

Different types of video camera equipment are used, depending on the diameter and condition of the storm sewer being tested.

Field crews should review storm drain maps, and preferably visit the site before selecting the video equipment for the test. A field visit helps determine the camera size needed to fit into the pipe, and if the storm drain has standing water.

In addition to standard safety equipment required for all manhole inspections, video testing requires a Closed-Circuit Television (CCTV) and supporting items. Many commercially available camera systems are specifically adapted to televise storm sewers, ranging from large truck or van-mounted systems to much smaller portable cameras. Cameras can be self-propelled or towed. Some specifications to look for include:

- The camera should be capable of radial view for inspection of the top, bottom, and sides of the pipe and for looking up lateral connections.
- The camera should be color.
- Lighting should be supplied by a lamp on the camera that can light the entire periphery of the pipe.

When inspecting the storm sewer, the CCTV is oriented to keep the lens as close as possible to the center of the pipe. The camera can be self-propelled through the pipe using a tractor or crawler unit or it may be towed through on a skid unit (see Figures 65 and 66). If the storm drain has ponded water, the camera should be attached to a raft, which floats through the storm sewer from one manhole to the next. To see details of the sewer, the camera and lights should be able to swivel both horizontally and vertically. A video record of the inspection should be made for future reference and repairs (see Figure 67).

Smoke Testing

Smoke testing is another “bottom up” approach to isolate illicit discharges. It works by introducing smoke into the storm drain system and observing where the smoke surfaces. The use of smoke testing to detect illicit discharges is a relatively new application, although many communities have used it to check for infiltration and inflow into their sanitary sewer network. Smoke testing can find improper

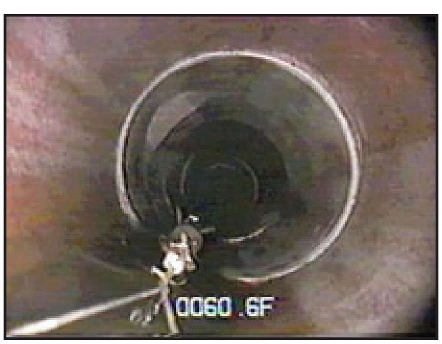


Figure 65: Camera being towed

Figure 66: Tractor-mounted camera

Figure 67: Review of an inspection video

connections, or damage to the storm drain system (Figure 68). This technique works best when the discharge is confined to the upper reaches of the storm drain network, where pipe diameters are to small for video testing and gaining access to multiple properties renders dye testing infeasible.

Notifying the public about the date and purpose of smoke testing before starting is critical. The smoke used is non-toxic, but can cause respiratory irritation, which can be a problem for some residents. Residents should be notified at least two weeks prior to testing, and should be provided the following information (Hurco Technologies, Inc., 2003):

- Date testing will occur
- Reason for smoke testing
- Precautions they can take to prevent smoke from entering their homes or businesses
- What they need to do if smoke enters their home or business, and any health concerns associated with the smoke
- A number residents can call to relay any particular health concerns (e.g., chronic respiratory problems)

Program managers should also notify local media to get the word out if extensive smoke testing is planned (e.g., television, newspaper, and radio). On the actual day of testing, local fire, police departments and 911 call centers should be notified to handle any calls from the public (Hurco Technologies, Inc., 2003).

The basic equipment needed for smoke testing includes manhole safety equipment, a smoke source, smoke blower, and sewer plugs. Two smoke sources can be used for smoke testing. The first is a smoke "bomb," or "candle" that burns at a controlled rate and releases very white smoke visible at relatively low concentrations (Figure 69). Smoke bombs are suspended beneath a blower in a manhole. Candles are available in 30 second to three minute sizes. Once opened, smoke bombs should be kept in a dry location and should be used within one year.

The second smoke source is liquid smoke, which is a petroleum-based product that is injected into the hot exhaust of a blower where it is heated and vaporized (Figure 70). The length of smoke production can vary depending on the length of the pipe being

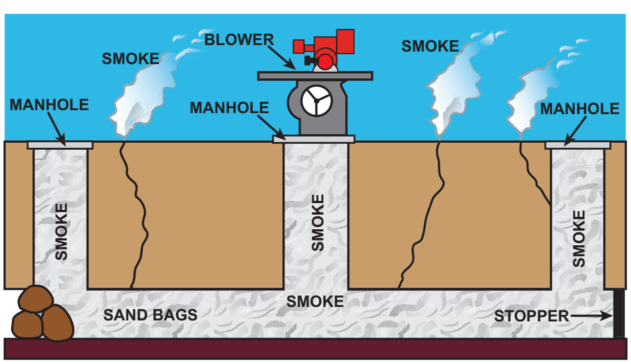


Figure 68: Smoke Testing System Schematic


Figure 69: Smoke Candles

Figure 70: Smoke blower

tested. In general, liquid smoke is not as consistently visible and does not travel as far as smoke from bombs (USA Blue Book).

Smoke blowers provide a high volume of air that forces smoke through the storm drain pipe. Two types of blowers are commonly used: “squirrel cage” blowers and direct-drive propeller blowers. Squirrel cage blowers are large and may weigh more than 100 pounds, but allow the operator to generate more controlled smoke output. Direct-drive propeller blowers are considerably lighter and more compact, which allows for easier transport and positioning.

Three basic steps are involved in smoke testing. First, the storm drain is sealed off by plugging storm drain inlets. Next, the smoke is released and forced by the blower through the storm drain system. Lastly, the crew looks for any escape of smoke above-ground to find potential leaks.

One of three methods can be used to seal off the storm drain. Sandbags can be lowered into place with a rope from the street surface. Alternatively, beach balls that have a diameter slightly larger than the drain can be inserted into the pipe. The beach ball is then placed in a mesh bag with a rope attached to it so it can be secured and retrieved. If the beach ball gets stuck in the pipe, it can simply be punctured, deflated and removed. Finally, expandable plugs are available, and may be inserted from the ground surface.

Blowers should be set up next to the open manhole after the smoke is started. Only one manhole is tested at a time. If smoke candles are used, crews simply light the candle, place it in a bucket, and lower it in the manhole. The crew then watches to see where smoke escapes from the pipe. The two most common situations that indicate an illicit discharge are when smoke is seen rising from internal plumbing fixtures (typically reported by residents) or from sewer vents. Sewer vents extend upward from the sewer lateral to release gas buildup, and are not supposed to be connected to the storm drain system.

13.4 Septic System Investigations

The techniques for tracing illicit discharges are different in rural or low-density residential watersheds. Often, these watersheds lack sanitary sewer service and storm water is conveyed through ditches or swales, rather than enclosed pipes. Consequently, many illicit discharges enter the stream as indirect discharges, through surface breakouts of septic fields or through straight pipe discharges from bypassed septic systems.

The two broad techniques used to find individual septic systems—on-site investigations and infrared imagery—are described in this section.

APPENDIX D
FLOW CHART METHOD: A TECHNIQUE TO INTERPRET INDICATOR DATA

- *Instrument calibration* – Depending on the method, instruments may come with a standard calibration curve, or may require calibration at each use. Lab analysts should periodically test the default calibration curve.

Table 44 summarizes estimated costs associated with sample analyses at a contract lab.

12.4 Techniques to Interpret Indicator Data

Program managers need to decide on the best combination of indicator parameters that will be used to confirm discharges and identify flow types. This section presents guidance on four techniques to interpret indicator parameter data:

- Flow Chart Method (recommended)
- Single Parameter Screening
- Industrial Flow Benchmarks
- Chemical Mass Balance Model (CMBM)

Table 44: Typical Per Sample Contract Lab Costs

Parameter	Costs
Ammonia	$12 - $25
Boron	$16 - $20
Chlorine	$6 - $10
Color	$7 - $11
Conductivity	$2 - $6
Detergents – Surfactants	$17- $35
Enterococci, *E. Coli* or Total Coliform	$17 - $35
Fluoride	$14 - $25
Hardness	$8 - $16
pH	$2 - $7
Potassium	$12 - $14
Turbidity	$9 - $12

All four techniques rely on benchmark concentrations for indicator parameters in order to distinguish among different flow types. Program managers are encouraged to adapt each technique based on local discharge concentration data, and some simple statistical methods for doing so are provided throughout the section.

The Flow Chart Method

The Flow Chart Method is recommended for most Phase II communities, and was originally developed by Pitt *et al.* (1993) and Lalor (1994) and subsequently updated based on new research by Pitt during this project. The Flow Chart Method can distinguish four major discharge types found in residential watersheds, including sewage and wash water flows that are normally the most common illicit discharges. Much of the data supporting the method were collected in Alabama and other regions, and some local adjustment may be needed in some communities. The Flow Chart Method is recommended because it is a relatively simple technique that analyzes four or five indicator parameters that are safe, reliable and inexpensive to measure. The basic decision points involved in the Flow Chart Method are shown in Figure 47 and described below:

Step 1: Separate clean flows from contaminated flows using detergents

The first step evaluates whether the discharge is derived from sewage or washwater sources, based on the presence of detergents. Boron and/or surfactants are used as the primary detergent indicator, and values of boron or surfactants that exceed 0.35 mg/L and 0.25 mg/L, respectively, signal that the discharge is contaminated by sewage or washwater.

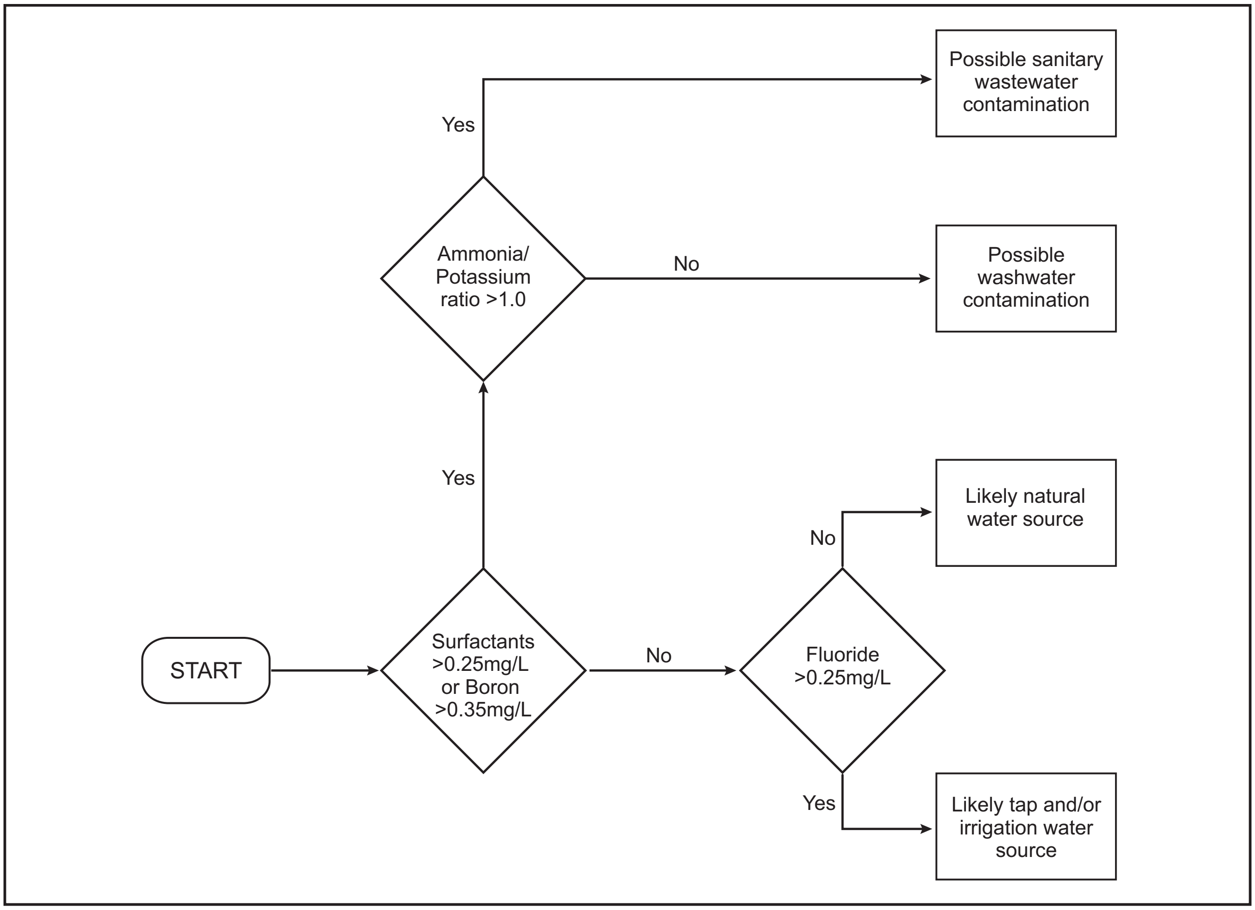


Figure 47: Flow Chart to Identify Illicit Discharges in Residential Watersheds

Step 2: Separate washwater from wastewater using the Ammonia/ Potassium ratio

If the discharge contains detergents, the next step is to determine whether they are derived from sewage or washwater, using the ammonia to potassium ratios. A ratio greater than one suggests sewage contamination, whereas ratios less than one indicate washwater contamination. The benchmark ratio was developed by Pitt *et al.* (1993) and Lalor (1994) based on testing in urban Alabama watersheds.

Step 3: Separate tap water from natural water

If the sample is free of detergents, the next step is to determine if the flow is derived from spring/groundwater or comes from tap water. The benchmark indicator used in this step is fluoride, with concentrations exceeding 0.60 mg/L indicating that potable water is the source. Fluoride levels between 0.13 and 0.6 may indicate non-target irrigation water. The purpose of determining the source of a relatively “clean discharge” is that it can point to water line breaks, outdoor washing, non-target irrigation and other uses of municipal water that generate flows with pollutants.

Adapting the Flow Chart Method

The Flow Chart Method is a robust tool for identifying illicit discharge types, but may need to be locally adapted, since much of the supporting data was collected in one region of the country. Program managers should look at four potential modifications to the flow chart in their community.

1) Is boron or surfactants a superior local indicator of detergents?

Surfactants are almost always a more reliable indicator of detergents, except for rare cases where groundwater has been contaminated by sewage. The disadvantage of surfactants is that the recommended analytical method uses a hazardous chemical as the reagent. Boron uses a safer analytical method. However, if boron is used as a detergent indicator, program managers should sample boron levels in groundwater and tap water, since they can vary regionally. Also, not all detergent formulations incorporate boron at high levels, so it may not always be a strong indicator.

2) Is the ammonia/potassium ratio of one the best benchmark to distinguish sewage from washwater?

The ammonia/potassium ratio is a good way to distinguish sewage from washwater, although the exact ratio appears to vary in different regions of the country. The benchmark value for the ratio was derived from extensive testing in one Alabama city. In fact, data collected in another Alabama city indicated an ammonia/potassium ratio of 0.6 distinguished sewage from wash water. Clearly, program managers should evaluate the ratio in their own community, although the proposed ratio of 1.0 should still capture the majority of sewage discharges. The ratio can be refined over time using indicator monitoring at local outfalls, or through water quality sampling of sewage and washwater flow types for the chemical library.

3) Is fluoride a good indicator of tap water?

Usually. The two exceptions are communities that do not fluoridate their drinking water or have elevated fluoride concentrations in groundwater. In both cases, alternative indicator parameters such as hardness or chlorine may be preferable.

4) Can the flow chart be expanded?

The flow chart presented in Figure 47 is actually a simplified version of a more complex flow chart developed by Pitt for this project, which is presented in Appendix H. An expanded flow chart can provide more consistent and detailed identification of flow types, but obviously requires more analytical work and data analysis. Section 12.5 provides guidance on statistical techniques to customize the flow chart method based on your local discharge data.

Single Parameter Screening

Research by Lalor (1994) suggests that detergents is the best single parameter to detect the presence or absence of the most common illicit discharges (sewage and washwater). The recommended analytical method for detergents uses a hazardous reagent, so the analysis needs to be conducted in a controlled laboratory setting with proper safety equipment. This may limit the flexibility of a community if it is conducting analyses in the field or in a simple office lab.

Ammonia is another single parameter indicator that has been used by some communities with widespread or severe sewage contamination. An ammonia concentration greater than 1 mg/L is generally considered to be a positive indicator of sewage contamination. Ammonia can be analyzed in the field using a portable spectrophotometer, which allows for fairly rapid results and the ability to immediately track down sources and improper connections (see Chapter 13 for details on tracking down illicit discharges)[11]. Since ammonia can be measured in the field, crews can get fast results and immediately proceed to track down the source of the discharge using pipe testing methods (see Chapter 13 for details).

As a single parameter, ammonia has some limitations. First, ammonia by itself may not always be capable of identifying sewage discharges, particularly if they are diluted by "clean" flows. Second, while some washwaters and industrial discharges have relatively high ammonia concentrations, not all do, which increases the prospects of false negatives. Lastly, other dry weather discharges, such as non-target irrigation, can also have high ammonia concentrations that can occasionally exceed 1 mg/L. Supplementing ammonia with potassium and looking at the ammonia/potassium ratio is a simple adjustment to the single parameter approach that helps to further and more accurately characterize the discharge. Ratios greater than one indicate a sewage source, while ratios less than or equal to one indicate a washwater source. Potassium is easily analyzed using a probe (Horiba Cardy™ is the recommended probe).

[11] In-field analysis may be appropriate when tracking down illicit flows, but it is typically associated with challenging and uncontrollable conditions. Therefore, it is generally recommended that analyses be conducted in a controlled lab setting.

Industrial Flow Benchmark

If a subwatershed has a high density of industrial generating sites, additional indicator parameters may be needed to detect and trace these unique discharges. They are often needed because industrial and commercial generating sites produce discharges that are often not composed of either sewage or washwater. Examples include industrial process water, or wash down water conveyed from a floor drain to the storm drain system.

This guidance identifies seven indicator parameters that serve as industrial flow benchmarks to help identify illicit discharges originating from industrial and other generating sites. The seven indicators (ammonia, color, conductivity, hardness, pH, potassium and turbidity) are used to identify liquid wastes and other industrial discharges that are not always picked up by the Flow Chart Method. Table 45 summarizes typical benchmark concentrations that can distinguish between unique industrial or commercial liquid wastes. Note that two of the seven indicator parameters, ammonia and potassium, are already incorporated into the flow chart method.

Table 46 illustrates how industrial benchmark parameters can be used independently or as a supplement to the flow chart method, based on data from Alabama (Appendix E). The best industrial benchmark parameters are identified in pink shading and can distinguish industrial sources from residential washwater in 80% of samples. Supplemental indicator parameters denoted by yellow shading, can distinguish industrial source from residential washwater in 50% of samples, or roughly one in two samples.

Most industrial discharges can consistently be identified by extremely high potassium levels. However, these discharges would be misclassified as washwater when just the Flow Chart Method is used. Other benchmark parameters have value in identifying specific industrial types or operations. For example, metal plating bath waste discharges are often indicated by extremely high conductivity, hardness and potassium concentrations.

Adapting Industrial Flow Benchmark

By their very nature, industrial and other generating sites can produce a bewildering diversity of discharges that are hard to classify. Therefore, program managers will experience some difficulty in differentiating industrial sources. Over time, the composition of industrial discharges can be refined as chemical libraries for specific industrial flow types and sources are developed. This can entail a great deal of sampling, but can reduce the number of false positive or negative readings.

Table 45: Benchmark Concentrations to Identify Industrial Discharges

Indicator Parameter	Benchmark Concentration	Notes
Ammonia	≥50 mg/L	• Existing “Flow Chart” Parameter • Concentrations higher than the benchmark can identify a few industrial discharges.
Color	≥500 Units	• Supplemental parameter that identifies a few specific industrial discharges. Should be refined with local data.
Conductivity	≥2,000 μS/cm	• Identifies a few industrial discharges • May be useful to distinguish between industrial sources.
Hardness	≤10 mg/L as CaCO3 ≥2,000 mg/L as CaCO3	• Identifies a few industrial discharges • May be useful to distinguish between industrial sources.
pH	≤5	• Only captures a few industrial discharges • High pH values may also indicate an industrial discharge but residential wash waters can have a high pH as well.
Potassium	≥20 mg/L	• Existing “Flow Chart” Parameter • Excellent indicator of a broad range of industrial discharges.
Turbidity	≥1,000 NTU	• Supplemental parameter that identifies a few specific industrial discharges. Should be refined with local data.

Table 46: Usefulness of Various Parameters to Identify Industrial Discharges

Industrial Benchmark Concentration	Detergents as Surfactants (mg/L)	Ammonia (mg/L)	Potassium (mg/L)	Initial "Flow Chart" Class	Color (Units)	Conductivity (:S/cm)1	Hardness (mg/L as $CaCO_3$)	pH	Turbidity (NTU)	Best Indicator Parameters to Identify This Flow Type	Additional Indicator Parameters to Identify This Flow Type
	--	≥50	≥20		≥500	≥2000	≤10 ≥2,000	≤5	≥1,000		
Concentrations in Industrial and Commercial Flow Types											
Automotive Manufacturer[1]	5	0.6	66	**Wash water**	15	220	30	6.7	118	Potassium	
Poultry Supplier[1]	5	4.2	41	**Wash water**	23	618	31	6.3	111	Potassium	
Roofing Product Manufacturing[1]	8	10.2	27	**Wash water**	>100[2]	242	32	7.1	229	None	Potassium Color
Uniform Manufacturing[1]	6	6.1	64	**Wash water**	>100[2]	798	35	10.4	2,631	Potassium	Color Turbidity
Radiator Flushing	15	(26.3)	(2,801)	**Wash water**	(3,000)	(3,278)	(5.6)	(7.0)	-	Potassium Conductivity Color	Hardness
Metal Plating Bath	7	(65.7)	(1,009)	**Wash water**	(104)	(10,352)	(1,429)	(4.9)	-	Ammonia Potassium Conductivity Hardness	pH
Commercial Car Wash	140	0.9; (0.2)	4; (43)	**Wash water**	>61; (222)	274; (485)	71; (157)	7.7; (6.7)	156		Potassium Turbidity
Commercial Laundry	(27)	(0.8)	3	**Wash water**	47	(563)	(36)	(9.1)	-		

Best Indicators, shaded in pink, distinguish this source from residential wash water in 80% of samples in both Tuscaloosa and Birmingham, AL.
Supplemental indicators, shaded in yellow, distinguish this source from residential wash water in 50% of samples, or in only one community.
(Data in parentheses are mean values from Birmingham); Data not in parentheses are from Tuscaloosa
[1] Fewer than 3 samples for these discharges.
[2] The color analytical technique used had a maximum value of 100, which was exceeded in all samples. Color may be a good indicator of these industrial discharges and the benchmark concentration may need adjustment downward for this specific community.

APPENDIX E
EXAMPLE OUTFALL RECONNAISSANCE INVENTORY SUMMARY AND FORM

Chapter 11: The Outfall Reconnaissance Inventory

This chapter describes a simple field assessment known as the Outfall Reconnaissance Inventory (ORI). The ORI is designed to fix the geospatial location and record basic characteristics of individual storm drain outfalls, evaluate suspect outfalls, and assess the severity of illicit discharge problems in a community. Field crews should walk all natural and man-made streams channels with perennial and intermittent flow, even if they do not appear on available maps (Figure 19). The goal is to complete the ORI on every stream mile in the MS4 within the first permit cycle, starting with priority subwatersheds identified during the desktop analysis. The results of the ORI are then used to help guide future outfall monitoring and discharge prevention efforts.

11.1 Getting Started

The ORI requires modest mapping, field equipment, staffing and training resources. A complete list of the required and optional resources needed to perform an ORI is presented in Table 30. The ORI can be combined with other stream assessment tools, and may be supplemented by simple indicator monitoring. Ideally, a Phase II community should plan on surveying its entire drainage network at least once over the course of each five-year permit cycle. Experience suggests that it may take up to three stream walks to identify all outfalls.

Figure 19: Walk all streams and constructed open channels

Best Times to Start

Timing is important when scheduling ORI field work. In most regions of the country, spring and fall are the best seasons to perform the ORI. Other seasons typically have challenges such as over-grown vegetation or high groundwater that mask illicit discharges, or make ORI data hard to interpret[9].

Prolonged dry periods during the non-growing season with low groundwater levels are optimal conditions for performing an ORI. Table 31 summarizes some of the regional factors to consider when scheduling ORI surveys in your community. Daily weather patterns also determine whether ORI field work should proceed. In general, ORI field work should be conducted at least 48 hours after the last runoff-producing rain event.

Field Maps

The field maps needed for the ORI are normally generated during the desktop assessment phase of the IDDE program described in Chapter 5. This section

[9] Upon initial program start-up, the ORI should be conducted during periods of low groundwater to more easily identify likely illicit discharges. However, it should be noted that high water tables can increase sewage contamination in storm drain networks due to infiltration and inflow interactions. Therefore, in certain situations, seasonal ORI surveys may be useful at identifying these types of discharges. Diagnosis of this source of contamination, however, can be challenging.

Table 30: Resources Needed to Conduct the ORI		
Need Area	**Minimum Needed**	**Optional but Helpful**
Mapping	• Roads • Streams	• Known problem areas • Major land uses • Outfalls • Specific industries • Storm drain network • SIC-coded buildings • Septics
Field Equipment	• 5 one-liter sample bottles • Backpack • Camera (preferably digital) • Cell phones or hand-held radios • Clip boards and pencils • Field sheets • First aid kit • Flash light or head lamp • GPS unit • Spray paint (or other marker) • Surgical gloves • Tape measure • Temperature probe • Waders (snake proof where necessary) • Watch with a second hand	• Portable Spectrophotometer and reagents (can be shared among crews) • Insect repellant • Machete/clippers • Sanitary wipes or biodegradable soap • Wide-mouth container to measure flow • Test strips or probes (e.g., pH and ammonia)
Staff	• Basic training on field methodology • Minimum two staff per crew	• Ability to track discharges up the drainage system • Knowledge of drainage area, to identify probable sources. • Knowledge of basic chemistry and biology

Table 31: Preferred Climate/Weather Considerations for Conducting the ORI		
Preferred Condition	**Reason**	**Notes/Regional Factors**
Low groundwater (e.g., very few flowing outfalls)	High groundwater can confound results	In cold regions, do not conduct the ORI in the early spring, when the ground is saturated from snowmelt.
No runoff-producing rainfall within 48 hours	Reduces the confounding influence of storm water	The specific time frame may vary depending on the drainage system.
Dry Season	Allows for more days of field work	Applies in regions of the country with a "wet/ dry seasonal pattern." This pattern is most pronounced in states bordering or slightly interior to the Gulf of Mexico or the Pacific Ocean.
Leaf Off	Dense vegetation makes finding outfalls difficult	Dense vegetation is most problematic in the southeastern United States. This criterion is helpful but not required.

provides guidance on the basic requirements for good field maps. First, ORI field maps do not need to be fancy. The scale and level of mapping detail will vary based on preferences and navigational skills of field crews. At a minimum, maps should have labeled streets and hydrologic features (USGS blue line streams, wetlands, and lakes), so field crews can orient themselves and record their findings spatially.

Field maps should delineate the contributing drainage area to major outfalls, but only if they are readily available. Urban landmarks such as land use, property boundaries, and storm drain infrastructure are also quite useful in the field. ORI field maps should be used to check the accuracy and quality of pre-existing mapping information, such as the location of outfalls and stream origins.

Basic street maps offer the advantage of simplicity, availability, and well-labeled road networks and urban landmarks. Supplemental maps such as a 1": 2000' scale USGS Quad sheet or finer scale aerial photograph are also recommended for the field. USGS Quad sheets are readily available and display major transportation networks and landmarks, "blue line" streams, wetlands, and topography. Quad maps may be adequate for less developed subwatersheds, but are not always accurate in more urban subwatersheds.

Recent aerial photographs may provide the best opportunity to navigate the subwatershed and assess existing land cover. Aerial photos, however, may lack topography and road names, can be costly, and are hard to record field notes on due to their darkness. GIS-ready aerial photos and USGS Quad sheets can be downloaded from the internet or obtained from local planning, parks, or public works agencies.

Field Sheets

ORI field sheets are used to record descriptive and quantitative information about each outfall inventoried in the field. Data from the field sheets represent the building blocks of an outfall tracking system allowing program managers to improve IDDE monitoring and management. A copy of the ORI field sheet is provided in Appendix D, and is also available as a Microsoft Word™ document. Program managers should modify the field sheet to meet the specific needs and unique conditions in their community.

Field crews should also carry an authorization letter and a list of emergency phone numbers to report any emergency leaks, spills, obvious illicit discharges or other water quality problems to the appropriate local authorities directly from the field. Local law enforcement agencies may also need to be made aware of the field work. Figure 20 shows an example of a water pollution emergency contact list developed by Montgomery County, MD.

Equipment

Basic field equipment needed for the ORI includes waders, a measuring tape, watch, camera, GPS unit, and surgical gloves (see Table 30). GPS units and digital cameras are usually the most expensive equipment items; however, some local agencies may already have them for other applications. Adequate ranging, water-resistant, downloadable GPS units can be purchased for less than $150. Digital cameras are preferred and can cost between $200 and $400, however, conventional or disposable cameras can also work, as long as they have flashes. Hand-held data recorders and customized software can be used to record text, photos, and GPS coordinates electronically in the field. While these technologies can eliminate field sheets and data entry procedures, they can be quite expensive. Field crews should always carry basic safety items, such as cell phones, surgical gloves, and first aid kits.

Staffing

The ORI requires at least a two-person crew, for safety and logistics. Three person crews provide greater safety and flexibility, which helps divide tasks, allows one person to assess adjacent land uses, and facilitates tracing outfalls to their source. All crew members should be trained on how to complete the ORI and should have a basic understanding of illicit discharges and their water quality impact. ORI crews can be staffed by trained volunteers, watershed groups and college interns. Experienced crews can normally expect to cover two to three stream miles per day, depending on stream access and outfall density.

11.2 Desktop Analysis to Support the ORI

Two tasks need to be done in the office before heading out to the field. The major ORI preparation tasks include estimating the total stream and channel mileage in the subwatershed and generating field maps. The total mileage helps program managers scope out how long the ORI will take and how much it will cost. As discussed before, field maps are an indispensable navigational aid for field crews working in the subwatershed.

Delineating Survey Reaches

ORI field maps should contain a preliminary delineation of **survey reaches**. The stream network within your subwatershed should be delineated into discrete segments of relatively uniform character. Delineating survey reaches provides good stopping and starting points for field crews, which

WATER POLLUTION PHONE NUMBERS TO CALL WHEN A WATER QUALITY PROBLEM IS OBSERVED or TO OBTAIN FURTHER INFORMATION ABOUT WATER QUALITY ISSUES
Spring 2001

COUNTY AGENCIES

DEP: Department of Environmental Protection
- DEPC: Division of Environmental Policy & Compliance
- WMD: Watershed Management Division

DPS: Department of Permitting Services
- LDS: Land Development Services
- SWM: Stormwater Management
- WS: Wells & Septic

INTER-COUNTY AGENCIES

MNCPPC: Maryland-National Capital Park & Planning Commission

WSSC: Washington Suburban Sanitary Commission

DHCD: Department of Housing & Community Development

DPWT: Department of Public Works & Transportation

PROBLEM/QUESTION	AGENCY	TELEPHONE NUMBER
ILLEGAL DUMPING HOTLINE	**DEPC:**	**240-777-7700** Daytime hours ←
	→ Nighttime hours	**240/777-DUMP (3867) or 240-777-7788**
Blocked storm drain, inlet or pipe or erosion from public storm drain	DPWT:	240/777-ROAD (7623) Highway Maintenance)
Discolored public drinking water, odor to drinking water		301/206-4002
Erosion, flooding, drainage problems between private properties	DHCD:	240/777-3600 (Code Enforcement)
Erosion - stream banks on park land	MNCPPC:	301/495-2535
Fire & Rescue Services (emergencies: 911)	(Non-Emergencies):	240/777-0744
Recycling Programs/Special pick up services	DPWT:	240/777-6400 or 6466
Sanitary sewer problems	WSSC:	301/206-4002
Sediment (mud) from construction site entering streams	LDS:	240/777-6366
Septic Leaks/ Septic Tanks	WS:	240/777-6300
Stormwater Management, pond safety and maintenance	DEPC:	240/777-7744
Stormwater Management and Sediment Control Plan Review issues	SWM:	240/777-6320
Stream Clean-ups	WMD:	240/777-7712
Swimming Pool Discharges	DEPC:	240/777-7770
Trash and debris in parks and streams	MNCPPC:	301/495-2535
Water main break	WSSC:	301/206-4002
Water pollution	DEPC:	240/777-7770
(discharging, dumping, chemical spills into streams or storm drains)	LDS:	240/777-6260
Water quality monitoring programs for schools (Stream Teams)	WMD:	240/777-7714
Wells and Well Inspections	WS:	240/777-6300

askDEP.com

Figure 20: Example of a comprehensive emergency contact list for Montgomery County, MD

is useful from a data management and logistics standpoint. Each survey reach should have its own unique identifying number to facilitate ORI data analysis and interpretation. Figure 21 illustrates some tips for delineating survey reaches, and additional guidance is offered below:

- Survey reaches should be established above the confluence of streams and between road crossings that serve as a convenient access point.
- Survey reaches should be defined at the transition between major changes in land use in the stream corridor (e.g. forested land to commercial area).
- Survey reaches should generally be limited to a quarter mile or less in length. Survey reaches in lightly developed subwatersheds can be longer than those in more developed subwatersheds, particularly if uniform stream corridor conditions are expected throughout the survey reach.
- Access through private or public property should be considered when delineating survey reaches as permission may be required.

It should be noted that initial field maps are not always accurate, and changes may need to be made in the field to adjust survey reaches to account for conditions such as underground streams, missing streams or long culverts. Nevertheless, upfront time invested in delineating survey reaches makes it easier for field crews to perform the ORI.

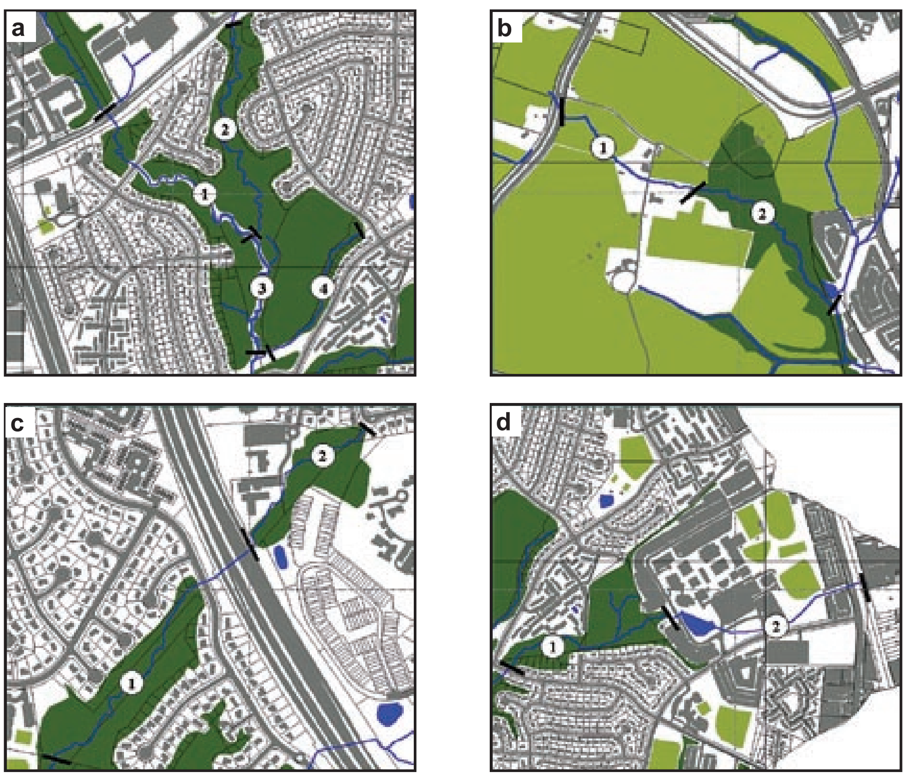


Figure 21: Various physical factors control how survey reaches are delineated. (a) Survey reaches based on the confluence of stream tributaries. (b) A long tributary split into ¼ mile survey reaches. (c) Based on a major road crossing (include the culvert in the downstream reach). (d) Based on significant changes in land use (significant changes in stream features often occur at road crossings, and these crossings often define the breakpoints between survey reaches).

11.3 Completing the ORI

Field crews conduct an ORI by walking all streams and channels to find outfalls, record their location spatially with a GPS unit and physically mark them with spray paint or other permanent marker. Crews also photograph each outfall and characterize its dimensions, shape, and component material, and record observations on basic sensory and physical indicators. If dry weather flow occurs at the outfall, additional flow and water quality data are collected. Field crews may also use field probes or test strips to measure indicators such as temperature, pH, and ammonia at flowing outfalls.

The ORI field sheet is divided into eight sections that address both flowing and non-flowing outfalls (Appendix D). Guidance on completing each section of the ORI field sheet is presented below.

Outfalls to Survey

The ORI applies to **all** outfalls encountered during the stream walk, regardless of diameter, with a few exceptions noted in Table 32. Common outfall conditions seen in communities are illustrated in Figure 22 As a rule, crews should only omit an outfall if they can definitively conclude it has no potential to contribute to a transitory illicit discharge. While EPA's Phase I guidance only targeted major outfalls (diameter of 36 inches or greater), documenting all outfalls is recommended, since smaller pipes make up the majority of all outfalls and frequently have illicit discharges (Pitt *et al.*, 1993 and Lalor, 1994). A separate ORI field sheet should be completed for each outfall.

Table 32: Outfalls to Include in the Screening

Outfalls to Record	Outfalls to Skip
• Both large and small diameter pipes that appear to be part of the storm drain infrastructure • Outfalls that appear to be piped headwater streams • Field connections to culverts • Submerged or partially submerged outfalls • Outfalls that are blocked with debris or sediment deposits • Pipes that appear to be outfalls from storm water treatment practices • Small diameter ductile iron pipes • Pipes that appear to only drain roof downspouts but that are subsurface, preventing definitive confirmation	• Drop inlets from roads in culverts (unless evidence of illegal dumping, dumpster leaks, etc.) • Cross-drainage culverts in transportation right-of-way (i.e., can see daylight at other end) • Weep holes • Flexible HDPE pipes that are known to serve as slope drains • Pipes that are clearly connected to roof downspouts via above-ground connections

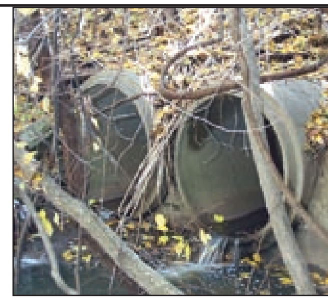
Ductile iron round pipe

4-6” HDPE; Check if roof leader connection (legal)

Field connection to inside of culvert; Always mark and record.

Small diameter (<2”) HDPE; Often a sump pump (legal), or may be used to discharge laundry water (illicit).

Elliptical RCP; Measure both horizontal and vertical diameters.



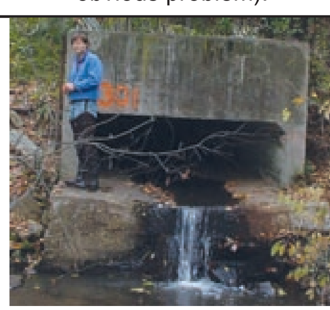
Double RCP round pipes; Mark as separate outfalls unless known to connect immediately up-pipe

Culvert (can see to other side); Don’t mark as an outfall

Open channel “chute” from commercial parking lot; Very unlikely illicit discharge. Mark, but do not return to sample (unless there is an obvious problem).

Small diameter PVC pipe; Mark, and look up-pipe to find the origin.

CMP outfall; Crews should also note upstream sewer crossing.



Box shaped outfall

CMP round pipe with two weep holes at bridge crossing. (Don’t mark weep holes)

Figure 22: Typical Outfall Types Found in the Field

Obvious Discharges

Field crews may occasionally encounter an obvious illicit discharge of sewage or other pollutants, typified by high turbidity, odors, floatables and unusual colors. When obvious discharges are encountered, field crews should STOP the ORI survey, track down the source of the discharge and immediately contact the appropriate water pollution agency for enforcement. Crews should photo-document the discharge, estimate its flow volume and collect a sample for water quality analysis (if this can be done safely). All three kinds of evidence are extremely helpful to support subsequent enforcement. Chapter 13 provides details on techniques to track down individual discharges.

11.4 ORI Section 1 - Background Data

The first section of the ORI field sheet is used to record basic data about the survey, including time of day, GPS coordinates for the outfall, field crew members, and current and past weather conditions (Figure 23). Much of the information in this section is self-explanatory, and is used to create an accurate record of when, where, and under what conditions ORI data were collected.

Every outfall should be photographed and marked by directly writing a unique identifying number on each outfall that serves as its subwatershed “address” (Figure 24). Crews can use spray paint or another temporary marker to mark outfalls, but may decide to replace temporary markings with permanent ones if the ORI is repeated later. Markings help crews confirm outfall locations during future investigations, and gives citizens a better way to report the location of spills or discharges when calling a water pollution hotline. Crews should mark the spatial location of all outfalls they encounter directly on field maps, and record the coordinates with a GPS unit that is accurate to within 10 feet. Crews should take a digital photo of each outfall, and record photo numbers in Section 1 of the field sheet.

Section 1: Background Data

Subwatershed:		Outfall ID:	
Today’s date:		Time (Military):	
Investigators:		Form completed by:	
Temperature (°F):	Rainfall (in.): Last 24 hours:	Last 48 hours:	
Latitude:	Longitude:	GPS Unit:	GPS LMK #:
Camera:		Photo #s:	
Land Use in Drainage Area (Check all that apply):			
☐ Industrial		☐ Open Space	
☐ Ultra-Urban Residential		☐ Institutional	
☐ Suburban Residential		Other: ________________	
☐ Commercial		Known Industries: ________________	
Notes (e.g., origin of outfall, if known):			

Figure 23: Section 1 of the ORI Field Sheet

Figure 24: Labeling an outfall (a variety of outfall naming conventions can be used)

The land use of the drainage area contributing to the outfall should also be recorded. This may not always be easy to characterize at large diameter outfalls that drain dozens or even hundreds of acres (unless you have aerial photographs). On the other hand, land use can be easily observed at smaller diameter outfalls, and in some cases, the specific origin can be found (e.g., a roof leader or a parking lot; Figure 25). The specific origin should be recorded in the "notes" portion of Section 1 on the field sheet.

11.5 ORI Section 2 - Outfall Description

This part of the ORI field sheet is where basic outfall characteristics are noted (Figure 26). These include material, and presence of flow at the outfall, as well as the pipe's dimensions (Figure 27). These measurements are used to confirm and supplement existing storm drain maps (if they are available). Many communities only map storm drain outfalls that exceed a given pipe diameter, and may not contain data on the material and condition of the pipe.

Figure 25: The origin of this corrugated plastic pipe was determined to be a roof leader from the house up the hill.

Section 2 of the field sheet also asks if the outfall is submerged in water or obstructed by sediment and the amount of flow, if present. Figure 28 provides some photos that illustrate how to characterize relative submergence, deposition and flow at outfalls. If no flow is observed at the outfall, you can skip the next two sections of the ORI field sheet and continue with Section 5.

Section 2: Outfall Description

LOCATION	MATERIAL		SHAPE		DIMENSIONS (IN.)	SUBMERGED
☐ **Closed Pipe**	☐ RCP ☐ PVC ☐ Steel ☐ Other: _________	☐ CMP ☐ HDPE	☐ Circular ☐ Eliptical ☐ Box ☐ Other: _____	☐ Single ☐ Double ☐ Triple ☐ Other: _____	Diameter/Dimensions: ____________________	In Water: ☐ No ☐ Partially ☐ Fully With Sediment: ☐ No ☐ Partially ☐ Fully
☐ **Open drainage**	☐ Concrete ☐ Earthen ☐ rip-rap ☐ Other: _____		☐ Trapezoid ☐ Parabolic ☐ Other: _____		Depth: _____ Top Width: _____ Bottom Width: _____	
☐ **In-Stream**	**(applicable when collecting samples)**					
Flow Present?	☐ Yes	☐ No	***If No, Skip to Section 5***			
Flow Description (If present)	☐ Trickle	☐ Moderate	☐ Substantial			

Figure 26: Section 2 of the ORI Field Sheet

Figure 27: Measuring Outfall Diameter

Submerged: More than ½ below water

Partially submerged: Bottom is below water

Fully submerged: Can’t see outfall

Outfall fully submerged by debris

Fully submerged from downstream trees trapping debris

Partially submerged by leaf debris “back water”

Trickle Flow: Very narrow stream of water

Moderate Flow: Steady stream, but very shallow depth

Significant flow
(Source is a fire hydrant discharge)

Figure 28: Characterizing Submersion and Flow

11.6 ORI Section 3 - Quantitative Characterization for Flowing Outfalls

This section of the ORI records direct measurements of **flowing outfalls**, such as flow, temperature, pH and ammonia (Figure 29). If desired, additional water quality parameters can be added to this section. Chapter 12 discusses the range of water quality parameters that can be used.

Field crews measure the rate of flow using one of two techniques. The first technique simply records the time it takes to fill a container of a known volume, such as a one liter sample bottle. In the second technique,

Section 3: Quantitative Characterization

FIELD DATA FOR FLOWING OUTFALLS				
PARAMETER		RESULT	UNIT	EQUIPMENT
☐Flow #1	Volume		Liter	Bottle
	Time to fill		Sec	
☐Flow #2	Flow depth		In	Tape measure
	Flow width	____’ ____”	Ft, In	Tape measure
	Measured length	____’ ____”	Ft, In	Tape measure
	Time of travel		S	Stop watch
Temperature			°F	Thermometer
pH			pH Units	Test strip/Probe
Ammonia			mg/L	Test strip

Figure 29: Section 3 of the ORI Field Sheet

the crew measures the velocity of flow, and multiplies it by the estimated cross sectional area of the flow.

To use the flow volume technique, it may be necessary to use a “homemade” container to capture flow, such as a cut out plastic milk container that is marked to show a one liter volume. The shape and flexibility of plastic containers allows crews to capture relatively flat and shallow flow (Figure 30). The flow volume is determined as the volume of flow captured in the container per unit time.

The second technique measures flow rate based on velocity and cross sectional area, and is preferred for larger discharges where containers are too small to effectively capture the flow (Figure 31). The crew measures and marks off a fixed flow length (usually about five feet), crumbles leaves or other light material, and drops them into the discharge (crews can also carry peanuts or ping pong balls to use). The crew then measures the time it takes the marker to travel across the length. The velocity of flow is computed as the length of the flow path (in feet) divided by the travel time (in seconds). Next, the cross-sectional flow area is measured by taking multiple readings of the depth and width of flow. Lastly, cross-sectional area (in square feet) is multiplied by flow velocity (feet/second) to calculate the flow rate (in cubic feet/second).

Crews may also want to measure the quality of the discharge using relatively inexpensive probes and test strips (e.g., water temperature, pH, and ammonia). The choice of which indicator parameters to measure is usually governed by the overall IDDE monitoring framework developed by the community. Some communities have used probes or test strips to measure additional indicators such as conductivity, chlorine, and hardness. Research by Pitt (for this project) suggests that probes by Horiba for pH and conductivity are the most reliable and

Figure 30: Measuring flow (as volume per time)

accurate, and that test strips have limited value.

When probes or test strips are used, measurements should be made from a sample bottle that contains flow captured from the outfall. The exact measurement recorded by the field probe should be recorded in Section 3 of the field sheet. Some interpolation may be required for test strips, but do not interpolate further than the mid-range between two color points.

11.7 ORI Section 4 – Physical Indicators for Flowing Outfalls Only

This section of the ORI field sheet records data about four sensory indicators associated with **flowing outfalls**—odor, color, turbidity and floatables (Figure 32). Sensory indicators can be detected by smell or sight, and require no measurement equipment. Sensory indicators do not always reliably predict illicit discharge, since the senses can be fooled, and may result in a "false negative" (i.e., sensory indicators fail to detect an illicit discharge when one is actually present). Sensory indicators are important, however, in detecting the most severe or obvious discharges. Section 4 of the field sheet asks whether the sensory indicator is present, and if so, what is its severity, on a scale of one to three.

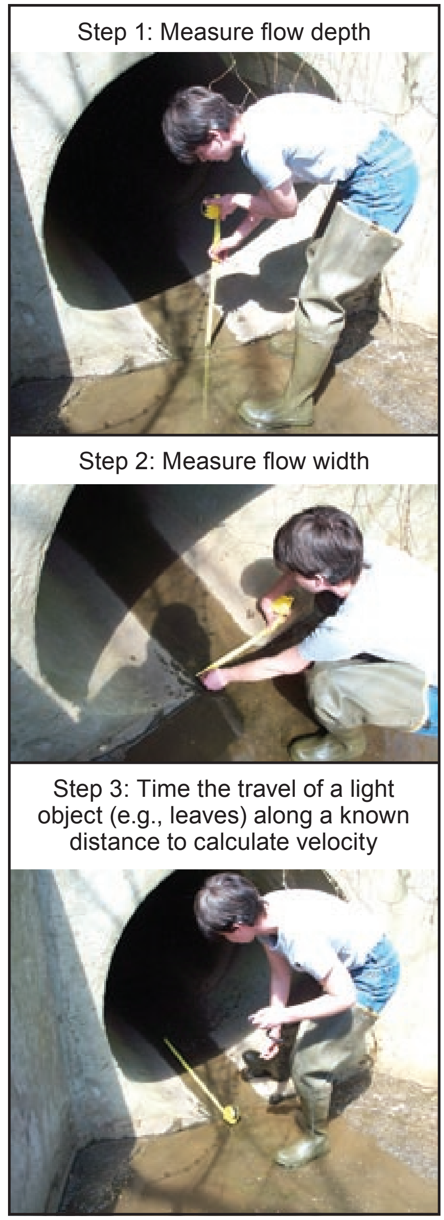


Figure 31: Measuring flow (as velocity times cross-sectional area)

Section 4: Physical Indicators for Flowing Outfalls Only
Are Any Physical Indicators Present in the flow? ☐ Yes ☐ No *(If No, Skip to Section 5)*

INDICATOR	CHECK if Present	DESCRIPTION	RELATIVE SEVERITY INDEX M(1-3)		
Odor	☐	☐ Sewage ☐ Rancid/sour ☐ Petroleum/gas ☐ Sulfide ☐ Other:	☐ 1 – Faint	☐ 2 – Easily detected	☐ 3 – Noticeable from a distance
Color	☐	☐ Clear ☐ Brown ☐ Gray ☐ Yellow ☐ Green ☐ Orange ☐ Red ☐Other:	☐ 1 – Faint colors in sample bottle	☐ 2 – Clearly visible in sample bottle	☐ 3 – Clearly visible in outfall flow
Turbidity	☐	See severity	☐ 1 – Slight cloudiness	☐ 2 – Cloudy	☐ 3 – Opaque
Floatables -Does Not Include Trash!!	☐	☐ Sewage (Toilet Paper, etc.) ☐ Suds ☐ Petroleum (oil sheen) ☐ Other:	☐ 1 – Few/slight; origin not obvious	☐ 2 – Some; indications of origin (e.g., possible suds or oil sheen)	☐ 3 - Some; origin clear (e.g., obvious oil sheen, suds, or floating sanitary materials)

Figure 32: Section 4 of the ORI Field Sheet

Odor

Section 4 asks for a description of any odors that emanate from the outfall and an associated severity score. Since noses have different sensitivities, the entire field crew should reach consensus about whether an odor is present and how severe it is. A severity score of one means that the odor is faint or the crew cannot agree on its presence or origin. A score of two indicates a moderate odor within the pipe. A score of three is assigned if the odor is so strong that the crew smells it a considerable distance away from the outfall.

TIP
Make sure the origin of the odor is the outfall. Sometimes shrubs, trash or carrion, or even the spray paint used to mark the outfall can confuse the noses of field crews.

Color

The color of the discharge, which can be clear, slightly tinted, or intense is recorded next. Color can be quantitatively analyzed in the lab, but the ORI only asks for a visual assessment of the discharge color and its intensity. The best way to measure color is to collect the discharge in a clear sample bottle and hold it up to the light (Figure 33). Field crews should also look for downstream plumes of color that appear to be associated with the outfall. Figure 34 illustrates the spectrum of colors that may be encountered during an ORI survey, and offers insight on how to rank the relative intensity or strength of discharge color. Color often helps identify industrial discharges; Appendix K provides guidance on colors often associated with specific industrial operations.

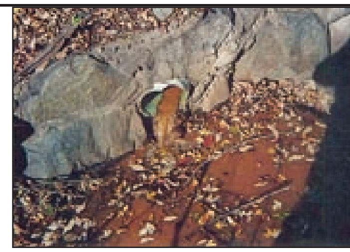
Turbidity

The ORI asks for a visual estimate of the turbidity of the discharge, which is a measure of the cloudiness of the water. Like color, turbidity is best observed in a clear sample bottle, and can be quantitatively measured using field probes. Crews should also look for turbidity in the plunge pool below the outfall, and note any downstream turbidity plumes that appear to be related to the outfall. Field crews can sometimes confuse turbidity with color, which are related but are not the same. Remember, turbidity is a measure of how easily light can penetrate through the sample bottle, whereas color is defined by the tint or intensity of the color observed. Figure 34 provides some examples of how to distinguish turbidity from color, and how to rank its relative severity.

Figure 33: Using a sample bottle to estimate color and turbidity

Color: Brown; Severity: 2
Turbidity Severity: 2

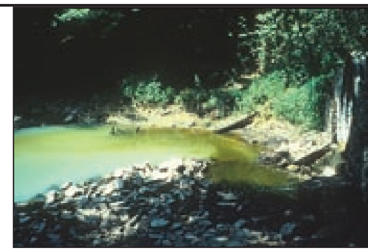
Color: Blue-green; Severity: 3
Turbidity Severity: 2



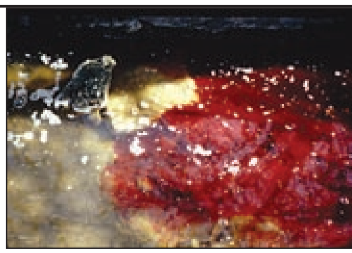
Highly Turbid Discharge
Color: Brown; Severity: 3
Turbidity Severity: 3

Sewage Discharge
Color: 3
Turbidity: 3

Paint
Color: White; Severity: 3
Turbidity: 3



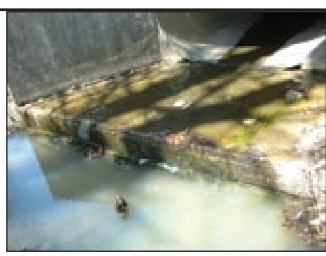
Industrial Discharge
Color: Green; Severity: 3
Turbidity Severity: 3



Blood
Color: Red; Severity: 3
Turbidity Severity: None

Failing Septic System:
Turbidity Severity: 3

Turbidity in Downstream Plume
Turbidity Severity: 2
(also confirm with sample bottle)

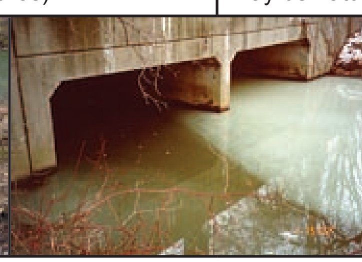


High Turbidity in Pool
Turbidity Severity: 2
(Confirm with sample bottle)

Iron Floc
Color: Reddish Orange; Severity: 3
(Often associated with a natural source)

Slight Turbidity
Turbidity: 1
(Difficult to interpret this observation; May be natural or an illicit discharge)

Construction Site Discharge
Turbidity Severity: 3



Discharge of Rinse from Floor Sanding (Found during wet weather)
Turbidity Severity: 3

Figure 34: Interpreting Color and Turbidity

Floatables

The last sensory indicator is the presence of any floatable materials in the discharge or the plunge pool below. Sewage, oil sheen, and suds are all examples of floatable indicators; trash and debris are generally not in the context of the ORI. The presence of floatable materials is determined visually, and some guidelines for ranking their severity are provided in Figure 35, and described below.

If you think the floatable is sewage, you should automatically assign it a severity score of three since no other source looks quite like it. Surface oil sheens are ranked based on their thickness and coverage. In some cases, surface sheens may not be related to oil discharges, but instead are created by in-stream processes, such as shown in Figure 36. A thick or swirling sheen associated with a petroleum-like odor may be diagnostic of an oil discharge.

Suds are rated based on their foaminess and staying power. A severity score of three is designated for thick foam that travels many feet before breaking up. Suds that break up quickly may simply reflect water turbulence, and do not necessarily have an illicit origin. Indeed, some streams have naturally occurring foams due to the decay of organic matter. On the other hand, suds that are accompanied by a strong organic or sewage-like odor may indicate a sanitary sewer leak or connection. If the suds have a fragrant odor, they may indicate the presence of laundry water or similar wash waters.

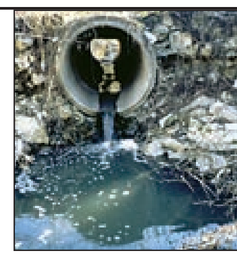
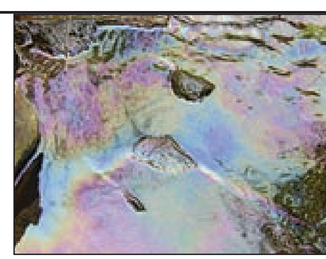
SUDS		
		
Natural Foam Note: Suds only associated with high flows at the "drop off" Do not record.	Low Severity Suds Rating: 1 Note: Suds do not appear to travel; very thin foam layer	High severity suds Rating: 3 Sewage
OIL SHEENS		
		
Low Severity Oil Sheen Rating: 1	Moderate Severity Oil Sheen Rating: 2	High Severity Oil Film Rating: 3

Figure 35: Determining the Severity of Floatables

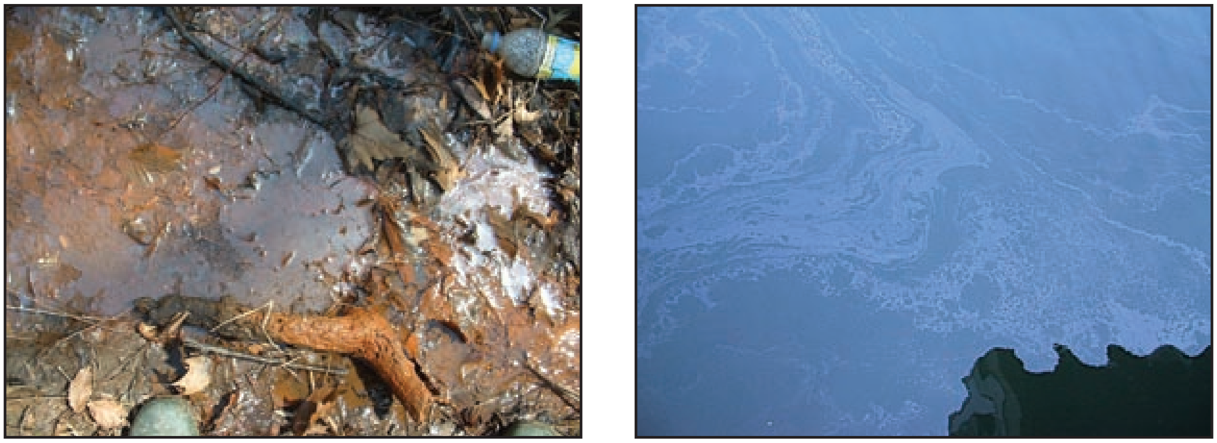


Figure 36: Synthetic versus Natural Sheen (a) Sheen from bacteria such as iron floc forms a sheet-like film that cracks if disturbed (b) Synthetic oil forms a swirling pattern

11.8 ORI Section 5 - Physical Indicators for Both Flowing and Non-Flowing Outfalls

Section 5 of the ORI field sheet examines physical indicators found at both **flowing and non-flowing** outfalls that can reveal the impact of past discharges (Figure 37). Physical indicators include outfall damage, outfall deposits or stains, abnormal vegetation growth, poor pool quality, and benthic growth on pipe surfaces. Common examples of physical indicators are portrayed in Figures 38 and 39. Many of these physical conditions can indicate that an intermittent or transitory discharge has occurred in the past, even if the pipe is not currently flowing. Physical indicators are not ranked according to their severity, because they are often subtle, difficult to interpret and could be caused by other sources. Still, physical indicators can provide strong clues about the discharge history of a storm water outfall, particularly if other discharge indicators accompany them.

Section 5: Physical Indicators for Both Flowing and Non-Flowing Outfalls
Are physical indicators that are not related to flow present? ☐ Yes ☐ No *(If No, Skip to Section 6)*

INDICATOR	CHECK if Present	DESCRIPTION	COMMENTS
Outfall Damage	☐	☐ Spalling, Cracking or Chipping ☐ Peeling Paint ☐ Corrosion	
Deposits/Stains	☐	☐ Oily ☐ Flow Line ☐ Paint ☐ Other:	
Abnormal Vegetation	☐	☐ Excessive ☐ Inhibited	
Poor pool quality	☐	☐ Odors ☐ Colors ☐ Floatables ☐ Oil Sheen ☐ Suds ☐ Excessive Algae ☐ Other:	
Pipe benthic growth	☐	☐ Brown ☐ Orange ☐ Green ☐ Other:	

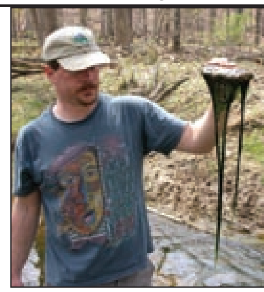
Figure 37: Section 5 of the ORI Field Sheet

Bacterial growth at this outfall indicates nutrient enrichment and a likely sewage source.

This bright red bacterial growth often indicates high manganese and iron concentrations. Surprisingly, it is not typically associated with illicit discharges.

Sporalitis filamentous bacteria, also known as “sewage fungus” can be used to track down sanitary sewer leaks.

Algal mats on lakes indicate eutrophication. Several sources can cause this problem. Investigate potential illicit sources.

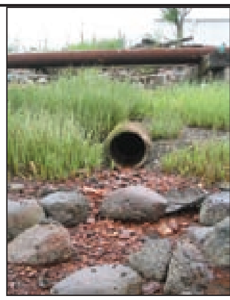


Illicit discharges or excessive nutrient application can lead to extreme algal growth on stream beds.

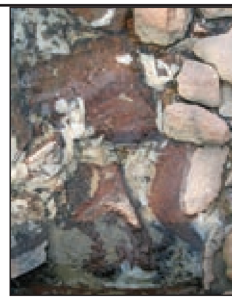
The drainage to this outfall most likely has a high nutrient concentration. The cause may be an illicit discharge, but may be excessive use of lawn chemicals.

This brownish algae indicates an elevated nutrient level.

Figure 38: Interpreting Benthic and Other Biotic Indicators

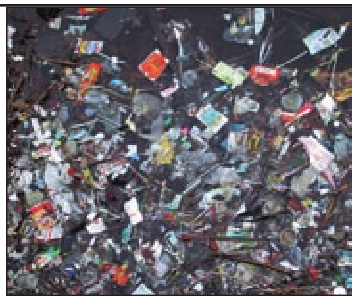


Reddish staining on the rocks below this outfall indicate high iron concentrations.



Toilet paper directly below the storm drain outlet.

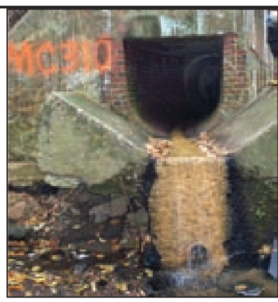
Watershed Protection??



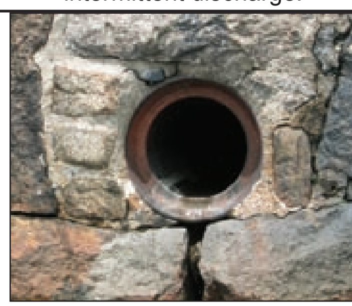
Trash is not an indicator of illicit discharges, but should be noted.

Staining at the base of the outfall may indicate a persistent, intermittent discharge.

Excessive vegetation may indicate enriched flows associated with sewage.



Brownish stain of unclear origin. May be from degradation of the brick infrastructure.



Cracked rock below the outfall may indicate an intermittent discharge.

Poor pool quality. Consider sampling from the pool to determine origin.

Figure 39: Typical Findings at Both Flowing and Non-Flowing Outfalls

11.9 ORI Sections 6-8 - Initial Outfall Designation and Actions

The last three sections of the ORI field sheet are where the crew designates the illicit discharge severity of the outfall and recommends appropriate management and monitoring actions (Figure 40). A discharge rating is designated as obvious, suspect, potential or unlikely, depending on the number and severity of discharge indicators checked in preceding sections.

It is important to understand that the ORI designation is only an initial determination of discharge potential. A more certain determination as to whether it actually is an illicit discharge is made using a more sophisticated indicator monitoring method. Nevertheless, the ORI outfall designation gives program managers a better understanding of the distribution and severity of illicit discharge problems within a subwatershed.

Section 7 of the ORI field sheet records whether indicator samples were collected for laboratory analysis, or whether an intermittent flow trap was installed (e.g., an optical brightener trap or caulk dam described in Chapter 13). Field crews should record whether the sample was taken from a pool or directly from the outfall, and the type of intermittent flow trap used, if any. This section can also be used to recommend follow-up sampling, if the crew does not carry sample bottles or traps during the survey.

The last section of the ORI field sheet is used to note any unusual conditions near the outfall such as dumping, pipe failure, bank erosion or maintenance needs. While these maintenance conditions are not directly related to illicit discharge detection, they often are of interest to other agencies and utilities that maintain infrastructure.

11.10 Customizing the ORI for a Community

The ORI method is meant to be adaptable, and should be modified to reflect local conditions and field experience. Some indicators can be dropped, added or modified in the ORI form. This section looks at four of the most common adaptations to the ORI:

- Open Channels
- Submerged/Tidally Influenced Outfalls
- Cold Climates
- Use of Biological Indicators

In each case, it may be desirable to revise the ORI field sheet to collect data reflecting these conditions.

Open Channels

Field crews face special challenges in more rural communities that have extensive open channel drainage. The ditches and channels serve as the primary storm water conveyance system, and may lack storm drain and sewer pipes. The open channel network is often very long with only a few obvious outfalls that are located far apart. While the network can have illicit discharges from septic systems, they can typically only be detected in the ORI if a straight pipe is found. Some adaptations for open channel systems are suggested in Table 33.

Section 6: Overall Outfall Characterization

☐ Unlikely	☐ Potential (presence of two or more indicators)	☐ Suspect (one or more indicators with a severity of 3)	☐ Obvious

Section 7: Data Collection

1. Sample for the lab?	☐ Yes	☐ No		
2. If yes, collected from:	☐ Flow	☐ Pool		
3. Intermittent flow trap set?	☐ Yes	☐ No	If Yes, type: ☐ OBM	☐ Caulk dam

Section 8: Any Non-Illicit Discharge Concerns (e.g., trash or needed infrastructure repairs)?

Figure 40: Sections 6-8 of the ORI Field Sheet

Submerged/Tidally Influenced Outfalls

The ORI can be problematic in coastal communities where outfalls are located along the waterfront and may be submerged at high tide. The ORI methods need to be significantly changed to address these constraints. Often, outfalls are initially located from offshore using canoes or boats, and then traced landward to the first manhole that is not tidally influenced. Field crews then access the storm drain pipe at the manhole and measure whatever indicators they can observe in the confined and dimly lit space. Table 33 recommends strategies to sample outfalls in the challenging environment of coastal communities.

Winter and Ice

Ice can be used as a discharge indicator in northern regions when ice forms in streams and pipes during the winter months (Figure 41). Because ice lasts for many weeks, and most illicit discharges are warm, astute field crews can interpret outfall history from ice melting patterns along pipes and streams. For example, exaggerated melting at a frozen or flowing outfall may indicate warm water from sewage or industrial discharge. Be careful, because groundwater is warm enough to cause some melting at below freezing temperatures. Also, ice acts like an intermittent flow trap, and literally freezes these discharges. Crews should also look for these traps to find any discolored ice within the pipe or below the outfall.

A final winter indicator is "rime ice," which forms when steam freezes. This beautiful ice formation is actually a good indicator of sewage or other relatively hot discharge that causes steam to form (Figure 41).

Biological Indicators

The diversity and pollution tolerance of various species of aquatic life are widely used as an indicator of overall stream health, and has sometimes been used to detect illicit discharges. One notable example is the presence of the red-eared slider turtle, which is used in Galveston, Texas to find sewage discharges, as they have a propensity for the nutrient rich waters associated with sewage (Figure 42).

Table 33: Special Considerations for Open Channels/Submerged Outfalls

OPEN CHANNELS	
Challenge	**Suggested Modification**
Too many miles of channel to walk	Stop walking at a given channel size or drainage area
Difficulty marking them	Mark on concrete or adjacent to earth channel
Interpreting physical indicators	For open channels with mild physical indicators, progress up the system to investigate further.
SUBMERGED/TIDALLY INFLUENCED OUTFALLS	
Challenge	**Suggested Modification**
Access for ORI – Tidal Influence	Access during low tide
Access for ORI – Always submerged	Access by boat or by shore walking
Interpreting physical indicators	For outfalls with mild physical indicators, also inspect from the nearest manhole that is not influenced by tides
Sampling (if necessary)	Sample "up pipe"

Figure 41: Cold climate indicators of illicit discharges

Figure 42: One biological indicator is this red-eared slider turtle

11.11 Interpreting ORI Data

The ORI generates a wealth of information that can provide managers with valuable insights about their illicit discharge problems, if the data are managed and analyzed effectively. The ORI can quickly define whether problems are clustered in a particular area or spread across the community. This section presents a series of methods to compile, organize and interpret ORI data, including:

1. Basic Data Management and Quality Control
2. Outfall Classification
3. Simple Suspect Outfall Counts
4. Mapping ORI Data
5. Subwatershed and Reach Screening
6. Characterizing IDDE Problems at the Community Level

The level of detail for each analysis method should be calibrated to local resources, program goals, and the actual discharge problems discovered in the stream corridor. In general, the most common conditions and problems will shape your initial monitoring strategy, which prioritizes the subwatersheds or reaches that will be targeted for more intensive investigations.

Program managers should analyze ORI data well before every stream mile is walked in the community, and use initial results to modify field methods. For example, if initial results reveal widespread potential problems, program managers may want to add more indicator monitoring to the ORI to track down individual discharge sources (see Chapter 12). Alternatively, if the same kind of discharge problem is repeatedly found, it may be wise to investigate whether there is a common source or activity generating it (e.g., high turbidity observed at many flowing outfalls as a result of equipment washing at active construction sites).

Basic Data Management and Quality Control

The ORI produces an enormous amount of raw data to characterize outfall conditions. It is not uncommon to compile dozens of individual ORI forms in a single subwatershed. The challenge is to devise a system to organize, process, and translate this data into simpler outputs and formats that can guide illicit discharge elimination efforts. The system starts with effective quality control procedures in the field.

Field sheets should be managed using either a three-ring binder or a clipboard. A small field binder offers the ability to quickly flip back and forth among the outfall forms. Authorization letters, emergency contact lists, and extra forms can also be tucked inside.

At the end of each day, field crews should regroup at a predetermined location to compare notes. The crew leader should confirm that all survey reaches and outfalls of interest have been surveyed, discuss initial findings, and deal with any logistical problems. This is also a good time to check whether field crews are measuring and recording outfall data in the same way, and are consistent in what they are (or are not) recording. Crew leaders should also use this time to review field forms for accuracy and thoroughness. Illegible handwriting should be neatened and details added to notes and any sketches. The crew leader should also organize the forms together into a single master binder or folder for future analysis.

Once crews return from the field, data should be entered into a spreadsheet or database. A Microsoft Access database is provided with this Manual as part of Appendix D (Figure 43), and is supplied on a compact disc with each hard copy. It can also be downloaded with Appendix D from http://www.stormwatercenter.net. Information stored in this database can easily be imported into a GIS for mapping purposes. The GIS can generate its own database table that allows the user to create subwatershed maps showing outfall characteristics and problem areas.

Once data entry is complete, be sure to check the quality of the data. This can be done quickly by randomly spot-checking 10% of the entered data. For example, if 50 field sheets were completed, check five of the spreadsheet or database entries. When transferring data into GIS, quality control maps that display labeled problem outfalls should be created. Each survey crew is responsible for reviewing the accuracy of these maps.

Outfall Classification

A simple outfall designation system has been developed to summarize the discharge potential for individual ORI field sheets. Table 34 presents the four outfall designations that can be made.

Table 34: Outfall Designation System Using ORI Data

Designation	Description
1. Obvious Discharge	Outfalls where there is an illicit discharge that doesn't even require sample collection for confirmation
2. Suspect Discharge	Flowing outfalls with high severity on one or more physical indicators
3. Potential Discharge	Flowing or non-flowing outfalls with presence of two or more physical indicators
4. Unlikely Discharge	Non-flowing outfalls with no physical indicators of an illicit discharge

Simple Suspect Outfall Counts

The first priority is to count the frequency of each outfall designation in the subwatershed or the community as a whole. This simple screening analysis counts the number of problem outfalls per stream mile (i.e., the sum of outfalls designated as having potential, suspected or obvious illicit discharge potential). The density of problem outfalls per stream mile is an important metric to target and screen subwatersheds.

Based on problem outfall counts, program managers may discover that a particular monitoring strategy may not apply to the community. For example, if few problem outfalls are found, an extensive follow-up monitoring program may not be needed, so that program resources can be shifted to pollution hotlines to report and control transitory discharges such as illegal dumping. The key point of this method is to avoid getting lost in the raw data, but look instead to find patterns that can shape a cost-effective IDDE program.

Mapping ORI Data

Maps are an excellent way to portray outfall data. If a GIS system is linked to the ORI database, maps that show the spatial distribution of problem outfalls, locations of dumping, and overall reach conditions can be easily generated. Moreover, GIS provides flexibility that allows for rapid updates to maps as new data are collected and compiled. The sophistication and detail of maps will depend on the initial findings, program goals, available software, and GIS capability.

Subwatershed maps are also an effective and important communication and education tool to engage stakeholders (e.g., public officials, businesses and community residents), as they can visually depict reach quality and the location of problem outfalls. The key point to remember is that maps are tools for understanding data. Try to map with a purpose in mind. A large number of cluttered maps may only confuse, while a smaller number with select data may stimulate ideas for the follow-up monitoring strategy.

Subwatershed and Survey Reach Screening

Problem outfall metrics are particularly valuable to screen or rank priority subwatersheds or survey reaches. The basic approach is simple: select the outfall metrics that are most important to IDDE program goals, and then see how individual subwatersheds or reaches rank in the process. This screening process can help determine which subwatersheds will be priorities for initial follow-up monitoring efforts. When feasible, the screening process should incorporate non-ORI data, such as existing dry weather water quality data, citizen complaints, permitted facilities, and habitat or biological stream indicators.

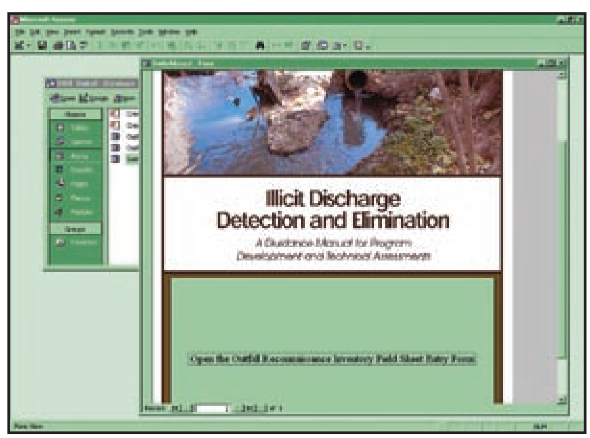


Figure 43: Sample screen from ORI Microsoft Access database

An example of how outfall metrics can screen subwatersheds is provided in Table 35. In this hypothetical example, four metrics were used to screen three subwatersheds within a community: number of suspect discharges, subwatershed population as a percent of the total community, number of industrial discharge permits, and number of outfalls per stream mile. Given these screening criteria, subwatershed C was selected for the next phase of detailed investigation.

Characterizing the IDDE Problem at the Community Level

ORI data should be used to continuously revisit and revise the IDDE program as more is learned about the nature and distribution of illicit discharge problems in the community. For example, ORI discharge designation should be compared against illicit discharge potential (IDP) predictions made during the original desktop analysis (Chapter 5) to refine discharge screening factors, and formulate new monitoring strategies.

In general, community illicit discharge problem can be characterized as minimal, clustered, or severe (Table 36). In the minimal scenario, very few and scattered problems exist; in the clustered scenario, problems are located in isolated subwatersheds; and in the severe scenario, problems are widespread.

Table 35: An Example of ORI Data Being Used to Compare Across Subwatersheds

	# of suspect discharges	Population as % of total community	# of industrial discharge permits	# of outfalls per stream/ conveyance mile
Subwatershed A	2	30	4	6
Subwatershed B	1	10	0	3
Subwatershed C	8	60	2	12

Table 36: Using Stream and ORI Data to Categorize IDDE Problems

Extent	ORI Support Data
Minimal	• Less than 10% of total outfalls are flowing • Less than 20% of total outfalls with obvious, suspect or potential designation
Clustered	• Two thirds of the flowing outfalls are located within one third of the subwatersheds • More than 20% of the communities subwatersheds have greater than 20% of outfalls with obvious, suspect or potential designation
Severe	• More than 10% of total outfalls are flowing • More than 50% of total outfalls with obvious, suspect or potential designation • More than 20% of total outfalls with obvious or suspect designation

11.12 Budgeting and Scoping the ORI

Many different factors come into play when budgeting and scoping an ORI survey: equipment needs, crew size and the stream miles that must be covered. This section presents some simple rules of thumb for ORI budgeting.

Equipment costs for the ORI are relatively minor, with basic equipment to outfit one team of three people totaling about $800 (Table 37). This cost includes one-time expenses to acquire waders, a digital camera and a GPS unit, as well as disposable supplies.

The majority of the budget for an ORI is for staffing the desktop analysis, field crews and data analysis. Field crews can consist of two or three members, and cover about two to three miles of stream (or open channel) per day. Three staff-days should be allocated for pre- and post-field work for each day spent in the field.

Table 38 presents example costs for two hypothetical communities that conduct the ORI. Community A has 10 miles of open channel to investigate, while Community B has 20 miles. In addition, Community A has fewer staff resources available and therefore uses two-person field crews, while Community B uses three-person field crews. Total costs are presented as annual costs, assuming that each community is able to conduct the ORI for all miles in one year.

Table 37: Typical Field Equipment Costs for the ORI

Item	Cost
100 Latex Disposable Gloves	$25
5 Wide Mouth Sample Bottles (1 Liter)	$20
Large Cooler	$25
3 Pairs of Waders	$150
Digital Camera	$200
20 Cans of Spray Paint	$50
Test Kits or Probes	$100-$500
1 GPS Unit	$150
1 Measuring Tape	$10
1 First Aid Kit	$30
Flashlights, Batteries, Labeling tape, Clipboards	$25
Total	**$785-$1185**

Table 38: Example ORI Costs		
Item	**Community A**	**Community B**
Field Equipment[1]	$700	$785
Staff Field Time[2]	$2,000	$6,000
Staff Office Time[3]	$3,000	$6,000
Total	**$5,700**	**$12,785**

[1] From Table 44
[2] Assumes $25/hour salary (2 person teams in Community A and three- person teams in Community B) and two miles of stream per day.
[3] Assumes three staff days for each day in field.

APPENDIX F
EXAMPLE OUTFALL INSPECTION FORM AND INSTRUCTIONS

Dry Weather Field Sheet

COUNTY OF SAN DIEGO
WATERSHED PROTECTION PROGRAM

DEPARTMENT OF PUBLIC WORKS
5201 RUFFIN ROAD, SUITE P
SAN DIEGO, CA 92123

2008 Dry Weather Monitoring Field Datasheet

New Site? ☐ Yes ☐ No ☐ IC/ID Follow-up for________________

GENERAL SITE DESCRIPTION

Site ID		**Site Type**		**Sample Event ID**		**Sample Event Type**	
Location	(NAD83 decimal degrees to 5 places)				**Watershed**	**Hydrologic Unit**	
Date		**Time**		**Latitude**	° N	**Hydrologic Area**	
Field Staff		**Thomas Guide**		**Longitude**	° W	**Hydrologic Subarea**	

QC Sample ☐ None ☐ Original ☐ Duplicate ☐ Blank ☐ Split ☐ Lab Standard

Land Use (Primary) (Check one only) ☐ Residential ☐ Rural Resid. ☐ Commercial ☐ Indusial ☐ Agriculture ☐ Parks ☐ Open

Land Use (Secondary) (Optional, >10%) ☐ Residential ☐ Rural Resid. ☐ Commercial ☐ Indusial ☐ Agr. ☐ Parks ☐ Open ☐ None

Conveyance (Check one only) ☐ Concrete Channel ☐ Natural Creek ☐ Earthen Channel ☐ Manhole ☐ Catch Basin ☐ Outlet ☐ Curb/Gutter

WATER FLOW ☐ Flowing ☐ Ponded ☐ Dry REFERRED FOR

GENERAL CONDITION

Weather ☐ Sunny ☐ Partly Cloudy ☐ Overcast ☐ Fog **Last Rain** ☐ > 72 hours ☐ < 72 hours ☐ None ☐ ≤ 0.1 inches

OBSERVATIONS N/A

Odor	☐ None	☐ Musty	☐ Rotten Eggs	☐ Chemical		☐ Sewage	☐ Other
Color	☐ None	☐ Yellow	☐ Brown (Silty)	☐ White (Milky)		☐ Gray	☐ Other
Clarity	☐ Clear	☐ Slightly Cloudy	☐ Opaque				☐ Other
Floatables	☐ None	☐ Trash	☐ Bubbles/Foam	☐ Sheen	☐ Algae	☐ Fecal Matter	☐ Other
Deposit	☐ None	☐ Coarse Particulate	☐ Fine Particulate	☐ Stain		☐ Oily Deposit	☐ Other
Vegetation	☐ None	☐ Limited	☐ Normal	☐ Excessive			☐ Other
Biology	☐ None	☐ Insects	☐ Algae ☐ Snails	☐ Fish	☐ Birds	☐ Cray Fish	☐ Other

FLOW MEASUREMENT N/A

Flowing Creek **Average**

Width	ft
Depth	ft
Velocity	ft/sec (enter 0 if water is ponded)
Length of Ponded Area	ft

Evidence of Overland Flow? ☐ Yes ☐ No ☐ Irrigation Runoff ☐ Other ________________

Outlet Diameter ____________ Liters/Second ____________

Leaf Float Distance ________ft Time ________sec

FIELD MEASUREMENT N/A

Horiba Meter: ☐ In Stream ☐ In Bucket ☐ Agitated (DO)

Sample Filtered for Test Kits? ☐ Yes ☐ No
Analytical Lab Sample Collected? ☐ Yes ☐ No

Parameter	Reading	Parameter	Reading	Parameter		1st Reading	Dil. Factor	Dil. Reading	Final
pH (Unit)		DO (mg/L)		Phosphate (PO_4)	mg/L				
Cond. (mS/cm)		Temp (°C)		Nitrate (NO_3)					
Turb. (NTU)		Salinity (%)		Ammonia (NH_3-N)					
				MBAS					

COMMENTS: ____

Completed by________________

COUNTY OF SAN DIEGO
WATERSHED PROTECTION PROGRAM

DEPARTMENT OF PUBLIC WORKS
5201 RUFFIN ROAD, SUITE P
SAN DIEGO, CA 92123

SiteType: DWM (Dry weather monitoring) – For sites that are within dry weather monitoring programs.
A, B, C, D… (IC/ID investigation) – For stations that are aimed at IC/ID follow-up investigations.

EventType: Field Screening
Confirmation
Source ID
Duplicate
Blank
Lab Standard

Action Levels

Field Screening Analyte	Action Level
pH	<6.5 or >9.0
Orthophosphate-P (mg/L)	2.0 (**6.0 PO_4**)
Nitrate-N (mg/L)	10.0 (**44.3 NO_3**)
Ammonia-N (mg/L)	1.0
MBAS	1.0
Turbidity (NTU)	B.P.J.
Temperature (ºC)	B.P.J.
Conductivity (µS/cm)	B.P.J.

Laboratory Analyte	Action Level
Oil and Grease (mg/L)	15
Diazinon & Chlorpyrifos (µg/L)	0.5
Dissolved Cd, Cu, Pb, Zn (µg/L)	C.T.R.
Total Coliform (MPN/100 mL)	50,000
Fecal Coliform (MPN/100 mL)	20,000
Enterococcus (MPN/100 mL)	10,000

Watersheds

Hydro. Unit	Watershed
902	Santa Margarita River
903	San Luis Rey River
904	Carlsbad Management Area
905	San Dieguito River
907	San Diego River
909	Sweetwater River
910	Otay River
911	Tijuana River

Land Use Types

1. **Residential**
Single-family and multi-family homes, mobile home parks, etc.

2. **Rural Residential**
Single-family homes located in rural areas with lot sizes of approximately 1 to 10 acres. Rural residential estates may have small orchards, fields or small storage buildings associated with the residential dwelling unit, etc.

3. **Commercial**
Offices, schools, shopping centers, auto dealerships, government/civic centers, cemeteries, churches, libraries, post offices, fire/police stations, military use, jails, prisons, border patrol holding stations, dormitories, hotels, motels, resorts, and casinos, etc.

4. **Agricultural**
Orchards, vineyards, nurseries, greenhouses, flower fields, dairies, livestock, poultry, equine ranches, row crops and grains, pasture, fallow, etc.

5. **Industrial**
Shipbuilding, airframe, aircraft manufacturing, industrial parks, manufacturing uses such as lumber, furniture, paper, rubber, stone, clay, and glass; auto repair services/recycling centers; warehousing, wholesale trade; mining, sand and gravel extraction, salt evaporation; junkyard, dumps/landfills; auto wrecking/dismantling and recycling centers, etc.

6. **Parks**
Recreation areas and centers, neighborhood parks, wildlife and nature preserves, golf courses, accessible sandy areas along the coast or major water bodies allowing swimming and picnicking, etc.

7. **Open**
Vacant and undeveloped lands, etc.

Directions for filling out the 2010
Dry Weather Field Data Sheet

Before Leaving the Office

1. Make sure that there is an updated list of constant information queried from the Dry Weather Database in the vehicle.
2. Make sure you have a list of Sample Event ID numbers, also kept in the vehicle.

Sampling Procedures

Location Information

When you get to a site, a field sheet should be completed whether or not flowing water is present. This includes dry sites and sites with ponded water. A new field sheet should also be completed for all upstream IC/ID's and duplicate samples.

1. **[Is this a new site? Yes/No]**. If yes be sure to turn the field sheet over and collect the GPS, location, report the land use, construction and conveyance type. If neither land use, construction or conveyance type information is collected this new site will not be identified in the constant information during future queries. Be sure to collect all information. If this is an old site, review the constant information found in the constant information folder to ensure that the GPS, land use, construction and conveyance information is correct. If anything needs changing, record this information on the back of the field sheet.
2. If the sampling event is an IC/ID, be sure to note the parameters being investigated, as this information is recorded in the database.

Flow Observed

1. **[Is flow observed at the site?]** Yes= flowing water, No=no flow or dry, Ponded=A pool of water, or water that does not appear to have any flow.

General Conditions

1. Use this section to report on the current weather conditions at the site. The **[Last Rain]** <72 hours should only be filled out if a very light rain occurred that was less than the 0.1 inch criteria. Sampling will not be conducted if rainfall >0.1" has occurred <72 hours.

Observations

1. This section should be completed only where flowing or ponded water is observed. This section is referring to the in-stream habitat. This includes the vegetation and biology, since we are concerned with how the quality of the water is serving as an indicator for stream health, by either supporting excessive algal growth, or very little biology. For a complete description of each of the observations refer to the attached sheet.

Flow Observations

1. Flow observation should be collected at every site. If the flow is too low to measure using the flow probe (refer to flow probe directions below), use the floating leaf method to estimate the flow. If you have encountered a pipe which is discharging water, you can measure the width of the pipe and count how many liters of water are captured in how many seconds. Be sure that when you use this method, you can capture all the water coming from the pipe in your container.

2. It is also important to note if there is any form of overland flow. This means that flowing water has to be observed discharging to the channel where the samples were collected. If there was, or is any evidence that water may have entered the channel do not check yes. Water has to be observed physically flowing into the channel. You can note in the comments section that overland flow appears to have just occurred. **[Evidence of overland Flow?]** If you do see overland flow, check yes and check whether it is irrigation runoff or other.

Water Sampling (Flow Measurement)

Be sure that all the questions are completed fully in this section.

1. **[Flowing Creek]** Record the creeks' water flow characteristics using the hand-held stick flow meter (FP-101 or FP-201). Record the water's "Width", "Depth", and "Velocity" (see Appendix 6) in the appropriate box on the field sheet using the measurement scale on the side of the stick flow meter (note: the scale is shown in tenths of a foot and not in inches). If the water is ponded record "0" (zero) for the "Velocity" and estimate the "Length" of the pond and record in the appropriate box on the field sheet. If the flow is too slow or small to be measured with the stick flow meter, then a "Leaf Float" estimation can be used to determine the velocity. The leaf float method is conducted by floating a small leaf on top of the water and noting the drift; record "Distance" in feet and "Time" in seconds. The final alternate flow measurement technique is accomplished by recording the time need to fill a container with a known volume.

2. **[Field Measurement]** Measuring the following field screening water quality properties using the Horiba U-10 multimeter: pH, conductivity, turbidity, dissolved oxygen (see Appendix 15), temperature, and salinity. Let readings stabilize before recording all values in the appropriate box on the field sheet.

3. **[Is the sample filtered?]** Sample may be filtered at some sites because of its turbid nature or to remove color interferences. This can affect the field analysis and is important to note.

4. **[Dilution and Parameter?]** If a dilution is run on any parameter you must record the dilution and the parameter on which it was conducted. If this information is not recorded, the value is assumed to be a non-exceedance in the database, except for any follow up sample(s) collected. This is critical for making sense of the data once it is queried from the database.

5. [**Field screening sample collected?**] Check yes or no, if field screening was conducted. (Field screening refers to the use of the field test kits to analyze a water sample, not simply taking Horiba measurements alone).

6. [**Analytical Lab Sample collected?**] Check yes or no, if a lab sample was collected, whether part of an IC/ID, regular field screening or QA/QC. This is the only relationship between what was conducted in the field and the laboratory data submitted by the analytical laboratory. We should be able to query the database for all sites where lab samples were collected and this information should correlate with the lab data.

Comments

The comments section of the field sheet is designed to capture any other relevant information about the site that is not clearly outlined on the field sheet. It can also contain further explanation of sample locations, address information or distinguishing characteristics about a particular site. Observations are an important part to collecting field data and this section should be completed at every site visit. Examples of other comments might by if the water was collected via a syringe or if the Horiba measurements were conducted in a bucket versus in-situ. Also, note if birds or other animals are present or evidence exists that animals were present (manure or foot prints) at the site.

For more location information please visit www.strand.com

Office Locations

Brenham, Texas | 979.836.7937

Cincinnati, Ohio | 513.861.5600

Columbus, Indiana | 812.372.9911

Columbus, Ohio | 614.835.0460

Joliet, Illinois | 815.744.4200

Lexington, Kentucky | 859.225.8500

Louisville, Kentucky | 502.583.7020

Madison, Wisconsin* | 608.251.4843

Milwaukee, Wisconsin | 414.271.0771

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