

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.

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Table 2: Land Uses, Generating Sites and Activities That Produce Indirect Discharges		
Land Use	Generating Site	Activity that Produces Discharge
Residential	<ul style="list-style-type: none"> • Apartments • Multi-family • Single Family Detached 	<ul style="list-style-type: none"> • Car Washing • Driveway Cleaning • Dumping/Spills (e.g., leaf litter and RV/boat holding tank effluent) • Equipment Washdowns • Lawn/Landscape Watering • Septic System Maintenance • Swimming Pool Discharges
Commercial	<ul style="list-style-type: none"> • Campgrounds/RV parks • Car Dealers/Rental Car Companies • Car Washes • Commercial Laundry/Dry Cleaning • Gas Stations/Auto Repair Shops • Marinas • Nurseries and Garden Centers • Oil Change Shops • Restaurants • Swimming Pools 	<ul style="list-style-type: none"> • Building Maintenance (power washing) • Dumping/Spills • Landscaping/Grounds Care (irrigation) • Outdoor Fluid Storage • Parking Lot Maintenance (power washing) • Vehicle Fueling • Vehicle Maintenance/Repair • Vehicle Washing • Washdown of greasy equipment and grease traps
Industrial	<ul style="list-style-type: none"> • Auto recyclers • Beverages and brewing • Construction vehicle washouts • Distribution centers • Food processing • Garbage truck washouts • Marinas, boat building and repair • Metal plating operations • Paper and wood products • Petroleum storage and refining • Printing 	<ul style="list-style-type: none"> • All commercial activities • Industrial process water or rinse water • Loading and un-loading area washdowns • Outdoor material storage (fluids)
Institutional	<ul style="list-style-type: none"> • Cemeteries • Churches • Corporate Campuses • Hospitals • Schools and Universities 	<ul style="list-style-type: none"> • Building Maintenance (e.g., power washing) • Dumping/Spills • Landscaping/Grounds Care (irrigation) • Parking Lot Maintenance (power washing) • Vehicle Washing
Municipal	<ul style="list-style-type: none"> • Airports • Landfills • Maintenance Depots • Municipal Fleet Storage Areas • Ports • Public Works Yards • Streets and Highways 	<ul style="list-style-type: none"> • Building Maintenance (power washing) • Dumping/Spills • Landscaping/Grounds Care (irrigation) • Outdoor Fluid Storage • Parking Lot Maintenance (power washing) • Road Maintenance • Spill Prevention/Response • Vehicle Fueling • Vehicle Maintenance/Repair • Vehicle Washing

pollution prevention practices. A series of carrots and sticks is used to reach out to targeted individuals to prevent illegal or unintentional illicit discharges.

8. Evaluate the Program – The last component addresses the ongoing management of the IDDE program. The measurable goals set for the IDDE program are periodically reviewed and revisited to determine if progress is being made, or implementation strategies need to be adjusted.

Within each program component, a community has many options to choose, based on its size, capability and the severity of its illicit discharge problems. Chapters 3 through 10 address each IDDE program component in more detail, and summarize

its purpose, methods, desired product or outcome, and budget implications. The remainder of each chapter provides program managers with detailed guidance to choose the best options to implement the program component in their community.

Scheduling of the eight IDDE program components is not always sequential and may overlap in some cases. In general, the first four program components should be scheduled for completion within the first year of the permit cycle in order to develop an effective program for the remaining years of the permit. Table 4 summarizes the specific tasks and products associated with each IDDE program component. The scheduling, costs and expertise needed for each IDDE program component are compared in Table 5.

Table 4: Key Tasks and Products in IDDE Program Implementation

Program Component	Key Tasks	Products
1. Audit existing programs	<ul style="list-style-type: none"> • Infrastructure Profile • Existing Legal Authority • Available Mapping • Experienced Field Crews • Access to Lab Services • Education and Outreach Outlets • Discharge Removal Capability • Program Budget and Financing 	<ul style="list-style-type: none"> • Agreement on Lead Agency • 5 year Program Development Plan • First Year Budget and Scope of Work
2. Establish responsibility and authority	<ul style="list-style-type: none"> • Review Existing Ordinances • Define “Illicit” • Provisions for Access/Inspections • Select Enforcement Tools • Design Tracking System 	<ul style="list-style-type: none"> • Adopt or Amend Ordinance • Implement Tracking System
3. Desktop assessment of illicit discharge potential	<ul style="list-style-type: none"> • Delineate Subwatersheds • Compile Mapping Layers/Data • Define Discharge Screening Factors • Screen Subwatersheds for Illicit Discharge Potential • Generate Maps for Field Screening 	<ul style="list-style-type: none"> • Prioritize Subwatersheds for Field Screening
4. Develop program goals and strategies	<ul style="list-style-type: none"> • Community Analysis of Illicit Discharge • Public Involvement 	<ul style="list-style-type: none"> • Measurable Program Goals • Implementation Strategies

Table 4: Key Tasks and Products in IDDE Program Implementation

Program Component	Key Tasks	Products
5. Search for illicit discharges problems in the field	<ul style="list-style-type: none"> • Outfall Reconnaissance Inventory (ORI) • Integrate ORI data in Tracking System • Follow-up Monitoring at Suspect Outfalls 	<ul style="list-style-type: none"> • Initial Storm Drain Outfall Map • Develop Monitoring Strategy
6. Isolate and fix individual discharges	<ul style="list-style-type: none"> • Implement Pollution Hotline • Trunk and On-site Investigations • Corrections and Enforcement 	<ul style="list-style-type: none"> • Maintain Tracking System
7. Prevent illicit discharges	<ul style="list-style-type: none"> • Select Key Discharge Behaviors • Prioritize Outreach Targets • Choose Effective Carrots and Sticks • Develop Budget and Delivery System 	<ul style="list-style-type: none"> • Implement Residential, Commercial, Industrial or Municipal Pollution Prevention Programs
8. Program evaluation	<ul style="list-style-type: none"> • Analyze Tracking System • Characterize Illicit Discharges Detected • Update Goals and Strategies 	<ul style="list-style-type: none"> • Annual Reports • Permit Renegotiation

Table 5: Comparison of IDDE Program Components

IDDE Program Component	When To Do It	Startup Costs	Annual Cost	Expertise Level	Type of Expertise
1. Audit	Immediately	\$	-0-	??	Planning/Permitting
2. Authority	Year 1	\$\$	\$??	Legal
3. Desktop Analysis	Year 1	\$\$	-0-	???	GIS
4. Goals/Strategies	Year 1	\$	-0-	??	Stakeholder Management
5. Field Search/Monitoring	Year 2 to 5	\$\$	\$\$\$\$???	Monitoring
6. Isolate and Fix	Year 2 to 5	\$	\$\$???	Pipe and Site Investigations
7. Prevention	Year 2 to 5	\$\$	\$\$\$??	Education
8. Evaluation/Tracking	Annually	-0-	\$?	Data Analysis
Key: \$ = <\$10,000 ? - Simple \$\$ = \$10,000 - 25,000 ?? - Moderately Difficult \$\$\$ = \$25,000 - 50,000 ??? - Complex \$\$\$\$ = > \$50,000					

2.1 Management Tips To Develop an Effective IDDE Program

Every community will develop a unique IDDE program that reflects its size, development history, land use, and infrastructure. Still, some common threads run through effective and well-managed local IDDE programs. Below are some tips on building an effective local.

1. Go after continuous sewage discharges first. Effective programs place a premium on keeping sewage out of the storm drain system. Continuous sewage discharges pose the greatest threat to water quality and public health, produce large pollutant loads, and can generally be permanently corrected when the offending connection is finally found. Intermittent or indirect discharges are harder to detect, and more difficult to fix.

3.1 Audit Overview

A community should conduct a quick audit of existing and needed capacity when developing its IDDE program. The audit helps develop realistic program goals, implementation strategies, schedules, and budgets to comply with NPDES permit requirements and improve water quality. The audit consists of external research, agency interviews and interagency meetings to determine existing resources and program gaps. The audit examines the community's current capabilities in eight topic areas: infrastructure profile, legal authority, available mapping, field staff experience, access to monitoring labs, education and outreach resources, discharge removal capability, and program budgets and financing.

Existing expertise is likely divided among multiple agencies (see Table 6) that should be contacted during the audit. Some of these agencies can become important partners in the development and implementation of the IDDE program, and contribute resources, program efficiencies and overall cost savings. The first agencies to interview are local emergency responders that already deal with spills, accidents, hazardous materials and sewage leaks that occur. In addition, it is worth getting to know the local agency responsible for plumbing code inspection during construction.

Table 7 provides representative examples of questions that the audit should ask to determine the needs and capabilities of a community associated with each program element.

Table 6: Potential Local Agencies and Departments to Contact During an Audit

Audit Topic	Potential Agencies and Departments	
Infrastructure Profile	<ul style="list-style-type: none"> Water and Sewer Authority 	<ul style="list-style-type: none"> Public Works
Existing Legal Authority	<ul style="list-style-type: none"> Public Works Planning Department Parks and Recreation Environmental Protection 	<ul style="list-style-type: none"> Local Health Department Road Engineering Fire, Police or Rescue (Hazardous material responders)
Available Mapping	<ul style="list-style-type: none"> Public Works Local Streets/Utilities 	<ul style="list-style-type: none"> Planning and Zoning Emergency Responders
Field Staff	<ul style="list-style-type: none"> Public Works Environmental Compliance Development Review 	<ul style="list-style-type: none"> Watershed Groups Fire, Building, Health and Code Inspectors
Access to Lab Services	<ul style="list-style-type: none"> Public Works Local College or University 	<ul style="list-style-type: none"> Drinking Water or Wastewater Treatment Plant Private Contract Monitoring Laboratories Health Department
Education and Outreach Resources	<ul style="list-style-type: none"> Parks and Schools Water and Sewer Utility 	<ul style="list-style-type: none"> Community Liaison Office Civic and Watershed Groups
Discharge Removal Capability	<ul style="list-style-type: none"> Fire, Rescue and Police Public Works 	<ul style="list-style-type: none"> Water and Sewer Utilities Private Plumbing Contractors
Program Budget and Financing	<ul style="list-style-type: none"> Grants Fines Application fees 	<ul style="list-style-type: none"> Utility Fees Department Operating Budget

Table 7: Potential IDDE Audit Questions	
Audit Topics	Questions
Infrastructure Profile	<ul style="list-style-type: none"> • How many miles of streams and storm drains exist in the MS4? • What is the area served by storm drains, sewers, and septic? • What is the general age and condition of the infrastructure?
Existing Legal Authority	<ul style="list-style-type: none"> • Does an illicit discharge ordinance already exist? • Does effective inter-departmental coordination and cooperation currently occur? • Is there an existing reporting and tracking system (e.g., hotline)? • Is the municipality involved with industrial storm water NPDES permit activities or pre-treatment programs?
Available Mapping Data	<ul style="list-style-type: none"> • Does current GIS data exist and does it include coverage of sanitary and storm sewer networks? • Is there a centralized location for the data? • Are digital and hardcopy versions of mapping data readily available?
Field Staff	<ul style="list-style-type: none"> • Are municipal staff available to walk stream miles and record information? • Do municipal staff have the training and expertise to lead a field team? • Are basic field supplies already owned by the municipality and available for use?
Access to Lab Services	<ul style="list-style-type: none"> • Does the municipality have access to an analytical laboratory? • Is there a local university or institution that might be a willing partner? • If yes, is the existing equipment and instrumentation considered to be safe, accurate and reliable? • Are experienced municipal staff available to conduct analytical analyses? • Does the lab and staff have the capability to conduct more sophisticated special studies?
Education and Outreach Resources	<ul style="list-style-type: none"> • Does the community already have an Internet website to post outreach materials? • Are there regular community events that can be used to spread the message? • Are good inter-agency communication mechanisms in place? • Do outreach materials on illicit discharges already exist?
Discharge Removal Capability	<ul style="list-style-type: none"> • Who currently responds to spills, overflows and hazardous material emergencies? • Are municipal staff properly equipped and trained to repair most common types of illicit connections? • Does the municipality have clear authority identifying responsible parties? • Is there a response time commitment to known and reported problems? • Is there a list of pre-approved contractors to perform corrections?
Program Budget and Financing	<ul style="list-style-type: none"> • Is there a dedicated annual budget line item planned for the IDDE program? • Are there cost-share arrangements/opportunities available with other departments? • Have grant awards been awarded to the municipality for special studies associated with watershed restoration in the past?

Table 17: Measurable Goals for an IDDE Program

EXAMPLE MEASURABLE GOALS	TIMEFRAME	PRIORITY
Goals related to overall program administration		
Audit existing capabilities and identify needs	Immediately	●
Designate one program head and identify key support staff		●
Develop a complete list of ongoing activities related to IDDE		○
Coordinate and communicate with other affected agencies	At program start up and continuously and regularly after that	●
Develop a projected 5-year budget		●
Secure funding to match 5-year goals		●
Draft and promulgate new or modified ordinance	Year 1	●
Establish a tracking and reporting system	Year 1	●
Goals related to outfall assessment		
Define and characterize drainage areas or sewer sheds	Year 1	●
Walk all stream miles	Begin in Year 1 and complete first screening by end of permit cycle. Repeat once per permit cycle	●
Develop a digital (e.g., GIS) map of all outfalls, land use, and other relevant infrastructure	Year 1 and continuously and regularly after that	●
Secure analytical laboratory services either internally or by arrangement with a private laboratory	Initiate in conjunction with field screening	●
Sample and trace the source of a percentage of flowing outfalls each year of permit cycle	Initiate during first permit cycle and expand and enhance where problems are observed	●
Conduct regular in-stream assessments		○
Conduct investigations at a percentage of non-flowing outfalls with poor in-stream water quality to look for intermittent flows		○
Integrate all collected stream data and citizen complaints into the GIS system	Initiate during first year and expand and enhance with time	○
Goals related to preventing illicit discharges		
Distribute educational materials to citizens and industries	Initiate during first year and expand and enhance with time	○
Conduct storm drain stenciling	Initiate during first permit cycle and expand and enhance where problems are observed	○
Hold hazardous waste collection days at least annually		○
Conduct upland subwatershed site reconnaissance surveys to better characterize generating site potential		○
Goals related to finding and fixing illicit discharges		
Develop a spill response plan and coordinate emergency response with other agencies	Immediately	●
Remove all obvious illicit discharges	Ongoing in conjunction with field screening and in response to hotline reports	●

Table 17: Measurable Goals for an IDDE Program

EXAMPLE MEASURABLE GOALS	TIMEFRAME	PRIORITY
Train staff on techniques to find the source of an illicit discharge	Initiate during first year and expand and enhance with time	●
Repair a fraction of the illicit discharges identified through field screening or citizen complaints	Initiate during first permit cycle and expand and enhance where problems are observed	●
Establish a hotline for public to call in and report incidents (consider establishing performance standards, such as guaranteed response time)	Initiate during first year and expand and enhance with time	○
Inspect and dye-test all industrial facilities	Initiate during first permit cycle and expand and enhance where problems are observed	○
Develop a system to track results of on-site inspections	Initiate during first year and expand and enhance with time	○
Establish an Adopt-a-Stream program	Initiate during first permit cycle and expand and enhance where problems are observed	○
Establish pre-approved list of plumbers and contractors to make corrections	Initiate during first year and expand and enhance with time	○
Key: ● Essential ○ Optional but Recommended		

Ultimately, IDDE program goals should be linked to water quality goals. Some common examples of water quality goals include:

- Keep raw or poorly-treated sewage out of streams
- Reduce pollutant loads during dry weather to help meet the TMDL for a water body
- Meet bacteria water quality standards for contact recreation during dry weather flows
- Reduce toxicant and other pollutant discharges to a stream to restore the abundance and diversity of aquatic insects or fish

A well-designed IDDE program may not guarantee that water quality goals will be always be achieved. Indeed, if program managers can document that illicit discharges do not contribute to poor water

quality, they may want to shift resources to other pollution sources or practices that do. Burton and Pitt (2002) offer a complete discussion on designing and conducting a receiving water investigation.

6.3 Crafting Implementation Strategies

In order to meet program goals, managers must devise cost-effective implementation strategies that are most appropriate for the types of illicit discharge problems they actually have. The community-wide illicit discharge potential (IDP) developed during the desktop analysis can be quite helpful in choosing implementation strategies. Table 18 presents implementation strategies that are geared to the findings of the community-wide IDP. As the community acquires more program experience, they can refine the strategies to better address program goals or unique watershed conditions (Table 19).







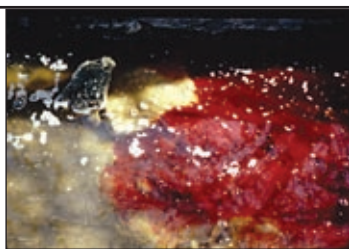


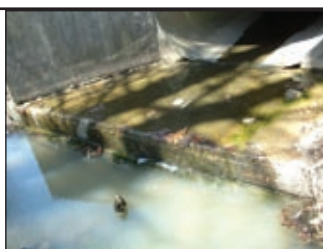



		
Color: Brown; Severity: 2 Turbidity Severity: 2	Color: Blue-green; Severity: 3 Turbidity Severity: 2	Highly Turbid Discharge Color: Brown; Severity: 3 Turbidity Severity: 3
		
Sewage Discharge Color: 3 Turbidity: 3	Paint Color: White; Severity: 3 Turbidity: 3	Industrial Discharge Color: Green; Severity: 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.






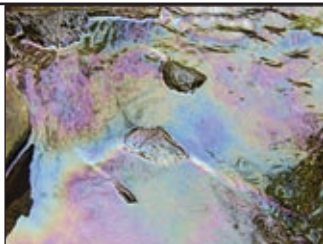
SUDS		
 <p>Natural Foam Note: Suds only associated with high flows at the "drop off" Do not record.</p>	 <p>Low Severity Suds Rating: 1 Note: Suds do not appear to travel; very thin foam layer</p>	 <p>High severity suds Rating: 3 Sewage</p>
OIL SHEENS		
 <p>Low Severity Oil Sheen Rating: 1</p>	 <p>Moderate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

Figure 35: Determining the Severity of Floatables

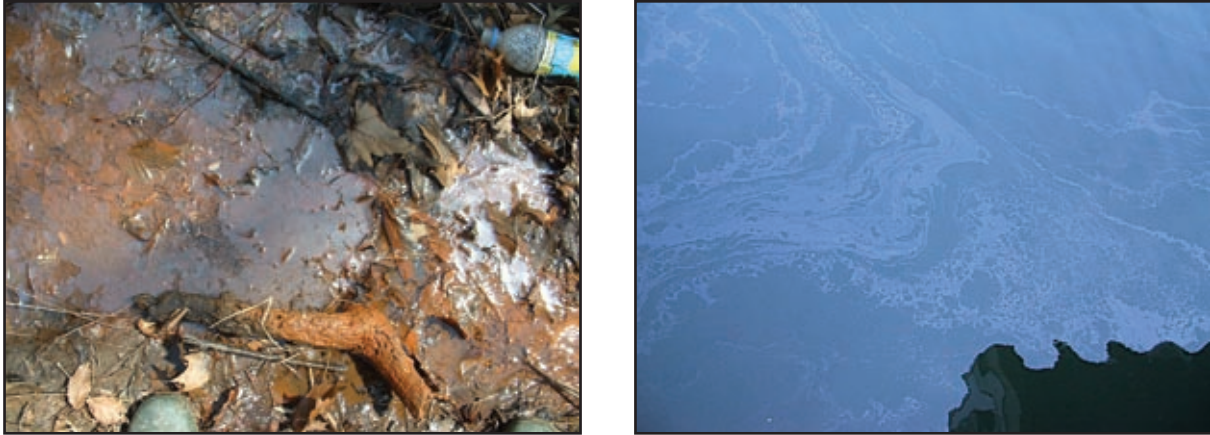


Figure 36: Synthetic versus Natural Sheen (a) Sheen from bacteria such as iron floc forms a sheet-like film that cracks if disturbed (b) Synthetic oil forms a swirling pattern

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	<input type="checkbox"/>	<input type="checkbox"/> Spalling, Cracking or Chipping <input type="checkbox"/> Peeling Paint <input type="checkbox"/> Corrosion	
Deposits/Stains	<input type="checkbox"/>	<input type="checkbox"/> Oily <input type="checkbox"/> Flow Line <input type="checkbox"/> Paint <input type="checkbox"/> Other:	
Abnormal Vegetation	<input type="checkbox"/>	<input type="checkbox"/> Excessive <input type="checkbox"/> Inhibited	
Poor pool quality	<input type="checkbox"/>	<input type="checkbox"/> Odors <input type="checkbox"/> Colors <input type="checkbox"/> Floatables <input type="checkbox"/> Oil Sheen <input type="checkbox"/> Suds <input type="checkbox"/> Excessive Algae <input type="checkbox"/> Other:	
Pipe benthic growth	<input type="checkbox"/>	<input type="checkbox"/> Brown <input type="checkbox"/> Orange <input type="checkbox"/> Green <input type="checkbox"/> Other:	

Figure 37: Section 5 of the ORI Field Sheet

 <p>Bacterial growth at this outfall indicates nutrient enrichment and a likely sewage source.</p>	 <p>This bright red bacterial growth often indicates high manganese and iron concentrations. Surprisingly, it is not typically associated with illicit discharges.</p>	 <p>Sporalitis filamentous bacteria, also known as “sewage fungus” can be used to track down sanitary sewer leaks.</p>
 <p>Algal mats on lakes indicate eutrophication. Several sources can cause this problem. Investigate potential illicit sources.</p>	 <p>Illicit discharges or excessive nutrient application can lead to extreme algal growth on stream beds.</p>	 <p>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.</p>
		

This brownish algae indicates an elevated nutrient level.

Figure 38: Interpreting Benthic and Other Biotic Indicators

 <p>Reddish staining on the rocks below this outfall indicate high iron concentrations.</p>	 <p>Toilet paper directly below the storm drain outlet.</p>	 <p>Watershed Protection??</p>
 <p>Trash is not an indicator of illicit discharges, but should be noted.</p>	 <p>Staining at the base of the outfall may indicate a persistent, intermittent discharge.</p>	 <p>Excessive vegetation may indicate enriched flows associated with sewage.</p>
 <p>Brownish stain of unclear origin. May be from degradation of the brick infrastructure.</p>	 <p>Cracked rock below the outfall may indicate an intermittent discharge.</p>	 <p>Poor pool quality. Consider sampling from the pool to determine origin.</p>

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