Shenandoah Valley MS4 Communities

Illicit Discharge Detection and Elimination Field Guide: How to Identify and Quickly Report Pollution Problems

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Written by: Center for Watershed Protection

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INTRODUCTION

What is an Illicit Discharge?

An Illicit discharge is flow to a municipal separate storm sewer system conveyance or natural water body during dry weather conditions that contains pollutants and/or pathogens. A dry weather flow without pollutants or pathogens (e.g. groundwater), is simply a discharge.

Why It Is Important to Report Illicit Discharges?

The primary reasons for noting and reporting illicit discharges are:

1) They contaminate water resources;
2) They may threaten public health and/or the ability of the public to enjoy water resources;
3) They are regulated under the Jurisdiction's Municipal Separate Storm Sewer System (MS4) permit and must be removed when detected. This permit applies to activities within the City/County, but is administered by the Virginia Department of Environmental Quality (DEQ) as part of the Clean Water Act.

What to Look For in The Course of Your Day

Many illicit discharges can be detected through visual assessments and simply paying attention to what's going on around you during routine activities. **This guide is intended to help find, track, and report illicit discharges,** thereby helping the City/County meet permit requirements. In general, what to look for in the field during the course of the day includes:

- Unusual odors, colors, or conditions in surface water, storm drain outfalls or inlets
- Cloudy or murky water
- Floatables, such as toilet paper, suds, or excessive trash
- Unnatural (excessive or dead) vegetation near an outfall pipe
- Odd deposits or stains on an outfall pipe
- Leaks, spills, or dumping of damaging fluids and/or materials

2. HOW TO USE THIS MANUAL

Intended Audience

This manual is intended to be used by City/County staff whose job necessitates frequent field or site visits, as well as staff responsible for administering the MS4 Permit. This may include staff from Public Works, Roads, Utilities, Erosion and Sediment Control Inspectors, Stormwater Inspectors, and others.

Purpose

The purpose of this manual is to assist field and program staff with proper identification, reporting, and resolution of pollution problems.

This manual is divided into several sections, described briefly below:

Common Pollution Problems – Describes common pollution problems that may be encountered during standard work days and routine activities. Problems are listed from those more likely to be encountered to less likely.

Illicit Discharge Characteristics – Describes characteristics and severity of various illicit discharge sources. This may be used to characterize pollution problems for reporting purposes or may be used for prioritization purposes during outfall inspections.

IDDE Written Procedures – Outlines procedures for illicit discharge screening, detection, tracking, and reporting, as required by the MS4 Permit.

Appendices – Contains field and laboratory forms, and other materials that are helpful for program documentation.

What To Report

Any flow occurring after 2 to 3 days of dry weather should be assessed according to the characteristics described in this guide. The flow may be present in an outfall, manhole, storm drain inlet, street or in any manner draining to the City/County's storm sewer system. Any potential problems should be reported AS SOON AS POSSIBLE. NOTE: Especially in the Shenandoah Valley, any such flow may be attributed to springs that intercept pipes and ditches. However, be aware that contaminants can intermingle with spring flow, so the testing procedures still apply.

WHAT TO REPORT:

- Location of problem
- Time problem was found
- Odor, color, turbidity, and floatables
- One or more digital photos to document the condition, if possible
- Any other relevant or pertinent information

TO WHOM TO REPORT:

- Stormwater Compliance Inspector, **540-XXX-XXXX, email**

3. COMMON POLLUTION PROBLEMS

Illicit discharges are considered "illicit" because storm sewer systems, unlike sanitary sewer systems, are not designed to accept, treat, or discharge non-stormwater wastes. There are two primary categories of illicit discharges, as follows:

- TRANSIENT – Short in duration, lasting only a short time and then disappearing. Examples include:
    - Materials that have been dumped into a storm drain (catch basin) or drainage way, and
    - A floor drain that is connected to the storm sewer.

- CONTINUOUS – Continuing without changing, stopping, or being interrupted. Examples include:
    - Sanitary wastewater piping that is cross-connected from a building or sanitary sewer line to the storm sewer, and
    - An industrial operational discharge that is not permitted.

Below you will find some common pollution problems and what you should do if you encounter them. For all cases in the "moderate" or "high" severity categories, note the location, take photos, and **contact the Stormwater Compliance Inspector at 540-XXX-XXXX, email.**

Sediment Discharge

Sediment or dirt should stay contained in a construction site and should not be on the streets where it can enter storm drains (**Figure 1**). Sediment problems are most likely to occur during or after rain, but may also occur if a site is being dewatered or if equipment is being washed down. Note that the source may be a regulated or un-regulated construction activity under the City/County's erosion and sediment control ordinance and/or Construction General Permit.

- **Where to look:** Streams, storm drains, concrete curb.
- **What to look for:** Brown/orange, turbid water, usually with no unusual odor.

Figure 1. Sediment Discharge (Examples)

Low Severity Sediment Discharge

Moderate Severity Sediment Discharge

Severe Severity Sediment Discharge

Sediment discharges usually originate on the landscape and look like the examples shown in **Figure 2**.

Figure 2. Typical Sediment Discharge Sources

Unprotected storm drain inlet

Sediment pile on the street

Construction site runoff

Failing silt fence

Waste Management

Trash and dumping areas are often found in vacant or infrequently visited parts of commercial and residential areas. Trash and dumping attract rodents, can wash into the storm drains and streams, and signals to others that it is acceptable to dump in the area. Improper dumpster and grease container management can also result in pollution that can wash into the storm drains and streams (**Figure 3**).

- **Where to look:** Behind restaurants, vacant buildings or homes, and/or dead end roads. Areas that people do not frequent such as near train tracks, behind buildings, and vacant lots.
- **What to look for:** Poorly managed grease containers and dumpsters, mattresses, furniture, tires, toys, food and drink containers, cigarettes, etc.

Figure 3. Trash / Dumping

Low Severity Waste Management – open dumspter with visible staining

Moderate Severity Waste Management – poorly managed dumpster and/or dumping

High Severity Waste Management – Dumping in vacant lot

High Severity Waste Management – Grease containers open, spills and stains on lot draining to storm drain

Yard Waste

Yard waste is usually piles of leaves, mulch, branches, or other residential waste (**Figure 4**). When yard waste is exposed to rain and weather, it can wash away and damage the environment. These excessive piles of yard waste are often found on the street, behind homes near streams, in riparian buffers, and in ditches. Yard waste can clog storm drain systems and choke streams.

- **Where to look:** Streets and sidewalks near homes. Ditches and streams near homes.
- **What to look for:** Piles of leaves, mulch, grass clippings, trees, sediment, trash, etc. Decomposed leaves create an "oily" multi-color sheen that breaks up when stirred with stick

Figure 4. Yard Waste

Low Severity Yard Waste Management – Leaves accumulating in street gutter

Moderate Severity Yard Waste Management – Clogged storm drain

High Severity Yard Waste Management – Pile of mulch in street next to storm drain

Hazardous Waste

Hazardous waste can be dangerous or potentially harmful to our health or the environment. Hazardous wastes can be liquids, solids, gases, or sludge. They can be discarded commercial products, like cleaning fluids or pesticides, or the by-products of manufacturing processes (**Figure 5**).

- **Where to look:** Automobile, construction site, and other commercial or residential businesses
- **What to look for:** Paint, oil, automobile parts, gas, construction material, chemical containers. Chemical/solvent odor

Figure 5. Hazardous Waste

Low Severity Hazardous Waste – Contains used oil, under partial cover

Moderate Severity Hazardous Waste – Batteries outside without cover, on pallets

High Severity Hazardous Waste – Uncovered, unlabeled leaking barrels

High Severity Hazardous Waste – Used oil container open with spills

Washing Activities

Outdoor washing may or may not be problematic. For example, hosing off a sidewalk or driveway or individual residential car may not generate significant flows or pollutant loads. These examples are not problematic unless done on an ongoing or chronic basis close to a waterway or storm drain. However, washing fueling areas, and power washing construction equipment in parking lots can generate significant flows or pollutant loads and are therefore problematic. Residential homeowner car washing and lawn watering are generally exempt activities, unless deemed to be "significant contributors of pollutants to the small MS4" (9VAC25-870-400 D 2 c 3). Washwater dumping and vehicle washing at commercial establishments is *not* acceptable. Some examples are shown in **Figure 6**.

- **Where to look:** Car washes, car dealerships and rental companies, fire stations, fleet maintenance areas, and parking lots with mobile car washes
- **What to look for:** Suds; sweet, fruity, detergent, or chlorine smells

Figure 6. Building power washing and outdoor vehicle washing

Low Severity Washing – Individual power washing building side without soap

Moderate Severity – Suds accumulating at outfall

High Severity – Fleet vehicle washing next to storm drain

Water Main Breaks

Potable water leaking into the storm drain system is generally not considered to be a significant illicit discharge. However, water main breaks (**Figure 7**) can damage infrastructure, waste treated drinking water supplies, threaten public safety, and harm streams if breaks generate excessively high flows. In addition, the Chesapeake Bay expert panel on "Nutrient Discharges from Grey Infrastructure" considers "drinking water transmission losses" to be a sources of nutrients that communities can potentially take credit for if leaks are fixed (Schueler et al., 2014). Water main issues may also be detected by the chlorine scent; if a strong chlorine scent is detected, this should be reported.

- **Where to look:** Streets, sidewalks, parking lots
- **What to look for:** Clear water seeping or spewing out of pavement

Figure 7. Water main break

Sewage Discharges

Sanitary sewage can enter the storm drain and streams through cracks in the pipes, an illicit connection, sanitary sewer overflow, failed septic system and/or straight pipes. Field crews may see any of these sources of discharges during routine activities. Some examples are shown in **Figure 8**.

- **Where to look:** In storm drains, near sewer manholes, in streams, exposed sewer pipes
- **What to look for:** Sewage smells, gray water, toilet paper, scum in or below pipes

Figure 8. Sanitary sewage discharge sources

Sanitary pipe break	Illicit sewage connection	Sanitary straight pipe
Illicit connection, downstream of source	Surcharging sanitary manhole in parking lot	

Pool Discharges

Chlorinated pool water being drained into a street or storm drain is considered an illicit discharge (**Figure 9**), while dechlorinated discharges generally are not (9VAC25-870-400 D 2 c 3).

- **Where to look:** Storm drain pipes, streets, driveways, yards
- **What to look for:** Clear water with chlorine odor

Figure 9. Suspect pool discharge

Landscape Irrigation Water

Landscape irrigation water can potentially carry excess nutrients and chemicals if it is coming from a highly fertilized area (**Figure 10**). In order to be considered an illicit discharge, irrigation water must be deemed by the MS4 to be a "significant contributor of pollutants to the small MS4" (9VAC25-870-400 D 2 c 3), which likely means that the issue is chronic and is leading to exceedances of one or more indicator thresholds (see **Section 5, IDDE Procedures**). Residential irrigation water is generally not a concern and does not need to be reported.

- **Where to look:** Nurseries, home improvement and garden supply stores, properties with highly manicured landscaping
- **What to look for:** Clear water with chlorine or fertilizer smell; algae growth in path of water

Figure 10. Suspect irrigation discharge

Irrigation water entering the storm drain system from a retail establishment

Accident Spills

Accident spills can enter ditches, storm drains, streams and rivers (**Figure 11**). Highway and road spills, particularly those involving hazardous waste, should be reported to 911. First responders will likely be the first personnel on-site, but the Stormwater Compliance Inspector may be of assistance in cases where spill response is needed.

Figure 11. Accident spills

Accidental spills can be significant sources of pollution to the storm drain system

4. ILLICIT DISCHARGE CHARACTERISTICS

Illicit discharges have certain characteristics that are important to note when developing a report or conducting outfall inspections. These characteristics include odor, color, turbidity, and floatables, which are described in more detail here.

Odor

Determine if there is an odor coming from the suspected illicit discharge. Potential odors that you may encounter are:

- Musty
- Sewage
- Rotten eggs (sulfide)
- Gas or oil
- Sharp, pungent (chemicals)
- Rancid/sour
- Chlorine
- Sweet/fruity

The field crew should reach consensus as to whether an odor is present and score it based on how severe it is. An example of a scoring system is:

Score	Description
1	Odor is faint or the crew cannot agree on its presence or origin.
2	Indicates a moderate odor.
3	Odor is so strong that crew smells it from a considerable distance away from the outfall.

TIPS:

(1) Make sure the origin of the odor is the outfall pipe. Sometimes shrubs, trash or dead animals, or even the spray paint used to mark the outfall can confuse the nose of field crews.

(2) Never inhale directly over the suspect area as it may contain vapors that could be harmful.

Color

Record the color intensity of the discharge which can be clear, slightly tinted or intense. The best way to measure color is to collect the discharge in a clear sample bottle and hold it to the light. Field crews should also look for downstream plumes of color that appear to be associated with the outfall. **Figure 12** illustrates the spectrum of colors that may be encountered during an inspection and offers insight on how to rank the relative intensity or discharge color strength. Color can often help identify industrial discharges (see **Table 1**). Iron floc, a red bacterium commonly found in streams and rivers (**Figure 13**), is generally *not* a concern. Sometimes fluorescent dyes used for dye testing (e.g., tracking floor drains or storm sewer connections) will end up at outfalls as well.

Table 1. Colors associated with common pollution problems	
Color	**Possible Sources**
Brown	• Construction • Meat • Printing facilities • Concrete, Stone, Clay, and/or Glass cutting • Metal grinding
Green	• Chemical plants, textiles • Algae or plankton bloom • Antifreeze (fluorescent green) • Fertilizer
Gray to White	• Dairy / food processing • Sewage • Concrete wash-out
Milky white	• Paint, lime, grease, concrete • Swimming pool filter backwash • Concrete wash-out • Stone cutting
Red	• Meat packing / processing
Red, purple, blue, black	• Fabric dyes, inks from paper and cardboard manufacturers

An example of a scoring system for color intensity is:

Score	Description
1	Flow is primarily clear, faint colors may be present
2	Clearly visible, moderately intense
3	Flow is intensely colored

Figure 12. Illicit discharge colors & intensity

Color: Clear, Intensity 1

Color: Brown, Intensity 2

Color: Purple, Intensity 3

Figure 13. Iron Floc

Iron floc in an outfall pipe

Iron floc in a stream

Turbidity

During inspections, make a visual estimation of the discharge turbidity. Turbidity is a measure of the water cloudiness. Like color, turbidity is best observed in a clear sample bottle and can be quantitatively measured in the field. Field crews should look for turbidity in the pool below the outfall and note any downstream turbidity plumes that appear to be related to the outfall. Turbidity can often times be confused with color, which are related but not the same. Turbidity is a measure of how easily light can penetrate through the water sample, whereas color is defined by the tint or intensity of the color observed. See **Figure 14** for how to rank turbidity severity.

Score	Description
1	Slight cloudiness to the water
2	Cloudy, more difficult to see through the water
3	Water is opaque; cannot see through

Figure 14. Turbidity

Turbidity Severity: 1

Turbidity Severity: 2

Turbidity Severity: 3

Floatables

Another visual indicator is the presence of any floatable materials in the discharge or the plunge pool below the outfall pipe. Sewage, oil sheen, and suds are all examples of floatable indicators. Trash and debris are generally not floatables in the context of illicit discharge investigations but should be noted in any case for potential dumping or yard waste concerns (see respective sections above). Some guidelines for ranking their severity are provided.

If you think the floatable is sewage, you should automatically assign it a severity score of 3 since no other source looks quite like it (see **Figure 8**). Surface oil sheens are ranked based on their thickness and coverage. A thick or swirling sheen associated with a petroleum-like odor indicates a likely oil discharge (**Figure 15**). In some cases, surface sheens may not be related to oil discharges, but instead are created by natural in-stream processes, such as the example shown in **Figure 16**. These natural decay sheens will crack and break up when swirled with a stick, but petroleum products will quickly coalesce back together.

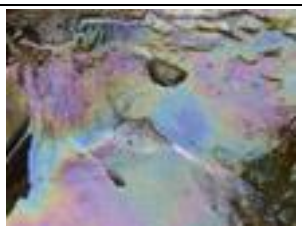
Suds are rated based on their foaminess and staying power. A severity score of 3 is designated for thick foam that travels many feet before breaking up (**Figure 17**). Suds that break up quickly may simply reflect water turbulence, and do not necessarily have an illicit origin. Some streams have naturally occurring foams due to the decay of organic matter. However, suds that are accompanied by a strong organic or sewage-like odor may indicate a sewage leak or illicit connection. If the suds have a fragrant odor, they may indicate the presence of laundry water or other wash waters.

Score	Description
1	Few/slight
2	Moderate
3	Severe

Figure 15. Oil Sheens

Low Severity Oil Sheen
Score: 1

Moderate Severity Oil Sheen
Score: 2



High Severity Oil Film
Score: 3

Figure 16. Synthetic vs. Natural Sheen

Sheen from bacteria such as iron floc forms a sheet-like film that cracks if disturbed

Synthetic oil forms a swirling pattern

Figure 17. Suds

Natural Foam - Do not record.
Note: Suds caused by turbulence

Low Severity Suds – Score: 1
Note: Suds do not appear to travel; very thin foam layer

Moderate severity suds – Score: 2	High severity suds – Score: 3

5. IDDE WRITTEN PROCEDURES

Purpose/Goal

The chief purpose of these procedures is to help protect local water quality and satisfy the requirements of Minimum Control Measure No.3 of the MS4 Permit (Section II B 3 c). The procedures provide a framework for MS4s to develop and implement a comprehensive plan to identify and eliminate dry weather illicit discharges to their systems.

Adopted from Brown et al. (2004), the protocol relies primarily on visual observations and the use of field test kits and portable instrumentation during dry weather to complete a thorough inspection of the communities' storm sewers in a prioritized manner. The protocol is applicable to most typical storm sewer systems; however, modifications to materials and methods may be required to address situations such as open channels, piped stream networks, systems impacted by sanitary sewer overflows, or situations where groundwater, backwater or other conditions preclude or confound adequate inspection. The primary focus of the protocol is sanitary waste, however, toxic and nuisance discharges may also be identified. Implementation of the protocol would satisfy the relevant conditions of Minimum Control Measure No. 3, illicit discharge detection & elimination (IDDE) of the City/County's NPDES MS4 Permit.

NOTE: The following procedures represent a fairly robust set of practices that would meet or exceed the requirement for "written procedures" in the MS4 General Permit. At points, the procedures intersect with particular sections of the General Permit, and these are noted in the text. Localities should review the procedures in the context of the permit, and modify to meet the capabilities and goals of the local program. In addition, MS4s should consult the Chesapeake Bay Program protocols for TMDL credits for reducing discharges from "Grey Infrastructure" to ascertain whether local programs can obtain additional credits towards needed MS4 pollutant reductions (Schueler et al., 2014):

http://chesapeakestormwater.net/bay-stormwater/baywide-stormwater-policy/urban-stormwater-workgroup/illicit-discharge-detection/

Illegal dumping located at or near an outfall should be reported to the **IDDE Coordinator at (540)XXX-XXXX or email**.
Needed infrastructure repairs should be reported to the **Public Works Department at (540)XXX-XXXX or email**.

Detection

Illicit discharges can be detected in several ways: citizen complaints, during regular outfall screening, and during other routine activities conducted by staff. Procedures to be followed at the outfall do not differ greatly based on the type of detection. These procedures are discussed below.

Outfall Inspections

Outfall inspections are to be conducted when at least **48 hours** has passed since the last precipitation event, unless responding to a citizen complaint or spill. Safety precautions are to be undertaken during the inspection, including:

- Wearing protective gloves;
- Wearing protective goggles if chemical testing takes place;
- Placing traffic cones and using flashers, lights, and other traffic control measures if needed;
- Using caution on slopes and at the edge of waterbodies;
- Disposing of chemical reagents or other waste as indicated on material safety data sheets; and
- Not entering manholes or storm sewers without confined space training.

Autumn (after leaf fall) is the ideal time to conduct outfall inspections. Vegetation is less likely to obstruct views of outfalls and groundwater influences may be diminished. Outfall inspections may be conducted during other seasons, but be aware of the following:

- Winter: frozen flows, cold temperatures affecting sampling equipment, and possible effect of snow melt and/or road salt on sample results.
- Spring: high groundwater table may lead to more flowing outfalls that originate from springs.
- Summer: vegetation may obstruct outfalls, air conditioning condensate may lead to more flowing outfalls (AC condensate is not considered an illicit discharge unless deemed by the MS4 to be a "significant contributor of pollutants" (9VAC25-870-400 D 2 c 3).

At the outfall, look for visual indicators of illicit discharges like those described in Section 4. Complete the Outfall Reconnaissance Inventory (ORI) form (see **Appendix A**), or similar field form, to record your observations.

If the outfall is not already in the jurisdiction's mapping system, collect GPS coordinates, and assign it a unique identifier code. Consider marking this code on the outfall with spray paint or waterproof marking stick in a prominent location such as the outfall headwall. This will help field crews identify specific outfalls in the future. New outfalls and unmapped stormwater infrastructure should be updated in the jurisdiction's master GIS system as soon as possible after identification. Stormwater pipe mapping should note the direction of flow in addition to pipe location.

Water Sampling

If the outfall has dry weather flow, take photos and collect a water sample as follows.

If possible, collect water from the flow directly in a clean glass bottle or, for bacteria analysis, a sterile plastic bottle or bag. If using a re-usable bottle, be sure to rinse the bottle and its cap one to three times with sample water for conditioning. If a dipper, bailer, bucket, or other device is used to collect a sample, be sure that they are also conditioned with the flow prior to final collection. Collect enough water to conduct all your field and laboratory tests, plus some extra for good measure.

Label each sample bag or bottle with the appropriate outfall ID, date and time of collection, and sample collector initials using a water-proof marker. (It is easier to label these BEFORE filling the

containers.) Bacteria samples are to be kept on ice and processed within a certain amount of time after collection – usually within 6 hours, but refer to bacteria kit or lab instructions for specific holding times. Other lab samples may also need to be kept on ice; consult the laboratory for special instructions. See **Table 2** for common holding times and methods for handling water samples for different parameters.

Table 2. Holding Times for Water Samples

Parameter	Holding Time	Notes
Bacteria	6 hours	Cool, 4ºC
Ammonia	Process immediately	Can preserve with sulfuric acid and hold for 28 days
Fluoride	28 days (HDPE plastic container only)	Cool, 4ºC
Anionic Surfactants	2 days	Cool, 4ºC
Potassium	6 months	Frozen
Total nitrogen / Total phosphorus	24 hours 30 days	Cool, 4ºC Frozen below -20ºC
pH	Process immediately	
Temperature	Process immediately	

Measuring Flow Rate

Flow measurements should be collected at each flowing outfall. The methods to be used are listed in priority preference below.

1. **Volume-based** – a 1-liter container jug or 5-gallon bucket is filled and the time taken to fill it is recorded with a stopwatch. Flow rate is obtained by converting liters or gallons to cubic feet and then dividing the volume by time. If the flow is difficult to obtain, a "spout" can be molded from plumber's putty to direct the flow into the measuring container.
2. **Weir equation** – average depth of flow and wetted width are collected at the outfall and the results are input into the equation:

   Q in cubic feet per second = 3.1 x wetted width (feet) x depth (feet) ^ 1.5

   Note: This method should only be used with a free-flowing outfall (i.e. water drops out of the pipe and falls to the stream channel) and when the depth of flow is relatively uniform.
3. **Cross-sectional area** – the cross-sectional area of the water is obtained by collecting the wetted width and average depth of water and multiplying the results. Velocity is obtained by using a stopwatch to measure the time it takes for a ping pong ball or other buoyant object to flow

over a known distance. The velocity measurement is repeated 3-5 times and the results averaged. Flow is obtained by multiplying cross-sectional area by velocity.

Regular inspections of outfalls are a primary part of an effective IDDE program and a regular schedule of long-term inspections for outfalls should be maintained. The MS4 Permit requires a *prioritized schedule of field screening activities determined by the operator based on such criteria as age of the infrastructure, land use, historic illegal discharges, dumping, or cross connections* (Section II B 3 c 1 a). **If the MS4 has less than 50 outfalls, all should be screened on an annual basis. For communities with 50 or more outfalls, a minimum of 50 should be screened annually.**

Non-routine Inspections

If an employee observes evidence of an illicit discharge during an informal or non-routine inspection, he/she should collect as much information (including photos) about the potential illicit discharge as possible then contact his/her supervisor or dispatch office so that appropriate action can be taken. A tracking sheet or spreadsheet (example provided in **Table 3**) can be used to collect the information observed. While it may not be reasonable to expect all field employees to have copies of the form with them at all times, there are other ways to collect the information:

- The person observing the discharge can provide the information verbally to dispatch or the supervisor, who can then complete the Illicit Discharge Tracking Sheet;
- The person can log as much information as they can recall onto the form upon returning to the office; or
- A third party (such as a code enforcement officer) dedicated to inspecting and tracing illicit discharges can be sent to the location as soon as possible where the potential illicit discharge was observed to collect the necessary information directly on the form.

Table 3. Illicit Discharge Tracking Sheet

Date Illicit Discharge Observed & Reported:	**Report Initiated by: Phone, drop-in, contact information, etc.**	**Location of Discharge: If known – lat/long, stream address or outfall #, nearby landmark, etc.**	**Description of Discharge: E.g. – dumping, wash water suds, oil, etc.**	**Actions to be Taken: Who What, When and How…(what should be done)**	**Results & Follow-Up of Investigation: Outcome of Actions taken and any necessary follow-up (what was done)**	**Date Investigation Resolved or Closed:**

It is important to collect as much information as possible at the time of initial observation because of the likelihood that a discharge may be transitory or intermittent. Initial identification of the likely or potential sources of the discharge is also very important.

Potential outfall investigation scenarios include:

1. No discharge present, no evidence of previous illicit discharge – Action: record and proceed to next outfall.
2. No discharge present, evidence of previous illicit discharge – Action: schedule for re-investigation in **one month**.
3. Discharge present – Action: note apparent quality of discharge, take sample for chemical analysis if necessary and appropriate, begin source tracking phase.

Drainage Area and Storm Drain Investigations

An illicit discharge investigation is to be conducted if any of the following apply:

- The overall outfall characterization as determined by the ORI (**Appendix A**) is determined to be "suspect" or "obvious."
- On-site or lab water testing results in values that exceed established thresholds. General thresholds are indicated in **Table 4** and **Figure 18**. Each MS4 may refine these thresholds through local sample analysis as the program evolves. See **Figure 19** for an example of thresholds that were derived over time for the City of Baltimore, MD. The **Figure 19** flowchart also starts with Ammonia as the main screening indicator, and this is recommended, since Ammonia is a strong all-around indicator, meters are easy to use in the field or lab, and waste disposal is easier than for the detergents/surfactants test.
- If the outfall is determined to have "potential" illicit discharges based on completion of the ORI, the outfall should be re-visited **three** additional times during the permit cycle to determine if an intermittent discharge may be present. Ideally, **one** re-visit will occur on a different day of the week than the original visit and/or at a different time of day.

Table 4. Dry weather outfall screening water quality indicators

Screening Parameter	Potential Source	Threshold
Ammonia	Wastewater or Industrial	>0.2 mg/l
Fluoride	Tap Water	>0.25 mg/l
Detergents	Wastewater, Washwater or Industrial	>0.25 mg/l
Potassium	Wastewater or Industrial	>5-6 ppm

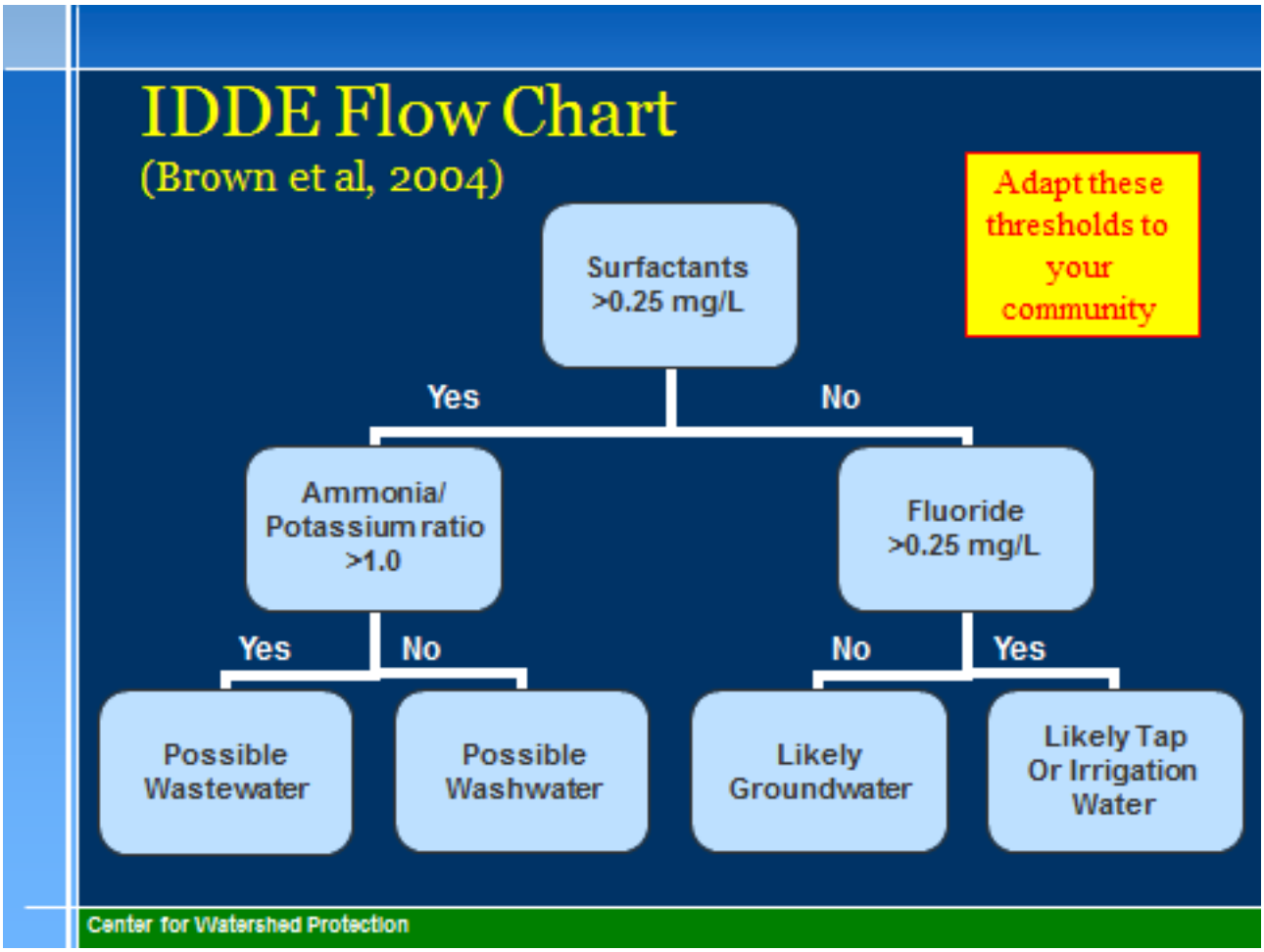


Figure 18. Flow chart method to determine if flow has an illicit discharge, based on thresholds for different parameters.

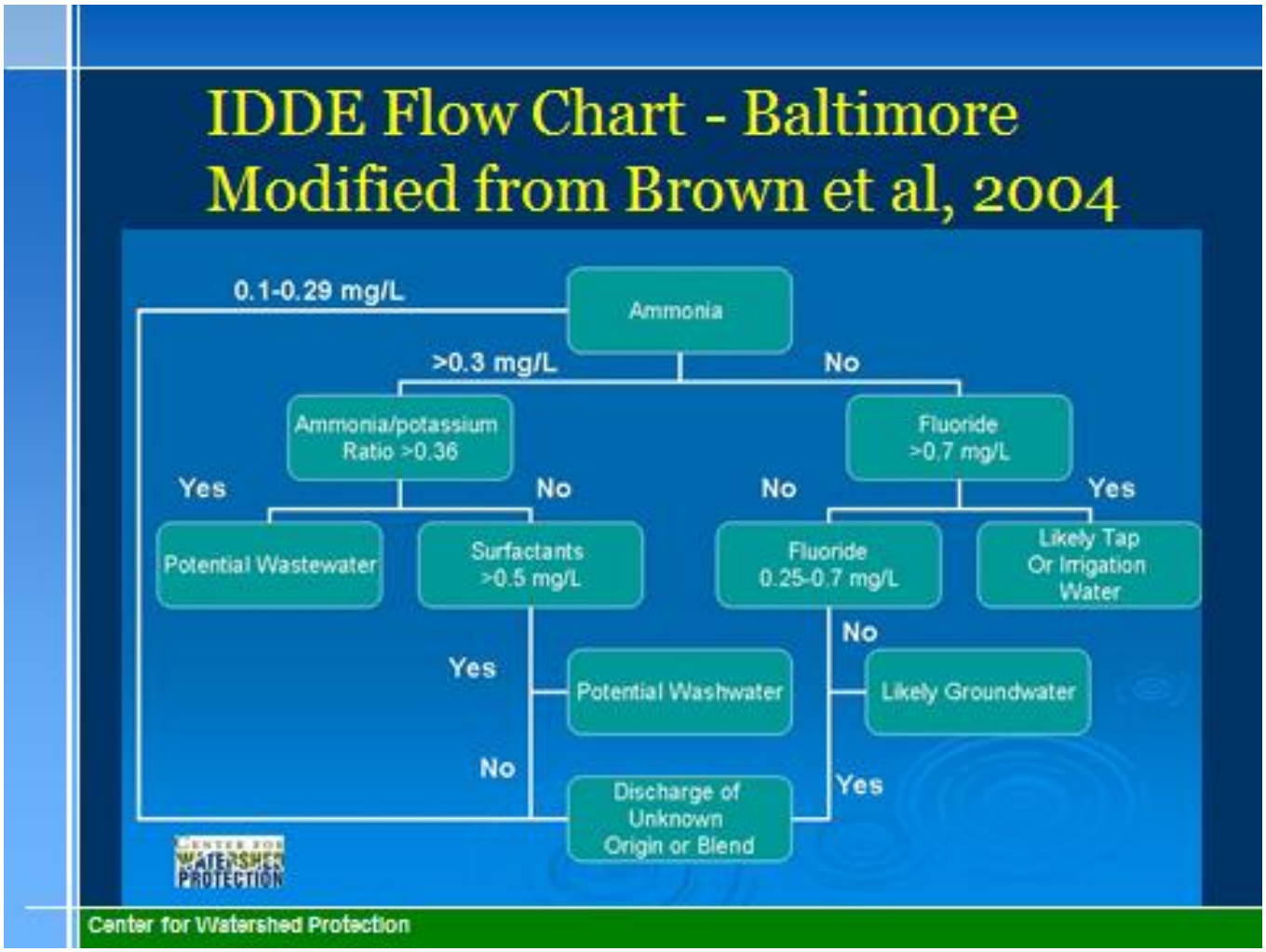


Figure 19. Flow chart method and thresholds adapted to conditions in City of Baltimore, MD.

If an illicit discharge is detected at an outfall, an investigation will be conducted to isolate the source of the discharge. **These investigations should commence within XX days of the initial identification of any observed continuous or intermittent potential illicit discharges.** Based on the MS4 Permit, potential illicit discharges from sewage or that are "significantly contaminated" must be investigated first (see severity ratings in **Section 4, Illicit Discharge Characteristics**). Potential illicit discharges that are deemed less hazardous to human health and safety (e.g., washwater) should be investigated, but as a secondary priority (Section II B 3 c 1 d).

The process for tracking a transient discharge (e.g., that enters the storm drain system directly through dumping or spills from the landscape) will follow the procedure for a *Drainage Area Investigation*. Tracking a continuous or intermittent discharge that likely occurs from direct or indirect entry into the storm drain system from the interaction of pipes underground will follow the procedure for a *Storm Drain Investigation*. Either investigation should be conducted during dry weather as described previously.

Public notification may be required in either type of investigation. If right of entry onto private property is required, the jurisdiction will **provide a letter/mailer to residents and property owners** located in the vicinity, notifying them of the scope and schedule of investigative work, and the potential need to gain access to their property to inspect plumbing fixtures.

Drainage Area Investigation

A survey by vehicle ("windshield survey") of the drainage area may be used to find the potential source of pollution if the discharge observed at an outfall has distinct or unique characteristics that allow crews to quickly ascertain the probable operation or business that is generating it (Brown et al, 2004). Discharges with a unique color, smell, or off-the-chart indicator sample reading may point to a specific industrial or commercial source. For example, if fuel is observed at an outfall, crews might quickly check every business operation in the drainage area that stores or dispenses fuel.

In larger or more complex drainage areas, GIS data can be analyzed to pinpoint the potential sources 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 that could be potential dischargers.

Storm Drain Investigation

Adequate storm and sanitary sewer mapping is a prerequisite to properly execute a storm drain investigation. As necessary and to the extent possible, infrastructure mapping should be verified in the field and corrected prior to investigations. This effort affords an opportunity to collect additional information such as latitude and longitude coordinates using a global position system (GPS) unit, if so desired. To facilitate subsequent investigations, tributary area delineations should be confirmed and junction manholes should be identified during this process.

Field crews strategically inspect manholes within the storm drain network system to measure chemical or physical indicators that can isolate discharges to a specific segment of the network. Once the pipe segment has been identified, on-site investigations are used to find the specific discharge or improper connection. This method involves progressive sampling at manholes in the storm drain network to narrow the discharge to an isolated pipe segment between two manholes. Field crews need to make two key decisions when conducting a storm drain network investigation—where to start sampling in the network and what indicators will be used to determine whether a manhole is considered "clean" or "dirty".

The field crew can sample the pipe network in one of three ways:

1. Crews can work progressively up the trunk from the outfall and test manholes along the way.
2. Crews can split the trunk into equal segments and test manholes at strategic junctions in the storm drain system.
3. Crews can work progressively down from the upper parts of the storm drain network toward the problem outfall.

During a manhole inspection, manholes are opened and inspected for visual evidence of contamination. Where **flow is observed**, and determined to be a potential illicit discharge through visual indicators and/or use of water testing equipment, the upstream tributary storm sewer system is isolated for investigation (e.g. further flow inspection, dye testing, CCTV). No additional downstream manhole inspections are performed unless the observed flow is determined to be uncontaminated or until all upstream illicit connections are identified and removed.

Where **flow is not observed, but an intermittent discharge is suspected, the MS4 Permit requires documentation of at least 3 separate investigations to observe the potential intermittent discharge, and proper documentation of those investigations** (Section II B 3 c 1 e).

Another method to locate and identify intermittent discharges attempts to contain the flow when it occurs. This method will likely require confined space entry procedures for entering junction manholes. All inlets to the structure should be partially dammed for 48 hours when no precipitation is forecasted. Inlets are damned by blocking a minimal percentage of the pipe diameter at the invert using sandbags, caulking, weirs/plates, or other temporary barriers. The manholes are thereafter re-inspected (prior to any precipitation or snow melt) for the capture of periodic or intermittent flows behind any of the inlet dams. The same visual observations and field testing is completed on any captured flow, and where contamination is identified, abatement is completed prior to inspecting downstream manholes.

Where flow is observed and does not demonstrate obvious indicators of contamination, samples are collected and analyzed and then compared with established benchmark values (see examples in **Table 4 and Figures 18 & 19**) to determine the likely source of the flow. This information facilitates the investigation of the upstream storm sewer system. Benchmark values may be refined over the course of investigations as the community develops a better sense of local threshold values for given indicators. In those manholes where periodic or intermittent flow is captured through damming inlets, additional laboratory testing (e.g. toxicity, metals, etc.) should be considered where an industrial discharge is suspected.

To facilitate investigations, storm drain infrastructure should possibly be cleaned to remove debris or blockages that could compromise investigations. Such material should be removed to the extent possible prior to investigations, however, some cleaning may occur concurrently as problems manifest themselves.

Isolation and confirmation of illicit sources
Where field monitoring has identified storm sewer systems to be influenced by sanitary flows or washwater, the tributary area is isolated for implementation of more detailed investigations.

Additional manholes along the tributary are inspected to refine the longitudinal location of potential contamination sources (e.g. individual or blocks of homes). Targeted internal plumbing inspections, dye testing, smoke testing or CCTV inspections are then employed to more efficiently confirm discrete flow sources. More information on these techniques can be found in Brown et al (2004), and as specified by local policies and legal authority (Section II B 3 c 1 f).

Per City/County Code, upon determination of the source, the City/County notifies the apparent responsible party that a violation of the stormwater ordinance exists. Voluntary compliance is the preferred response. If voluntary compliance cannot be achieved through negotiation, the program administrator may initiate formal enforcement action as specified in the local ordinance.

Post-Removal Confirmation (Section II B 3 c 1 g)
After completing the removal of illicit discharges from a subdrainage area, the subdrainage area is re-inspected to verify corrections. Depending on the extent and timing of corrections, verification monitoring can be done at the initial junction manhole or the closest downstream manhole to each correction. Verification is accomplished by using the same visual inspection, field monitoring, and damming techniques as described above.

Program Tracking, Reporting & Evaluation
The program must include a mechanism to track and document all investigations (Section II B 3 c 1 h). **Table 3** or similar spreadsheet, database, or MS4 tracking program can be used for this purpose. The permit also contains specific MS4 reporting elements (Section II B 3 f).

The MS4 may wish to track additional elements in order to evaluate the program and make efficiency improvements through time. Below is a list of possible tracking metrics:

- Number/% of manholes/structures inspected
- Number/% of outfalls screened
- Number/% of illicit discharges identified through:
    - visual inspections
    - field testing results
    - temporary damming (intermittent discharges)
- Number/% of homes inspected/dye tested
- Footage/% of pipe inspected by CCTV
- Number/% of illicit discharges removed
- Estimated flow/volume of illicit discharges removed
- Footage and location of infrastructure jetting/cleaning required
- Infrastructure defects identified and repaired
- Water main breaks identified and repaired
- Cost of illicit discharge removals (total, average unit costs)

References

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Appendix A:

Outfall Reconnaissance Inventory (ORI) Form

OUTFALL RECONNAISSANCE INVENTORY/ SAMPLE COLLECTION FIELD SHEET

Section 1: Background Data

Subwatershed:		Outfall ID:	
Today's date:		Time (Military):	
Investigators:		Form completed by:	
Air 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
☐ Ultra-Urban Residential
☐ Suburban Residential
☐ Commercial
☐ Open Space
☐ Institutional

Other: _____

Known Industries: _____

Notes (e.g., origin of outfall, if known, conveyance type):

Section 2: Outfall Description

LOCATION	MATERIAL		SHAPE		DIMENSIONS (IN.)	SUBMERGED
☐ **Closed Pipe**	☐ RCP ☐ PVC ☐ Steel ☐ Other: _____	☐ CMP ☐ HDPE	☐ Circular ☐ Elliptical ☐ Box ☐ Other: _____	☐ Single ☐ Double ☐ Triple ☐ Other: _____	Diameter, circular: _____ Dimensions, Box: h - _____ w - _____ Elliptical: h - _____ w - _____	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**	**Complete Stream Discharge form**					

Flow Present? ☐ **Yes** ☐ **No** *If No, Skip to Section 5* **Flow Description (If present)** ☐ **Trickle** ☐ **Moderate** ☐ **Substantial**

Section 3: Quantitative Characterization

FIELD DATA FOR FLOWING OUTFALLS				
PARAMETER		**RESULT**	**UNIT**	**EQUIPMENT**
☐Flow #1	Volume		Liter	Bottle
	Time to fill		Sec	Stopwatch
☐Flow #2	Flow depth	1. 2. 3. 4.	In	Tape measure
	Flow width	_____' _____"	Ft, In	Tape measure
	Measured length	_____' _____"	Ft, In	Tape measure
	Time of travel	1. 2. 3. 4.	S	Stop watch
Water Temperature			°F	Thermometer
Ammonia			mg/L	Ammonia photometer
Salinity		Dilution? %	ppm	Refractometer
Conductivity		Dilution? %	µs	Conductivity meter
pH			pH	pH meter
Potassium			ppm	Potassium ion meter
Fluoride			mg/L	Fluoride photometer
Detergents			ppm	Colorimeter

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 (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)

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:	

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? ☐ No	☐ Yes	☐ No	2.	Sterile sample for bacteria analysis?	☐ Yes	
3.	If yes, collected from: ☐ No	☐ Flow	☐ Pool	4.	Sample for optical brightener?	☐ Yes	
5.	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)?