Appendix C

MS4 Outfall Monitoring Procedures and Datasheet

Intentionally Left Blank

City of El Centro
Dry Weather MS4 Outfall Monitoring Field Datasheet

Visit Type: ☐ Field Screening ☐ Follow-Up for________________________			
Site ID:		Latitude:	
		Longitude:	
Location:		Date:	Observer(s):
		Time:	Photo #s:

Conveyance:
(select only one)

☐ Outlet ☐ Manhole ☐ Concrete Channel ☐ Natural Creek ☐ Earthen Channel ☐ Other

Atmospheric Conditions:
Last Rain ☐ < 72 hours but ≤ 0.1” ☐ > 72 hours

Flow

Water Flow: ☐ Flowing ☐ Ponded ☐ Dry Flow Rate:_______ gpm Flow reaches receiving water?: ☐ Yes ☐ No ☐ Unknown

Flowing Pipe

Diameter		ft
Depth		ft
Velocity		ft/sec

*Flow rate(gpm) = area(ft²)*velocity(ft/sec)*448.8*
*Area = Ta*diameter² (See tabulated values (Ta) chart)*

Filling a Bottle or Known Volume

Volume		mL
Time to Fill		sec

1 Liter/sec = 15.85 gpm

Velocity Area Method (Leaf Float)

Width		in
Depth		in
Velocity		ft/sec

*Flow rate(gpm) = width(ft)*depth(ft)*velocity(ft/sec)*448.8*
Use correction factor of 0.5 to 0.9 depending on conveyance surface roughness.

Observations

Odor	☐ None	☐ Sewage	☐ Sulfides	☐ Petroleum	☐ Manure	☐ Other	☐ na (dry)
Color	☐ None	☐ Yellow	☐ Brown	☐ White	☐ Gray	☐ Other	☐ na (dry)
Clarity	☐ Clear	☐ Cloudy (> 4” vis)	☐ Murky (< 4” vis)	☐ Other	☐ na (dry)		
Floatables	☐ None	☐ Trash	☐ Bubbles	☐ Foam	☐ Oily Sheen	☐ Other	☐ na (dry)
Deposits	☐ None	☐ Coarse Particulates	☐ Fine Particulates	☐ Stains	☐ Oily Deposits	☐ Other	
Structural Condition	☐ Normal	☐ Damaged	☐ Scour Pond	☐ Erosion	☐ Blockage	☐ Other (i.e., submerged)	

Trash Assessment

Rating: ☐ None ☐ Optimal ☐ Suboptimal ☐ Marginal ☐ Submarginal ☐Poor

Evidence of Illegal Dumping: ☐ Yes *(describe in comments)* ☐ No Potential Threat To: ☐ Human Health ☐ Aquatic Health

Comments: ____

____

Tests:

Temp (°C)		Cond. (mS/cm)		Hardness (mg/L CaCO3)		Color (unit)		Fluoride (mg/L)	
pH (pH units)		Turbidity (NTU)		Potassium (mg/L)		Ammonia (mg/L)		MBAS (mg/L)	

Analytical Lab Samples Collected? ☐ Yes ☐ No

Follow-Up Investigation (complete only for sites with exceedances)

Evidence of Obvious IC/ID: ☐ Odor ☐ Color ☐ Clarity ☐ Floatables ☐ High Flow ☐ Non-Standard Connection ☐ Other ________________ ☐ No

Flow Source: ☐ Groundwater ☐ Seepage ☐ Irrigation Runoff ☐ Vehicle Washing ☐ Wet Cleaning ☐ Construction ☐ Pool or Spa ☐ Water Line Break ☐ NPDES Permitted Discharge ☐ Other__________________ ☐ Unable to Determine

Basis for Source Identification: ☐ Observed Discharge ☐ Indirect Evidence ☐ Historical Data ☐ Other______________ ☐ na (Not Determined)

If Identified, Was Source Eliminated? *(If yes, describe in notes below)* ☐ Yes ☐ No

Source ID/Elimination Notes:

____

____

____

____

____

____

Table of Contents

Introduction to Illicit Discharge Detection and Elimination ....p. 2

Definitions....................p. 2

Federal requirements....................p. 4

Illicit Discharge Detection and Tracking Procedures....................p. 6

Overview....................p. 6

Desktop assessment of illicit discharge potential....................p. 6

Field screening of outfalls....................p. 10

Non-routine inspections....................p. 17

Drainage Area and Storm Drain Investigations....................p. 18

Post-Removal Confirmation....................p. 21

Safety Procedures....................p. 22

References Cited....................p. 24

ATTACHMENT A: ORI Form....................p. 25

ATTACHMENT B: Mapping the System....................p. 27

ATTACHMENT C: Outfall Reconnaissance Inventory/ Sample Collection Lab Sheet....................p. 29

Introduction to Illicit Discharge Detection & Elimination (IDDE)

An illicit discharge is "Any discharge to a municipal separate storm sewer that is not composed entirely of storm water, except discharges pursuant to a National Pollutant Discharge Elimination System (NPDES) permit and discharges resulting from fire-fighting activities." (NOTE: there are several types of NPDES permits and their intent is to authorize discharges provided permit requirements, such as effluent limits, are being met.)

These are two categories of illicit discharges, as follows:

- TRANSIENT – Short in duration, lasting only a short time and then disappearing.
    - Examples of *Direct* transient illicit discharges include:
        - A straight pipe from an unpermitted industrial facility that discharges washwater or process water; and
        - A floor drain that is connected to the storm sewer.
    - Examples of *Indirect* transient illicit discharges include:
        - Materials that have been dumped into a storm drain inlet or catch basin (Figure 1),
        - An old or damaged sanitary sewer line that is leaking fluids into groundwater that then seeps into a storm sewer line or drainage way, and
        - A failing septic system that is leaking into a cracked storm sewer line.
- 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,
    - A broken sanitary line (Figure 2), and
    - An industrial operational discharge that doesn't meet permit requirements.

Illicit discharges are considered "illicit" because storm sewer systems, unlike sanitary sewer systems, are not designed to accept, treat, or discharge non-storm water wastes.

Figure 1. Indirect, transient discharge: concrete slurry discharges from storm drain outfall to stream.

Figure 2. Direct, continuous discharge: broken sanitary line.

Federal requirements

Established in 1972 and amended in 1977 and 1987, the Clean Water Act (CWA) is the primary federal law governing water pollution. The Act requires states to set clean water standards to protect uses such as swimming, fishing, and drinking, and for the regulation of pollution discharges. The CWA initially focused on addressing water quality issues caused by point sources of pollution (e.g., wastewater treatment plants and industry) by making it unlawful to discharge any pollutant into navigable waters, unless a permit was obtained under its provisions. These permits, known as National Pollutant Discharge Elimination System (NPDES) permits, prevent the degradation of water quality by limiting pollution discharges to what can be safely assimilated by the environment. In 1987, the CWA was expanded to include non-point sources of urban pollution by requiring municipalities with separate storm sewer systems (referred to as "MS4s") to be permitted. Phase I of these permits, issued in 1990, requires medium and large cities or certain counties with populations of 100,000 or more to obtain NPDES permit coverage for their stormwater discharges. Phase II, issued in 1999, requires regulated small MS4s in urbanized areas, as well as small MS4s outside the urbanized areas that are designated by the permitting authority, to obtain NPDES permit coverage for their stormwater discharges. Generally, Phase I MS4s are covered by individual permits and Phase II MS4s are covered by a general permit. Each regulated MS4 is required to develop and implement a stormwater management program to reduce the contamination of stormwater runoff and prohibit illicit discharges.

What is required?

Recognizing the adverse effects illicit discharges can have on receiving waters, the Phase II Final Rule requires an operator of a regulated small MS4 to develop, implement and enforce an illicit discharge detection and elimination (IDDE) program, which is one of six minimum measures required under the Phase II stormwater program. The IDDE program must include the following:

- A storm sewer system map, showing the location of all outfalls and the names and location of all waters of the United States that receive discharges from those outfalls;
- Through an ordinance, or other regulatory mechanism, a prohibition (to the extent allowable under State, Tribal, or local law) on illicit discharges into the MS4, and appropriate enforcement procedures and actions;
- A plan to detect and address illicit discharges, including illegal dumping, into the MS4;
- The education of public employees, businesses, and the general public about the hazards associated with illegal discharges and improper disposal of waste; and
- The determination of appropriate best management practices (BMPs) and measurable goals for this minimum control measure.

This document provides guidance on procedures for detecting and tracking illicit discharges through a desktop assessment of illicit discharge potential, field screening of outfalls to detect illicit discharges and drainage area investigations to locate and remove the source of the discharge.

For more information…

- EPA's Best Management Practices (BMPs) and Resources for IDDE: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=3
- Brown, E., Caraco, D., and Pitt, R. 2004. *Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessment*. Center for Watershed Protection and University of Alabama. EPA X-82907801-0.U.S. EPA Office of Wastewater Management, Washington, D.C. Available at: http://cfpub.epa.gov/npdes/docs.cfm?program_id=6&view=allprog&sort=name#iddemanual

Illicit Discharge Detection and Tracking Procedures

Overview

This document outlines a common framework through which communities can develop a comprehensive plan to identify and eliminate dry weather illicit discharges to their separate storm sewer systems. The primary steps to identify illicit discharges and track their sources include: 1) conduct a desktop assessment of illicit discharge potential to identify priority locations for screening, 2) conduct field screening of outfalls in priority subwatersheds, and 3) conduct drainage area and storm drain investigations to identify the source(s) of all confirmed illicit discharges. Protocols for each step are described below. Further detail is provided in Brown et al. (2004).

Desktop assessment of illicit discharge potential

A desktop assessment of illicit discharge potential (IDP) uses mapping and other available data to determine the potential severity of illicit discharges within a community, and identifies which subwatersheds or generating land uses merit priority investigation. This assessment, recommended by Brown et al. (2004) provides insight on how to narrow your illicit discharge search, and is helpful when designing a discharge tracking system to best suit your needs. The desktop assessment draws on existing background data and anecdotal information to initially characterize IDP at the subwatershed level. Subwatersheds are then screened based on their composite score, and are designated as having a low, medium or high risk:

- Low – no known illicit discharge problems in the subwatershed.
- Medium– problems are confined to a few stream reaches, outfalls or specific generating sites in the subwatershed.
- High – Problems are suspected to be severe throughout the subwatershed.

The recommended scale for desktop assessments is the subwatershed or sewershed, which typically range from two to 10 square miles in area. Next, mapping, monitoring and other data are analyzed to identify subwatersheds with the greatest potential to contribute illicit discharges. The analysis can encompass up to 10 different screening factors. The desktop assessment consists of five basic steps:

Step 1: Delineate subwatersheds – This step may already be completed. If not, hydrologic, infrastructure and topographic map layers are needed to delineate the boundaries. Guidance on the techniques for accurately delineating subwatershed boundaries can be found in United States Geological Survey 2009 Federal Guidelines, Requirements, and Procedures for the National Watershed Boundary Dataset: ftp://ftp-fc.sc.egov.usda.gov/NCGC/products/watershed/hu-standards.pdf. The use of digital elevation models (DEMs) and GIS can also make subwatershed delineation an easier and faster, automated process.

Step 2: Compile mapping layers and subwatershed data – This step is best accomplished with the use of Geographic Information System (GIS). If GIS is not available, consider the use of Google Maps or other free mapping software. A list of suggested data can be found in Table 1 (from Brown et al. 2004).

Table 1: Useful Data for the Desktop Assessment of Illicit Discharge Potential

	Data	Likely Format
Recommended	Aerial photos or orthophotos	Digital map
	Subwatershed or catchment boundaries	Digital or hardcopy map
	Hydrology including piped streams	Digital or hardcopy map
	Land use or zoning	Digital or hardcopy map
	NPDES storm water permittees	Digital data or map
	Outfalls	Digital or hardcopy map
	Sewer system, 1" = 200' scale or better	Digital or hardcopy map
	Standard Industrial Classification codes for all industries	Digital or hardcopy data
	Storm drain system, 1" = 200' scale or better	Digital or hardcopy map
	Street map or equivalent GIS layers	Digital or hardcopy map
	Topography (5 foot contours or better)	Digital or hardcopy map
Optional	Age of development	Narrative data
	As-builts or construction drawings	Hardcopy map
	Condition of infrastructure	Narrative data
	Field inspection records	Hardcopy or digital data
	Depth to water table and groundwater quality	Digital data or maps
	Historical industrial uses or landfills	Narrative data or hardcopy map
	Known locations of illicit discharges (current and past)	Narrative data or digital map
	Outfall and stream monitoring data	Digital data
	Parcel boundaries	Digital or hardcopy map
	Pollution complaints	Narrative data
	Pre-development hydrology	Narrative data or hardcopy map
	Sanitary sewer Infiltration and Inflow (I/I) surveys	Hardcopy or digital data
	Septic tank locations or area served by septic systems	Hardcopy or digital map
	Sewer system evaluation surveys	Hardcopy or digital data
	Thermal imaging data	Digital data

Step 3: Compute discharge screening factors – Potential discharge screening factors are illustrated in Table 2.

Step 4: Screen for illicit discharge potential at the subwatershed and community level - Select the group of screening factors that apply most to your community, and assign them a relative weight. Next, points are assigned for each subwatershed based on defined scoring criteria for each screening factor. The total subwatershed score for all of the screening factors is then used to designate whether it has a low, medium or high risk to produce illicit discharges (Figure 3).

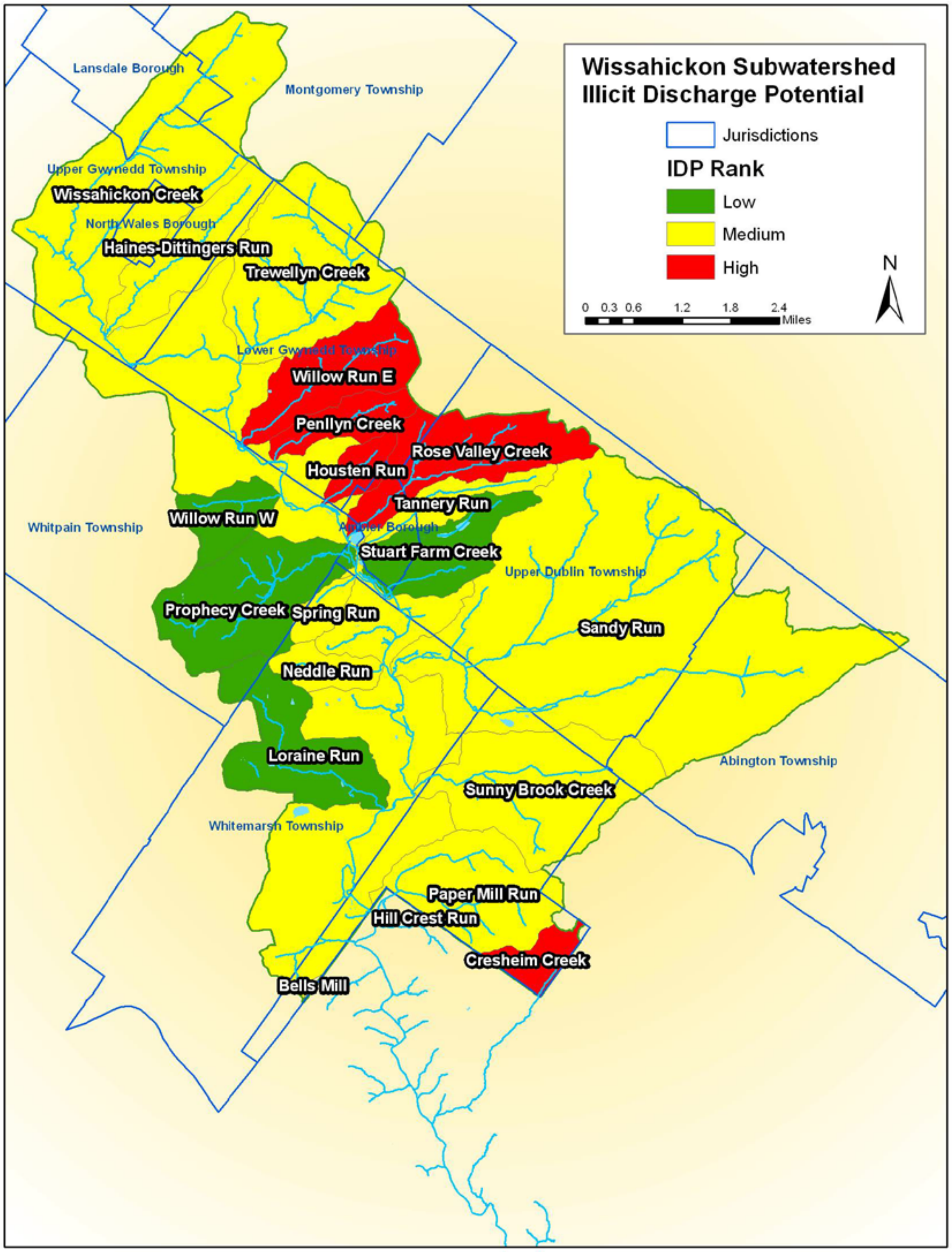

Figure 3. Illicit discharge potential analysis of the Wissahickon watershed in southeastern Pennsylvania.

Table 2: Defining Discharge Screening Factors in a Community	
Discharge Screening Factors	**Defining and Deriving the Factor**
1. Past Discharge Complaints and Reports	Frequency of past discharge complaints, hotline reports, and spill responses per subwatershed. Any subwatershed with a history of discharge complaints should automatically be designated as having high IDP.
2. Poor Dry Weather Water Quality	Frequency that *individual* samples of dry weather water quality exceed benchmark values for bacteria, nutrients, conductivity or other predetermined indicators. High risk if two or more exceedances are found in any given year.
3. Density of Generating Sites or Industrial NPDES Storm Water Permits	Density of more than 10 generating sites or five industrial NPDES storm water sites per square mile indicates high IDP. Density determined by screening business or permit databases.
4. Storm Water Outfall Density	Density of mapped storm water outfalls in the subwatershed, expressed as the average number per stream or channel mile. A density of more than 20 outfalls per stream mile indicates high IDP.
5. Age of Subwatershed Development	Defined as the average age of the majority of development in a subwatershed. High IDP is often indicated for developments older than 50 years. Determined from tax maps and parcel data, or from other known information about neighborhoods.
6. Sewer Conversion	Subwatersheds that had septic systems but have been connected to the sanitary sewer system in the last 30 years have high IDP.
7. Historic Combined Sewer Systems	Subwatersheds that were once served by combined sewer system but were subsequently separated have a high IDP.
8. Presence of Older Industrial Operations	Subwatersheds with more than 5% of its area in industrial sites that are more than 40 years old are considered to have high IDP. Determined from historic zoning, tax maps, and "old-timers."
9. Aging or Failing Sewer Infrastructure	Defined as the age and condition of the subwatershed sewer network. High IDP is indicated when the sewer age exceeds design life of its construction materials (e.g., 50 years) or when clusters of pipe breaks, spills, overflows or I/I are reported by sewer authorities.
10. Density of Aging Septic Systems	Subwatersheds with a density of more than 100 older drain fields per square mile are considered to have high IDP. Determined from analysis of lot size outside of sewer service boundaries.

Table 2: Defining Discharge Screening Factors in a Community	
Discharge Screening Factors	**Defining and Deriving the Factor**
11. Thermal Anomalies	Thermal imaging data records images of heat radiating from the Earth's surface by aircraft equipped with an infrared video camera, which is similar to the technology used in night vision aids. Ground and stream surfaces tend to have fairly constant temperatures, so lighter (warmer) areas are readily identified as "thermal anomalies. Some of these anomalies may represent problems with the sewer system or sources of water pollution, but others may be caused by natural conditions, such as groundwater discharge. Subwatersheds with thermal anomalies can be considered to have higher IDP than those without them.

Step 5: Generate maps to support field investigations - Create relatively simple maps that show streams, channels, streets, landmarks, property boundaries and known outfall locations. Provide enough information so crews can find their way in the field without getting lost, but otherwise keep them uncluttered. Low altitude aerial photos are also a handy resource when available.

Consult Brown et al. (2004) for more detail on the desktop assessment.

Field screening of outfalls

Illicit discharges can be detected in several ways: citizen complaints, during regular outfall screening and during other routine activities conducted by staff. This section describes a protocol to be used during regular outfall screening, although sampling procedures to be followed at the outfall do not differ greatly based on the type of detection. Adapted 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 tidal 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 under Minimum Control Measure No. 3, illicit discharge detection & elimination (IDDE), of a community’s NPDES MS4 Permit.

Rapid field screening of stormwater outfalls in priority subwatersheds is conducted during dry weather to identify potential illicit discharges (i.e., flowing outfalls) and is followed by indicator monitoring to characterize flow types to aid in finding sources. Table 3 lists the common indicator parameters used to detect illicit discharges. The field screening can also be used to develop a systematic outfall inventory and map of the MS4. 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. At a minimum, all outfalls should be inspected during the first NPDES permit cycle by walking entire stream reaches. Further inspections should be conducted during subsequent permit cycles.

Table 3. Recommended Indicator Parameters Used to Detect Illicit Discharges

Parameter	Discharge Types it can Detect				Laboratory/Analytical Challenges
	Sewage	Washwater	Tap Water	Industrial or Commercial Liquid Wastes	
Ammonia	●	⦿	○	⦿	Can change into other nitrogen forms as flow travels to the outfall
Detergents – Surfactants	●	●	○	⦿	Reagent is a hazardous waste
E. coli, Enterococci, or Total Coliform	⦿	○	○	○	24-hour wait for results
Fluoride*	○	○	●	⦿	Exception for communities that do not fluoridate their tap water
Potassium	⦿	○	○	●	

● Can almost always (>80% of samples) distinguish this discharge from clean flow types (e.g., tap water or natural water). For tap water, can distinguish from natural water.

⦿ Can sometimes (>50% of samples) distinguish this discharge from clean flow types depending on regional characteristics, or can be helpful in combination with another parameter

○ Poor indicator. Cannot reliably detect illicit discharges, or cannot detect tap water

Data sources: Brown et al. (2004)

*Fluoride is a poor indicator when used as a single parameter, but when combined with additional parameters (such as detergents, ammonia and potassium), it can almost always distinguish between sewage and washwater.

Field Preparation

While a complete overview of field preparation for outfall screening can be found in Brown et al. (2004), some basic checklists for field preparation are provided below for convenience.

When to conduct an outfall survey?

- During the dry season (in regions with a clearly defined dry season)
- Late Fall/Early Spring- outfalls are easiest to spot during leaf-off conditions (especially in the southeast where excessive vegetation can limit access to outfalls); however, if part of the IDDE work is investigating swimming pool discharges it may require field work outside of the leaf-off time frame.
- After a dry period of **at least 48 hours** (trace rainfall activity may be acceptable depending on the size of the watershed).
- Early Morning/Late Afternoon- though not always possible, checking outfalls when people are home may increase the chances of catching an illicit connection.
- Avoid conditions during snow melt and/or if salt has been applied to the road system draining to the outfalls. Also note that some field tests (e.g. ammonia, chlorine) are affected by cold temperatures or confounded by the presence of salt (detergents).
- If outfall monitoring is occurring along a tidal body of water, data collection dates and times should be selected to take advantage of the lowest possible tide, this will allow for the easiest, safest and most accurate and complete assessment of outfalls.

The first step to successful field work is to have a map with the necessary information. Some data can be considered extremely helpful, but optional, while other data is required (Table 4). Maps should be provided in the field binders on 8.5 X 11 paper at a scale ranging from 1:1000 to 1:10000 (Figure 4).

Table 4: Map Preparation

Desired Data Layers	*Optional Data Layers*
Roads	Aerial Photography
Streams	Sewer infrastructure
Watershed Boundaries	Critical/ Resource Protection Areas
Outfall locations	Land Cover
Manhole Locations	Topography
Stormwater infrastructure	Current / former combined sewer pipes/outfalls
Jurisdictional Boundaries	

Figure 4. Example field map at 1:6,000 scale.

A field and lab supply list is provided in Table 5.

Table 5: Suggested Supply List	
Field	***Lab***
Field Binder with maps	Detergent test kits
Camera	Fluoride meter + reagents
GPS Unit	Potassium meter + standards
Measuring tape	Bacteria plates
Outfall marker	Incubator
Field Tape (50' min)	Sterile 1-ml pipettes
Stopwatch	Alconox or other cleaning solution
Ping-pong ball	Deionized water
Flashlight	Stopwatch
Graduated milk jug (marked at 1 L)	Gloves
Gloves	Filter

Table 5: Suggested Supply List	
Field	***Lab***
Dipper and/or telescoping rod	Filter paper
Pencils/Pens	Material Data Safety Sheets
Sharpies	
First Aid Kit	
Deionized Water	
Sterile sample bottles*	
Cooler and ice packs	
Nalgene bottles*	
Ammonia meter + reagents	
Chemwipes	
Ziploc Bags	
Waders	
*1 bottle each/site plus extra for duplicates	

A checklist of items to include in the Field Binders is provided below:

- ☐ Contact Numbers for Field Crews (i.e. cell phone number)
- ☐ Meeting Location/Address
- ☐ Safety Procedures and Emergency Numbers
- ☐ Location of Nearest Hospital
- ☐ Field Maps
- ☐ Chain-of Custody Form
- ☐ Outfall Reconnaissance Inventory Forms (see Appendix A)

Preparation of supplies should include the following:

☐ Ensure batteries in cameras, GPS units, meters, etc. are charged.

☐ Ensure all sample bottles are cleaned with Alcanox or similar cleaning product.

☐ Remove old labels from sample bottles and replace with new labels, if necessary.

☐ Ensure you have one bottle for each anticipated outfall as well as extra bottles for randomly selected replicates, if needed.

☐ Freeze all ice packs.

☐ Set temperature of incubator to that specified by manufacturer for bacterium of interest.

Outfall screening procedures

The primary field screening tool is the Outfall Reconnaissance Inventory (ORI) form, which is provided in Appendix A and described fully in Brown et al. (2004). The basic procedure at each outfall is to take a picture of the outfall and, if the outfall is not already in the jurisdiction's mapping system, collect GPS coordinates and label the outfall with spray paint or waterproof marking stick in a prominent location such as the outfall headwall (see Appendix B for more information on mapping a stormwater drainage system). Next, an ORI form is completed, which includes recording a description of the outfall (e.g., pipe material, diameter), a description of physical indicators of potential illicit discharges for both flowing and non-flowing outfalls and the results of flow and water quality measurements taken at flowing outfalls. A description of the flow measurement and sampling procedures is provided below.

If the outfall has dry weather flow, three samples should be collected: one for on-site analysis of ammonia; one for bacteria, fluoride, potassium and detergents; and one for total nitrogen and total phosphorus. The procedure for collecting a water sample is as follows:

1. Put on gloves;
2. When possible, sample the flow directly in a clean, glass bottle or sterilized plastic bottle or bag;
3. Be sure to rinse the bottle once with flow from the sample water for conditioning;
4. If a dipper, bailer, bucket or other device is used to collect a sample, be sure that they are conditioned with the flow prior to final collection as well;
5. Sample bottles are to be labeled with the appropriate outfall ID, date of collection, and sample collector initials using a water-proof marker;
6. Collect replicates as specified for local program, if needed; and
7. Put samples for lab in cooler with ice.

Next, conduct the ammonia test following the instructions provided by the manufacturer of the test kit. Record the results on the ORI from. Be sure to rinse probes/cuvets with distilled water after sample analysis.

Lastly, measure the flow rate at all flowing outfalls. Flow measurements can be difficult to accurately collect in certain situations, for example, when the flow is too large or too little to collect with the chosen container. As such, three methods are presented and are listed in priority preference:

Method 1**:** Utilizing a graduated milk jug marked at 1 Liter and a stopwatch record the amount of time required to fill the jug to 1 Liter. Ensure you are capturing the entire flow. When the flow is only a trickle, use a smaller volume container and follow the same method. The following equation is used to calculate flow: **Discharge = Volume filled (cu. ft.) x Time (sec).** For pipes that are discharging larger volumes where it is not be possible to capture the volume in a graduated container, see Method 2.

Method 2: 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. Utilizing a tape measure, record the flow depth in the pipe at the deepest point (thalweg) and the total flow width. Then use the following equation: **Discharge= 3.1 x wetted width (ft) x flow depth (ft) ^1.5**

Method 3: Using a tape measure record the width of the flow. Next measure and record the depth of the flow. Using a measuring tape, ping pong ball, and stop watch, record the length of time it takes to travel a known distance and. Repeat velocity measurement 3-5 times and average the results. Then use the following equations to calculate the flow rate and record the results on the ORI form:

Area= Wetted width (ft) x flow depth (ft)

Velocity= Length of ping pong ball run (ft) / Time (sec)

Discharge= Area x Velocity

All samples collected for external lab analysis should be preserved as specified by the lab for the parameter of interest. See Standard Methods for the Examination of Water and Wastewater for more information about sample collection and sample preservation: http://www.standardmethods.org/. Bacteria samples are to be processed within 6 hours of collection and incubated at the appropriate temperature and for the necessary length of time as indicated by the bacteria plate manufacturer. Results of additional field and/or lab analysis can be recorded on the Outfall Reconnaissance Inventory/ Sample Collection Lab Sheet (Appendix C).

Follow up

All outfalls with a confirmed illicit discharge will require a drainage area investigation as described in the next section. If the outfall is determined to have a potential illicit discharge based on physical indicators, but samples do not exceed established water quality thresholds, the outfall should be re-visited two 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.

Nitrogen, phosphorus and bacteria pollutant loads can be estimated for each outfall screened through an illicit discharge program. By doing so, the quantitative benefit of removing the illicit discharge can be tracked internally and reported to regulating authorities and the public. Pollutant reductions can be accounted for in MS4 program reports as well as for Total Maximum Daily Load (TMDL) implementation and tracking. By conducting routine outfall screening on a watershed scale in concert with instream monitoring for the same parameters, inferences can be made regarding the illicit discharge pollution load proportional to baseflow conditions.

A pollutant load accounting spreadsheet is provided at www.cwp.org for use in estimating loads from illicit discharges. Total nitrogen and total phosphorus concentrations are required inputs, along with an accurate flow measurement. Standard conversions are used to report results in pounds of nutrients per year and gallons per year. Similar calculations can be computed for bacteria, although these are not included in the spreadsheet.

New outfalls and unmapped stormwater infrastructure should be updated in the jurisdiction's master GIS system as soon as possible at the office after identification. Stormwater pipe mapping should note the direction of flow in addition to pipe location. Any illegal dumping or needed infrastructure repairs found in the field should be reported immediately to the appropriate agency.

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 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 (Table 6) can be used to collect the information observed. While it may not be reasonable to expect all public works employees to have copies of the form 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.

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.

Table 6. Illicit Discharge Tracking Sheet						
Date 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)	**Description of Resolution:** Outcome of Actions taken and any necessary follow-up (what was done)	**Date Resolved:**

Drainage Area and Storm Drain Investigations

An illicit discharge source investigation should be conducted for all outfalls where any of the following apply:

- The overall outfall characterization as determined by the ORI is determined to be "suspect" or "obvious" as indicated in Section 6 of the ORI.
- On-site or lab analysis results in values that exceed established thresholds indicated in Table 2. Thresholds can be adjusted as needed to reflect local conditions.
- A "weight-of-evidence" approach is recommended, that is, using more than one indicator to determine the presence of an illicit discharge.

Table 2. Threshold levels for screening parameters used in illicit discharge surveys		
Parameter	**Threshold**	**Source**
Ammonia	>0.1 mg/L	Brown et al (2004)
E. coli	>235 CFU/100 ml (grab sample)	EPA (1986)
Total coliform	>10,000 CFU/100 ml (grab sample)	California state standard (Dorfman and Rosselot, 2011)
Fluoride	>0.25 mg/L	Brown et al (2004)
Detergents	>0.25 mg/L	Brown et al (2004)
Potassium	>6 ppm	Guidance extrapolated from Lilly and Sturm (2010)

Table 2. Threshold levels for screening parameters used in illicit discharge surveys		
Parameter	**Threshold**	**Source**
Ammonia : potassium ratio	Determine locally	>0.3 based on CWP field studies in the Mid-Atlantic but the ratio varies regionally. Guidance extrapolated from Lilly and Sturm (2010)

An illicit discharge source investigation is conducted to isolate the source of the pollution. There are two types of source investigations: Drainage Area Investigations and Storm Drain Investigations. An illicit discharge that is determined to be likely transient in frequency, entering the storm drain system directly through dumping or spills from the landscape will follow the procedure for a *Drainage Area Investigation*. 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.

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 building owners located within subject drainage basin and/or sewershed notifying them of the scope and schedule of investigative work, and the potential need to gain access to their property to inspect plumbing fixtures. Assessor's records will provide property owner identification.

Drainage Area Investigation

A rapid windshield survey of the drainage area may be used to find the potential discharger or generating sites 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.

A rapid drive-by survey works well in small drainage areas, particularly if field crews are already familiar with its business operations. Field crews can match the characteristics of the discharge to the most likely type of generating site, and then inspect all of the sites of the same type within the drainage area until the culprit is found. For example, if fuel is observed at an outfall, crews might quickly check every business operation in the catchment that stores or dispenses fuel.

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 Standard Industrial Classification (SIC) code data are available digitally, GIS can be used to pull up specific hotspot operations or generating sites that could be potential dischargers.

Storm Drain Investigation

In a Storm Drain Investigation, 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:

- Crews can work progressively up the trunk from the outfall and test manholes along the way.
- Crews can split the trunk into equal segments and test manholes at strategic junctions in the storm drain system.
- 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 contaminated through visual indicators or field monitoring, 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** in a junction manhole, all inlets to the structure are partially dammed for the next 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. In addition to documenting investigative efforts in written and photographic form, it is recommended that information and observations regarding the construction, condition, and operation of the structures also be compiled.

Where flow is observed and does not demonstrate obvious indicators of contamination, samples are collected and analyzed and then compared with established benchmark values to determine the likely prominent 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 when compared with the actual incidences of observed flow sources. 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.

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.

To facilitate investigations, storm drain infrastructure should be evaluated for the need to 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.

Where field monitoring has identified storm sewer systems to be influenced by sanitary flows or washwaters, 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).

Post-Removal Confirmation

As the sources of illicit discharges are confirmed, measures to correct them must be taken, working with the property owner or other responsible party. The exact type of repair needed will depend on the type of discharge and mode of transmission. Additional guidance on eliminating illicit discharges is provided in Brown et al. (2004).

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.

In addition to verifying removal of individual illicit discharges, the progress of the IDDE program should be evaluated by tracking metrics such as:

- Number or % of manholes/structures inspected
- Number or % of outfalls screened
- Number or % of illicit discharges identified through:
    - visual inspections
    - field testing results
    - temporary damming
- Number or % of homes inspected/dye tested
- Footage or % of pipe inspected by CCTV

- Number or % 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)

Safety Procedures

The field activities described in this guide involve sampling of potentially contaminated water and, as such, have some associated risk. As with any field procedures, appropriate precautions should be taken to ensure the safety of field crews. General and specific suggested safety procedures are provided below.

General suggestions

- While performing field work activities, use appropriate caution, make an effort to recognize potentially dangerous situations while performing field work, and take the proper steps to avoid or minimize them.
- Field work activities should not be performed alone.
- A list of team member and emergency contact numbers should be kept with each field team.
- Long pants and close-toed shoes are strongly recommended.
- Carry adequate water, sunscreen, and bug repellent if needed.
- Employees should use their judgment to ensure their safety while working during inclement weather. It may be necessary to suspend and/or reschedule field work if the weather will not permit safe and effective completion of the activities. Recommended precautions include:
    - Severe heat or cold: Dress appropriately, take breaks as needed to warm up or cool down, and stay hydrated.
    - Thunderstorms: Stop working, get out of the water, if applicable, and take shelter if there is a threat of lightning strikes.
    - Snowstorms, flooding, tornadoes, and other dangerous weather: Field work should be stopped or canceled if dangerous weather arises or is predicted.

- Each field work team should have a functioning mobile phone and a fully-stocked first aid kit.

Public roadways

- Whenever work will be performed in or near a public roadway, wear a high-visibility safety vest.

Manholes and similar structures

If a manhole cover or similar structure must be removed (in order to determine sewer line configuration, for example):

- Safety-toe footwear (steel-toed shoes) should be worn.
- Lifting manhole covers should be done with the proper tools and technique so as to avoid injury.
- The open cover should only remain open as long as necessary to gather the required information, and should never be left unattended.
- Due to the potential dangers of confined spaces, do not enter a manhole or put your head below the rim of the opening.

Stream walks and illicit discharges

- Properly fitting waders with high-traction soles should be worn when walking in a stream.
- Rubber gloves should be worn if contact with polluted water is expected.
- Skin contact with suspected illicit discharges should be avoided.
- Hand sanitizer and/or careful hand washing should be employed after potential contact with polluted water.
- High-visibility orange or yellow vests should be worn during hunting season.
- Wear safety goggles when performing any chemical tests.
- Reagents and other chemicals should be used and disposed of properly by following the guidance on the MSDS safety sheets.

References Cited

Boston Water & Sewer Commission. 2004. *A systematic Methodology for the Identification and Remediation of Illegal Connections.* 2003 Stormwater Management Report, chap. 2.1.

Brown, E., D. Caraco and R. Pitt. 2004. *Illicit Discharge Detection and Elimination: a guidance manual for program development and technical assessments*. Center for Watershed Protection and University of Alabama. EPA X-82907801-0.U.S. EPA Office of Wastewater Management, Washington, D.C.

Dorfman, Mark & Kirsten Sinclair Rosselot. 2011. Testing the Waters: A Guide to Water Quality at Vacation Beaches. Natural Resources Defense Council. http://www.nrdc.org/water/oceans/ttw/titinx.asp

Environmental Protection Agency. 1986. Ambient Water Quality Criteria for Bacteria. EPA440/5-84-002.

Lilly, Lori and Paul Sturm. 2010. *Technical Memorandum: Illicit Discharge Monitoring in Baltimore Watersheds*. Center for Watershed Protection. Ellicott City, MD.

APPENDIX A. OUTFALL RECONAISSANCE 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:	
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 ☐ Commercial ☐ Open Space ☐ Suburban Residential ☐ Institutional

Other: ____________________ Known Industries: ____________________

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

Section 2: Outfall Description

LOCATION	MATERIAL		SHAPE		DIMENSIONS (IN.)	SUBMERGED
☐ Closed Pipe ☐ Manhole	☐ RCP ☐ PVC ☐ Steel ☐ Other: ______	☐ CMP ☐ HDPE	☐ Circular ☐ Elliptical ☐ Box ☐ Other: ____	☐ Single ☐ Double ☐ Triple ☐ Other: ____	Diameter, circular: ____ Box: h - ____ w - ____ Elliptical: h - ____ w - ____	In Water: ☐ No ☐ Partially* ☐ Fully* With Sediment: ☐ No ☐ Partially ☐ Fully
☐ Open drainage	☐ Concrete ☐ Other: ______	☐ rip-rap ☐ Earthen	☐ 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** ☐ Trickle	☐ Moderate	☐ Substantial
***Tidal?**	☐ Yes	☐ No	If yes, *stage*	☐ **Flood** ☐ **Ebb**	**Time:**	

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		In	Tape measure
(only for free-flowing outfalls)	Wetted width		ft	Tape measure
☐Flow #3	Flow width	______' ______"	Ft, In	Tape measure
	Flow depth		In	Tape measure
	Time of travel (avg)	1.______2. ______3.______	Sec	Stop watch
	Measured length	______' ______"	Ft, In	Tape measure
Ammonia			mg/L	Specific ion probe Type:

Illicit Discharge Detection and Elimination

Outfall Reconnaissance Inventory Field Sheet

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 external lab?	☐ Yes	☐ No	2. Sample for CWP?	☐ Yes	☐ No	3. Sterile sample for bacteria analysis?	☐ Yes ☐ No
4. Sample(s) collected from:	☐ Flow	☐ Pool					
5. Duplicate collected?	☐ Yes	☐ No	*If yes, check appropriate:*	☐ External lab	☐ CWP	☐ Sterile	

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

Center f

APPENDIX B. MAPPING THE SYSTEM

This section was modified from the New Hampshire Estuaries Project, November, 2006 "*Guidelines and Standard Operating Procedures: Illicit Discharge Detection & Elimination and Pollution Prevention / Good Housekeeping.*" Pp. 17-18.

Completing a map of the storm drain system is best accomplished through the use of geographic information systems (GIS).

A sample strategy for mapping an MS4 community is as follows:

1. Review/Office Preparation:

   a. Check existing available mapping data in high priority areas first, then in medium priority areas, then low priority areas (planning board submittals or as-builts are a good resource for locations).

   b. Decide on and document a numbering or naming system for outfalls and other structures. Establishment of a simple unique numbering system (SWO-0001, SWO-0002, etc.) will facilitate future inspections and documentation of maintenance.

   c. Select a method to mark outfalls in the field (using spray paint, paint pen, or signs or markers), and place an order for necessary materials. (Marking the outfalls ensures they can be consistently identified in the field, but is not required.)

   d. Obtain equipment for mapping (see Equipment List).

   e. Develop a schedule for completing (use town or city parcel grid or watershed areas).

   f. Conduct preliminary reconnaissance to evaluate if watercraft are necessary to view the banks of the waterbody.

2. Field check:

   a. Using existing paper maps as a basis for locations, field personnel should start a mapping program by walking all named waterbodies within a given area of the community and collecting outfall location and design information using global positioning system (GPS) equipment capable of sub-meter (approximately 3-foot) accuracy. Use of a data logger and data collection software, such as Pathfinder®, will allow the generation of GIS files that will be useful for many years. Utilize the Outfall Reconnaissance Inventory (ORI) form for outfall characterization.

Equipment List for mapping:

1. Existing paper maps
2. Field sheets
3. Camera
4. GPS unit
5. Spray paint
6. Cell phone or handheld radio
7. Clip boards and pencils
8. First aid kit
9. Flashlight
10. Protective gloves
11. Tape measure
12. Waders
13. Temperature probe
14. Sop watch
15. Sample bottles
16. Dry erase board (for photos)
17. Hand sanitizer
18. Sampling pole
19. Mirror (for light)
20. Safety vests

b. Collect dry weather inspection information whenever possible. Dry weather discharge information can either be collected on the paper forms for manual entry into a separate database at a later time, or can be directly entered into a database on a laptop or the data logger on-site.

c. Mark the outfall with its identifier for future location and easy reference using spray paint, paint markers, or pre-manufactured signs.

3. Develop Initial GIS Maps: If the storm drain system is being mapped as part of a larger GIS database for the municipality, the data collected can be displayed with any of the existing data sets. If the storm drain system is not part of a larger data set, the Program Manager must determine what background the maps should be displayed on, such as an aerial photograph, United States Geological Survey (USGS) quadrangles, or a set of roads, political boundaries, waterbodies, and watershed information.

4. Review and field check other structures (catch basins, culverts, pipes, ditches, drain manholes, etc.):

a. Scan and digitize any paper maps of the system into GIS-compatible files or use aerial photographs to identify point structures. An efficient way to do this is to send field staff along with catch basin cleaning crews to confirm catch basin locations, to observe the interior of structures, to determine which pipes enter and leave the structure, and to obtain design information on the pipes and structures. A GPS unit with a data logger can be used to record the location and design information related to the structures.

b. Field check digitized data.

c. Assign unique identifiers to remaining structures (CB-00X for catch basins, DMH-00X for drain manholes, etc.), and a set of attributes and allowable fields to describe the structure.

5. Incorporate field data into GIS and revise as necessary: Once the GPS data files have been converted into GIS layers, and revised maps have been produced, these maps should be proofed to assess their accuracy and completeness. The reviewer should document any additional data requirements, and correct any errors in the information collected. A relational database can help illustrate connections between pipes, outfalls, and other structures.

It should be noted that there are many possible mapping strategies for a given municipality depending on the amount and format of available storm drain system data and the resources that are available. The strategy described above is presented as one way to complete mapping. For a small to medium size community (6,000 to 10,000 people), this process could take approximately two years to complete, depending upon availability of resources and land use.

APPENDIX C. Outfall Reconnaissance Inventory/ Sample Collection Lab Sheet

Subwatershed:			Outfall ID:	
Today's date:			Duplicate? (yes/no):	
Analysis Technician:			Form completed by:	
LAB DATA FOR FLOWING OUTFALLS				
PARAMETER	**RESULT**		**UNIT**	**EQUIPMENT**
Ammonia QC check (10% of samples)			mg/L	Colorimeter
Fluoride			mg/L	Specific ion probe
Potassium			ppm	Compact Ion Meter
Conductivity			µs	Conductivity Meter
Bacteria	***Count***	***Dilution (1:1 or 1:100)***		
Red w/ gas			CFUs	Petrifilm plate
Blue w/ gas			CFUs	Petrifilm plate