Illicit Discharge Detection and Elimination (IDDE) Plan

Town of Sherborn, Massachusetts

Updated- September 2020

Prepared by:

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1. Introduction

1.1 MS4 Program

This Illicit Discharge Detection and Elimination (IDDE) Plan has been developed by the Town of Sherborn (the Town) to address the requirements of the United States Environmental Protection Agency's (USEPA's) 2016 National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4) in Massachusetts, hereafter referred to as the "2016 Massachusetts MS4 Permit" or "MS4 Permit."

The 2016 Massachusetts MS4 Permit requires that each permittee, or regulated community, address six Minimum Control Measures. These measures include the following:

1. Public Education and Outreach
2. Public Involvement and Participation
3. Illicit Discharge Detection and Elimination Program
4. Construction Site Stormwater Runoff Control
5. Stormwater Management in New Development and Redevelopment (Post Construction Stormwater Management); and
6. Good Housekeeping and Pollution Prevention for Permittee Owned Operations.

Under Minimum Control Measure 3, the permittee is required to implement an IDDE program to systematically find and eliminate sources of non-stormwater discharges to its municipal separate storm sewer system and implement procedures to prevent such discharges. The IDDE program must also be recorded in a written (hardcopy or electronic) document. This IDDE Plan has been prepared to address this requirement.

This plan represents a continuation of Sherborn's efforts to prevent pollution throughout the Town's stormwater system. Sanitary sewer overflows are not an issue and illicit connections to the storm sewer system are less likely here because there are no sanitary sewers, however Sherborn will continue to monitor for illicit discharge as described in the sections that follow.

1.2 Illicit Discharges

An "illicit discharge" is any discharge to a drainage system that is not composed entirely of stormwater, except for discharges pursuant to a NPDES permit (other than the NPDES permit for discharges from the MS4), discharges pursuant to a Sherborn Non-Stormwater Discharge Permit, and discharges resulting from fire-fighting activities.

Illicit discharges may take a variety of forms. Illicit discharges may enter the drainage system through direct or indirect connections. Direct connections may be relatively obvious, such as cross-connections of septic services to the storm drain system. Indirect illicit discharges may be more difficult to detect or address, such as failing septic systems that discharge untreated sewage to a ditch within the MS4, or a sump pump that discharges contaminated water on an intermittent basis.

Some illicit discharges are intentional, such as dumping used oil (or other pollutant) into catch basins, a resident or contractor illegally tapping a new septic lateral into a storm drain pipe to avoid the costs of septic construction and service, and illegal dumping of yard wastes into surface waters.

Some illicit discharges are related to the unsuitability of original infrastructure to the modern regulatory environment. Examples of illicit discharges in this category include connected floor drains in old buildings, as well as septic system overflows that enter the drainage system. Sump pumps legally connected to the storm drain system may be used inappropriately, such as for the disposal of floor washwater or old household products, in many cases due to a lack of understanding on the part of the homeowner.

Regardless of the intention, when not addressed, illicit discharges can contribute high levels of pollutants, such as heavy metals, toxics, oil, grease, solvents, nutrients, and pathogens to surface waters. Elimination of some discharges may require substantial costs and efforts, such as funding and designing a project to improve septic systems. Others, such as improving self-policing of dog waste management, can be accomplished by outreach in conjunction with the minimal additional cost of dog waste bins and the municipal commitment to disposal of collected materials on a regular basis.

1.3 Allowable Non-Stormwater Discharges

The following categories of non-stormwater discharges are allowed under the MS4 Permit unless the Town of Sherborn, USEPA or Massachusetts Department of Environmental Protection (MassDEP) identifies any category or individual discharge of non-stormwater discharge as a significant contributor of pollutants to the MS4:

- Water line flushing
- Landscape irrigation
- Diverted stream flows
- Rising ground water
- Uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20))
- Uncontaminated pumped groundwater
- Discharge from potable water sources
- Foundation drains
- Air conditioning condensation
- Irrigation water, springs
- Water from crawl space pumps
- Footing drains
- Lawn watering
- Individual resident car washing
- De-chlorinated swimming pool discharges
- Street wash waters
- Residential building wash waters without detergents

If these discharges are identified as significant contributors to the MS4, they must be considered an “illicit discharge” and addressed in the IDDE Plan (i.e. - control these sources so they are no longer significant contributors of pollutants, and/or eliminate them entirely).

As part of the Stormwater Management By-law (General By-laws of the Town of Sherborn, Chapter 25[1], **Appendix A**), Sherborn has preemptively prohibited de-chlorinated swimming pool discharges and discharges from any non-stormwater discharge into the street. Sherborn requires Non-Stormwater Discharge Permits for the discharge of any uncontaminated pumped groundwater with specifications for the following sources: foundations, crawl spaces, and footings.

[1]General Bylaws of the Town of Sherborn, Chapter 25: https://www.sherbornma.org/files -under ‘Select Board’s Office’

1.4 Receiving Waters and Impairments

An investigation was performed for the "impaired waters" that receive stormwater from the MS4 within the boundaries of the Town's regulated area based on the 2016 Massachusetts Integrated List of Waters and other sources that designate impairment of waters. Impaired waters are water bodies that do not meet water quality standards for one or more designated use(s) such as recreation or aquatic habitat. The investigation concluded that Sherborn's MS4 does not discharge into any impaired waters. Although the Sherborn's area includes three impaired waterbodies- Charles River, Little Farm Pond and Farm Pond; the MS4 regulated area is not near any of these waterbodies and Sherborn's regulated infrastructure does not discharge to them. See the map in **Appendix B** for reference.

1.5 IDDE Program Goals, Framework, and Timeline

The goals of the IDDE program are to find and eliminate illicit discharges to municipal separate storm sewer system and to prevent illicit discharges from happening in the future. The program consists of the following major components as outlined in the MS4 Permit:

- Legal authority and regulatory mechanism to prohibit illicit discharges and enforce this prohibition;
- Storm system mapping;
- Inventory and ranking of outfalls;
- Dry weather outfall screening;
- Catchment investigations;
- Identification/confirmation of illicit sources;
- Illicit discharge removal;
- Follow-up screening; and
- Employee training.

The IDDE investigation procedure framework is shown in **Figure 1-1**. The required timeline for implementing the IDDE program is shown in **Table 1**.

Figure 1. IDDE Investigation Procedure Framework

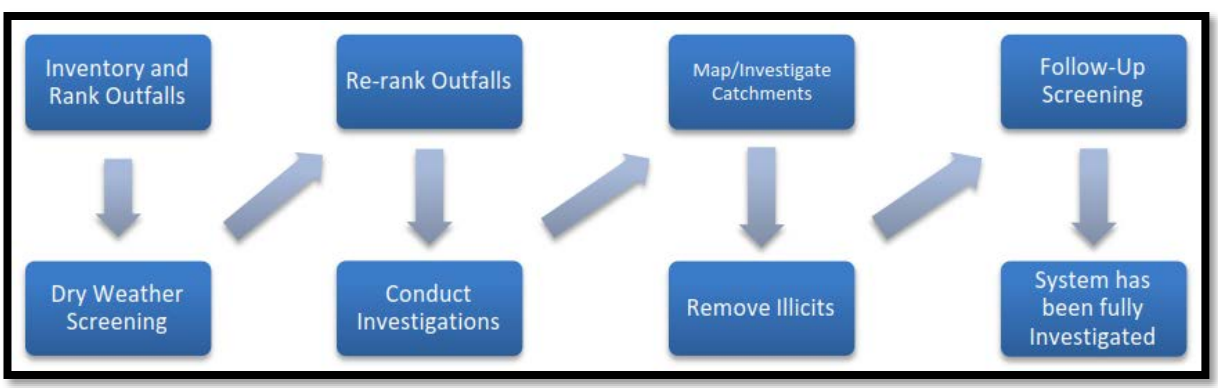

Table 1. IDDE Program Implementation Timeline

IDDE Program Requirement	Completion Dates in Permit Year and Fiscal Year				
	Year 1 FY2019	Year 2 FY2020	Year 3 FY2021	Year 7 FY2025	Year 10 FY2028
Written IDDE Program Plan; including the Catchment Investigation Procedure	X				
Phase I Mapping		X			
Phase II Mapping					X
Dry Weather Outfall Screening			X		
Follow-up Ranking of Outfalls and Interconnections			X		
Catchment Investigations – Problem Outfalls				X	
Catchment Investigations – All Problem, High, and Low Priority Outfalls					X

1.6 Work Completed to Date

The 2003 MS4 Permit required each MS4 community to develop a plan to detect illicit discharges using a combination of storm system mapping, adopting a regulatory mechanism to prohibit illicit discharges and enforce this prohibition, and identifying tools and methods to investigate suspected illicit discharges. Each MS4 community was also required to define how confirmed discharges would be eliminated and how the removal would be documented.

The Town has completed the following IDDE program activities consistent with the 2003 MS4 Permit requirements:

- Developed a map of outfalls and receiving waters
- Developed procedures for locating illicit discharges (i.e., visual screening of outfalls for dry weather discharges, dye or smoke testing)
- Developed procedures for locating the source of the discharge
- Developed procedures for removal of the source of an illicit discharge
- Developed procedures for documenting actions and evaluating impacts on the storm sewer system subsequent to removal

The Town has also completed some of the IDDE program activities required for the 2016 permit. These activities are described in the sections below.

2. Authority and Statement of IDDE Responsibilities

2.1 Legal Authority

The Town has adopted an Illicit Discharge Detection and Elimination Authority as an amendment to the Stormwater Management By-law (General Bylaws of the Town of Sherborn, Chapter 25).. A copy of the amendment is provided in **Appendix A**. The amendment provides the Town with adequate legal authority to:

- Prohibit illicit discharges;
- Investigate suspected illicit discharges;
- Eliminate illicit discharges, including discharges from properties not owned by or controlled by the MS4 that discharge into the MS4 system; and
- Implement appropriate enforcement procedures and actions.
- Prohibit de-chlorinated swimming pool discharges and discharges from any non-stormwater discharge into the street.
- Requires permits for the discharge of any uncontaminated pumped groundwater with specifications for the following sources: foundations, crawl spaces, and footings.

2.2 Statement of Responsibilities

The Department of Public Works is the lead municipal agency responsible for implementing and administering the IDDE program pursuant to the provisions of the Illicit Discharge Detection and Elimination Authority, which includes issuing permits and enforcing any regulations, violation notices, or enforcement orders, and may pursue all civil and criminal remedies for such violations.

3. Stormwater System Mapping

The 2016 MS4 Permit requirements involve a more detailed storm system map than was required by the 2003 MS4 Permit. The additional mapping is intended to facilitate the identification of key infrastructure, factors influencing proper system operation, and the potential for illicit discharges. The 2016 MS4 Permit requires the storm system map to be updated in two phases as outlined below. The Department of Public Works is responsible for updating the stormwater system mapping pursuant to the 2016 MS4 Permit. All of Phase I and some Phase II mapping requirements have already been met.

A paper copy of the basic storm system map that contains the outfalls and receiving waters is provided in **Appendix B**. An online map of the stormwater system that includes the most recent version of outfalls, pipes, manholes, and catch basins is included at the following public website:

https://www.mapsonline.net/sherbornma/index.html

To access the stormwater layers click on the 'Layers' tab on the left side of the screen then select the 'Stormwater System' layers from the table of contents. Both regulated and non-regulated storm system discharge points are shown. The regulated parts of the storm system are marked by a yellow triangle at the outfall. Greater detail is available on the map by zooming in.

The Town has contracted PeopleGIS to provide a framework for management and publishing their stormwater geodatabase online. Stormwater Suite has features specifically created for compliance with the MS4 permit. This system is driven by a database that tracks progress of the IDDE program and has mobile capabilities for mapping, planning, and system maintenance tracking.

3.1 Phase I Mapping Requirements

Phase I mapping was completed within two (2) years of the effective date of the permit (on July 1, 2020) and includes the following information for Town owned infrastructure:

- Outfalls and receiving waters (previously required by the MS4-2003 permit);
- Open channel conveyances (swales, ditches, etc.);
- ;
- Municipally owned stormwater treatment structures;
- Waterbodies identified by name and indication of all use impairments as identified on the most recent EPA approved Massachusetts Integrated List of Waters report; and
- Initial catchment delineations. Topographic contours and drainage system information may be used to produce initial catchment delineations.

Interconnections with other MS4s and other storm sewer systems are also required under the 2016 permit however, there are no interconnections (places where the stormwater system flows to another entity and then is discharged into a Water of the US) in Sherborn. The Town will report on the progress towards completion of the storm system map in each annual report.

3.2 Phase II Mapping

Phase II mapping must be completed within ten (10) years of the effective date of the permit (by July 1, 2028). The requirements include the following information:

- Outfall spatial location (latitude and longitude with a minimum accuracy of +/-30 feet);
- Pipes;
- Manholes;
- Catch basins;
- Refined catchment delineations (catchment delineations must be updated to reflect information collected during catchment investigations);

All outfall locations have been obtained to the accuracy noted above. Most pipes, manholes, and catch basins have also been mapped. Mapping will be refined during catchment investigation efforts. Municipal sanitary systems and combined sewer systems are also required to be mapped; however these are not present in Sherborn. The Town will update its stormwater mapping by July 1, 2028 to include refined catchment delineations.

3.3 Mapping Updates

Mapping in May 2020-

Sherborn did not make any changes to the receiving waters or impairments during Permit Year 2. However, there were some changes to the outfalls. In May 2020, Sherborn performed mapping analysis of their mapped infrastructure with two objectives: 1) to determine if there were additional outfalls remaining to be mapped, and 2) to determine if there were mapped outfalls that were not actually outfalls under the current permit definition. First, areas that needed field inspection were identified from desktop analysis. Then as determinations were made on site, five new outfalls were found (OF-82 through OF-86). Three of these outfalls had small catchment areas with only 2-5 catch basins, and two of the outfalls had larger catchments including one that drains seven catch basins off Thoroughbred Drive and another off of North Main Street that drains approximately 18 to 25 catch basins. Sherborn maintains a thorough record of discharge locations, including unregulated discharge points where stormwater discharges to land or is outside of the regulated area. Accordingly, four other non-regulated discharge points were mapped. All mapping updates were entered in Sherborn's PeopleGIS geodatabase along with other structure and discharge information.

Six outfalls were removed from the outfall list after further field investigation. Four of the removed outfalls (OF-20 and OF-21 at the north end of Old Orchard Road; and OF-46 and OF-47 on Washington Street) were actually the upstream and downstream ends of two culverts and not actually outfalls by the 2016 MS4 permit definition. Accordingly, it was verified that these culverts were not significantly longer than the roadway width and that they only carried stream water, not stormwater. These end points were replaced with lines representing the culverts. Two outfalls were actually duplicate records of outfalls that were mapped in dense riparian vegetation and wood debris (OF-31 and OF-34, both off of Peckham Hill Road). One outfall (OF-43 in front of 42 Washington Street) needed to be moved so that tested water was not mixing with other natural sources of flow from a stream culvert. Sherborn now has a total of 40 regulated outfalls.

4. Sanitary Sewer Overflows (SSOs)

The 2016 MS4 Permit requires municipalities to prohibit illicit discharges, including sanitary sewer overflows (SSOs), to the separate storm sewer system. SSOs are discharges of untreated sanitary wastewater from a municipal sanitary sewer that can contaminate surface waters, cause serious water quality problems and property damage, and threaten public health. Sherborn does not have any sanitary sewers in Town. Wastewater produced by residences and businesses are entirely treated by septic systems. Therefore an SSO inventory is not applicable to Sherborn.

5. Assessment and Priority Ranking of Outfalls

The 2016 MS4 Permit requires an assessment and priority ranking of outfalls in terms of their potential to have illicit discharges and SSOs and the related public health significance. Sherborn's risk for IDDE is reduced because there are no sanitary sewers and therefore no risk for SSO's. The ranking helps determine the priority order for performing IDDE investigations and meeting permit milestones.

5.1 Outfall Catchment Delineations

A catchment is the area that drains to an individual outfall[2] or interconnection.[3] The catchments for each of the MS4 outfalls will be delineated to define contributing areas for investigation of potential sources of illicit discharges. Catchments are typically delineated based on topographic contours and mapped drainage infrastructure, where available. As described in **Section 3**, initial catchment delineations were completed as part of the Phase I mapping, and refined catchment delineations will be completed as part of the Phase II mapping to reflect information collected during catchment investigations. Catchment Investigations are due to be completed in FY 2028.

5.2 Outfall and Interconnection Inventory and Ranking

The Department of Public Works completed an initial outfall and interconnection inventory and priority ranking to assess illicit discharge potential based on existing information with the first draft of this plan. An updated inventory and ranking will be updated annually. The inventory will be updated annually to include data collected in connection with dry weather screening and other relevant inspections.

The outfall and interconnection inventory identifies each outfall and interconnection discharging from the MS4, records its location and condition, and provides a framework for tracking inspections, screenings and other IDDE program activities.

Outfalls and interconnections are classified into one of the following categories:

1. **Problem Outfalls**: Outfalls/interconnections with known or suspected contributions of illicit discharges based on existing information shall be designated as Problem Outfalls. This shall include any outfalls/interconnections where previous screening indicates likely sewer input. Likely sewer input indicators are any of the following:
    - Olfactory or visual evidence of sewage,

[2] **Outfall** means a point source as defined by 40 CFR § 122.2 as the point where the municipal separate storm sewer discharges to waters of the United States. An outfall does not include open conveyances connecting two municipal separate storm sewers or pipes, tunnels or other conveyances that connect segments of the same stream or other waters of the United States and that are used to convey waters of the United States. Culverts longer than a simple road crossing shall be included in the inventory unless the permittee can confirm that they are free of any connections and simply convey waters of the United States.

[3] **Interconnection** means the point (excluding sheet flow over impervious surfaces) where the permittee's MS4 discharges to another MS4 or other storm sewer system, through which the discharge is conveyed to waters of the United States or to another storm sewer system and eventually to a water of the United States.

- Ammonia ≥ 0.5 mg/L, surfactants ≥ 0.25 mg/L, and bacteria levels greater than the water quality criteria applicable to the receiving water, or
- Ammonia ≥ 0.5 mg/L, surfactants ≥ 0.25 mg/L, and detectable levels of chlorine.

Dry weather screening and sampling, as described in **Section 6** of this IDDE Plan and Part 2.3.4.7.b of the MS4 Permit, is not required for Problem Outfalls. There are currently no Problem Outfalls in Sherborn

1. **High Priority Outfalls**: Outfalls/interconnections that have not been classified as Problem Outfalls and that are:
   - Discharging to an area of concern to public health due to proximity of public beaches, recreational areas, drinking water supplies or shellfish beds
   - Determined by the permittee as high priority based on the characteristics listed below or other available information.
2. **Low Priority Outfalls**: Outfalls/interconnections determined by the permittee as low priority based on the characteristics listed below or other available information.
3. **Excluded outfalls**: Outfalls/interconnections with no potential for illicit discharges may be excluded from the IDDE program. This category is limited to roadway drainage in undeveloped areas with no dwellings and no sanitary sewers; drainage for athletic fields, parks or undeveloped green space and associated parking without services; cross-country drainage alignments (that neither cross nor are in proximity to sanitary sewer alignments) through undeveloped land. This may be easy to identify in Sherborn since there are no sanitary sewers.

Outfalls have been ranked into the above priority categories (except for excluded outfalls, which may be excluded from the IDDE program) based on the following characteristics of the area that drains to each outfall, where information is available.

- **Previous screening results and dry weather flow –** Previous screening/sampling results indicate likely input from sanitary flow (see criteria above for Problem Outfalls). Previous screening results indicate dry weather flow from outfalls (this excludes culverts that have flow from the stream it carries).
- **Area of Concern-** Discharging to an area of concern to public health due to proximity of public beaches, recreational areas, drinking water supplies or shellfish beds**.**
- **Past discharge complaints and reports.**
- **Poor receiving water quality observed or listed** – the following guidelines are recommended to identify waters as having a high illicit discharge potential once tested:
  - Exceeding water quality standards for bacteria
  - Ammonia levels above 0.5 mg/l
  - Surfactants levels greater than or equal to 0.25 mg/l

  Waters are also listed in the Massachusetts Impaired Waters list and TMDLs.
- **Density of generating sites** – Generating sites are those places, including institutional, municipal, commercial, or industrial sites, with a potential to generate pollutants that could contribute to illicit discharges. Examples of these sites include, but are not limited to: car dealers, car washes, gas stations, garden centers, and industrial manufacturing areas.
- **Age of development and infrastructure** – Industrial areas greater than 40 years old will probably have a high illicit discharge potential. Developments 20 years or younger will probably have a low illicit discharge potential.
- **Combined sewers historically in the area**- There was never combined sewers in Sherborn.

- **Surrounding density of aging septic systems** – Septic systems thirty years or older in residential land use areas are prone to have failures and may have a high illicit discharge potential.
- **Long Culverted Streams** – Culverts longer that the roadway have a tendency for higher Illicit discharge potential
- **Connections from residences found** – During previous inspections some connections were found to catch basins, these were rated based on pollution potential.

Table 2 is the outfall inventory and priority ranking matrix. Methods for ranking and the scoring system are further specified in the footnotes below the table.

Table 2. Outfall Inventory and Priority Ranking Matrix – The Town of Sherborn, Massachusetts – Revision Date 11/6/2020 **(Continues on next two pages)**

Outfall ID	Receiving Water	Previous Screening Results Indicate Likely Wastewater Input?[1]	Discharging to Area of Concern to Public Health?[2]	Frequency of Past Discharge Complaints	Receiving Water Quality Observed[3]	Density of Generating Sites[4]	Age of Development/ Infrastructure[5]	Historic Combined Sewer?	Aging Septic?[6]	Long Culverted Streams?[7]	Water Quality Limited Waters[8]	Connections from Residences Found[9]	Dry Weather Flow?[10]	Additional Characteristics	Score	Priority Ranking
Information Source->		Outfall Inspections and Sample Results	GIS Maps, Recreation Areas, Recreational Uses	Town Staff	Sampling Data	Land Use/GIS Maps, Aerial Photography	Land Use Information, Visual Observation	Town Staff, GIS Maps	Land Use, Town Staff	GIS Maps	Impaired Waters List, TMDLs	Previous inspections	Previous Outfall Inspections			
		Yes = 15 (Problem Outfall)	High = 10	Frequent = 3	Poor = 3	High = 6	High = 3	Yes = 5	Many = 6	Yes = 3	Severe= 10	High Pollution Potential = 8	Heavy Flow = 8	Notes		
Scoring Criteria->		No = 0	Low = 0	Occasional = 2	Fair = 2	Medium = 3	Medium = 2	No = 0	Few = 2	No = 0	Slight= 5	Low Pollution Potential = 4	Light Flow = 4			
				None = 0	Good = 0	Low = 1	Low = 1		None = 0		None=0	None = 0	No Flow = 0			
OF-15	Large Wetland System	0	0	0	0	6	3	0	2	0	0	0	0	Behind Sherborn Fuel Gas Station. Drains developed area	11	High Priority
OF-37	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	4	0	6" pipe from residence, from pool or sump	9	High Priority
OF-38	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	4	0	6" pipe from residence, likely Stormwater	9	High Priority
OF-60	Small Pond	0	0	0	0	1	2	0	2	0	0	4	0	4" pipe from residence, from pool or garage	9	High Priority
OF-86	Wetland	0	0	0	0	3	3	0	2	0	0	0	0	Catchment needs more mapping investigation. Crosses under tracks in a developed area	8	High Priority
OF-50	Small Wetland	0	0	0	0	3	2	0	2	0	0	0	0		7	Low Priority
OF-11	Large Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-22	Tributaries to Dirty Meadow Brook	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-23	Tributaries to Dirty Meadow Brook	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-24	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-25	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-26	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-27	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-28	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority

Outfall ID	Receiving Water	Previous Screening Results Indicate Likely Wastewater Input?[1]	Discharging to Area of Concern to Public Health?[2]	Frequency of Past Discharge Complaints	Receiving Water Quality Observed[3]	Density of Generating Sites[4]	Age of Development/ Infrastructure[5]	Historic Combined Sewer?	Aging Septic?[6]	Long Culverted Streams?[7]	Water Quality Limited Waters[8]	Connections from Residences Found[9]	Dry Weather Flow?[10]	Additional Characteristics	Score	Priority Ranking
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		Yes = 15 (Problem Outfall)	High = 10	Frequent = 3	Poor = 3	High = 6	High = 3	Yes = 5	Many = 6	Yes = 3	Severe= 10	High Pollution Potential = 8	Heavy Flow = 8	Notes		
Scoring Criteria->		No = 0	Low = 0	Occasional = 2	Fair = 2	Medium = 3	Medium = 2	No = 0	Few = 2	No = 0	Slight= 5	Low Pollution Potential = 4	Light Flow = 4			
				None = 0	Good = 0	Low = 1	Low = 1		None = 0		None=0	None = 0	No Flow = 0			
OF-32	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-33	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-35	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-39	Tributaries to Dirty Meadow Brook	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-40	Tributaries to Dirty Meadow Brook	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-41	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	0	0	Inlet to a pond, potential outfall	5	Low Priority
OF-43	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	0	0	Connection of stormdrain to culvert that drains a pond	5	Low Priority
OF-44	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-45	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-48	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-49	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-51	Tributary to Indian Brook	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-53	Large Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-54	Large Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-55	Tributaries to Dirty Meadow Brook	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority

Outfall ID	Receiving Water	Previous Screening Results Indicate Likely Wastewater Input?[1]	Discharging to Area of Concern to Public Health?[2]	Frequency of Past Discharge Complaints	Receiving Water Quality Observed[3]	Density of Generating Sites[4]	Age of Development/ Infrastructure[5]	Historic Combined Sewer?	Aging Septic?[6]	Long Culverted Streams?[7]	Water Quality Limited Waters[8]	Connections from Residences Found[9]	Dry Weather Flow?[10]	Additional Characteristics	Score	Priority Ranking
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				None = 0	Good = 0	Low = 1	Low = 1		None = 0		None=0	None = 0	No Flow = 0			
OF-61	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-67	Tributary to Indian Brook	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-75	Tributary to Indian Brook	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-76	Tributaries to Dirty Meadow Brook	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-77	Wetland	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-78	Dopping Brook	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-79	Dopping Brook	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-83	Indian Brook	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority
OF-85	Wetland	0	0	0	0	1	2	0	2	0	0	0	0	Outfall likely submerged in flooded wetland	5	Low Priority
OF-82	Wetland	0	0	0	0	1	2	0	0	0	0	0	0		3	Low Priority
OF-84	Pond	0	0	0	0	1	2	0	0	0	0	0	0		3	Low Priority
OF-32	Sewall Brook Wetland System	0	0	0	0	1	2	0	2	0	0	0	0		5	Low Priority

[1] Previous screening results indicate likely wastewater input if any of the following are true:

- Olfactory or visual evidence of wastewater,
- Ammonia ≥ 0.5 mg/L, surfactants ≥ 0.25 mg/L, and bacteria levels greater than the water quality criteria applicable to the receiving water, or
- Ammonia ≥ 0.5 mg/L, surfactants ≥ 0.25 mg/L, and detectable levels of chlorine

[2] Outfalls/interconnections that discharge to or in the vicinity of any of the following areas: public beaches, recreational areas, drinking water supplies, or shellfish beds

[3] Receiving water quality based on latest version of MassDEP Integrated List of Waters.

- Poor = Waters with approved TMDLs (Category 4a Waters) where illicit discharges have the potential to contain the pollutant identified as the cause of the impairment
- Fair = Water quality limited waterbodies that receive a discharge from the MS4 (Category 5 Waters)
- Good = No water quality impairments
- Outfalls that discharge to impaired waters were automatically given a High Priority ranking.

[4] Generating sites are institutional, municipal, commercial, or industrial sites with a potential to contribute to illicit discharges (e.g., car dealers, car washes, gas stations, garden centers, industrial manufacturing, etc.)

[5] Age of development and infrastructure:

- High = Industrial areas greater than 40 years old
- Medium = Developments 20-40 years old
- Low = Developments less than 20 years old

[6] Aging septic systems are septic systems 30 years or older in residential areas.
[7] Long culverted streams are culverts than are significantly longer than the roadway crossing.
[8] Water Quality Limited waters include waters listed in the most recent Massachusetts Impaired Water (303d) list and those with TMDLs or any other documentation that shows pollutants present.
[9] Residential connections with the MS4 found during inspections. Pollution potential was assessed by observations of standing water in catch basins and the direction of pipes.
[10] Dry weather flow was assessed during previous outfall inspections. Light flow is any flow up to 5 gallons per minute and heavy flow was considered anything greater than that.

6. Dry Weather Outfall Screening and Sampling

Dry weather flow is a common indicator of potential illicit connections. The MS4 Permit requires all outfalls/interconnections (excluding Problem and excluded Outfalls) to be inspected for the presence of dry weather flow. The Department of Public Works is responsible for conducting dry weather outfall screening, starting with High Priority outfalls, followed by Low Priority outfalls, based on the priority rankings described in the previous section. All outfalls have been screened during dry weather, these procedures apply to follow up investigations and any additional outfalls that may be found.

6.1 Weather Conditions

Dry weather outfall screening and sampling may occur when no more than 0.1 inches of rainfall has occurred in the previous 24-hour period and no significant snow melt is occurring. Drier weather with relatively low groundwater levels typical of the time period from mid-summer to early fall is recommended to reduce unnecessary effort in water quality sampling. For purposes of determining dry weather conditions, program staff will use precipitation data from the 'Sherborn Station' weather station (Station ID: KMASHERB3). If the 'Sherborn Station' weather station is not available or not reporting current weather data, then the 'Woodland St, Sherborn' weather station (Station ID: KMASHERB9) will be used as a back-up.

6.2 Dry Weather Screening/Sampling Procedure

6.2.1 General Procedure

The dry weather outfall inspection and sampling procedure consists of the following general steps:

1. Identify outfall(s) to be screened/sampled based on the outfall inventory, priority ranking, and what outfalls have not been sampled.
2. Acquire the necessary staff, mapping, and field equipment (see **Table 3** for list of potential field equipment).
3. Conduct the outfall inspection during dry weather:
    a. Mark and photograph the outfall.
    b. Record the inspection information and outfall characteristics (using paper forms or digital form using a tablet or similar device with PeopleGIS) (see example form in **Appendix C**).
    c. Look for and record visual/olfactory evidence of pollutants in flowing outfalls including odor, color, turbidity, and floatable matter (suds, bubbles, excrement, toilet paper or sanitary products). Also observe outfalls for deposits and stains, vegetation, and damage to outfall structures.
4. If flow is observed, sample and test the flow following the procedures described in the following sections.
5. If no flow is observed, but evidence of illicit flow exists (illicit discharges are often intermittent or transitory), revisit the outfall during dry weather within one week of the initial observation, if practicable, to perform a second dry weather screening and sample any observed flow. Other techniques can be used to detect intermittent or transitory flows including conducting inspections during evenings or weekends and using optical brighteners.

6. Input results from screening and sampling into the PeopleGIS database if it hasn't already been directly entered from the field. Include pertinent information in the outfall/interconnection inventory and priority ranking.
7. Include all screening data in the annual report. Use an output table from PeopleGIS.

Previous outfall screening/sampling conducted under the 2013 MS4 Permit may be used to satisfy the dry weather outfall/screening requirements of the 2016 MS4 Permit only if the previous screening and sampling was substantially equivalent to that required by the 2016 MS4 Permit, including the list of analytes outlined in Section 2.3.4.7.b.iii.4 of the 2016 permit.

6.2.2 Field Equipment

Table 3 lists field equipment commonly used for dry weather outfall screening and sampling.

Table 3. Field Equipment – Dry Weather Outfall Screening and Sampling

Equipment	Use/Notes
Clipboard	For organization of field sheets and writing surface
Field Sheets	Field sheets for both dry weather inspection and Dry weather sampling should be available with extras
Chain of Custody Forms	To ensure proper handling of all samples
Pens/Pencils/Permanent Markers	For proper labeling
Nitrile Gloves	To protect the sampler as well as the sample from contamination
Flashlight/headlamp w/batteries	For looking in outfalls or manholes, helpful in early mornings as well
Cooler with Ice	For transporting samples to the laboratory
Digital Camera	For documenting field conditions at time of inspection
Personal Protective Equipment (PPE)	Reflective vest, Safety glasses and boots at a minimum
GPS Receiver	For taking spatial location data
Water Quality Sonde	If needed, for sampling conductivity, temperature, pH
Water Quality Meter	Hand held meter, if available, for testing for various water quality parameters such as ammonia, surfactants and chlorine
Test Kits	Have extra kits on hand to sample more outfalls than are anticipated to be screened in a single day
Label Tape	For labeling sample containers
Sample Containers	Make sure all sample containers are clean. Keep extra sample containers on hand at all times. Make sure there are proper sample containers for what is being sampled for (i.e., bacteria requires sterile containers).
Pry Bar or Pick	For opening catch basins and manholes when necessary
Sandbags	For damming low flows to take samples
Small Mallet or Hammer	Helping to free stuck manhole and catch basin covers
Utility Knife	Multiple uses
Measuring Tape	Measuring distances and depth of flow
Safety Cones	Safety
Hand Sanitizer	Disinfectant/decontaminant
Zip Ties/Duct Tape	For making field repairs
Rubber Boots/Waders	For accessing shallow streams/areas
Sampling Pole/Dipper/Sampling Cage	For accessing hard to reach outfalls and manholes

6.2.3 Sample Collection and Analysis

If flow is present during a dry weather outfall inspection, a sample will be collected and analyzed for the required permit parameters[4] listed in **Table 4**. The general procedure for collection of outfall samples is as follows:

1. Fill out all sample information on sample bottles, in PeopleGIS using a tablet, and in field data sheets (see **Appendix C** for Field Sheets).
2. Put on protective gloves (nitrile/latex/other) before sampling.
3. Collect sample with dipper or directly in sample containers. If possible, collect water from the flow directly in the sample bottle. Be careful not to disturb sediments.
4. If using a dipper or other device, triple rinse the device with distilled water and then in water to be sampled (not for bacteria sampling).
5. Use test strips, test kits, and field meters (rinse similar to dipper) for most parameters (see **Table 4**)
6. Place laboratory samples on ice for analysis of bacteria and pollutants of concern
7. Fill out chain-of-custody form for laboratory samples
8. Deliver samples to Alpha Analytical, Inc. of Westborough, Massachusetts.
9. Dispose of used test strips and test kit ampules properly
10. Decontaminate all testing personnel and equipment

If an outfall is submerged (either partially or completely, or inaccessible) field staff will proceed to the first accessible upstream manhole or structure for the observation and sampling and report the location with the screening results. Field staff will continue to the next upstream structure until there is no longer an influence from the receiving water on the visual inspection or sampling.

Field test kits or field instrumentation are permitted for all parameters except indicator bacteria and any pollutants of concern. Field kits need to have appropriate detection limits and ranges. **Table 4** lists various field test kits and field instruments that can be used for outfall sampling associated with the 2016 MS4 Permit parameters, other than indicator bacteria and any pollutants of concern. Analytic procedures and user's manuals for field test kits and field instrumentation are provided in **Appendix D**.

Table 4. Sampling Parameters and Analysis Methods

Analyte or Parameter	Instrumentation (Portable Meter)	Field Test Kit
Ammonia	CHEMetrics™ V-2000 Colorimeter Hach™ DR/890 Colorimeter Hach™ Pocket Colorimeter™ II	CHEMetrics™ K-1410 CHEMetrics™ K-1510 (series) Hach™ NI-SA Hach™ Ammonia Test Strips
Surfactants (Detergents)	CHEMetrics™ I-2017	CHEMetrics™ K-9400 and K-9404 Hach™ DE-2
Chlorine	CHEMetrics™ V-2000, K-2513 Hach™ Pocket Colorimeter™ II	NA
Conductivity	CHEMetrics™ I-1200 YSI Pro30 YSI EC300A Oakton 450	NA
Temperature	YSI Pro30 YSI EC300A	NA

[4] Other potentially useful parameters, although not required by the MS4 Permit, include **fluoride** (indicator of potable water sources in areas where water supplies are fluoridated), **potassium** (high levels may indicate the presence of sanitary wastewater), and **optical brighteners** (indicative of laundry detergents).

Analyte or Parameter	Instrumentation (Portable Meter)	Field Test Kit
	Oakton 450	
Salinity	YSI Pro30 YSI EC300A Oakton 450	NA
Temperature	YSI Pro30 YSI EC300A Oakton 450	NA
Indicator Bacteria: ***E. coli*** **(freshwater) or** **Enterococcus (saline water)**	EPA certified laboratory procedure (40 CFR § 136)	NA
Pollutants of Concern[1]	EPA certified laboratory procedure (40 CFR § 136)	NA

[1]Where the discharge is directly into a water quality limited water or a water subject to an approved TMDL, the sample must be analyzed for the pollutant(s) of concern identified as the cause of the water quality impairment.

Testing for indicator bacteria and any pollutants of concern must be conducted using analytical methods and procedures found in 40 CFR § 136.[5] Samples for laboratory analysis must also be stored and preserved in accordance with procedures found in 40 CFR § 136. **Table 5** lists analytical methods, detection limits, hold times, and preservatives for laboratory analysis of dry weather sampling parameters.

Table 5. Analytical Method Details

Analyte or Parameter	Analytical Method	Detection Limit	Max. Hold Time	Preservative
Ammonia	**EPA**: 350.2 **SM**[1]: 4500-NH3C	0.05 mg/L	28 days	Cool ≤6°C, H_2SO_4 to pH <2, No preservative required if analyzed immediately.
Surfactants	**SM**: 5540-C	0.01 mg/L	48 hours	Cool ≤6°C
Chlorine	**SM**: 4500-Cl G	0.02 mg/L	Analyze within 15 minutes	None Required
Temperature	**SM**: 2550B	*NA*	Immediate	None Required
Specific Conductance	**EPA**: 120.1 **SM**: 2510B	0.2 µs/cm	28 days	Cool ≤6°C
Salinity	**SM**: 2520		28 days	Cool ≤6°C

[5] 40 CFR § 136: http://www.ecfr.gov/cgi-bin/text-idx?SID=b3b41fdea0b7b0b8cd6c4304d86271b7&mc=true&node=pt40.25.136&rgn=div5

Analyte or Parameter	Analytical Method	Detection Limit	Max. Hold Time	Preservative
Indicator Bacteria: ***E. coli*** **Enterococcus**	*E. coli* **EPA**: 1603 **SM**: 9221B, 9221F, 9223 B **Other**: Colilert®, Colilert-18® *Enterococcus* **EPA**: 1600 **SM**: 9230 C **Other**: Enterolert®	*E. coli* **EPA**: 1 cfu/100mL **SM**: 2 MPN/100mL **Other**: 1 MPN/100mL *Enterococcus* **EPA**: 1 cfu/100mL **SM**: 1 MPN/100mL **Other**: 1 MPN/100mL	8 hours	Cool ≤10°C, 0.0008% $Na_2S_2O_3$
Total Phosphorus	**EPA**: Manual-365.3, Automated Ascorbic acid digestion-365.1 Rev. 2, ICP/AES4-200.7 Rev. 4.4 **SM**: 4500-P E-F	**EPA**: 0.01 mg/L **SM** : 0.01 mg/L	28 days	Cool ≤6°C, H_2SO_4 to pH <2
Total Nitrogen[2]	**EPA**: Cadmium reduction (automated)-353.2 Rev. 2.0, **SM**: 4500-NO_3 E-F	**EPA**: 0.05 mg/L **SM** : 0.05 mg/L	28 days	Cool ≤6°C, H_2SO_4 to pH <2

[1] SM = Standard Method

[2] Ammonia + Nitrate/Nitrate methods are for Nitrate-Nitrate and need to be combined with Ammonia listed above.

6.3 Interpreting Outfall Sampling Results

Outfall analytical data from dry weather sampling can be used to help identify the major type or source of discharge. **Table 6** shows values identified by the U.S. EPA and the Center for Watershed Protection as typical screening values for select parameters. These represent the typical concentration (or value) of each parameter expected to be found in stormwater. Screening values that exceed these benchmarks may be indicative of pollution and/or illicit discharges.

Table 6. Benchmark Analyte Values

Analyte or Parameter	Benchmark
Ammonia	>0.5 mg/L
Conductivity	>2,000 µS/cm
Surfactants	>0.25 mg/L
Chlorine	>0.02 mg/L (detectable levels per the 2016 MS4 Permit)
Indicator Bacteria[6]**:** ***E.coli*** ***Enterococcus***	*E. coli*: the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml *Enterococcus:* the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml

6.4 Follow-up Ranking of Outfalls and Interconnections

The Town has updated and re-prioritized the initial outfall and interconnection rankings based on information gathered during dry weather screening. The rankings will be completed within three (3) years of the effective date of the permit (July 1, 2021).

Outfalls/interconnections where relevant information was found indicating sewer input to the MS4 or sampling results indicating wastewater input are highly likely to contain illicit discharges from sanitary sources. Such outfalls/interconnections will be ranked at the top of the High Priority Outfalls category for investigation. Other outfalls and interconnections may be re-ranked based on any new information from the dry weather screening.

[6] Massachusetts Water Quality Standards: http://www.mass.gov/eea/docs/dep/service/regulations/314cmr04.pdf

7. Catchment Investigations

If stormwater outfalls with evidence of illicit discharges have been identified, various methods can be used to trace the source of the potential discharge within the outfall catchment area. Catchment investigation techniques include but are not limited to review of maps, historic plans, and records; manhole observation; dry and wet weather sampling; video inspection; smoke testing; and dye testing. This section outlines a systematic procedure to investigate outfall catchments to trace the source of potential illicit discharges. All data collected as part of the catchment investigations will be recorded and reported in each annual report.

The guidelines below list the order in which the catchments for outfalls and interconnections must be investigated based on the outfall ranking results:

- Catchment investigations for Problem Outfalls and outfalls/interconnections where dry weather indicates illicit connections are to be completed between the beginning of FY2021 (Permit Year 3) to the end of FY 2025 (Permit Year 7).
- Investigations of all High and Low Priority outfalls (the remaining outfalls) must be completed by Year 10 and should follow the order as listed in the outfall ranking table (Table 2).

7.1 System Vulnerability Factors

The Department of Public Works will review relevant mapping and historic plans and records to identify areas within the catchment with higher potential for illicit discharge. This information incorporated into this investigation will be greatly reduced from a typical town and from the guidelines identified in the MS4 permit because there are no sanitary sewer systems in Sherborn. The following information will be reviewed:

- Plans related to the construction of the drainage network
- Prior work on storm drains
- Board of Health or other municipal data on septic systems
- Septic system breakouts.

Based on the review of this information, the presence of any of the following **System Vulnerability Factors (SVFs)** will be identified for each catchment:

- Widespread code-required septic system upgrades required at property transfers (indicative of inadequate soils, water table separation, or other physical constraints of the area rather that poor owner maintenance)
- History of multiple Board of Health actions addressing widespread septic system failures (indicative of inadequate soils, water table separation, or other physical constraints of the area rather that poor owner maintenance).

An SVF inventory will be documented for each catchment (see **Table 7**), retained as part of this IDDE Plan, and included in the annual report.

Table 7. Outfall Catchment System Vulnerability Factor (SVF) Inventory – The Town of Sherborn, Massachusetts – Revision Date: 05/31/2019

Outfall ID	Receiving Water	1 Septic with Poor Soils or Water Table Separation	2 History of BOH Actions Addressing Septic Failure
Sample Outfall 1	XYZ River	Yes/No	Yes/No

Presence/Absence Evaluation Criteria:

1. Widespread code-required septic system upgrades required at property transfers (indicative of inadequate soils, water table separation, or other physical constraints of the area rather that poor owner maintenance)
2. History of multiple Board of Health actions addressing widespread septic system failures (indicative of inadequate soils, water table separation, or other physical constraints of the area rather that poor owner maintenance).

7.2 Dry Weather Manhole Inspections

The Department of Public Works will implement a dry weather storm drain network investigation that involves systematically and progressively observing, sampling and evaluating key junction manholes in the MS4 to determine the approximate location of suspected illicit discharges.

The Department of Public Works will be responsible for implementing the dry weather manhole inspection program and making updates as necessary. Infrastructure information will be incorporated into the storm system map, and catchment delineations will be refined based on the field investigation, where necessary. The SVF inventory will also be updated based on information obtained during the field investigations, where necessary.

Several important terms related to the dry weather manhole inspection program are defined by the MS4 Permit as follows:

- **Junction Manhole** is a manhole or structure with two or more inlets accepting flow from two or more MS4 alignments. Manholes with inlets solely from private storm drains, individual catch basins, or both are not considered junction manholes for these purposes.
- **Key Junction Manholes** are those junction manholes that can represent one or more junction manholes without compromising adequate implementation of the illicit discharge program. Adequate implementation of the illicit discharge program would not be compromised if the exclusion of a particular junction manhole as a key junction manhole would not affect the permittee’s ability to determine the possible presence of an upstream illicit discharge. A permittee may exclude a junction manhole located upstream from another located in the immediate vicinity or that is serving a drainage alignment with no potential for illicit connections.

For all catchments identified for investigation, during dry weather, field crews will systematically inspect **key junction manholes** for evidence of illicit discharges. This program involves progressive inspection and sampling at manholes in the storm drain network to isolate and eliminate illicit discharges.

The manhole inspection methodology will be conducted in one of two ways (or a combination of both):

- By working progressively up from the outfall and inspecting key junction manholes along the way, or
- By working progressively down from the upper parts of the catchment toward the outfall.

For most catchments, manhole inspections will proceed from the outfall moving up into the system. However, the decision to move up or down the system depends on the nature of the drainage system and the surrounding land use and the availability of information on the catchment and drainage system. Moving up the system can begin immediately when an illicit discharge is detected at an outfall, and only a map of the storm drain system is required. Moving down the system requires more advance preparation and reliable drainage system information on the upstream segments of the storm drain system but may be more efficient if the sources of illicit discharges are believed to be located in the upstream portions of the catchment area. Once a manhole inspection methodology has been selected, investigations will continue systematically through the catchment.

Inspection of key junction manholes will proceed as follows:

1. Manholes will be opened and inspected for visual and olfactory evidence of illicit connections. Use PeopleGIS forms for this. Alternatively hard copy forms can be used, then that information can be entered into PeopleGIS in the office. A sample field inspection form is provided in **Appendix C**.
2. If flow is observed, a sample will be collected and analyzed at a minimum for ammonia, chlorine, and surfactants. Field kits can be used for these analyses. Sampling and analysis will be in accordance with procedures outlined in **Section 6**. Additional indicator sampling may assist in determining potential sources (e.g., bacteria for sanitary flows, conductivity to detect tidal backwater, etc.).

3. Where sampling results or visual or olfactory evidence indicate potential illicit discharges, the area draining to the junction manhole will be flagged for further upstream manhole investigation and/or isolation and confirmation of sources.
4. Subsequent key junction manhole inspections will proceed until the location of suspected illicit discharges can be isolated to a pipe segment between two manholes.

If no evidence of an illicit discharge is found, catchment investigations will be considered complete upon completion of key junction manhole sampling.

7.3 Wet Weather Outfall Sampling

Where a minimum of one (1) System Vulnerability Factor (SVF) is identified based on previous information or the catchment investigation, a wet weather investigation must also be conducted at the associated outfall. The Department of Public Works will be responsible for implementing the wet weather outfall sampling program and making updates as necessary. Wet weather sampling and data collection will use a tablet logged into PeopleGIS. Specific forms are included for entry directly into the Town's stormwater database.

Outfalls will be inspected and sampled under wet weather conditions, to the extent necessary, to determine whether high groundwater in areas served by septic systems result in discharges of sanitary flow to the MS4. Wet weather outfall sampling will proceed as follows:

1. At least one wet weather sample will be collected at the outfall for the same parameters required during dry weather screening.
2. Wet weather sampling will occur during or after a storm event of sufficient depth or intensity to produce a stormwater discharge at the outfall. There is no specific rainfall amount that will trigger sampling, although minimum storm event intensities that are likely to trigger sanitary interconnections are preferred. To the extent feasible, sampling should occur during the spring (March through June) when groundwater levels are relatively high.
3. If wet weather outfall sampling indicates a potential illicit discharge, then additional wet weather source sampling will be performed, as warranted, or source isolation and confirmation procedures will be followed as described in **Section 7.4**.
4. If wet weather outfall sampling does not identify evidence of illicit discharges, and no evidence of an illicit discharge is found during dry weather manhole inspections, catchment investigations will be considered complete.

7.4 Source Isolation and Confirmation

Once the source of an illicit discharge is approximated between two manholes, more detailed investigation techniques will be used to isolate and confirm the source of the illicit discharge. The following methods may be used in isolating and confirming the source of illicit discharges:

- Sandbagging
- Smoke Testing
- Dye Testing
- CCTV/Video Inspections
- Optical Brightener Monitoring
- IDDE Canines
- On-Site Septic Investigations
- Infrared Imagery

These methods are described in the sections below. More detailed instructions, strategies, and Standard Operating Procedures (SOPs) for source isolation and these IDDE methods are provided in **Appendix E**. Techniques specific to areas served by septic systems include on-site investigations and infrared imagery (see Section 13.4 in Appendix E for details).

Public notification is an important aspect of a detailed source investigation program. Prior to smoke testing, dye testing, or TV inspections, the Town will notify property owners in the affected area. Smoke testing notification will include phone calls, hanging door tags, or emails for single family homes, businesses and building lobbies for multi-family dwellings.

7.4.1 Sandbagging

This technique can be particularly useful when attempting to isolate intermittent illicit discharges or those with very little perceptible flow. The technique involves placing sandbags or similar barriers (e.g., caulking, weirs/plates, or other temporary barriers) within outlets to manholes to form a temporary dam that collects any intermittent flows that may occur. Sandbags are typically left in place for 48 hours and should only be installed when dry weather is forecast. If flow has collected behind the sandbags/barriers after 48 hours, it can be assessed using visual observations or by sampling. If no flow collects behind the sandbag, the upstream pipe network can be ruled out as a source of the intermittent discharge. Finding appropriate durations of dry weather and the need for multiple trips to each manhole makes this method both time-consuming and somewhat limiting.

7.4.2 Smoke Testing

Smoke testing involves injecting non-toxic smoke into drain lines and noting the emergence of smoke from plumbing vents in illegally connected buildings or from cracks and leaks in the system itself. Typically, a smoke bomb or smoke generator is used to inject the smoke into the system at a catch basin or manhole and air is then forced through the system. Test personnel are placed in areas where there are suspected illegal connections or cracks/leaks, noting any escape of smoke (indicating an illicit connection or damaged storm drain infrastructure). It is important when using this technique to make proper notifications to area residents and business owners as well as local police and fire departments.

It should be noted that smoke may cause minor irritation of respiratory passages. Residents with respiratory conditions may need to be monitored or evacuated from the area of testing altogether to ensure safety during testing.

7.4.3 Dye Testing

Dye testing involves flushing non-toxic dye into plumbing fixtures such as toilets, showers, and sinks and observing nearby storm drains and stormwater outfalls for the presence of the dye. Like smoke testing, it is important to inform residents and business owners. Police, fire, and local public health staff should also be notified prior to testing in preparation of responding to citizen phone calls concerning the dye and their presence in local surface waters.

A team of two or more people is needed to perform dye testing (ideally, all with two-way radios). One person is inside the building, while the others are stationed at the appropriate storm sewer manhole (which should be opened) and/or outfalls. The person inside the building adds dye into a plumbing fixture (i.e., toilet or sink) and runs a sufficient amount of water to move the dye through the plumbing system. The person inside the building then radios to the outside crew that the dye has been dropped, and the outside crew watches for the dye in the storm sewer, recording the presence or absence of the dye.

The test can be relatively quick (about 30 minutes per test), effective (results are usually definitive), and inexpensive. Dye testing is best used when the likely source of an illicit discharge has been narrowed down to a few specific houses or businesses.

7.4.4 CCTV/Video Inspection

Another method of source isolation involves the use of mobile video cameras that are guided remotely through stormwater drain lines to observe possible illicit discharges. IDDE program staff can review the videos and note any visible illicit discharges. While this tool is both effective and usually definitive, it can be costly and time consuming when compared to other source isolation techniques.

7.4.5 Optical Brightener Monitoring

Optical brighteners are fluorescent dyes that are used in detergents and paper products to enhance their appearance. The presence of optical brighteners in surface waters or dry weather discharges suggests there is a possible illicit discharge or insufficient removal through adsorption in nearby septic systems or wastewater treatment. Optical brightener monitoring can be done in two ways. The most common, and least expensive, methodology involves placing a cotton pad in a wire cage and securing it in a pipe, manhole, catch basin, or inlet to capture intermittent dry weather flows. The pad is retrieved later and placed under UV light to determine the presence/absence of brighteners during the monitoring period. A second methodology uses handheld fluorometers to detect optical brighteners in water sample collected from outfalls or ambient surface waters. Use of a fluorometer, while more quantitative, is typically more expensive and is not as effective at isolating intermittent discharges as other source isolation techniques.

7.4.6 IDDE Canines

Dogs specifically trained to smell human related sewage are becoming a cost-effective way to isolate and identify sources of illicit discharges. While not widespread now, the use of IDDE canines is growing as is their accuracy. The use of IDDE canines is not recommended as a standalone practice for source identification; rather it is recommended as a tool to supplement other conventional methods, such as dye testing, to fully verify sources of illicit discharges.

7.4.7 On-Site Septic Investigations

Three kinds of on-site investigations can be performed at individual properties to determine if the septic system is failing, including homeowner survey, surface condition analysis and a detailed system inspection. The first two investigations are rapid and relatively simple assessments typically conducted in targeted watershed areas. Detailed system inspections are a much more thorough investigation of the functioning of the septic system that is conducted by a certified professional. Detailed system inspections may occur at time of sale of a property, or be triggered by poor scores on the rapid homeowner survey or surface condition analysis.

7.4.8 Infrared Imagery

Infrared imagery is a special type of photography with gray or color scales that represent differences in temperature and emissivity of objects in the image and can be used to locate sewage discharges. Several different infrared imagery techniques can be used to identify illicit discharges. The two most common are aerial infrared thermography and color infrared aerial photography.

7.5 Illicit Discharge Removal

When the specific source of an illicit discharge is identified, the Town will exercise its authority as necessary to require its removal. The annual report will include the status of IDDE investigation and removal activities including the following information for each confirmed source:

- The location of the discharge and its source(s);
- A description of the discharge;
- The method of discovery;
- Date of discovery;

- Date of elimination, mitigation or enforcement action OR planned corrective measures and a schedule for completing the illicit discharge removal; and
- Estimate of the volume of flow removed.

7.5.1 Confirmatory Outfall Screening

Within one (1) year of removal of all identified illicit discharges within a catchment area, confirmatory outfall or interconnection screening will be conducted. The confirmatory screening will be conducted in dry weather unless System Vulnerability Factors have been identified, in which case both dry weather and wet weather confirmatory screening will be conducted. If confirmatory screening indicates evidence of additional illicit discharges, the catchment will be scheduled for additional investigation.

7.6 Ongoing Screening

Upon completion of all catchment investigations and illicit discharge removal and confirmation (if necessary), each outfall or interconnection will be re-prioritized for screening and scheduled for ongoing screening once every five (5) years. Ongoing screening will consist of dry weather screening and sampling consistent with the procedures described in **Section 6** of this plan. Ongoing wet weather screening and sampling will also be conducted at outfalls where wet weather screening was required due to System Vulnerability Factors and will be conducted in accordance with the procedures described in **Section 7.3**. All sampling results will be reported in the annual report.

8. Training

Annual IDDE training will be made available to all employees involved in the IDDE program. This training will at a minimum include information on how to identify illicit discharges, and may also include additional training specific to the functions of certain personnel and their function within the framework of the IDDE program. Training records will be maintained in **Appendix F**. The frequency and type of training will be included in the annual report.

9. Annual Progress Reporting

The progress and success of the IDDE program will be evaluated on an annual basis. The evaluation will be documented in the annual report and will include the following indicators of program progress:

- Number of illicit discharges identified and removed;
- Number and percent of total outfall catchments served by the MS4 evaluated using the catchment investigation procedure;
- Number of dry weather outfall inspections/screenings;
- Number of wet weather outfall inspections/sampling events;
- Number of enforcement notices issued;
- All dry weather and wet weather screening and sampling results;
- Estimate of the volume of sewage removed, as applicable; and
- Number of employees trained annually.

The success of the IDDE program will be measured by the IDDE activities completed within the required permit timelines. The stormwater suite in PeopleGIS will be used to output data reports show the progress of many of these items.

Appendix A

Legal Authority (IDDE Bylaw)

CHAPTER 25. COMPREHENSIVE STORMWATER MANAGEMENT BY-LAW

(Added 2011)

Section 1: Authority

This By-law is adopted under authority granted by the Home Rule Amendment of the Massachusetts Constitution, the Home Rule statutes and pursuant to the regulations of the federal Clean Water Act found at 40 CFR 122.34.

Section 2: Purpose

The purpose of this By-law is to regulate discharges to the Municipal Separate Storm Sewer System (MS4) to protect the Town of Sherborn's water bodies and groundwater and to safeguard the public health, safety, welfare and the environment. Increased and contaminated stormwater runoff associated with construction sites, developed land uses and the accompanying increase in impervious surface are major causes of impairment of water quality and flow in lakes, ponds, streams, rivers, wetlands and groundwater. This purpose is accomplished through the following:

2.1 Institute water resource protection measures identified in the Supplemental Final Comprehensive Water Resource Management Plan / Environmental Impact Report - Commonwealth of Massachusetts EOEA File Number 8844 (CWRMP);

2.2 Protect groundwater and surface water from degradation;

2.3 Promote groundwater recharge;

2.4 Require practices to control the flow of stormwater from new and redeveloped sites into the Town storm drainage system in order to prevent flooding and erosion;

2.5 Require practices that eliminate soil erosion and sedimentation and control the volume and rate of stormwater runoff resulting from land disturbance activities;

2.6 Prevent pollutants from entering the Town's Municipal Separate Storm Sewer System (MS4) and minimize discharge of pollutants from the MS4;

2.7 Ensure that soil erosion and sedimentation control measures and stormwater runoff control practices are incorporated into the site planning and design process and are implemented and maintained;

2.8 Ensure adequate long-term operation and maintenance of structural stormwater best management practices so that they work as designed;

2.9 Comply with state and federal statutes and regulations relating to stormwater discharges; and

2.10 Establish the Town's legal authority to ensure compliance with the provisions of this By-law through inspection, monitoring, and enforcement.

Nothing in this By-law is intended to replace the requirements of the Town of Sherborn Zoning By-law, General By-laws, or any other By-law that may be adopted by the Town of Sherborn. Any activity subject to the provisions of the above-cited By-laws must comply with the specifications of each.

Section 3: Definitions

Except as listed below, words, all terms, abbreviations and acronyms that appear in this bylaw and are also defined in Appendix A of the Final 2016 Massachusetts Small MS4 General Permit ("Appendix A") signed April 4, 2016 with an effective date of July 1, 2018, (MS4 General Permit) or as most recently amended, shall be construed to have the meaning presented in Appendix A.

Illicit Connection -- A surface or subsurface drain or conveyance, which allows an illicit discharge (as described in Section 4.1 below) into the municipal storm drain system, including without limitation sewage, process wastewater, or wash water and any connections from indoor drains, sinks, or toilets, regardless of whether said connection was previously allowed or approved before the effective date of this Bylaw.

Any other definitions that apply in the interpretation and implementation of this By-law shall be included as part of any Stormwater Regulations promulgated as permitted under Section 5.2 of this By-law.

Section 4: Applicability

4.1 Illicit Discharges - The following activities are prohibited:

a. Illicit Discharges – No person shall dump, discharge, cause or allow to be discharged any pollutant, unauthorized stormwater or non-stormwater discharge into the municipal separate storm sewer system (MS4) and/or Town right-of-way.

b. Illicit Connections – No person shall construct, use, allow, maintain or continue any illicit connection to the municipal separate storm sewer system, regardless of whether the connection was permissible under applicable law, regulation or custom at the time of connection.

c. Obstruction of MS4 – No person shall obstruct or interfere with the normal flow of storm water into or out of the MS4 without prior written approval from the Director of Community Maintenance and Development (CMD).

d. Yard Wastes – No person shall dump or dispose of yard waste (leaves, grass clippings, etc.) into the MS4, or into catch basins, retention/detention basins or any other component of a stormwater management system which discharges to the MS4.

4.2 Permitted Non-Stormwater Discharges

A limited category of non-stormwater discharges are only allowed with a permit from the Director of CMD. Such permits may be granted only following an examination of potential alternatives and a finding by the Director that there is no viable alternative. These categories are:

a. Uncontaminated pumped ground water
b. Foundation drains
c. Water from crawl space pumps
d. Footing drains

4.3. Prohibited Non-Stormwater Discharges

The following non-stormwater discharges are strictly prohibited:

a. De-chlorinated swimming pool discharges
b. Discharging water from any source into the street

4.4 Land Disturbance

No person shall undertake construction activity that requires **(a)** Planning Board review (including new subdivisions, special permits for multi-family development, and site plan review for new commercial/industrial development or redevelopment), **(b)** a Building Permit (such as new single family residential development or redevelopment), or **(c)** utility line work, AND if the activity will disturb or alter one acre or more of land, either initially or as part of a common plan for development that will disturb or alter one acre or more of land, without obtaining a Stormwater Management Permit (SMP) from the Planning Board.

Any activity that is subject to Site Plan Review or the Subdivision Control Law or requires a Special Permit from the Planning Board per the Sherborn Zoning Bylaw shall be eligible for an SMP to be reviewed and granted as a component of such other permitting process.

4. 5 Exemptions

The following activities shall be exempt from the requirement for an SMP:

4.5.1 Normal maintenance and improvement of land in agricultural use as defined by M.G.L. Chapter 128 Section 1A.

4.~~2~~5.2 Maintenance of existing landscaping, gardens or lawn areas.

4.5.3 Creating impervious area consisting of a previously existing unpaved driveway for a single family dwelling, or expansion of an existing paved driveway for a single family dwelling.

4.5.4 The construction of fencing that will not alter existing terrain or drainage patterns.

4.5.5 Construction or maintenance and repair of utility service lines (gas, water, electric, telephone, fire alarms, etc.) other than drainage lines or systems, which will not alter terrain, ground cover, or drainage patterns.

4.5.6 Emergency repairs to any stormwater management facility.

4.5.7 Any work or projects for which all necessary approvals and permits, including building permits, have been issued before the effective date of this By-law.

4.5.8 Construction of items normally appurtenant to residential uses, such as decks; patios; walkways; fruit, vegetable, or flower gardens; driveways; sheds; swimming pools; and tennis or basketball courts**.**

4.5.9 Repair or replacement of septic systems.

4.5.10 Any construction activity or project wholly within the jurisdiction of the Conservation Commission provided that an Order of Conditions has been issued by the Conservation Commission.

Section 5: Administration

5.1 The Planning Board shall administer and implement the Land Disturbance provisions of this By-law, and Community Maintenance and Development shall administer and implement the Illicit Discharges provisions.

5.2 Rules And Regulations - The Planning Board and CMD may adopt, and periodically amend, Rules and Regulations relating to the terms, performance standards, conditions, definitions, enforcement, fees (including application, inspection, and/or consultant fees), procedures and administration of this Comprehensive Stormwater Management By-law by majority vote of the Planning Board, after conducting a public hearing to receive comments on any proposed Rules and Regulations or revisions thereto. Such hearing dates shall be advertised in a newspaper of general local circulation, at least seven days prior to the hearing date. After public notice and public hearing, the Planning Board may promulgate Rules and Regulations to effectuate the purposes of this By-law. Failure by the Planning Board to promulgate such Rules and Regulations or a legal declaration of their invalidity by a court shall not act to suspend or invalidate the effect of this By-law.

5.3 Stormwater Management Handbook and NPDES Permits - The Planning Board will utilize the policy, criteria and information including specifications and standards of the latest edition of the Massachusetts Stormwater Management Standards and Handbook for execution of the provisions of this By-law. This Handbook includes a list of acceptable stormwater treatment practices, including the specific design criteria for each stormwater practice. The standards and handbook may be updated and expanded periodically, based on improvements in engineering, science, monitoring, and local maintenance experience. The Planning Board will also utilize the provisions of the MS4 General Permit and other NPDES permits.

5.4 Actions - The Planning Board may take any of the following actions as a result of an application for a Stormwater Management Permit as more specifically defined as part of Stormwater Regulations promulgated as a result of this By-law: Approval, Approval with Conditions, or Disapproval.

5.5 Appeals Of Actions - A decision of the Planning Board shall be final. A decision by the Planning Board made under this Section 24 shall be reviewable in the Superior Court in an action in the nature of certiorari filed within 60 days thereof, in accordance with Massachusetts General Laws chapter 249 Section 4.

5.6 Permits And Procedures - Permit Procedures and Requirements shall be defined and included as part of any Rules and Regulations promulgated as permitted under Section 5.2 of this By-law.

5.7 Water Resources Mitigation Fund - The Planning Board may allow the applicant to contribute to the Town of Sherborn Water Resources Mitigation Fund where it has been demonstrated that there are not sufficient conditions for onsite stormwater best management practices in order to meet the Performance Standards as described in the Regulations promulgated under this By-law. Funds may be used to design and construct stormwater projects that will improve the quality and quantity of surface waters in Sherborn by treating and recharging storm water from existing impervious surfaces that is now discharged to said waters with inadequate treatment or recharge. The amount of the contribution to the fund shall be determined by the Planning Board.

Section 6: Enforcement.

6.1 Land Disturbance

6.1.1 The Community Maintenance & Development Department ("CM&D"), Building Inspector and the Police shall be the enforcement agents. When the Planning Board or its enforcing agent determines that an activity is not being carried out in accordance with the requirements of this Chapter, Stormwater Regulations or an SMP, the agent shall issue a written notice of violation to the owner of the property. Persons receiving a notice of violation may be required to:

6.1.2 Halt all construction activities until there is compliance. A "stop work order" will be in effect until the Planning Board or its agent confirms that the activity is in compliance and the violation has been satisfactorily addressed.

6.1.3 Maintain, install or perform additional erosion and sedimentation control measures;

6.1.4 Monitor, analyze and report to the Planning Board regarding progress in addressing activities cited in a notice of violation;

6.1.5 Remediate erosion and sedimentation resulting directly or indirectly from the activity.

6.1.6 Failure to comply with a notice of violation in the time specified therein constitutes a violation of this By-law and may result in penalties in accordance with the enforcement measures authorized in this Chapter.

6.1.7 Upon identification of the illicit source all responsible parties will be notified. Immediate cessation of improper disposal practices are required. Where elimination of an illicit discharge within 60 days of its identification is not possible, CMD shall immediately commence actions necessary for elimination. CMD will then establish an expeditious schedule for its elimination and report the dates of identification and schedules for removal in the annual MS4 reports to EPA. In the interim, CMD shall take all reasonable and prudent measures to minimize the discharge of pollutants to and from its MS4."

6.2 Illicit Discharges

6.2.1 The CMD Director or his designee shall be the enforcement agent for illicit discharges.

6.2.2 Penalty. Any person who violates any provision of this Chapter, Regulations, or SMP's or violation notices issued thereunder, may be punished by a fine of not more than $250.00. Each day or part thereof that such violation occurs or continues shall constitute a separate offense, and each provision of the Chapter, Regulations or SMP violated, shall constitute a separate offense.

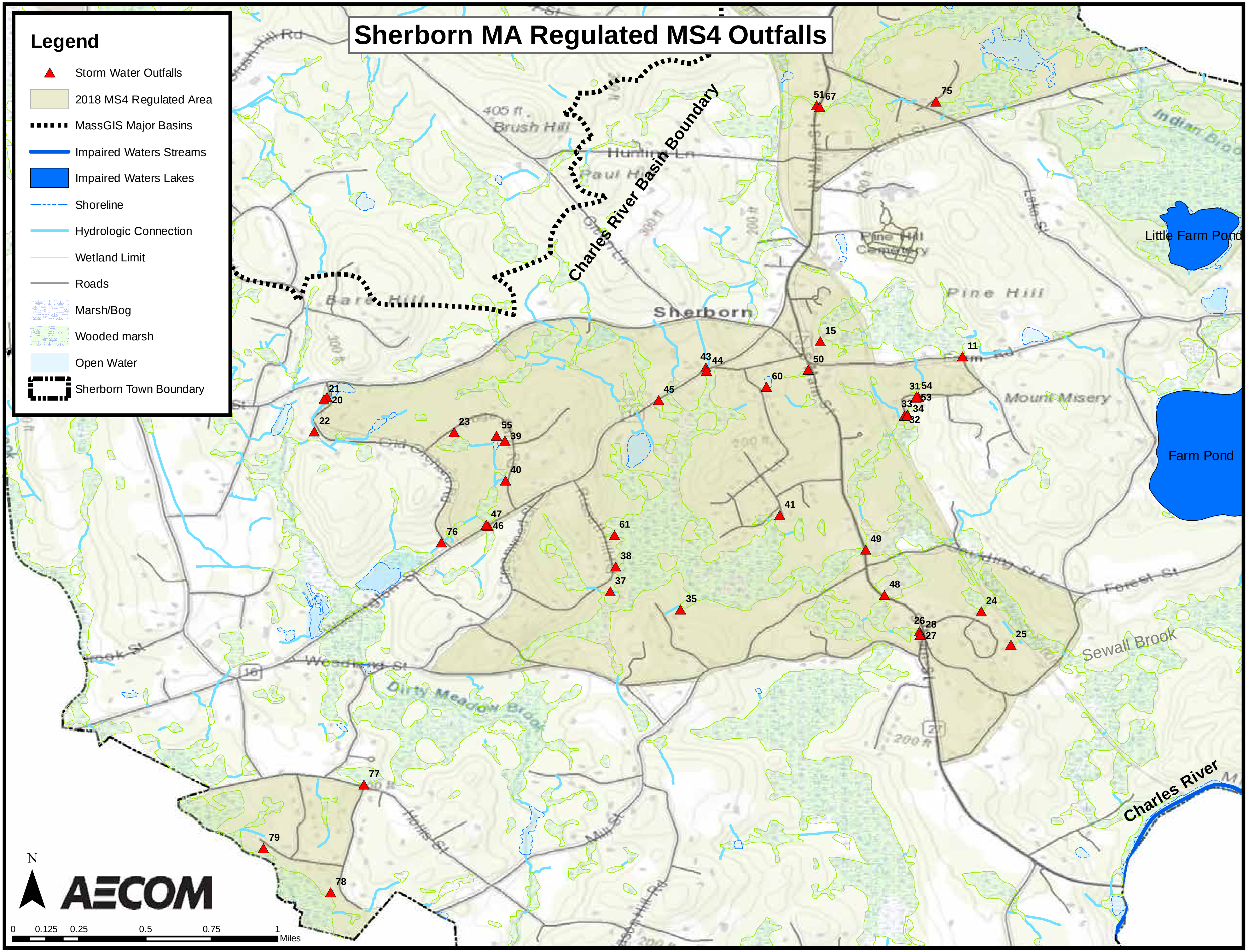
6.2.3 Non-Criminal Disposition. As an alternative to the penalty in Section 6.2, the enforcing authority may elect to utilize the non-criminal disposition procedure set forth in Chapter 16, Section 2 of the General Bylaws of the Town of Sherborn. Each day or part thereof that such violation occurs or continues shall constitute a separate offense, and each provision of this Chapter, Regulation or permit violated shall constitute a separate offense. The penalty for non-criminal disposition shall be $200.00 per violation.

Section 7 Severability

If any provision, paragraph, sentence, or clause of this By-law shall be held invalid for any reason, all other provisions shall continue in full force and effect.

Appendix B

Storm System Mapping



Sherborn MA Regulated MS4 Outfalls
Legend
Storm Water Outfalls
2018 MS4 Regulated Area
MassGIS Major Basins
Impaired Waters Streams
Impaired Waters Lakes
Shoreline
Hydrologic Connection
Wetland Limit
Roads
Marsh/Bog
Wooded marsh
Open Water
Sherborn Town Boundary
Charles River Basin Boundary
Sherborn
Little Farm Pond
Farm Pond
Sewall Brook
Charles River
Dirty Meadow Brook
Pine Hill
Mount Misery
Brush Hill
Bare Hill
N
AECOM
0
0.125
0.25
0.5
0.75
1
Miles

Appendix C

Field Forms and Inspection SOPs

SOP 1: DRY WEATHER OUTFALL INSPECTION

Introduction

Outfalls from an engineered storm drain system can be in the form of pipes or ditches. Under current and pending regulations, it is important to inspect and document water quality from these outfalls under both dry weather and wet weather conditions. SOP 2, "Wet Weather Outfall Inspection", covers the objectives of that type of inspection. This SOP discusses the dry weather inspection objectives, and how they differ from wet weather inspection objectives.

During a dry weather period, it is anticipated that minimal flow from stormwater outfalls will be observed. Therefore, dry weather inspections aim to characterize any/all flow observed during a dry weather period and identify potential source(s) of an illicit discharge through qualitative testing; further described in SOP 13, "Water Quality Screening in the Field".

Objectives of Dry Weather Inspections

A dry weather period is a time interval during which less than 0.1 inch of rain is observed across a minimum of 72 hours. Unlike wet weather sampling, dry weather inspections are not intended to capture a "first flush" of stormwater discharge, rather they are intended to identify any/all discharges from a stormwater outfall during a period without recorded rainfall. The objective of inspections during a dry weather period is to characterize observed discharges and facilitate detection of illicit discharges.

Visual Condition Assessment

The attached Dry Weather Outfall Inspection Survey is a tool to assist in documenting observations related to the both quantitative and qualitative characteristics of any/all flows conveyed by the structure during a dry period.

For any visual observation of pollution in a stormwater outfall discharge, an investigation into the pollution source should occur, but the following are often true:

1. Foam: indicator of upstream vehicle washing activities, or an illicit discharge.
2. Oil sheen: result of a leak or spill.
3. Cloudiness: indicator of suspended solids such as dust, ash, powdered chemicals and ground up materials.
4. Color or odor: Indicator of raw materials, chemicals, or sewage.
5. Excessive sediment: indicator or disturbed earth of other unpaved areas lacking adequate erosion control measures.
6. Sanitary waste and optical enhancers (fluorescent dyes added to laundry detergent and some toilet paper): indicators of illicit discharge.
7. Orange staining: indicator of high mineral concentrations.

Many of these observations are indicators of an illicit discharge. Examples of illicit discharges include: cross-connections of sewer services to engineered storm drain systems; leaking septic systems; intentional discharge of pollutants to catch basins; combined sewer overflows; connected floor drains; and sump pumps connected to the system (under some circumstances). Additional guidelines for illicit discharge investigations are included in SOP 10, "Locating Illicit Discharges".

The Wet Weather Outfall Inspection Survey includes fields where these and other specific observations can be noted. The inspector shall indicate the presence of a specific water quality indicator or parameter by marking "Yes". If "Yes" is marked, provide additional details in the comments section. If the indictor in question is not present mark "No".

Within the comments section, provide additional information with regard to recorded precipitation totals, or more detailed descriptions of observations made during the inspection and corrective actions taken.

Conditional and Qualitative Considerations

Although many of the parameters listed above are considered to be indicators of illicit discharge, the presence of a parameter is not absolute evidence of an illicit discharge.

Some of these indicators may occur naturally. Orange staining may be the result of naturally occurring iron, and therefore unrelated to pollution. Foam can be formed when the physical characteristics of water are altered by the presence of organic materials. Foam is typically found in waters with high organic content such as bog lakes, streams that originate from bog lakes, productive lakes, wetlands, or woody areas. To determine the difference between natural foam and foam cause by pollution, consider the following:

1. Wind direction or turbulence: natural foam occurrences on the beach coincide with onshore winds. Often, foam can be found along a shoreline and/or on open waters during windy days. Natural occurrences in rivers can be found downstream of a turbulent site.
2. Proximity to a potential pollution source: some entities including the textile industry, paper production facilities, oil industries, and fire fighting activities work with materials that cause foaming in water. If these materials are released to a water body in large quantities, they can cause foaming. Also, the presence of silt in water, such as from a construction site can cause foam.
3. Feeling: natural foam is typically persistent, light, not slimy to the touch.
4. Presence of decomposing plants or organic material in the water.

Some of the indicators can have multiple causes or sources. For example, both bacteria and petroleum can create a sheen on the water surface. The source of the sheen can be differentiated by disturbing it, such as with a pole. A sheen caused by oil will remain intact and move in a swirl pattern; a sheen caused by bacteria will separate and appear "blocky". Bacterial or naturally occurring sheens are usually silver or relatively dull in color and will break up into a number of small patches of sheen. The cause may be presence of iron, decomposition of organic material or presence of certain bacteria. Bacterial sheen is not a pollutant but should be noted.

Optical enhancers at high concentrations are sometimes visible to the naked eye as a bluish-purple haze in the water. However, due to physiological variation of the human eye, not all inspectors may be able to identify the presence of these materials, and quantitative testing is the preferred method to confirm the presence of these compounds. Optical enhancers are typically detected through the use of clean, white cotton pads placed within the discharge for several days, dried, and viewed under a fluorometer. If the cotton pad fluoresces, optical enhancers are assumed to be present. The magnitude of the fluorescence, as measured in fluorescent units, can be used to correlate the concentration of optical enhancers in water to other samples collected locally.

Measuring Water Quality

Based on the results of the Visual Condition Assessment, it may be necessary to collect additional data about water quality. Water quality samples can be in the form of screening using field test kits and instrumentation, or by discrete analytical samples processed by a laboratory.

Information on selecting and using field test kits and instrumentation is included in SOP 13, "Water Quality Screening in the Field." The Inspection Survey also provides values for what can be considered an appropriate benchmark for a variety of parameters that can be evaluated in the field.

If the results of screening using field test kits indicate that the outfall's water quality exceeds the benchmarks provided, collection of discrete analytical samples should be considered.

Analytical Sample Collection

Sample collection methods may vary based on specific outfall limitations, but shall follow test procedures outlined in 40 CFR 136. A discrete manual or grab sample can classify water at a distinct point in time. These samples are easily collected and used primarily when the water quality of the discharge is expected to be homogeneous, or unchanging, in nature. A flow-weighted composite sample will classify water quality over a measured period of time. These samples are used when the water quality of the discharge is expected to be heterogeneous, or fluctuating, in nature. Grab samples are more common for dry weather outfall inspections due to the time-sensitive nature of the process.

Protocols for collecting a grab sample shall include the following:

1. Do not eat, drink or smoke during sample collection and processing.
2. Do not collect or process samples near a running vehicle.
3. Do not park vehicles in the immediate sample collection area, including both running and non-running vehicles.
4. Always wear clean, powder-free nitrile gloves when handling sample containers and lids.
5. Never touch the inside surface of a sample container or lid, even with gloved hands.

6. Never allow the inner surface of a sample container or lid to be contacted by any material other than the sample water.
7. Collect samples while facing upstream and so as not to disturb water or sediments in the outfall pipe or ditch.
8. Do not overfill sample containers, and do not dump out any liquid in them. Liquids are often added to sample containers intentionally by the analytical laboratory as a preservative or for pH adjustment.
9. Slowly lower the bottle into the water to avoid bottom disturbance and stirring up sediment.
10. Do not allow any object or material to fall into or contact the collected water sample.
11. Do not allow rainwater to drip from rain gear or other surfaces into sample containers.
12. Replace and tighten sample container lids immediately after sample collection.
13. Accurately label the sample with the time and location.
14. Document on the Wet Weather Outfall Inspection Survey that analytical samples were collected, specify parameters, and note the sample time on the Inspection Survey. This creates a reference point for samples.

Analytical Sample Quality Control and Assurance

Upon completion of successful sample collection, the samples must be sent or delivered to a MassDEP-approved laboratory for analytical testing. Quality control and assurance are important to ensuring accurate analytical test results.

Sample preservation is required to prevent contaminate degradation between sampling and analysis, and should be completed in accordance with 40 CFR 136.3.

Maximum acceptable holding times are also specified for each analytical method in 40 CFR 136.3. Holding time is defined as the period of time between sample collection and extraction for analysis of the sample at the laboratory. Holding time is important because prompt laboratory analysis allows the laboratory to review the data and if analytical problems are found, re-analyze the affected samples within the holding times.

Chain of custody forms are designed to provide sample submittal information and document transfers of sample custody. The forms are typically provided by the laboratory and must be completed by the field sampling personnel for each sample submitted to the lab for analysis. The document must be signed by both the person releasing the sample and the person receiving the sample every time the sample changes hands. The sampling personnel shall keep one copy of the form and send the remaining copies to the laboratory with the samples. Custody seals, which are dated, signed and affixed to the sample container, may be used if the samples are shipped in a cooler via courier or commercial overnight shipping.

Attachments

1. Dry Weather Outfall Inspection Survey

Related Standard Operating Procedures

1. SOP 2, Wet Weather Outfall Inspection
2. SOP 10, Locating Illicit Discharges
3. SOP 13, Water Quality Screening in the Field

Outfall ID: ______________ **Town:** ______________

Inspector: ______________ **Date:** ______________

Street Name ______________________________

Last rainfall event ______________________________

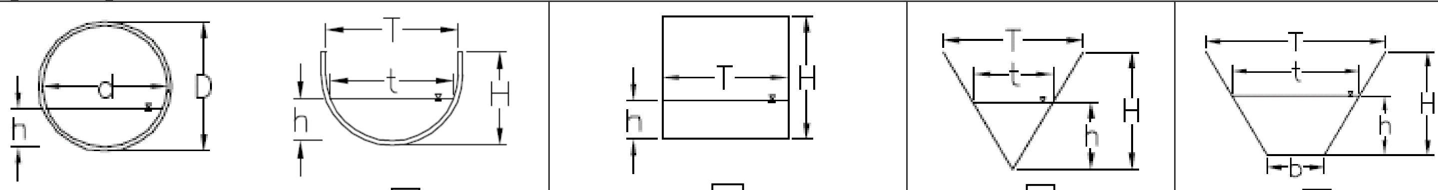
CMRSWC

DRY WEATHER OUTFALL INSPECTION SURVEY

Type of Outfall (check one):	**Pipe Outfall** ☐	**Open Swale Outfall** ☐
Outfall Label:	**Stencil** ☐ **Ground Inset** ☐ **Sign** ☐	**None** ☐ **Other**__________

Pipe Material:	Concrete ☐ Corrugated metal ☐ Clay Tile ☐ Plastic ☐ Other: __________ ☐	**Pipe Condition:**	Good ☐ Poor ☐ Fair ☐ Crumbling ☐
Swale Material:	Paved (asphalt) ☐ Concrete ☐ Earthen ☐ Stone ☐ Other: __________ ☐	**Swale Condition:**	Good ☐ Poor ☐ Fair ☐ Crumbling ☐

Shape of Pipe/Swale (check one)



Rounded Pipe/Swale ☐ ☐	Rectangular Pipe/Swale ☐	Triangular Swale ☐	Trapezoidal Swale ☐

Pipe Measurements:	**Swale Measurements:**	**Is there a headwall?**	**Location Sketch**
Inner Dia. (in): d= _____	Swale Width (in): T= _____	Yes ☐ No ☐	
Outer Dia. (in): D= _____	Flow Width (in): t = _____	**Condition:**	
Pipe Width (in): T= _____	Swale Height (in): H= _____	Good ☐ Poor ☐	
Pipe Height (in): H= _____	Flow Height (in): h= _____*	Fair ☐ Crumbling ☐	
Flow Width (in): h= _____*	Bottom Width (in): b=_____		

Description of Flow: Heavy ☐ Moderate ☐ Trickling ☐ Dry ☐

If the outlet is submerged check yes and indicate approximate height of water above the outlet invert. h above invert (in):	**Circle All Materials Present:**	
Odor: Yes ☐ No ☐ **Optical enhancers suspected?** Yes ☐ No ☐ **Has channelization occurred?** Yes ☐ No ☐ **Has scouring occurred below the outlet?** Yes ☐ No ☐	Rip rap Excessive sediment	Sheen: Bacterial Sheen: Petroleum
Required Maintenance: Tree Work; Ditch Work; Structural Corrosion; N/A; Remove Trash/Debris; Blocked Pipe; Erosion at Structure; Other	Foam Sanitary Waste Orange Staining	Floatables Algae Excessive Vegetation
Comments:		

OUTFALL INSPECTION 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 ☐ CMP ☐ PVC ☐ HDPE ☐ Steel ☐ Other: ________	☐ Circular ☐ Single ☐ Elliptical ☐ Double ☐ Box ☐ Triple ☐ Other: ____ ☐ Other: ____	Diameter, circular: ____ Box: h - ____ w - ____ Elliptical: h - ____ w - ____	In Water: ☐ No ☐ Partially* ☐ Fully* With Sediment: ☐ No ☐ Partially ☐ Fully
☐ **Open drainage**	☐ Concrete ☐ rip-rap ☐ Earthen ☐ Other: ________	☐ Trapezoid ☐ Other:________ ☐ Parabolic	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 (only for free-flowing outfalls)	Flow depth		In	Tape measure
	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:

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?

SOP 2: WET WEATHER OUTFALL INSPECTION

Introduction

Outfalls from an engineered storm drain system can be in the form of pipes or ditches. Under current and pending regulations, it is important to inspect and document water quality from these outfalls under both dry weather and wet weather conditions. SOP 1, "Dry Weather Outfall Inspection", covers the objectives of that type of inspection. This SOP discusses wet weather inspection objectives and how they differ from dry weather inspection objectives. The primary difference is that wet weather inspection aims to describe and evaluate the first flush of stormwater discharged from an outfall during a storm, representing the maximum pollutant load managed by receiving water.

Definition of Wet Weather

A storm is considered a representative wet weather event if greater than 0.1 inch of rain falls and occurs at least 72 hours after the previously measurable (greater than 0.1 inch of rainfall) storm event. In some watersheds, based on the amount of impervious surface present, increased discharge from an outfall may not result from 0.1 inch of rain. An understanding of how outfalls respond to different events will develop as the inspection process proceeds over several months, allowing the inspectors to refine an approach for inspections.

Ideally, the evaluation and any samples collected should occur within the first 30 minutes of discharge to reflect the first flush or maximum pollutant load.

Typical practice is to prepare for a wet weather inspection event when weather forecasts show a 40% chance of rain or greater. If the inspector intends to collect analytical samples, coordination with the laboratory for bottleware and for sample drop-off needs to occur in advance.

Visual Condition Assessment

The attached Wet Weather Outfall Inspection Survey should be used to document observations related to the quality of stormwater conveyed by the structure. Observations such as the following can indicate sources of pollution within the storm drain system:

- Oil sheen
- Discoloration
- Trash and debris

For any visual observation of pollution in a stormwater outfall discharge, an investigation into the pollution source should occur, but the following are often true:

1. Foam: indicator of upstream vehicle washing activities, or an illicit discharge.
2. Oil sheen: result of a leak or spill.

3. Cloudiness: indicator of suspended solids such as dust, ash, powdered chemicals and ground up materials.
4. Color or odor: Indicator of raw materials, chemicals, or sewage.
5. Excessive sediment: indicator or disturbed earth of other unpaved areas lacking adequate erosion control measures.
6. Sanitary waste and optical enhancers (fluorescent dyes added to laundry detergent and some toilet paper): indicators of illicit discharge.
7. Orange staining: indicator of high mineral concentrations.

Many of these observations are indicators of an illicit discharge. Examples of illicit discharges include: cross-connections of sewer services to engineered storm drain systems; leaking septic systems; intentional discharge of pollutants to catch basins; combined sewer overflows; connected floor drains; and sump pumps connected to the system (under some circumstances). Additional guidelines for illicit discharge investigations are included in SOP 10, “Locating Illicit Discharges”.

The Wet Weather Outfall Inspection Survey includes fields where these and other specific observations can be noted. The inspector shall indicate the presence of a specific water quality indicator or parameter by marking “Yes”. If “Yes” is marked, provide additional details in the comments section. If the indictor in question is not present mark “No”.

Within the comments section, provide additional information with regard to recorded precipitation totals, or more detailed descriptions of observations made during the inspection and corrective actions taken.

Conditional and Qualitative Considerations

Although many of the parameters listed above are considered to be indicators of illicit discharge, the presence of a parameter is not absolute evidence of an illicit discharge.

Some of these indicators may occur naturally. Orange staining may be the result of naturally occurring iron, and therefore unrelated to pollution. Foam can be formed when the physical characteristics of water are altered by the presence of organic materials. Foam is typically found in waters with high organic content such as bog lakes, streams that originate from bog lakes, productive lakes, wetlands, or woody areas. To determine the difference between natural foam and foam cause by pollution, consider the following:

1. Wind direction or turbulence: natural foam occurrences on the beach coincide with onshore winds. Often, foam can be found along a shoreline and/or on open waters during windy days. Natural occurrences in rivers can be found downstream of a turbulent site.
2. Proximity to a potential pollution source: some entities including the textile industry, paper production facilities, oil industries, and fire fighting activities work with materials that cause foaming in water. If these materials are released to a water body in large quantities, they can cause foaming. Also, the presence of silt in water, such as from a construction site can cause foam.
3. Feeling: natural foam is typically persistent, light, not slimy to the touch.

4. Presence of decomposing plants or organic material in the water.

Some of the indicators can have multiple causes or sources. For example, both bacteria and petroleum can create a sheen on the water surface. The source of the sheen can be differentiated by disturbing it, such as with a pole. A sheen caused by oil will remain intact and move in a swirl pattern; a sheen caused by bacteria will separate and appear "blocky". Bacterial or naturally occurring sheens are usually silver or relatively dull in color and will break up into a number of small patches of sheen. The cause may be presence of iron, decomposition of organic material or presence of certain bacteria. Bacterial sheen is not a pollutant but should be noted.

Optical enhancers at high concentrations are sometimes visible to the naked eye as a bluish-purple haze in the water. However, due to physiological variation of the human eye, not all inspectors may be able to identify the presence of these materials, and quantitative testing is the preferred method to confirm the presence of these compounds. Optical enhancers are typically detected through the use of clean, white cotton pads placed within the discharge for several days, dried, and viewed under a fluorometer. If the cotton pad fluoresces, optical enhancers are assumed to be present. The magnitude of the fluorescence, as measured in fluorescent units, can be used to correlate the concentration of optical enhancers in water to other samples collected locally.

Measuring Water Quality

Based on the results of the Visual Condition Assessment, it may be necessary to collect additional data about water quality. Water quality samples can be in the form of screening using field test kits or by discrete analytical samples processed by a laboratory.

Information on how to use field test kits is included in SOP 13, "Water Quality Screening with Field Test Kits", and the Wet Weather Outfall Inspection Survey includes fields to document the results of such screening. The Inspection Survey also provides values for what can be considered an appropriate benchmark for a variety of parameters that can be evaluated with field test kits.

If the results of screening using field test kits indicate that the outfall's water quality exceeds the benchmarks provided, collection of discrete analytical samples should be considered.

Analytical Sample Collection

Sample collection methods may vary based on specific outfall limitations but shall follow test procedures outlined in 40 CFR 136. A discrete manual or grab sample can classify water at a distinct point in time. These samples are easily collected and used primarily when the water quality of the discharge is expected to be homogeneous, or unchanging, in nature. A flow-weighted composite sample will classify water quality over a measured period of time. These samples are used when the water quality of the discharge is expected to be heterogeneous, or fluctuating, in nature. Grab samples are more common for wet weather outfall inspections due to the time-sensitive nature of the process.

Protocols for collecting a grab sample shall include the following:

1. Do not eat, drink or smoke during sample collection and processing.
2. Do not collect or process samples near a running vehicle.
3. Do not park vehicles in the immediate sample collection area, including both running and non-running vehicles.
4. Always wear clean, powder-free nitrile gloves when handling sample containers and lids.
5. Never touch the inside surface of a sample container or lid, even with gloved hands.
6. Never allow the inner surface of a sample container or lid to be contacted by any material other than the sample water.
7. Collect samples while facing upstream and so as not to disturb water or sediments in the outfall pipe or ditch.
8. Do not overfill sample containers, and do not dump out any liquid in them. Liquids are often added to sample containers intentionally by the analytical laboratory as a preservative or for pH adjustment.
9. Slowly lower the bottle into the water to avoid bottom disturbance and stirring up sediment.
10. Do not allow any object or material to fall into or contact the collected water sample.
11. Do not allow rainwater to drip from rain gear or other surfaces into sample containers.
12. Replace and tighten sample container lids immediately after sample collection.
13. Accurately label the sample with the time and location.
14. Document on the Wet Weather Outfall Inspection Survey that analytical samples were collected, specify parameters, and note the sample time on the Inspection Survey. This creates a reference point for samples.

Analytical Sample Quality Control and Assurance

Upon completion of successful sample collection, the samples must be sent or delivered to a MassDEP-approved laboratory for analytical testing. Quality control and assurance are important to ensuring accurate analytical test results.

Sample preservation is required to prevent contaminant degradation between sampling and analysis and should be completed in accordance with 40 CFR 136.3.

Maximum acceptable holding times are also specified for each analytical method in 40 CFR 136.3. Holding time is defined as the period of time between sample collection and extraction for analysis of the sample at the laboratory. Holding time is important because prompt laboratory analysis allows the laboratory to review the data and if analytical problems are found, re-analyze the affected samples within the holding times.

Chain of custody forms are designed to provide sample submittal information and document transfers of sample custody. The forms are typically provided by the laboratory and must be completed by the field sampling personnel for each sample submitted to the lab for analysis. The document must be signed by both the person releasing the sample and the person receiving the sample every time the sample changes hands. The sampling personnel shall keep one copy of the form and send the remaining copies to the laboratory with the samples. Custody seals, which are dated, signed and affixed to the sample container, may be used if the samples are shipped in a cooler via courier or commercial overnight shipping.

Attachments

1. Wet Weather Outfall Inspection Survey

Related Standard Operating Procedures

1. SOP 1, Dry Weather Outfall Inspection
2. SOP 10, Locating Illicit Discharges
3. SOP 13, Water Quality Screening in the Field

Outfall I.D.: ____________ **Date:** ____________

Inspector: ____________

Time of Inspection: ____________

Street Name ____________

Last rainfall event ____________

WET WEATHER OUTFALL INSPECTION SURVEY

Visual Inspection:	**Yes**	**No**	**Comments (Include probable source of observed contamination):**
Color	☐	☐	
Odor	☐	☐	
Turbidity	☐	☐	
Excessive Sediment	☐	☐	
Sanitary Waste	☐	☐	
Pet Waste	☐	☐	
Floatable Solids	☐	☐	
Oil Sheen	☐	☐	
Bacterial Sheen	☐	☐	
Foam	☐	☐	
Algae	☐	☐	
Orange Staining	☐	☐	
Excessive Vegetation	☐	☐	
Optical Enhancers	☐	☐	
Other ____________			

WET WEATHER OUTFALL INSPECTION SURVEY

Sample Parameters	Analytical Test Method	Benchmark	Field Screening Result	Full Analytical?
Ammonia[1]	EPA 350.2/SM4500-NH3C	>0.5 mg/L		☐ Yes ☐ No
Boron[1]	EPA 212.3	>35.0 mg/L		☐ Yes ☐ No
Chloride[2]	EPA 300.0	230 mg/L		☐ Yes ☐ No
Color[1]	EPA 110.1/110.2	>500 units		☐ Yes ☐ No
Detergents & Surfactants[3]	EPA 425.1/SM5540C	>0.25 mg/L		☐ Yes ☐ No
Fluoride[3]	EPA 300.0	>0.25 mg/L		☐ Yes ☐ No
Hardness[1]	EPA 130.2	<10 mg/L or >2,000 mg/L		☐ Yes ☐ No
pH[1]	EPA 150.1/SM 4500H	<5		☐ Yes ☐ No
Potassium[1]	EPA 200.7	>20 mg/L		☐ Yes ☐ No
Specific Conductance[1]	SM 2510B	>2,000 µS/cm		☐ Yes ☐ No
Turbidity[1]	EPA 180.1	>1,000 NTU		☐ Yes ☐ No
Comments:				

[1] – *Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments*, Center for Watershed Protection and Robert Pitt of University of Alabama, 2004, p. 134, Table 45.

[2] – *Env –Ws 1703.21Water Quality Criteria for Toxic Substances,* State of New Hampshire Department of Surface Water Quality Regulations.

[2] – *Appendix I – Field Measurements, Benchmarks and Instrumentation*, Draft Massachusetts North Coastal Small MS4 General Permit, 2009.

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

MANHOLE INSPECTION LOG

Manhole ID No. [ ]

Inspection Date: ____________________________ Tributary Area:____

Street: ___________________________________ Manhole Type:

Inspection: Not Found ____ Surface ____ Internal ____ Storm Drain ______

Follow Up Inspection __________ High Outlet ________ Lovejoy ________

Time Since Last Rain:

Inspector: _________________________________ < 48 hours _____ 48 – 72 hours _____ > 72 hours _____

Observations:

Standing Water in Manhole: Yes ____ No ____ Color of Water: Clear ____ Cloudy ____ Other _______________

Flow in Manhole: Yes _____ No _____ Velocity: Slow _____ Medium _____ Fast _____ Depth of Flow: _____ in.

Color of Flow: No Flow: _____ Clear _____ Cloudy _____ Suspended Solids _____ Other ____________________

Blockages: Yes _____ No _____ Sediment in Manhole: Yes ____ No____ If Yes: Percent of Pipe Filled: _____ %

Floatables: None _____ Sewage _____ Oily Sheen ______ Foam _____ Other ______________________________

Odor: None _____ Sewage _____ Oil _____ Soap _____Other ____

Field Testing:

pH _____ Temp _____ Spec. Cond. _____ Surfactants: Yes _____ No __ Ammonia: Yes _____ No __

Contamination:

Found During Inspection Yes __ Check one: __Observation __Positive Test Kit Result

No __ Sandbagged Placed No __ Yes ____ Give Date _________

Sandbag Checked (Date): __________ and Flow was __ Captured __ Not Captured:

If Flow Captured, Check one: Visual Evidence Test Kit Positive Test Kit Negative (Not Contaminated)

Condition of Manhole:

Grade: At _____ Above_____ Below _____

Common Manholes:

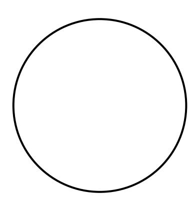
		Yes	No	NA
High Outlet: Blocked		___	___	___
Lovejoy: Cover Plate in Place		___	___	___

	Good	Fair	Poor	Comments
Pavement	_____	_____	_____	____________________
Cover	_____	_____	_____	____________________
Frame	_____	_____	_____	____________________
Corbel	_____	_____	_____	____________________
Walls	_____	_____	_____	____________________
Floor	_____	_____	_____	____________________

Construction Material:

	Brick	Precast	Other
Corbel	____	_____	____________________
Walls	____	_____	____________________
Floor	____	_____	____________________

Comments: Manhole Correct as Mapped Yes _____ No _____ **N↑**



Plan of Manhole

Continue on back if necessary

SOP 3: CATCH BASIN INSPECTION AND CLEANING

Introduction

Catch basins help minimize flooding and protect water quality by removing trash, sediment, decaying debris, and other solids from stormwater runoff. These materials are retained in a sump below the invert of the outlet pipe. Catch basin cleaning reduces foul odors, prevents clogs in the storm drain system, and reduces the loading of suspended solids, nutrients, and bacteria to receiving waters.

During regular cleaning and inspection procedures, data can be gathered related to the condition of the physical basin structure and its frame and grate and the quality of stormwater conveyed by the structure. Observations such as the following can indicate sources of pollution within the storm drain system:

- Oil sheen
- Discoloration
- Trash and debris

Both bacteria and petroleum can create a sheen on the water surface. The source of the sheen can be differentiated by disturbing it, such as with a pole. A sheen caused by a oil will remain intact and move in a swirl pattern; a sheen caused by bacteria will separate and appear “blocky”. Bacterial sheen is not a pollutant but should be noted.

Observations such as the following can indicate a potential connection of a sanitary sewer to the storm drain system, which is an illicit discharge.

- Indications of sanitary sewage, including fecal matter or sewage odors
- Foaming, such as from detergent
- Optical enhancers, fluorescent dye added to laundry detergent

Each catch basin should be cleaned and inspected at least annually. Catch basins in high-use areas may require more frequent cleaning. Performing street sweeping on an appropriate schedule will reduce the amount of sediment, debris, and organic matter entering the catch basins, which will in turn reduce the frequency with which structures need to be cleaned.

Cleaning Procedure

Catch basin inspection cleaning procedures should address both the grate opening and the basin’s sump. Document any and all observations about the condition of the catch basin structure and water quality on the Catch Basin Inspection Form (attached).

Catch basin inspection and cleaning procedures include the following:

1. Work upstream to downstream.
2. Clean sediment and trash off grate.
3. Visually inspect the outside of the grate.

4. Visually inspect the inside of the catch basin to determine cleaning needs.
5. Inspect catch basin for structural integrity.
6. Determine the most appropriate equipment and method for cleaning each catch basin.
    a. Manually use a shovel to remove accumulated sediments, or
    b. Use a bucket loader to remove accumulated sediments, or
    c. Use a high pressure washer to clean any remaining material out of catch basin while capturing the slurry with a vacuum.
    d. If necessary, after the catch basin is clean, use the rodder of the vacuum truck to clean downstream pipe and pull back sediment that might have entered downstream pipe.
7. If contamination is suspected, chemical analysis will be required to determine if the materials comply with the Massachusetts DEP Hazardous Waste Regulations, 310 CMR 30.000 (http://www.mass.gov/dep/service/regulations/310cmr30.pdf). Chemical analysis required will depend on suspected contaminants. Note the identification number of the catch basin on the sample label, and note sample collection on the Catch Basin Inspection Form.
8. Properly dispose of collected sediments. See following section for guidance.
9. If fluids collected during catch basin cleaning are not being handled and disposed of by a third party, dispose of these fluids to a sanitary sewer system, with permission of the system operator.
10. If illicit discharges are observed or suspected, notify the appropriate Department (see "SOP 10: Addressing Illicit Discharges").
11. At the end of each day, document location and number of catch basins cleaned, amount of waste collected, and disposal method for all screenings.
12. Report additional maintenance or repair needs to the appropriate Department.

Disposal of Screenings

Catch basin cleanings from storm water-only drainage systems may be disposed at any landfill that is permitted by MassDEP to accept solid waste. MassDEP does not routinely require stormwater-only catch basin cleanings to be tested before disposal, unless there is evidence that they have been contaminated by a spill or some other means.

Screenings may need to be placed in a drying bed to allow water to evaporate before proper disposal. In this case, ensure that the screenings are managed to prevent pollution.

Attachments

1. Catch Basin Inspection Form

Related Standard Operating Procedures

1. SOP 10, Addressing Illicit Discharges
2. SOP 13, Water Quality Screening in the Field

Job No.: ______________ **Town:** ______________

Inspector: ______________ **Date:** ______________

CMRSWC

CATCH BASIN INSPECTION FORM

Catch Basin I.D.	______________	**Final Discharge from Structure?** Yes ☐ No ☐ **If Yes, Discharge to Outfall No:**______________

Catch Basin Label: **Stencil** ☐ **Ground Inset** ☐ **Sign** ☐ **None** ☐ **Other**______________

Basin Material:	Concrete ☐ Corrugated metal ☐ Stone ☐ Brick ☐ Other: ______________ ☐	**Catch Basin Condition:**	Good ☐ Poor ☐ Fair ☐ Crumbling ☐
Pipe Material:	Concrete ☐ HDPE ☐ PVC ☐ Clay Tile ☐ Other:______________	**Pipe Measurements:**	Inlet Dia. (in): d= ____ Outlet Dia. (in): D= ____

Required Maintenance/ Problems (check all that apply):

- ☐ Tree Work Required
- ☐ New Grate is Required
- ☐ Pipe is Blocked
- ☐ Frame Maintenance is Required
- ☐ Remove Accumulated Sediment
- ☐ Pipe Maintenance is Required
- ☐ Basin Undermined or Bypassed
- ☐ Cannot Remove Cover
- ☐ Ditch Work
- ☐ Corrosion at Structure
- ☐ Erosion Around Structure
- ☐ Remove Trash & Debris
- ☐ Need Cement Around Grate

Other: ______________

Catch Basin Grate Type :	**Sediment Buildup Depth :**	**Description of Flow:**	**Street Name/ Structure Location:**
Bar: ☐ Cascade: ☐ Other:______________ Properly Aligned: Yes ☐ No ☐	0-6 (in): _____ 6-12(in): _____ 12-18 (in): _____ 18-24 (in): _____ 24 + (in): _____	Heavy ☐ Moderate ☐ Slight ☐ Trickling ☐	

***If the outlet is submerged check yes and indicate approximate height of water above the outlet invert.** h above invert (in):___ Yes ☐ No ☐

☐ **Flow** ☐ **Standing Water** **(check one or both)**	**Observations:** Color: Odor:	

Weather Conditions : Dry > 24 hours ☐ Wet ☐

Sample of Screenings Collected for Analysis? Yes ☐ No ☐

Comments:

Circle those present:

Foam	Oil Sheen
Sanitary Waste	Bacterial Sheen
Orange Staining	Floatables
Excessive sediment	Pet Waste
Other:_______	Optical Enhancers

Appendix D

Water Quality Analysis Instructions, User's Manuals, and Standard Operating Procedures

Appendix E

Source Isolation and Confirmation Methods: Instructions and SOPs

SOP: LOCATING ILLICIT DISCHARGES

Introduction

An "illicit discharge" is any discharge to an engineered storm drain system that is not composed entirely of stormwater unless the discharge is defined as an allowable non-stormwater discharge under the 2003 Massachusetts MS4 Permit. Illicit discharges may enter the engineered storm drain system through direct or indirect connections, such as: cross-connections of sewer services to engineered storm drain systems; leaking septic systems; intentional discharge of pollutants to catch basins; combined sewer overflows; connected floor drains; and sump pumps connected to the system (under some circumstances). Illicit discharges can contribute high levels of pollutants, such as heavy metals, toxics, oil, grease, solvents, nutrients, and pathogens to receiving streams.

Illicit discharges can be located by several methods, including routine dry weather outfall inspections and catch basin inspections, which are described in detail in SOP 1, "Dry Weather Outfall Inspection" and SOP 3, "Catch Basin Inspection and Cleaning", respectively, as well as from citizen reports.

This SOP assumes that the municipality has legal authority (i.e., a bylaw or ordinance) in place, per the requirements of the 2003 Massachusetts MS4 Permit, to prohibit the connection of non-stormwater discharges into the storm drain system. The authority or department for addressing illicit discharge reports would be clearly identified in the municipality's legal authority. In Massachusetts, this is typically a combination of the Board of Health, the Department of Public Works (or Highway Department), and the local sanitary sewer department or commission. In some communities, the Conservation Commission may also play a role. This SOP refers to "appropriate authority" generically to reflect differences in how municipalities have identified these roles.

Identifying Illicit Discharges

The following are often indicators of an illicit discharge from stormwater outfall:

1. Foam: indicator of upstream vehicle washing activities, or an illicit discharge.
2. Oil sheen: result of a leak or spill.
3. Cloudiness: indicator of suspended solids such as dust, ash, powdered chemicals and ground up materials.
4. Color or odor: Indicator of raw materials, chemicals, or sewage.
5. Excessive sediment: indicator of disturbed earth of other unpaved areas lacking adequate erosion control measures.
6. Sanitary waste and optical enhancers (fluorescent dyes added to laundry detergent): indicator of the cross-connection of a sewer service.
7. Orange staining: indicator of high mineral concentrations.

Both bacteria and petroleum can create a sheen on the water surface. The source of the sheen can be differentiated by disturbing it, such as with a pole. A sheen caused by oil will remain intact and move in a swirl pattern; a sheen caused by bacteria will separate and appear "blocky". Bacterial sheen is not a pollutant but should be noted.

Citizen Call in Reports

Reports by residents and other users of a water body can be effective tools in identifying the presence of illicit discharges. Many communities have set up phone hotlines for this purpose, or have provided guidance to local police departments and dispatch centers to manage data reported in this manner. Municipal employees and the general public should receive education to help identify the signs of illicit discharges and should be informed how to report such incidents.

When a call is received about a suspected illicit discharge, the attached IDDE Incident Tracking Sheet shall be used to document appropriate information. Subsequent steps for taking action to trace, document, and eliminate the illicit discharge are described in the following sections.

Potential illicit discharges reported by citizens should be reviewed on an annual basis to locate patterns of illicit discharges, identify high-priority catchments, and evaluate the call-in inspection program.

Tracing Illicit Discharges

Whenever an illicit discharge is suspected, regardless of how it was identified, the attached IDDE Incident Tracking Sheet should be utilized. The Incident Tracking Sheet shall be provided to the appropriate authority (i.e., Board of Health, Department of Public Works, etc.), which shall promptly investigate the reported incident.

If the presence of an illicit discharge is confirmed by the authority, but its source is unidentified, additional procedures to determine the source of the illicit discharge should be completed.

1. Review and consider information collected when illicit discharge was initially identified, for example, the time of day and the weather conditions for the previous 72 hours. Also consider and review past reports or investigations of similar illicit discharges in the area.
2. Obtain storm drain mapping for the area of the reported illicit discharge. If possible, use a tracking system that can be linked to your system map, such as GIS.
3. Document current conditions at the location of the observed illicit discharge point, including odors, water appearance, estimated flow, presence of floatables, and other pertinent information. Photograph relevant evidence.
4. If there continues to be evidence of the illicit discharge, collect water quality data using the methods described in SOP 13, "Water Quality Screening in the Field". This may include using field test kits or instrumentation, or collecting analytical samples for full laboratory analysis.
5. Move upstream from the point of observation to identify the source of the discharge, using the system mapping to determine infrastructure, tributary pipes, and drainage areas that contribute. At each point, survey the general area and surrounding properties to identify potential sources of the illicit discharge. Document observations at each point on the IDDE Incident Tracking Sheet as well as with photographs.
6. Continue this process until the illicit discharge is no longer observed, which will define the boundaries of the likely source. For example if the illicit discharge is present in catch basin 137

but not the next upstream catch basin, 138, the source of the illicit discharge is between these two structures.

If the source of the illicit discharge could not be determined by this survey, consider using dye testing, smoke testing, or closed-circuit television inspection (CCTV) to locate the illicit discharge.

Dye Testing

Dye testing is used to confirm a suspected illicit connection to a storm drain system. Prior to testing, permission to access the site should be obtained. Dye is discharged into the suspected fixture, and nearby storm drain structures and sanitary sewer manholes observed for presence of the dye. Each fixture, such as sinks, toilets, and sump pumps, should be tested separately. A third-party contractor may be required to perform this testing activity.

Smoke Testing

Smoke testing is a useful method of locating the source of illicit discharges when there is no obvious potential source. Smoke testing is an appropriate tracing technique for short sections of pipe and for pipes with small diameters. Smoke added to the storm drain system will emerge in connected locations. A third-party contractor may be required to perform this testing activity.

Closed Circuit Television Inspection (CCTV)

Televised video inspection can be used to locate illicit connections and infiltration from sanitary sewers. In CCTV, cameras are used to record the interior of the storm drain pipes. They can be manually pushed with a stiff cable or guided remotely on treads or wheels. A third-party contractor may be required to perform this testing activity.

If the source is located, follow steps for removing the illicit discharge. Document repairs, new sanitary sewer connections, and other corrective actions required to accomplish this objective. If the source still cannot be located, add the pipe segment to a future inspection program.

This process is demonstrated visually on the last page of this SOP.

Removing Illicit Discharges

Proper removal of an illicit discharge will ensure it does not recur. Refer to Table SOP 10-1, attached for, for examples of the notification process.

In any scenario, conduct a follow up inspection to confirm that the illicit discharge has been removed. Suspend access to the storm drain system if an “imminent and substantial danger” exists or if there is a threat of serious physical harm to humans or the environment.

Attachments

1. Illicit Discharge Incident Tracking Sheet

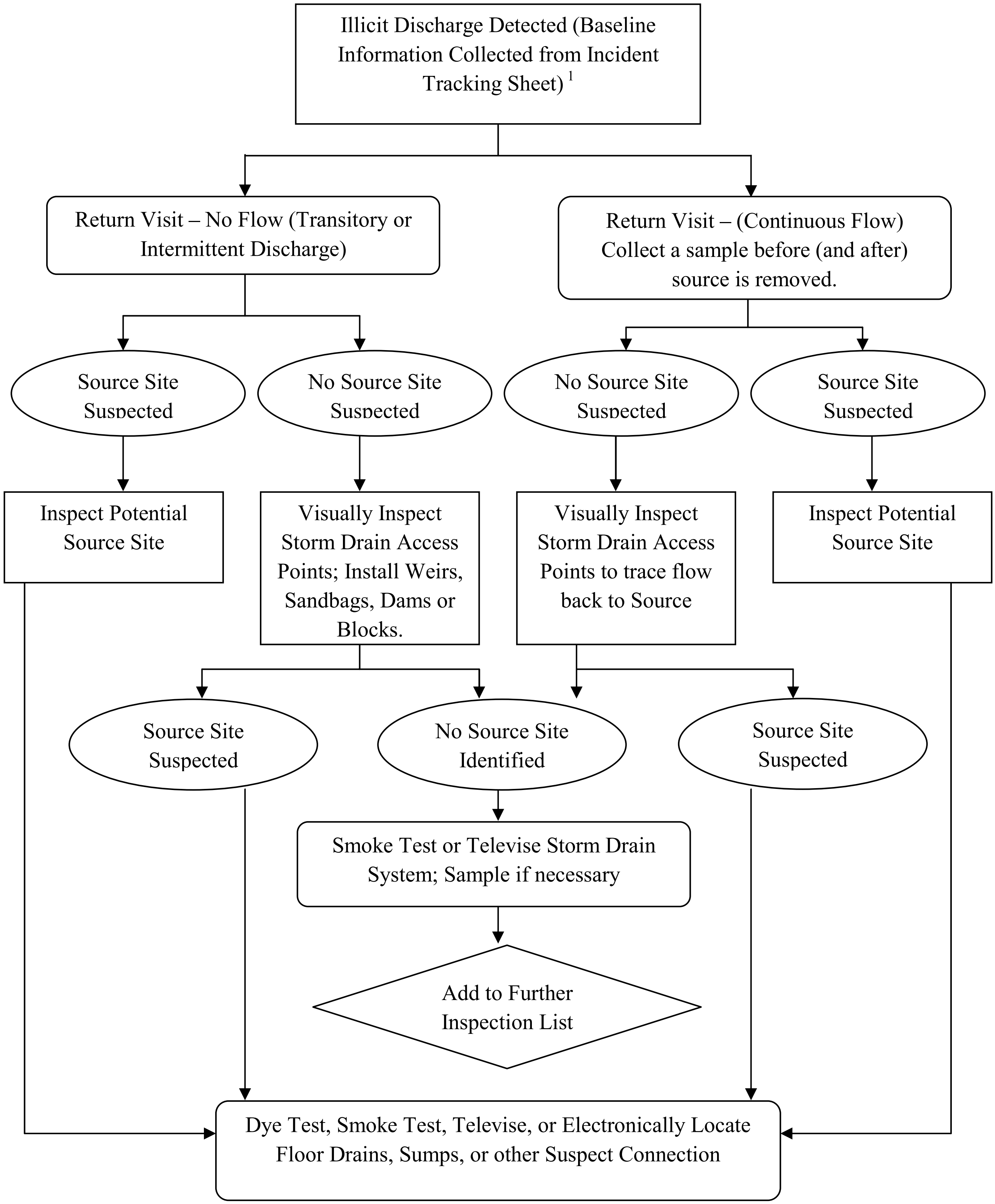
Related Standard Operating Procedures

1. SOP 1: Dry Weather Outfall Inspection
2. SOP 2: Wet Weather Outfall Inspection
3. SOP 3: Catch Basin Inspection
4. SOP 13: Using Field Test Kits For Outfall Screening
5. SOP 15: Private Drainage Connections

Table SOP 10-1

Notification and Removal Procedures for Illicit Discharges into the Municipal Separate Storm Sewer System

Financially Responsible	Source Identified	Enforcement Authority	Procedure to Follow
Private Property Owner	One-time illicit discharge (e.g. spill, dumping, etc.)	Ordinance enforcement authority (e.g. Code Enforcement Officer)	• Contact Owner • Issue Notice of Violation • Issue fine
Private Property Owner	Intermittent or continuous illicit discharge from legal connection	Ordinance enforcement authority (e.g. Code Enforcement Officer)	• Contact Owner • Issue Notice of Violation • Determine schedule for removal • Confirm removal
Private Property Owner	Intermittent or continuous illicit discharge from illegal connection or indirect (e.g. infiltration or failed septic)	Plumbing Inspector or ordinance enforcement authority	• Notify Plumbing Inspector or ordinance enforcement authority
Municipal	Intermittent or continuous illicit discharge from illegal connection or indirect (e.g. failed sewer line)	Ordinance enforcement authority (e.g. Code Enforcement Officer)	• Issue work order • Schedule removal • Remove connection • Confirm removal
Exempt 3rd Party	Any	USEPA	• Notify exempt third party and USEPA of illicit discharge


Illicit Discharge Detected (Baseline Information Collected from Incident Tracking Sheet) [1]
Return Visit – No Flow (Transitory or Intermittent Discharge)
Return Visit – (Continuous Flow) Collect a sample before (and after) source is removed.
Source Site Suspected
No Source Site Suspected
No Source Site Suspected
Source Site Suspected
Inspect Potential Source Site
Visually Inspect Storm Drain Access Points; Install Weirs, Sandbags, Dams or Blocks.
Visually Inspect Storm Drain Access Points to trace flow back to Source
Inspect Potential Source Site
Source Site Suspected
No Source Site Identified
Source Site Suspected
Smoke Test or Televise Storm Drain System; Sample if necessary
Add to Further Inspection List
Dye Test, Smoke Test, Televise, or Electronically Locate Floor Drains, Sumps, or other Suspect Connection

[1] – *Guidelines and Standard Operating Procedures: Illicit Discharge Detection and Elimination and Pollution Prevention/Good Housekeeping for Stormwater Phase II Communities in New Hampshire,* New Hampshire Estuary Project, 2006, p. 25, Figure 2-1.

Illicit Discharge Incident Tracking Sheet

<table>
<tr><td colspan="6">Incident ID:</td></tr>
<tr><td colspan="6">Responder Information (for Citizen-Reported issues)</td></tr>
<tr><td colspan="3">Call Taken By:</td><td colspan="3">Call Date:</td></tr>
<tr><td colspan="3">Call Time:</td><td colspan="3">Precipitation (inches)
in past 24-48 hours:</td></tr>
<tr><td colspan="3">Observer Information</td><td colspan="3"></td></tr>
<tr><td colspan="3">Date and Time of Observation:</td><td colspan="3">Observed During Regular Maintenance or Inspections? ☐ Yes ☐ No</td></tr>
<tr><td colspan="6">Caller Contact Information (optional) or Municipal Employee Information:</td></tr>
<tr><td colspan="6">Observation Location: (complete one or more below)</td></tr>
<tr><td colspan="6">Latitude and Longitude:</td></tr>
<tr><td colspan="6">Stream Address or Outfall #:</td></tr>
<tr><td colspan="6">Closest Street Address:</td></tr>
<tr><td colspan="6">Nearby Landmark:</td></tr>
<tr><td colspan="2">Primary Location Description</td><td colspan="4">Secondary Location Description:</td></tr>
<tr><td colspan="2">☐Stream Corridor (In or adjacent to stream)</td><td>☐Outfall</td><td colspan="2">☐In-stream Flow</td><td>☐Along Banks</td></tr>
<tr><td colspan="2">☐Upland Area (Land not adjacent to stream)</td><td>☐Near Storm Drain</td><td colspan="3">☐Near other water source (stormwater pond, wetland, ect.):</td></tr>
<tr><td colspan="6">Narrative description of location:</td></tr>
<tr><td colspan="6">Upland Problem Indicator Description</td></tr>
<tr><td>☐Dumping</td><td colspan="3">☐Oil/Solvents/Chemicals</td><td colspan="2">☐Sewage</td></tr>
<tr><td>☐Detergent, suds, etc.</td><td colspan="5">☐Other:________________________________</td></tr>
<tr><td colspan="6">Stream Corridor Problem Indicator Description</td></tr>
<tr><td rowspan="2">Odor</td><td>☐None</td><td>☐Sewage</td><td colspan="2">☐Rancid/Sour</td><td>☐Petroleum (gas)</td></tr>
<tr><td>☐Sulfide (rotten eggs); natural gas</td><td colspan="4">☐Other: Describe in “Narrative” section</td></tr>
<tr><td rowspan="3">Appearance</td><td>☐“Normal”</td><td>☐Oil Sheen</td><td colspan="2">☐Cloudy</td><td>☐Foam</td></tr>
<tr><td colspan="5">☐Optical enhancers ☐ Discolored</td></tr>
<tr><td colspan="5">☐Other: Describe in “Narrative” section</td></tr>
<tr><td rowspan="2">Floatables</td><td>☐None</td><td>☐Sewage (toilet paper, etc)</td><td colspan="2">☐Algae</td><td>☐Trash or debris</td></tr>
<tr><td colspan="5">☐Other: Describe in “Narrative” section</td></tr>
<tr><td colspan="6">Narrative description of problem indicators:</td></tr>
<tr><td colspan="6">Suspected Source (name, personal or vehicle description, license plate #, address, etc.):</td></tr>
</table>

Excepted from: Brown, E., Caraco, D., & Pitt, R. (2004). Illicit Discharge Detection and Elimination: a guidance manual for program development and technical assessments. Water Permits Division, Office of Water and Wastewater, US Environmental Protection Agency.

Chapter 13: Tracking Discharges To A Source

Once an illicit discharge is found, a combination of methods is used to isolate its specific source. This chapter describes the four investigation options that are introduced below.

Storm Drain Network 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.

Drainage Area Investigation

This method relies on an analysis of land use or other characteristics of the drainage area that is producing the illicit discharge. The investigation can be as simple as a "windshield" survey of the drainage area or a more complex mapping analysis of the storm drain network and potential generating sites. Drainage area investigations work best when prior indicator monitoring reveals strong clues as to the likely generating site producing the discharge.

On-site Investigation

On-site methods are used to trace the source of an illicit discharge in a pipe segment, and may involve dye, video or smoke testing within isolated segments of the storm drain network.

Septic System Investigation

Low-density residential watersheds may require special investigation methods if they are not served by sanitary sewers and/or storm water is conveyed in ditches or swales. The major illicit discharges found in low-density development are failing septic systems and illegal dumping. Homeowner surveys, surface inspections and infrared photography have all been effectively used to find failing septic systems in low-density watersheds.

13.1 Storm Drain Network Investigations

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.

Where to Sample in the Storm Drain Network

The field crew should decide how to attack the pipe network that contributes to a problem outfall. Three options can be used:

- 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.

The decision to move up, split, or move down the trunk depends on the nature and land use of the contributing drainage area. Some guidance for making this decision is provided in Table 53. Each option requires different levels of advance preparation. Moving up the trunk can begin immediately when an illicit discharge is detected at the outfall, and only requires a map of the storm drain system. Splitting the trunk and moving down the system require a little more preparation to analyze the storm drain map to find the critical branches to strategically sample manholes. Accurate storm drain maps are needed for all three options. If good mapping is not available, dye tracing can help identify manholes, pipes and junctions, and establish a new map of the storm drain network.

Option 1: Move up the Trunk

Moving up the trunk of the storm drain network is effective for illicit discharge problems in relatively small drainage areas. Field crews start with the manhole closest to the outfall, and progressively move up the network, inspecting manholes until indicators reveal that the discharge is no longer present (Figure 50). The goal is to isolate the discharge between two storm drain manholes.

Table 53: Methods to Attack the Storm Drain Network

Method	Nature of Investigation	Drainage System	Advance Prep Required
Follow the discharge up	Narrow source of an individual discharge	Small diameter outfall (< 36”) Simple drainage network	No
Split into segments	Narrow source of a discharge identified at outfall	Large diameter outfall (> 36”), Complex drainage Logistical or traffic issues may make sampling difficult.	Yes
Move down the storm drain	Multiple types of pollution, many suspected problems—possibly due to old plumbing practices or number of NPDES permits	Very large drainage area (> one square mile).	Yes

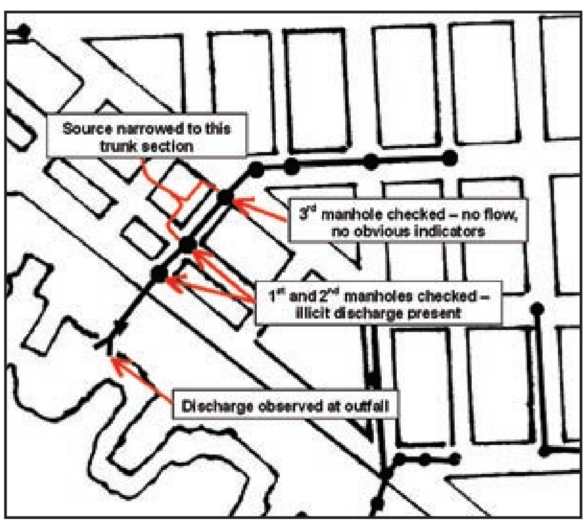


Figure 50: Example investigation following the source up the storm drain system

Option 2: Split the storm drain network

When splitting the storm drain network, field crews select strategic manholes at junctions in the storm drain network to isolate discharges. This option is particularly suited in larger and more complex drainage areas since it can limit the total number of manholes to inspect, and it can avoid locations where access and traffic are problematic.

The method for splitting the trunk is as follows:

1. Review a map of the storm drain network leading to the suspect outfall.
2. Identify major contributing branches to the trunk. The trunk is defined as the largest diameter pipe in the storm drain network that leads directly to the outfall. The “branches” are networks of smaller pipes that contribute to the trunk.
3. Identify manholes to inspect at the farthest downstream node of each contributing branch and one immediately upstream (Figure 51).
4. Working up the network, investigate manholes on each contributing branch and trunk, until the source is narrowed to a specific section of the trunk or contributing branch.
5. Once the discharge is narrowed to a specific section of trunk, select the appropriate on-site investigation method to trace the exact source.
6. If narrowed to a contributing branch, move up or split the branch until a specific pipe segment is isolated, and commence the appropriate on-site investigation to determine the source.

Option 3: Move down the storm drain network

In this option, crews start by inspecting manholes at the “headwaters” of the storm drain network, and progressively move down pipe. This approach works best in very large drainage areas that have many potential continuous and/or intermittent discharges. The Boston Water and Sewer Commission has employed the headwater option to investigate intermittent discharges in complex drainage areas up to three square miles (Jewell, 2001). Field crews certify that each upstream branch of the storm drain network has no contributing discharges before moving down pipe to a “junction manhole” (Figure 52). If discharges are found, the crew performs dye testing to pinpoint the discharge. The crew then confirms that the discharge is removed before moving farther down the pipe network. Figure 53 presents a detailed flow chart that describes this option for analyzing the storm drain network.

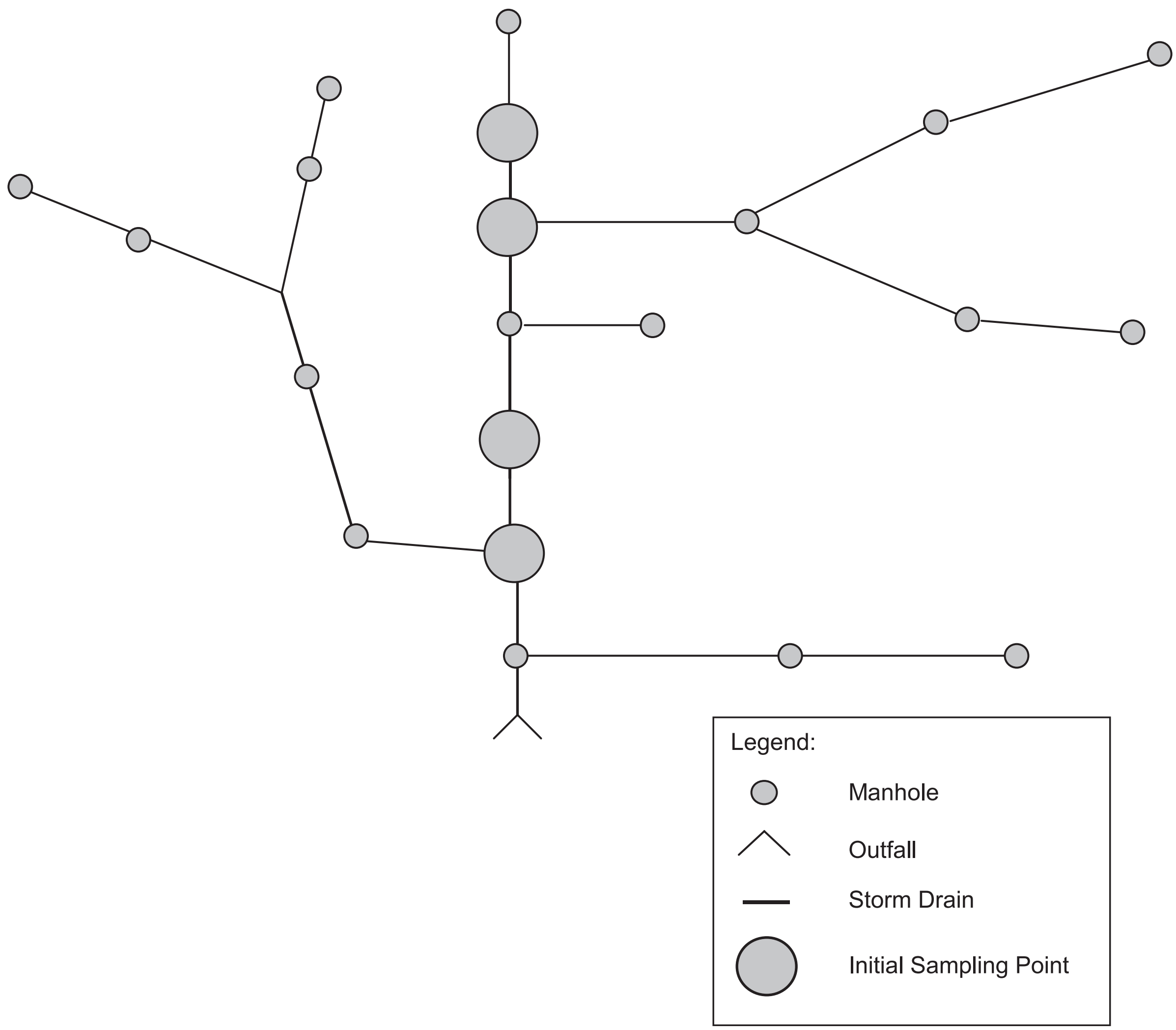


Figure 51: Key initial sampling points along the trunk of the storm drain

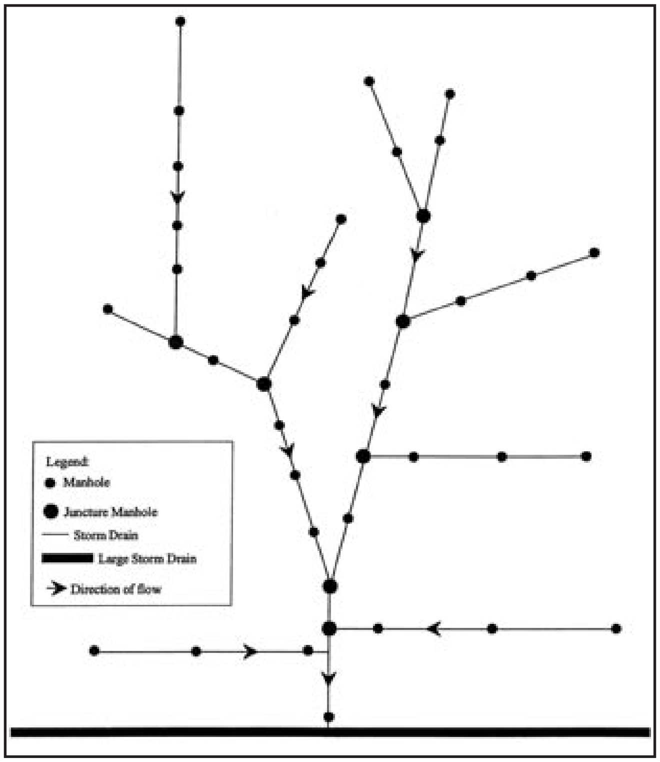


Figure 52: Storm Drain Schematic Identifying "Juncture Manholes" (Source: Jewell, 2001)

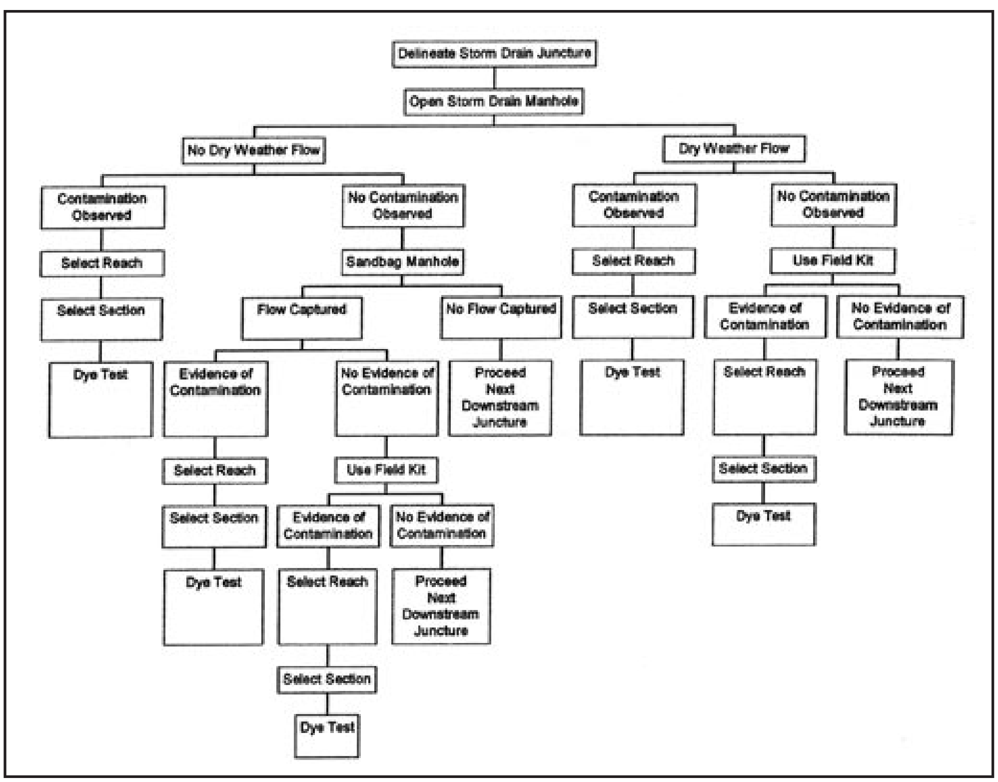


Figure 53: A Process for Following Discharges Down the Pipe (Source: Jewell, 2001)

Dye Testing to Create a Storm Drain Map

As noted earlier, storm drain network investigations are extremely difficult to perform if accurate storm drain maps are not available. In these situations, field crews may need to resort to dye testing to determine the flowpath within the storm drain network. Fluorescent dye is introduced into the storm drain network and suspected manholes are then inspected to trace the path of flow through the network (U.S. EPA, 1990). Two or three member crews are needed for dye testing. One person drops the dye into the trunk while the other(s) looks for evidence of the dye down pipe.

To conduct the investigation, a point of interest or down pipe "stopping point" is identified. Dye is then introduced into manholes upstream of the stopping point to determine if they are connected. The process continues in a systematic manner until an upstream manhole can no longer be determined, whereby a branch or trunk of the system can be defined, updated or corrected. More information on dye testing methods is provided in Section 13.3.

Manhole Inspection: Visual Observations and Indicator Sampling

Two primary methods are used to characterize discharges observed during manhole inspections—visual observations and indicator sampling. In both methods, field crews must first open the manhole to determine whether an illicit discharge is present. Manhole inspections require a crew of two and should be conducted during dry weather conditions.

Basic field equipment and safety procedures required for manhole inspections are outlined in Table 54. In particular, field crews need to be careful about how they will safely divert traffic (Figure 54). Other safety considerations include proper lifting of manhole covers to reduce the potential for back injuries, and testing whether any toxic or flammable fumes exist within the manhole before the cover is removed. Wayne County, MI has developed some useful operational procedures for inspecting manholes, which are summarized in Table 55.

Table 54: Basic Field Equipment Checklist

• Camera and film or digital camera	• Storm drain, stream, and street maps
• Clipboards	• Reflective safety vests
• Field sheets	• Rubber / latex gloves
• Field vehicle	• Sledgehammer
• First aid kit	• Spray paint
• Flashlight or spotlight	• Tape measures
• Gas monitor and probe	• Traffic cones
• Manhole hook/crow bar	• Two-way radios
• Mirror	• Waterproof marker/ pen
• Hand held global positioning satellite (GPS) system receiver (best resolution available within budget, at least 6' accuracy)	

Figure 54: Traffic cones divert traffic from manhole inspection area

Table 55: Field Procedure for Removal of Manhole Covers *(Adapted from: Pomeroy et al., 1996)*
Field Procedures: 1. Locate the manhole cover to be removed. 2. Divert road and foot traffic away from the manhole using traffic cones. 3. Use the tip of a crowbar to lift the manhole cover up high enough to insert the gas monitor probe. Take care to avoid creating a spark that could ignite explosive gases that may have accumulated under the lid. Follow procedures outlined for the gas monitor to test for accumulated gases. 4. If the gas monitor alarm sounds, close the manhole immediately. Do not attempt to open the manhole until some time is allowed for gases to dissipate. 5. If the gas monitor indicates the area is clear of hazards, remove the monitor probe and position the manhole hook under the flange. Remove the crowbar. Pull the lid off with the hook. 6. When testing is completed and the manhole is no longer needed, use the manhole hook to pull the cover back in place. Make sure the lid is settled in the flange securely. 7. Check the area to ensure that all equipment is removed from the area prior to leaving.
Safety Considerations: 1. Do not lift the manhole cover with your back muscles. 2. Wear steel-toed boots or safety shoes to protect feet from possible crushing injuries that could occur while handling manhole covers. 3. Do not move manhole covers with hands or fingers. 4. Wear safety vests or reflective clothing so that the field crew will be visible to traffic. 5. Manholes may only be entered by properly trained and equipped personnel and when all OSHA and local rules a.

Visual Observations During Manhole Inspection

Visual observations are used to observe conditions in the manhole and look for any signs of sewage or dry weather flow. Visual observations work best for obvious illicit discharges that are not masked by groundwater or other "clean" discharges, as shown in Figure 55. Typically, crews progressively inspect manholes in the storm drain network to look for contaminated flows. Key visual observations that are made during manhole inspections include:

- Presence of flow
- Colors
- Odors
- Floatable materials
- Deposits or stains (intermittent flows)

Figure 55: Manhole observation (left) indicates a sewage discharge. Source is identified at an adjacent sewer manhole that overflowed into the storm drain system (right).

Indicator Sampling

If dry weather flow is observed in the manhole, the field crew can collect a sample by attaching a bucket or bottle to a tape measure/rope and lowering it into the manhole (Figure 56). The sample is then immediately analyzed in the field using probes or other tests to get fast results as to whether the flow is clean or dirty. The most common indicator parameter is ammonia, although other potential indicators are described in Chapter 12.

Manhole indicator data is analyzed by looking for "hits," which are individual samples that exceed a benchmark concentration. In addition, trends in indicator concentrations are also examined throughout the storm drain network.

Figure 56: Techniques to sample from the storm drain

Figure 57 profiles a storm drain network investigation that used ammonia as the indicator parameter and a benchmark concentration of 1.0 mg/L. At both the outfall and the first manhole up the trunk, field crews recorded finding "hits" for ammonia of 2.2 mg/L and 2.3 mg/L, respectively. Subsequent manhole inspections further up the network revealed one manhole with no flow, and a second with a hit for ammonia (2.4 mg/L). The crew then tracked the discharge upstream of the second manhole, and found a third manhole with a low ammonia reading (0.05 mg/L) and a fourth with a much higher reading (4.3 mg/L). The crew then redirected its effort to sample above the fourth manhole with the 4.3 mg/L concentration, only to find another low reading. Based on this pattern, the crew concluded the discharge source was located between these two manholes, as nothing else could explain this sudden increase in concentration over this length of pipe.

The results of storm drain network investigations should be systematically documented to guide future discharge investigations, and describe any infrastructure maintenance problems encountered. An example of a sample manhole inspection field log is displayed in Figure 58.

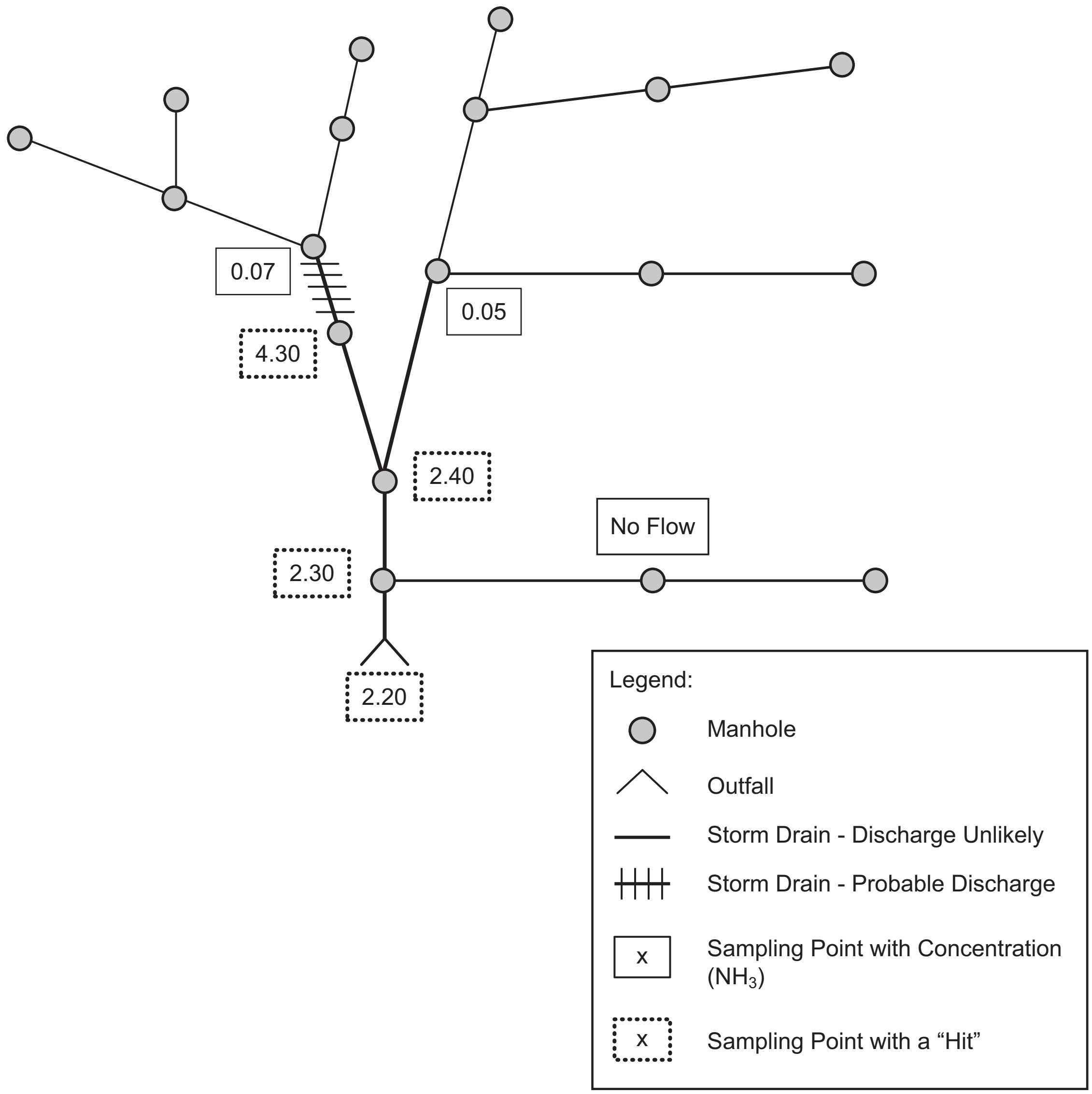


Figure 57: Use of ammonia as a trace parameter to identify illicit discharges

BOSTON WATER AND SEWER COMMISSION
MANHOLE INSPECTION LOG

Manhole ID No.

Inspection Date: ____________________ Tributary Area: ______________________________

Street: __________________________ Manhole Type:

Inspection: Not Found ___ Surface ___ Internal ___ Sanitary Sewer _____ Storm Drain _____

Follow Up Inspection _________ High Outlet _______ Lovejoy _______

Time Since Last Rain:

Inspector: _________________________ < 48 hours _____ 48 – 72 hours _____ > 72 hours _____

Observations:

Standing Water in Manhole: Yes ____ No ____ Color of Water: Clear ____ Cloudy ____ Other ____________

Flow in Manhole: Yes _____ No _____ Velocity: Slow _____ Medium _____ Fast _____ Depth of Flow: _____ in.

Color of Flow: No Flow: _____ Clear _____ Cloudy _____ Suspended Solids _____ Other ________________

Blockages: Yes _____ No _____ Sediment in Manhole: Yes ____ No____ If Yes: Percent of Pipe Filled: _____ %

Floatables: None _____ Sewage _____ Oily Sheen ______ Foam _____ Other ______________________

Odor: None _____ Sewage _____ Oil _____ Soap _____Other ______________________________

Field Testing:

pH _____ Temp _____ Spec. Cond. _____ Surfactants: Yes _____ No __ Ammonia: Yes _____ No __

Contamination:

Found During Inspection Yes __ Check one: __Observation __Positive Test Kit Result

No __ Sandbagged Placed No __ Yes ____ Give Date _______

Sandbag Checked (Date): _______ Flow was ____ Captured ____ Not Captured

Condition of Manhole:

Grade: At _____ Above_____ Below _____ High Outlet: Blocked — Common Manholes: Yes ___ No ___ NA ___

Lovejoy: Cover Plate in Place Yes ___ No ___ NA ___

	Good	Fair	Poor	Comments
Pavement	____	____	____	______________
Cover	____	____	____	______________
Frame	____	____	____	______________
Corbel	____	____	____	______________
Walls	____	____	____	______________
Floor	____	____	____	______________

Construction Material:

	Brick	Precast	Other
Corbel	___	___	______________
Walls	___	___	______________
Floor	___	___	______________

Comments: Manhole Correct as Mapped Yes _____ No _____

N↑

Plan of Manhole

Figure 58: Boston Water and Sewer Commission Manhole Inspection Log (Source: Jewell, 2001)

Methods to isolate intermittent discharges in the storm drain network

Intermittent discharges are often challenging to trace in the storm drain network, although four techniques have been used with some success.

Sandbags

This technique involves placement of sandbags or similar barriers within strategic manholes in the storm drain network to form a temporary dam that collects any intermittent flows that may occur. Any flow collected behind the sandbag is then assessed using visual observations or by indicator sampling. Sandbags are lowered on a rope through the manhole to form a dam along the bottom of the storm drain, taking care not to fully block the pipe (in case it rains before the sandbag is retrieved). Sandbags are typically installed at junctions in the network to eliminate contributing branches from further consideration (Figure 59). If no flow collects behind the sandbag, the upstream pipe network can be ruled out as a source of the intermittent discharge.

Sandbags are typically left in place for no more than 48 hours, and should only be installed when dry weather is forecast. Sandbags should not be left in place during a heavy rainstorm. They may cause a blockage in the storm drain, or, they may be washed downstream and lost. The biggest downside to sandbagging is that it requires at least two trips to each manhole.

Optical Brightener Monitoring (OBM) Traps

Optical brightener monitoring (OBM) traps, profiled in Chapter 12, can also be used to detect intermittent flows at manhole junctions. When these absorbent pads are anchored in the pipe to capture dry weather flows, they can be used to determine the presence of flow and/or detergents. These OBM traps are frequently installed by lowering them into an open-grate drop inlet or storm drain inlet, as shown in Figure 60. The pads are then retrieved after 48 hours and are observed under a fluorescent light (this method is most reliable for undiluted washwaters).

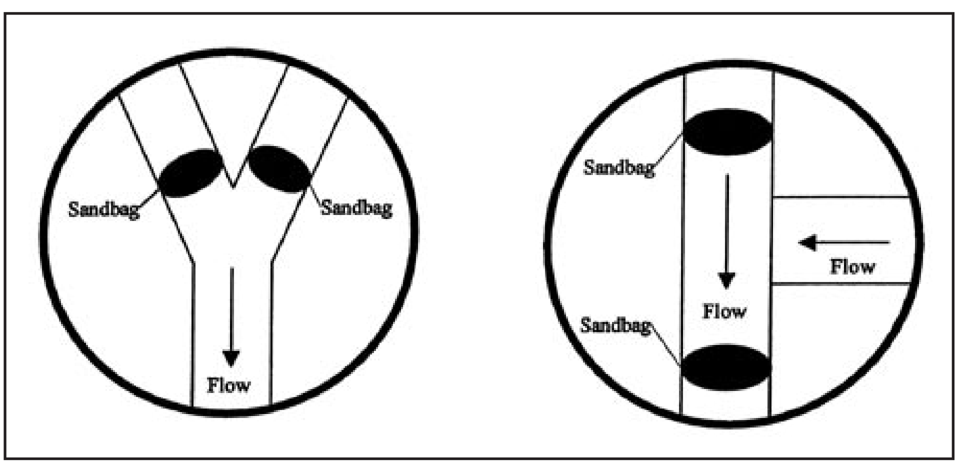


Figure 59: Example sandbag placement (Source: Jewell, 2001)

Figure 60: Optical Brightener Placement in the Storm Drain
(Source: Sargent and Castonguay, 1998)

Automatic Samplers

A few communities have installed automated samplers at strategic points within the storm drain network system that are triggered by small dry weather flows and collect water quality samples of intermittent discharges. Automated sampling can be extremely expensive, and is primarily used in very complex drainage areas that have severe intermittent discharge problems. Automated samplers can pinpoint the specific date and hours when discharges occur, and characterize its chemical composition, which can help crews fingerprint the generating source.

Observation of Deposits or Stains

Intermittent discharges often leave deposits or stains within the storm drain pipe or manhole after they have passed. Thus, crews should note whether any deposits or stains are present in the manhole, even if no dry weather flow is observed. In some cases, the origin of the discharge can be surmised by collecting indicator samples in the water ponded within the manhole sump. Stains and deposits, however, are not always a conclusive way to trace intermittent discharges in the storm drain network.

13.2 Drainage Area Investigations

The source of some illicit discharges can be determined through a survey or analysis of the drainage area of the problem outfall. The simplest approach is a rapid windshield survey of the drainage area to find the potential discharger or generating sites. A more sophisticated approach relies on an analysis of available GIS data and permit databases to identify industrial or other generating sites. In both cases, drainage area investigations are only effective 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. Often, discharges with a unique color, smell, or off-the-chart indicator sample reading may point to a specific industrial or commercial source. Drainage area investigations are not helpful in tracing sewage discharges, since they are often not always related to specific land uses or generating sites.

Rapid Windshield Survey

A rapid drive-by survey works well in small drainage areas, particularly if field crews are already familiar with its business operations. Field crews try to 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. Another example is illustrated in Figure 61 where extremely dense algal growth was observed in a small stream during the winter. Field crews were aware of a fertilizer storage site in the drainage area, and a quick inspection identified it as the culprit.

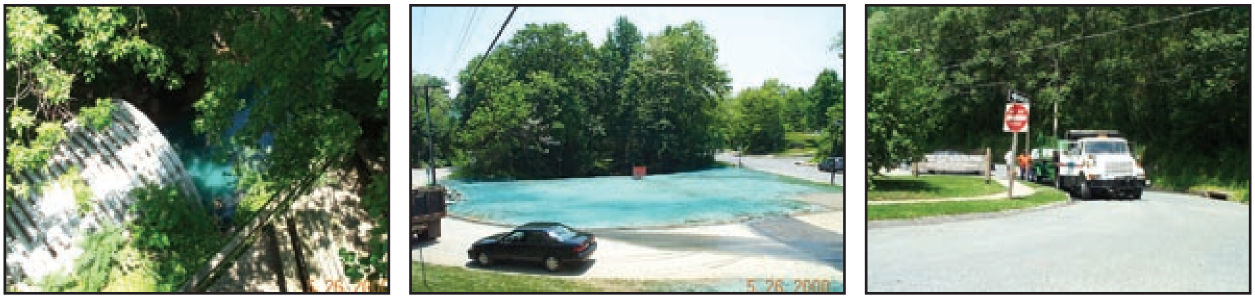


Figure 61: Symptom (left): Discoloration of stream; Diagnosis: Extra hydroseed leftover from an upstream application (middle) was dumped into a storm drain by municipal officials (right).

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

Detailed Drainage Area Investigations

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

13.3 On-site Investigations

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

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

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

TIP

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

Figure 63: Dye Testing Plumbing (NEIWPCC, 2003)

Dye Testing

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

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

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

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

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

Table 57: Key Field Equipment for Dye Testing *(Source: Wayne County, MI, 2000)*
Maps, Documents • Sewer and storm drain maps (sufficient detail to locate manholes) • Site plan and building diagram • Letter describing the investigation • Identification (e.g., badge or ID card) • Educational materials (to supplement pollution prevention efforts) • List of agencies to contact if the dye discharges to a stream. • Name of contact at the facility
Equipment to Find and Lift the Manhole Safely (small manhole often in a lawn) • Probe • Metal detector • Crow bar • Safety equipment (hard hats, eye protection, gloves, safety vests, steel-toed boots, traffic control equipment, protective clothing, gas monitor)
Equipment for Actual Dye Testing and Communications • 2-way radio • Dye (liquid or "test strips") • High powered lamps or flashlights • Water hoses • Camera


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

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

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

Table 58: Dye Testing Options

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

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

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

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

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

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

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

Video Testing

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

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

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

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

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

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

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

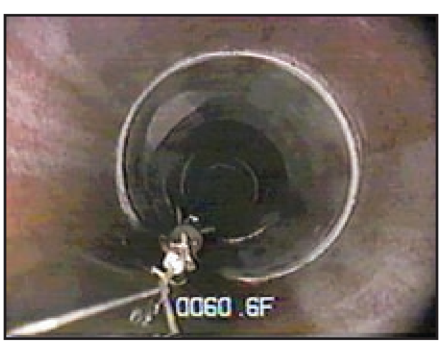


Figure 65: Camera being towed

Smoke Testing

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

Figure 66: Tractor-mounted camera

Figure 67: Review of an inspection video

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

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

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

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

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

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

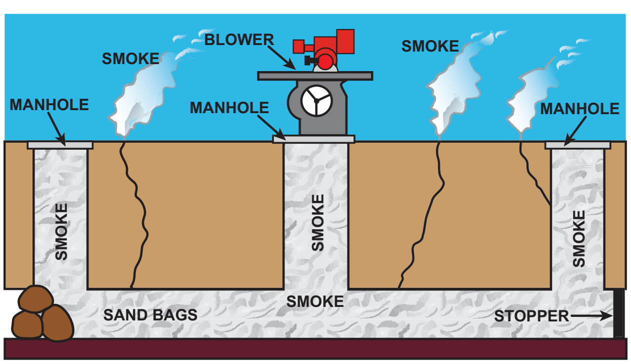


Figure 68: Smoke Testing System Schematic

Figure 69: Smoke Candles

Figure 70: Smoke blower

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

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

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

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

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

13.4 Septic System Investigations

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

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

On-Site Septic Investigations

Three kinds of on-site investigations can be performed at individual properties to determine if the septic system is failing, including homeowner survey, surface condition analysis and a detailed system inspection. The first two investigations are rapid and relatively simple assessments typically conducted in targeted watershed areas. Detailed system inspections are a much more thorough investigation of the functioning of the septic system that is conducted by a certified professional. Detailed system inspections may occur at time of sale of a property, or be triggered by poor scores on the rapid homeowner survey or surface condition analysis.

Homeowner Survey

The homeowner survey consists of a brief interview with the property owner to determine the potential for current or future failure of the septic system, and is often done in conjunction with a surface condition analysis.

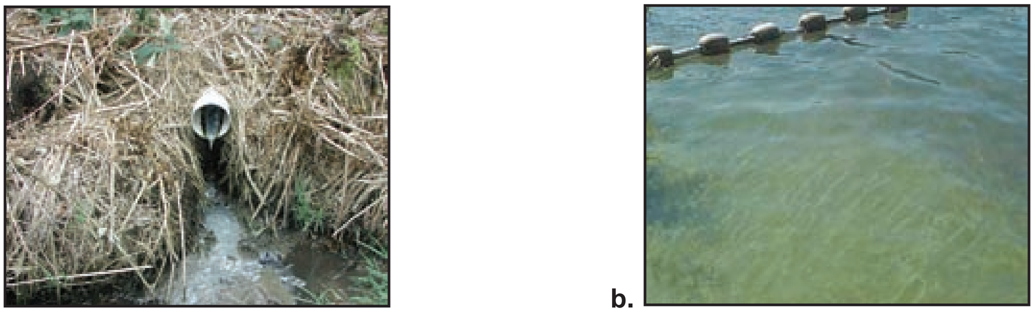
Table 60 highlights some common questions to ask in the survey, which inquire about resident behaviors, system performance and maintenance activity.

Surface Condition Analysis

The surface condition analysis is a rapid site assessment where field crews look for obvious indicators that point to current or potential production of illicit discharges by the septic system (Figure 71). Some of the key surface conditions to analyze have been described by Andrews *et al*., (1997) and are described below:

- Foul odors in the yard
- Wet, spongy ground; lush plant growth; or burnt grass near the drain field
- Algal blooms or excessive weed growth in adjacent ditches, ponds and streams
- Shrubs or trees with root damage within 10 feet of the system
- Cars, boats, or other heavy objects located over the field that could crush lateral pipes
- Storm water flowing over the drain field
- Cave-ins or exposed system components
- Visible liquid on the surface of the drain field (e.g., surface breakouts)
- Obvious system bypasses (e.g., straight pipe discharges)

Table 60: Septic System Homeowner Survey Questions *(Adapted from Andrews et al., 1997 and Holmes Inspection Services)*
• How many people live in the house?[1] • What is the septic tank capacity?[2] • Do drains in the house empty slowly or not at all? • When was the last time the system was inspected or maintained? • Does sewage back up into the house through drain lines? • Are there any wet, smelly spots in the yard? • Is the septic tank effluent piped so it drains to a road ditch, a storm sewer, a stream, or is it connected to a farm drain tile?
[1] Water usage ranges from 50 to 100 gallons per day per person. This information can be used to estimate the wastewater load from the house (Andrews et. al, 1997). *[2] The septic tank should be large enough to hold two days' worth of wastewater (Andrews et. al, 1997).*



a. b.

Figure 71: (a) Straight pipe discharge to nearby stream. (b) Algal bloom in a nearby pond.
(Sources: a- Snohomish County, WA, b- King County, WA)

Detailed System Inspection

The detailed system inspection is a much more thorough inspection of the performance and function of the septic system, and must be completed by a certified professional. The inspector certifies the structural integrity of all components of the system, and checks the depth of solids in the septic tank to determine if the system needs to be pumped out. The inspector also sketches the system, and estimates distance to groundwater, surface water, and drinking water sources. An example septic system inspection form from Massachusetts can be found at http://www.state.ma.us/dep/brp/wwm/soilsys.htm.

Although not always incorporated into the inspection, dye testing can sometimes point to leaks from broken pipes, or direct discharges through straight pipes that might be missed during routine inspection. Dye can be introduced into plumbing fixtures in the home, and flushed with sufficient running water. The inspector then watches the septic field, nearby ditches, watercourses and manholes for any signs of the dye. The dye may take several hours to appear, so crews may want to place charcoal packets in adjacent waters to capture dye until they can return later to retrieve them.

Infrared Imagery

Infrared imagery is a special type of photography with gray or color scales that represent differences in temperature and emissivity of objects in the image (www.stocktoninfrared.com), and can be used to locate sewage discharges. Several different infrared imagery techniques can be used to identify illicit discharges. The following discussion highlights two of these: aerial infrared thermography[13] and color infrared aerial photography.

Infrared Thermography

Infrared thermography is increasingly being used to detect illicit discharges and failing septic systems. The technique uses the temperature difference of sewage as a marker to locate these illicit discharges. Figure 72 illustrates the thermal difference

[13] Infrared thermography is also being used by communities such as Mecklenburg County and the City of Charlotte in NC to detect illicit discharges at outfalls.

between an outfall discharge (with a higher temperature) and a stream.

The equipment needed to conduct aerial infrared thermography includes an aircraft (plane or helicopter); a high-resolution, large format, infrared camera with appropriate mount; a GPS unit; and digital recording equipment. If a plane is used, a higher resolution camera is required since it must operate at higher altitudes. Pilots should be experienced since flights take place at night, slowly, and at a low altitude. The camera may be handheld, but a mounted camera will provide significantly clearer results for a larger area. The GPS can be combined with a mobile mapping program and a video encoder-decoder that encodes and displays the coordinates, date, and time (Stockton, 2000). The infrared data are analyzed after the flight by trained analysts to locate suspected discharges, and field crews then inspect the ground-truthed sites to confirm the presence of a failing septic system.

Late fall, winter, and early spring are typically the best times of year to conduct these investigations in most regions of the country. This allows for a bigger difference between receiving water and discharge temperatures, and interference from vegetation is minimized (Stockton, 2004b). In addition, flights should take place at night to minimize reflected and direct daylight solar radiation that may adversely affect the imagery (Stockton, 2004b).

Color Infrared Aerial Photography

Color infrared aerial photography looks for changes in plant growth, differences in soil moisture content, and the presence of standing water on the ground to primarily identify failing septic systems (Figure 73).

The Tennessee Valley Authority (TVA) uses color infrared aerial photography to detect failing septic systems in reservoir watersheds. Local health departments conduct follow-up ground-truthing surveys to determine if a system is actually failing (Sagona, 1986). Similar to thermography, it is recommended that flights take place at night, during leaf-off conditions, or when the water table is at a seasonal high (which is when most failures typically occur (U.S. EPA, 1999).

Figure 72: Aerial thermography showing sewage leak

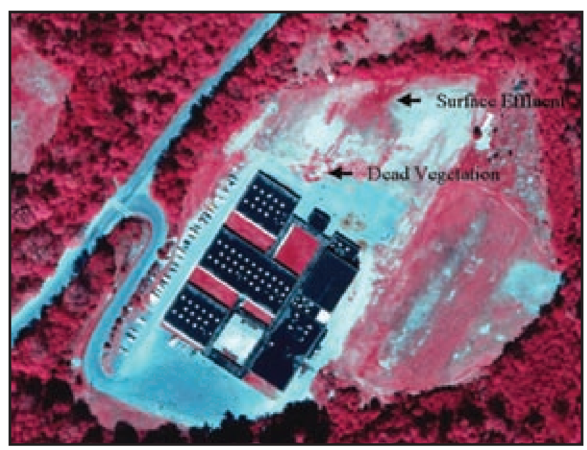


Figure 73: Dead vegetation and surface effluent are evidence of a septic system surface failure.
(Source: U.S. EPA, 1999)

13.5 The Cost to Trace Illicit Discharge Sources

Tracing illicit discharges to their source can be an elusive and complex process, and precise staffing and budget data are difficult to estimate. Experience of Phase I NPDES communities that have done these investigations in the past can shed some light on cost estimates. Some details on unit costs for common illicit discharge investigations are provided below.

Costs for Dye, Video, and Smoke Testing

The cost of smoke, dye, and video testing can be substantial and staff intensive, and often depend on investigation specific factors, such as the complexity of the drainage network, density and age of buildings, and complexity of land use. Wayne County, MI, has estimated the cost of dye testing at $900 per facility. Video testing costs range from $1.50 to $2.00 per foot, although this increases by $1.00 per foot if pipe cleaning is needed prior to testing.

Table 61 summarizes the costs of start-up equipment for basic manhole entry and inspection, which is needed regardless of which type of test is performed. Tables 62 through 64 provide specific equipment costs for dye, video and smoke testing, respectively.

Table 61: Common Field Equipment Needed for Dye, Video, and Smoke Testing

Item	Cost
1 Digital Camera	$200
Clipboards, Pens, Batteries	$25
1 Field vehicle	$15,000 - $35,000
1 First aid kit	$30
1 Spotlight	$40
1 Gas monitor and probe	$900 - $2,100
1 Hand-held GPS Unit	$150
2 Two-way radios	$250 - $750
1 Manhole hook	$80 - $130
1 Mirror	$70 - $130
2 Reflective safety vests	$40
Rubber/latex gloves (box of 100)	$25
1 Can of Spray Paint	$5
4 Traffic Cones	$50

Table 62: Equipment Costs for Dye Testing		
Product	**Water Volume**	**Cost**
Dye Strips	1 strip/500 gallons	$75 – $94 per 100 strips
Dye Tablets	0 – 50,000 gallons	$40 per 200 tablets
Liquid Concentrate (Rhodamine WT)	0 – 50,000 gallons	$80 – $90 per gallon $15 – $20 per pint
Powder	50,000 + gallons	$77 per lb
Dye Wax Cakes	20,000 – 50,000 gallons	$12 per one 1.25 ounce cake
Dye Wax Donuts	50,000 + gallons	$104 – $132 per 42 oz. donut
Price Sources: *Aquatic Eco-Systems http://www.aquaticeco.com/* *Cole Parmer http:/www.coleparmer.com* *USA Blue Book http:/www.usabluebook.com*		

Table 63: Equipment Costs for Video Testing	
Equipment	**Cost**
GEN-EYE 2™ B&W Sewer Camera with VCR & 200' Push Cable	$5,800
100' Push Rod and Reel Camera for 2" – 10" Pipes	$5,300
200' Push Rod and Reel Camera for 8" – 24" Pipes	$5,800
Custom Saturn III Inspection System 500' cable for 6-16" Lines	$32,000 ($33,000 with 1000 foot cable)
OUTPOST • Box with build-out • Generator • Washdown system	$6,000 $2,000 $1,000
Video Inspection Trailer • 7'x10' trailer & build-out • Hardware and software package • Incidentals	$18,500 $15,000 $5,000
Sprinter Chassis Inspection Vehicle • Van (with build-out for inspecting 6" – 24" pipes) • Crawler (needed to inspect pipes >24") • Software upgrade (optional but helpful for extensive pipe systems)	$130,000 $18,000 $8,000
Sources: USA Blue Book and Envirotech	

Table 64: Equipment Costs for Smoke Testing	
Equipment	**Cost**
Smoke Blower	$1,000 to $2,000 each
Liquid Smoke	$38 to $45 per gallon
Smoke Candles, 30 second (4,000 cubic feet)	$27.50 per dozen
Smoke Candles, 60 Second (8,000 cubic feet)	$30.50 per dozen
Smoke Candles, 3 Minute (40,000 cubic feet)	$60.00 per dozen
Sources: Hurco Tech, 2003 and Cherne Industries, 2003	

Costs for Septic System Investigations

Most septic system investigations are relatively low cost, but factors such as private property access, notification, and the total number of sites investigated can increase costs. Unit costs for the three major septic system investigations are described below.

Homeowner Survey and Surface Condition Analysis

Both the homeowner survey and the surface condition analysis are relatively low cost investigation techniques. Assuming that a staff person can investigate one home per hour, the average cost per inspection is approximately $25. A substantial cost savings can be realized by using interns or volunteers to conduct these simple investigations.

Detailed System Inspection

Septic system inspections are more expensive, but a typical unit cost is about $250, and may also include an additional cost of pumping the system, at roughly $150, if pumping is required to complete the inspection (Wayne County, 2003). This cost is typically charged to the homeowner as part of a home inspection.

Aerial Infrared Thermography

The equipment needed to conduct aerial infrared thermography is expensive; cameras alone may range from $250,000 to $500,000 (Stockton, 2004a). However, private contractors provide this service. In general, the cost to contract an aerial infrared thermography investigation depends on the length of the flight (flights typically follow streams or rivers); how difficult it will be to fly the route; the number of heat anomalies expected to be encountered; the expected post-flight processing time (typically, four to five hours of analysis for every hour flown); and the distance of the site from the plane's "home" (Stockton, 2004a). The cost range is typically $150 to $400 per mile of stream or river flown, which includes the flight and post-flight analyses (Stockton, 2004a).

As an alternative, local police departments may already own an infrared imaging system that may be used. For instance, the Arkansas Department of Health used a state police helicopter with a Forward Looking Infrared (FLIR) imaging system, GPS, video equipment, and maps (Eddy, 2000). The disadvantage to this is that the equipment may not be available at optimal times to conduct the investigation. In addition, infrared imaging equipment used by police departments may not be sensitive enough to detect the narrow range of temperature difference (only a few degrees) often expected for sewage flows (Stockton, 2004a).

Appendix F

IDDE Employee Training Record

Illicit Discharge Detection and Elimination (IDDE)
Employee Training Record

Sherborn, Ma

Date of Training: ____________________________

Duration of Training: ________________________

Name	Title	Signature