ILLICIT DISCHARGE DETECTION & ELIMINATION PLAN

FOR

TOWN OF CANTON, MASSACHUSETTS

LATEST REVISION: JUNE 2019

PREPARED BY:

KLEINFELDER
Bright People. Right Solutions.
TABLE OF CONTENTS

1. INTRODUCTION .................................................................................................................. 1
   1.1 NPDES MS4 PROGRAM ................................................................................................. 1
   1.2 ILlicit DISCHARGES .................................................................................................... 1
       1.2.1 Allowable Non-Storm Water Discharges .............................................................. 1
   1.3 RECEIVING WATERS & IMPAIRMENTS................................................................. 3
   1.4 PROGRAM GOALS & IMPLEMENTATION STRATEGIES ...................................... 4
       1.4.1 Mapping & Desktop Screening ............................................................................ 6
       1.4.2 Isolation & Elimination of Discharges ................................................................. 6
       1.4.3 Field Screening ..................................................................................................... 6
       1.4.4 Education & Discharge Prevention ................................................................. 6
       1.4.5 Program Evaluation ............................................................................................. 7

2. TOWN OF CANTON LEGAL AUTHORITY & RESPONSIBILITIES .............................. 8
   2.1 LEGAL AUTHORITY ..................................................................................................... 8
   2.2 PROGRAM RESPONSIBILITIES .................................................................................. 8

3. TOWN OF CANTON STORM SYSTEM MAPPING ...................................................... 10
   3.1 IDDE MAPPING REQUIREMENTS: PHASE I ............................................................ 10
   3.2 IDDE MAPPING REQUIREMENTS: PHASE II .......................................................... 10
   3.3 MAPPING METHODOLOGY .................................................................................... 11
   3.4 OUTFALL INVENTORY & CATEGORIZATION ............................................................. 11
       3.4.1 2009 - 2012 Outfall Inventory ............................................................................ 11
       3.4.2 2019 Outfall Inventory ..................................................................................... 11

4. SANITARY SEWER OVERFLOWS (SSOS) ................................................................. 12

5. ASSESSMENT AND RANKING OF OUTFALLS AND INTERCONNECTIONS .......... 15
   5.1 OUTFALLS CATCHMENT DELINEATION PROCEDURE ...................................... 15
   5.2 CLASSIFY AND RANK OUTFALLS ........................................................................ 16
       5.2.1 Problem OUTFALLS ......................................................................................... 17
       5.2.2 High Priority OUTFALLS ................................................................................ 18
       5.2.3 Low Priority OUTFALLS ................................................................................. 19
       5.2.4 Excluded OUTFALLS ...................................................................................... 19
       5.2.5 Preliminary Outfall Ranking ............................................................................. 19

6. DRY WEATHER SCREENING AND SAMPLING ................................................ 20
   6.1 DRY WEATHER SCREENING/SAMPLING PROCEDURES .................................. 20
       6.1.1 General Procedure ............................................................................................ 20
       6.1.2 Follow-Up Monitoring ..................................................................................... 21
       6.1.3 Field Equipment .............................................................................................. 22
       6.1.4 Sampling Procedures ....................................................................................... 23
   6.2 INTERPRETING OUTFALL SAMPLING RESULTS ............................................. 27
   6.3 MS4 INTERCONNECTION MONITORING ............................................................. 27
   6.4 DATA TRACKING ...................................................................................................... 27

7. CATCHMENT INVESTIGATION ................................................................................. 28
   7.1 SYSTEM VULNERABILITY FACTORS .................................................................... 28
   7.2 DRY WEATHER MANHOLE INSPECTIONS ......................................................... 31
7.3 Wet Weather Outfall Sampling ................................................................................. 32
7.4 Source Isolation and Confirmation ............................................................................ 33
  7.4.1 Sandbagging ...................................................................................................... 33
  7.4.2 Dye Testing ..................................................................................................... 33
  7.4.3 CCTV Inspections ............................................................................................ 34
  7.4.4 Safety Considerations ....................................................................................... 34
7.5 Illicit Discharge Removal ......................................................................................... 35
  7.5.1 Confirmatory Outfall Screening ........................................................................ 36
7.6 Ongoing Screening ................................................................................................. 36

8. Training .................................................................................................................... 36

9. Progress Reporting .................................................................................................. 36

LIST OF TABLES AND FIGURES

Table 1: Receiving Waterbodies and Their Impairments ................................................. 3
Table 2: IDDE Program Implementation Timeline ............................................................. 5
Figure 1: IDDE Investigation Procedure Framework ......................................................... 5
Table 3: MS4 Outfall Categorization Scenarios ................................................................. 12
Table 4: SSO Inventory .................................................................................................. 14
Table 5: Outfall Priority Classification .......................................................................... 17
Table 6: Minimum Sampling Parameters for Dry Weather Screening ............................ 20
Table 7: Outfall Observations and Possible Sources ....................................................... 21
Table 8: Field Equipment – Dry Weather Outfall Screening and Sampling ................... 22
Table 9: Field Sampling Analyses .................................................................................. 24
Table 10: Sampling Parameters and Analysis Methods ................................................... 25
Table 11: Required Analytical Methods, Detection Limits, Hold Times, and Preservatives 26
Table 12: IDDE Schedule for Completion of Catchment Investigations ........................ 28
Table 13: Outfall Catchment System Vulnerability Factor (SVF) Inventory .................... 30

LIST OF APPENDICES

Appendix A .................................................................................................................. STORMWATER BASE MAP
Appendix B .................................................................................................................. CONSOLIDATED DRAINAGE BYLAW
Appendix C .................................................................................................................. MAPC OUTFALL CATCHMENT MAPPING AND RANKING
Appendix D .................................................................................................................. NSP OUTFALL INVENTORY AND PRIORITIZATION TOOL
Appendix E .................................................................................................................. PRELIMINARY OUTFALL RANKING
Appendix F .................................................................................................................. INSPECTION FIELD FORMS & SAMPLING PROCEDURES
Appendix G .................................................................................................................. ANALYTICAL TESTING METHODS – IMPAIRED WATERS
Appendix H .................................................................................................................. ANALYTICAL TESTING PARAMETERS AND GUIDANCE
Appendix I .................................................................................................................. IDDE TRAINING
**Definitions**

**Best Management Practice (BMP)**: An activity, procedure, restraint, or structural improvement that helps to reduce the quantity or improve the quality of stormwater runoff.

**Catch basin**: A chamber or well, usually built to the curb line of a street that allows surface water to discharge into a storm water drain.

**Clean Water Act**: The Federal Water Pollution Control Act (33 U.S.C. § 1251 et seq.) as hereafter amended.

**Discharge of Pollutants**: The addition of any pollutant or combination of pollutants into the municipal storm drain system or into the waters of the United States or Commonwealth from any source.

**Groundwater**: Water beneath the surface of the ground.

**Illicit Connection**: A surface or subsurface drain or conveyance, which allows an illicit discharge 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, permitted, or approved before the effective date of bylaws enacted to prohibit such discharges.

**Illicit Discharge**: Direct or indirect discharge to the municipal storm drain system that is not composed entirely of stormwater, except as exempted by the EPA’s Phase II regulations.

**Manhole** – Sewer system structure typically made out of brick, concrete block, or monolithic concrete sections. Manholes have solid covers that do not accept runoff like a catch basin. Manholes within a storm sewer system are installed typically at bends in pipe runs, every 300 feet to 400 feet within a storm sewer pipe run, intersections of two or more pipe runs, and at the ends of pipe runs. Manholes allow for the cleaning and inspection of storm sewer systems. Manholes are typically ‘fed’ stormwater by catch basins and upstream storm sewer pipes.

**Junction Manhole** – Under the Permit, a 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.

**Municipal Separate Storm Sewer System (MS4)**: The system of conveyances designed or used for collecting or conveying stormwater, including any road with a drainage system, street, gutter, curb, inlet, piped storm drain, pumping facility, retention or detention basin, natural or man-made or altered drainage channel, reservoir, and other drainage structure that together comprise the storm drainage system owned or operated by the Town of Canton.

**National Pollutant Discharge Elimination System NPDES) Stormwater Discharge Permit**: A permit issued by United States Environmental Protection Agency or jointly with the Commonwealth of Massachusetts that authorizes the discharge of pollutants to waters of the United States.
Non-Stormwater Discharge: Discharge to the municipal storm drain system not composed entirely of stormwater.

Pollutant: Any element or property of sewage, agricultural, industrial or commercial waste, runoff, leachate, heated effluent, or other matter whether originating at a point or nonpoint source, that is or may be introduced into any sewage treatment works or waters of the Commonwealth. Pollutants shall include without limitation:
(1) paints, varnishes, and solvents;
(2) oil and other automotive fluids;
(3) non-hazardous liquid and solid wastes and yard wastes;
(4) refuse, rubbish, garbage, litter, or other discarded or abandoned objects, accumulations and floatables;
(5) pesticides, herbicides, and fertilizers;
(6) hazardous materials and wastes; sewage, fecal coliform and pathogens;
(7) dissolved and particulate metals;
(8) animal wastes;
(9) rock; sand; salt, soils;
(10) construction wastes and residues;
(11) and noxious or offensive matter of any kind.

Stormwater: Runoff from precipitation or snow melt.

Wastewater: Any sanitary waste, sludge, or septic tank or cesspool overflow, and water that during manufacturing, cleaning or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct or waste product.

Outfall – means a point source at the point where a municipal separate storm sewer discharges to waters of the United States. Point source means a discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, (also bridge drains); this term does not include return flows from irrigated agriculture or agricultural storm water runoff.

Storm sewer - A sewer that carries only surface runoff, street wash, and snow melt from the land. In a separate sewer system, storm sewers are separate from those that carry domestic and commercial wastewater (sanitary sewers).
Acronyms

BMP – Best Management Practice
DWF – Dry Weather Flow
EPA – Environmental Protection Agency
GIS – Geographic Information System
GPS – Global Positioning System
IDDE – Illicit Discharge Detection and Elimination
MassDEP – Massachusetts Department of Environmental Protection
MS4 – Municipal Separate Storm Sewer System
NOI – Notice of Intent
NPDES – National Pollutant Discharge Elimination System
SWMP – Storm Water Management Plan
1. INTRODUCTION

1.1 NPDES MS4 Program

This document has been prepared for the Town of Canton, Massachusetts to address requirements of the Town as a permittee under the United States Environmental Protection Agency’s (EPA) 2016 National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4), hereinafter referred to as the “2016 MS4 Permit” or “Permit”.

The NPDES MS4 Permit allows permittees to discharge stormwater in compliance with the Clean Water Act, as amended (33 U.S.C. § 1251 et seq) and the Massachusetts Clean Waters Act, as amended (M.G.L. Chap. 21§§ 26-53), provided that the permit conditions are met.

The 2016 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 (IDDE) 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 and represents an update to the previous IDDE Plan the Town prepared and has been implementing since 2014.

1.2 Illicit Discharges

Discharges from stormwater management systems throughout urbanized areas have often included wastes and wastewater from non-stormwater sources. These flows are designated as “Illicit Discharges” because they consist of or contain materials the stormwater drainage system is not designed to treat, transport or discharge. Illicit Discharges are therefore considered by Federal regulations to be “...any discharge to an MS4 that is not composed entirely of stormwater…” There are a few particular exceptions to this definition, such as discharges from NPDES-permitted industrial sources and discharges from firefighting activities.
Illicit discharges enter stormwater systems through either direct connections (e.g., wastewater piping either mistakenly or deliberately connected to the storm drains) or indirect connections (e.g., infiltration from cracked sanitary systems, spills collected by drain outlets, or paint or used oil dumped directly into a drain). The untreated discharges then can contribute high levels of pollutants to receiving water bodies (for example, heavy metals, toxics, oil and grease, solvents, nutrients, viruses, and bacteria). Specific examples of illicit discharges include sanitary wastewater, effluent from septic tanks, car wash wastewaters, improper oil disposal, radiator flushing, laundry wastewaters, spills from roadway accidents, improper disposal of auto and household toxics. Pollutant levels from these illicit discharges have been shown to be high enough to significantly degrade receiving water quality and threaten aquatic, wildlife, and human health.

Illicit dry weather discharges are often characterized as continuous, intermittent or transitory. Continuous discharges are generally the easiest to identify and can typically be observed through a routine outfall monitoring program. Intermittent discharges may only happen during specific hours, days or seasons and are more difficult to capture through routine or periodic monitoring. An intermittent discharge could be created by illicit laundry hook-ups or slop sinks that are only in use for short periods. A different type of monitoring or investigation may be required (such as upstream temporary dams). Transitory discharges are usually the result of an accident or spill that gets into the drain system. These may be virtually impossible to identify through routine monitoring. All three of these discharge types represent a significant threat to receiving water quality and an effective IDDE program will address all of these different circumstances.

1.2.1 Allowable Non-Storm Water Discharges

The following non-storm water discharges are authorized provided it has been determined by the permittee that they are not significant contributors of pollutants to the MS4. If these discharges are identified as significant contributors to the MS4, they must be addressed in the Illicit Discharge Detection and Elimination Plan:

- water line flushing,
- landscape irrigation,
- diverted stream flows,
- rising ground waters,
- uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20)),
- uncontaminated pumped ground water,
- 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,
- flows from riparian habitats and wetlands,
- dechlorinated swimming pool discharges,
- street wash water, and
- residential building wash waters, without detergents.

Discharges or flows from firefighting activities occur during emergency situations. The permittee is not expected to evaluate firefighting discharges with regard to pollutant contributions. Therefore, these
discharges are authorized as allowable non-storm water discharges, unless identified, by EPA, as significant sources of pollutants to Waters of the U.S.

1.3 Receiving Waters & Impairments

Table 1: list all the receiving waterbodies found within the boundaries of the Town of Canton and their impairments, based on the latest Massachusetts Final Year 2014 Integrated List of Waters as of December 2015. 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.

Five waterbodies in Canton are impaired for bacteria (fecal coliform) or pathogens (E. coli). Catchments draining to any waterbody impaired for bacteria or pathogens should be designated either Problem Catchments or High priority in implementation of the IDDE program, as discussed in Section 5.

Table 1: Receiving Waterbodies and Their Impairments

<table>
<thead>
<tr>
<th>2014 Impaired Water (Impairment Category*)</th>
<th>Segment ID</th>
<th>2014 Impairments</th>
<th>Approved TMDL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponkapog Brook (4a)</td>
<td>MA73-27</td>
<td>E.coli, Fecal Coliform</td>
<td>2592</td>
</tr>
<tr>
<td>Ponkapog Pond (4a)</td>
<td>MA73043</td>
<td>(Eurasian Water Milfoil, Myriophyllum spicatum**)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Non-native aquatic plants**)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mercury in fish</td>
<td>42409</td>
</tr>
<tr>
<td>Reservoir Pond (4a)</td>
<td>MA73048</td>
<td>(Non-native aquatic plants**)</td>
<td>42400</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mercury in fish</td>
<td></td>
</tr>
<tr>
<td>Glen Echo Pond (4c)</td>
<td>MA73022</td>
<td>(Non-native aquatic plants**)</td>
<td></td>
</tr>
<tr>
<td>Pequid Brook (5)</td>
<td>MA73-22</td>
<td>Dissolved Oxygen</td>
<td></td>
</tr>
<tr>
<td>Neponset River (5)</td>
<td>MA73-01</td>
<td>DDT</td>
<td>54840</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E. Coli</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Excess algal growth</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dissolved Oxygen</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PCB in Fish Tissue</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Phosphorus</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sedimentation/Siltation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Suspended Solids (TSS)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Turbidity</td>
<td></td>
</tr>
<tr>
<td>Neponset River (5)</td>
<td>MA73-02</td>
<td>(Debris/Floatables/Trash**)</td>
<td>2592</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DDT</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>E. Coli, Fecal Coliform</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Foam/flocs/scum/oil slicks</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dissolved Oxygen</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PCB in fish tissue</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Turbidity</td>
<td></td>
</tr>
</tbody>
</table>
## 1.4 Program Goals & Implementation Strategies

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 2016 MS4 Permit:

- Legal authority and regulatory mechanism to prohibit illicit discharges and enforce this prohibition
- Storm system mapping
- Inventory of sanitary sewer overflows
- Inventory and ranking of outfalls
- Dry weather outfall screening
- Catchment investigations

### 2014 Impaired Water (Impairment Category*)

<table>
<thead>
<tr>
<th>2014 Impaired Water (Impairment Category*)</th>
<th>Segment ID</th>
<th>2014 Impairments</th>
<th>Approved TMDL</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Branch of Neponset River (known locally as the Canton River) (5)</td>
<td>MA73-05</td>
<td>(Low flow alterations**) Aquatic Macroinvertebrate Bioassessments Fecal coliform, E.coli DDT Dissolved Oxygen PCB in fish Water Temperature Other</td>
<td>2592</td>
</tr>
<tr>
<td>Forge Pond (5)</td>
<td>MA73020</td>
<td>Turbidity</td>
<td></td>
</tr>
<tr>
<td>Beaver Meadow Brook (5)</td>
<td>MA73-20</td>
<td>Dissolved Oxygen</td>
<td></td>
</tr>
<tr>
<td>Massapoag Brook (5)</td>
<td>MA73-21</td>
<td>(Non-native aquatic plants**) Aquatic Macroinvertebrate Bioassessments Total Phosphorus Turbidity</td>
<td></td>
</tr>
<tr>
<td>Bolivar Pond (5)</td>
<td>MA73-005</td>
<td>(Non-native aquatic plants**) Turbidity</td>
<td></td>
</tr>
<tr>
<td>Pecunit Brook (4a)</td>
<td>MA73-25</td>
<td>E. Coli</td>
<td>54842</td>
</tr>
<tr>
<td>Pequid Brook (5)</td>
<td>MA73-22</td>
<td>Dissolved oxygen</td>
<td></td>
</tr>
<tr>
<td>Steep Hill Brook (3)</td>
<td>MA73-18</td>
<td>No known impairments</td>
<td></td>
</tr>
</tbody>
</table>

### Other Receiving Waters

| Other Receiving Waters | | |
|------------------------|-----------------|
| York Brook             | No known impairments |

**Notes:**

*Category Definitions:

- 1. **Category Definitions:**
  - 2- Attaining some uses; other uses not assessed
  - 3- Insufficient information to make assessments for any use
  - 4a - TMDL completed and approved for one or more pollutants
  - 4c – Impairment not caused by a pollutant
  - 5- Impaired and requiring a TMDL
  - **- TMDL not required (non-pollutant)
- Identification/confirmation of illicit sources
- Illicit discharge removal
- Follow-up screening
- Employee training.

The required timeline for implementing the IDDE program is shown in Table 2. The IDDE investigation procedure framework is shown in Figure 1.

**Table 2: IDDE Program Implementation Timeline**

<table>
<thead>
<tr>
<th>IDDE Program Requirement</th>
<th>Completion Date from Effective Date of Permit</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written IDDE Program Plan</td>
<td>X</td>
<td>Completed</td>
</tr>
<tr>
<td>SSO Inventory</td>
<td>X</td>
<td>Completed</td>
</tr>
<tr>
<td>Written Catchment Investigation Procedure</td>
<td>X</td>
<td>Completed</td>
</tr>
<tr>
<td>Phase I Mapping</td>
<td>X</td>
<td>Completed</td>
</tr>
<tr>
<td>Phase II Mapping</td>
<td>X</td>
<td>In progress</td>
</tr>
<tr>
<td>IDDE Regulatory Mechanism or By-law (if not already in place)</td>
<td>X</td>
<td>Completed</td>
</tr>
<tr>
<td>Dry Weather Outfall Screening</td>
<td>X</td>
<td>In progress</td>
</tr>
<tr>
<td>Follow-up Ranking of Outfalls and Interconnections</td>
<td>X</td>
<td>Not started</td>
</tr>
<tr>
<td>Catchment Investigations – Problem Outfalls</td>
<td>X</td>
<td>Not started</td>
</tr>
<tr>
<td>Catchment Investigations – all Problem, High and Low Priority Outfalls</td>
<td>X</td>
<td>Not started</td>
</tr>
</tbody>
</table>

**Figure 1: IDDE Investigation Procedure Framework**
1.4.1 Mapping & Desktop Screening

Canton has developed a Town-wide base map of the stormwater system consistent with Permit requirements and it is shown in Appendix A as the Stormwater Base Map. The map is continually being updated, modified or corrected as data is obtained and confirmed. Further information regarding the status of the Town’s mapping efforts is provided in Section 3.

The Stormwater Base Map has been employed in tandem with an analysis of land use, infrastructure conditions, historical operating data, topography, and factors specific to Canton’s built and natural environment. This data allows the Town to define the drainage catchments that are associated with each of the identified, regulated outfalls in the community and prioritize them on the basis of their potential to include illicit connections to the storm drain system. Further information on this process is provided in Section 3.

1.4.2 Isolation & Elimination of Discharges

One of the distinctions between the existing 2003 MS4 Permit and the 2016 MS4 Permit is the prescribed manner in which illicit discharge investigations must be implemented. Canton’s pre-existing program, detailed in Appendix A, is already more pro-active than many other communities, however, to meet the standards of the Permit, a more detailed investigation of the drainage system will be required. The manner in which the Town will implement the investigation program is described in detail in Sections 6 and 7.

1.4.3 Field Screening

Since 2009, Canton has been conducting an aggressive outfall inventory and dry and wet weather outfall monitoring program and investigated all the outfall structures within the Town. This process included many outfalls that are not jurisdictional under the MS4. This program has provided qualitative and analytical data that was used in the catchment prioritization process. This inventory constitutes the first step in a progression of field investigations that will ultimately include visual observation of a large percentage of the drainage system beyond just the outfalls. Not all discharge types lend themselves to identification through this kind of outfall monitoring effort. The data compiled to date, however, will help the Town determine the likelihood and type of discharge for a subset of outfalls that have been targeted for additional investigation.

1.4.4 Education & Discharge Prevention

As part of the Town’s MS4 Stormwater Management Program, Canton has implemented a public education initiative as well as a public participation program in conformance with Minimum Control Measures No. 1 and 2 of the 2016 MS4 Permit. These are an important component of an overall effort to prevent illicit discharges at their source.
As described in Section 2, the Town’s Consolidated Drainage By-law provides the Town with the authority to enter premises that are subject to construction and industrial stormwater permits to determine if they are operating in conformance with those permits. The Town of Canton’s Consolidated Drainage By-law also provides the authority to prohibit direct sump or drainage hook-ups from residences without consent and a permit from the Department of Public Works. Requiring a permit provides an additional opportunity for public education and provides the Town with another means of establishing inspection authority on private property.

1.4.4.1 Illegal Dumping

The illicit discharges mentioned above are those that typically occur on a regular, or at least recurring basis. Another type of illicit discharge is illegal dumping. Specific examples of illegal dumping include:

- Used motor oil poured into a catch basin
- Paint poured into a catch basin

Because of the irregular nature of illegal dumping such as this, it is very difficult to detect during an outfall inspection program. Inspectors may see some evidence of previous illegal dumping at an outfall, but it would be very coincidental for an illegal dumping activity to be underway right at the time the downstream outfall is being inspected. In light of this, a different approach needs to be taken in detecting and addressing illegal dumping.

Canton has taken steps to prevent illegal dumping by stenciling catch basins. Because illegal dumping to the storm sewer system tends to be a very irregular occurrence, and is difficult to detect from outfall inspections, the MS4 must rely heavily on the public. If the residents are educated about the dangers and consequences of illegal dumping, they will be more likely to:

- Avoid dumping, themselves
- Urge others not to dump
- Report occurrences of dumping they are aware of

In conjunction with public education and drain stencilling, Canton implemented a Citizen Requests online platform, in which the public can report any drainage issues or storm drain clean out requests, report spills, or other issues of concern such as unusual smells in the vicinity of water bodies.

1.4.5 Program Evaluation

The IDDE Program is evaluated on a continuous basis and at the end of each annual NPDES reporting cycle. The Town of Canton has to date been implementing IDDE under the requirements of the 2003 Permit, using the guidance of the December 2008 EPA New England Illicit Discharge Detection & Elimination Protocol. As part of the process of preparing for the 2016 MS4 Permit, Canton’s existing IDDE protocols have been reviewed. In this IDDE Plan, protocols have been formally described and modified where necessary to comply with the requirements of the 2016 MS4 Permit.
2. TOWN OF CANTON LEGAL AUTHORITY & RESPONSIBILITIES

2.1 Legal Authority

The Town of Canton has adopted a Consolidated Drainage By-law, as Section 16 of its General Bylaws (Revised 2017). A copy of the Consolidated Drainage Bylaw is provided in Appendix B. As required by the Permit, the Consolidated Drainage By-law provides the Town with adequate legal authority to:

- Prohibit illicit discharges;
- investigate suspected ID;
- eliminate ID (including those not owned or controlled by the MS4 that discharge into the MS4 system) and,
- enforce the IDDE program.

The Consolidated Drainage By-law defines the following terms:

**Illegal Discharge.** “Any direct or indirect non-storm water discharge to the storm drain system, except as exempted in Section 8 of this by-law.”

**Illicit Connections.** “An illicit connection is defined as either of the following: Any drain or conveyance, whether on the surface or subsurface, which allows an illegal discharge to enter the storm drain system including but not limited to any conveyances which allow any non-storm water discharge including sewage, process wastewater, and wash water to enter the storm drain system and any connections to the storm drain system from indoor drains and sinks, regardless of whether said drain or connection had been previously allowed, permitted, or approved by an authorized enforcement agency or, any drain or conveyance connected from a commercial or industrial land use to the storm drain system which has not been documented in plans, maps, or equivalent records and approved by an authorized enforcement agency.”

In addition to the Consolidated Drainage By-law, the Town has other legal authority pertaining to stormwater management:

- Article XXI, Stormwater Management, of the General By-laws (Revised 2017) gives the Conservation Commission authority to develop regulations and permits pertaining to post-construction stormwater management, and to adopt a stormwater credit system. It also gives the Board of Selectmen authority to adopt a Stormwater Utility.
- Article XX, Soil Erosion and Sediment Control, of the General By-laws (Revised 2017) regulates land disturbance of any area 5,000 square feet or greater and requires the filing of an application for a land disturbance permit with the Conservation Commission.

2.2 Program Responsibilities

As per the Consolidated Drainage By-law, the Department of Public Works is responsible for administering, implementing, and enforcing the provisions of the bylaw, which prohibits illicit
discharges. The DPW is responsible for all aspects of the IDDE Program, including ID identification and reporting, elimination of IDs, documentation and verification of ID elimination, and tracking and reporting of program progress.
3. TOWN OF CANTON STORM SYSTEM MAPPING

This Plan includes an MS4 System Map to address mapping requirements under the 2016 MS4 Permit. The Town originally submitted its MS4 System Map to the EPA in 2009. An updated map, which included improvements to the GIS data, was included in the Notice of Intent (NOI) submitted to the EPA in September 2018. Since submitting the NOI, the Town has continued to update and improve its GIS and outfall database. The Stormwater Base Map (Appendix A) uses the most up-to-date data provided by the Town in March 2019 and includes the following information:

- wetlands
- MS4 outfalls
- Initial catchment delineations
- Catch basins
- receiving waters (including those that are impaired)
- drainage pipes
- interconnections with other MS4 permittees
- stormwater BMP structures (oil water separators, stormceptors, detention areas)

The 2016 MS4 Permit requires the storm sewer system map to be updated in two phases as outlined below. The DPW’s GIS Coordinator is responsible for updating the stormwater system mapping pursuant to the Permit. The Town of Canton will report on the progress towards completion of the storm sewer system map in each annual report. Updates to the Stormwater Base Map will be included in Appendix A.

3.1 IDDE Mapping Requirements: Phase I

Phase 1 of the mapping must be completed within two years of the permit’s effective date and contain the following information:

- Outfalls and their receiving waters (required by 2003 MS4 Permit);
- Open channel conveyances (swales, ditches, etc.);
- Interconnections with other MS4s and others storm sewer systems;
- Municipally owned stormwater treatment structures (e.g., detention and retention basins, infiltration systems, bioretention areas, water quality swales, gross particle separators, oil/water separators, or other proprietary systems);
- Waterbodies identified by name and indication of all use impairments as identified on the most recent EPA approved Massachusetts Integrated List of waters report pursuant to Clean Water Act section 303(d) and 305(b); and,
- Initial catchment delineations. Any available system data and topographic information may be used to produce initial catchment delineations. For this Permit, a catchment is the area that drains to an individual outfall or interconnection.

3.2 IDDE Mapping Requirements: Phase II

Phase II mapping must be completed within ten (10) years of the effective date of the Permit (July 1, 2028) and 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;
✓ Municipal Sanitary Sewer system (if available);
✓ Municipal combined sewer system (if applicable).

3.3 Mapping Methodology

GIS data for the stormwater system provided by the Town originated from a 2003 study (Stormwater Drainage Plan, December 2003, Vollmer Associates). The Vollmer study included record drawing digitizing and data attribute editing, GPS survey, and GIS map creation. The Town has since been continually updating the location and attributes of its stormwater infrastructure through field GPS mapping and inspection and additional record drawing reviews.

3.4 Outfall Inventory & Categorization

3.4.1 2009 - 2012 Outfall Inventory
Between 2009 and 2012, the Town inventoried, and dry weather screened 270 outfalls. During this aggressive inspection and monitoring program, it was determined that only 154 of the 270 outfalls were MS4 jurisdictional outfalls.

3.4.2 2019 Outfall Inventory
The Town of Canton spent additional time and effort since 2013 to update the MS4 system map. The outfalls, and their catchments, included in this IDDE Plan are based on the most recent GIS and Access database data from March 2019. The March 2019 inventory included a total of 576 outfalls, a significant increase since the Town of Canton started to track outfalls.

In summary, the March 2019 outfall inventory included:
• 252 Private- or State-owned outfalls
• 324 Municipal-owned outfalls, which included:
  o 150 Non-MS4 Outfalls
  o 100 MS4 Outfalls
  o 67 Outfalls with unknown MS4 status.

In June 2019, these 67 Unknown outfalls were further reviewed and sorted into MS4 and Non-MS4 categories based on the methodology developed in 2013 and summarized in Table 3. After this review, the total number of MS4 Outfalls in Canton is 148. This number is lower that the number of outfalls included in the NOI submission to EPA in September 2018. The Town of Canton was in the process of switching between asset management software systems and the data transfer produced information with a some incomplete data. The decision was made to be conservative and include all the outfalls that had
missing information as MS4 outfalls in the NOI, and hence the number of MS4 Outfalls in the NOI was 341.

Since the NOI submission in 2018, the data was reviewed and updated to produce the March 2019 data, which is the most current and update available outfall dataset.

Table 3: MS4 Outfall Categorization Scenarios

<table>
<thead>
<tr>
<th>Example Scenario</th>
<th>Categorization</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outfall discharging to isolated wetland</td>
<td>Non-MS4</td>
<td>Not discharging to a water of US or MA</td>
</tr>
<tr>
<td>Outfall discharge becomes non-point flow before or is across a flow barrier from a jurisdictional water</td>
<td>Non-MS4</td>
<td>Not a point source discharge</td>
</tr>
<tr>
<td>Outfall discharging not directly to water, but discharges to top of bank or flow otherwise expected to discharge to jurisdictional water/wetland</td>
<td>MS4</td>
<td>Outfall likely to create channelized flow to water of US/MA</td>
</tr>
<tr>
<td>Outfall is actually a culvert pipe that connects water bodies</td>
<td>Not an Outfall</td>
<td>Does not discharge stormwater to a water body</td>
</tr>
</tbody>
</table>

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. SSOs can be caused by blockages, line breaks, sewer defects that allow stormwater and groundwater to overload the system, power failures, improper sewer design, and vandalism.

Upon detection of an SSO, the Town of Canton will eliminate it as expeditiously as possible and take interim measures to minimize the discharge of pollutants to and from its MS4 until the SSO is eliminated. Upon becoming aware of an SSO to the MS4, the Town will provide oral notice to EPA within 24 hours and written notice to EPA and MassDEP within five (5) days.

The Town of Canton has reviewed available documentation pertaining to SSOs and completed an inventory of SSOs that have discharged to the MS4 within the five (5) years prior to the effective date of the 2016 MS4 Permit. The inventory includes all SSOs that occurred during wet or dry weather resulting from inadequate conveyance capacities or where interconnectivity of the storm and sanitary sewer infrastructure allows for transfer of flow between systems. As of June 2019, no SSOs have discharged to the MS4 within the five years prior to July 1, 2018.
The inventory in Table 4 will be updated by the DPW when new SSOs are detected. The SSO inventory will be included in the annual report, including the status of mitigation and corrective measures to address each identified SSO.
### Table 4: SSO Inventory

<table>
<thead>
<tr>
<th>SSO Location¹</th>
<th>Discharge Statement²</th>
<th>Date³</th>
<th>Time Start³</th>
<th>Time End³</th>
<th>Estimated Volume⁴</th>
<th>Description⁵</th>
<th>Mitigation Completed⁶</th>
<th>Mitigation Planned⁷</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ Location (approximate street crossing/address and receiving water, if any)
² A clear statement of whether the discharge entered a surface water directly or entered the MS4
³ Date(s) and time(s) of each known SSO occurrence (i.e., beginning and end of any known discharge)
⁴ Estimated volume(s) of the occurrence
⁵ Description of the occurrence indicating known or suspected cause(s)
⁶ Mitigation and corrective measures completed with dates implemented
⁷ Mitigation and corrective measures planned with implementation schedules
5. ASSESSMENT AND RANKING OF OUTFALLS AND INTERCONNECTIONS

As was described above in Section 3, during 2019, 148 outfalls were identified as jurisdictional under the MS4 Permit (‘MS4 Outfalls’). The 148 MS4 Outfalls were also identified on the Stormwater Base Map (Appendix A). The 2016 MS4 Permit requires that each outfall be categorized and ranked based on the potential to have illicit discharges. The ranking helps determine the priority order for performing IDDE investigations and meeting Permit milestones. The stormwater catchment areas for each of the 148 MS4 outfalls were delineated and prioritized for future IDDE investigation, as described below.

5.1 Outfalls Catchment Delineation Procedure

A catchment is the area that drains to an individual outfall1 or interconnection2. The purpose of delineating MS4 outfall catchments under the 2016 MS4 Permit is to define contributing areas for investigation of potential sources of illicit discharges, if any, within the catchment. As such, the catchment delineations are a planning and investigation tool. They are not intended to be at the rigorous level of detail that would be used for determining the volume of stormwater contributing for sizing and designing stormwater treatment, for example.

Traditionally watershed delineation is done manually by using topographic and contour maps. With the help of Geographical Information Systems (GIS) and Digital Elevation Models (DEM), computers can automate the process of delineation with terrain processing techniques. This section describes the development of the MS4 catchment boundaries for the Town of Canton using these techniques with the PCSWMM hydraulic/hydrology modeling software.

The following data were used in this delineation exercise:
- Updated list of outfalls from March 2019, Town of Canton GIS
- LiDAR Digital Elevation Model, MassGIS
- Stormwater drain pipes, Town of Canton GIS
- Culverts, Town of Canton GIS
- Local rivers and streams, MassGIS
- Department of Environmental Protection wetlands and hydraulic connections, MassGIS

A hydraulic and hydrologic modeling software, PCSWMM, developed by CHI, Inc. was used for this exercise. PCSWMM can perform terrain processing algorithms using the listed data above to generate catchment boundaries, the user can define a target area size to discretize the watershed.

The Watershed Delineation Tool (WDT) in PCSWMM reconditions the DEM with the burn-in stream layers and delineation points to create depressions and sinks, the reconditioned DEM will help the tool to

---

1 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.

2 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.
generate flow paths within the watershed and the density of the flow paths is correlated to the user-defined target discretization level. The flow paths visualize how water would converge within the watershed, catchment boundaries are then generated by grouping flow paths that concentrate at the same downstream location.

Three iterations were run in the WDT to generate catchment boundaries at discretization levels of 10 acres, 20 acres and 50 acres. The 50-acre results provide a balance of catchment size while maintaining delineation boundary details, these results were then quality-checked and manually post-processed in GIS against a list of outfalls.

The original list of outfalls from the March 2019 update has 576 records, with a multitude of MS4/Non-MS4 outfalls, ownerships and connectivity setup to the Town’s drainage system. For the purpose of this exercise, the list is filtered to include only outfalls that are relevant to the 2016 MS4 Permit. Outfalls that are Non-MS4, state-owned or privately-owned outfalls were excluded. The filtered list of MS4 outfalls was then matched to their respective catchments based on the 50-acre results. In areas where multiple outfalls are located within a close proximity, the 10-acre and 20-acre catchment delineations helped to refine the 50-acre results as necessary.

Overall, this approach is effective in generating a preliminary set of catchments that can be improved by additional data or field inspections. The generated delineation will only be as accurate as the resolution of the raw DEM, and flow paths generated from the software can also be improved when data gaps such as missing drain pipes connectivity in the Town’s GIS database are filled in.

Once delineated, the catchments were prioritized for dry weather screening and investigation as described below.

### 5.2 Classify and Rank Outfalls

The 2016 MS4 Permit, Part 2.3.4.7.a, specifies the four categories in which all the MS4 outfalls should be categorized and the characteristics that can help make that determination, as shown in Table 5.

To rank the MS4 outfall, the following information was used:

- the Town’s existing outfall database,
- previous interviews,
- base mapping, and Neponset Stormwater Partnership (NSP) IDDE Outfall Inventory and Prioritization Tool (the NSP Outfall Tool).

The NSP Outfall Tool is a Microsoft Excel spreadsheet that ranks outfalls, and their respective catchments, based on criteria pulled directly from the Permit. Some fields in the spreadsheet were filled using GIS, while others were filled using local knowledge of the stormwater system and the Town. The outfall prioritization was completed by following the methods and procedures detailed in MAPC’s Outfall Catchment Mapping and Ranking (Appendix C) and NSP’s Instructions and Background Outfall Inventory and Prioritization Tool (Appendix D).
Two changes were made to the NSP Outfall Tool:

- There are no surface drinking water supplies in Canton, so the column where that information would have been captured was used to capture discharges to bacteria/pathogen impaired waterbodies. Per the Permit, catchments draining to any waterbody impaired for bacteria or pathogens shall be designated either Problem or High Priority. For Canton, any catchments draining to the Neponset River, the East Branch Neponset River, and the Pecunit Brook were automatically designated as High priority.
- The formula for determining the priority category was adjusted because all the outfalls in Canton were categorized as High priority before the adjustment.

The results of the outfall classification are summarized in Table 5 and discussed below.

### Table 5: Outfall Priority Classification

<table>
<thead>
<tr>
<th>Priority</th>
<th>Description</th>
<th>Quantity of Outfalls in Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROBLEM</td>
<td>Known or suspected illicit discharge. This designation is given to any outfall where non-stormwater discharge is suspected from the dry weather inspections (or prior reports).</td>
<td>1</td>
</tr>
<tr>
<td>HIGH</td>
<td>High potential for illicit discharge / High priority for investigation.</td>
<td>77</td>
</tr>
<tr>
<td>LOW</td>
<td>Low potential for illicit discharge / Low priority for investigation.</td>
<td>70</td>
</tr>
<tr>
<td>EXCLUDED</td>
<td>No potential for illicit discharge / No needed investigation.</td>
<td>None</td>
</tr>
</tbody>
</table>

**Under the 2016 MS4 Permit requirements, Canton is required to complete dry weather screening of all High and Low Priority Outfalls and ranking of outfalls by the end of Year 3.**

During 2009 – 2016 Canton conducted dry weather screening of 97 of these outfalls and the Town may pursue obtaining credit for this prior work.

#### 5.2.1 Problem Outfalls

In accordance with the 2016 MS4 Permit, catchments shall be categorized as Problem if there are known illicit discharges associated with them.

Problem outfalls are determined based on currently available outfall information and institutional knowledge about the existence of an illicit discharge. As described by section 2.3.4.7.a.ii, Problem outfall indicators include:

- Olfactory or visual evidence of sewage,
- Ammonia $\geq 0.5$ mg/L, surfactants $\geq 0.25$ mg/L, and bacteria levels greater than the water quality criteria applicable to the receiving water, or
- Ammonia $\geq 0.5$ mg/L, surfactants $\geq 0.25$ mg/L, and detectable levels of chlorine.
The Town of Canton completed dry and wet sampling at all the outfalls between 2009 and 2016. These sampling results were used to determine if any of the 148 MS4 Outfalls have sewage indicators. None of the outfalls sampled meet the sewage indicator criteria.

All Problem outfalls represent an illicit discharge, and therefore must be immediately eliminated. The screening process to confirm an illicit discharge is included in Section 6. If a discharge cannot be eliminated within 60 days, the Town of Canton is required to establish an elimination schedule, as well as record the progress in its annual reports. Dry weather screening and sampling, as described in Section 6 of this IDDE Plan, and Part 2.3.4.7.b of the Permit, is not required for Problem Outfalls.

There is one outfall catchment for which the Town identified known problems with non-stormwater discharges after receiving odor and visual complaints: Outfall 480. Outfall 480 is adjacent to the Del Monte Produce plant and receives discharge from dumpsters outside containing waste from the plant’s fruit processing operations. Multiple departments within the Town (Board of Health, Building Department, and DPW) have been working on finding a resolution. Since 2018, the Board of Health Department, MassDEP and Massachusetts Water Resources Authority are working together to bring this discharge into compliance. In October 2018, MassDEP samples the storm drain system adjacent to Del Monte and the water was clear and odorless. Del Monte has plans to build a canopy that will prevent stormwater getting into the dumpster area. Once the canopy is in place, dumpster area trench drains will collect non-stormwater flows for proper disposal into the sewer system and flows to the existing drainage system will be free of fruit processing residuals.

The Town will continue to update EPA on the status of this illicit discharge through the annual reports and this IDDE Plan.

5.2.2 High Priority Outfalls

High priority outfalls are outfalls that have a higher likelihood of contributing to an illicit discharge. All High priority outfalls must be screened within the first three years of the Permit effective date, following the procedures detailed in Section 6.

Outfalls that drain to impaired waterbodies, are near public recreational areas, or are in close proximity to drinking water wells are considered to have a high priority in the IDDE ranking. Additionally, the following factors must be considered (although not all may apply) when classifying an outfall as a High Priority Outfall:

- Past discharge complaints or reports
- Poor receiving water quality
- Density of generating sites, such as institutional, municipal, commercial, or industrial sites with potential to generate pollutants that could contribute to illicit discharges - for example: car dealers, car washes, garage/gas stations, garden centers, industrial manufacturing, residential areas with swimming pools
- Age of surrounding development and infrastructure
- Sewer conversion from septic areas
- Historic combined sewer areas
- Surrounding density of aging septic system
- Long stretches of culverted streams
- Water quality limited waterbodies or waters with approved TMDLs that receive a discharge form the MS4
- Any additional characteristics that the Town considers relevant.

Seventy-seven (77) outfalls in Canton are classified as High priority outfalls because they either discharge into a waterbody impaired for bacteria/pathogens or they discharge within 100 meters from recreational areas. The Town of Canton will start the dry weather screening with these High priority outfalls.

5.2.3 Low Priority Outfalls

The remaining 70 MS4 outfalls were ranked Low priority. Most of these outfalls will be screened after the High priority outfalls, but not later than July 30, 2021.

5.2.4 Excluded Outfalls

Any outfall with no potential for illicit discharge is considered an Excluded outfall and does not need to be considered as a part of the IDDE Plan. This category includes outfalls leading to roadway drainage in undeveloped areas, athletic field drainage, undeveloped green space or parking without services, or alignments through undeveloped land.

None of the 148 MS4 outfalls in Canton are classified as Excluded.

5.2.5 Preliminary Outfall Ranking

The Outfall Tool can sort the records in the spreadsheet either by priority category or dry weather screening priority. For this IDDE Plan, the latter was chosen because this sorting is meant to help communities target outfall screening and sampling by stream reach. This will allow field crews to proceed quickly down the length of one stream and ensures that each day’s samples will need to be tested by the same parameters based on the stream’s impairments. The Preliminary Outfall Ranking is included in Appendix E.
6. DRY WEATHER SCREENING AND SAMPLING

According to the Permit, all MS4 outfalls and interconnections (except for Problem and Excluded Outfalls) need to be inspected for the presence of dry weather flow within three (3) years of the Permit effective date. Using the outfall ranking discussed in Section 5, the Town will screen, and sample where appropriate, all High and Low priority outfalls before July 2021. The presence of dry weather flow can be a strong indicator of an illicit connection, and this screening is a logical starting point for identifying potential areas of concern.

6.1 Dry Weather Screening/Sampling Procedures

Dry Weather Screening (DWS) shall proceed only when no more than 0.1 inch of rainfall has occurred in the previous 24-hour period and no significant snow melt is occurring. For purposes of determining dry weather conditions, staff will use precipitation data from the closest National Weather Service Center, which is located at the Norwood Memorial Airport (KOWD).

6.1.1 General Procedure

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

- Identify outfall(s) to be screened/sampled based on initial outfall inventory and priority ranking
- Acquire the necessary staff, mapping, and field equipment
- Conduct the outfall inspection during dry weather:
  - Mark and photograph the outfall
  - Record the inspection information and outfall characteristics in Cityworks (see form in Appendix F)
  - 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.
- If flow is observed, sample and test the flow following the procedures described in the following sections and Appendix F. At a minimum, the flow will be sampled and tested for the following minimum parameters:

<table>
<thead>
<tr>
<th>Table 6: Minimum Sampling Parameters for Dry Weather Screening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
</tr>
</tbody>
</table>

Note: If the discharge is directly into an impaired water (see Table 1), then the flow must also be tested for the pollutants identified as causing the impairment for that water body (e.g., metals, nitrogen, phosphorus, oil and grease, etc.)- see Appendix G for requirements for Impaired Water testing.
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.

Input results from screening and sampling into spreadsheet/database. Include pertinent information in the outfall/interconnection inventory and priority ranking.

Include all screening data in the Annual Report.

If pollutants are present in discharge consistent with adjacent impaired waters, the Town will take measures to minimize or eliminate the source of pollution.

Document those measures in the SWMP and Annual Reports.

Analytical Method procedures and guidance are listed in Appendix F and I.

6.1.2 Follow-Up Monitoring

Dry weather flow is a strong indicator of illicit discharges, but it is not the only physical sign of potential illicit connections. Taking careful note of the conditions around the outfall is critical to finding non-stormwater discharges. Illicit discharges can be intermittent or sporadic. Other indicators of past flow may be present even if there is no active dry weather flow at the time of the field visit. If no dry weather flow is observed, but visual / olfactory (V/O) indicators of prior illicit discharge flow are seen, then the outfall should be revisited to check for flows. Table 7 is a helpful reminder for understanding confusing field observations. This Table, originally adapted from Pitt et al. 1993, was modified for the Town’s use in 2019.

### Table 7: Outfall Observations and Possible Sources

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Observations</th>
<th>Possible Reason/Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odor</td>
<td>Sewage</td>
<td>Stale sanitary wastewater, especially pooled near outfall</td>
</tr>
<tr>
<td></td>
<td>Sulfur (rotten eggs)</td>
<td>Industries discharge sulfide components or organics (meat packers, canneries, dairies, etc.). Also could be petroleum related &quot;high-sulfur&quot; fuels.</td>
</tr>
<tr>
<td></td>
<td>Rancid-sour</td>
<td>Food preparation facilities (restaurants, hotels, etc.)</td>
</tr>
<tr>
<td></td>
<td>Oil and gas</td>
<td>Petroleum refineries or many facilities associated with vehicle maintenance or petroleum product storage</td>
</tr>
<tr>
<td></td>
<td>Chlorine</td>
<td>Residential pool, or drinking water, likely not recurrent</td>
</tr>
<tr>
<td>Color</td>
<td>Yellow</td>
<td>Chemical plants, textile and tanning plants</td>
</tr>
<tr>
<td></td>
<td>Brown</td>
<td>Meat packers, printing plants, metal works, stone and concrete, fertilizers, and petroleum refining facilities.</td>
</tr>
<tr>
<td></td>
<td>Green</td>
<td>Chemical plants, textile facilities</td>
</tr>
<tr>
<td></td>
<td>Red</td>
<td>Metal packers, metal works</td>
</tr>
<tr>
<td></td>
<td>Gray</td>
<td>Dairies, and sewage</td>
</tr>
<tr>
<td>Turbidity</td>
<td>Cloudy</td>
<td>Sanitary wastewater, concrete or stone operations, fertilizer facilities, and automotive dealers</td>
</tr>
<tr>
<td></td>
<td>Opaque</td>
<td>Food processors, lumber mills, metal operations, pigment plants</td>
</tr>
<tr>
<td>Floatable Matter</td>
<td>Oil sheen, grease</td>
<td>Petroleum refineries or storage facilities and vehicle service facilities, and restaurants</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Sewage</td>
<td>Sanitary wastewater</td>
<td></td>
</tr>
<tr>
<td>Soap/bubbles</td>
<td>Sanitary wastewater</td>
<td></td>
</tr>
<tr>
<td>Deposits and Stains</td>
<td>Sediment</td>
<td>Construction site erosion</td>
</tr>
<tr>
<td>Oily</td>
<td>Sanitary wastewater</td>
<td></td>
</tr>
<tr>
<td>Vegetation</td>
<td>Excessive Growth</td>
<td>Food product facilities, fertilizers, farming agricultural use.</td>
</tr>
<tr>
<td></td>
<td>Inhibited growth, stressed vegetation</td>
<td>High stormwater flows, beverage facilities, printing plants, metal product facilities, drug manufacturing, petroleum facilities, vehicle service facilities and automobile dealers</td>
</tr>
<tr>
<td>Damage to Outfall Structures</td>
<td>Concrete cracking</td>
<td>Industrial flows, chemicals</td>
</tr>
<tr>
<td></td>
<td>Concrete spalling</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Peeling paint</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Metal corrosion</td>
<td></td>
</tr>
</tbody>
</table>

### 6.1.3 Field Equipment

Table 8 lists field equipment commonly used for dry weather outfall screening and sampling.

**Table 8: Field Equipment – Dry Weather Outfall Screening and Sampling**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Use/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clipboard</td>
<td>For organization of field sheets and writing surface</td>
</tr>
<tr>
<td>Field Sheets</td>
<td>Field sheets for both dry weather inspection and Dry weather sampling should be available with extras</td>
</tr>
<tr>
<td>Chain of Custody Forms</td>
<td>To ensure proper handling of all samples</td>
</tr>
<tr>
<td>Pens/Pencils/Permanent Markers</td>
<td>For proper labeling</td>
</tr>
<tr>
<td>Nitrile Gloves</td>
<td>To protect the sampler as well as the sample from contamination</td>
</tr>
<tr>
<td>Flashlight/headlamp w/batteries</td>
<td>For looking in outfalls or manholes, helpful in early mornings as well</td>
</tr>
<tr>
<td>Cooler with Ice</td>
<td>For transporting samples to the laboratory</td>
</tr>
<tr>
<td>Digital Camera</td>
<td>For documenting field conditions at time of inspection</td>
</tr>
<tr>
<td>Personal Protective Equipment (PPE)</td>
<td>Reflective vest, Safety glasses and boots at a minimum</td>
</tr>
<tr>
<td>GPS Receiver</td>
<td>For taking spatial location data</td>
</tr>
<tr>
<td>Water Quality Sonde</td>
<td>If needed, for sampling conductivity, temperature, pH</td>
</tr>
<tr>
<td>Water Quality Meter</td>
<td>Hand held meter, if available, for testing for various water quality parameters such as ammonia, surfactants and chlorine</td>
</tr>
<tr>
<td>Test Kits</td>
<td>Have extra kits on hand to sample more outfalls than are anticipated to be screened in a single day</td>
</tr>
<tr>
<td>Label Tape</td>
<td>For labeling sample containers</td>
</tr>
</tbody>
</table>
### Equipment

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Use/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Containers</td>
<td>Make sure all sample containers are clean.</td>
</tr>
<tr>
<td></td>
<td>Keep extra sample containers on hand at all times.</td>
</tr>
<tr>
<td></td>
<td>Make sure there are proper sample containers for what is being sampled for</td>
</tr>
<tr>
<td></td>
<td>(i.e., bacteria requires sterile containers).</td>
</tr>
<tr>
<td>Pry Bar or Pick</td>
<td>For opening catch basins and manholes when necessary</td>
</tr>
<tr>
<td>Sandbags</td>
<td>For damming low flows in order to take samples</td>
</tr>
<tr>
<td>Small Mallet or Hammer</td>
<td>Helping to free stuck manhole and catch basin covers</td>
</tr>
<tr>
<td>Utility Knife</td>
<td>Multiple uses</td>
</tr>
<tr>
<td>Measuring Tape</td>
<td>Measuring distances and depth of flow</td>
</tr>
<tr>
<td>Safety Cones</td>
<td>Safety</td>
</tr>
<tr>
<td>Hand Sanitizer</td>
<td>Disinfectant/decontaminant</td>
</tr>
<tr>
<td>Zip Ties/Duct Tape</td>
<td>For making field repairs</td>
</tr>
<tr>
<td>Rubber Boots/Waders</td>
<td>For accessing shallow streams/areas</td>
</tr>
<tr>
<td>Sampling Pole/Dipper/Sampling</td>
<td>For accessing hard to reach outfalls and manholes</td>
</tr>
</tbody>
</table>

### 6.1.4 Sampling Procedures

If flow is present during a dry weather outfall inspection, a sample will be collected and analyzed for the required parameters listed in Table 6. All analyses except for indicator bacteria and pollutants of concern can be completed in the field. In Canton, the pollutants of concern include:

- **Phosphorus**: Neponset River (MA73-01), Massapoag Brook
- **Fecal Coliform**: Ponkapog Brook, Neponset River (MS73-02), East Branch of Neponset River
- **Turbidity**: Neponset River (MA73-01 and MA73-02), Forge Pond, Massapoag Brook, Bolivar Pond,
- **Dissolved oxygen**: Pequid Brook, Neponset River (MA73-01 and MA73-02), East Branch of Neponset River, Beaver Brook Meadow, Pequid Brook
- **Excess algal growth**: Neponset River (MA73-01)
- **Total Suspended Solids and Sedimentation/Siltation**: Neponset River (MA73-01)
- **E. coli**: Ponkapog Brook, Neponset River (MA73-01 and MA73-02), East Branch of Neponset River, Pecunit Brook.

The general procedure for collection of outfall samples is as follows:

1. Fill out all sample information on sample bottles and 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).

---

3 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).
5. Use test strips, test kits, and field meters (rinse similar to dipper) for most parameters (see Table 9 and 10).

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. Coordinate laboratory pick-up or deliver samples directly to selected laboratory.

9. Dispose of used test strips and test kit ampules properly.

10. Decontaminate all testing personnel and equipment.

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. Analytic procedures and user’s manuals for field test kits and field instrumentation are provided in Appendix F. Testing for indicator bacteria and any pollutants of concern must be conducted using analytical methods and procedures found in 40 CFR § 136.4 Samples for laboratory analysis must also be stored and preserved in accordance with procedures found in 40 CFR § 136. Sampling analytical method guidance is presented in Appendix H.

In the event that 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. The location of observation and sampling will be recorded with the results.

Table 9 summarizes the sampling needs for parameters to be analyzed in the field. The threshold indicator value is included in the permit as an indicator of a potential illicit connection.

**Table 9: Field Sampling Analyses**

<table>
<thead>
<tr>
<th>Sampling Parameter</th>
<th>Sampling Container</th>
<th>Volume</th>
<th>Method</th>
<th>Threshold Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td>Glass or plastic</td>
<td>Enough volume to submerge probe/strip</td>
<td>WQ Meter/Test Kit</td>
<td>0.5 mg/L</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Glass or plastic</td>
<td></td>
<td>WQ Meter</td>
<td>0.02 mg/L</td>
</tr>
<tr>
<td>Conductivity</td>
<td>Glass or plastic</td>
<td></td>
<td>WQ Meter</td>
<td>--</td>
</tr>
<tr>
<td>Salinity</td>
<td>Glass or plastic</td>
<td></td>
<td>WQ Meter</td>
<td>--</td>
</tr>
<tr>
<td>Surfactants</td>
<td></td>
<td></td>
<td>WQ Meter/Test Kit</td>
<td>0.25 mg/L</td>
</tr>
<tr>
<td>Water Temperature</td>
<td></td>
<td></td>
<td>WQ Meter</td>
<td>--</td>
</tr>
</tbody>
</table>

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 10 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 F.

---

4 40 CFR § 136: [http://www.ecfr.gov/cgi-bin/text-idx?SID=b3b41fdea0b7b0b8cd6c4304d86271b7&mc=true&node=pt40.25.136&rgn=div5](http://www.ecfr.gov/cgi-bin/text-idx?SID=b3b41fdea0b7b0b8cd6c4304d86271b7&mc=true&node=pt40.25.136&rgn=div5)
Table 10: Sampling Parameters and Analysis Methods

<table>
<thead>
<tr>
<th>Analyte or Parameter</th>
<th>Instrumentation (Portable Meter)</th>
<th>Field Test Kit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td>CHEMetrics™ V-2000 Colorimeter</td>
<td>CHEMetrics™ K-1410</td>
</tr>
<tr>
<td></td>
<td>Hach™ DR/890 Colorimeter</td>
<td>CHEMetrics™ K-1510</td>
</tr>
<tr>
<td></td>
<td>Hach™ Pocket Colorimeter™ II</td>
<td>(series) Hach™ NI-SA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hach™ Ammonia Test Strips</td>
</tr>
<tr>
<td>Chlorine</td>
<td>CHEMetrics™ V-2000, K-2513</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Hach™ Pocket Colorimeter™ II</td>
<td></td>
</tr>
<tr>
<td>Conductivity</td>
<td>CHEMetrics™ I-1200</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>YSI Pro30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>YSI EC300A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oakton 450</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>YSI Pro30</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>YSI EC300A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oakton 450</td>
<td></td>
</tr>
<tr>
<td>Salinity</td>
<td>YSI Pro30</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>YSI EC300A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oakton 450</td>
<td></td>
</tr>
</tbody>
</table>

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. Samples for laboratory analysis must also be stored and preserved in accordance with procedures found in 40 CFR § 136. The pollutants of concern in Wayland include phosphorus, fecal coliform, turbidity, and enterococcus.

Table 11 lists analytical methods, detection limits, hold times, and preservatives for laboratory analysis of dry weather sampling parameters. Although all parameters are included in this table, it should be noted that laboratory analysis is not required for ammonia, surfactants, chlorine, temperature, specific conductance, and salinity, if field instrumentation or test kits in Table 6-4 are used.

5 40 CFR § 136: [http://www.ecfr.gov/cgi-bin/text-idx?SID=b3b41fdea0b7b0b8cd6c4304d86271b7&mc=true&node=pt40.25.136&rgn=div5](http://www.ecfr.gov/cgi-bin/text-idx?SID=b3b41fdea0b7b0b8cd6c4304d86271b7&mc=true&node=pt40.25.136&rgn=div5)
### Table 11: Required Analytical Methods, Detection Limits, Hold Times, and Preservatives

<table>
<thead>
<tr>
<th>Analyte or Parameter</th>
<th>Analytical Method</th>
<th>Detection Limit</th>
<th>Max. Hold Time</th>
<th>Preservative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td>EPA: 350.2, SM: 4500-NH3C</td>
<td>0.05 mg/L</td>
<td>28 days</td>
<td>Cool ≤6°C, H₂SO₄ to pH &lt;2, No preservative required if analyzed immediately</td>
</tr>
<tr>
<td>Surfactants</td>
<td>SM: 5540-C</td>
<td>0.01 mg/L</td>
<td>48 hours</td>
<td>Cool ≤6°C</td>
</tr>
<tr>
<td>Chlorine</td>
<td>SM: 4500-Cl G</td>
<td>0.02 mg/L</td>
<td>Analyze within 15 minutes</td>
<td>None Required</td>
</tr>
<tr>
<td>Temperature</td>
<td>SM: 2550B</td>
<td>NA</td>
<td>Immediate</td>
<td>None Required</td>
</tr>
<tr>
<td>Specific Conductance</td>
<td>EPA: 120.1, SM: 2510B</td>
<td>0.2 µs/cm</td>
<td>28 days</td>
<td>Cool ≤6°C</td>
</tr>
<tr>
<td>Salinity</td>
<td>SM: 2520</td>
<td>-</td>
<td>28 days</td>
<td>Cool ≤6°C</td>
</tr>
<tr>
<td>Indicator Bacteria:</td>
<td>Enterococcus, EPA: 1600, SM: 9230 C Other: Enterolert®</td>
<td>Enterococcus</td>
<td>8 hours</td>
<td>Cool ≤10°C, 0.0008% Na₂S₂O₃</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>EPA: Manual-365.3, Automated Ascorbic acid digestion-365.1, ICP/AES4-200.7 Rev. 4.4 SM: 4500-P E-F</td>
<td>EPA: 0.01 mg/L, SM: 0.01 mg/L</td>
<td>28 days</td>
<td>Cool ≤6°C, H₂SO₄ to pH &lt;2</td>
</tr>
<tr>
<td>Fecal Coliform</td>
<td>EPA: 1680; 1681</td>
<td>1 cfu/100 mL; 2 MPN/100 mL</td>
<td>6 hours</td>
<td>Cool ≤ 6°C</td>
</tr>
<tr>
<td>Turbidity</td>
<td>EPA: 180.1, SM: 2130 B-2011</td>
<td>0.02 NTU</td>
<td>48 hours</td>
<td>Cool ≤4°C</td>
</tr>
<tr>
<td>Enterococcus</td>
<td>EPA: 1600, SM: 9230 C Other: Enterolert®</td>
<td>EPA: 1 cfu/100 mL, SM: 1 MPN/100 mL Other: 1 MPN/100 mL</td>
<td>8 hours</td>
<td>Cool ≤10°C, 0.0008% Na₂S₂O₃</td>
</tr>
</tbody>
</table>

**Pollutants of Concern**

<table>
<thead>
<tr>
<th>Analyte or Parameter</th>
<th>Analytical Method</th>
<th>Detection Limit</th>
<th>Max. Hold Time</th>
<th>Preservative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Phosphorus</td>
<td>EPA: Manual-365.3, Automated Ascorbic acid digestion-365.1, ICP/AES4-200.7 Rev. 4.4 SM: 4500-P E-F</td>
<td>EPA: 0.01 mg/L, SM: 0.01 mg/L</td>
<td>28 days</td>
<td>Cool ≤6°C, H₂SO₄ to pH &lt;2</td>
</tr>
<tr>
<td>Fecal Coliform</td>
<td>EPA: 1680; 1681</td>
<td>1 cfu/100 mL; 2 MPN/100 mL</td>
<td>6 hours</td>
<td>Cool ≤ 6°C</td>
</tr>
<tr>
<td>Turbidity</td>
<td>EPA: 180.1, SM: 2130 B-2011</td>
<td>0.02 NTU</td>
<td>48 hours</td>
<td>Cool ≤4°C</td>
</tr>
<tr>
<td>Enterococcus</td>
<td>EPA: 1600, SM: 9230 C Other: Enterolert®</td>
<td>EPA: 1 cfu/100 mL, SM: 1 MPN/100 mL Other: 1 MPN/100 mL</td>
<td>8 hours</td>
<td>Cool ≤10°C, 0.0008% Na₂S₂O₃</td>
</tr>
</tbody>
</table>

SM = Standard Methods
6.2 Interpreting Outfall Sampling Results

Based on the results collected, the Town will determine if there are potential illicit connections from sanitary sources. An illicit sanitary source is likely if outfall sample results include the following values:

- Ammonia ≥ 0.5 mg/L
- Surfactants ≥ 0.25 mg/L, AND
- Bacteria > 235 cfu/mL for swimming or > 410 cfu/mL for other waters

Or

- Ammonia ≥ 0.5 mg/L
- Surfactants ≥ 0.25 mg/L, AND
- Detectable levels of chlorine (> 0.2 mg/L)

Additionally, if conductivity is measured above 2,000 µS/cm, this indicates potential for an illicit connection.

Based on the dry weather screening results, the Town will continue to update its ranking and further investigate potential connections through catchment investigations.

6.3 MS4 Interconnection Monitoring

There is one other MS4 permit holder in the Town of Canton: the Massachusetts State Hospital School (MSHS). The Town will investigate its drainage system near the MSHS to determine if there is a physical connection with Canton’s MS4. If there is, Canton will conduct dry weather screening and wet weather sampling at those point(s) of interconnection.

6.4 Data Tracking

The Outfall Monitoring Program data will continue to be tracked in the DPW’s Outfall Database. The database will be linked into the Town’s GIS.

The Town of Canton will update and re-prioritize the initial outfall and interconnection rankings based on information gathered during dry weather screening. The rankings will be updated periodically as dry weather screening information becomes available but 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 sewer 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.
7. CATCHMENT INVESTIGATION

Once 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.

Catchments are investigated in order of priority, with catchments draining to Problem Outfalls investigated first, followed by High Priority and then Low Priority Outfalls. Within each category the catchments are investigated in the order they are ranked. Work can be ongoing in multiple catchments simultaneously to expedite the process. Table 12 provides a schedule for completion of catchment investigations.

### Table 12: IDDE Schedule for Completion of Catchment Investigations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Start</th>
<th>Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Catchments</td>
<td>No later than 2 years from permit effective date</td>
<td>Within 7 years of permit effective date</td>
</tr>
<tr>
<td>Catchments with sewer input identified at outfall¹</td>
<td>No permit requirement</td>
<td>Within 7 years of permit effective date</td>
</tr>
<tr>
<td>All Catchments</td>
<td>No permit requirement</td>
<td>Within 10 years of permit effective date</td>
</tr>
</tbody>
</table>

¹Likely sewer input indicators are any of the following:
- Olfactory or visual evidence of sewage;
- Ammonia $\geq 0.5$ mg/L, surfactants $\geq 0.25$ mg/L, and bacteria levels greater than the water quality criteria applicable to the receiving water; or
- Ammonia $\geq 0.5$ mg/L, surfactants $\geq 0.25$ mg/L, and detectable levels of chlorine.

All data collected as part of the catchment investigations will be recorded and reported in each annual report.

7.1 System Vulnerability Factors

The DPW will review relevant mapping and historic plans and records to identify areas within the catchment with higher potential for illicit connections. The following information will be reviewed:

- Plans related to the construction of the drainage network
- Plans related to the construction of the sewer drainage network
- Prior work on storm drains or sewer lines
- Board of Health or other municipal data on septic systems
- Complaint records related to SSOs
- 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:
• History of SSOs, including, but not limited to, those resulting from wet weather, high water table, or fat/oil/grease blockages
• Common or twin-invert manholes serving storm and sanitary sewer alignments
• Common trench construction serving both storm and sanitary sewer alignments
• Crossings of storm and sanitary sewer alignments where the sanitary system is shallower than the storm drain system
• Sanitary sewer alignments known or suspected to have been constructed with an underdrain system
• Inadequate sanitary sewer level of service (LOS) resulting in regular surcharging, customer back-ups, or frequent customer complaints
• Areas formerly served by combined sewer systems
• Sanitary sewer infrastructure defects such as leaking service laterals, cracked, broken, or offset sanitary infrastructure, directly piped connections between storm drain and sanitary sewer infrastructure, or other vulnerability factors identified through Inflow/Infiltration Analyses, Sanitary Sewer Evaluation Surveys, or other infrastructure investigations
• Sewer pump/lift stations, siphons, or known sanitary sewer restrictions where power/equipment failures or blockages could readily result in SSOs
• Any sanitary sewer and storm drain infrastructure greater than 40 years old
• 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).

A SVF inventory will be documented for each catchment (see Table 13), retained as part of this IDDE Plan, and included in the annual report.
## Table 13: Outfall Catchment System Vulnerability Factor (SVF) Inventory

<table>
<thead>
<tr>
<th>Outfall ID</th>
<th>Receiving Water</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>XYZ River</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>Yes/No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Presence/Absence Evaluation Criteria:

1. History of SSOs, including, but not limited to, those resulting from wet weather, high water table, or fat/oil/grease blockages
2. Common or twin invert manholes serving storm and sanitary sewer alignments
3. Common trench construction serving both storm and sanitary sewer alignments
4. Crossings of storm and sanitary sewer alignments where the sanitary system is shallower than the storm drain system
5. Sanitary sewer alignments known or suspected to have been constructed with an underdrain system
6. Inadequate sanitary sewer level of service (LOS) resulting in regular surcharging, customer back-ups, or frequent customer complaints
7. Areas formerly served by combined sewer systems
8. Sanitary sewer infrastructure defects such as leaking service laterals, cracked, broken, or offset sanitary infrastructure, directly piped connections between storm drain and sanitary sewer infrastructure, or other vulnerability factors identified through Inflow/Infiltration Analyses, Sanitary Sewer Evaluation Surveys, or other infrastructure investigations
9. Sewer pump/lift stations, siphons, or known sanitary sewer restrictions where power/equipment failures or blockages could readily result in SSOs
10. Any sanitary sewer and storm drain infrastructure greater than 40 years old
11. 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 than poor owner maintenance)
12. 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 than poor owner maintenance)
7.2 **Dry Weather Manhole Inspections**

The Town of Canton 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 or SSOs.

The DPW 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 2016 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. A sample field inspection form is provided in Appendix F.

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 or SSOs, 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 or SSOs can be isolated to a pipe segment between two manholes.

5. 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 DPW will be responsible for implementing the wet weather outfall sampling program and making updates as necessary.

These outfalls will be inspected and sampled under wet weather conditions, to the extent necessary, to determine whether wet weather-induced high flows in sanitary sewers or 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 sewer 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

These are all options that the Town can rely on. However, sandbagging, dye testing, and CCTV inspections if necessary, will be utilized first. Any homeowners or businesses that will be impacted by these investigations will be notified prior to starting.

These methods are described in the sections below. Public notification is an important aspect of a detailed source investigation program. Prior to dye testing or CCTV inspections, the DPW will notify property owners in the affected area.

### 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 Dye Testing

Dye testing involves flushing non-toxic dye into plumbing fixtures such as toilets, showers, and sinks and observing nearby storm drains and sewer manholes as well as stormwater outfalls for the presence of the dye. It is important to inform local residents and business owners before dye testing is performed. Police, fire, and local public health staff should also be notified prior to testing in preparation for 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 and sanitary sewer manholes (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 and sanitary 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.

7.4.3 CCTV Inspections

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.

7.4.4 Safety Considerations

Safety of personnel is of the utmost importance, so a discussion summary of safety issues is provided below:

<table>
<thead>
<tr>
<th>MANHOLE / CATCH BASIN INSPECTION: IMPORTANT SAFETY INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>The underground structures that form a stormwater collection network (catch basins, manholes etc) are part of a dangerous environment, and it is vital that all appropriate safety precautions are taken. Some examples of the safety issues that can occur when working with a storm sewer network are:</td>
</tr>
<tr>
<td>❑ Inhaling poisonous gases that can accumulate inside the piping system.</td>
</tr>
<tr>
<td>❑ Falling into a manhole and being swept down a storm drain pipe.</td>
</tr>
<tr>
<td>❑ Being struck by traffic while inspecting catch basins or manholes on the street.</td>
</tr>
<tr>
<td>❑ Falling while accessing outfalls with unstable banks.</td>
</tr>
<tr>
<td>❑ Infection from raw sewage or chemicals.</td>
</tr>
<tr>
<td>❑ Poison ivy.</td>
</tr>
</tbody>
</table>

In most cases, any of the activities that are necessary as part of an inspection of a catch basin or manhole, undertaken as part of dry weather flow follow up, can be performed from the street or ground level. For example:

| ❑ Flow depths can be measured using long sticks |
| ❑ Samples can be taken by bottles held by extension holders |
| ❑ Visual inspections can be performed using flashlights or mirrors |

If for some reason entry into the system is deemed necessary, it is extremely important to note the following
### MANHOLE / CATCH BASIN INSPECTION: IMPORTANT SAFETY INFORMATION

NO INDIVIDUAL, UNDER ANY CIRCUMSTANCE, SHOULD ENTER INTO ANY PART OF THE STORM SEWER SYSTEM, UNLESS THAT INDIVIDUAL HAS RECEIVED COMPLETE OSHA CONFINED-SPACE-ENTRY TRAINING, AND IS FULLY QUALIFIED TO OPERATE IN A CONFINED SPACE ENVIRONMENT. NO INDIVIDUAL, TRAINED OR NOT, SHOULD ENTER CONFINED SPACE WITHOUT ADEQUATE SUPPORT FROM ADDITIONAL PERSONNEL AND APPROPRIATE EQUIPMENT.

If an inspector is unsure whether he/she is qualified to enter into a confined space, it is likely they are not qualified. Review the following website for additional information, or speak with the MS4 authority to clarify any safety issues.  [http://www.osha.gov/SLTC/confinedspaces/](http://www.osha.gov/SLTC/confinedspaces/)

Other common-sense safety issues to be aware of include, but are not limited to:

- **Danger from passing traffic** – check with local police department to determine if a police detail is needed on streets where the storm system may be inspected.
- **Communication** – Inspectors should ensure that they carry walkie-talkies or cell-phones to enable them to stay in contact with the MS4 authority. No inspector should go into the field without letting the MS4 authority where they will be and when they expect to be finished.

Inspectors should plan carefully for field work and should make themselves fully aware of any site-specific condition they may encounter.

**Weather Conditions** – As in conducting outfall inspections, it is important to conduct dry-weather-flow source location tracing activities during dry weather flow conditions. Seasonally, the best times of year are late spring and early fall when there is little vegetation to camouflage the outfalls and the ground water tables are low prohibiting infiltration into the system. Tracing should be conducted at least 48 hours after any significant rainfall event to minimize the impact of delayed storm flow on inspections.

### 7.5 Illicit Discharge Removal

When the specific source of an illicit discharge is identified, Canton will exercise its authority as necessary to require its removal within 60 days. 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
- 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 SSOs and may also include additional training specific to the functions of particular personnel and their function within the framework of the IDDE program. Training records will be maintained in Appendix I. The frequency and type of training will be included in the annual report.

9. PROGRESS REPORTING

Canton will report on the following indicators of IDDE Program progress in the SWMP update and in the Annual Reports:

- # of catchments investigated per year in relation to required milestones
- # of dry weather outfall inspections
- # of wet weather outfall monitoring
- # of illicit discharges identified
- # of enforcement notices issued
- # of illicit discharges eliminated and time from confirmation to elimination
- % of MS4 catchment area investigated
- # of employees trained annually

Metrics for success of the IDDE Program will be: 1) all illicit discharges action steps taken per the Permit required timelines, 2) prioritized catchments investigated within Permit required timelines.
APPENDIX A

Stormwater Base Map
APPENDIX B

Consolidated Drainage Bylaw
Works, or his designees, shall be deemed to be enforcing person(s).

Section 15. Poles And Overhead Wires And Associated Overhead Structures; Prohibited 16-15
Any person, firm, corporation, partnership, their agents and employees, who has been granted, or may be granted, any license, permission, or other authority to construct or to maintain poles and overhead wires and associated overhead structures upon, along, under or across any public ways, is forbidden from installing or constructing, and shall remove immediately any poles, overhead wires and associated overhead structures which are located on, along, or across the following section of roadway described below:

Washington Street from Sherman Street to Neponset Street.

Section 16: Consolidated Drainage By-law16-16

Subsection 1. Purpose
The purpose of this by-law is to preserve and maintain the waterways in the Town of Canton and to protect the Town of Canton’s drinking water supply from contamination, recognizing that much of the storm water which falls on the Town’s surface eventually makes its way to one of the many brooks, streams or rivers that run through the Town.

A corollary purpose of this by-law is to provide for the health, safety, and general welfare of the citizens of the Town of Canton through the regulation of non-storm water discharges to the storm drainage system to the maximum extent practicable as required by federal and state law. This by-law establishes methods for controlling the introduction of pollutants into the municipal separate storm drain system [storm sewer system (MS4)] in order to comply with requirements of the National Pollutant Discharge Elimination System (NPDES) permit process. The objectives of this by-law are:

(1) To regulate the contribution of pollutants to the municipal separate storm sewer system (MS4) by storm water discharges by any user.

(2) To prohibit illicit connections and discharges to the municipal separate storm sewer system

(3) To establish legal authority to carry out all inspection, surveillance and monitoring procedures necessary to ensure compliance with this by-law

All new construction in the Town shall incorporate systems to encourage the recharge of storm water back into the groundwater table. Contractors are

16-15 Inserted under article 39, ATM April 24, 2000.
16-16 Inserted under article 35, ATM May 2, 2001.
directed to the applicable sections of the "Rules and Regulations" of the Planning Board.

**Subsection 2. Definitions**
For the purposes of this by-law, the following shall mean:

**Authorized Enforcement Agency:** The Town of Canton Department of Public Works (DPW), employees or designees of the Superintendent, designated to enforce this bylaw.

**Best Management Practices (BMPs):** schedules of activities, prohibitions of practices, general good housekeeping practices, pollution prevention and educational practices, maintenance procedures, and other management practices to prevent or reduce the discharge of pollutants directly or indirectly to storm water, receiving waters, or storm water conveyance systems. BMPs also include treatment practices, operating procedures, and practices to control site runoff, spillage or leaks, sludge or water disposal, or drainage from raw materials storage.

**Clean Water Act.** The federal Water Pollution Control Act (33 U.S.C. § 1251 et seq.), and any subsequent amendments thereto.

**Construction Activity.** Activities subject to NPDES Construction Permits. These include construction projects resulting in land disturbance of 5 acres or more. Such activities include but are not limited to clearing and grubbing, grading, excavating, and demolition.

**Drainage System:** The storm water collection system which is made up of the open water courses, swales, ditches, culverts, canals, streams, and pipes through which the surface water flows and the town ways over which it flows.

**Groundwater:** All water found beneath the surface of the ground.

**Hazardous Materials.** Any material, including any substance, waste, or combination thereof, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may cause, or significantly contribute to, a substantial present or potential hazard to human health, safety, property, or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

**Illegal Discharge.** Any direct or indirect non-storm water discharge to the storm drain system, except as exempted in Section 8 of this by-law.

**Illicit Connections.** An illicit connection is defined as either of the following: Any drain or conveyance, whether on the surface or subsurface, which allows an illegal discharge to enter the storm drain system including but not limited to any conveyances which allow any non-storm water discharge including sewage, process wastewater, and wash water to enter the storm drain system and any
connections to the storm drain system from indoor drains and sinks, regardless of whether said drain or connection had been previously allowed, permitted, or approved by an authorized enforcement agency or,

Any drain or conveyance connected from a commercial or industrial land use to the storm drain system which has not been documented in plans, maps, or equivalent records and approved by an authorized enforcement agency.

**Impervious Surfaces**: Materials or structures on or above the ground that does not allow precipitation to infiltrate to the underlying soil.

**Industrial Activity**. Activities subject to NPDES Industrial Permits as defined in 40 CFR, Section 122.26 (b)(14).

**National Pollutant Discharge Elimination System (NPDES) Storm Water Discharge Permit**. Means a permit issued by EPA (or by a State under authority delegated pursuant to 33 USC § 1342(b)) that authorizes the discharge of pollutants to waters of the United States, whether the permit is applicable on an individual, group, or general area-wide basis.

**Non-Storm Water Discharge**. Any discharge to the storm drain system that is not composed entirely of storm water.

**Person**: means any individual, association, organization, partnership, firm, corporation or other entity recognized by-law and acting as either the owner or as the owner's agent.

**Pollutant**. Anything which causes or contributes to pollution. Pollutants may include, but are not limited to: paints, varnishes, and solvents; oil and other automotive fluids; non-hazardous liquid and solid wastes and yard wastes; refuse, rubbish, garbage, litter, or other discarded or abandoned objects, ordinances, and accumulations, so that same may cause or contribute to pollution; floatables; pesticides, herbicides, and fertilizers; hazardous substances and wastes; sewage, fecal coliform and pathogens; dissolved and particulate metals; animal wastes; wastes and residues that result from constructing a building or structure; and noxious or offensive matter of any kind.

**Premises**. Any building, lot, parcel of land, or portion of land whether improved or unimproved including adjacent sidewalks and parking strips.

**Recharge Areas**: Areas that collect precipitation or surface water and carry it to an aquifer.

**Storm Drainage System**. Publicly owned facilities by which storm water is collected and/or conveyed, including but not limited to any roads with drainage systems, municipal streets, gutters, curbs, inlets, piped storm drains, pumping facilities, retention and detention basins, natural and human-made or altered drainage channels, reservoirs, and other drainage structures.
Storm Water. Rainfall that exceeds the soils capacity to absorb and runs across
the surface to brooks and streams to be collected in the ponds and rivers of the
Town. Any surface flow, runoff, and drainage consisting entirely of water from
any form of natural precipitation, and resulting from such precipitation.

Storm Water Pollution Prevention Plan: A document which describes the Best
Management Practices and activities to be implemented by a person or business
to identify sources of pollution or contamination at a site and the actions to
eliminate or reduce pollutant discharges to storm water, storm water conveyance
systems, and/or receiving waters to the maximum extent practicable.

Toxic or Hazardous Material: Any material or mixture of physical, chemical,
infectious characteristics posing a significant, actual or potential hazard to the
water supply or a hazard to human health if such substance or mixture were
discharged to the land or water of the Town of Canton. Toxic or hazardous
materials include, without limitation, synthetic organic chemicals, petroleum
products, heavy metals, radioactive or infectious wastes, acids and alkalis, and
all substances defined as Toxic or Hazardous under Massachusetts General
Laws Chapter 21C and 21E, and 310 CMR 30.00, and also including such
products as solvents and thinners in quantities greater than normal household
use.

Wastewater means any water or other liquid, other than uncontaminated storm
water, discharged from a facility.

Subsection 3. Applicability
This by-law shall apply to all water entering the storm drain system generated on
any developed and undeveloped lands unless explicitly exempted by an
authorized enforcement agency.

Subsection 4. Other Applicable By-Laws
The reader is directed to the following By-laws, which contain regulations
concerning drainage:

Article XIV Police Regulations; Section 38A Grading of Residence Lots and
Section 51. Regulations for New Dwellings.

Article XV Wetlands Protection By-law

Article XVI Miscellaneous, Section 3. Soil Removal

Zoning By-law, Section E, Article 5.2, Groundwater Protection District

Article XVII Hazardous Materials Regulations of the Board of Health
Subsection 5. **Responsibility For Administration**
The Department of Public Works shall administer, implement, and enforce the provisions of this by-law. Any powers granted or duties imposed upon the authorized enforcement agency may be delegated in writing by the Superintendent of Public Works to persons or entities acting in the beneficial interest of or in the employ of the agency.

Subsection 6. **Severability**
The provisions of this by-law are hereby declared to be severable. If any provision, clause, sentence, or paragraph of this by-law or the application thereof to any person, establishment, or circumstances shall be held invalid, such invalidity shall not affect the other provisions or application of this by-law.

Subsection 7. **Ultimate Responsibility**
The standards set forth herein and promulgated pursuant to this by-law are minimum standards; therefore this by-law does not intend nor imply that compliance by any person will ensure that there will be no contamination, pollution, nor unauthorized discharge of pollutants.

Subsection 8. **Prohibited Activities**

**Prohibition of Illegal Discharges.**
No person shall discharge or cause to be discharged into the municipal storm drain system or watercourses any materials, including but not limited to, pollutants or waters containing any pollutants that cause or contribute to a violation of applicable water quality standards, other than storm water.

The commencement, conduct or continuance of any non-storm water discharge to the storm drain system is prohibited except as described as follows:

The following discharges are exempt from discharge prohibitions established by this by-law: water line flushing or other potable water sources, landscape irrigation or lawn watering, diverted stream flows, rising ground water, ground water infiltration to storm drains, uncontaminated pumped ground water, foundation or footing drains (not including active groundwater dewatering systems), crawl space pumps, air conditioning condensation, springs, non-commercial washing of vehicles, natural riparian habitat or wet-land flows, swimming pools (if dechlorinated - typically less than one PPM chlorine), fire fighting activities, and any other water source not containing Pollutants.

Discharges specified in writing by the authorized enforcement agency as being necessary to protect public health and safety.

Dye testing is an allowable discharge, but requires a verbal notification to the authorized enforcement agency prior to the time of the test.

The prohibition shall not apply to any non-storm water discharge permitted under an NPDES permit, waiver, or waste discharge order issued to the discharger and administered under the authority of the Federal Environmental Protection
Agency, provided that the discharger is in full compliance with all requirements of the permit, waiver, or order and other applicable laws and regulations, and provided that written approval has been granted by the DPW for any discharge to the storm drain system.

**Prohibition of Illicit Connections.**
The construction, use, maintenance or continued existence of illicit connections to the storm drain system is prohibited.

This prohibition expressly includes, without limitation; illicit connections made in the past, regardless of whether the connection was permissible under law or practices applicable or prevailing at the time of connection.

A person is considered to be in violation of this by-law if the person connects a line conveying sewage to the MS4, or allows such a connection to continue.

No person shall block, cause to be filled or in any way obstruct the normal flow of storm water into or out of the storm water disposal system.

No person shall dump or dispose of yard waste (leaves, grass clippings, etc.) into the open watercourses (swales, brooks and streams), that make up the storm water system.

No person shall discharge, or cause to be discharged, water or any other liquid, on to the streets, sidewalks or ways of the town in such a manner as to cause an obstruction of traffic or to endanger travel by freezing or otherwise.

No one shall deliberately direct, or cause to be directed, an increase or change to the flow of storm water from one’s own property onto abutting property.

**Subsection 9. Other Prohibited Activities**

**Drains** - No one shall tie any pump, cellar, yard, roof or area drain directly into the storm water drainage system without a permit from the Department of Public Works.

**Catch basins** - No person shall directly or indirectly dump, discharge or cause or allow to be discharged into any catchbasin, any solid waste, construction debris, paint or paint product, antifreeze, hazardous waste, oil, gasoline, grease and all other automotive and petroleum products, solvents and degreasers, drain cleaners, commercial and household cleaners, soap, detergent, ammonia, food and food waste, grass or yard waste, animal feces, dirt, sand gravel or other pollutant. Any person determined by the DPW to be responsible for the discharge of any of the above substances to a catchbasin may be held responsible for cleaning the catchbasin and any other portions of the storm water system impacted, paying the cost for such cleaning or for paying any penalties assessed by the Town.
All catch basins constructed shall be equipped with oil interceptors (hoods) approved by the Department of Public Works.

**Pools**: Residents shall drain their pools in such a way as not to cause a nuisance to the neighborhood. Pool water shall be dechlorinated by allowing it to stand for a week prior to draining.

**Sanitary Sewer System**: It is strictly prohibited by both town and MWRA regulations to tie any type of drain into the sanitary sewer system. This restriction applies to all types of drainage, including roof drains and cellar or basement drains.

**Septage**: No person shall discharge or cause or allow to be discharged any septage, or septage tank or cesspool overflow into the Town's storm water drainage system.

**Storage & Disposal of Hazardous Material**: No one shall dispose of anything other than clear water into the town's storm drainage system. The disposal of waste, gasoline or any other hazardous material into the storm drainage system is strictly prohibited and is in violation of various state and federal pollution laws.

**Private drainage systems**: It is prohibited for anyone with a private drainage system from tying into the public storm water disposal system without a permit from the Department of Public Works. The maintenance of any and all private drainage systems shall be the responsibility of the owners.

**Subsection 10. New Construction**

All new drainage construction in the Town of Canton shall be constructed in accordance with Section 3.6 STORMWATER MANAGEMENT of the Rules and Regulation of the Planning Board.

Any new construction, which shall render impervious 15% or 2,500 square feet of any lot, whichever is greater, shall require a drainage permit from the Department of Public Works.

**Subsection 11. Suspension Of MS4 Access**

**Suspension due to Illicit Discharges in Emergency Situations**

The DPW may, without prior notice, suspend MS4 discharge access to a person when such suspension is necessary to stop an actual or threatened discharge which presents or may present imminent and substantial danger to the environment, or to the health or welfare of persons, or to the MS4 or waters of the United States. If the violator fails to comply with a suspension order issued in an emergency, the authorized enforcement agency may take such steps as deemed necessary to prevent or minimize damage to the MS4 or Waters of the United States, or to minimize danger to persons.
Suspension due to the Detection of Illicit Discharge
Any person discharging to the MS4 in violation of this by-law may have their MS4 access terminated if such termination would abate or reduce an illicit discharge. The authorized enforcement agency will notify a violator of the proposed termination of its MS4 access. The violator may petition the authorized enforcement agency for a reconsideration and hearing.

A person commits an offense if the person reinstates MS4 access to premises terminated pursuant to this Section, without the prior approval of the authorized enforcement agency.

Subsection 12. Industrial Or Construction Activity Discharges
Any person subject to an industrial or construction activity NPDES storm water discharge permit shall comply with all provisions of such permit. Proof of compliance with said permit may be required in a form acceptable to the Department of Public Works prior to the allowing of discharges to the MS4.

This section applies to all facilities that have storm water discharges associated with industrial activity, including construction activity.

Access to Facilities.
The DPW shall be permitted to enter and inspect facilities subject to regulation under this by-law as often as may be necessary to determine compliance with this by-law. If a discharger has security measures in force which require proper identification and clearance before entry into its premises, the discharger shall make the necessary arrangements to allow access to representatives of the authorized enforcement agency.

Facility operators shall allow the DPW ready access to all parts of the premises for the purposes of inspection, sampling, examination and copying of records that must be kept under the conditions of an NPDES permit to discharge storm water, and the performance of any additional duties as defined by state and federal law.

The DPW shall have the right to set up on any permitted facility such devices as are necessary in the opinion of the authorized enforcement agency to conduct monitoring and/or sampling of the facility's storm water discharge.

The DPW has the right to require the discharger to install monitoring equipment as necessary. The facility's sampling and monitoring equipment shall be maintained at all times in a safe and proper operating condition by the discharger at its own expense. All devices used to measure storm water flow and quality shall be calibrated to ensure their accuracy.

Any temporary or permanent obstruction to safe and easy access to the facility to be inspected and/or sampled shall be promptly removed by the operator at the
written or oral request of the DPW and shall not be replaced. The costs of clearing such access shall be borne by the operator.

Unreasonable delays in allowing the DPW access to a permitted facility is a violation of a storm water discharge permit and of this by-law. A person who is the operator of a facility with a NPDES permit to discharge storm water associated with industrial activity commits an offense if the person denies the authorized enforcement agency reasonable access to the permitted facility for the purpose of conducting any activity authorized or required by this by-law.

If the DPW has been refused access to any part of the premises from which storm water is discharged, and he/she is able to demonstrate probable cause to believe that there may be a violation of this by-law, or that there is a need to inspect and/or sample as part of a routine inspection and sampling program designed to verify compliance with this by-law or any order issued hereunder, or to protect the overall public health, safety, and welfare of the community, then the authorized enforcement agency may seek issuance of a search warrant from any court of competent jurisdiction.

**Subsection 14. Requirement To Prevent, Control, And Reduce Storm Water Pollutants By The Use Of Best Management Practices**

The DPW will adopt requirements identifying Best Management Practices for any activity, operation, or facility, which may cause or contribute to pollution or contamination of storm water, the storm drain system, or waters of the U.S. The owner or operator of a commercial or industrial establishment shall provide, at their own expense, reasonable protection from accidental discharge of prohibited materials or other wastes into the municipal storm drain system or watercourses through the use of these structural and non-structural BMPs. Further, any person responsible for a property or premise, which is, or may be, the source of an illicit discharge, may be required to implement, at said person's expense, additional structural and non-structural BMPs to prevent the further discharge of pollutants to the municipal separate storm sewer system. Compliance with all terms and conditions of a valid NPDES permit authorizing the discharge of storm water associated with industrial activity, to the extent practicable, shall be deemed compliance with the provisions of this section. These BMPs shall be part of a storm water pollution prevention plan (SWPP) as necessary for compliance with requirements of the NPDES permit.

**Subsection 15. Watercourse Protection**

Every person owning property through which a watercourse passes, or such person's lessee, shall keep and maintain that part of the watercourse within the property free of trash, debris, excessive vegetation, and other obstacles that would pollute, contaminate, or significantly retard the flow of water through the watercourse. In addition, the owner or lessee shall maintain existing privately owned structures within or adjacent to a watercourse, so that such structures will not become a hazard to the use, function, or physical integrity of the watercourse.
Subsection 16. Notification Of Spills
Notwithstanding other requirements of law, as soon as any person responsible for a facility or operation, or responsible for emergency response for a facility or operation has information of any known or suspected release of materials which are resulting or may result in illegal discharges or pollutants discharging into storm water, the storm drain system, or water of the U.S. said person shall take all necessary steps to ensure the discovery, containment, and cleanup of such release. In the event of such a release of hazardous materials said person shall immediately notify emergency response agencies of the occurrence via emergency dispatch services. In the event of a release of non-hazardous materials, said person shall notify the authorized enforcement agency in person or by phone or facsimile no later than the next business day. Notifications in person or by phone shall be confirmed by written notice addressed and mailed to the DPW within three business days of the phone notice. If the discharge of prohibited materials emanates from a commercial or industrial establishment, the owner or operator of such establishment shall also retain an on-site written record of the discharge and the actions taken to prevent its recurrence. Such records shall be retained for at least three years.

Subsection 17. Special Provisions In General
For commercial and industrial uses, to the extent feasible, run-off from impervious surfaces shall be recharged on site by diverting runoff toward areas covered with vegetation for surface infiltration. Such run-off shall not be discharged directly to rivers, streams or other surface water bodies. Subsurface infiltration shall be used only where other methods are infeasible and shall be preceded by oil, grease and sediment traps, to facilitate removal of any contaminates. All recharge areas shall be permanently maintained in full working order by the owner(s).

Commercial cleaners:
It is prohibited for commercial home cleaners, rug cleaners, car washes, etc., to dispose of their wastewater into the storm water system.

Dumpsters:
Areas around dumpsters shall be bermed and drained to a central catchbasin, which shall be equipped with an oil interceptor approved by the Department of Public Works.

Fertilizer storage:
The outdoor storage of salt, de-icing material, pesticides or herbicides is prohibited. The commercial storage of fertilizers and other soil conditioners shall be within structures designed to prevent the generation and escape of contaminated run-off or leachate.
Stables, (etc.):
Any stable, feedlot, kennel or resident who houses more than four farm animals shall provide for the pretreatment of all run-off from the property as approved by the Board of Selectmen. All permanent animal manure storage areas shall be covered and/or contained to prevent the generation and escape of contaminated run-off or leachate.

Vehicular storage:
Any area where more than six (6) vehicles are stored or parked for a period of more than one week shall be drained to catchbasins equipped with oil interceptors.

Subsection 18. Enforcement Notice of Violation.
Whenever the DPW finds that a person has violated a prohibition or failed to meet a requirement of this by-law, the authorized enforcement agency may order compliance by written notice of violation to the responsible person. Such notice may require without limitation:
(a) The performance of monitoring, analyses, and reporting;
(b) The elimination of illicit connections or discharges;
(c) That violating discharges, practices, or operations shall cease and desist;
(d) The abatement or remediation of storm water pollution or contamination hazards and the restoration of any affected property; and
(e) Payment of a fine to cover administrative and remediation costs; and
(f) The implementation of source control or treatment BMPs.
If abatement of a violation and/or restoration of affected property is required; the notice shall set forth a deadline within which such remediation or restoration must be completed. Said notice shall further advise that, should the violator fail to remediate or restore within the established deadline, the work will be done by a designated governmental agency or a contractor and the expense thereof shall be charged to the violator.

2. Appeal of Notice of Violation
Any person receiving a Notice of Violation may appeal the determination of the authorized enforcement agency. The notice of appeal must be received within 30 days from the date of the Notice of Violation. Hearing on the appeal before the appropriate authority or his/her designee shall take place within 30 days from the date of receipt of the notice of appeal. The decision of the municipal authority or their designee shall be final.

3. Enforcement Measures After Appeal
If the violation has not been corrected pursuant to the requirements set forth in the Notice of Violation, or, in the event of an appeal, within 30 days the decision of the Department of Public Works upholding the decision of the authorized enforcement agency, then representatives of the authorized enforcement agency shall enter upon the subject private property and are authorized to take any and all measures necessary to abate the violation and/or restore the property. It shall
be unlawful for any person, owner, agent or person in possession of any premises to refuse to allow the government agency or designated contractor to enter upon the premises for the purposes set forth above.

4. Cost of Abatement of the Violation
Within 30 days after abatement of the violation, the owner of the property will be notified of the cost of abatement, including administrative costs. The property owner may file a written protest objecting to the amount of the assessment within 30 days. If the amount due is not paid within a timely manner as determined by the decision of the municipal authority or by the expiration of the time in which to file an appeal, the charges shall become a special assessment against the property and shall constitute a lien on the property for the amount of the assessment.

Any person violating any of the provisions of this article shall become liable to the city by reason of such violation. The liability shall be paid in not more than 12 equal payments. Interest shall be added to any balance which remains unpaid after such thirty-first day at the same rate as is provided in Section fifty-seven of Chapter fifty-nine of the General Laws.

5. Injunctive Relief
It shall be unlawful for any person to violate any provision or fail to comply with any of the requirements of this by-law. If a person has violated or continues to violate the provisions of this by-law, the authorized enforcement agency may petition for a preliminary or permanent injunction restraining the person from activities which would create further violations or compelling the person to perform abatement or remediation of the violation.

6. Compensatory Action
In lieu of enforcement proceedings, penalties, and remedies authorized by this by-law, the authorized enforcement agency may impose upon a violator alternative compensatory action such as storm drain stenciling, attendance at compliance workshops, creek cleanup, etc.

7. Violations Deemed a Public Nuisance
In addition to the enforcement procedures and penalties provided, any condition caused or permitted to exist in violation of any of the provisions of this by-law is a threat to public health, safety, and welfare, and is declared and deemed a nuisance, and may be summarily abated or restored at the violator's expense, and/or a civil action to abate, enjoin, or otherwise compel the cessation of such nuisance may be taken.

8. Criminal Prosecution
Any person that has violated or continues to violate this by-law shall be liable to criminal prosecution to the fullest extent of the law, and shall be subject to a criminal penalty of $300.00 dollars per violation per day.
The authorized enforcement agency may recover all attorneys’ fees court costs and other expenses associated with enforcement of this by-law, including sampling and monitoring expenses.

9. Remedies Not Exclusive
The remedies listed in this by-law are not exclusive of any other remedies available under any applicable federal, state or local law and it is within the discretion of the authorized enforcement agency to seek cumulative remedies.

Subsection 19. Penalties
Any person or entity who violates this by-law shall be liable to the Town in the amount of $50.00 for the first day, and $50.00 for each day thereafter during which such violation shall continue. Each separate instance of noncompliance following the issuance of any warning or citation pursuant to this section shall constitute a separate violation.

Implementation of special provisions:
Residents and owners of commercial establishments shall have one year from the effective date of this by-law for the implementation of the regulations under the special provisions above.

Section 17. Mapping Commission 16-17
(a) Establishment – There is hereby established a mapping commission for the purpose of developing or coordinating the development of comprehensive maps of Canton, including, but not limited to, parcel boundaries, location of utility lines, pipelines, and other structures, land use or items of geographic or geological interest.

(b) Composition, Term of Office – The Mapping Commission shall consist of the Superintendent of Public Works, the head of the engineering division within the Department of Public Works, the Town Planner and the Information Systems Manager who shall serve by virtue of their office as members of the Mapping Commission.

(c) Powers and Duties – The Mapping Commission shall: (1) develop and administer programs relating to mapping of the community; (2) advise, assist and cooperate with state, regional and federal agencies in developing appropriate programs and policies relating to such mapping; (3) apply for, receive, expend, represent and act on behalf of the town in connection with federal grants, grant programs or reimbursements or private grants; (4) accept gifts, grants, bequests and devises from any source, whether public or private, for the purpose of assisting in the discharge of its duties; (5) seek to coordinate the activities of governmental and private bodies organized for similar purposes. The Mapping Commission shall seek to coordinate all mapping efforts in Canton in order that

16-17 Inserted under article 47, ATM May13, 2002.
APPENDIX C

MAPC Outfall Catchment Mapping and Ranking
Outfall Catchment Mapping and Ranking

Last updated: December 27, 2017

Background

The federal Clean Water Act, passed in 1972, established regulation of pollutant discharges into “waters of the United States.”¹ This law requires municipalities to qualify for a permit under the National Pollutant Discharge Elimination System (NPEDS) program in order to lawfully discharge stormwater into rivers, streams, and lakes. In Massachusetts, the 2003 Region 1 Final General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4 permit hereafter) is in effect, although it expired in 2008, and a new permit was signed in April of 2016.² The permit was set to go into effect on July 1, 2017, but the US Environmental Protection Agency postponed the effective date one year, until July 1, 2018. Under the terms of the new permit, MS4 municipalities will be required to adopt stronger measures for minimizing the impact of pollutants from their stormwater on the cleanliness of the receiving waters.³

In 2013, the Neponset River Watershed Association (NepRWA) and MAPC secured a Community Innovation Challenge (CIC) grant from the state of Massachusetts to assist the Neponset Valley Watershed municipalities in collaborating to adopt a new approach to meet the new MS4 requirements. The CIC grant program promoted municipal efficiency through regional collaboration. In this case, the goal was to provide policy templates, recommendations, and technical tools that Neponset Valley municipalities could use to meet the new requirements of the MS4 permit. Representatives from conservation commissions and departments of public works who are both involved in the permitting or in operation and management of stormwater came together to create the Neponset Valley Regional Stormwater Collaborative. The collaborative includes representatives from Canton, Dedham, Foxborough, Medfield, Milton, Norwood, Randolph, Sharon, Stoughton, Walpole, Westwood, and the Boston Water and Sewer Commission, with a representative from Boston participating as a technical advisor.

In order for Massachusetts MS4 municipalities to meet the terms of the new permit, they must meet more stringent illicit discharge detection and elimination (IDDE) requirements. “Illicit Discharges” are any substances that enter the stormwater system other than stormwater, including chemicals, oils, gasoline, or waste.⁴ Such discharges are associated with auto or other industrial activities.

older residences, and failing septic systems. According to the new MS4 permit, Massachusetts MS4 municipalities will be required to a) identify receiving waters associated with each outfall, b) delineate catchment areas draining to each outfall, and c) rate the potential for illicit discharge of the outfall catchment areas as High or Low. This rating can be used as a tool to focus outreach, infrastructure, and enforcement campaigns to property owners or neighborhoods. Meeting this standard requires technical analysis of hydrology, topography, land use, and stormwater infrastructure. This document describes the methods that MAPC has developed to meet the terms of each of these new requirements.

Several public agencies have previously tackled the task of automatically delineating catchments using topographic data in cities such as San Francisco, Portland, and Tampa. By adopting these methods in Massachusetts, municipalities should be able to meet the requirements more cost-effectively. However, any attempt at standardization must contend with the highly varied quality and completeness of municipal stormwater infrastructure data and the often limited technical capacity available at the local level. To reduce redundancy of effort and account for the varied resources available in different cities and towns, MAPC built on previous examples by developing a regionally applicable method to conduct this analysis that requires a minimum of local stormwater infrastructure data in a standardized format. MAPC has published and maintains a set instructions and of ArcGIS tools that can be applied for any municipality in Massachusetts and potentially beyond. This document describes the method and provides instructions for implementing it using ArcGIS and CommunityViz, an ArcGIS add-in.

MAPC has applied this method in a number of municipalities, including the Towns of Milton, Westwood, Stoughton, and Medfield. Other consultants and GIS Analysts working throughout the state and beyond have also downloaded and applied this methodology.

Data and Software Requirements

Catchment delineation
- ArcGIS 10.2 or above
- Spatial Analyst extension

Catchment ranking
- ArcGIS 10.2 or above
- Microsoft Excel

Stormwater Infrastructure Data
- Complete inventory of catch basins within municipal boundaries, regardless of ownership

• Catch basins have an integer ID field that corresponds to outfall IDs (see “Creating Outfall Catchments” below)
• Optional: “Owner” or other fields used to group catch basins into catchment areas.

Other Data Inputs
• Digital Elevation Model (DEM): for this analysis, we used the high resolution (1m) digital elevation models. These models were created from point data captured by Lidar sensors in flights from 2002 to 2012, and processed by USGS.
• Vector feature classes to “etch” into the DEM, such as:
  o Water features: MassDEP Hydrography
  o Road center lines: MassDOT Road Inventory
  o Gutters or edges of rights of way: MAPC Massachusetts Land Parcel Database.

Assigning Outfalls to Receiving Waters

The new permit requires for each municipal outfall to be associated with receiving waters both for the Notice of Intent, and for the outfall priority ranking requirement. The Notice of Intent that municipalities submit to the Department of Environmental Protection in the fall after the permit goes into effect requires municipalities to list each body of water receiving stormwater from the municipality, along with each impairment and the number of outfalls that contribute stormwater to each. Using GIS and various reference datasets such as topography and wetlands, outfalls can be assigned IDs from the MassDEP Impaired Waters dataset, or the 303(d) waters, named for section 303(d) of the Federal Clean Water Act. Section 303(d) requires each state to monitor the quality of its bodies of water. This dataset includes both a line and polygon feature class representing the bodies of water that MassDEP monitors according to the requirements of section 303(d). Each stream segment or lake has a unique identifier, or “AU ID.”

---

Figure 1. Using the USGS Hydrography dataset to associate the outfall to the Impaired Water.

Figure 2. Using wetlands (left) and topographic contours (right) to associate outfalls with Impaired Waters

Delineating Outfall Catchments

The basic process for delineating the catchment areas for each outfall was to download, assemble, and enhance the Digital Elevation Model, then use it to define small catchments for each catch basin, and finally aggregate those smaller catchments into larger outfall catchment areas. In order to streamline the process for municipalities across Massachusetts, we created three custom ArcGIS tools: the Lidar Mosaic tool, the Create Burn Raster tool, and the Complete Watershed tool, packaged as the MAPC Catchment Delineation Toolbox. The tools are publicly available for download on Github.\footnote{Go to https://github.com/MAPC/stormwater-toolkit to download the toolbox.}

\footnote{Go to https://github.com/MAPC/stormwater-toolkit to download the toolbox.}
Preprocessing the DEM

First, we downloaded the relevant Lidar images from MassGIS and mosaicked them into a single DEM. We built this process into an ArcGIS script tool called the Lidar Mosaic Tool. To use this tool, download the relevant Lidar images from MassGIS. Then, unzip all the files and save them in a single folder. Finally, run the tool inputting the folder in the “workspace” box and the desired name of the output raster (without an extension) in the “output raster” box.13

The Lidar Mosaic tool performs the following steps:

1. Sets Null value to <-400
2. Builds Pyramids and Calculates Statistics
3. Mosaics to New Raster

Enhancing the DEM

Although the digital elevation model has a very high spatial resolution, it is still not precise enough to capture the relief and drainage patterns created by gutters, curbs, road crowns, or other features that are small but greatly impact stormwater runoff patterns. In order to take these important stormwater control features into account, we enhance the DEM to simulate these features by “burning” or etching them into the DEM. This process ensures that within an urban area, water is modeled as flowing off of properties and into roadways, where it cannot leave a gutter once it enters one, and does not cross the crown of the road. In addition to modeling

---

13 The tool is set to mosaic using the value of the first listed raster in the case of overlapping rasters. It is also set to pull the pixel type from the first raster listed, so please use caution when mosaicking rasters from different lidar flyovers. This may require additional processing.
features of the urban landscape more faithfully, we burned in the streambeds and other bodies of water because the DEM did not accurately capture the known streambed for smaller streams that lay in flat floodplains. The image on the lower left shows a hillshade of the Lidar DEM before features were burned into it. The flat area in the southeast actually contains a streambed with a flat floodplain, which does not appear on the DEM, which means that the watershed tool will not accurately map the flow accumulation in this area. The roads also appear completely flat, as the slight curve of the road crown is not represented in the DEM. The lower right image shows the area after gutters, road crowns, and water bodies have been burned into it, which corrects these flat areas by etching known features into the elevation model, making it more representative of the hydrologic conditions in the area.

Figure 4. Hillshades before and after enhancement.

To enhance the DEM, we created several “burn” rasters, which are raster representations of features such as streams or gutters. The cells representing the feature are set to the “burn value,” or the value, in map units, that will be added to the original DEM, and all other cells are set to zero. We created an ArcGIS script tool to create these rasters more easily (Figure 3).

Figure 5. Create Burn Raster script tool.
This tool performs the following steps

1. Sets environments
   A. Processing Extent > Snap Raster: select lidar mosaic
   B. Processing Extent > Extent: same as lidar mosaic
   C. Raster Analysis > Cell size: same as lidar mosaic
   D. Raster Analysis > Mask: same as lidar mosaic

2. Creates an editable copy of the vector feature class

3. Adds a field to the vector’s attribute table called “Burn_Val.”

4. Populates the new field with the burn value.

5. Converts the vector to a raster

6. Converts nulls to zeros

7. Saves results

For example, to create a burn raster for the road crown, a user inputs the DEM that will be enhanced with the burn raster, the road center line shapefile or feature class as the “Input Vector”, then enters .5 into the “Enter Burn Value” field, and finally names the output file. The user should repeat this process with any other variable. For gutters, stream channels, or other features that will be subtracted from the DEM rather than added, users can enter a negative number. This tool can be run in batch mode (right click > batch) to create several burn rasters at once. See table 1 for an example of values used for the Town of Milton.

![Figure 6. Create Burn Raster script tool in batch mode.](image)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Data Source</th>
<th>Burn value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gutters</td>
<td>MAPC Statewide Parcel dataset, ROWs converted to polylines</td>
<td>-0.25m</td>
</tr>
<tr>
<td>Road Crowns</td>
<td>MassDOT Road centerlines</td>
<td>0.50m</td>
</tr>
<tr>
<td>Water Features</td>
<td>MassDEP</td>
<td>-0.25m</td>
</tr>
</tbody>
</table>

There is an ArcHydro tool called “DEM Reconditioning” that performs a similar function to burning streams or rivers into a DEM. This tool creates a stepped groove of a specified width along a linear feature. This tool cannot be used on polygons such as wide rivers, lakes, or ponds, however.
After creating the set of burn rasters, the user should add the burn rasters to the DEM using the Raster Calculator.

Creating Catch Basin Catchments

To simplify the steps necessary to create catch basin watersheds, we created a “Complete Watershed” script tool. Tool inputs are the enhanced DEM, the pour point (catch basin) vector layer, the field to be used for catch basin IDs, the maximum snap distance, and finally a name for the output file. The inputs have the following requirements: 1) the workspace must be a geodatabase, 2) both the Lidar DEM and the catch basin file should be stored within the workspace geodatabase, 3) neither input file should be nested in a group layer in the map document, and 4) the “snap point field” should be an integer.
The tool combines the following steps:

1. Fills any sinks in the enhanced DEM
2. Creates a flow direction raster from the filled DEM
3. Creates a flow accumulation raster using the flow direction raster
4. Snaps the pour points (catch basins) to pixels with high accumulated flow within the specified snap distance (in map units)
5. Creates watersheds using the flow direction raster and snapped pour points as inputs
6. Converts the watershed raster to a vector

Snapping the pour points (step 4 above) is particularly important, since catch basins points may not coincide with the pixels where the gutters have been burned into the DEM. For this step, the inputs are the point feature class representing the catch basins, and a maximum snap distance in map units. The tool will shift the location of the catch basins to coincide with pixels of highest flow accumulation in the flow accumulation raster within the radius specified as the “snap distance.” If this step is skipped, water will be modeled as flowing past the catch basins. The default value in this field is 5 map units. For the Town of Milton, we evaluated a range of radii and arrived at a maximum snap distance of 10 meters—the width of an average roadway—by visually assessing the distance between the catch basin points and the areas of high flow accumulation. If catch basin catchments look “stringy” or extremely small, try adjusting the snap distance.

The output of this tool is a set of very small watersheds—one for each catch basin. The tool will also output a set of intermediate rasters that can be used for troubleshooting or for other analyses.
The “cbid_int” field in the output raster matches the catch basin integer field, and can be used to join the original attribute table to the watershed layer.

Creating Outfall Catchments – An example from Milton, Massachusetts

The MS4 permit draft requires municipalities to delineate land areas that contribute rain water runoff to particular outfalls, so the small catch basin catchment areas must be “dissolved” into larger units based on which outfall they feed into. In order to achieve this, the catch basin feature
class should contain a field that assigns each feature to an outfall. This way, catch basins

catchment areas that drain to the same outfall can be grouped.

This grouping can be done based on local knowledge of the stormwater system. MAPC has also
developed a methodology for linking catch basins and their outfalls using a common ID. Inputs are
point feature classes for catch basins and outfalls and a line feature class representing
stormwater pipes. This method will not produce a perfect result, but will likely save municipal staff
time by providing a preliminary result that can be modified manually. Using the methods outlined
here, municipalities will not need perfectly clean, accurate, and precise datasets in order to begin
tracing evidence of illicit discharge discovered at an outfall back to the land area that
contributed rain water to that outfall. The following sections describes how we conducted this
analysis for the Town of Milton.

Creating “pipe system” IDs

To connect catch basins to their outfalls, we:

1. Buffered the pipe line features out according to the pipe diameter, then dissolve into a
large multipart polygon.
2. Exploded the multipart polygon into many single part pipe polygons.
3. Created a “Pipesys_ID” field in the attribute table of the new pipe polygon feature class.
4. Populated the “Pipesys_ID” field with the OID number using the field calculator.
5. Performed a spatial join to link the original pipe line network to the pipe polygon feature
class.
6. Performed additional spatial joins to link the pipe polygon feature class to both the catch
basins and the outfalls.

At this point, all interconnected pipes shared a Pipesys_ID, and all associated outfalls and
catch basins shared that ID. When selecting the buffer distance, we visually inspected the spatial
relationship between a sample of the catch basins and outfalls and the pipe lines. Although in
some cases the point features were not snapped to the line network precisely, in most cases they
still intersected with the buffered pipe systems, so the imprecision did not affect the results.
Another way to address snapping errors in the data would be to set a search distance when
performing the spatial join.

Checking the data

After applying the automated method above to Milton’s data, we noticed several
inconsistencies in the infrastructure data. Common errors include pipe systems without associated
outfalls, catch basins with no associated pipe networks, interconnected pipe networks, and outfalls
with no associated pipe network or “uphill” outfalls. We met with officials from Milton’s
Department of Public Works to correct some of these areas based on their local knowledge. The
local DPW staff informed us of some of the most common sources for these errors. The Milton
DPW has a very complete dataset recording the location of every catch basin in the municipality. Because those features are easily visible from the surface, and their locations are relatively predictable, they were able to perform a survey recording each catch basin location in the town with a GPS. The underground components of the infrastructure were much more difficult for them to survey, because the pipe networks may be very old in some parts of town, or are not owned or operated by the municipality, and they do not have access to the plans for those segments of pipes and their associated outfalls.

Table 2. Common problems with municipal stormwater data.

<table>
<thead>
<tr>
<th>Data Problem</th>
<th>Common Causes</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe Systems with no associated outfall</td>
<td>The outfall may belong to DCR, MassDOT, or a private system, or the system may be so old that no plans exist</td>
<td>Outfall imputed based on local knowledge, owner recorded in a separate “owner” field</td>
</tr>
<tr>
<td>Catch basins with no associated pipe networks</td>
<td>Most catch basins were recorded in a survey of the entire town, so even though the catch basin was visible to the surveyor, the town may not own the catch basin, or the catch basin may be in a development that has not submitted their stormwater infrastructure plans to the town.</td>
<td>Catch basins are assigned a new pipe system ID, and an outfall is imputed based on local knowledge. If the catch basins are not owned by the town, the owner is recorded in the “owner” field.</td>
</tr>
<tr>
<td>Interconnected Pipe networks</td>
<td>Pipe networks may be interconnected, but for this method, each catch basin may be assigned to only one outfall, so the Town DPW stormwater experts were able to assess which outfall was most likely associated with each catch basin.</td>
<td>Pipe networks split by assigning certain segments distinct pipe system IDs based on local knowledge. Catch basin and outfall IDs changed to match associated pipes.</td>
</tr>
<tr>
<td>Outfalls with no associated pipe network or outfalls that appear in unlikely positions, such as on hilltops</td>
<td>Could be a pipe end erroneously recorded as an outfall</td>
<td>Do not assign catch basins to these outfalls. No additional solution needed. Could flag for field investigation.</td>
</tr>
</tbody>
</table>

In order to resolve these issues enough to aggregate the catchments by outfall, we made manual adjustments to the network based on the DPW staff’s extensive experience and personal knowledge of the stormwater system. In instances where a pipe network may be interconnected and could outfall to more than one place, for example, we adjusted the data based on information from the DPW staff.
We initially identified instances where more than one outfall was associated with an interconnected pipe network by using the “find identical” tool, then joining the output table back to the outfall table. In the image below, for example, the automated method assigned a single ID to outfalls 1, 2, and 3, because they are associated with a single interconnected pipe network. In order to assign only one outfall to each catch basin, we assigned new unique IDs to each outfall and manually assigned them to appropriate pipes and catch basins.

Catch basin 4 in the image below is an example of a catch basin that was missed by the automated method of ID assignment, since the small joining pipe segment is missing from the dataset. Such catch basins were assigned manually whenever possible.

We also added an “owner” field to account for interconnections in the infrastructure. According to the permit, municipalities must monitor not only their own outfalls, but also interconnections with other systems. For the purposes of the new MS4 permit, an interconnection is “the point where the permittee’s MS4 discharges to another MS4 or other storm sewer system, through which the

Figure 9. Splitting pipe systems by outfall.
discharge is conveyed to waters of the United States.” Additionally, some areas that do not have much potential for illicit discharge, such as “roadway drainage in undeveloped areas with no dwellings and no sanitary sewers, drainage for athletic fields, parks, and associated parking without services, cross country drainage alignments,” may be excluded from regulation by the permit. There is a cemetery in Milton, for example, that is on a private stormwater pipe system, and may also be excluded since it would be considered an undeveloped area with no dwellings under the terms of the permit. Drainage along roadways in the Blue Hills would also be excluded for the same reason.

After each catch basin was assigned to a pipe system, which was in turn associated with a single outfall, we merged the smaller catch basin catchments into larger catchments based on outfall and owner. Merging on owner as well as outfall allows municipalities to distinguish between MS4 regulated areas and areas that would be exempt because of a private system or another exemption. See the image below for the resulting output:

---

14 United States Environmental Protection Agency. 2016: 34
15 United States Environmental Protection Agency. 2016: 35
Figure 10. Outfall Catchments.

Ranking Catchments

Once we delineated outfall catchments for Milton and linked outfalls with Impaired Waters in Milton, we ranked Milton’s outfall catchments according to how likely they were to contribute pollution to the receiving waters. NepRWA developed a spreadsheet-based method to prioritize outfalls and catchments based on criteria pulled directly from the language of the new permit. Some fields in the spreadsheet can be completed using GIS, and other should be completed using local knowledge of the stormwater system and municipality.

This spreadsheet analysis evaluates sites based on a set of specified quantitative criteria pulled directly from the language of the permit.

In this case, the presence of older homes, industrial uses, septic systems, and other physical features were summarized into a composite score from 0 to 100. Catchments with a median score or below were considered low priority, catchments within the third quartile were considered
medium, and those within the top quartile were considered high priority, or most likely to contribute illicit discharges to impaired waters.

Land use codes were designated as medium or high potential for illicit discharges using information found in the 2004 manual from Center for Watershed Protection, titled “Illicit Discharge Detection and Elimination: a guidance manual for program development and technical assessments”\(^{(1)}\). The guidance manual provided illicit discharge pollution potential for a variety of land uses and included their SIC codes in Attachment A, which were compared to and converted to NAICS codes during this process.

We used the following criteria for the analysis:

**Generating sites, Businesses**

We used two data sources to capture information on businesses that are at high or medium risk for illicit discharge into the stormwater system, and used these two datasets to create lists of high and medium risk businesses, which we then combined to create an index of generating businesses. One dataset is the Massachusetts Land Parcel Database, which summarizes the assessor’s records associated with each parcel. This dataset contains a land use code assigned by the assessor. These codes can be very specific—gas stations are distinguished from automobile repair shops, for example. The other dataset is establishment listings published by InfoGroup. Each business in this dataset has an associated classification code as well. These codes, called North American Industry Classification System (NAICS) codes are the standardized codes used by the US Census Bureau and other federal agencies for collecting economic data. These codes are even more specific than those from the parcel dataset. See the tables below for descriptions of the business types that we classified into high and medium risk businesses.

<table>
<thead>
<tr>
<th>High Potential businesses:</th>
<th>• Heavy Construction equipment rental and leasing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Building and heavy construction (for land disturbing activities)</td>
</tr>
<tr>
<td></td>
<td>• Buildings for manufacturing operations</td>
</tr>
<tr>
<td></td>
<td>• Apparel and other fabrics</td>
</tr>
<tr>
<td></td>
<td>• Auto recyclers and scrap yards</td>
</tr>
<tr>
<td></td>
<td>• Boat building and repair</td>
</tr>
<tr>
<td></td>
<td>• Chemical products</td>
</tr>
<tr>
<td></td>
<td>• Food processing</td>
</tr>
<tr>
<td></td>
<td>• Garbage truck washout activities</td>
</tr>
<tr>
<td></td>
<td>• Leather tanners</td>
</tr>
<tr>
<td></td>
<td>• Paper and wood products</td>
</tr>
<tr>
<td></td>
<td>• Petroleum storage and refining/gas production plants</td>
</tr>
<tr>
<td></td>
<td>• Tanks holding fuel and oil for retail distribution</td>
</tr>
<tr>
<td></td>
<td>• Natural or manufactured gas storage</td>
</tr>
<tr>
<td></td>
<td>• Textile mills</td>
</tr>
<tr>
<td></td>
<td>• Transportation equipment</td>
</tr>
<tr>
<td></td>
<td>• Landfills and hazardous waste material disposal</td>
</tr>
<tr>
<td></td>
<td>• Maintenance depots</td>
</tr>
<tr>
<td></td>
<td>• Streets and highways construction</td>
</tr>
</tbody>
</table>

High Potential businesses:

- Metal production, plating, and engraving operations
- Facilities providing building materials, hardware, and farm equipment, heating, hardware, plumbing, lumber supplies and equipment
- Ports
- Railroads
- Petroleum bulk stations or terminals
- Research and development facilities

Medium Potential businesses:

- Auto repair facilities/ automotive vehicles or supplies sales and service
- Automobile parking lots or garages
- Bus transportation facilities and related properties
- Campgrounds/RV parks
- Car dealers
- Car washes
- Food stores and wholesale beverage/supermarkets
- Small retail and services stores
- Eating and drinking establishments
- Gasoline stations/ fuel service areas
- Marinas
- Nurseries and garden centers
- Oil change shops
- Restaurants
- Chemical products
- Food processing
- Rubber and plastics
- Colleges and universities
- Airports
- Rental car lots
- US postal service
- Trucking companies and distribution centers

Figure 11. Lists of commercial potential illicit discharge generating sites.

To create the Business Generator Index, we multiplied the count of medium risk businesses from both datasets within each catchment by five, and added the result to the count of high risk businesses multiplied by ten (medium risk businesses * 5 + high risk businesses * 10). Next, we divided this index by the acreage of the catchment to produce a density index. We used the generating site index density value as a criterion for the suitability analysis.

Generating sites, Residential

For residential properties, the age of the house contributes to its risk for contributing illicit discharge to the stormwater system. The draft Massachusetts MS4 permit states that one of the ranking factors that MS4 municipalities are to consider is “Age of development and infrastructure – Industrial areas greater than 40 years old and areas where the sanitary sewer system is more 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.”\(^{17}\) We created a residential index similar to that of the business index. In this case, we used the same parcel database, this time using the “last built date.” We used this category based on the assumption that new construction

\(^{17}\) United States Environmental Protection Agency. 2016: 35.
or drastic rebuilding would be required to follow the building codes in effect at the date of construction.

Again, we created two categories of residential risk: high, for the count of houses in a catchment built more than 40 years ago, and medium, for the count of houses in the catchment built 20 to 40 years ago. We created an index using the same formula as that for the business index (count of medium risk *5 + count of high risk *10), and divided the result by the acreage of the catchment. We used this housing index per acre value as a criterion for the suitability model.

Sewer and Septic

We also created criteria reflecting the density of sewer lines and the concentration of septic systems within each catchment. Based on the line shapefiles we got from the GIS Analyst at Milton’s DPW sent us, we calculated the length of sewer pipe within each catchment divided by the total area of that catchment. Milton also provided us with a shapefile representing each parcel that has a septic system. For the “septic” criterion, we simply divided the number of septic systems in each catchment by the acreage of that catchment.

Quality of Receiving Waters

As described above, each catchment was associated with a single receiving water in the Integrated List of Waters created and maintained by MassDEP and published by MassGIS. We used the category of the associated receiving waters as a criterion within the suitability analysis. Categories of Impaired waters range from 1 to 5, with 5 being the most impaired, and 1 being unimpaired. Category 2 and 3 waters may be unimpaired for some uses and not assessed for others, or there may not be enough information available to make an assessment. Within Milton, all waters were rated a category 5, but elsewhere in the Neponset Watershed, some of the waters rank in a lower category, so we included the receiving water criterion even though it makes no difference in the rankings of the catchments for Milton.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Generating Site Index Density</td>
<td>Count of businesses of specified types divided by catchment area (in acres)</td>
</tr>
<tr>
<td>Density of older houses</td>
<td>Summary index, weighted count of houses older than 40 and 20 years.</td>
</tr>
<tr>
<td>Density of sewer pipes</td>
<td>Length of sewer pipes per acre</td>
</tr>
<tr>
<td>Density of septic systems</td>
<td>Number of septic systems per acre</td>
</tr>
</tbody>
</table>

Table 3. Ranking criteria and weights
Discussion

The increasingly stringent requirements of federal stormwater permits combined with the lack of dedicated funding streams for stormwater infrastructure maintenance present substantial challenges to local jurisdictions. Given these circumstances, municipalities will greatly benefit from tools that allow them to cost-effectively satisfy analytical permit requirements so that resources and attention can be focused on infrastructure, outreach, and enforcement. This document describes one such tool recently prepared by MAPC and now available to any city or town in Massachusetts.

The methodology and data resources described here will help many municipalities meet the “catchment delineation” requirement in the system mapping section of the new MS4 permit, provided the Outfall/Interconnection Inventory is relatively complete, and gaps in knowledge can be filled by DPW staff. Cities and towns do not need to collect or develop detailed stormwater infrastructure information, and MAPC has also provided highly detailed information on land uses and establishments that pose a higher risk for water pollution, eliminating the need for cities and towns to acquire or compile such data. Furthermore, the tool is structured to provide the specific types of data and designations required by the NPDES permit. For example, the permit requires municipalities to classify catchments into four groups—excluded, high priority, low priority, and problem. These products should help municipalities with the first three categories. If municipalities assign an “owner” to each catch basin, they will be able to distinguish between excluded and included catchments. The step-by-step instructions provided in this document, combined with the published data catalog and ArcGIS tool published online, will enable jurisdictions or consultants with relatively modest technical capabilities to use this method.

The delineation methodology and ranking process has some limitations that could be addressed through additional data collection. For example, it would have been useful to include the age of the sewer pipes as a ranking criterion. Most municipalities in the Neponset Watershed do not have this data available, however. The catchment ranking described here does not distinguish between problem catchments and other catchments. For the purposes of the MS4 permit, a “problem outfall” is one that has had an outfall that tested as contaminated, or that direct observation indicates that there is some kind of illicit discharge connected to that outfall. Such a catchment would be considered a problem catchment regardless of its ranking in this suitability analysis, and must be investigated. In the future, the ranking could include historical data on whether a catchment has ever been designated a problem catchment, so that former problem

| Quality of receiving waters | Category of water, 3, 4, or 5 | 303(d) Integrated List of Waters dataset from MassDEP, available through MassGIS |

---

18 United States Environmental Protection Agency. 2016: 32.
19 United States Environmental Protection Agency. 2016: 34.
catchments will rank higher than those that have had no observed contamination. If data are available, such analysis could be easily incorporated into a future version of the tool.
APPENDIX D

NSP Outfall Inventory and Prioritization Tool
Instructions and Background
Outfall Inventory
and Prioritization Tool

Version 2
March 21, 2019
Change Log

Final V1: Original version of the instructions and the tool, now deprecated.

Final V2: Major reorganization of instructions document to correspond with IDDE Plan procedures as outlined in NSP IDDE SWMP. Changes were too extensive to be tracked using track changes. Important modifications were also made to the tool itself, though these were less extensive than changes to the instructions.
# Table of Contents

Introduction......................................................................................................................... 1

Credits................................................................................................................................. 1

Prerequisites and Technical Support ...................................................................................... 1

Phase I: Preliminary Outfall Inventory and Ranking .............................................................. 2

  Phase I, Step 1: Complete Information in Infrastructure and Investigation Section .............. 3

  Phase I, Step 2: Catchment Composition Score .................................................................... 4

  Phase I, Step 3: Receiving Water Score ................................................................................ 5

  Phase I, Step 4: Preliminary Outfall Score and Priority Ranking: ......................................... 6

  Phase I, Step 6: Sort by Priority Outfall Ranking and Save a Snapshot ................................. 6

  Phase I, Step 7: Sort Outfalls by Waterbody to Determine Order of Dry Weather Screening .... 7

Phase II: Update the Outfall Tool to Reflect Progress of Dry or Wet Weather Outfall Screening .... 7

  Phase II, Step 1: Document Progress in Completing Dry Weather Outfall Screening ........... 7

  Phase II, Step 2: Document Progress in Completing Wet Weather Outfall Screening .......... 8

  Phase II, Step 3: Document Problem Catchment Investigation & Illicit Elimination ............. 8

  Phase II, Step 4: Annual Reporting and Follow Up Outfall Ranking .................................... 8

Phase III: Catchment Investigation & Discharge Elimination ............................................... 8

  Phase III, Step 1: Track Progress of Catchment Investigations and Schedule Wet Weather Investigations or Discharge Elimination as Needed ........................................... 9

  Phase III, Step 2: Annual Reporting .................................................................................... 9

Description of All Spreadsheet Fields and Tabs ..................................................................... 9
Introduction
The 2016 Final Massachusetts Small MS4 General Permit requires that permittees undertake five major tasks for Illicit Discharge Detection and Elimination (IDDE):

1) Initial ranking of outfalls and interconnections
2) Dry weather outfall and interconnection screening
3) Follow up ranking of outfalls and interconnections
4) Dry weather catchment investigation
5) Wet weather outfall screening and catchment investigation (only if applicable)

The Neponset Stormwater Partnership (NSP) Model IDDE Program Document and Stormwater Management Program (the model IDDE SWMP) provides a detailed description of the steps and tasks involved in the IDDE process. If you have not done so already, we recommend that you review that document to familiarize yourself with the steps and tasks involved.

The Neponset Stormwater Partnership (NSP) IDDE Outfall Inventory and Prioritization Tool (“the Outfall Tool” or “the Tool”) is intended to help communities plan, document, and report on their IDDE work at various key stages by providing a framework for ranking and tracking outfalls and their associated catchments.

This document provides instructions for using the Outfall Tool. A brief description of each field in the Outfall Tool is included at the end of the document.

The NSP Outfall Tool is distributed as an unlocked MS Excel spreadsheet. While we describe our suggested approach to using the Outfall Tool below, communities are welcome to modify the Tool in any way they see fit to adapt it to their own approach.

Credits
The NSP Outfall Tool was developed through a cooperative effort by the Neponset River Watershed Association (NepRWA) and the Metropolitan Area Planning Council (MAPC) using funds provided by NSP member communities as well as MetroFuture Technical Assistance Grant Funds from the MAPC.

Prerequisites and Technical Support
In order to use the NSP Outfall Tool, several prerequisites need to be in place:

- The catchment area associated with each of your drain outfalls needs to be delineated. For most members of the NSP, this work has already been completed using the MAPC catchment delineation methodology. Your initial catchment delineation does not need to be perfect. You can update and refine it as you complete your catchment investigation work.
- Key attributes about land uses in your catchments should be extracted from available GIS data. For most NSP towns, this work has already been completed by the MAPC.
- Available receiving water quality data should be assembled. This has already been done for several of the NSP towns by NepRWA.

NepRWA will prepare a template of the NSP Outfall Tool that is pre-populated with the above data for participating NSP towns upon request.
Technical support on setting up and using the NSP Outfall Tool or guidance for pre-populating data within the prioritization is available for NSP member communities from NepRWA and/or the MAPC. Please contact stormwater@neponset.org to request assistance.

Excel Tips:

- The spreadsheet includes two “macros” that allow you to sort the sheet in specific ways just by clicking a button. In order for this to work you will need to choose “enable active content” when you open the file.
- Selected columns and rows have been “grouped” to make it easy to expand or hide sections of the form. This makes it easier to navigate the wide spreadsheet. Just click the + or – buttons in the top margin to expand or contract groups of columns.
- The spreadsheet uses named ranges of rows to do some calculations. The area in black at the far bottom of the spreadsheet is outside the named ranges. To avoid breaking the calculations, if you need to add rows, insert them above the bottom of the named ranges (i.e. in the white rows not the black area).
- Data in the yellow row right below the field headings contains examples of what should go in the corresponding fields. You may need to click the + in the left margin to expand this row.
- Where a column contains a calculation, it has been given a background color to highlight this fact.
- Depending on how your particular copy of the tool is setup, data in the catchment score area may be linked to the raw data extracted from GIS which is stored on a separate tab of the workbook. If applicable this information will remain linked even if you sort the rows on the main worksheet.
- At the end of this document, we describe the intended use of each field in the spreadsheet.

Phase I: Preliminary Outfall Inventory and Ranking

The preliminary outfall inventory and ranking must be prepared by the end of permit year 1 (6/30/19). The goals of the preliminary inventory and ranking are to collect and organize available information about outfalls and catchments, recognizing that this information may be somewhat limited at the beginning of the IDDE process. Using this information, during Phase I you will:

- Identify known “problem” outfalls that will bypass dry weather screening and go directly to catchment investigation.
- Prepare a preliminary ranking of your outfalls into the categories of “high priority,” “low priority,” and “excluded,” as a first indication of the order in which their associated catchments will be investigated.
- Group outfalls by stream to determine the order of dry-weather screening (recommended but not required).
- Flag any catchments with already known system vulnerability factors that will require wet weather screening.

The Outfall Tool helps you to rank the outfalls and interconnections based on three broad categories of information:

- “Infrastructure and investigation data” provided by the Town
- “Catchment composition data” extracted from GIS
- “Receiving water quality data” assembled from available sources
Available information for each of the three categories is used to develop category scores. The weighted average of the category scores is used to calculate each outfall or interconnection’s final score. The final scores are then used to rank each of the outfalls as excluded, problem, high, or low priority. Finally, the outfalls are then grouped by stream segment and the stream segments are ranked to determine the order of dry weather outfall screening.

**Phase I, Step 1: Complete Information in Infrastructure and Investigation Section**

The infrastructure and investigation category score is largely based on permittee knowledge and existing records. Town records, GIS data, and institutional knowledge from long-time staff members should be assembled and reviewed in preparation for filling in this portion of the tool. During this initial phase, you may have only limited available information to enter in this section of the tool, which is fine.

The information in this section is required by section 2.3.4.7.a.ii-iii and 2.4.3.8.c.i of the permit. You may want to review these sections of the permit if you have any questions about what to enter.

For each outfall, put a “1” or a “0” in each column in this section. A “1” denotes presence and “0” denotes absence. The infrastructure and investigation category score for each outfall is calculated by taking the sum of each of the above scores, dividing it by the number of factors in the category and multiplying that number by 100.

The fields in this section are fairly self-explanatory. They include:

- Known or suspected problems. Entering a “1” automatically categorizes the outfall as a “problem.” If you found sewage indicators during 2003 screening, enter a “1” here unless your 2003 screening fully meets the 2016 screening requirements, in which case enter it under the column for “Sewage indicators found during 2016 dry screening.”
• Past complaints. Entering a “1” automatically categorizes the outfall as a “problem.”
• Sewage indicators found during 2016 dry screening. Entering a “1” automatically categorizes the outfall as a “problem.” If no screening that meets all the 2016 MS4 Permit screening requirements has occurred yet, leave this field blank for now. If you enter a value in this field, we recommend also updating the “date outfall screening completed” field to the far right of the spreadsheet at the same time.
• Catchments with past septic to sewer conversion or combined sewer separation.
• Outfalls that discharge to culverted stream longer than a street crossing.
• High density of aging septic systems. The permit does not define what constitutes “high” density so make your own determination.
• One or more system vulnerability factors (as defined in the MS4 permit 2.4.3.8.c.i). Even if there are multiple system vulnerability factors only enter “1” in this field. Entering a “1” automatically flags the field for wet weather screening. Refer to the NSP model SWMP or the permit for a discussion of required and recommended system vulnerability factors.
• Sewage Indicators Found During WET Screening. Entering a “1” automatically categorizes the outfall as a “problem.”

The NSP Outfall Tool is designed to be used on an ongoing basis through all the different stages of the IDDE process. As such some fields, especially in the infrastructure section of the tool, will be left blank during the early portion of the IDDE process when information is not available, and may be filled in later or may have their values revised later, as new information is discovered. As described further below, we therefore recommend maintaining a “working” copy of the tool and periodically making “archive” or static PDF copies of the Tool at certain stages of the process to serve as a snapshot in time.

**Phase 1, Step 2: Catchment Composition Score**
For NSP communities using the tool, this section of the form will be pre-filled for you. The catchment composition category score is calculated using the density of the following:

- Catchment area (acres)
- Number of Medium Loading Businesses
- Number of High Loading Businesses
- Number of Houses (20-40 years old)
- Number of Houses (>40 years old)
- Length of Sewer Pipes in Catchment (Miles)

The information in this section is required by section 2.3.4.7.a.ii-iii of the permit. You may want to review this section of the permit if you have any questions about what is included here.

These data were generated using ArcGIS and the MAPC developed methodology. These data can be updated as land uses change through time by following the MAPC methodology.

Raw sub-scores in this category are normalized to a scale of 0 to 1 by dividing each value by the maximum value for that component. The final catchment composition category score is calculated by taking the average of the normalized commercial, residential, and sewer pipe sub-scores.

---

Phase 1, Step 3: Receiving Water Score
The receiving water category score is calculated from two main components, the receiving water use score and the receiving water quality score. For NSP communities using the tool, this section of the form will be pre-filled for you.

Receiving Water Use Score
The receiving water USE score is based on whether an outfall discharges to or near an area of concern to public health due to proximity of:
- Discharge to Public Beach, Shellfish or Recreational areas. For NSP communities, this information has been pre-filled by NepRWA and MAPC based on a combination of GIS and local knowledge. Communities should review this information and update it based on your own local knowledge.
- Discharge to Surface Water Supply Area. There are no surface drinking water supplies in NSP communities, so this field has been pre-filled with “0.”

A combination of MassGIS layers and local knowledge are used to determine if an outfall is within an area of concern to public health. Any outfalls within 500 meters of a public beach, drinking water supply or a shell fish bed, and any outfalls within 100 meters of recreational area. Recreational areas include known areas of more intensive recreational water contact such as canoe launches. These setbacks and the meaning of “recreational areas” are not specified in the MS4 permit. Outfalls within and area of concern are marked with a “1” all others are marked “0.”

If any of the above waterway-uses are present the outfall is automatically classified as a high priority (i.e. marking an outfall as a “1” makes it high priority automatically).

Receiving Water Quality Score
Each receiving water body was evaluated for:
- The number of stormwater related impairments from the MassDEP 303d List
- Average instream E. coli concentration where available

A list of the water quality impairments for each water body was compiled by NepRWA using the Massachusetts year 2014 Integrated List of Waters. For purposes of the Outfall Tool, any impairments that require additional monitoring under the 2016 MS4 permit are considered “stormwater-related.”

The average instream E. coli concentration is based on available ambient water quality data collected by Massachusetts Department of Environmental Protection, and/or the Neponset River Watershed Association. It is important to note that we do not have E. coli data for every waterbody. This was not an attempt to raise the priority of certain waterbodies, but is instead the result of a lack of available data. Waterbodies lacking any available data are scored as “1” in an attempt to minimize scoring bias on the basis of data availability. Any additional data which the Town may have access to can be added to this section by following the scoring scheme below. Note that if no data is available, you should enter “unknown” or another text string rather than leaving this field blank.

Table 1: Receiving Water Scoring Scheme

<table>
<thead>
<tr>
<th>“Stormwater Related” Impairments Score</th>
<th>Dry Weather E. coli Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score</td>
<td>Number of Impairments</td>
</tr>
<tr>
<td>0</td>
<td>No Impairments</td>
</tr>
<tr>
<td>1</td>
<td>1-2 Impairment(s)</td>
</tr>
<tr>
<td>2</td>
<td>3-4 Impairments</td>
</tr>
<tr>
<td>3</td>
<td>≥ 5 Impairments</td>
</tr>
</tbody>
</table>
The total receiving water quality score is calculated by taking the sum of the individual factors scores and dividing them by 7 (the maximum score possible).

**Phase 1, Step 4: Preliminary Outfall Score and Priority Ranking:**
The final overall score for each outfall and interconnection is automatically calculated by the Outfall Tool as data is filled in. The Tool uses a weighted average of the three category scores (infrastructure, catchment and water quality) to determine the final overall score. By default, the formulas in the NSP Outfall Tool weights each category equally. However, this weighting is not dictated by the permit, and the scores can be weighted as you see fit by editing the excel formula in the “final score” column.

As data is filled in for all outfalls (i.e. rows) in the Tool, the Tool automatically calculates the “EPA Priority Rank” using the formula contained in the field of the same name.

The formula determines outfall priority ranks based on two tests:

1) The 2016 MS4 permit defines certain attributes that if present automatically rank an outfall or interconnection as a problem or high priority. Outfalls or interconnections with these attributes are automatically ranked accordingly. These characteristics are described above and include

- Known or suspected problems, past complaints, sewage indicators in dry or wet screening.
- Outfalls near beaches, recreation areas, drinking water sources and shellfish beds.

2) Where these “automatic” attributes aren’t present, outfalls and interconnections are ranked according to their final score. By default, the NSP Outfall Tool ranks outfalls and interconnections that have final scores that are above the median score as “high priority,” and those with scores below the median as “low.” However, this approach is not dictated by the permit, and one may adjust this approach by modifying the formula in the “EPA Priority Ranking” column.

Investigation of ALL catchments must be completed by permit year 10, irrespective of priority rank. As such, defining an outfall as “high” or “low” priority has effectively no regulatory meaning. Problem outfalls do not need to undergo dry weather outfall screening, and must begin catchment investigation by the end of year two (6/30/20) and must be complete by the end of year seven.

**Phase 1, Step 6: Sort by Priority Outfall Ranking and Save a Snapshot**
Sort the records in the spreadsheet first by “EPA Priority Category” and then by “Final Outfall Score.” The Tool includes a button titled “Sort for Catchments” at the top of the “Ranking Output” section that allows you to easily execute the recommended sort order.

At this point the sorted content of the tool represents your “Preliminary Outfall Ranking” which is due 6/20/19, and needs to be included in your year one annual report.

To permanently capture your Preliminary Outfall Ranking, we recommend that you save a copy of the workbook under a new name such as “Preliminary Outfall Ranking INSERT DATE Archive,” and that you also save a copy of the spreadsheet as a PDF by choosing “Save As” and selecting the .PDF file format option in the dropdown list right below the filename field. You may want to collapse or expand different sections of the form so that it fits on the page more easily.
Phase I. Step 7: Sort Outfalls by Waterbody to Determine Order of Dry Weather Screening

In order to increase dry weather outfall screening efficiency, the NSP SWMP suggests that outfall screening take place by stream reach. This will allow field crews to proceed quickly down the length of one stream, rather than moving from place to place to check on outfalls scattered across the town. This approach also ensures that each day’s samples will need to be tested for the same parameters based on stream impairments. However, this recommended approach is not required by the permit.

In order to determine which stream segments should be screened first, the Outfall Tool calculates the number of high priority outfalls found on each stream reach (MassDEP AU ID). This value is found in the “Waterbody Ranking for Outfall Screening” column.

To determine which stream or waterbody should be screened first, simply re-sort the sheet first by “Waterbody Ranking for Outfall Screening” and then by “MassDEP Stream Segment ID” and lastly by the Town’s outfall ID code. This will group the outfalls by stream, in order of priority. Again, the Outfall Tool provides a button named “Sort For Dry Screen” to make it easy to execute this sort order.

For planning purposes, we recommend that you then fill in a value in the “Date, Month or Year Dry Outfall Screening Scheduled” column, and review the overall number of outfalls to be covered during various time periods to balance the program workload.

Note that you may want to undertake some further manual sorting and re-ordering to accommodate any outfalls that don’t have an MassDEP Stream Segment, or other irregularities. You can refine your dry weather screening plan, by adjusting the value in the “Date, Month or Year Dry Outfall Screening Scheduled” field and re-sorting the sheet on that column.

At this point, you should save snapshot copy of the spreadsheet or a PDF to document your justification for the order in which you decided perform dry weather screening on your streams and waterways.

Phase II: Update the Outfall Tool to Reflect Progress of Dry or Wet Weather Outfall Screening

The next phase of the overall IDDE process is to conduct dry weather outfall screening and inspection. Generally, Phase II begins once Phase I is completed, and must be finished by the end of permit year three (see caveats below). During this period, you may also be conducting wet weather outfall screening (if any) on outfalls with known system vulnerability factors, and documenting the progress of catchment investigation and repair for any problem outfalls. You need to report on your progress in each of these areas in each annual report during this period.

Note: once dry weather outfall screening has begun there is no need to revise your planned schedule for which streams will be screened first.

Phase II, Step 1: Document Progress in Completing Dry Weather Outfall Screening

The dry weather outfall screening will generate extensive records from individual outfall field inspection forms to lab test results and other materials. During this phase, the Outfall Tool provides a convenient way to summarize and report your overall progress.

As you complete dry weather screenings, update the working copy of your Outfall Tool by filling in the following fields:
• Date Dry Outfall Screening Completed. Located on the far right in the “Tracking” section of the sheet. Fill in the date that dry weather inspection/screening was completed on each outfall.
• Sewage Indicators Found During Dry Screening. Located in the “Infrastructure” section of the Tool. Fill in a “1” if sewage indicators were found and a “0” if they were not found. Leave this blank until you have completed the dry screening for the 2016 permit.

As you fill in this information, the outfall ranking scores will automatically update themselves.

Phase II, Step 2: Document Progress in Completing Wet Weather Outfall Screening
The permit does not require that wet weather screening be completed until the deadline for catchment investigation (i.e. year 10). However, where system vulnerability factors are known in advance of catchment investigation, we recommend completing wet weather outfall screening in advance of catchment investigation.

Irrespective of when you complete wet weather outfall screening, you should summarize your progress in this area by updating the “Date WET Outfall Screening Completed” field and simultaneously entering a “1” or “0” in the field for “Sewage Indicators Found During WET Screening,” located in the infrastructure section of the form.

Phase II, Step 3: Document Problem Catchment Investigation & Illicit Elimination
In the event that you have known problem outfalls, you will likely begin catchment investigation on them while dry weather screening is still ongoing, and you may identify and even eliminate illicit discharges during this period. If so, use the appropriate fields in the program tracking section of the form to summarize this work. Catchment investigation for problem outfalls must begin during permit year two (ending 6/30/20) and be complete by the end of permit year seven.

Phase II, Step 4: Annual Reporting and Follow Up Outfall Ranking
During Phase II you should update the Outfall Tool on an ongoing basis as you complete your IDDE work as described above. As you do so, catchment scores and EPA outfall categories will be automatically updated on a continuous basis. Re-sort the Outfall Tool using the sort for catchments button and make a PDF of the Outfall Tool and/or an Excel archive copy of the Tool to include in each annual report. At a minimum, you must submit the “follow up ranking of outfalls” by the end of permit year three (6/30/21).

Phase III: Catchment Investigation & Discharge Elimination
The last major phase of the overall IDDE process is catchment investigation. During this phase you will conduct internal inspections of junction manholes in all outfall catchments (except excluded outfalls) beginning with problem catchments and working your way down from high priority to low priority based on your follow up ranking of outfalls.

EPA assumes that during this phase, you may discover previously unknown system vulnerability factors, in which case, wet weather screening and wet weather catchment investigation will also need to be conducted as described in the NSP model SWMP. Refer to the model IDDE SWMP or the permit (section 2.4.3.8.c.i) for a discussion of required and recommended system vulnerability factors.

During Phase III, the NSP Outfall Tool can be used to summarize, track and report on your progress in each of these tasks.
Phase III, Step 1: Track Progress of Catchment Investigations and Schedule Wet Weather Investigations or Discharge Elimination as Needed

As you complete your catchment investigations, use the Outfall Tool to track your work by updating the following fields in the “Program Tracking” section of the tool on a continuous basis and at least annually:

- Date Catchment Investig. Scheduled
- Date WET Outfall Screening Scheduled
- Date WET Outfall Screening Completed
- Date Catchment Investig. Completed
- Catchment Investig. Status
- Date Illicit Discharge Source Confirmed
- Est. Illicit Discharge Volume (GPD)
- Date Illicit Discharge Elimination Scheduled
- Date Illicit Discharge Elimination Completed

At the same time, you should also update the “Infrastructure” section of the tool with newly discovered information including:

- System Vulnerability Factors Present in Catchment
- Sewage Indicators Found During WET Screening

Phase III, Step 2: Annual Reporting

During Phase III you should update the Outfall Tool on an ongoing basis and at least annually as you complete your IDDE work. Re-sort the Outfall Tool using the “sort for catchment” button and make a PDF of the Outfall Tool and/or an Excel archive copy of the Tool to include in each annual report.

Description of All Spreadsheet Fields and Tabs

Outfall Information Section

This section contains general identification information about each outfall and its corresponding receiving water. For NSP members this section has been pre-filled based on town mapping data but will need to be updated if new outfalls are discovered during field missions.

Owner – In most cases this will be the town that owns the outfall or interconnection

MassDEP Stream Segment – The Massachusetts DEP Assessment Unit ID (AU ID) for the receiving water body.

Waterbody Name – The name of the receiving waterbody. You can also put brief notes in this field.

Excluded Outfall? – Enter “1” if outfall is excluded. An outfall is excluded from screening if it meets the qualifications defined in section 2.3.4.7.a. ii. If the reason for exclusion is because the outfall is not waters of the US or not town-owned (see NSP Model IDDE SWMP), update the remarks field and/or the owner field as needed. Entering a “1” automatically sets the “EPA priority category” to “excluded.”

Outfall ID – Each outfall should have a unique identifier for data tracking purposes. This number is generated from the town’s system mapping or outfall database.
**Infrastructure and Investigation Data Section**

This section contains information based on previous reports, town knowledge, and infrastructure investigations. The “Sewage Indicators Found” and “System Vulnerability Factors Present” sections need to be updated on an ongoing basis as outfall screening and catchment investigations provide new data.

**Known or Suspected Problem? Including 2003 MS4 screening** – This indicates whether or not there is evidence of an illicit discharge from outfall screening or reports prior to the 2016 MS4 permit. If sewage indicators were found during screening under the 2003 permit, enter a “1” here. Entering a “1” automatically sets the EPA priority category to “Problem.” If a problem was found during 2003 screening, fixed, and then confirmed clean, enter a “0” and add a comment in the notes field.

**Past Discharge Complaints or Reports?** – This section indicates if the outfall has past complaints of discharges from citizens or environmental groups (hot spot reports), or the catchment has past complaints of backups or SSOs. Entering a “1” automatically sets the EPA priority category to “Problem.”

**Sewage Indicators Found during 2016 MS4 DRY Screening** – This section indicates if sewage indicators were found for an outfall during DRY WEATHER screening for the 2016 MS4 Permit. This needs to be updated regularly once dry screening begins. Entering a “1” automatically sets the EPA priority category to “Problem.” This field should be left blank until 2016 screening for the outfall is completed.

**Septic to Sewer Conversion or CSO Separation in Catchment?** – Indicates whether or not there have historically been areas in the catchment converted from septic to sewer, or if areas in the catchment were formerly served by a combined sewer system which has been separated.

**Discharges to Culverted Stream Longer Than Street Crossing?** – Indicates an outfall that discharges to a culverted stream. Do not include outfalls that discharge to a simple road crossing culvert. Enter “1” if the outfall discharges inside a long culvert, otherwise enter “0”.

**High Density of Aging Septic Systems?** – Indicates an outfall whose catchment includes a high density of aging septic systems. The permit does not define what constitutes a “high” density. Enter a “1” if the catchment has an unusual number of failed septic systems, otherwise enter “0”.

**System Vulnerability Factors Present** – This indicates that there are system vulnerability factors (SVFs) in the catchment. The list of required and optional SVFs can be found in the NSP model IDDE SWMP or in section 2.3.4.8.c.i. of the MS4 Permit. This should be initially filled out based on town knowledge and available records (which may be limited at first), and then updated regularly as new information is discovered through the catchment investigation process. Enter a “1” if there are known SVFs, otherwise enter “0”.

**Sewage Indicators Found during WET Screening** – This section indicates if sewage indicators were found for an outfall during WET WEATHER screening for the 2016 MS4 Permit. If no wet weather screening has been performed, leave it blank. This field should be updated regularly once wet screening (if any) begins. Enter “1” if sewage indicators were found, enter “0” if they were not. Entering a “1” automatically sets the EPA priority category to “Problem.” A wet weather catchment investigation is then also required.

**Infrastructure Score** – The infrastructure score is a measure of how likely an outfall will have an illicit discharge based on prior investigations and existing infrastructure. The infrastructure score for each outfall is calculated by taking the average of the component scores in this section multiplied by 100.
Catchment Composition Section

The catchment composition section assesses the potential for a catchment to have an illicit discharge in it based on the types of land use and infrastructure within the catchment. These data were generated using the MAPC “MS4 Outfall Catchment Calculator” method documentation for which can be found on the NSP member resources page HERE or refer to the full documentation and GIS tools on GitHub. For NSP communities, this section will be pre-filled.

Catchment area (acres) – The size of the catchment associated with a specific outfall in acres from GIS.

Number of Medium Loading Businesses – The number of businesses within the catchment that have medium risk of having an associated illicit discharge according to The Center for Watershed Protection².

Number of High Loading Businesses – The number of businesses within the catchment that have a high risk of having an associated illicit discharge according to The Center for Watershed Protection².

Raw Generating Site Score (Businesses) – A weighted risk score based on the following formula ((Number of Medium loading businesses*5) + (Number of High loading businesses*10)). The permit does not define “density” so this specific approach is not required.

Normalized Generating Site Score (Businesses) – Divides the raw business generating site score by the maximum business generating score to normalize the values so they can be combined into a total catchment score.

Number of Houses (20-40 years old) – The number of houses within the catchment that have a medium risk of have an associated illicit discharge based on house age.

Number of Houses (>40 years old) – The number of houses within the catchment that have a high risk of having an associated illicit discharge based on house age.

Raw Generating Site Score (Residential) – A weighted risk score based on the following formula ((Number of 20-40 year old homes*5) + (Number of older than 40 year old Homes*10)). The permit does not define “density” so this specific approach is not required.

Normalized Generating Site Score (Residential) – Divides the raw residential generating site score by the maximum residential generating site score to normalize the values so they can be combined into a total catchment score.

Length of Sewer Pipes in Catchment (Miles) – The amount of sewerage within the catchment based on total length of pipe

Normalized Sewer Pipe Score – The length of sewer pipe in the catchment divided by the catchment area further divided by the maximum length of sewer pipes in catchment. The permit does not define “density” so this specific approach is not required.

**Catchment Score** – This score is an estimate of the probability that an outfall will have an illicit discharge based on the composition of its catchment. The catchment score for each outfall is calculated by taking the average of the component scores in this section multiplied by 100.

**Receiving Water Section**

This section contains information about the uses and pollution level of the waterway to which each outfall discharges. The information for this section is based on MassGIS data, ambient water quality data, and local knowledge.

**Discharge to Pub Beach, Shellfish or Rec** – Indicates whether the outfall discharges within a close proximity of a public beach, recreation area, or shellfish bed. A 500-meter buffer around public beaches, drinking water supplies, and shellfish beds was used, and a 100-meter buffer around boat/canoe launches was used. The public beach and recreation area GIS layer should be supplemented with town knowledge.

**Discharge to Surface Water Supply Area** – This indicates whether or not the outfall discharges to a surface water supply.

**Dry Weather E. coli Concentration** – The average dry weather concentration of E. coli in the waterbody to which the outfall discharges. Based on data available from MassDEP, the Neponset River Watershed Association or other sources where available. This information should be pre-filled for NSP member communities and should be reviewed and updated with any additional local knowledge. Note if there is no data for an outfall’s receiving water you should enter “unknown” or another text string rather than leaving this field blank so that the E. coli score column will be set to “1” rather than blank.

**Dry Weather E. coli Score** – This section is a score based on the average concentration of E. coli bacteria for each receiving waterbody. Not every water body has available E. coli data. To reduce the bias that would be created if a stream lacks E. coli data, all outfalls without data are stored as a “1”.

**Stormwater Related Impairments** – This section reflects whether or not the receiving waterbody has stormwater related impairments. The numerical value in this field is a score based on how many impairments the waterbody has. An impairment is considered stormwater related if EPA requires additional monitoring for it. This information is pre-filled for NSP member communities or can be found in each community’s NOI.

**Receiving Water Score** – The receiving water score is an estimate of the likelihood that an outfall contains an illicit discharge and the risk it poses to human health based on the recreational uses and quality of the receiving water. This score is calculated by taking average of the component scores multiplied by 100.

**Ranking Output**

The ranking output section contains the final score and the various rankings based on those scores. It also indicates whether an outfall requires additional wet weather screening. We recommend that outfall screenings be conducted according to stream rank. The order of catchment investigations should proceed with problem outfalls first, then high priority, etc sub-sorted by highest final outfall score first.
**Final Outfall Score** – The final outfall score is the overall score each outfall receives based on its three component scores (Infrastructure and Investigation, Catchment Composition, and Receiving Water).

**EPA Priority Category** – The EPA Priority Category is based either on the presence or absence of certain criteria or the final outfall score. Outfalls with final outfall scores greater than the median score are considered high priority and those with lesser values are considered low priority.

**Number of High Priority Outfalls** – A count of the number of high priority outfalls in the AU ID of the current outfall. In effect this filed groups the outfalls by AU ID and is use to determine the order of outfall screening.

**Stream Ranking for Outfall Screening** – The stream ranking is how we recommend you prioritize outfall screening in order to maximize dry weather outfall screening efficiency in the field. This section ranks the receiving waterbodies by the number of high priority outfalls they contain with #1 being the highest rank.

**Wet Weather Screening Required** – Indicates whether or not wet weather screening will be required based on the presence or absence of system vulnerability factors in the catchment as indicated in the infrastructure section of the form.

**Program Tracking**
This section allows for easy tracking of screening and investigation progress and needs to be updated regularly.

**Date DRY Outfall Screening Scheduled** – Use this field to organize your work by entering a specific date, a year or other indicator of when the work is planned. Should be scheduled according to the EPA priority ranks and stream rank starting with high priority outfalls. Note that the results of the screening (i.e. clean or polluted) are summarized by updating the “screening” field in the infrastructure section of the form.

**Date DRY Outfall Screening Completed** – Enter the actual date that screening was marked complete.

**Date WET Outfall Screening Scheduled** -- Enter a specific date, a year or other indicator of when the wet weather screening is planned. If wet weather screening is not required, leave field blank.

**Date WET Outfall Screening Completed** -- Enter the actual date that screening was marked complete.

**Date Catchment Investig. Scheduled** -- Enter a specific date, a year or other indicator of when the investigation is scheduled to begin. Catchment investigations should begin with problem outfalls, and proceed according to catchment score through High Priority and Low Priority.

**Date Catchment Investig. Completed** -- Enter the actual date that investigation was marked complete.

**Catchment Investigation Status** – Once catchment investigation has begun, enter a short code of your own choice that summarizes the status of the investigation. We suggest the following scheme:

- “Ongoing.” Investigation started but not yet completed.
- “Ongoing, Awaiting Repairs.” Problems discovered during investigation, and remaining junction manholes cannot be inspected until upstream repairs are implemented.
- “Complete.” Catchment is complete with no outstanding issues.
• “Complete, Inconclusive.” Outfall shows sewage indicators and all junction manholes inspected in dry (and where applicable wet) weather, but source not found. Will need to be scheduled for further investigation.
• “Complete, Awaiting Repairs.” All junction manholes inspected, problems were found and are awaiting repair.

**Date Illicit Discharge Source Confirmed** – If illicit discharge was found, enter the date the source was confirmed. If no illicit discharge in catchment, leave blank.

**Est. Illicit Discharge Volume (GPD)** – If illicit discharge was found, enter the estimated volume of discharge in gallons per day. If no illicit discharge in catchment, leave blank.

**Date Illicit Discharge Elimination Scheduled** – If illicit discharge was found, source isolated, and repair plan developed, enter the estimated date, month or year when you expect the repair to be implemented. If no illicit discharge in catchment, leave blank.

**Date Illicit Discharge Elimination Completed** – Enter the date on which you confirmed that the illicit discharge had been eliminated. If no illicit discharge in catchment, leave blank.

**Year Ongoing Outfall Screening Scheduled** – Once catchment investigation has been completed, indicate the year in which ongoing outfall screening has been scheduled (every 5 years). Otherwise leave blank.

**Remarks** – This is a place to record any notes related to an outfall and its investigations.
APPENDIX E

Preliminary Outfall Ranking
<table>
<thead>
<tr>
<th>Outfall ID</th>
<th>EPA Priority Category</th>
<th>Final Outfall Score</th>
<th>Date Previous DRY Outfall Screening</th>
<th>MassDEP Stream</th>
<th>Waterbody Name</th>
<th>Waterbody Ranking for Dry</th>
<th>Number of High Priority Outfalls</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUT_480</td>
<td>Problem</td>
<td>n/a</td>
<td>17-Jul-12</td>
<td>MA73-02</td>
<td>Neponset River</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>OUT_071</td>
<td>High</td>
<td>0.40</td>
<td>9-Aug-10</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_251</td>
<td>High</td>
<td>0.29</td>
<td>22-Jul-10</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_020</td>
<td>High</td>
<td>0.29</td>
<td>22-Jul-10</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_921</td>
<td>High</td>
<td>0.25</td>
<td>22-Jul-10</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_823</td>
<td>High</td>
<td>0.25</td>
<td>22-Jul-10</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_010</td>
<td>High</td>
<td>0.24</td>
<td>7-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_762</td>
<td>High</td>
<td>0.24</td>
<td>7-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_814</td>
<td>High</td>
<td>0.24</td>
<td>7-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_045</td>
<td>High</td>
<td>0.24</td>
<td>7-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_856</td>
<td>High</td>
<td>0.23</td>
<td>21-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_421</td>
<td>High</td>
<td>0.22</td>
<td>21-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_044</td>
<td>High</td>
<td>0.21</td>
<td>21-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_247</td>
<td>High</td>
<td>0.21</td>
<td>21-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_419</td>
<td>High</td>
<td>0.21</td>
<td>21-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_012</td>
<td>High</td>
<td>0.20</td>
<td>21-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_009</td>
<td>High</td>
<td>0.20</td>
<td>21-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_255</td>
<td>High</td>
<td>0.20</td>
<td>21-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_254</td>
<td>High</td>
<td>0.20</td>
<td>21-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_054</td>
<td>High</td>
<td>0.20</td>
<td>21-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_060</td>
<td>High</td>
<td>0.20</td>
<td>21-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_743</td>
<td>High</td>
<td>0.20</td>
<td>21-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_522</td>
<td>High</td>
<td>0.19</td>
<td>21-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_932</td>
<td>High</td>
<td>0.19</td>
<td>21-Aug-12</td>
<td>MA73-05</td>
<td>East Branch Neponset River</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>OUT_166</td>
<td>High</td>
<td>0.31</td>
<td>28-Jul-10</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_168</td>
<td>High</td>
<td>0.13</td>
<td>28-Jul-10</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_119</td>
<td>High</td>
<td>0.12</td>
<td>2-Sep-10</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_173</td>
<td>High</td>
<td>0.12</td>
<td>28-Jul-10</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_165</td>
<td>High</td>
<td>0.11</td>
<td>13-Sep-12</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_118</td>
<td>High</td>
<td>0.11</td>
<td>13-Sep-12</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_174</td>
<td>High</td>
<td>0.11</td>
<td>13-Sep-12</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_280</td>
<td>High</td>
<td>0.10</td>
<td>13-Sep-12</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_822</td>
<td>High</td>
<td>0.10</td>
<td>13-Sep-12</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_738</td>
<td>High</td>
<td>0.10</td>
<td>13-Sep-12</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_123</td>
<td>High</td>
<td>0.10</td>
<td>13-Sep-12</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_117</td>
<td>High</td>
<td>0.10</td>
<td>13-Sep-12</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
</tbody>
</table>

Note: Ranking is in order of priority (High versus Low) and stream reach (the reach with the most High Priority outfalls should be screened first). This ranking is meant to streamline the screening and sampling process.
# Town of Canton - Preliminary Ranking List of MS4 Outfalls for Dry Weather Screening

<table>
<thead>
<tr>
<th>Outfall ID</th>
<th>EPA Priority Category</th>
<th>Final Outfall Score</th>
<th>Date Previous DRY Outfall Screening</th>
<th>MassDEP Stream</th>
<th>Waterbody Name</th>
<th>Ranking for Dry</th>
<th>Number of High Priority Outfalls</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUT_530</td>
<td>High</td>
<td>0.10</td>
<td>11-Jul-12</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_513</td>
<td>High</td>
<td>0.10</td>
<td>1-Aug-11</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_121</td>
<td>High</td>
<td>0.10</td>
<td>28-Jul-10</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_281</td>
<td>Low</td>
<td>0.07</td>
<td>9-Aug-10</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_217</td>
<td>Low</td>
<td>0.06</td>
<td>1-Aug-11</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_739</td>
<td>Low</td>
<td>0.05</td>
<td></td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_122</td>
<td>Low</td>
<td>0.05</td>
<td>28-Jul-10</td>
<td>MA73-27</td>
<td>Ponkapoag Brook</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>OUT_243</td>
<td>High</td>
<td>0.41</td>
<td>25-Jul-12</td>
<td>MA73-02</td>
<td>Neponset River</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>OUT_026</td>
<td>High</td>
<td>0.28</td>
<td>25-Jul-12</td>
<td>MA73-02</td>
<td>Neponset River</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>OUT_241</td>
<td>High</td>
<td>0.25</td>
<td>22-Jul-10</td>
<td>MA73-02</td>
<td>Neponset River</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>OUT_008</td>
<td>High</td>
<td>0.25</td>
<td>25-Jul-12</td>
<td>MA73-02</td>
<td>Neponset River</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>OUT_829</td>
<td>High</td>
<td>0.24</td>
<td></td>
<td>MA73-02</td>
<td>Neponset River</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>OUT_460</td>
<td>High</td>
<td>0.22</td>
<td>21-Aug-12</td>
<td>MA73-02</td>
<td>Neponset River</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>OUT_087</td>
<td>High</td>
<td>0.21</td>
<td></td>
<td>MA73-02</td>
<td>Neponset River</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>OUT_520</td>
<td>High</td>
<td>0.21</td>
<td>1-Aug-11</td>
<td>MA73-02</td>
<td>Neponset River</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>OUT_007</td>
<td>High</td>
<td>0.20</td>
<td>25-Jul-12</td>
<td>MA73-02</td>
<td>Neponset River</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>OUT_607</td>
<td>High</td>
<td>0.20</td>
<td>24-Apr-13</td>
<td>MA73-02</td>
<td>Neponset River</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>OUT_240</td>
<td>High</td>
<td>0.20</td>
<td>28-Aug-11</td>
<td>MA73-02</td>
<td>Neponset River</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>OUT_940</td>
<td>High</td>
<td>0.19</td>
<td></td>
<td>MA73-02</td>
<td>Neponset River</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>OUT_452</td>
<td>High</td>
<td>0.19</td>
<td>22-Aug-10</td>
<td>MA73-02</td>
<td>Neponset River</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>OUT_681</td>
<td>High</td>
<td>0.12</td>
<td>2-Aug-16</td>
<td>MA73-005</td>
<td>Bolivar Pond</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>OUT_937</td>
<td>High</td>
<td>0.12</td>
<td></td>
<td>MA73-005</td>
<td>Bolivar Pond</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>OUT_102</td>
<td>High</td>
<td>0.11</td>
<td>7-Aug-12</td>
<td>MA73-005</td>
<td>Bolivar Pond</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>OUT_259</td>
<td>High</td>
<td>0.11</td>
<td>11-Aug-10</td>
<td>MA73-005</td>
<td>Bolivar Pond</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>OUT_741</td>
<td>High</td>
<td>0.11</td>
<td></td>
<td>MA73-005</td>
<td>Bolivar Pond</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>OUT_101</td>
<td>High</td>
<td>0.10</td>
<td>7-Aug-12</td>
<td>MA73-005</td>
<td>Bolivar Pond</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>OUT_771</td>
<td>High</td>
<td>0.10</td>
<td></td>
<td>MA73-005</td>
<td>Bolivar Pond</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>OUT_702</td>
<td>Low</td>
<td>0.05</td>
<td></td>
<td>MA73-005</td>
<td>Bolivar Pond</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>OUT_701</td>
<td>Low</td>
<td>0.05</td>
<td></td>
<td>MA73-005</td>
<td>Bolivar Pond</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>OUT_249</td>
<td>High</td>
<td>0.14</td>
<td>9-Aug-10</td>
<td>MA73-25</td>
<td>Pecunit Brook</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>OUT_248</td>
<td>High</td>
<td>0.12</td>
<td>9-Aug-10</td>
<td>MA73-25</td>
<td>Pecunit Brook</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>OUT_089</td>
<td>High</td>
<td>0.11</td>
<td>7-Aug-12</td>
<td>MA73-25</td>
<td>Pecunit Brook</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>OUT_901</td>
<td>High</td>
<td>0.11</td>
<td></td>
<td>MA73-25</td>
<td>Pecunit Brook</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>OUT_095</td>
<td>High</td>
<td>0.10</td>
<td>7-Aug-12</td>
<td>MA73-25</td>
<td>Pecunit Brook</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>OUT_092</td>
<td>High</td>
<td>0.10</td>
<td>7-Aug-12</td>
<td>MA73-25</td>
<td>Pecunit Brook</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>OUT_088</td>
<td>High</td>
<td>0.10</td>
<td>7-Aug-12</td>
<td>MA73-25</td>
<td>Pecunit Brook</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>OUT_764</td>
<td>Low</td>
<td>0.11</td>
<td></td>
<td>MA73-20</td>
<td>Beaver Meadow Brook</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

Note: Ranking is in order of priority (High versus Low) and stream reach (the reach with the most High Priority outfalls should be screened first). This ranking is meant to streamline the screening and sampling process.
### Town of Canton - Preliminary Ranking List of MS4 Outfalls for Dry Weather Screening

<table>
<thead>
<tr>
<th>Outfall ID</th>
<th>EPA Priority Category</th>
<th>Final Outfall Score</th>
<th>Date Previous DRY Outfall Screening</th>
<th>MassDEP Stream</th>
<th>Waterbody Name</th>
<th>Waterbody Ranking for Dry</th>
<th>Number of High Priority Outfalls</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUT_463</td>
<td>High</td>
<td>0.11</td>
<td>11-Aug-10</td>
<td>MA73-20</td>
<td>Beaver Meadow Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_740</td>
<td>High</td>
<td>0.10</td>
<td></td>
<td>MA73-20</td>
<td>Beaver Meadow Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_857</td>
<td>High</td>
<td>0.10</td>
<td></td>
<td>MA73-20</td>
<td>Beaver Meadow Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_474</td>
<td>Low</td>
<td>0.09</td>
<td>2-Sep-10</td>
<td>MA73-20</td>
<td>Beaver Meadow Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_462</td>
<td>Low</td>
<td>0.08</td>
<td>18-Aug-10</td>
<td>MA73-20</td>
<td>Beaver Meadow Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_778</td>
<td>Low</td>
<td>0.08</td>
<td></td>
<td>MA73-20</td>
<td>Beaver Meadow Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_134</td>
<td>Low</td>
<td>0.07</td>
<td>2-Sep-10</td>
<td>MA73-20</td>
<td>Beaver Meadow Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_832</td>
<td>Low</td>
<td>0.07</td>
<td></td>
<td>MA73-20</td>
<td>Beaver Meadow Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_133</td>
<td>Low</td>
<td>0.06</td>
<td>1-Sep-11</td>
<td>MA73-20</td>
<td>Beaver Meadow Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_855</td>
<td>Low</td>
<td>0.06</td>
<td></td>
<td>MA73-20</td>
<td>Beaver Meadow Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_132</td>
<td>Low</td>
<td>0.05</td>
<td>1-Sep-11</td>
<td>MA73-20</td>
<td>Beaver Meadow Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_268</td>
<td>Low</td>
<td>0.15</td>
<td>8-Sep-10</td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_438</td>
<td>High</td>
<td>0.11</td>
<td>1-Sep-11</td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_112</td>
<td>High</td>
<td>0.10</td>
<td>1-Sep-11</td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_858</td>
<td>High</td>
<td>0.10</td>
<td></td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_746</td>
<td>Low</td>
<td>0.08</td>
<td></td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_408</td>
<td>Low</td>
<td>0.08</td>
<td>18-Aug-10</td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_742</td>
<td>Low</td>
<td>0.08</td>
<td></td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_110</td>
<td>Low</td>
<td>0.07</td>
<td>7-Aug-12</td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_941</td>
<td>Low</td>
<td>0.06</td>
<td></td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_482</td>
<td>Low</td>
<td>0.05</td>
<td>30-Aug-12</td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_416</td>
<td>Low</td>
<td>0.05</td>
<td>16-Jul-12</td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_838</td>
<td>Low</td>
<td>0.05</td>
<td></td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_939</td>
<td>Low</td>
<td>0.05</td>
<td></td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_231</td>
<td>Low</td>
<td>0.05</td>
<td>18-Aug-10</td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_668</td>
<td>Low</td>
<td>0.05</td>
<td></td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_418</td>
<td>Low</td>
<td>0.05</td>
<td>1-Aug-11</td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_275</td>
<td>Low</td>
<td>0.05</td>
<td>9-Aug-10</td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_289</td>
<td>Low</td>
<td>0.05</td>
<td></td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_233</td>
<td>Low</td>
<td>0.05</td>
<td>2-Sep-10</td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_232</td>
<td>Low</td>
<td>0.05</td>
<td>18-Aug-10</td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_853</td>
<td>Low</td>
<td>0.05</td>
<td></td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_854</td>
<td>Low</td>
<td>0.05</td>
<td></td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_294</td>
<td>Low</td>
<td>0.05</td>
<td>1-Aug-11</td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_733</td>
<td>Low</td>
<td>0.05</td>
<td></td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_919</td>
<td>Low</td>
<td>0.05</td>
<td></td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_467</td>
<td>Low</td>
<td>0.05</td>
<td>1-Aug-11</td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

Note: Ranking is in order of priority (High versus Low) and stream reach (the reach with the most High Priority outfalls should be screened first). This ranking is meant to streamline the screening and sampling process.
<table>
<thead>
<tr>
<th>Outfall ID</th>
<th>EPA Priority Category</th>
<th>Final Outfall Score</th>
<th>Date Previous DRY Outfall Screening</th>
<th>MassDEP Stream</th>
<th>Waterbody Name</th>
<th>Waterbody Ranking for Dry</th>
<th>Number of High Priority Outfalls</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUT_731</td>
<td>Low</td>
<td>0.05</td>
<td></td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_917</td>
<td>Low</td>
<td>0.05</td>
<td></td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_728</td>
<td>Low</td>
<td>0.06</td>
<td></td>
<td>MA73-22</td>
<td>Pequid Brook</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>OUT_851</td>
<td>Low</td>
<td>0.12</td>
<td></td>
<td>MA73020</td>
<td>Forge Pond</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>OUT_300</td>
<td>High</td>
<td>0.10</td>
<td>11-Aug-10</td>
<td>MA73020</td>
<td>Forge Pond</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>OUT_755</td>
<td>High</td>
<td>0.10</td>
<td></td>
<td>MA73020</td>
<td>Forge Pond</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>OUT_048</td>
<td>Low</td>
<td>0.08</td>
<td>7-Aug-12</td>
<td>MA73020</td>
<td>Forge Pond</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>OUT_046</td>
<td>Low</td>
<td>0.06</td>
<td>11-Aug-12</td>
<td>MA73020</td>
<td>Forge Pond</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>OUT_150</td>
<td>High</td>
<td>0.19</td>
<td>11-Aug-10</td>
<td>MA73048</td>
<td>Reservoir Pond</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>OUT_197</td>
<td>High</td>
<td>0.15</td>
<td>18-Aug-10</td>
<td>MA73048</td>
<td>Reservoir Pond</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>OUT_113</td>
<td>Low</td>
<td>0.07</td>
<td>22-Jul-10</td>
<td>MA73048</td>
<td>Reservoir Pond</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>OUT_116</td>
<td>Low</td>
<td>0.07</td>
<td>2-Sep-10</td>
<td>MA73048</td>
<td>Reservoir Pond</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>OUT_685</td>
<td>Low</td>
<td>0.07</td>
<td>4-Nov-16</td>
<td>MA73048</td>
<td>Reservoir Pond</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>OUT_610</td>
<td>Low</td>
<td>0.07</td>
<td></td>
<td>MA73048</td>
<td>Reservoir Pond</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>OUT_617</td>
<td>Low</td>
<td>0.06</td>
<td></td>
<td>MA73048</td>
<td>Reservoir Pond</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>OUT_682</td>
<td>Low</td>
<td>0.06</td>
<td>26-Oct-16</td>
<td>MA73048</td>
<td>Reservoir Pond</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>OUT_686</td>
<td>Low</td>
<td>0.05</td>
<td>4-Nov-16</td>
<td>MA73048</td>
<td>Reservoir Pond</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>OUT_684</td>
<td>Low</td>
<td>0.05</td>
<td>4-Nov-16</td>
<td>MA73048</td>
<td>Reservoir Pond</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>OUT_683</td>
<td>Low</td>
<td>0.05</td>
<td>4-Nov-16</td>
<td>MA73048</td>
<td>Reservoir Pond</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>OUT_250</td>
<td>High</td>
<td>0.17</td>
<td>9-Aug-10</td>
<td>MA73043</td>
<td>Ponkapoag Pond</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>OUT_001</td>
<td>Low</td>
<td>0.15</td>
<td>25-Jul-12</td>
<td>MA73-21</td>
<td>Massapoag Brook</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>OUT_836</td>
<td>Low</td>
<td>0.15</td>
<td></td>
<td>MA73-21</td>
<td>Massapoag Brook</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>OUT_005</td>
<td>Low</td>
<td>0.12</td>
<td>25-Jul-12</td>
<td>MA73-21</td>
<td>Massapoag Brook</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>OUT_029</td>
<td>Low</td>
<td>0.12</td>
<td>7-Aug-12</td>
<td>MA73-21</td>
<td>Massapoag Brook</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>OUT_299</td>
<td>Low</td>
<td>0.12</td>
<td>7-Aug-12</td>
<td>MA73-21</td>
<td>Massapoag Brook</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>OUT_014</td>
<td>Low</td>
<td>0.11</td>
<td>21-Sep-11</td>
<td>MA73-21</td>
<td>Massapoag Brook</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>OUT_031</td>
<td>Low</td>
<td>0.11</td>
<td>21-Sep-11</td>
<td>MA73-21</td>
<td>Massapoag Brook</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>OUT_030</td>
<td>Low</td>
<td>0.10</td>
<td>7-Aug-12</td>
<td>MA73-21</td>
<td>Massapoag Brook</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>OUT_035</td>
<td>Low</td>
<td>0.10</td>
<td>2-Sep-10</td>
<td>MA73-21</td>
<td>Massapoag Brook</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>OUT_236</td>
<td>Low</td>
<td>0.02</td>
<td>21-Sep-11</td>
<td>MA73-13</td>
<td>Steep Hill Brook</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>OUT_016</td>
<td>Low</td>
<td>0.00</td>
<td>7-Aug-12</td>
<td>MA73-13</td>
<td>Steep Hill Brook</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>OUT_015</td>
<td>Low</td>
<td>0.00</td>
<td>7-Aug-12</td>
<td>MA73-13</td>
<td>Steep Hill Brook</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>OUT_745</td>
<td>Low</td>
<td>0.00</td>
<td></td>
<td>York Brook</td>
<td></td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>OUT_710</td>
<td>Low</td>
<td>0.00</td>
<td></td>
<td>York Brook</td>
<td></td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>OUT_304</td>
<td>Low</td>
<td>0.00</td>
<td>18-Sep-10</td>
<td>York Brook</td>
<td></td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>OUT_723</td>
<td>Low</td>
<td>0.00</td>
<td></td>
<td>York Brook</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: Ranking is in order of priority (High versus Low) and stream reach (the reach with the most High Priority outfalls should be screened first). This ranking is meant to streamline the screening and sampling process.
APPENDIX F

 Inspection Field Forms & Sampling Procedures
## Details

**Inspection ID:** 432

**Location:**

**Status:** Open

**Resolution:**

**Inspected By:**

### Conditions

**Sample Category:**
- Dry Weather
- Wet Weather

**Previous 24 hour rainfall (in.)**

**Previous 48 hour rainfall (in.)**

**Air Temperature (deg F)**

### Field Data

**Nearest House / Utility Pole**

**Subwatershed:**
- East Branch
- Pecunit Brook
- Southwest
- Fowl Meadow North
- Porikapoag Brook
- Fowl Meadow South
- Reservoir Pond
- Watershed Town of Milton

**Land Use in Drainage Area (select all that apply):**
- Industrial
- Ultra-urban Residential
- Suburban Residential
- Commercial
- Open Space
- Institutional
- Other

**Other Description (If selected):**

**Known Industries:**

**Notes:**

### Outfall Characteristics

**Type:**

**Shape:**
- Circular
- Elliptical
- Box
- Other

**Shape Size:**
- Single
- Double
- Triple
- Other
### Flow Characteristics

**Flow Present?**
- Yes
- No

**Flow Description:**
- Trickle
- Moderate
- Substantial

### Physical Indicators (Flushing Outfalls Only)

**Odor?:**
- Yes
- No

**Odor - Description:**
- Sewage
- Rancid/Sour
- Petroleum/Gas
- Sulfide
- Other

**Odor - Other description:**

**Odor - Relative Severity Index (1-3):**
- 1 - Faint
- 2 - Easily Detected
- 3 - Noticeable from a Distance

**Color?:**
- Yes
- No

**Color - Description:**
- Clear
- Brown
- Gray
- Yellow
- Green
- Orange
- Red
- Other

**Color - Other description:**

**Color - Relative Severity Index (1-3):**
- 1 - Faint colors in sample bottle
- 2 - Clearly visible in sample bottle
- 3 - Clearly visible in outfall flow

**Turbidity?:**
- Yes
- No

**Turbidity - Relative Severity Index (1-3):**
- 1 - Slight cloudiness
- 2 - Cloudy
- 3 - Opaque

**Floatables? (does not include trash):**
- Yes
- No

**Floatables - Description**
- Sewage (Toilet Paper, etc.)
- Suds
- Petroleum (Oil Sheen)
- Other

**Floatables - Other description:**

**Floatables - Relative Severity Index (1-3):**
- 1 - Few/Small, Origin (e.g., possible suds or oil sheen, suds, or floating sanitary
- 2 - Some; Indications of
- 3 - Some; Origin clear (e.g., obvious

---

**Dimensions (in.):**

**Number of Grates:**
<table>
<thead>
<tr>
<th>Physical Indicators (Flowing and non-flowing outfalls)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outfall Damage?</strong></td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td><strong>Damage Details:</strong></td>
</tr>
<tr>
<td>Corrosion</td>
</tr>
<tr>
<td>Peeling Paint</td>
</tr>
<tr>
<td>Spalling, Cracking, or Chipping</td>
</tr>
<tr>
<td><strong>Deposits/Stains?</strong></td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td><strong>Stain Details:</strong></td>
</tr>
<tr>
<td>Flow Line</td>
</tr>
<tr>
<td>Oily</td>
</tr>
<tr>
<td>Paint</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td><strong>Stain Details Other Description:</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Abnormal Vegetation?</strong></td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td><strong>Vegetation Details:</strong></td>
</tr>
<tr>
<td>Excessive</td>
</tr>
<tr>
<td>Inhibited</td>
</tr>
<tr>
<td><strong>Poor Pool Quality?</strong></td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td><strong>Pool Quality Details:</strong></td>
</tr>
<tr>
<td>Colors</td>
</tr>
<tr>
<td>Excessive Algae</td>
</tr>
<tr>
<td>Floatables</td>
</tr>
<tr>
<td>Odors</td>
</tr>
<tr>
<td>Suds</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td><strong>Pool Quality Details Other Description:</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Pipe Benthic Growth?</strong></td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td><strong>Benthic Growth Details:</strong></td>
</tr>
<tr>
<td>Brown</td>
</tr>
<tr>
<td>Green</td>
</tr>
<tr>
<td>Orange</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td><strong>Benthic Growth Details Other Description:</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Quantitative Characterization - Field Data Analysis for Flowing Outfalls</strong></td>
</tr>
<tr>
<td><strong>Temperature (in degrees F)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Temperature Exceeds Allowable Limits</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>pH (in pH units)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>pH Exceeds Allowable Limits (&lt;= 5 pH)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Ammonia (in mg/L)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Ammonia Exceeds Allowable Limits (&gt; 0.82 mg/L)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Test</td>
</tr>
<tr>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>Potassium (in mg/L)</td>
</tr>
<tr>
<td>Potassium Exceeds Allowable Limits</td>
</tr>
<tr>
<td>Detergents (mg/L)</td>
</tr>
<tr>
<td>Detergents Exceed Allowable Limits (&gt; 0.25 mg/L)</td>
</tr>
<tr>
<td>E. Coli (in cfu/ml)</td>
</tr>
<tr>
<td>E. Coli Exceeds Allowable Limits (&gt;=1.90-9.7E2 cfu/ml)</td>
</tr>
<tr>
<td>Flouride (in mg/L)</td>
</tr>
<tr>
<td>Flouride Exceeds Allowable Limits (&lt;1.8 mg/L)</td>
</tr>
</tbody>
</table>

**Flouride Analysis Date:**

**Flouride Test Analyzer:**

**Other Test Analysis Date:**

**Other Test Analyzer:**

**Overall Outfall Characterization**

<table>
<thead>
<tr>
<th>Potential for Illicit Discharge</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlikely</td>
<td></td>
</tr>
<tr>
<td>Potential (Presence of two or more indicators)</td>
<td></td>
</tr>
<tr>
<td>Suspect (One or more indicators with a severity of 3)</td>
<td></td>
</tr>
<tr>
<td>Obvious</td>
<td></td>
</tr>
</tbody>
</table>

**Follow-up Recommended?**

- Yes
- No

**Follow-up Recommendation Comments:**

**Reset**

**Comments**

<table>
<thead>
<tr>
<th>Observation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Repairs</td>
<td></td>
</tr>
<tr>
<td>Recommendation</td>
<td></td>
</tr>
</tbody>
</table>

**Cond. Score:** 0
Test preparation

**CAUTION: **Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.

- Put the color disc on the center pin in the color comparator box (numbers to the front).
- Use sunlight or a lamp as a light source to find the color match with the color comparator box.
- Rinse the tubes with sample before the test. Rinse the tubes with deionized water after the test.
- If the color match is between two segments, use the value that is in the middle of the two segments.
- If the color disc becomes wet internally, pull apart the flat plastic sides to open the color disc. Remove the thin inner disc. Dry all parts with a soft cloth. Assemble when fully dry.
- To verify the test accuracy, use a standard solution as the sample.
- This test kit is for seawater. If used for brackish or fresh water, the test kit gives a higher than actual value. The error in brackish water is usually less than 10%. The error in low salinity or fresh water is a maximum 16%.
- This test is very sensitive to contamination. Try to get the same result on a second test. Fully rinse the tubes with fresh sample before the second test. The reagents clean the tubes during the first test.
- To increase the range of this test to 4 mg/L NH₃–N, dilute the sample as follows. Use a 3-mL syringe to add 2.5 mL of sample to each tube. Dilute the sample to the 5-mL mark with deionized water. Use the diluted sample in the test procedure and multiply the result by 2.

**Test procedure—Ammonia-nitrogen (0–2.0 mg/L NH₃–N)**

1. Fill two tubes to the first line (5 mL) with sample.
2. Put one tube into the left opening of the color comparator box.
3. Add one Ammonia Salicylate Reagent Powder Pillow to the second tube.
4. Put a stopper on the tube. Shake until the powder fully dissolves.
5. Wait 3 minutes.
6. Add one Ammonia Cyanurate Reagent Powder Pillow to the same tube. Put a stopper on the tube.
7. Shake until the powder fully dissolves.
9. Put the second tube into the color comparator box.
10. Hold the color comparator box in front of a light source. Turn the color disc to find the color match.
11. Read the result in mg/L in the scale window.

**Replacement items**

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Item no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia Salicylate Reagent Powder Pillows, 5 mL</td>
<td>50/pkg</td>
<td>2395266</td>
</tr>
<tr>
<td>Ammonia Cyanurate Reagent Powder Pillows, 5 mL</td>
<td>50/pkg</td>
<td>2395466</td>
</tr>
<tr>
<td>Color disc, ammonia nitrogen, salicylate, 0–2.0 mg/L</td>
<td>each</td>
<td>9261300</td>
</tr>
<tr>
<td>Color comparator box</td>
<td>each</td>
<td>173200</td>
</tr>
<tr>
<td>Glass viewing tubes, glass, 18 mm</td>
<td>6/pkg</td>
<td>173006</td>
</tr>
<tr>
<td>Stoppers for 18-mm glass tubes and AccuVac Ampuls</td>
<td>6/pkg</td>
<td>173106</td>
</tr>
</tbody>
</table>

**Optional items**

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Item no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen ammonia standard solution, 1.0 mg/L NH₃–N</td>
<td>500 mL</td>
<td>189149</td>
</tr>
<tr>
<td>Water, deionized</td>
<td>500 mL</td>
<td>27249</td>
</tr>
<tr>
<td>Syringe, Luer-Lok® Tip, 3 mL</td>
<td>each</td>
<td>4321300</td>
</tr>
</tbody>
</table>
Calculate the mg/L NH₃ and mg/L NH₄⁺

Ammonia in water is in the form of the ammonium ion (NH₄⁺) and un-ionized ammonia (NH₃). NH₃ is toxic to fish. Table 1 shows that the percent of NH₃ increases as the pH and temperature increase. This test kit measures both NH₄⁺ and NH₃ as ammonia nitrogen (NH₃–N).

To calculate the mg/L NH₃ in the sample, refer to Table 1 and the equation that follows.

\[
\text{mg/L NH}_3 = \left(\text{mg/L NH}_3–\text{N} \times \text{percent NH}_3 \text{ from Table 1}\right) \div 100 \times 1.2
\]

**Example:** The test result was 1.6 mg/L NH₃–N. The sample pH was 7.6 and the sample temperature was 16 °C. The mg/L NH₃ is \((1.6 \times 1.16) \div 100 \times 1.2 = 0.02 \text{ mg/L NH}_3\).

To calculate the mg/L NH₄⁺ in the sample, refer to Table 1 and the equation that follows.

\[
\text{mg/L NH}_4^+ = \left(\text{mg/L NH}_3–\text{N} \times (100 – \text{percent NH}_3 \text{ from Table 1})\right) \div 100 \times 1.3
\]

**Example:** The test result was 1.6 mg/L NH₃–N. The sample pH was 7.6 and the sample temperature was 16 °C. The mg/L NH₄⁺ is \((1.6 \times (100 – 1.16)) \div 100 \times 1.3 = 2.056 \text{ mg/L NH}_4^+\).

<table>
<thead>
<tr>
<th>pH</th>
<th>16 °C</th>
<th>18 °C</th>
<th>20 °C</th>
<th>22 °C</th>
<th>24 °C</th>
<th>26 °C</th>
<th>28 °C</th>
<th>30 °C</th>
<th>32 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.0</td>
<td>0.29</td>
<td>0.34</td>
<td>0.39</td>
<td>0.46</td>
<td>0.52</td>
<td>0.60</td>
<td>0.69</td>
<td>0.80</td>
<td>0.91</td>
</tr>
<tr>
<td>7.2</td>
<td>0.46</td>
<td>0.54</td>
<td>0.62</td>
<td>0.82</td>
<td>0.83</td>
<td>0.96</td>
<td>1.10</td>
<td>1.26</td>
<td>1.44</td>
</tr>
<tr>
<td>7.4</td>
<td>0.73</td>
<td>0.85</td>
<td>0.98</td>
<td>1.14</td>
<td>1.31</td>
<td>1.50</td>
<td>1.73</td>
<td>1.98</td>
<td>2.26</td>
</tr>
<tr>
<td>7.6</td>
<td>1.16</td>
<td>1.34</td>
<td>1.55</td>
<td>1.79</td>
<td>2.06</td>
<td>2.36</td>
<td>2.71</td>
<td>3.10</td>
<td>3.53</td>
</tr>
<tr>
<td>7.8</td>
<td>1.82</td>
<td>2.11</td>
<td>2.44</td>
<td>2.81</td>
<td>3.22</td>
<td>3.70</td>
<td>4.23</td>
<td>4.82</td>
<td>5.48</td>
</tr>
<tr>
<td>8.0</td>
<td>2.86</td>
<td>3.30</td>
<td>3.81</td>
<td>4.38</td>
<td>5.02</td>
<td>5.74</td>
<td>6.54</td>
<td>7.43</td>
<td>8.42</td>
</tr>
<tr>
<td>8.2</td>
<td>4.45</td>
<td>5.14</td>
<td>5.90</td>
<td>6.76</td>
<td>7.72</td>
<td>8.80</td>
<td>9.98</td>
<td>11.29</td>
<td>12.72</td>
</tr>
<tr>
<td>8.4</td>
<td>6.88</td>
<td>7.90</td>
<td>9.04</td>
<td>10.31</td>
<td>11.71</td>
<td>13.26</td>
<td>14.95</td>
<td>16.78</td>
<td>18.77</td>
</tr>
<tr>
<td>8.6</td>
<td>10.48</td>
<td>11.97</td>
<td>13.61</td>
<td>15.41</td>
<td>17.37</td>
<td>19.50</td>
<td>21.78</td>
<td>24.22</td>
<td>26.80</td>
</tr>
<tr>
<td>8.8</td>
<td>15.66</td>
<td>17.73</td>
<td>19.98</td>
<td>22.41</td>
<td>25.00</td>
<td>27.74</td>
<td>30.62</td>
<td>33.62</td>
<td>36.72</td>
</tr>
<tr>
<td>9.0</td>
<td>22.73</td>
<td>25.46</td>
<td>28.36</td>
<td>31.40</td>
<td>34.56</td>
<td>37.83</td>
<td>41.16</td>
<td>44.53</td>
<td>47.91</td>
</tr>
<tr>
<td>9.2</td>
<td>31.80</td>
<td>35.12</td>
<td>38.55</td>
<td>42.04</td>
<td>45.57</td>
<td>49.09</td>
<td>52.58</td>
<td>55.99</td>
<td>59.31</td>
</tr>
<tr>
<td>9.4</td>
<td>42.49</td>
<td>46.18</td>
<td>49.85</td>
<td>53.48</td>
<td>57.02</td>
<td>60.45</td>
<td>63.73</td>
<td>66.85</td>
<td>69.79</td>
</tr>
<tr>
<td>9.6</td>
<td>53.94</td>
<td>57.62</td>
<td>61.17</td>
<td>64.56</td>
<td>67.77</td>
<td>70.78</td>
<td>73.58</td>
<td>76.17</td>
<td>78.55</td>
</tr>
<tr>
<td>9.8</td>
<td>64.99</td>
<td>68.31</td>
<td>71.40</td>
<td>74.28</td>
<td>76.92</td>
<td>79.33</td>
<td>81.53</td>
<td>83.51</td>
<td>85.30</td>
</tr>
<tr>
<td>10.0</td>
<td>74.63</td>
<td>77.35</td>
<td>79.83</td>
<td>82.07</td>
<td>84.08</td>
<td>85.88</td>
<td>87.49</td>
<td>88.92</td>
<td>90.19</td>
</tr>
<tr>
<td>10.2</td>
<td>82.34</td>
<td>84.41</td>
<td>86.25</td>
<td>87.88</td>
<td>89.33</td>
<td>90.60</td>
<td>91.73</td>
<td>92.71</td>
<td>93.58</td>
</tr>
</tbody>
</table>
Detergents CHEMets Kit
K-9400/R-9400: 0 - 3 ppm

Test Procedure
1. Rinse the reaction tube with the sample to be tested, and then fill it to the 5 mL mark with the sample.
2. While holding the double-tipped ampoule in a vertical position, snap the upper tip using the tip breaking tool (fig. 1).
3. Invert the ampoule and position the open end over the reaction tube. Snap the upper tip and allow the contents to drain into the reaction tube (fig. 1).
4. Cap the reaction tube and shake it vigorously for 30 seconds. Allow the tube to stand undisturbed for 1 minute.
5. Make sure that the flexible tubing is firmly attached to the CHEMets ampoule tip.
6. Insert the CHEMets assembly (tubing first) into the reaction tube making sure that the end of the flexible tubing is at the bottom of the tube. Break the tip of the CHEMets ampoule by gently pressing it against the side of the reaction tube (fig. 2). The ampoule should draw in fluid only from the organic phase (bottom layer).
7. When filling is complete, remove the CHEMets assembly from the reaction tube.
8. Remove the flexible tubing from the CHEMets ampoule and wipe all liquid from the exterior of the ampoule. Place an ampoule cap firmly onto the tip of the CHEMets ampoule. Invert the ampoule several times, allowing the bubble to travel from end to end.
9. Obtain a test result by placing the ampoule, flat end first, into the comparator. Hold the comparator up toward a source of light and view from the bottom. Rotate the comparator until the best color match is found (fig. 3).

Tip Breaker
The tip breaker opens for easy disposal of the glass tips (pull lever away from body of tip breaker or pull open the side wall). The tip breaker will work most effectively if the tips are emptied out frequently.

Test Method
The Detergents CHEMets® test kit employs the methylene blue extraction method. Anionic detergents react with methylene blue to form a blue complex that is extracted into an immiscible organic solvent. The intensity of the blue color is directly related to the concentration of "methylene blue active substances (MBAS)" in the sample. Anionic detergents are one of the most prominent methylene blue active substances. Test results are expressed in ppm (mg/Liter) linear alkylbenzene sulfonate (equivalent weight 325).

Safety Information
Read SDS (available at www.chemetrics.com) before performing this test procedure. Wear safety glasses and protective gloves.

www.chemetrics.com
4295 Catlett Road, Midland, VA 22728 U.S.A.
Phone: (800) 356-3072; Fax: (540) 788-4856
E-Mail: orders@chemetrics.com
Feb. 18, Rev. 10
Method 8167

CHLORINE, TOTAL, Low Range (0 to 2.00 mg/L Cl₂)

For water, wastewater and seawater

DPD Method* USEPA accepted (powder pillows only)**

Measuring Hints
If the sample temporarily turns yellow after reagent addition or the display shows overrange (flashing 2.20 in display), dilute a fresh sample and repeat the test. A slight loss of chlorine may occur because of the dilution. Multiply the result by the appropriate dilution factor.

* Adapted from Standard Methods for the Examination of Water and Wastewater.
** Procedure is equivalent to USEPA method 330.5 for wastewater and Standard Method 4500-C1 G for drinking water.
1. Fill a 10-mL cell to the 10-mL line with sample. Cap.

*Note:* Samples must be analyzed immediately and cannot be preserved for later analysis.

*Note:* Be sure the instrument is in the low range mode. See page 37.

2. Add the contents of one DPD Total Chlorine Powder Pillow to the sample cell (the prepared sample). Cap and gently shake for 20 seconds.

*Note:* Gently shaking dissipates bubbles which may form in samples containing dissolved gases.

*Note:* A pink color will form if chlorine is present.

*Note:* Accuracy is not affected by undissolved powder.

3. Wait 3 minutes. During this period, proceed with steps 4–8.
4. Fill a 10-mL sample cell to the 10-mL line with sample (the blank). Cap.

5. Remove the instrument cap.

Note: For best results, zero the instrument and read the sample under the same lighting conditions.

6. Place the blank in the cell holder, with the diamond mark facing you. Tightly cover the cell with the instrument cap (flat side should face the back of the instrument).

Note: Wipe liquid off sample cells.
7. Press: ZERO
The instrument will turn on and the display will show - - - followed by 0.00.
Note: The instrument automatically shuts off after 1 minute and stores the last zero in memory. Press READ to complete the analysis.

8. Remove the cell from the cell holder.

9. Within 3 minutes after the 3-minute reaction period, place the prepared sample in the cell holder.
Note: Wipe liquid off sample cells.
10. Cover the cell with instrument cap.

11. Press: **READ**
The instrument will show - - - followed by the result in mg/L total chlorine.

**Note:** If the sample temporarily turns yellow after reagent addition or shows overrange (flashing 2.20), dilute a fresh sample and repeat the test. Some loss of chlorine may occur. Multiply the result by the dilution factor.
CHLORINE, TOTAL, Low Range, continued

Using AccuVac® Ampuls

1. Fill a 10-mL sample cell to the 10-mL line with sample (the blank). Cap. Collect at least 40 mL of sample in a 50-mL beaker. 
   Note: Samples must be analyzed immediately and cannot be preserved for later analysis.

2. Fill a DPD Total Chlorine Reagent AccuVac Ampul with sample (the prepared sample).
   Note: Keep the tip immersed until the ampule fills completely.
   Note: Be sure the instrument is in low range. See page 37.

3. Quickly invert the ampule several times to mix. Wipe off any liquid or fingerprints.
   Note: A pink color will develop if chlorine is present.
   Note: Accuracy is not affected by undissolved powder.
CHLORINE, TOTAL, Low Range, continued

4. Wait 3 minutes. During this period, proceed with steps 5–8.

5. Remove the instrument cap.
   
   **Note:** For best results, zero and read the sample measurements under the same lighting conditions.

6. Place the blank in the cell holder with the diamond mark facing you. Tightly cover the cell with the instrument cap (flat side should face the back of the instrument).

   **Note:** Wipe liquid off sample cells.
7. Press: **ZERO**

The instrument will turn on and the display will show - - - then 0.00.

*Note:* The instrument automatically shuts off after 1 minute and stores the last zero in memory. Press **READ** to complete the analysis.

8. Within 3 minutes after the 3-minute reaction period, place the prepared sample in the cell holder.

*Note:* Wipe liquid off sample cells.

9. Cover the ampule with the instrument cap.
10. Press: **READ**

The instrument will show - - - followed by the result in mg/L total chlorine.

**Note:** If the sample temporarily turns yellow after reagent addition or shows overrange (flashing 2.2b), dilute a fresh sample and repeat the test. Some loss of chlorine may occur. Multiply the result by the dilution factor.
CHLORINE, TOTAL, Low Range, continued

Accuracy Check

Standard Additions Method

a. Snap the neck off a Chlorine Standard Solution Voluette® Ampule.

b. Use a TenSette® pipet to add 0.1, 0.2, and 0.3 mL of standard to three 25-mL samples. Swirl gently to mix. (For AccuVac Ampuls, use 50-mL beakers.)

c. Analyze a 10-mL aliquot of each sample as described in the procedure. Each 0.1 mL of standard will cause an incremental increase in chlorine, the exact value depends on the concentration of the Voluette ampule standard. Check the certificate enclosed with the Voluette ampules for this value.

d. If these increases do not occur, call Hach at 800-227-4224. Outside the United States, contact the Hach office or distributor serving you.

Interferences

Samples containing more than the 250 mg/L alkalinity or 150 mg/L acidity as CaCO₃ may inhibit full color development, or the color may fade instantly. Neutralize these samples to pH 6–7 with 1 N Sulfuric Acid or 1 N Sodium Hydroxide. Determine the
amount required on a separate 10-mL sample. Add the same amount to the sample to be tested. Correct for the additional volume.

Bromine, iodine, ozone and oxidized forms of manganese and chromium may also react and read as chlorine.

To compensate for the effects of manganese (Mn⁴⁺) or chromium (Cr⁶⁺), adjust the pH to 6–7 as described above. To a 25-mL sample, add 3 drops of 30 g/L Potassium Iodide Solution, mix, and wait one minute. Add 3 drops of 5 g/L Sodium Arsenite and mix. If chromium is present, allow exactly the same reaction period with DPD for both analyses. Subtract the result of this test from the original analysis to obtain the accurate chlorine concentration.

DPD Total Chlorine Reagent Powder Pillows and AccuVac Ampuls contain a buffer formulation that withstands high levels (at least 1000 mg/L) of hardness without interference.
CHLORINE, TOTAL, Low Range, continued

REQUIRED REAGENTS

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Cat. No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPD Total Chlorine Reagent Powder Pillows</td>
<td>100/pkg....</td>
<td>21056-69</td>
</tr>
<tr>
<td>or DPD Total Chlorine Reagent AccuVac® Ampuls</td>
<td>25/pkg.....</td>
<td>25030-25</td>
</tr>
</tbody>
</table>

REQUIRED APPARATUS (AccuVac® Ampuls)

Beaker, 50 mL................................................................. each............. 500-41

OPTIONAL REAGENTS

Chlorine Standard Solution Voluette®
Ampules, 50-75 mg/L, 10 mL........................................... 16/pkg....... 14268-10

Chlorine Standards, secondary, SpecV™,
0.0, 0.2, 0.8, and 1.5 mg/L ........................................... 4/set....... 26353-00

DPD Total Chlorine Reagent w/dispensing cap ........... 250 tests...... 21056-29

Potassium Iodide Solution, 30 g/L.............................. 100 mL MDB*............ 343-32

Sodium Arsenite Solution, 5 g/L................................. 100 mL MDB........... 1047-32

Sodium Hydroxide Standard Solution, 1 N...................... 100 mL MDB........... 1045-32

Sulfuric Acid Standard Solution, 1 N......................... 100 mL MDB........... 1270-32

Water, deionized.............................................................. 4 L............. 272-56

* Marked Dropper Bottle
<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Cat. No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AccuVac® Snapper Kit</td>
<td>each</td>
<td>24052-00</td>
</tr>
<tr>
<td>Batteries, AAA, alkaline</td>
<td>4/pkg</td>
<td>46743-00</td>
</tr>
<tr>
<td>Caps for 10-mL sample cells</td>
<td>12/pkg</td>
<td>24018-12</td>
</tr>
<tr>
<td>Cylinder, graduated, 25 mL, poly</td>
<td>each</td>
<td>1081-40</td>
</tr>
<tr>
<td>Cylinder, graduated, 100 mL, PMP</td>
<td>each</td>
<td>2172-42</td>
</tr>
<tr>
<td>sension™ Basic Portable pH Meter, with electrode</td>
<td>each</td>
<td>51700-10</td>
</tr>
<tr>
<td>Pipet, TenSette®, 0.1 to 1.0 mL</td>
<td>each</td>
<td>19700-01</td>
</tr>
<tr>
<td>Pipet Tips, For 19700-01 TenSette®</td>
<td>50/pkg</td>
<td>21856-96</td>
</tr>
<tr>
<td>Sample Cells, 10-mL with screw caps</td>
<td>6/pkg</td>
<td>24276-06</td>
</tr>
</tbody>
</table>

**REPLACEMENT PARTS**

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Cat. No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instrument Cap/light shield</td>
<td>each</td>
<td>46704-00</td>
</tr>
<tr>
<td>Instrument Manual</td>
<td>each</td>
<td>46760-88</td>
</tr>
</tbody>
</table>

63
# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warranty</td>
<td>i</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Getting Started</td>
<td>1</td>
</tr>
<tr>
<td>Initial Inspection</td>
<td>1</td>
</tr>
<tr>
<td>Battery Installation</td>
<td>1</td>
</tr>
<tr>
<td>Key Pad</td>
<td>2</td>
</tr>
<tr>
<td>Connecting the Probe/Cable Assembly</td>
<td>3</td>
</tr>
<tr>
<td>Run Screen</td>
<td>4</td>
</tr>
<tr>
<td>Backlight</td>
<td>5</td>
</tr>
<tr>
<td>Powering Off</td>
<td>5</td>
</tr>
<tr>
<td>Navigation</td>
<td>5</td>
</tr>
<tr>
<td>First Power On</td>
<td>5</td>
</tr>
<tr>
<td>System Setup Menu</td>
<td>6</td>
</tr>
<tr>
<td>Audio</td>
<td>7</td>
</tr>
<tr>
<td>Contrast</td>
<td>7</td>
</tr>
<tr>
<td>Conductivity Units (Cond. Units)</td>
<td>8</td>
</tr>
<tr>
<td>Conductivity Auto Stable (Cond. Auto Stable)</td>
<td>9</td>
</tr>
<tr>
<td>Temperature Units</td>
<td>9</td>
</tr>
<tr>
<td>Specific Conductance Reference Temp. (SPC Ref. Temp.)</td>
<td>10</td>
</tr>
<tr>
<td>Specific Conductance Temperature Coefficient (SPC %/°C)</td>
<td>10</td>
</tr>
<tr>
<td>TDS Constant</td>
<td>10</td>
</tr>
<tr>
<td>Language</td>
<td>11</td>
</tr>
<tr>
<td>Auto Shutoff</td>
<td>11</td>
</tr>
<tr>
<td>Cell Constant</td>
<td>11</td>
</tr>
<tr>
<td>Resetting the System Setup Menu to</td>
<td>12</td>
</tr>
<tr>
<td>Factory Default</td>
<td></td>
</tr>
<tr>
<td>Calibration</td>
<td>12</td>
</tr>
<tr>
<td>Temperature</td>
<td>12</td>
</tr>
<tr>
<td>Conductivity Calibration</td>
<td>12</td>
</tr>
</tbody>
</table>
WARRANTY

The YSI Professional 30 instrument (Pro30) is warranted for three (3) years from date of purchase by the end user against defects in materials and workmanship, exclusive of batteries and any damage caused by defective batteries. Pro30 cable/probe assemblies are warranted for two (2) years from date of purchase by the end user against defects in material and workmanship. Pro30 instruments & cables are warranted for 90 days from date of purchase by the end user against defects in material and workmanship when purchased by rental agencies for rental purposes. Within the warranty period, YSI will repair or replace, at its sole discretion, free of charge, any product that YSI determines to be covered by this warranty.

To exercise this warranty, call your local YSI representative, or contact YSI Customer Service in Yellow Springs, Ohio at +1 937 767-7241, 800-897-4151 or visit www.YSI.com for a Product Return Form. Send the product and proof of purchase, transportation prepaid, to the Authorized Service Center selected by YSI. Repair or replacement will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days from date of repair or replacement.

LIMITATION OF WARRANTY

This Warranty does not apply to any YSI product damage or failure caused by:

1. Failure to install, operate or use the product in accordance with YSI’s written instructions;
2. Abuse or misuse of the product;
3. Failure to maintain the product in accordance with YSI’s written instructions or standard industry procedure;
4. Any improper repairs to the product;
5. Use by you of defective or improper components or parts in servicing or repairing the product;
6. Modification of the product in any way not expressly authorized by YSI.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. YSI’S LIABILITY UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT, AND THIS SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY. IN NO EVENT SHALL YSI BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY.
INTRODUCTION

Thank you for purchasing the YSI Pro30, an instrument from the YSI Professional Series product family. The Pro30 measures conductivity and temperature in water. The Pro30 features an impact resistant and waterproof (IP-67) case, a rugged MS-8 (military-spec) cable connector, backlit display, user-selectable sensor options, 50 data set memory, internal barometer and a rubber over-mold case.

The Pro30 provides valuable instructions and prompts near the bottom of the display that will guide you through operation and use. However, reading the entire manual is recommended for a better understanding of the instrument’s features.

GETTING STARTED

INITIAL INSPECTION

Carefully unpack the instrument and accessories and inspect for damage. Compare received parts with items on the packing list. If any parts or materials are damaged or missing, contact YSI Customer Service at 800-897-4151 (+1 937 767-7241) or the authorized YSI distributor from whom the instrument was purchased.

BATTERY INSTALLATION

The instrument requires 2 alkaline C-cell batteries. Under normal conditions, the average battery life is 425 hours at room temperature without using the back light. A battery symbol $\text{Battery}$ will blink in the lower, left corner of the display to indicate low batteries when approximately 1 hour of battery life remains.

To install or replace the batteries:
1. Turn the instrument off and flip over to view the battery cover on the back.
2. Unscrew the four captive battery cover screws.
3. Remove the battery cover and remove the old batteries if necessary.
4. Install the new batteries, ensuring correct polarity alignment (figure 1).

The Pro30 cannot communicate to a PC via a Pro Series communications saddle. Connecting the Pro30 to a communication saddle may cause erratic instrument behavior.
5. Place the battery cover on the back of the instrument and tighten the four screws. Do not over-tighten.

![Figure 1. Pro30 with battery cover removed. Notice battery symbols indicating polarities.](image)

*The waterproof instrument case is sealed at the factory and is not to be opened, except by authorized service technicians. Do not attempt to separate the two halves of the instrument case as this may damage the instrument, break the waterproof seal, and will void the warranty.*

### KEY PAD

<table>
<thead>
<tr>
<th>Number</th>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="cal_icon" alt="Cal" /></td>
<td><strong>Calibrate</strong> Press and hold for 3 seconds to calibrate. Opens Calibrate menu from the Run screen.</td>
</tr>
<tr>
<td>2</td>
<td><img src="up_arrow_icon" alt="Up Arrow" /></td>
<td><strong>Up Arrow</strong> Use to navigate through menus, to navigate through box options along the bottom of the Run screen and to increase numerical inputs.</td>
</tr>
<tr>
<td>3</td>
<td><img src="power_icon" alt="Power and Backlight" /></td>
<td><strong>Power and Backlight</strong> Press once to turn instrument on. Press a second time to turn backlight on. Press a third time to turn backlight off. Press and hold for 3 seconds to turn instrument off.</td>
</tr>
<tr>
<td>4</td>
<td><img src="menu_icon" alt="Menu" /></td>
<td><strong>Menu</strong> Use to enter the System Setup menu from the Run screen.</td>
</tr>
<tr>
<td>5</td>
<td><img src="enter_icon" alt="Enter" /></td>
<td><strong>Enter</strong> Press to confirm entries and selections.</td>
</tr>
<tr>
<td>6</td>
<td><img src="down_arrow_icon" alt="Down Arrow" /></td>
<td><strong>Down Arrow</strong> Use to navigate through menus, to navigate through box options at the bottom of the Run screen and to decrease numerical inputs.</td>
</tr>
</tbody>
</table>

### CONNECTING THE PROBE/CABLE ASSEMBLY TO THE INSTRUMENT

The conductivity and temperature sensors are integral to the cable assembly; therefore, they cannot be removed from the cable.

To connect the cable, align the keys on the cable connector to the slots on the instrument connector. Push together firmly and then twist the outer ring until it locks into place (figure 3). This connection is water-proof.

![Figure 2. Keypad](image)
Figure 3, Note the keyed connector.

RUN SCREEN

Press the power/backlight key to turn the instrument on. The instrument will run through a self test and briefly display a splash screen with system information before displaying the main Run screen (figure 4). The first time the Pro30 is turned on, it will prompt you to select a language; see the First Power On section of this manual for more information.

BACKLIGHT

Once the instrument is powered on, pressing the power/backlight key will turn on the display backlight. The backlight will remain on until the key is pressed again or after two minutes of not pressing any key on the keypad.

POWERING OFF

To turn the instrument off, press and hold the power/backlight key for three seconds.

NAVIGATION

The up and down arrow keys allow you to navigate through the functions of the Pro30.

NAVIGATING THE RUN SCREEN

When in the Run screen, the up and down arrow keys will move the highlighted box along the bottom options. Once a box is highlighted, press enter to access the highlighted option.

Description of Run screen box functions from left to right:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAVE</td>
<td>Highlight and press enter to save displayed data to memory.</td>
</tr>
<tr>
<td>DATA</td>
<td>Highlight and press enter to view and/or erase saved data.</td>
</tr>
</tbody>
</table>

NAVIGATING THE SYSTEM SETUP MENU

When in the System Setup menu, the up and down arrow keys will move the highlighted bar up and down the system setup options. See the System Setup menu section of this manual for more information about these options.

FIRST POWER ON

The instrument will step through an initial language configuration when powered on for the first time. Use the up or down arrow keys to highlight the
appropriate language then press enter to confirm (figure 5). If an incorrect language is selected, it may be changed in the System Setup menu.

![Select Language: English, Français, Español, Deutsch](Figure 5, Select language.)

After selecting a language, the Run screen will be displayed. The next time the instrument is powered up, the Run screen will display immediately after the splash screen.

**SYSTEM SETUP MENU**

Press the menu key to access the System Setup menu. The System Setup menu contains multiple screens that are notated as 'pages'. The current page is indicated near the bottom of the display (figure 6).

Use the up and down arrow keys to scroll through menu options and menu pages.

**EXITING THE SYSTEM SETUP MENU**

To exit the System Setup menu, press the down arrow key until the ESC - Exit box is highlighted, then press enter to return to the Run screen.

**AUDIO**

Audio can be enabled or disabled by using the up or down arrow keys to highlight Audio and pressing enter. When enabled, there will be an ‘X’ in the box next to Audio.

When Audio is enabled, the Pro30 will beep twice to indicate stability when Auto Stable is enabled. The instrument will also beep when a key is pressed. When Audio is disabled, the Pro30 will not beep.

**CONTRAST**

To adjust the display Contrast, use the up or down arrow keys to highlight Contrast, then press enter. Next, use the up or down arrow keys to adjust the contrast. The up arrow key will darken the contrast and the down arrow key will lighten the contrast. After adjusting the contrast, press enter to save and exit the Contrast adjustment option.

**EMERGENCY CONTRAST ADJUSTMENT**

If necessary, there is an alternate method of adjusting the contrast. To adjust the contrast, press and hold the menu key, then press the up arrow key to darken the contrast or press the down arrow key to lighten the contrast.
**CONDUCTIVITY UNITS (COND. UNITS)**

Highlight Cond. Units (Conductivity Units) and press enter to open a submenu that allows you to select the conductivity units to be displayed on the Run screen. Highlight a unit and press enter to enable or disable it. An enabled conductivity unit will have an ‘X’ in the box next to it. Highlight the ESC-Exit box along the bottom of the display and press enter to save any changes and to close the conductivity units submenu.

There are seven options for displaying conductivity. Only four units can be enabled at the same time:

- **COND-mS/cm** displays conductivity in milliSiemens per centimeter.
- **COND-uS/cm** displays conductivity in microSiemens per centimeter.
- **SPC-mS/cm** displays Specific Conductance in milliSiemens per centimeter. Specific Conductance is temperature compensated conductivity.
- **SPC-uS/cm** displays Specific Conductance in microSiemens per centimeter. Specific Conductance is temperature compensated conductivity.
- **Sal ppt** displays salinity in parts per thousand. The salinity reading is calculated from the instrument’s conductivity and temperature values using algorithms found in *Standard Methods for the Examination of Water and Wastewater*.
- **TDS g/L** displays Total Dissolved Solids in grams per liter. TDS is calculated from conductivity and temperature using a user-selectable TDS constant.
- **TDS mg/L** displays Total Dissolved Solids in milligrams per liter. TDS is calculated from conductivity and temperature using a user-selectable TDS constant.

Note: 1 milliSiemen = 1,000 microSiemens.

**SPECIFIC CONDUCTANCE**

The conductivity of a sample is highly dependent on temperature, varying as much as 3% for each change of one degree Celsius (temperature coefficient = 3%/°C). In addition, the temperature coefficient itself varies with the nature of the ionic species present in the sample. Therefore, it is useful to compensate for this temperature dependence in order to quickly compare conductivity readings taken at different temperatures.

The Pro30 can display non-temperature compensated conductivity as well as temperature compensated Specific Conductance. If Specific Conductance is selected, the Pro30 uses the temperature and conductivity values associated with each measurement to calculate a specific conductance value compensated to a user selected reference temperature, see below. Additionally, the user can select the temperature coefficient from 0% to 4%.

Using the Pro30’s default reference temperature and temperature coefficient (25 °C and 1.91%), the calculation is carried out as follows:

\[
\text{Specific Conductance (25°C)} = \frac{\text{Conductivity of sample}}{1 + 0.0191 \times (T - 25)}
\]

\(T = \text{Temperature of the sample in °C}\)

**CONDUCTIVITY AUTO STABLE (COND. AUTO STABLE)**

Auto Stable utilizes preset values to indicate when a reading is stable. The preset values are adjustable in the System Setup menu. The user can input a % change in readings (0.0 to 1.9) over ‘x’ amount of time in seconds (3-19).

Highlight Cond. Auto Stable, then press enter to open the submenu.

Use the up or down arrow keys to highlight the % change or seconds (secs) input field, then press enter to make the highlighted field adjustable. Use the up or down arrow keys to adjust the selected value, then press enter to confirm changes. Once you have confirmed any changes, highlight the ESC-Exit box along the bottom of the display and press enter to close the Auto Stable submenu.

To disable Auto Stable, set the % Change input to 0.0.

When Auto Stable is enabled, an \(\text{AS}\) symbol will display next to the reading on the Run screen and blink during stabilization. When the dissolved oxygen and/or conductivity reading stabilizes based on the Auto Stable settings, the \(\text{AS}\) symbol will display steadily and the instrument will beep twice if Audio is turned on.

**TEMPERATURE UNITS**

Highlight Temperature Units and press enter to open a submenu that allows you to change the temperature units displayed on the Run screen. Highlight the desired unit (Celsius or Fahrenheit) and press enter to enable. The enabled temperature unit will have an ‘X’ in the box next to it. Only one unit may be enabled at a time. Highlight the ESC-Exit box and press enter to save any changes and to close the Temperature Units submenu.
**SPECIFIC CONDUCTANCE REFERENCE TEMPERATURE (SPC REF. TEMP.)**

SPC Ref. Temp. (Specific Conductance Reference Temperature) is the reference temperature used to calculate Specific Conductance. The reference temperature range is 15 and 25 °C. The default value is 25 °C.

To change the reference temperature, highlight SPC Ref. Temp. and press enter to open the submenu. With the reference temperature highlighted, press enter to make the field adjustable. Next, use the up or down arrow key to increase or decrease the value. Press enter to save the new reference temperature. Next, highlight the ESC-Exit box and press enter to close the submenu.

**SPECIFIC CONDUCTANCE TEMPERATURE COEFFICIENT (SPC %/°C)**

SPC %/°C (Specific Conductance Temperature Coefficient) is the temperature coefficient used to calculate Specific Conductance. The coefficient range is 0.00 to 4.00. The default value is 1.91% which is based on KCl standards.

To change the temperature coefficient, highlight SPC %/°C and press enter to open the submenu. With the temperature coefficient highlighted, press enter to make the field adjustable. Next, use the up or down arrow key to increase or decrease the value. Press enter to save the new coefficient. Next, highlight the ESC-Exit box and press enter to close the submenu.

**TDS CONSTANT**

TDS Constant is a multiplier used to calculate an estimated TDS (Total Dissolved Solids) value from conductivity. The multiplier is used to convert Specific Conductance in mS/cm to TDS in g/L. The Pro30's default value is 0.65. This multiplier is highly dependent on the nature of the ionic species present in the water sample. To be assured of moderate accuracy for the conversion, you must determine a multiplier for the water at your sampling site. Use the following procedure to determine the multiplier for a specific sample:

1. Determine the specific conductance of a water sample from the site;
2. Filter a sample of water from the site;
3. Completely evaporate the water from a carefully measured volume of the filtered sample to yield a dry solid;
4. Accurately weigh the remaining solid;
5. Divide the weight of the solid (in grams) by the volume of water used (in liters) to yield the TDS value in g/L for this site;
6. Divide the TDS value in g/L by the specific conductance of the water in mS/cm to yield the conversion multiplier. Be certain to use the correct units.

If the nature of the ionic species at the site changes between sampling studies, the TDS values will be in error. TDS cannot be calculated accurately from specific conductance unless the make-up of the chemical species in the water remains constant.

To change the TDS Constant in the Pro30, highlight TDS Constant and press enter to open the submenu. With the TDS Constant highlighted, press enter to make the field adjustable. Next, use the up or down arrow key to increase or decrease the value. The input range is 0.30 to 1.00. Press enter to save the new TDS Constant. Next, highlight the ESC-Exit box and press enter to close the submenu.

**LANGUAGE**

Highlight Language and press enter to open a submenu that allows you to change the language. Highlight the desired language (English, Spanish, German, or French) and press enter to enable. The enabled language will have an 'X' in the box next to it. Highlight ESC-Exit box and press enter to save any changes and to close the Language submenu.

The text in the boxes along the bottom of the Run screen will always be displayed in English regardless of the language enabled in the System Setup menu.

**AUTO SHUTOFF**

Auto Shutoff allows you to set the instrument to turn off automatically after a period of time. Use the up or down arrow keys to highlight Auto Shutoff, then press enter to open the submenu. Press enter while the minute field is highlighted to make it adjustable. Next, use the up or down arrow keys to adjust the shut off time from 0 to 60 minutes. Press enter to save the new shutoff time. Next, highlight the ESC-Exit box and press enter to close the submenu.

To disable Auto Shutoff, set the Time in Minutes to 0 (zero).

**CELL CONSTANT**

The Cell Constant displays the cell constant of the conductivity cell. The cell constant is calculated and updated each time a conductivity calibration is performed. The cell constant range is 4.0 to 6.0. Resetting the System Menu resets the cell constant to 5.0.
RESETING THE SYSTEM SETUP MENU TO FACTORY DEFAULT

To reset the Pro30 settings to factory default, press the down arrow key while in the System Setup menu until the Reset - box is highlighted, then press enter. The instrument will ask you to confirm the reset. Highlight Yes and press enter to continue with the reset or highlight No and press enter to cancel the reset. A Factory Reset will not affect data saved in the instrument’s memory.

The following will be set in the Pro30 after performing a reset:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Reset Defaults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio</td>
<td>On</td>
</tr>
<tr>
<td>Contrast</td>
<td>Set to mid range</td>
</tr>
<tr>
<td>Conductivity Units</td>
<td>cond uS/cm, spc mS/cm, spc uS/cm and sal ppt</td>
</tr>
<tr>
<td>Conductivity Auto Stable</td>
<td>Off (0.0 % Change and 10 seconds)</td>
</tr>
<tr>
<td>SPC Reference Temperature</td>
<td>25°C</td>
</tr>
<tr>
<td>SPC Temperature Coefficient</td>
<td>1.91%/°C</td>
</tr>
<tr>
<td>TDS Constant</td>
<td>0.65</td>
</tr>
<tr>
<td>Temperature Units</td>
<td>°C</td>
</tr>
<tr>
<td>Language</td>
<td>English</td>
</tr>
<tr>
<td>Auto Shutoff</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Conductivity Cell Constant</td>
<td>Cell constant reset to 5.0*</td>
</tr>
</tbody>
</table>

*It is recommended to perform a Conductivity calibration after performing a reset.

CALIBRATION

TEMPERATURE

All Pro30 cables have built-in temperature sensors. Temperature calibration is not required nor is it available.

CONDUCTIVITY CALIBRATION

Ensure the conductivity sensor is clean and dry before performing a conductivity, specific conductance or salinity calibration.

CALIBRATING SPECIFIC (SP.) CONDUCTANCE OR CONDUCTIVITY

Note: When calibrating Specific Conductance, the Pro30 uses the factory default values for the Specific Conductance Reference Temperature and the Specific Conductance Temperature Coefficient regardless of what is configured in the System Setup Menu. The default value for the Reference Temperature is 25°C and the default value for the Temperature Coefficient is 1.91%/°C. It is important to note that the Temperature Coefficient of a calibration solution is dependent on the contents of the solution. Therefore, YSI recommends using a traceable calibration solution made of KCl (potassium chloride) when calibrating Specific Conductance since these solutions typically have a Temperature Coefficient of 1.91%/°C. Additionally, be sure to enter the value of the solution as it is listed for 25°C when calibrating Specific Conductance.

1. Fill a clean container (i.e. plastic cup or glass beaker) with fresh, traceable conductivity calibration solution and place the sensor into the solution. The solution must cover the holes of the conductivity sensor that are closest to the cable (figure 7). Ensure the entire conductivity sensor is submerged in the solution or the instrument will read approximately half the expected value. Gently move the probe up and down to remove any air bubbles from the conductivity sensor.
CALIBRATING IN SALINITY

1. Fill a clean container (i.e. plastic cup or glass beaker) with fresh, traceable salinity calibration solution and place the sensor into the solution. The solution must cover the holes of the conductivity sensor that are closest to the cable (figure 7). Ensure the entire conductivity sensor is submerged in the solution or the instrument will read approximately half the expected value. Gently move the probe up and down to remove any air bubbles from the conductivity sensor.

2. Turn the instrument on and allow the conductivity and temperature readings to stabilize. Press and hold the Cal key for 3 seconds. Highlight Conductivity and press enter. Next, highlight the desired calibration method, Sp. Conductance or Conductivity, and press enter.

3. Highlight the units you wish to calibrate, either uS/cm or mS/cm, and press enter. 1 mS = 1,000 uS. Next, use the up or down arrow key to adjust the value on the display to match the value of the salinity solution. Depressing either the up or down arrow key for 5 seconds will move the changing digit one place to the left. The Pro30 will remember the entered calibration value and display it the next time a salinity calibration is performed.

4. Press enter to complete the calibration. Or, press Cal to cancel the calibration and return to the Run screen.

5. ‘Calibration Successful’ will display for a few seconds to indicate a successful calibration and then the instrument will return to the Run screen.

6. If the calibration is unsuccessful, an error message will display on the screen. Press the Cal key to exit the calibration error message and return to the Run screen. See the Troubleshooting guide for possible solutions.

TAKING MEASUREMENTS

Before taking measurements, be sure the instrument has been calibrated to ensure the most accurate readings. Place the probe in the sample to be measured and give the probe a quick shake to release any air bubbles. Be sure the conductivity sensor is completely submerged in the sample. The two holes near the cable should be covered by the sample for accurate conductivity readings (figure 7). Allow the temperature readings to stabilize.

SAVING AND VIEWING DATA

The Pro30 can store 50 data sets in non-volatile memory for later viewing. A data set includes the values currently on the display, i.e. temperature, dissolved oxygen and two conductivity parameters. Each data point is referenced with a data set number, 01 through 50.
SAVING DATA

From the Run screen, use the up or down arrow keys to highlight the Save box and press enter to save the current readings. The instrument will indicate the data set is saved and display the saved data set’s number (figure 8).

The instrument will display 'Memory Full' if all 50 data sets have been saved and you attempt to save another data set.

VIEWING AND ERASING SAVED DATA - DATA MODE

Data mode allows you to view and erase saved data. From the Run screen, use the up or down arrow keys to highlight Data and press enter to access Data mode. Note that the function boxes at the bottom of the display are different in Data mode (figure 9).

VIEWING DATA

Once in Data mode, use the up and down arrow keys to view saved data sets in sequential order or press enter to access the bottom functions. After accessing the bottom functions, highlight the Data box and press enter to regain access to viewing data. The data set displayed is indicated by the data set number, 01 through 50.

ERASING DATA

While viewing saved data, press the enter key to access the function boxes at the bottom of the display. Next, use the up or down arrow keys to highlight Erase, then press enter. The instrument will give you the option to erase one data set or all data sets (figure 10).
Use the up or down arrow key to select Erase Data Set, Erase All Sets or the ESC-Exit function box, then press enter to confirm.

Select ESC-Exit and press enter to exit Erase mode without erasing any data.

Select Erase Data Set and press enter to erase the data set that was displayed before entering Erase mode. For example, if data set 12 was displayed before entering erase mode, and Erase Data Set is selected, Data Set 12 will be erased from memory and the data sets AFTER that number will move up to keep them sequential. For example, if there are 15 records and number 12 is erased then 13 becomes 12, 14 becomes 13, and 15 becomes 14. The instrument will return to Data mode after erasing one data set.

Select Erase All Data Sets and press enter to clear the Pro30 memory and return to Data mode.

EXITING DATA MODE

While in Data mode, press enter to access the bottom functions. Next, highlight the ESC-Exit box and press enter to return to the Run screen.

CARE, MAINTENANCE AND STORAGE

This section describes the proper procedures for care, maintenance and storage of the instrument. The goal is to maximize their lifetime and minimize downtime associated with improper instrument usage.

GENERAL MAINTENANCE

GENERAL MAINTENANCE - GASKET

The instrument utilizes a gasket as a seal to prevent water from entering the battery compartment. Following the recommended procedures will help keep the instrument functioning properly.

If the gasket and sealing surfaces are not maintained properly, it is possible that water can enter the battery compartment. If water enters this area, it can severely damage the battery terminals causing loss of battery power and corrosion to the battery terminals. Therefore, when the battery compartment lid is removed, the gasket that provides the seal should be carefully inspected for contamination (i.e. debris, grit, etc.) and cleaned with water and mild detergent if necessary.

SENSOR MAINTENANCE

SENSOR MAINTENANCE - TEMPERATURE

You must keep the temperature sensor free of build up. Other than that, no additional maintenance is required. A toothbrush can be used to scrub the temperature sensor if needed.

SENSOR MAINTENANCE - CONDUCTIVITY

The openings that allow sample access to the conductivity electrodes should be cleaned regularly. The small cleaning brush included in the Maintenance Kit is intended for this purpose. Dip the brush in clean water and insert it into each hole 10 to 12 times. In the event that deposits have formed on the electrodes, it may be necessary to use a mild detergent (laboratory grade soap or bathroom foaming tile cleaner) with the brush. Rinse thoroughly with clean water, then check the response and accuracy of the conductivity cell with a calibration solution.
**SENSOR STORAGE**

**SHORT AND LONG TERM STORAGE**

For both short and long term storage, the conductivity sensor should be stored clean and dry.

Remove the batteries from the instrument when storing it for long periods of time (>30 days).

Long Term Storage Temperature: -5 to 70°C (23 to 158°F)

**TROUBLESHOOTING**

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instrument will not turn on, a battery symbol appears,</td>
<td>1. Low battery voltage, replace batteries.</td>
</tr>
<tr>
<td>or “Critical Shutdown” displays on the screen.</td>
<td>2. Batteries installed incorrectly, check battery polarity.</td>
</tr>
<tr>
<td></td>
<td>3. Return system for service.</td>
</tr>
<tr>
<td>Temperature values display Over or Undr on Run screen.</td>
<td>1. Sample temperature is less than -5°C or more than +55°C. Increase or decrease</td>
</tr>
<tr>
<td></td>
<td>the sample temperature to bring within the allowable range.</td>
</tr>
<tr>
<td></td>
<td>2. Contact YSI Tech Support.</td>
</tr>
<tr>
<td>Instrument will not calibrate the Conductivity sensor; instrument</td>
<td>1. Ensure the conductivity sensor is clean. Follow the cleaning procedures</td>
</tr>
<tr>
<td>displays “Calibration Over”,</td>
<td>in the Care, Maintenance and Storage section of this manual.</td>
</tr>
<tr>
<td>“Calibration Under”, or “Unstable Reading” during calibration.</td>
<td>2. Verify the calibration solution is above the two holes near the cable, see figure 8.</td>
</tr>
<tr>
<td></td>
<td>3. Verify the calibration solution is not expired or contaminated. Try a new bottle of solution.</td>
</tr>
<tr>
<td></td>
<td>4. Ensure you are entering in the correct value for the solution according to the measurement units. 1 mS = 1,000 uS.</td>
</tr>
<tr>
<td></td>
<td>5. Allow sufficient stabilization time for conductivity and temperature AND wait at least 3 seconds before confirming a calibration.</td>
</tr>
<tr>
<td></td>
<td>6. Contact YSI Tech Support.</td>
</tr>
</tbody>
</table>

Conductivity readings are inaccurate.

1. Ensure the conductivity sensor is clean. Follow the cleaning procedures in the Care, Maintenance and Storage section of this manual.
2. Verify the sample is above the two holes near the cable, see figure 8.
3. Verify calibration.
4. Verify temperature readings are accurate.
5. Verify the correct units are setup in the System Setup menu, i.e. uS vs mS and Conductivity vs. Specific Conductance.
6. Contact YSI Tech Support.

Conductivity values display Over or Undr on Run screen.

1. Ensure the conductivity sensor is clean. Follow the cleaning procedures in the Care, Maintenance and Storage section of this manual.
2. Verify the sample is above the two holes near the cable, see figure 8.
3. Verify calibration.
4. Verify temperature readings are accurate.
5. Sample conductivity is outside the measurement range of the instrument, i.e. 0-200 mS.
6. Contact YSI Tech Support.
**SPECIFICATIONS**

These specifications represent typical performance and are subject to change without notice. For the latest product specification information, please visit YSI’s website at www.ysi.com or contact YSI Tech Support.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
<th>Resolution</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>-5 to 55°C</td>
<td>0.1°C</td>
<td>± 0.2°C</td>
</tr>
<tr>
<td>Conductivity</td>
<td>0-500 μS/cm</td>
<td>0.0001 to 0.1 μS/cm</td>
<td>Instrument only: ± 0.5% of the reading or 1 μS/cm, whichever is greater. Instrument with 1 or 4 meter cables: ± 1.0% of the reading or 1 μS/cm, whichever is greater. Instrument with 10, 20, or 30 meter cables: ± 2.0% of the reading or 1 μS/cm, whichever is greater.</td>
</tr>
<tr>
<td></td>
<td>0-5 mS/cm</td>
<td>0.1 mS/cm</td>
<td>Instrument only: ± 0.5% of the reading or 1 μS/cm, whichever is greater. Instrument with 1 or 4 meter cables: ± 1.0% of the reading or 1 μS/cm, whichever is greater. Instrument with 10, 20, or 30 meter cables: ± 2.0% of the reading or 1 μS/cm, whichever is greater.</td>
</tr>
<tr>
<td></td>
<td>0-50 mS/cm</td>
<td>0.1 to 0 μS/cm (range dependent)</td>
<td>Instrument only: ± 0.5% of the reading or 1 μS/cm, whichever is greater. Instrument with 1 or 4 meter cables: ± 1.0% of the reading or 1 μS/cm, whichever is greater. Instrument with 10, 20, or 30 meter cables: ± 2.0% of the reading or 1 μS/cm, whichever is greater.</td>
</tr>
<tr>
<td></td>
<td>0-200 mS/cm (auto ranging)</td>
<td>0.1 to 0 μS/cm (range dependent)</td>
<td>Instrument only: ± 0.5% of the reading or 1 μS/cm, whichever is greater. Instrument with 1 or 4 meter cables: ± 1.0% of the reading or 1 μS/cm, whichever is greater. Instrument with 10, 20, or 30 meter cables: ± 2.0% of the reading or 1 μS/cm, whichever is greater.</td>
</tr>
<tr>
<td>Salinity</td>
<td>0 to 70 ppt</td>
<td>0.1 ppt</td>
<td>± 1.0% of the reading or ± 0.1 ppt, whichever is greater.</td>
</tr>
<tr>
<td>Total Dissolved Solids (TDS)</td>
<td>0 to 100 g/L. TDS Constant range: 0.3 to 1.00 (0.65 default)</td>
<td>0.0001 to 0.1 g/L (range dependent)</td>
<td>Dependent on accuracy of temperature, conductivity and TDS Constant.</td>
</tr>
</tbody>
</table>

**ACCESSORIES / PART NUMBERS**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6050030</td>
<td>Pro30 Instrument</td>
</tr>
<tr>
<td>60530-1, -4, -10, -20, or -30</td>
<td>1, 4, 10, 20, 30-meter cable assembly*</td>
</tr>
<tr>
<td>603077</td>
<td>Flow cell</td>
</tr>
<tr>
<td>603056</td>
<td>Flow cell mounting spike</td>
</tr>
<tr>
<td>603075</td>
<td>Carrying case, soft-sided</td>
</tr>
<tr>
<td>603074</td>
<td>Carrying case, hard-sided</td>
</tr>
<tr>
<td>603069</td>
<td>Belt clip</td>
</tr>
<tr>
<td>063517</td>
<td>Ultra clamp for instrument</td>
</tr>
<tr>
<td>063507</td>
<td>Tripod for instrument</td>
</tr>
<tr>
<td>603062</td>
<td>Cable management kit, included with all cables longer then 1 meter.</td>
</tr>
<tr>
<td>605978</td>
<td>Cable weight, 4.9 oz, stackable</td>
</tr>
<tr>
<td>603070</td>
<td>Shoulder strap</td>
</tr>
<tr>
<td>060907</td>
<td>Conductivity Calibration Solution, 1,000 μS/cm. 1 box of 8 pints.</td>
</tr>
<tr>
<td>060911</td>
<td>Conductivity Calibration Solution, 10,000 μS/cm. 1 box of 8 pints.</td>
</tr>
<tr>
<td>060660</td>
<td>Conductivity Calibration Solution, 50,000 μS/cm. 1 box of 8 pints.</td>
</tr>
<tr>
<td>065274</td>
<td>Conductivity Calibration Solution, 100,000 μS/cm. 1 box of 8 pints.</td>
</tr>
</tbody>
</table>

*All cables include a temperature and conductivity sensor.
DECLARATION OF CONFORMITY

The undersigned hereby declares on behalf of the named manufacturer under our sole responsibility that the listed product conforms to the requirements for the listed European Council Directive(s) and carries the CE mark accordingly.

Manufacturer: YSI Incorporated
1725 Brannum Lane
Yellow Springs, OH 45387
USA

Product Name: Pro30 Water Quality Instrument

Model Numbers

Instrument/Accessory: Pro30 (6050030)
Probe/Cable Assemblies: 60530-1, -4, -10, -20, and -30

Conforms to the following:

Directives:
- IEC 61326-1:2005
- RoHS 2002/95/EC
- WEEE 2002/96/EC
- IP-67 Protection per ANSI/IEC 60529-2004

Harmonized Standards:

Supplementary Information:
All performance met the operation criteria as follows:
1. ESD, IEC 61000-4-2:2001, Performance Criterion B
2. Radiated Immunity, IEC 61000-4-3, Performance Criterion A
4. Radio Frequency, Continuous Conducted Immunity, IEC61000-4-6, Performance Criterion A

Authorized EU Representative: YSI Hydrodata Ltd
Unit 2 Focal Point, Lacerta Court, Works Road
Letchworth, Hertfordshire, SG6 1FJ UK

Signed: Lisa M. Abel                    Date: 27 June 2011
Title: Director of Quality

RECYCLING

YSI is committed to reducing the environmental footprint in the course of doing business. Even though materials reduction is the ultimate goal, we know there must be a concerted effort to responsibly deal with materials after they’ve served a long, productive life-cycle. YSI’s recycling program ensures that old equipment is processed in an environmentally friendly way, reducing the amount of materials going to landfills.

- Printed Circuit Boards are sent to facilities that process and reclaim as much material for recycling as possible.
- Plastics enter a material recycling process and are not incinerated or sent to landfills.
- Batteries are removed and sent to battery recyclers for dedicated metals.

When the time comes for you to recycle, follow the easy steps outlined at www.ysi.com.

BATTERY DISPOSAL

The Pro30 is powered by alkaline batteries which the user must remove and dispose of when the batteries no longer power the instrument. Disposal requirements vary by country and region, and users are expected to understand and follow the battery disposal requirements for their specific locale.
CONTACT INFORMATION

ORDERING AND TECHNICAL SUPPORT

Telephone:  800 897 4151 (USA)
            +1 937 767 7241 (Globally)
            Monday through Friday, 8:00 AM to 5:00 ET

Fax:       +1 937 767 9353 (orders)
            +1 937 767 1058 (technical support)

Email:     environmental@ysi.com
Mail:       YSI Incorporated
            1725 Brannum Lane
            Yellow Springs, OH 45387  USA

Internet:  www.ysi.com

When placing an order please have the following available:
1.) YSI account number (if available)
2.) Name and phone number
3.) Purchase Order or Credit Card number
4.) Model Number or brief description
5.) Billing and shipping addresses
6.) Quantity

SERVICE INFORMATION

YSI has authorized service centers throughout the United States and Internationally. For the nearest service center information, please visit www.ysi.
com and click ‘Support’ or contact YSI Technical Support directly at 800-897-4151 (+1 937-767-7241).

When returning a product for service, include the Product Return form with cleaning certification. The form must be completely filled out for a YSI Service Center to accept the instrument for service. The form may be downloaded from www.ysi.com by clicking on the ‘Support’.

Item # 606082
Rev A
Drawing # A606082
July 2011

©2011 YSI Incorporated.
1. Push the CALIBRATION key to enter the Calibration mode. Follow the instructions on the display.
   Note: Gently invert each standard before inserting the standard.

2. Insert the 20 NTU StabiCal Standard and close the lid.
   Note: The standard to be inserted is bordered.

3. Push Read. The display shows Stabilizing and then shows the result.

4. Repeat Step 2 and 3 with the 100 NTU and 800 NTU StabiCal Standard.
   Note: Push Done to complete a 2 point calibration.

5. Push Done to review the calibration details.

6. Push Store to save the results. After a calibration is complete, the meter automatically goes into the Verify Cal mode. Refer to Calibration verification (Verify Cal) on page 16.

---

**Turbidity measurement**

---

**WARNING**

Potential explosion and fire hazard. This turbidimeter is designed for water based samples. Do not measure solvent or combustible based samples.

Readings can be taken with the Normal reading mode, Signal Average mode or in the Rapidly Settling Turbidity mode. Refer to Reading modes on page 16 for more information. For accurate turbidity readings use clean sample cells and remove air bubbles (degassing).

**Measurement notes**

Proper measurement techniques are important in minimizing the effects of instrument variation, stray light and air bubbles. Use the following measurement notes for proper measurements.

**Instrument**

- Make sure that the meter is placed on a level, stationary surface during the measurement.
  Note: Do not hold the meter in the hand during measurement.
- Always close the sample compartment lid during measurement, calibration and storage.
- Remove sample cell and batteries from the instrument if the instrument is stored for an extended time period (more than a month).
- Keep the sample compartment lid closed to prevent the entry of dust and dirt.

**Sample cells**

- Always cap the sample cell to prevent spillage of the sample into the instrument.
- Always use clean sample cells in good condition. Dirty, scratched or damaged cells can cause inaccurate readings.
- Make sure that cold samples do not “fog” the sample cell.
- Store sample cells filled with distilled or deionized water and cap tightly.

**Measurement**
• Measure samples immediately to prevent temperature changes and settling. Before a measurement is taken, always make sure that the sample is homogeneous throughout.
• Avoid sample dilution when possible.
• Avoid operation in direct sunlight.

**Turbidity measurement procedure**

*Note: Before a measurement is taken, always make sure that the sample is homogeneous throughout.*

1. Collect a representative sample in a clean container. Fill a sample cell to the line (about 15 mL). Take care to handle the sample cell by the top. Cap the cell.

2. Wipe the cell with a soft, lint-free cloth to remove water spots and fingerprints.

3. Apply a thin film of silicone oil. Wipe with a soft cloth to obtain an even film over the entire surface (Apply silicone oil to a sample cell on page 17).

4. Push the Power key to turn the meter on. Place the instrument on a flat, sturdy surface. *Note: Do not hold the instrument while making measurements.*

5. Gently invert and then insert the sample cell in the instrument cell compartment so the diamond or orientation mark aligns with the raised orientation mark in front of the cell compartment. Close the lid.

6. Push Read. The display shows Stabilizing then the turbidity in NTU (FNU). The result is shown and stored automatically (Refer to Data management on page 11).

**Data management**

**About stored data**

The following types of data are stored in the data log:

• Reading Log: stores automatically each time a sample reading is taken (500 records).
• Calibration Log: stores only when Store is selected at the end of a calibration (25 records).
• Verify Cal Log: stores only after Done is selected at the end of a verification calibration (250 records).

When the data log becomes full, the oldest data point is deleted when more data is added to the log.

**View data log**

The data log contains Reading Log, Calibration Log and Verify Cal log. All logs can be sorted by date.
## Manhole Inspection Form

### MANHOLE DETAILS

<table>
<thead>
<tr>
<th>Location</th>
<th>Material</th>
<th>MH Cover size</th>
<th>MH Barrel size</th>
<th>Direction Effluent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadway</td>
<td>Brick</td>
<td>22&quot;</td>
<td>48&quot;</td>
<td>NW</td>
</tr>
<tr>
<td>Gutter</td>
<td>Block</td>
<td>24&quot;</td>
<td>60&quot;</td>
<td></td>
</tr>
<tr>
<td>Paved Alley</td>
<td>Concrete</td>
<td>30&quot;</td>
<td>Other (below)</td>
<td></td>
</tr>
<tr>
<td>Unpaved Alley</td>
<td>Lined</td>
<td>36&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easement</td>
<td>Other</td>
<td>Other (describe)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### CONDITION

<table>
<thead>
<tr>
<th>Cover:</th>
<th>Ring &amp; Frame</th>
<th>Cone &amp; Riser</th>
<th>Barrel:</th>
<th>Rungs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serviceable</td>
<td>Serviceable</td>
<td>Serviceable</td>
<td>Serviceable</td>
<td>Serviceable</td>
</tr>
<tr>
<td>Loose</td>
<td>Loose</td>
<td>Cracked/Broken</td>
<td>Corroded</td>
<td>Corroded</td>
</tr>
<tr>
<td>Below Grade</td>
<td>Displaced</td>
<td>Misaligned</td>
<td>Infiltration</td>
<td>Infiltration</td>
</tr>
<tr>
<td>Damaged</td>
<td>Missing Gout</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sealed</td>
<td>Raise</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holes (# of holes)</td>
<td>Lower</td>
<td>Roots at Joints</td>
<td>Roots at Joints</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bench:</th>
<th>Channel:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serviceable</td>
<td>Serviceable</td>
</tr>
<tr>
<td>Cracked/Broken</td>
<td>Obstructed</td>
</tr>
<tr>
<td>Bad base joint</td>
<td>Bad joints</td>
</tr>
<tr>
<td>Roots at connection</td>
<td></td>
</tr>
</tbody>
</table>

### Hydraulics

<table>
<thead>
<tr>
<th>Indications of Surcharge?:</th>
<th>Issues:</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Grease</td>
</tr>
<tr>
<td>Minor</td>
<td>Debris</td>
</tr>
<tr>
<td>Yes, need followup</td>
<td>Silt</td>
</tr>
<tr>
<td>Infiltration, if yes, note below</td>
<td>Infiltration, if yes, note below</td>
</tr>
<tr>
<td>(None, Minor, Some, Excessive)</td>
<td>(None, Minor, Some, Excessive)</td>
</tr>
</tbody>
</table>

### Describes Flow:

<table>
<thead>
<tr>
<th>Describe Flow:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steady</td>
</tr>
<tr>
<td>Pulsing</td>
</tr>
<tr>
<td>Turbulent</td>
</tr>
<tr>
<td>Surfacing</td>
</tr>
<tr>
<td>Sluggish</td>
</tr>
</tbody>
</table>

### Comments:

[Blank space for comments]
APPENDIX G

Analytical Testing Methods – Impaired Waters
# Appendix G

**Massachusetts Small MS4 Permit Monitoring Requirements**

*For Discharges into Impaired Waters – Parameters and Methods*

<table>
<thead>
<tr>
<th>Pollutant Causing Impairment</th>
<th>Monitoring Parameter</th>
<th>EPA or Approved Method No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>Aluminum, Total</td>
<td>200.7; 200.8; 200.9</td>
</tr>
<tr>
<td>Ammonia (Un-ionized)</td>
<td>Ammonia – Nitrogen</td>
<td>350.1</td>
</tr>
<tr>
<td>Arsenic</td>
<td>Arsenic, Total</td>
<td>200.7; 200.8; 200.9</td>
</tr>
<tr>
<td>Cadmium</td>
<td>Cadmium, Total</td>
<td>200.7; 200.8; 200.9</td>
</tr>
<tr>
<td>Chlordane</td>
<td>NMR</td>
<td>608; 625</td>
</tr>
<tr>
<td>Chloride</td>
<td>Chloride</td>
<td>300</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>Chromium, Total</td>
<td>200.7; 200.8; 200.9</td>
</tr>
<tr>
<td>Copper</td>
<td>Copper, Total</td>
<td>200.7; 200.8; 200.9</td>
</tr>
<tr>
<td>DDT</td>
<td>NMR</td>
<td>608; 625</td>
</tr>
<tr>
<td>DEHP (Di-sec-octyl phthalate)</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Dioxin (including 2,3,7,8-TCDD)</td>
<td>NMR</td>
<td>613; 1613</td>
</tr>
<tr>
<td>Dioxin (2,3,7,8-Tetrachlorodibenzo-p-dioxin only)</td>
<td>NMR</td>
<td>613</td>
</tr>
<tr>
<td>Lead</td>
<td>Lead, Total</td>
<td>200.7; 200.8; 200.9</td>
</tr>
<tr>
<td>Mercury in Water Column</td>
<td>NMR unless potentially present such (e.g., salvage yards crushing vehicles with Hg switches)</td>
<td>200.7; 200.8; 200.9</td>
</tr>
<tr>
<td>Nitrogen (Total)</td>
<td>Nitrogen, Total</td>
<td>351.1/351.2 + 353.2</td>
</tr>
<tr>
<td>Pentachlorophenol (PCP)</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Petroleum Hydrocarbons</td>
<td>Oil and Grease</td>
<td>1664</td>
</tr>
<tr>
<td>Phosphorus (Total)</td>
<td>Phosphorus, Total</td>
<td>365.1; 365.2; 365.3; SM 4500-P-E</td>
</tr>
<tr>
<td>Polychlorinated biphenyls</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Polycyclic Aromatic Hydrocarbons (PAHs) (Aquatic Ecosystems)</td>
<td>PAHs</td>
<td>610; 1625</td>
</tr>
<tr>
<td>Sulfide-Hydrogen Sulfide</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Mercury in Fish Tissue</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>PCB in Fish Tissue</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>Total Dissolved Solids</td>
<td>160.1</td>
</tr>
<tr>
<td>Total Suspended Solids (TSS)</td>
<td>Total Suspended Solids</td>
<td>160.2, 180.1</td>
</tr>
<tr>
<td>Turbidity</td>
<td>Total Suspended Solids and Turbidity</td>
<td>160.2, 180.1</td>
</tr>
<tr>
<td>Secchi disk transparency</td>
<td>Total Suspended Solids</td>
<td>160.2</td>
</tr>
<tr>
<td>Sediment Screening Value (Exceedence)</td>
<td>Total Suspended Solids</td>
<td>160.2</td>
</tr>
<tr>
<td>Sedimentation/Siltation</td>
<td>Total Suspended Solids</td>
<td>160.2</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Bottom Deposits</td>
<td>Total Suspended Solids</td>
<td>160.2</td>
</tr>
<tr>
<td>Color</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>pH, High</td>
<td>pH</td>
<td>150.2</td>
</tr>
<tr>
<td>pH, Low</td>
<td>pH</td>
<td>150.2</td>
</tr>
<tr>
<td>Taste and Odor</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Temperature, water</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Salinity</td>
<td>Specific Conductance</td>
<td>120.1</td>
</tr>
<tr>
<td>Enterococcus</td>
<td>Enterococcus</td>
<td>1106.1; 1600; Enterolert® 12 22.</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>E. coli</td>
<td>1103.1; 1603; Colilert® 12 16, Colilert-18® 12 15 16.; mColiBlue-24®17.</td>
</tr>
<tr>
<td>Fecal Coliform</td>
<td>Fecal Coliform</td>
<td>1680; 1681</td>
</tr>
<tr>
<td>Organic Enrichment (Sewage)</td>
<td>Enterococcus (marine waters) or E. coli (freshwater)</td>
<td>1106.1; 1600</td>
</tr>
<tr>
<td>Debris/Floatables/Trash</td>
<td>NMR</td>
<td>or</td>
</tr>
<tr>
<td>Foam/Flocs/Scum/Oil Slicks</td>
<td>Contact MassDEP</td>
<td>1103.1; 1603</td>
</tr>
<tr>
<td>Oil and Grease</td>
<td>Oil and Grease</td>
<td>---</td>
</tr>
<tr>
<td>Chlorophyll-a</td>
<td>Total Phosphorus</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>(freshwater)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Nitrogen</td>
<td>1664</td>
</tr>
<tr>
<td></td>
<td>(marine waters)</td>
<td></td>
</tr>
<tr>
<td>Nutrient/Eutrophication</td>
<td>Total Phosphorus</td>
<td>365.1; 365.2; 365.3</td>
</tr>
<tr>
<td>Biological Indicators</td>
<td>(freshwater)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Nitrogen</td>
<td>351.1/351.2 + 353.2</td>
</tr>
<tr>
<td></td>
<td>(marine waters)</td>
<td></td>
</tr>
<tr>
<td>Dissolved oxygen saturation /</td>
<td>Dissolved Oxygen</td>
<td>365.1; 365.2; 365.3</td>
</tr>
<tr>
<td>Oxygen, Dissolved</td>
<td>Temperature</td>
<td>351.1/351.2 + 353.2</td>
</tr>
<tr>
<td></td>
<td>BOD5</td>
<td>360.1; 360.2</td>
</tr>
<tr>
<td></td>
<td>Total Phosphorus</td>
<td>SM-2550</td>
</tr>
<tr>
<td></td>
<td>(freshwater)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Nitrogen</td>
<td>SM-5210</td>
</tr>
<tr>
<td></td>
<td>(marine waters)</td>
<td></td>
</tr>
<tr>
<td>Excess Algal Growth</td>
<td>Total Phosphorus</td>
<td>365.1; 365.2; 365.3</td>
</tr>
<tr>
<td></td>
<td>(freshwater)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Nitrogen</td>
<td>351.1/351.2 + 353.2</td>
</tr>
<tr>
<td></td>
<td>(marine waters)</td>
<td></td>
</tr>
<tr>
<td>Aquatic Plants (Macrophytes)</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Abnormal Fish deformities, erosions, lesions, tumors (DELT)</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Abnormal Fish Histology (Lesions)</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Estuarine Bioassessments</td>
<td>Contact MassDEP</td>
<td>---</td>
</tr>
<tr>
<td>Fishes Bioassessments</td>
<td>Contact MassDEP</td>
<td>---</td>
</tr>
<tr>
<td>Aquatic Macroinvertebrate Bioassessments</td>
<td>Contact MassDEP</td>
<td>---</td>
</tr>
<tr>
<td>Combined Biota/Habitat Bioassessments</td>
<td>Contact MassDEP</td>
<td>---</td>
</tr>
<tr>
<td>Habitat Assessment (Streams)</td>
<td>Contact MassDEP</td>
<td>---</td>
</tr>
<tr>
<td>Lack of a coldwater assemblage</td>
<td>Contact MassDEP</td>
<td>---</td>
</tr>
<tr>
<td>Fish Kills</td>
<td>Contact MassDEP</td>
<td>---</td>
</tr>
<tr>
<td>Whole Effluent Toxicity (WET)</td>
<td>Contact MassDEP</td>
<td>---</td>
</tr>
<tr>
<td>Ambient Bioassays -- Chronic Aquatic Toxicity</td>
<td>Contact MassDEP</td>
<td>---</td>
</tr>
<tr>
<td>Sediment Bioassays -- Acute Toxicity Freshwater</td>
<td>Contact MassDEP</td>
<td>---</td>
</tr>
<tr>
<td>Sediment Bioassays -- Chronic Toxicity Freshwater</td>
<td>Contact MassDEP</td>
<td>---</td>
</tr>
<tr>
<td>Fish-Passage Barrier</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Alteration in stream-side or littoral vegetative covers</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Low flow alterations</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Other flow regime alterations</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Physical substrate habitat alterations</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Other anthropogenic substrate alterations</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Non-Native Aquatic Plants</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Eurasian Water Milfoil, Myriophyllum spicatum</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Zebra mussel, Dreissena polymorph</td>
<td>NMR</td>
<td>---</td>
</tr>
<tr>
<td>Other</td>
<td>Contact MassDEP</td>
<td>---</td>
</tr>
</tbody>
</table>

Notes:

NMR” indicates no monitoring required

“Total Phosphorus (freshwater)” indicates monitoring required for total phosphorus where stormwater discharges to a water body that is freshwater

“Total Nitrogen (marine water)” indicates monitoring required for total nitrogen where stormwater discharges to a water body that is a marine or estuarine water
APPENDIX H

Analytical Testing Parameters and Guidance
Appendix F: Analytical Procedures for Outfall Monitoring

Ammonia

Ammonia is a good indicator of sewage, since its concentration is much higher there than in groundwater or tap water. High ammonia concentrations may also indicate liquid wastes from some industrial sites. Ammonia is relatively simple and safe to analyze. Some challenges include the tendency for ammonia to volatilize (i.e., turn into a gas and become non-conservative) and its potential generation from non-human sources, such as pets or wildlife.

Boron

Boron is an element present in the compound borax, which is often found in detergent and soap formulations. Consequently, boron is a good potential indicator for both laundry wash water and sewage. Preliminary research from Alabama supports this contention, particularly when it is combined with other detergent indicators, such as surfactants (Pitt, IDDE Project Support Material). Boron may not be a useful indicator everywhere in the country since it may be found at elevated levels in groundwater in some regions and is a common ingredient in water softeners products. Program mangers should collect data on boron concentrations in local tap water and groundwater sources to confirm whether it will be an effective indicator of illicit discharges.

Chlorine

Chlorine is used throughout the country to disinfect tap water, except where private wells provide the water supply. Chlorine concentrations in tap water tend to be significantly higher than most other discharge types. Unfortunately, chlorine is extremely volatile, and even moderate levels of organic materials can cause chlorine levels to drop below detection levels. Because chlorine is non-conservative, it is not a reliable indicator, although if very high chlorine levels are measured, it is a strong indication of a water line break, swimming pool discharge, or industrial discharge from a chlorine bleaching process.

Color

Color is a numeric computation of the color observed in a water quality sample, as measured in cobalt-platinum units (APHA, 1998). Both industrial liquid wastes and sewage tend to have elevated color values. Unfortunately, some “clean” flow types can also have high color values. Field testing by Pitt (IDDE Project Support Material) found high color values associated for all contaminated flows, but also many uncontaminated flows, which yielded numerous false positives. Overall, color may be a good first screen for problem outfalls, but needs to be supplemented by other indicator parameters.

Conductivity

Conductivity, or specific conductance, is a measure of how easily electricity can flow through a water sample. Conductivity is often strongly correlated with the total amount of dissolved material in water, known as Total Dissolved Solids. The utility of conductivity as an indicator depends on whether concentrations are elevated in “natural” or clean waters. In particular, conductivity is a poor indicator of illicit discharge in estuarine waters or in northern regions where deicing salts are used (both have high conductivity readings).

Field testing in Alabama suggests that conductivity has limited value to detect sewage or wash water (Pitt, IDDE Project Support Material). Conductivity has some
value in detecting industrial discharges that can exhibit extremely high conductivity readings. Conductivity is extremely easy to measure with field probes, so it has the potential to be a useful supplemental indicator in subwatersheds that are dominated by industrial land uses.

**Detergents**

Most illicit discharges have elevated concentration of detergents. Sewage and washwater discharges contain detergents used to clean clothes or dishes, whereas liquid wastes contain detergents from industrial or commercial cleansers. The nearly universal presence of detergents in illicit discharges, combined with their absence in natural waters or tap water, makes them an excellent indicator. Research has revealed three indicator parameters that measure the level of detergent or its components—surfactants, fluorescence, and surface tension (Pitt, IDDE Project Support Material). Surfactants have been the most widely applied and transferable of the three indicators. Fluorescence and surface tension show promise, but only limited field testing has been performed on these more experimental parameters. Methods and laboratory protocols for each of the three detergent indicator parameters are reviewed in Appendix F2.

**E. coli, Enterococci and Total Coliform**

Each of these bacteria is found at very high concentrations in sewage compared to other flow types, and is a good indicator of sewage or septage discharges, unless pet or wildlife sources exist in the subwatershed. Overall, bacteria are good supplemental indicators and can be used to find “problem” streams or outfalls that exceed public health standards. Relatively simple analytical methods are now available to test for bacteria indicators, although they still suffer from two monitoring constraints. The first is the relatively long analysis time (18-24 hours) to get results, and the second is that the waste produced by the tests may be classified as a biohazard and require special disposal techniques.

**Fluorescence**

Laundry detergents are highly fluorescent because optical brighteners are added to the formula to produce “brighter whites.” Optical brighteners are the reason that white clothes appear to have a bluish color when placed under a fluorescent light. Fluorescence is a very sensitive indicator of the presence of detergents in discharges, using a fluorometer to measure fluorescence at specific wavelengths of light. Since no chemicals are needed for testing, fluorometers have minimal safety and waste disposal concerns.

Some technical concerns do limit the utility of fluorescence as an indicator of illicit discharges. The concerns include the presence of fluorescence in non-illicit flow types such as irrigation water, the considerable variation of fluorescence between different detergent brands, and the lack of a readily standard or benchmark concentration for optical brighteners. For example, Pitt (IDDE Project Support Material) measured fluorescence in mg/L of Tide™ brand detergent, and found the degree of fluorescence varied regionally, temporally, and between specific detergent formulations.

Given these current limitations, fluorescence is best combined with other detergent indicators such as surfactants. Appendix F3 should be consulted for more detailed information on analytical methods and experimental field testing using fluorescence as an indicator parameter.
Appendix F: Analytical Procedures for Outfall Monitoring

**Fluoride**

Fluoride is added to drinking water supplies in most communities to improve dental health, and normally found at a concentration of two parts per million in tapwater. Consequently, fluoride is an excellent conservative indicator of tap water discharges or leaks from water supply pipes that end up in the storm drain. Fluoride is obviously not a good indicator in communities that do not fluoridate drinking water, or where individual wells provide drinking water. One key constraint is that the reagent used in the recommended analytical method for fluoride is considered a hazardous waste, and must be disposed of properly.

**Hardness**

Hardness measures the positive ions dissolved in water and primarily include magnesium and calcium in natural waters, but are sometimes influenced by other metals. Field testing by Pitt (IDDE Project Support Material) suggests that hardness has limited value as an indicator parameter, except when values are extremely high or low (which may signal the presence of some liquid wastes). Hardness may be applicable in communities where hardness levels are elevated in groundwater due to karst or limestone terrain. In these regions, hardness can help distinguish natural groundwater flows present in outfalls from tap water and other flow types.

**pH**

Most discharge flow types are neutral, having a pH value around 7, although groundwater concentrations can be somewhat variable. pH is a reasonably good indicator for liquid wastes from industries, which can have very high or low pH (ranging from 3 to 12). The pH of residential wash water tends to be rather basic (pH of 8 or 9). The pH of a discharge is very simple to monitor in the field with low cost test strips or probes. Although pH data is often not conclusive by itself, it can identify problem outfalls that merit follow-up investigations using more effective indicators.

**Potassium**

Potassium is found at relatively high concentrations in sewage, and extremely high concentrations in many industrial process waters. Consequently, potassium can act as a good first screen for industrial wastes, and can also be used in combination with ammonia to distinguish wash waters from sanitary wastes. (See Chapter 12). Simple field probes can detect potassium at relatively high concentrations (5 mg/L), whereas more complex colorimetric tests are needed to detect potassium concentrations lower than 5 mg/L.

**Surface Tension**

Surfactants remove dirt particles by reducing the surface tension of the bubbles formed in laundry water when it is agitated. Reduced surface tension makes dirt particles less likely to settle on a solid surface (e.g., clothes or dishes) and become suspended instead on the water’s surface. The visible manifestation of reduced surface tension is the formation of foam or bubbles on the water surface. Pitt (IDDE Project Support Material) tested a very simple procedure to measure surface tension that quantifies the formation of foam and bubbles in sample bottles. Initial laboratory tests suggest that surface tension is a good indicator of surfactants, but only when they are present at relatively high concentrations. Section F3 provides a more detailed description of the surface tension measurement procedure.
**Surfactants**

Surfactants are the active ingredient in most commercial detergents, and are typically measured as Methyl Blue Active Substances (or MBAS). They are a synthetic replacement for soap, which builds up deposits on clothing over time. Since surfactants are not found in nature, but are always present in detergents, they are excellent indicators of sewage and wash waters. The presence of surfactants in cleansers, emulsifiers and lubricants also makes them an excellent indicator of industrial or commercial liquid wastes. In fact, research by Pitt (IDDE Project Support Material) found that detergents were an excellent indicator of “contaminated” discharges in Alabama (i.e., discharges that were not tap water or groundwater). Several analytical methods are available to monitor surfactants. Unfortunately, the reagents used involve toluene, chloroform, or benzene, each of which is considered a hazardous waste with a potential human health risk. The most common analysis method uses chloroform as a reagent, and is recommended because it is relatively safer when compared to other reagents.

**Turbidity**

Turbidity is a quantitative measure of cloudiness in water, and is normally measured with a simple field probe. While turbidity itself cannot always distinguish between contaminated flow types, it is a potentially useful screening indicator to determine if the discharge is contaminated (i.e., not composed of tap water or groundwater).

**Research Indicators**

In recent years, researchers have explored a series of other indicators to identify illicit discharges, including fecal steroids (such as coprostanol), caffeine, specific fragrances associated with detergents and stable isotopes of oxygen. Each of these research indicators is profiled in Pitt (IDDE Project Support Material) and summarized below in Table F1. Most research indicators require sophisticated equipment and specific expertise that limit their utility as a general indicator, given the high sampling cost and long turn-around times needed. To date, field tests of research indicators have yielded mixed results, and they are currently thought to be more appropriate for special research projects than for routine outfall testing. While they are not discussed further in this manual, future research and testing may improve their utility as indicators of illicit discharges.
<table>
<thead>
<tr>
<th>Parameter Group</th>
<th>Comments</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coprostanol and other fecal sterol compounds</td>
<td>Used to indicate presence of sanitary sewage</td>
<td>Possibly useful. Expensive analysis with GC/MSD. Not specific to human wastes or recent contamination. Most useful when analyzing particulate fractions of wastewaters or sediments.</td>
</tr>
<tr>
<td>Specific detergent compounds (LAS, fabric whiteners, and perfumes)</td>
<td>Used to indicate presence of sanitary sewage</td>
<td>Possibly useful. Expensive analyses with HPLC. A good and sensitive confirmatory method.</td>
</tr>
<tr>
<td>Pharmaceuticals (colfibrin acid, aspirin, ibuprofen, steroids, illegal drugs, etc.)</td>
<td>Used to indicate presence of sanitary sewage</td>
<td>Possibly useful. Expensive analyses with HPLC. A good and sensitive confirmatory method.</td>
</tr>
<tr>
<td>Caffeine</td>
<td>Used to indicate presence of sanitary sewage</td>
<td>Not very useful. Expensive analyses with GC/MSD. Numerous false negatives, as typical analytical methods not suitably sensitive.</td>
</tr>
<tr>
<td>DNA profiling of microorganisms</td>
<td>Used to identify sources of microorganisms</td>
<td>Likely useful, but currently requires extensive background information on likely sources in drainage. Could be very useful if method can be simplified, but with less specific results.</td>
</tr>
<tr>
<td>UV absorbance at 228 nm</td>
<td>Used to identify presence of sanitary sewage</td>
<td>Possibly useful, if UV spectrophotometer available. Simple and direct analyses. Sensitive to varying levels of sanitary sewage, but may not be useful with dilute solutions. Further testing needed to investigate sensitivity in field trials.</td>
</tr>
<tr>
<td>Stable isotopes of oxygen</td>
<td>Used to identify major sources of water</td>
<td>May be useful in area having distant domestic water sources and distant groundwater recharge areas. Expensive and time consuming procedure. Can not distinguish between wastewaters if all have common source.</td>
</tr>
</tbody>
</table>

GC/MSD - Gas Chromatography/Mass Selective Detector
HPLC - High Performance Liquid Chromatography
Appendix F2: “Off-the Shelf” Analytical Methodologies
F2.1 Ammonia (0 to 0.50 mg/L NH₃-N)

Equipment/Supplies Needed
- Hach bench top or portable spectrophotometer or colorimeter (see ordering information below)
- ammonia nitrogen reagent set for 25-mL samples
- ammonia nitrogen standard solution

Procedure
Refer to Hach method 8155 for Nitrogen, Ammonia Salicylate Method (0 to 0.50 mg/L NH₃-N) for a 25mL sample. In this method, ammonia compounds combine with chlorine to form monochloramine. Monochloramine reacts with salicylate to form 5-aminosalicylate. The 5-aminosalicylate is oxidized in the presence of sodium nitroprusside catalyst to form a blue-colored compound. The blue color is masked by the yellow color from the excess reagent present to give a final green-colored solution.

Duration of Test for Each Sample
Because of the duration of this test, samples should be run in batches of about six. From start to finish, each batch of six samples takes about 25 minutes, including the time taken to clean the sample cells and reset the instrument between each batch.

Hazardous Reagents
According to good laboratory practice, the contents of each sample cell, after the analysis, should be poured into another properly-labeled container for proper disposal.

Ease of Analysis
This procedure is time-consuming and should be performed indoors.

Ordering Information
Vendor: Hach Company
PO Box 389
Loveland, CO 80539-0389
Tel: 800-227-4224
Fax: 970-669-2932
Website: www.hach.com

[Note: The direct-Nessler method may be preferred due to its faster reaction times, but Nessler reagent is toxic and corrosive. Nessler reagent, according to its MSDS, causes severe burns, is an acute and a cumulative poison, and is a teratogen. It also contains from 5 to 10% mercuric iodide. It is now recommended that the more sensitive salicylate method because of the lower concentrations experienced in this research, and because of its lower toxicity and easier disposal requirements. The salicylate method was therefore used for this project, although prior research found it to be somewhat less satisfactory than the Nessler method.]

<table>
<thead>
<tr>
<th>Equipment/Supplies Needed for Ammonia Analysis</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>One of the colorimeters, or spectrophotometers, listed previously will be needed. Alternatively, a dedicated colorimeter can be used, but that will only be useable for a single analyte.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ammonia-Nitrogen Reagent Set (25mL test) salicylate method (2243700)</td>
<td>1 set of 100 tests</td>
<td>$180.56</td>
</tr>
<tr>
<td>Ammonia cyanurate reagent powder pillows (2395566)</td>
<td>1 pk of 50 pillows</td>
<td>$ 20.20</td>
</tr>
<tr>
<td>Ammonia salicylate reagent powder pillows (2395366)</td>
<td>1 pk of 50 pillows</td>
<td>$ 25.55</td>
</tr>
</tbody>
</table>
F2.2 BORON (Low range 0 to 1.50 mg/L as B)

**Equipment/Supplies Needed**
- A Hach bench top or portable spectrophotometer or colorimeter (see ordering information below)
- Boron test kit
- 1-inch plastic sample cells (at least 2).

**Procedure**
Refer to Hach Azomethine-H Method 10061, which is adapted from ISO method 9390. In this procedure, Azomethine-H, a Schiff base, is formed by the condensation of an aminonaphthol with an aldehyde by the catalytic action of boron. The boron concentration in the sample is proportional to the developed color. Follow the Hach instructions that come with the reagent set for the specific procedure.

**Duration of Test for Each Sample**
Each batch of six samples takes approximately 20 minutes.

**Hazardous Reagents**
Standard laboratory practice requires that all unwanted chemicals be properly disposed.

**Ease of Analysis**
The procedure is a little time consuming, but several samples can be analyzed together.

**Ordering Information**
Vendor: Hach Company
PO Box 389
Loveland, CO 80539-0389
Tel: 800-227-4224
Fax: 970-669-2932
Website: [www.hach.com](http://www.hach.com)

---

<table>
<thead>
<tr>
<th>Item (Catalog Number)</th>
<th>Quantity</th>
<th>Price*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boron Test Kit (0-1.5 mg/L) BoroTrace (Azomethine-H) Method (2666900)</td>
<td>1 set of 100 tests</td>
<td>$50.00</td>
</tr>
<tr>
<td>BoroTrace 2 reagent (2666669)</td>
<td>1 pk of 100 pillows</td>
<td>$30.00</td>
</tr>
<tr>
<td>BoroTrace 3 reagent (2666799)</td>
<td>1 pk of 100 pillows</td>
<td>$20.65</td>
</tr>
<tr>
<td>EDTA Solution 1M (2241925)</td>
<td>50 mL</td>
<td></td>
</tr>
<tr>
<td>DR/890 portable colorimeter</td>
<td>1</td>
<td>$929.00</td>
</tr>
<tr>
<td>DR/2500 spectrophotometer</td>
<td>1</td>
<td>$2200.00</td>
</tr>
<tr>
<td>DR/2400 portable spectrophotometer</td>
<td>1</td>
<td>$1,995.00</td>
</tr>
<tr>
<td>DR/4000 V Spectrophotometer</td>
<td>1</td>
<td>$5500.00</td>
</tr>
</tbody>
</table>

*Only one spectrophotometer is needed
*The per-sample expendable cost is therefore about $2.00.
F2.3 **COLOR (0 – 100 APHA Platinum Cobalt Units)**

**Equipment/Supplies needed**
One Hach color test kit Model CO-1 which measures color using a color disc for comparison.

**Procedure**
The following procedure is described in the test kit.

**Low Range**
1. Place the lengthwise viewing adapter in the comparator.
2. Fill one sample tube to the line underlining “Cat. 1730-00” with the sample. This will be approximately 15mL. If not using 1730-00 tubes, fill to the line founds at approximately 3 inches up from the bottom of the tube.
3. Place the tube containing the water sample into the comparator in the right-hand position.
4. Fill the other sample tube with colorless water to the line underlining “Cat. 1730-00.” Insert this tube in the left-side comparator opening.
5. Hold the comparator with the tube tops pointing to a window or light source at approximately a 45 degree angle (with the light coming in through the top of the tubes). View through the openings in the front of the comparator. When viewing, use care to not spill samples from unstoppered tubes.

6. Rotate the disc until a color match is obtained. The reading obtained through the scale window is the apparent color in APHA Platinum Cobalt Units.

**High Range**
1. If the lengthwise viewing adapter is in place, remove it.
2. Fill one of the tubes to the 5mL mark with the water sample.
3. Insert the tube in the right top opening of the comparator.
4. Fill the other tube to the 5mL mark with clear water and insert this tube into the left opening of the comparator.
5. Hold the comparator up to a light source as explained above. The reading obtained through the scale window is multiplied by 5 to obtained the apparent color.

**Duration of Test for Each Sample**
One minute

**Hazardous Reagents**
None.

**Ease of Analysis**
This procedure easy and fast and can be performed outside of the laboratory.

**Ordering Information**
**Vendor:** Hach Company  
PO Box 389  
Loveland, CO 80539-0389  
Tel: 800-227-4224  
Fax: 970-669-2932  
Website: [www.hach.com](http://www.hach.com)

<table>
<thead>
<tr>
<th>Equipment/Supplies Needed for Color Analysis</th>
<th>Item (Catalog Number)</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Color Test Kit (0-100 mg/L) (223400)</td>
<td>one kit</td>
<td>$51.50</td>
</tr>
</tbody>
</table>
F2.4 CONDUCTIVITY

Equipment/Supplies Needed
- Cardy pocket-sized conductivity meter model B-173 made by Horiba
- Conductivity standard that comes with the meter.

Calibration
Before any measurements can be performed the instrument must first be calibrated. The meter should hold its calibration for an extended period, but it is best to check the calibration before each sample batch.
1. Press the POWER button.
2. Place a drop of the 1.41 µS/cm standard solution onto the sensor cell.
3. Press the CAL/MODE button to display the CAL mark and 1.41. Calibration is complete when the CAL mark disappears.
4. Wash the sensor with tap water, and dry with a tissue.

Measurement
1. Check first to see which mode the instrument is in by looking for the arrow pointing at the mS/cm or µS/cm.
2. Add a drop of the sample onto the sensor cell using a pipette (or the sensor may be immersed into the sample).
3. When the smiley face ☻ appears, take a reading. Be sure to note the units.

Duration of Test for Each Sample
1 minute

Hazardous Reagents
None

Ease of Analysis
Simple and fast. Can be used in the field.

Ordering Information
Vendor: Cole-Parmer Instrument Company
625 East bunker Court
Vernon Hills, IL 60061-1844
Phone: 1-800-323-4340
FAX: 847-247-2929
Website: www.coleparmer.com

<table>
<thead>
<tr>
<th>Equipment/Supplies Needed for Conductivity Analysis</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardy pocket-sized conductivity meter and accessories (EW-05751-10)</td>
<td>$269.00</td>
</tr>
<tr>
<td>Replacement cardy conductivity sensor cartridge (EW-05751-52)</td>
<td>$ 82.00</td>
</tr>
<tr>
<td>Replacement cardy conductivity solution kit (EW-05751-70)</td>
<td>$ 43.00</td>
</tr>
</tbody>
</table>
F2.5 **Detergents** (0-3 ppm)

**Equipment/Supplies needed**
- Detergents (anionic surfactants) kit from CHEMetrics.

**Procedure**
The following procedure comes with the Detergents kit. The Detergents CHEMets® test employs the methylene blue extraction method. Anionic detergents react with methylene blue to form a blue complex that is extracted into an immiscible organic solvent. The intensity of the blue color is directly related to the concentration of “methylene blue active substances (MBAS)” in the sample. Anionic detergents are one of the most prominent methylene blue active substances. Test results are expressed in mg/L linear alkylbenzene sulfonate.

1. Rinse the reaction tube with sample, and then fill it to the 5 mL mark with sample.
2. While holding the double-tipped ampoule in a vertical position, snap the upper tip using the tip-breaking tool.
3. Invert the ampoule and position the open end over the reaction tube. Snap the upper tip and allow the contents to drain into the reaction tube.
4. Cap the reaction tube and shake it vigorously for 30 seconds. Allow the tube to stand undisturbed for approximately 1 minute.
5. Make sure that the flexible tubing is firmly attached to the CHEMet ampoule tip.
6. Insert the CHEMet assembly (tubing first) into the reaction tube making sure that the end of the flexible tubing is at the bottom of the tube. Break the tip of the CHEMet ampoule by gently pressing it against the side of the reaction tube. The ampoule should draw in fluid only from the organic phase (bottom layer).
7. When filling is complete, remove the CHEMet assembly from the reaction tube.
8. Invert the ampoule several times, allowing the bubble to travel from end to end each time.
9. Using a tissue, remove the tubing from the ampoule tip. Wipe all liquid from the exterior of the ampoule, then place a small white cap firmly onto the tip of the ampoule.
10. Place the CHEMet ampoule, flat end downward into the center tube of the comparator. Direct the top of the comparator up toward a source of bright light while viewing from the bottom. Rotate the comparator until the color standard below the CHEMet ampoule shows the closest match. If the color of the CHEMet ampoule is between two color standards, a concentration estimate can be made.

**Duration of Test for Each Sample**
Approximately 7 minutes per sample.

**Hazardous Reagents**
The main components of the double-tipped ampoule are considered hazardous, and possibly carcinogenic (contains chloroform). The used ampoule should be placed back in the test kit box for later disposal at a hazardous waste facility. Use proper safety protection when performing this test: laboratory coat, gloves, and safety glasses. It is also strongly recommended that the test be performed under a laboratory fume hood. Wash hands thoroughly after handling the kit.
Appendix F: Analytical Procedures for Outfall Monitoring

**Ease of Analysis**
This procedure may be performed outside of a standard laboratory, if well ventilated. Produces hazardous chemicals.

**Ordering Information**
Vendor: CHEMetrics, Inc
4295 Catlett Rd
Calverton, VA 20138
Phone 1-800-356-3072
FAX 1-540-788-4856
Website: www.chemetrics.com

<table>
<thead>
<tr>
<th>Equipment/Supplies Needed for Detergents Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item (Catalog Number)</td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>Detergent kit (anionic surfactants) (K-9400)</td>
</tr>
<tr>
<td>Detergent kit refill (R-9400)</td>
</tr>
</tbody>
</table>

*The per-sample expendable cost is therefore $2.52.
F2.6  _E. coli_

**Equipment/Supplies Needed**
- Colilert reagent, sterile sample bottles for 100 mL samples
- Quanti-Tray 2000
- Colilert comparator predispensed in a Quanti-Tray/2000 incubator
- UV light from IDEXX.

**Enumeration Procedure**
1. Add contents of one Colilert snap pack to a 100 mL room temperature water sample in a sterile vessel. The standard Colilert reagent is recommended when evaluating Enterococci simultaneously so the samples are both ready to read in 24 hours. If only _E. coli_ are to be evaluated, then the faster Colilert-18 reagent can be used if reading the results in 18 hours instead of 24 hours is important.
2. Cap vessel and shake until dissolved.
3. Pour sample/reagent mixture into a Quanti-Tray/2000 and seal in an IDEXX Quanti-Tray Sealer.
4. Place the sealed tray in a 35±0.5°C incubator for 24 hours.
5. Read results according to the Results Interpretation table below. Count the number of positive wells and refer to the MPN table provided with the Quanti-Trays to obtain a Most Probable Number.

**Results Interpretation**

<table>
<thead>
<tr>
<th>Appearance</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less yellow than the comparator</td>
<td>Negative for total coliforms and <em>E. coli</em></td>
</tr>
<tr>
<td>Yellow equal to or greater than the comparator</td>
<td>Positive for total coliforms</td>
</tr>
<tr>
<td>Yellow and fluorescence equal to or greater than the comparator</td>
<td>Positive for <em>E. coli</em></td>
</tr>
</tbody>
</table>

**Duration of Test for Each Sample**
Once the Quanti-Tray sealer is warm (10 min), it takes approximately 5 minutes per sample to label, seal and incubate the Quanti-Tray. After 24 hours, it takes 1-2 minutes to read the sample results under the UV lamp.

**Hazardous Reagents**
Used Quanti-Trays must be disposed of in a biohazard bag and handled by appropriate biohazard disposal facility, using similar practices as for alternative bacteria analysis methods.

**Ease of Analysis**
Not a difficult procedure to learn. Knowledge of proper handling of bacterial specimens is necessary. Cannot be performed in the field.

**Ordering Information**
Vendor:  IDEXX
1 IDEXX Drive
Westbrook, ME  04092
Phone: 1-800-321-0207
Fax: 207-856-0630
E-mail: water@idexx.com
Website: www.idexx.com/water

Appearance
Result
Less yellow than the comparator Negative for total coliforms and _E. coli_
Yellow equal to or greater than the comparator Positive for total coliforms
Yellow and fluorescence equal to or greater than the comparator Positive for _E. coli_
## Equipment/Supplies Needed for E. coli Analysis

<table>
<thead>
<tr>
<th>Item (Catalog Number)</th>
<th>Quantity</th>
<th>Price*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colilert reagent for 100mL sample (WP200)</td>
<td>200-pack</td>
<td>$1,020.00</td>
</tr>
<tr>
<td>120mL vessel with 100mL line, sodium thiosulfate &amp; label</td>
<td>200-pack</td>
<td>$90.00</td>
</tr>
<tr>
<td>(WV120ST-200)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>97-well sterile Quanti-Tray/2000 trays (WQT-2K)</td>
<td>100-pack</td>
<td>$110.00</td>
</tr>
<tr>
<td>Quality control kit (E. coli, Klebsiela, Pseudomonas A).</td>
<td>n/a</td>
<td>$120.00</td>
</tr>
<tr>
<td>(WKT1001)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colilert comparator predispensed in a Quanti-Tray/2000</td>
<td>1</td>
<td>$6.00</td>
</tr>
<tr>
<td>(WQT2KC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quanti-Tray Sealer (115V) with 51-well rubber insert (WQTS2X-115)</td>
<td>1</td>
<td>$3,500.00</td>
</tr>
<tr>
<td>6 watt UV lamp 110 volt (WL160)</td>
<td>1</td>
<td>$89.00</td>
</tr>
<tr>
<td>Incubator 120V, 30-65°C, 14&quot;x14&quot;x14&quot; (W1300)</td>
<td>2</td>
<td>$389.00</td>
</tr>
</tbody>
</table>

*See the Enterococci table above for equipment that can be shared when conducting both analyses.

*The per-sample expendable cost (reagent, bottle, and tray) is about $6.65.
Appendix F: Analytical Procedures for Outfall Monitoring

F2.7 ENTEROCOCCI

**Equipment/Supplies Needed**
- Enterolert reagent
- Sterile sample bottles for 100 mL samples
- Quanti-Tray 2000
- Incubator
- UV light from IDEXX

**Enumeration Test Procedure**
1. Carefully separate a Snap Pack from its strip, taking care not to accidentally open the next pack.
2. Tap the reagent snap pack to ensure that all of the Enterolert powder is in the bottom part of the pack.
3. Open the pack by snapping back the top at the score line. Caution: Do not touch the opening of the pack.
4. Add the reagent to a 100 mL water sample in a sterile bottle.
5. Aseptically cap and seal the vessel.
6. Shake to completely dissolve reagent.
7. Pour the sample/reagent mixture into a Quanti-Tray avoiding contact with the foil pull tab. Seal the tray according to Quanti-Tray instructions.
8. Incubate for 24 hours at 41\(^\circ\)±5\(^\circ\) C.
9. Read the results at 24 hours by placing a 6 watt, 365 nm wavelength UV light within five inches of the Quanti-Tray in a dark environment. Be sure the light is facing away from your eyes and toward the Quanti-Tray. Count the number of fluorescent Quanti-Tray wells. The fluorescence intensity of positive wells may vary.
10. Refer to the MPN table provided with the Quanti-Tray to determine the Most Probable Number of Enterococci in your sample.

**Procedural Notes**
If the sample is inadvertently incubated over 28 hours without observation, the following guidelines apply:
- Lack of fluorescence after 28 hours is a valid negative test
- Fluorescence after 28 hours is an invalid result
- Use sterile water, not buffered water for making dilutions. Enterolert is already buffered. Always add Enterolert to the proper volume of diluted sample after making dilutions.
- For comparison, a water blank can be used when interpreting results.

**Duration of Test for Each Sample**
Once the Quanti-Tray sealer is warm (10 min), it takes approximately 5 minutes per sample to mix, label, seal and place the Quanti-Tray in the incubator. After 24 hours, it takes 1-2 minutes to read the sample results under the UV lamp.

**Hazardous Reagents**
Used Quanti-Trays must be disposed of in a biohazard bag and handled by appropriate biohazard disposal facility, just like any other bacteria analysis materials.

**Ease of Analysis**
Not difficult procedure to learn. Knowledge of proper handling of bacterial specimens is necessary. Cannot be performed in the field.

**Ordering Information**
Vendor: IDEXX

1 IDEXX Drive  
Westbrook, ME  04092  
Phone: 1-800-321-0207  
Fax: 207-856-0630  
E-mail: water@idexx.com  
Website: www.idexx.com/water
### Equipment/Supplies Needed for Enterococci Analysis

<table>
<thead>
<tr>
<th>Item (Catalog Number)</th>
<th>Quantity</th>
<th>Price*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enteroletert reagent for 100 mL samples (WENT200)</td>
<td>200-pack</td>
<td>$1,020.00</td>
</tr>
<tr>
<td>120 mL pre-sterilized vessel with 100 mL line, sodium thiosulfate &amp; label (WV120ST-200)</td>
<td>200-pack</td>
<td>$90.00</td>
</tr>
<tr>
<td>97-well sterile Quanti-Tray/2000 trays (WQT-2K)</td>
<td>100-pack</td>
<td>$110.00</td>
</tr>
<tr>
<td>Quality control kit (E. coli, Klebsiela, Pseudomonas A). (WKT 1001)</td>
<td>n/a</td>
<td>$120.00</td>
</tr>
<tr>
<td>Quanti-Tray Sealer (115V) with 51-well rubber insert (WQTS2X-115)</td>
<td>1</td>
<td>$3,500.00</td>
</tr>
<tr>
<td>6 watt UV lamp 110 volt (WL160)</td>
<td>1</td>
<td>$89.00</td>
</tr>
<tr>
<td>Incubator 120V, 30-65°C, 14”x14”x14” (WI300)</td>
<td>2</td>
<td>$389.00</td>
</tr>
</tbody>
</table>

1. Same expendable materials as for the E. coli method, additional should be ordered for each method
2. Same as for the E. coli method and can be shared
3. Although the same, a second incubator is needed for the E. coli method because of the different temperature settings and the normal need to evaluate Enterococci and E. coli simultaneously

*The per-sample expendable cost (reagent, bottle, and tray) is about $6.65.
F2.8 FLUORIDE (0 TO 2.00 MG/L F\(^{-}\))

**Equipment/Supplies Needed**
- Hach bench top or portable spectrophotometer or colorimeter (see ordering information below)
- AccuVac Vial Adaptor (for older spectrophotometers)
- SPADNS Fluoride Reagent AccuVac Ampuls.

**Procedure**
Refer to Hach SPADNS Method 8029 which is adapted from Standard Methods for the Examination of Water and Wastewater. This procedure involves the reaction of fluoride with a red zirconium-dye solution. The fluoride combines with part of the zirconium to form a colorless complex, thus bleaching the red color in an amount proportional to the fluoride concentration.

**Duration of Test for Each Sample**
Each sample takes an average of 3 minutes to test.

---

### Hazardous Reagents
The SPANDS reagent is a hazardous solution. The used AccuVacs should be placed back in the Styrofoam shipping container for storage and then disposed properly through a hazardous waste disposal company.

### Ease of Analysis
The procedure is relatively easy and fast and can be performed in the field using a portable spectrophotometer or colorimeter. However, as for all tests, it is recommended that the analyses be conducted in a laboratory, or at least in a work room having good lighting and water.

### Ordering Information
**Vendor:** Hach Company  
PO Box 389  
Loveland, CO 80539-0389  
Tel: 800-227-4224  
Fax: 970-669-2932  
Website: www.hach.com

---

### Equipment/Supplies Needed for Fluoride Analysis

<table>
<thead>
<tr>
<th>Item (Catalog Number)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluoride Reagent (SPADNS) AccuVac Ampuls [1 set of 25 AccuVacs (2 needed per test)] (2506025)</td>
<td>$17.00</td>
</tr>
<tr>
<td>Adapter, AccuVac vial (needed for older spectrophotometers DR/2000 and DR/3000) (43784-00)</td>
<td>$5.40</td>
</tr>
<tr>
<td>DR/890 portable colorimeter programmed with 90 tests. Includes 2 sample cells, COD &amp; TnT tube adapter, instrument, procedure manual and batteries. Portable instrument that can be used for many different analytes, but fewer than the following instruments. (48470000)</td>
<td>$929.00</td>
</tr>
<tr>
<td>DR/2500 spectrophotometer includes 6 one-inch round sample cells, instrument and procedure manual, and DR/Check Absorbance Standards. Compact laboratory instrument having many capabilities. (59000000)</td>
<td>$2,200.00</td>
</tr>
<tr>
<td>DR/2400 portable spectrophotometer includes one-inch sample cells, instrument and procedures manuals. Portable instrument having many capabilities. (59400000)</td>
<td>$1,995.00</td>
</tr>
<tr>
<td>DR/4000 V Spectrophotometer. Visible spectrum only (320 to 1100nm). Includes 1-inch matched sample cells/ AccuVacc and 16-mm vial adapters; a Single Cell Module; 1-inch and 1-cm cell adapters; dust cover; replacement lamp kit; an illustrated manual set; and a power cord. UV-Vis laboratory instrument having vast capabilities. (48100-00)</td>
<td>$5,500.00</td>
</tr>
</tbody>
</table>

*only one spectrophotometer is needed*  
*The per-sample expendable cost is about $1.36.*
Appendix F: Analytical Procedures for Outfall Monitoring

F2.9 pH

Equipment/Supplies Needed
- Cardy pocket-sized pH meter model B-213 made by Horiba
- pH standards that come with the meter.

Calibration
The meter should hold its calibration for an extended period, but it is best to check the calibration before each sample batch.
1. Press the ON/OFF button.
2. Place approximately 1 mL of the yellow pH 7.0 standard solution onto the sensor cell (be careful not to touch the sensor with the dropper or pipette, the cell is covered with a very thin and fragile glass cover slip).
3. Press the CAL button to display the black CAL mark in the upper right corner and 7.0.
4. Calibration is complete when the CAL mark disappears. Wash the sensor with tap or distilled water and dry with a tissue.
5. Press CAL again so that 4.01 and CAL are displayed to calibrate using the pink pH 4.01 buffer. Follow the same procedure as above.

Measurement
1. Place a drop of the sample water onto the sensor cell (usually around 1 mL). Alternatively, you may dip the meter into the water to be tested.
2. When the smiley face ✨ appears, read the number.
3. Press the ON/OFF button to turn the power OFF.
4. Wash the sensor with tap water or distilled water. Wipe off any residual water on the sensor with a tissue.
5. Be sure the protective cap is covering the sensor and put the pH meter back in its protective case.

Duration of Test for Each Sample
Calibration takes around 3 minutes, and testing of each sample is only about 30 seconds.

Hazardous Reagents
None

Ease of Analysis
Simple and fast. Can be used in the field.

Ordering Information
Vendor: Cole-Parmer Instrument Co.
625 East Bunker Court
Vernon Hills, IL 60061-1844
Phone: 1-800-323-4340
FAX: 847-247-2929
Website: www.coleparmer.com

<table>
<thead>
<tr>
<th>Item (Catalog Number)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardy twin pH meter and accessories (EW-05759-00)</td>
<td>$238.00</td>
</tr>
<tr>
<td>Replacement pH sensor cartridge (EW-05759-0)</td>
<td>$105.00</td>
</tr>
<tr>
<td>Replacement pH solution kit (EW-05751-70)</td>
<td>$29.00</td>
</tr>
</tbody>
</table>
Appendix F: Analytical Procedures for Outfall Monitoring

F2.10  POTASSIUM

Equipment/Supplies Needed
- Cardy potassium compact meter by Horiba model C-131
- Accessories that come with the meter.

Two-Point Calibration (Monthly)
1. Turn the power ON
2. Open the sensor cover and wipe the sensor pad clean with a piece of tissue and deionized water, then wipe it dry with a piece of tissue. Repeat this several times.
3. Place a piece of sampling sheet onto the sensor pad, and drip 2 to 5 drops of the standard STD solution onto it (or drip the solution directly onto the sensor pad).
4. After the readout has stabilized, adjust the STD dial so that the display reads 20X100. After cleaning the sensor according to step (2), follow the same procedure using the standards SLOPE solution and after the readout has stabilized, adjust slope volume so that the display reads 15X10.
5. After cleaning several times with deionized water, measure the standard STD solution again.
6. Recalibrate if the reading is not (20±2)X100.
7. Wipe the sensor pad with deionized water, then wipe it dry.

One-Point Calibration (Daily)
1. Turn the power ON.
2. Open the sensor cover, and wipe the sensor pad clean with deionized water, then wipe it dry.
3. Repeat this procedure several times.
4. Place a piece of sampling sheet onto the sensor pad, and drip 2 to 5 drops of the standard STD solution on it (or drip the solution directly onto the sensor pad).
5. After the readout has stabilized, adjust the STD dial so that the display reads 20X100.
6. Wipe the sensor pad with deionized water, and then wipe it dry.
7. If the sample is below 500 ppm (mg/L), use the SLOPE solution and adjust the STD dial to read 15X10.

Measurement
1. Place the sample directly onto the sensor pad or measurement can be aided by placing the sample onto a piece of sampling sheet.
2. Read the concentration directly from the display.
3. Clean the sensor with deionized water and wipe it clean after each sample is analyzed.
4. When finished with all samples, turn the power OFF.
5. Clean the surface of the sensor pad with deionized water and wipe dry for storage.

Duration of Test for Each Sample
Calibration takes around 5 minutes and testing of each sample is only 30 seconds.

Hazardous Reagents
None

Ease of Analysis
Simple and fast. Can be used in the field.

Ordering Information
Vendor: Cole-Parmer Instrument Company
625 East Bunker Court
Vernon Hills, IL 60061-1844
Phone: 1-800-323-4340
FAX: 847-247-2929
Website: www.coleparmer.com
**Equipment/Supplies Needed for pH Analysis**

<table>
<thead>
<tr>
<th>Item (Catalog Number)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardy potassium compact meter and accessories (EW-05755-00)</td>
<td>$239.00</td>
</tr>
<tr>
<td>Replacement cardy potassium sensor cartridge (EW-05755-500)</td>
<td>$64.00</td>
</tr>
<tr>
<td>Replacement cardy potassium solution kit (EW-05755-60)</td>
<td>$33.00</td>
</tr>
</tbody>
</table>

*Note: This procedure is rapid and inexpensive, however, it only has a detection limit of about 1 mg/L, and reads in increments of 1 mg/L. This level of precision is not typically a problem for moderately contaminated samples (when the results are most useful); however, it presents challenges when used for cleaner water. Specifically, since the Flow Chart Method relies on the ammonia to potassium ratio to distinguish between washwaters and sanitary wastewaters, a “non detect” (i.e., <1) potassium concentration results in an indeterminant ratio value. Where clean water is being analyzed and more sensitive potassium values are needed, the only real option is to use other laboratory methods (either ICP or atomic absorption). Other simple field procedures (such as the method supplied by HACH) rely on a photometric measurement of a floc and are not very repeatable for these types of samples.*
F2.11 TOTAL HARDNESS (10 – 4000 mg/L as CaCO₃)

Equipment/Supplies Needed
- Hach digital titrator
- Total hardness titration cartridge
- ManVer 2 hardness indicator
- Hardness 1 buffer solution.

Procedure
Refer to Hach Method 8213 for Hardness, Total (10-4000 mg/L as CaCO₃) digital titrator method using EDTA. This procedure involves buffering the sample first to pH 10.1, adding of the ManVer 2 Hardness Indicator, which forms a red complex with a portion of the calcium and magnesium in the sample, and then titrating with EDTA. The EDTA titrant reacts first with the free calcium and magnesium ions, then with those bound to the indicator, causing it to change to a blue color at the end point.

Duration of Test for Each Sample
Approximately 5 minutes.

Hazardous Reagents
The mixture of sample, buffer solution, hardness indicator, and EDTA must be stored properly in a labeled container until disposal by a hazardous waste disposal facility.

Ease of Analysis
This procedure is not recommended to be performed in the field. Produces hazardous chemicals.

Ordering Information
Vendor: Hach Company
PO Box 389
Loveland, CO 80539-0389
Tel: 800-227-4224
Fax: 970-669-2932
Website: www.hach.com

<table>
<thead>
<tr>
<th>Equipment/Supplies Needed for Total Hardness Analysis</th>
<th>Quantity</th>
<th>Price*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Titrator with plastic case, manual and 5 straight delivery tubes (1690001)</td>
<td>1 titrator</td>
<td>$105.00</td>
</tr>
<tr>
<td>Total hardness titration cartridge (EDTA 0.0800M) (1436401)</td>
<td>1</td>
<td>$10.70</td>
</tr>
<tr>
<td>Total hardness titration cartridge (EDTA 0.800M) (1439901)</td>
<td>1</td>
<td>$10.70</td>
</tr>
<tr>
<td>Delivery tube, (straight with J hook) for titration (1720500)</td>
<td>Pack of 5</td>
<td>$4.85</td>
</tr>
<tr>
<td>ManVer 2 Hardness Indicator Powder Pillow (85199)</td>
<td>1 pack of 100 pillows</td>
<td>$9.85</td>
</tr>
<tr>
<td>Hardness 1 buffer solution (42432)</td>
<td>One 100 mL bottle</td>
<td>$8.40</td>
</tr>
</tbody>
</table>

*The per sample expendable cost is about $0.25, depending on the hardness level.
Appendix F: Analytical Procedures for Outfall Monitoring

F2.12 TURBIDITY

**Equipment/Supplies Needed**
- Benchtop or portable turbidimeter. The range of readings in NTU will depend upon the instrument.

**Procedure**
(This is a general procedure for turbidity. Follow your turbidimeter’s instructions): 
1. First, the instrument must be calibrated using the standards supplied with the instrument. If calibration is satisfactory, continue with sample measurement.
2. Samples are normally stored under refrigeration. Before analyzing for turbidity, the samples must first be brought back to room temperature. This is done to prevent the formation of frost on the outside of the glass sample cells used in the turbidity measurement.
3. Pour the sample into a sample cell (until almost full or to the fill line), cap the cell, then turn it upside down 2 to 3 times for mixing. Do not shake vigorously.
4. Keep the sample cell vertical for 4-5 seconds and wipe the outside to remove fingerprints.
5. Place the cell into the turbidity meter and take a reading.

**Duration of test for each sample**
Approximately one minute. This does not include the time spent bringing the sample to room temperature.

**Hazardous Reagent**
None

**Ease of Analysis**
Relatively simple and may be performed outside of the laboratory using a portable turbidimeter.

**Ordering Information**
Vendor: Hach Company  
PO Box 389  
Loveland, CO 80539-0389  
Tel: 800-227-4224  
Fax: 970-669-2932  
Website: www.hach.com

<table>
<thead>
<tr>
<th>Equipment/Supplies Needed for Turbidity Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item (Catalog Number)</strong></td>
</tr>
<tr>
<td>2100P Portable Turbidimeter range 1-1000 NTU includes nine sample cells, primary standards, silicone oil &amp; oiling cloth, manual, quick reference card and case. (4650000)</td>
</tr>
<tr>
<td><strong>Quantity</strong></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td><strong>Price</strong></td>
</tr>
<tr>
<td>$837.00</td>
</tr>
</tbody>
</table>
Appendix F3. METHODOLOGIES AND LAB TESTING OF TECHNIQUES TO MEASURE DETERGENTS
F3.1 **CHEMetrics Detergent Test Kit**

Detergents were measured using the CHEMetrics detergent test kit, which detects Methylene Blue Active Substances (MBAS), an important ingredient of detergent products. The minimum detection limit (MDL) of the kit is 0.25mg/L. This is a very simple test, but the accuracy of the tests depends on the analyst’s skill with the color comparator. One of the problems with this method is the upper limit of 3 mg/L. Higher values can only be measured with dilution of the sample prior to analysis. This extra step requires extra time when measuring laundry, carwash and sewage samples, when the detergent values are in hundreds of mg/L.

This kit also contains chloroform, an expected carcinogen. Great care must therefore be taken when conducting this analysis and when handling the kit materials. The alternative detergent field test kit from HACH uses much larger quantities of benzene, also a known carcinogen, and is not as well contained as the chloroform in this preferred kit. An important aspect of this research was investigating alternative analytes that could be used instead of detergents.

The main components of the CHEMetrics detergent test kit (Figure F3.1) are:

1. Test tube
2. Comparator device
3. Snapper
4. Double tipped ampoule containing chloroform and other reagents (blue stained)
5. CHEMets ampoule (empty vacuum ampoule)

Figure F3.1: CHEMetrics detergent test kit components
**Test Procedure Summary**

This test should preferably be conducted in a laboratory fume hood due to the possibility of exposure to chloroform.

1. Pour 5 mL of the sample into the test tube.
2. Snap one tip of the double tipped ampoule, keeping the other tip inside the tube, but above the sample level. Invert the snapped tip into the tube and snap the other tip of the ampoule. Let the blue chemical (containing chloroform) completely empty into the test tube.
3. Cap the tube tightly and shake the solution for 30 seconds. Keep the solution undisturbed for 1 minute in a test tube rack.
4. Remove the cap from the tube and insert the vacuum CHEMets ampoule into the test tube. Care must be taken so that the small plastic tube at the tip of the ampoule touches the bottom of the tube.
5. Snap the CHEMets ampoule tip by the side of the test tube and let the solution flow through the tube into the CHEMets ampoule.
6. Take off the plastic tube and wipe off the tip of the ampoule. Put the provided white cap on the tip of the ampoule and place it in the color comparator.
7. Compare the color of the solution inside the ampoule with the color comparator. The colors range from light blue (0.25 mg/L) to dark blue (3 mg/L). If the color is darker than the given colors in the comparator, the sample needs to be diluted and retested. No color indicates <0.25 mg/L value for detergents. The test tube needs to be disposed of carefully because it contains a hazardous chemical (chloroform).

**Harmful Chemicals in CHEMetrics Detergent Test Kit**

The main components of the double tipped ampoule are methylene blue, sulfuric acid, sodium phosphate, water and chloroform. Chloroform may affect the liver, kidney and central nervous system, and is a known carcinogen. On exposure, it causes irritation to eyes, skin and mucous membranes. It may also cause burning of the throat, mouth esophagus and stomach. It may also cause nausea, vomiting and diarrhea. Wash your hands thoroughly after handling the kit and conduct the analysis in a well-ventilated area, preferably in a laboratory fume hood. Avoid contact with the eyes. Safety glasses and gloves are required while doing this test. If there is a spill, take up with an absorbent material. Keep the reagents in the ampoule for final disposal, in accordance with regulations.
F3.2 FLUORESCENCE MONITORING USING THE GFL-1 FLUOROMETER

Introduction
Fluorescence is the property of the whiteners in detergents that cause treated fabrics to fluoresce in the presence of ultraviolet rays, giving laundered materials an impression of extra cleanliness. These are also referred to as bluing, brighteners or optical brighteners and have been an important ingredient of most laundry detergents for many years. The effectiveness of the brighteners varies by the concentration of the detergents in the wash water. The detection of optical brighteners has been used as an indicator for the presence of laundry wastewater, and municipal sewage, in urban waters.

One method of quantifying fluorescence in the laboratory is by using a fluorometer calibrated for detergents. In our tests, we used the GFL-1 Portable Field fluorometer (Figure F3.2).

The components of the GFL-1 Fluorometer are the power switch, sample chamber, battery compartment, source module, detector filter cartridge, display, keypad, and the interface port. A 1.2 Ah rechargeable lead-acid battery powers the unit when in the field. The fluorometer contains high efficiency interference filters optimized for fluorescence detection. It contains a silicon photodiode detector and a LED source. The interface port is also used as the battery charger port. A 192 X 192 dot LCD screen is used for text and graphical data presentation.

Figure F3.2: GFL-1 Portable Field Fluorometer
Calibration

Before the instrument is used, it should be calibrated with a detergent solution. No general standard detergent solution is available, so a commercially available detergent is used to prepare standard solutions. For this research, a common commercial detergent, Procter & Gamble’s Tide™ was used. The purpose of calibrating the fluorometer is to set the instrument fluorescent signal levels to correspond to different concentrations of this commercial detergent. Single point and multipoint calibrations are available with this fluorometer. The manufacturers report that the solution used in calibration is unimportant in that the procedure is the same regardless of the solution used. A five-point calibration method is used for instrument calibration. To test a sample, the instrument must be in “test mode.” The test mode cannot be used until a calibration table has been built, or an existing one is made active. If there is no active calibration table, the test mode screen will automatically default to the “calibration menu” screen.

To install a new calibration table, select CREATE CAL TABLE by pressing 1 on the keypad. Soon the cal table builder screen appears on the display. Since a five point calibration is being done, six different concentrations of Tide detergent were made: 0.5mg/L, 5mg/L, 10mg/L, 50mg/L, 100mg/L, 500mg/L. A concentration of 25 mg/L of Tide corresponds to a typical working solution for a batch of laundry. The sample bottles for the GFL-1 fluorometer come with the instrument. These are the only sample bottles that can be used for the measurement of fluorescence. There are five steps in making a calibration table:

**Step 1**
The screen will prompt to insert the most concentrated reference in order to set the detector gain. In this case, the highest concentration is 500mg/L. Press ENTER.

**Step 2**
Insert the blank and press ENTER.

**Step 3**
The next step is to enter the calibration units (e.g., mg/L). Pressing the ENTER key takes the user to the next step.

**Step 4**
This step prompts the user to insert a reference sample of any concentration. After inserting the reference sample, press ENTER. The screen will then prompt the user to enter the concentration value for the inserted reference sample. After setting the known reference, the screen will ask whether or not to do another point. Press YES and repeat the above sequence until you have inserted all the prepared reference samples. The reference samples should be inserted in a random fashion and not in the order of increasing or decreasing values of concentration.

**Step 5**
The last step prompts the user to name the calibration table. It should be noted that calibration tables are not saved until a name is given to the table. Then press ENTER.

Now the fluorometer is ready to start running samples.

**Sample Test Mode**
Figure F3.3 is the first screen display shown after switching on the fluorometer. Press 1 for the test mode, since the calibration table has already been saved.
Press 2 for using the saved calibration table as the active calibration table in the memory. The next screen would prompt you to enter the desired table number saved. If you have saved only one calibration table, press 1.

Place a blank sample in the sample chamber and press ENTER (Figure F3.5). You will then see the screen displayed in Figure F3.6.
Press 1 for doing discrete bottle sampling. A new screen will appear (Figure F3.7).
With calibration complete, the instrument is ready to analyze the samples. To run a test, simply load a sample into the chamber and press ENTER. The unit will measure the sample and present the data a few seconds later. A busy message indicates that the test is in progress. Press ESC to return to the main menu.

**Initial Tests using the Fluorometer**

Initial tests were conducted after the first calibration to get an indication of the repeatability and drift of the results obtained from the new instrument. Five different concentrations of Tide detergent samples were made and tested for fluorescence after varying periods of time. The results of these tests are shown in Figure F3.8.

It is obvious that the fluorescence signal from Tide degrades with time and that the analyses should be evaluated within two hours. Other samples of commercial and household detergents were also evaluated and degradation of fluorescence with time was also identified. The largest changes occurred between about one and two hours after sample preparation. There was very little change after this initial two hour period. In the real world, the time between mixing of a laundry detergent with the washwater at the laundry, its discharge, and its analysis in the laboratory is at least two hours. Therefore, the fluorescence values used are those obtained after the signals have reached a relatively constant value. The results of the tests on certain commercial and household detergents are shown in Figure F3.9.

![Figure F3.8: Changes in Tide Detergent Fluorescence over Time](image-url)
The commercial laundry detergent samples in this graph were Polard, Penny Profit, Soaps n Suds, and Cleansing Tide. The others are household detergents (Cheer, Purex, Sam’s Choice, Gain, Surf, Fab, and Fabricare). Soaps n Suds had a steep drop in fluorescence after one hour of preparation of the sample. After two hours, the fluorescence values stayed relatively constant without further changes. There was only one sample (Polard, a commercial detergent) that did not show any change in its fluorescence value. This detergent also had the lowest fluorescence signal of any of the samples. Although equal concentrations of all of these detergents were evaluated (50 mg/L), the fluorescence values ranged from 5 mg/L to 100 mg/L, as Tide. Obviously, the ingredients of the different detergents varied greatly.

**Figure F3.9: Changing Fluorescence with Time**

### F3.3 Surface Tension Test for the Detection of Detergents

**Introduction**
This discussion presents a proposed sensitive method to detect detergents without hazardous chemicals and with standard laboratory equipment. The method uses the property of the detergent to decrease the surface tension of the bubbles formed when the sample is agitated. Different detergents at different pHs were used during these tests. Results indicate that the method can be used to detect detergent concentrations above 1 mg/L, and can be used as a presence/absence test for concentrations above 0.3 mg/L. The method also was verified with samples collected from a known inappropriate detergent discharge.
One of the effects of detergents in water is the reduction in surface tension. When a sample of water with detergent is agitated, air is mixed with water, creating bubbles. Because the surface tension is reduced, the tension that controls the pressure of the air is low and the surface film is not destroyed. This property can be used to estimate the detergent concentration based on the amount of foam produced after the sample is agitated.

The amount of foam formed after a sample of water with detergent is agitated can be affected by various parameters. Temperature can affect the surface tension of the water. An increase in the temperature will reduce the surface tension. Foam production can also be affected by the chemical composition of the water. As an example, low pH will decrease the foam production.

The following discussion presents an inexpensive, safe, and reasonably sensitive method to estimate the detergent concentrations in a water sample using common laboratory equipment and without hazardous reagents.

**Methods**

General laboratory equipment was used to generate foam from samples of distilled water and detergent at different concentrations. The idea of the experiment was to drop the sample inside a burette from a constant elevation and to measure the height of the foam created 10 seconds and 1 minute after the last drop fell.

**Apparatus:**

- A rectangular base support and rod assembly
- A 50 mL burette
- A clamp to hold the burette
- A 25 mL blowout pipette
- Two 10 mL pipettes
- A stop watch
- A 200 mL volumetric flask
- A portable pH meter

A rectangular base support was used to hold the burette vertically. Using a 25 mL pipette, a 25 mL sample was released into the 50 mL burette. The sample was released by free fall from near the top of the burette, taking care that the sample does not touch the wall of the burette to maximize the amount of bubbles that can be produced. An initial reading of the foam height was taken 10 seconds after the pipette was drained. A final reading was obtained 50 seconds later.

**Reagents:**

- Detergent (Tide)
- Distilled water
- 500 mL NaOH 1N
- 500 mL H₂SO₄ 0.02N

Four samples at the same concentration were created at the same time. Four stands and four burettes were used for each concentration. After the reading, the burettes were washed for more than 2 minutes until they were clean.

To obtain more foam during the experiment, the pH was increased up to 12. The sample was diluted with distilled water and 10 mL of 1N NaOH added. The sample was prepared in a 200 mL volumetric flask. NaOH was selected because it is present in most of the detergents. After the reading was taken, the sample (200 mL) was neutralized with 100 mL 0.05N H₂SO₄ before disposal.

**Results**

Table F3.11 shows the foam reading above the water surface 10 seconds and 1 minute after the last drop.
The results indicate that this method can be used as a presence/absence test for detergent concentrations between 0.2 and 1 mg/L (as Tide) and to estimate concentrations above 1 mg/L. The method is simple and does not require specialized equipment.

An advantage of this method is that the equipment is easily available and inexpensive. The disadvantages are the variability in readings due to changes in temperature and characteristics of the detergents.

Figure F3.10 shows the results from concentrations between 10 and 50 mg/L. For readings above 10 mg/L, if the level of detergent increases the height of the foam also increases in a parabolic shape. It was also observed that the repeatability of the results decrease at high levels.

For levels of detergent lower than 10 mg/L, there is not an important change in the reading. The minimum reading that can be obtained from the burette is 0.05 mL. For samples in this range the reading is close to the precision of the instrument. Figure F3.11 shows the results from concentrations between 0 and 5 mg/L.

Readings below 1.0 mg/L create a circle of bubbles around the wall of the pipette. This circle was not present when distilled water was used. This procedure can be used as a presence/absence test. The circle was observed for concentration of detergent higher than 0.2 mg/L.

**Conclusions**

The new method is an inexpensive, safe and moderately accurate method to estimate the presence of detergents in concentrations above 0.2 mg/L. For detergent concentrations above 10 mg/L, the method can be used to quantify the concentrations. These higher concentrations have been observed in sewage, industrial discharges, laundries and car wash areas.

<table>
<thead>
<tr>
<th>Concentration (mg/L, as Tide)</th>
<th>Foam Height after 10 sec. (mL)</th>
<th>Foam Height after 1 min. (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.2</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>0.3</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>0.4</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>0.5</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>0.7</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>1</td>
<td>0.05, 0.05, 0.05, 0.05</td>
<td>0.05, 0.05, 0.05, 0.05</td>
</tr>
<tr>
<td>2</td>
<td>0.1, 0.1, 0.1, 0.1</td>
<td>0.1, 0.1, 0.1, 0.1</td>
</tr>
<tr>
<td>3</td>
<td>0.1, 0.1, 0.15, 0.15</td>
<td>0.1, 0.1, 0.15, 0.15</td>
</tr>
<tr>
<td>5</td>
<td>0.15, 0.15, 0.15, 0.15</td>
<td>0.15, 0.15, 0.15, 0.15</td>
</tr>
<tr>
<td>10</td>
<td>0.2, 0.2, 0.2, 0.2</td>
<td>0.35, 0.4, 0.4, 0.4</td>
</tr>
<tr>
<td>20</td>
<td>0.8, 0.6, 0.6, 0.6</td>
<td>1.5, 1.3, 1.4, 1.3</td>
</tr>
<tr>
<td>50</td>
<td>2.6, 2.6, 3.0, 2.8</td>
<td>3.8, 3.5, 3.7, 3.6</td>
</tr>
</tbody>
</table>
Figure F3.10: Correlation Between Concentration and Foam Height at Higher Concentrations

\[
\text{Height (m)} = 0.0008x^2 + 0.0147x + 0.0282
\]

\[
R^2 = 0.993
\]
Appendix F: Analytical Procedures for Outfall Monitoring

Concentration Vs Foam Height

\[ y = 0.008x^2 + 0.1467x + 0.282 \]

\[ R^2 = 0.993 \]

Figure F3.11: Correlation Between Concentration and Foam Height at Lower Concentrations
APPENDIX F4:  LAB TESTING OF “OPTICAL BRIGHTENER MONITORING” TO FIND INTERMITTENT DISCHARGES
Introduction

Fabric brighteners are fluorescent dyes added to soaps and detergents. These are used to produce a brightening effect after laundering. They absorb the UV rays of the sunlight and then fluoresce as a bright blue.

Optical Brightener Monitoring (OBM) is a new method for detecting fluorescent materials in water samples. It is based on a method used to measure the presence of strongly fluorescent tracer dyes.

Briefly, cotton pads that are free of fabric brighteners are used for checking the presence of optical brighteners in water samples. Cotton pads are soaked in the water sample and then dried in a darkened room. The pads are then viewed with ultraviolet (UV) light to check for the presence of fluorescence. This is an inexpensive, but much less sensitive, method for the detection of fluorescence compared to fluorometers.

Homemade OBM traps are inexpensive and easy to make. Table F4.1 lists the average costs of the supplies needed to make OBM traps, most of which can be found at a local hardware or home improvement store.

The following tests were conducted to determine how effective this test would be to detect inappropriate discharges originating from washwaters or sanitary wastewaters to storm drainage systems. This test may have several advantages compared to other methods used to detect these wastewaters: fluorometers are very expensive, detergent analyses can be hazardous, and the boron content of detergents varies widely. In addition, the OBM method usually involves placing the test pads in the targeted water for extended periods (up to several days) and may therefore be sensitive to intermittent discharges. These tests were therefore conducted to determine the sensitivity of the OBM method and to investigate its reliability under both field and laboratory conditions.

Table F4.1: Start-Up Costs for Optical Brightener Monitoring
(Source: Sargent and Castonguay, 1998)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 - 1/2” wire mesh (cages)</td>
<td>$75.75</td>
</tr>
<tr>
<td>42 feet black plastic mesh</td>
<td>$4.50</td>
</tr>
<tr>
<td>100 yards 20 lb. test monofilament</td>
<td>$2.00</td>
</tr>
<tr>
<td>500 elastics</td>
<td>$10.00</td>
</tr>
<tr>
<td>1000 staples</td>
<td>$5.00</td>
</tr>
<tr>
<td>Unexposed labels</td>
<td>$12.00</td>
</tr>
<tr>
<td>5 boxes plastic bags</td>
<td>$5.00</td>
</tr>
<tr>
<td>200 craft sticks</td>
<td>$2.00</td>
</tr>
<tr>
<td>25 aluminum spikes</td>
<td>$23.00</td>
</tr>
<tr>
<td>1 case unwashed cotton pads</td>
<td>$88.00</td>
</tr>
<tr>
<td>12 rubber gloves</td>
<td>$16.00</td>
</tr>
<tr>
<td>6 watt UV light with 2 bulbs</td>
<td>$240.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$483.25</strong></td>
</tr>
</tbody>
</table>
**Test Procedure**

**Step One:**
Care should be taken so that samples are handled properly with no cross contamination. Gloves free of fabric brightener should be worn at all times when handling the test materials. The field test kit includes brightener-free cotton pads and a sampler cage to hold the pads in place if they are to be deployed for extended periods. The sampler cage is a non-metallic plastic, or a vinyl coated black wire cage having 0.5” openings. The cage consists of two hinged pieces approximately 5” by 5”. This cage should be fabricated so that it will hold the fabric pads at approximately a 30 to 45 degree angle. The open end of this cage is held closed with an elastic band. A 4 to 6 watt long-wave fluorescent UV ultraviolet light is used to observe fluorescence on the fabric.

**Step Two:** (Placement)
At an outfall or small stream sampling location, the wire cage is secured by a heavy monofilament fishing line tied to a branch, a rock, or an aluminum spike. In sampling catchbasins, the wire cage is lowered into the catch basin by the monofilament fishing line that is then tied to the grate cover or other object. The wire cage is suspended within the water flow. The fabric pad is generally exposed for seven days. If intermittent flows are present, the device may be kept for an even longer period. However for quick sampling, the pad needs to be exposed to a water sample for at least one hour. If rust or sediment obscures the sample, then the duration needs to be shortened.

**Step Three:** (Retrieval)
After the samplers are retrieved from the water, the pads are removed from the sampling device. The pads are then rinsed in the sampling water to remove any surface sediment, and squeezed to remove excess water without tearing or ripping the pads. The pads are also labeled (see Figure F4.2).

All labels must be analyzed using the UV light to check for the presence of brighteners, as most white paper contains optical brighteners that can interfere with the optical brightener measurements of the pads. Label information should include, location, day/time of placement, and day/time of removal. The stiff paper labels are stapled to the retrieved sampling pads, placed in a zip lock bag, and kept in the dark as they are being transported to the laboratory. Upon arrival at the laboratory, the pads are dried in a darkened room (where they will not come into contact with direct sunlight) by hanging on a non-cotton monofilament line (see Figure F4.2). The line should either be replaced or cleaned by a cotton pad after every use.

**Step Four:** (Analysis)
The pads are viewed in a darkened room using a long-wavelength UV light source. The pads are easiest to examine in a dark room using a special UV lamp viewing cabinet. A non-exposed pad is used as a control. The pad will fluoresce if it is positive for brighteners, while it will be noticeably drab like the control pad if it is negative. Uneven exposure of the pad to optical brighteners may result in uneven fluorescence of the pad. If the reason for partial fluorescence can be explained then the pad should be regarded as positive. Specks or spots of fluorescence on the pads may be ignored.
Method Modifications

While reviewing the prior methods for the OBM for inappropriate discharge detection, the following issues were brought up:

a) Do the pads need to be left in the field for extended periods and how long should the pads be exposed to the sample water?

b) Are there any detrimental effects of direct exposure to sunlight while drying the cotton pads?

c) What is the sensitivity of the OBM compared to the other tests used to detect washwaters and sanitary wastewaters?

The above points are discussed in the following paragraphs.

Leaving the cotton pad and the sampling device at the sampling location

If there is continuous flow at an outfall, there is no need to keep the pads at the outfall for extended periods. If grab samples are collected from the flowing outfalls for later chemical tests, a separate sample bottle can be conveniently collected for optical brightener tests. During our analyses, the cotton pads were immersed in the sample bottles at the time of sample collection. This sampling modification greatly reduced the time and effort needed to conduct the tests. Our initial tests indicated that the high sediment loads associated with the outfall discharges would hinder the ability to measure the fluorescence due to coating the fabrics with silt. If the pads were placed in the OBM sample bottles when the water was collected, the time required to bring the samples to the laboratory was thought to be sufficient to affect the pads. Tests were conducted in the laboratory to determine the time needed to affect the pads. The standard procedure used at least a one hour exposure period.
Direct exposure to sunlight while drying the cotton pads.

There was a concern related to the degradation of fabric fluorescence in the presence of sunlight, especially after the fluorometer tests indicated significant decreases in water sample fluorescence during the first hour or two after detergent mixing. In order to test this concern, two samples were prepared with the same concentration of detergents. Two cotton pads were immersed in each of the bottles. One was dried under the direct exposure of sunlight, while the other one was dried in a dark room. After 24 hours, both sets of pads gave the same fluorescence under the ultraviolet light. Therefore, it was concluded that direct sunlight exposure to the dried cotton pads did not affect the test results.

Other sampling and laboratory practices that were important included using gloves while handling the pads, and testing the cotton pads for fluorescence under the UV lamp before their use.

Laboratory Verification using Standard Samples and Field Use In Cribbs Mill Creek

The basic OBM method is a presence/absence test, with unknown sensitivity. In order to make this test more useful, additional tests were conducted. The initial test used different Tide detergent standards. Tide detergent samples were made with concentrations of 0.5 mg/L, 5 mg/L, 10 mg/L, 20 mg/L, 30 mg/L, 50 mg/L, 100 mg/L, and 500 mg/L. Samples from each dried test pad were attached onto a card, as shown in Figure F4.4.

![Figure F4.4: Standard Tide OBM Pads](image-url)
As can be seen in Figure F3.4, concentrations below 35 mg/L all look identical. The 50 mg/L Tide solution (the first one with an obvious fluorescence response) is representative of a full-strength washwater as typically used in household laundry. Thus, it may be concluded that the OBM method may not be useful for samples having anything less than full-strength washwaters.

The maximum fluorescence concentration obtained from the Cribbs Mill Creek samples was 17mg/L (as Tide), and no positive responses for fluorescence using the OBM method were found.

**Conclusion**

This test was originally designed to identify faulty septic systems and storm drainage systems using fluorescent dyes. The fluorescent dyes (Fluorescence and Rhodamine FWT) used in these types of tests are very strong dyes and are used in moderate concentrations. They are therefore much easier to be detected by the cotton pads and the OBM method than the fabric brighteners in washwaters. OBM is a quick, easy, and inexpensive method, but can only reliably detect undiluted washwaters, and likely will miss the more common diluted washwaters found as inappropriate discharges. Other simple methods exist that are more sensitive, although the OBM method may be most suitable if intermittent discharges of undiluted washwaters are expected.
Appendix F5. **In-House Analytical Considerations for Indicator Parameters**
Appendix F: Analytical Procedures for Outfall Monitoring

Introduction
Program managers need to understand the basic analytical options and safety considerations, for each analytical method used to measure indicator parameters. This understanding helps program managers choose what indicator parameters to collect and where they should be analyzed. This section provides a summary of the basics.

Table F5.1 summarizes the recommended analysis method associated with each indicator parameter. An extended description of each analysis method is provided below.

*Colorimetric* – Colorimetric methods utilize specialized instruments such as a colorimeter or a spectrophotometer (Figure F5.1). The two instruments are similar and quantify parameter concentrations by adding reagents to the sample and passing through a defined spectrum of light. In general, spectrophotometers can analyze a much broader range of parameters than colorimeters.

<table>
<thead>
<tr>
<th>Indicator Parameter</th>
<th>Method</th>
<th>Analysis Type</th>
<th>Limit of Detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td>HACH Method 8155</td>
<td>Colorimetric</td>
<td>0.01 mg/L</td>
</tr>
<tr>
<td>Boron</td>
<td>HACH Method 10061</td>
<td>Colorimetric</td>
<td>0.02 mg/L</td>
</tr>
<tr>
<td>Chlorine</td>
<td>HACH Method 8021</td>
<td>Colorimetric</td>
<td>0.02 mg/L</td>
</tr>
<tr>
<td>Color</td>
<td>HACH Color Wheel</td>
<td>Color Comparator</td>
<td>1 color unit</td>
</tr>
<tr>
<td>Conductivity</td>
<td>Various Probe or Meter Techniques</td>
<td>Probe or Meter</td>
<td>N/A</td>
</tr>
<tr>
<td>Detergents – Surfactants</td>
<td>Chemetrics Chemets</td>
<td>Color Comparator</td>
<td>0.25 mg/L</td>
</tr>
<tr>
<td>E. coli, Total Coliform, Enterococci</td>
<td>IDEXX: Colilert Or Enterolert</td>
<td>IDEXX: Colilert Or Enterolert</td>
<td>1 MPN/100 mL</td>
</tr>
<tr>
<td>Fluoride</td>
<td>HACH Method 8029</td>
<td>Colorimetric</td>
<td>0.01 mg/L</td>
</tr>
<tr>
<td>Hardness</td>
<td>HACH Method 8213</td>
<td>Titration</td>
<td>1 mg/L</td>
</tr>
<tr>
<td>Potassium</td>
<td>HACH Method 8049</td>
<td>Colorimetric</td>
<td>0.1 mg/L</td>
</tr>
<tr>
<td></td>
<td>Horiba Probe</td>
<td>Probe</td>
<td>5 mg/L</td>
</tr>
<tr>
<td>PH</td>
<td>Probe (Various)</td>
<td>Probe or Meter</td>
<td>1 pH unit</td>
</tr>
<tr>
<td>Turbidity</td>
<td>Various Turbidity Meters</td>
<td>Probe or Meter</td>
<td>1 NTU</td>
</tr>
</tbody>
</table>

Figure F5.1: Spectrophotometer
**Color Comparator** – This analysis method is a less quantitative version of the colorimetric method. Samples are prepared by adding reagents, and assessing the color in comparison to a color cube (see Figure F5.2) or color disk that assigns a concentration for different color shades.

![Figure F5.2: HACH Color Cube Comparator](image)

**Probes** – These methods use a probe to pass an electrical current through the sample for specific light wavelength (for most indicators) or measure the scatter of light (for turbidity). While results are immediate, lab analysts need to frequently calibrate the probe using standard solutions to assure accurate data.

**Titration** – Titration techniques measure the concentration of indicator parameters by determining the amount of a reagent needed to produce a specific reaction in the sample, which is often indicated by a color change. Lab analysts carefully record the amount of reagent added to the sample using a “ burette,” which is a graduated cylinder with a valve-controlled opening at the bottom. An alternative and more precise technique is a digital titrator. Both methods rely on equations or lookup tables that relate to the amount of reagent added to the estimated concentration of the indicator parameter.

**IDEXX Techniques: Colilert or Colisure** - These proprietary methods are used to measure *E. coli*, total coliform and Enterococci bacteria. Samples are sealed along with a reagent in a specialized tray that is then placed into an incubator for 24 hours. The analyst then measures the number of cells in the tray that have changed color or shine under a fluorescent bulb, which is used to indicate the amount of bacteria in the sample (Figure F5.3). The IDEXX method uses a standard chart to relate the number of cells that have a positive reaction to the presence of bacteria. The IDEXX method is fairly simple and safe, but requires fairly expensive equipment.

**Safety and Waste Management Considerations**

Each analysis method has special safety and waste disposal considerations, which are outlined in Table F5.2.

![Figure F5.3: IDEXX Results](image)
### Table F5.2: Special Safety and Waste Management Considerations

<table>
<thead>
<tr>
<th>Indicator Parameter</th>
<th>Method</th>
<th>Major Health Risks</th>
<th>Special Disposal Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detergents – Surfactants</td>
<td>Chemetrics Chemets</td>
<td>Carcinogenic. Causes dermatitis and lung infection. Need to provide ventilation.</td>
<td>Hazardous Waste</td>
</tr>
<tr>
<td><em>E. coli; Total Coliform; Enterococci</em></td>
<td>IDEXX: Colilert Or Enterolert</td>
<td>OK</td>
<td>Potential Biohazard (Consult State Health Agency for requirements)</td>
</tr>
<tr>
<td>Fluoride</td>
<td>HACH Method 8029</td>
<td>Causes erosion of teeth.</td>
<td>Reagent is a hazardous waste.</td>
</tr>
<tr>
<td>Hardness</td>
<td>HACH Method 8213</td>
<td>No major</td>
<td>Reaction produces a hazardous waste.</td>
</tr>
</tbody>
</table>

**TIP**

The IDEXX technique requires a special adaptation when used to measure *E. coli* in discharges from storm drain outfalls. The concentration that distinguishes sewage from other discharges is greater than 12,000MPN/100ml. Using this method, the maximum readable concentration is only 2,619MPN/ml. Dilute outfall samples to 10-20% of their original concentrations with deionized water in order to read the very high concentrations of *E. coli* that identify sewage discharges.

### References


APPENDIX I

IDDE Training
IDDE PLAN ANNUAL TRAINING
TOWN OF CANTON, MA

<table>
<thead>
<tr>
<th>NAME (PRINT)</th>
<th>DEPARTMENT</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
What is the MS4 Permit?

To comply with U.S. Clean Water Act, the Town of Canton is subject to the NPDES Municipal Separate Stormwater System (MS4) Permit. The MS4 Permit, administered by the U.S. Environmental Protection Agency (US EPA), regulates what communities can discharge into the rivers, lakes, and ponds.

What is the IDDE Program?

Illicit Discharge Detection & Elimination (IDDE) is the process by which a municipality served by a separate stormwater permit maintains the integrity of its stormwater drainage network, ensuring that only stormwater runoff is being conveyed through pipes and outfall structures to water bodies.

What is an Illicit Discharge?

Illicit Discharges are “any discharge to an MS4 that is not composed entirely of stormwater.”

There are a variety of different sources of Illicit Discharges, for example:

- improper pipe connections (i.e., sanitary sewer or non-stormwater discharges) into the MS4 by residential or commercial uses;
- Sanitary Sewer Overflow (SSO) events;
- leakage and seepage (often referred to Inflow + Infiltration, or “I&I”);
- other sources of cross-contamination; or
- improper disposal and/or wash-off of substances into catch basins.
How will I be able to identify an Illicit Discharge?

❖ **During dry weather**: Illicit Discharges are most easily identifiable during dry weather conditions (i.e., between rain events). MS4 pipes and outfalls typically do not convey flow during dry weather. The presence of flow or questionable deposits or stains makes it easy to detect Illicit Discharges and their sources. Some outfalls have flow year-round because they are in high groundwater table locations.

❖ **During wet weather**: Illicit Discharges may also be identified during wet weather conditions by looking for specific characteristics at or near the outfalls. For instance, specific odors (such as sewage or “rotten egg” smells), discolorations, turbidity (poor clarity), floatable matter (i.e., oil sheen, grease, soap/bubbles), outfall structure damage, or impacts on vegetation (e.g. bare patches, overgrowth, spot algal blooms) are indicators of a potential illicit connection.

For additional guidance, refer to the IDDE Field Assessment – Companion Sheet

What is my role in the IDDE program, and how can I help ensure its success?

A proper IDDE program requires regular **inspection** of stormwater outfalls, **identification** of non-compliant conditions, and the **elimination** of Illicit Discharges. To achieve IDDE program goals, quality observation, timely feedback, and follow-up with key IDDE program personnel is required. Key tasks include:

- Document any unusual flows or characteristics with time-stamped photos, location of outfall, and detailed description of observation(s). Include potential source(s) of discharge, if known.

- Notify **Barbara Thissell Reardon** (339-502-5747; breardon@town.canton.ma.us) **on the same day as observation**.

- Help sample the dry or wet weather flow, as necessary.
Between rainfall events, it may be possible to detect Illicit Discharges from non-stormwater sources by the presence of dry weather flow, or questionable deposits, stains, or odors. During wet weather, the table can help in determining the source.

Contact Barbara Thissell Reardon (339-502-5747) on the same day as Illicit Discharge observation to report conditions. For additional information, refer to the IDDE Plan.
## TRAINING ATTENDANCE

IDDE PLAN ANNUAL TRAINING  
TOWN OF CANTON, MA

<table>
<thead>
<tr>
<th>NAME (PRINT)</th>
<th>DEPARTMENT</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lisa Grega</td>
<td>DPW - Engineering</td>
<td>June 25, 2019</td>
</tr>
<tr>
<td>Kelsey Quinnan</td>
<td>DPW - Engineering</td>
<td>6/25/2019</td>
</tr>
<tr>
<td>William J Walsh Jr.</td>
<td>Public Work Dept.</td>
<td>6-25-2019</td>
</tr>
<tr>
<td>Barbara Reardon</td>
<td>DPW Engineering</td>
<td>6/25/2019</td>
</tr>
</tbody>
</table>