

Illicit Discharge Detection and Elimination (IDDE) Plan

Town of Middleton, Massachusetts

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Prepared by:

AECOM

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1. Introduction

1.1 MS4 Program

This Illicit Discharge Detection and Elimination (IDDE) Plan has been developed to address the requirements of the United States Environmental Protection Agency's (USEPA's) 2016 National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4) in Massachusetts, hereafter referred to as the "2016 Massachusetts MS4 Permit" or "MS4 Permit." This IDDE Plan is based on a 2016 template provided by US EPA on their MS4 website for use by permittees; the template was prepared for US EPA by the Central Massachusetts Regional Stormwater Coalition.

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

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

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

1.2 Illicit Discharges

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

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

Some illicit discharges are intentional, such as dumping used oil (or other pollutant) into catch basins, a resident or contractor illegally tapping a new sewer lateral into a storm drainpipe to avoid the costs of a sewer connection fee and service, and illegal dumping of yard wastes into surface waters. Some illicit discharges are related to the unsuitability of original infrastructure to the modern regulatory environment. Examples of illicit discharges in this category include connected floor drains in old buildings, as well as sanitary sewer overflows that enter the drainage system. Sump pumps legally connected to the storm drain system may be used inappropriately, such as for the disposal of floor wash water or old household products, in many cases due to a lack of understanding on the part of the homeowner.

Elimination of some discharges may require substantial costs and efforts, such as funding and designing a project to reconnect sanitary sewer laterals. Others, such as improving self-policing of dog waste management, can be

accomplished by outreach in conjunction with the minimal additional cost of dog waste bins and the municipal commitment to disposal of collected materials on a regular basis.

Regardless of the intention, when not addressed, illicit discharges can contribute high levels of pollutants, such as heavy metals, toxics, oil, grease, solvents, nutrients, and pathogens to surface waters.

1.3 Allowable Non-Stormwater Discharges

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

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

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

1.4 Receiving Waters and Impairments

Table 1-1 lists the “impaired waters” within the boundaries of the Town’s regulated area based on the 2016 Massachusetts Integrated List of Waters produced by MassDEP every two years. 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.

Table 1-1: Impaired Waters

Water Body Name	Segment ID	Category ¹	Impairment(s)	Associated Approved TMDL
Unnamed Tributary	MA92-12	5	Fecal Coliform	N/A

¹Category 5 Waters – impaired water bodies that require a TMDL.

“Approved TMDLs” are those that have been approved by EPA as of the date of issuance of the 2016 MS4 Permit.

1.5 IDDE Program Goals, Framework, and Timeline

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

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

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

Figure 1-1: IDDE Investigation Procedure Framework

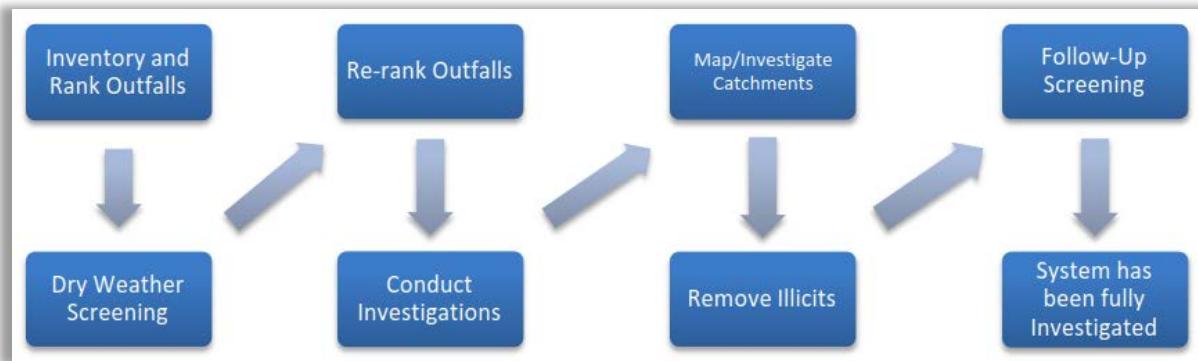


Table 1-2: IDDE Program Implementation Timeline

IDDE Program Requirement	Completion Date from Effective Date of Permit					
	1 Year	1.5 Years	2 Years	3 Years	7 Years	10 Years
Written IDDE Program Plan	X					
Written Catchment Investigation Procedure		X				
Phase I Mapping			X			
Phase II Mapping						X
IDDE Regulatory Mechanism or By-Law (if not already in place)				X		
Dry Weather Outfall Screening				X		
Follow-up Ranking of Outfalls and Interconnections				X		
Catchment Investigations – Problem Outfalls					X	
Catchment Investigations – all Problem, High, and Low Priority Outfalls						X

1.6 Work Completed to Date

The 2003 MS4 Permit required each MS4 community to develop a plan to detect illicit discharges using a combination of storm system mapping and creating and enforcing regulatory mechanisms to prohibit illicit discharges. Each MS4 community was also required to define how confirmed discharges would be eliminated and how the removal would be documented.

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

- Developed a map of outfalls and receiving waters
- Adopted an IDDE bylaw or regulatory mechanism

2. Authority and Statement of IDDE Responsibilities

2.1 Legal Authority

The Town has adopted an Illicit Discharge Detection and Elimination Authority on September 17th, 2014. A copy of the Authority is provided in **Appendix A**. The Authority provides the Town with adequate legal authority to:

- Prevent pollutants from entering municipal separate storm sewer system;
- Prohibit illicit discharges;
- Require the removal of illicit connections;
- Investigate suspected illicit discharges;
- Eliminate illicit discharges, including discharges from properties not owned by or controlled by the MS4 that discharge into the MS4 system; and
- Implement appropriate enforcement procedures and actions.

The Town has reviewed its current Illicit Discharge Detection and Elimination Authority and related land use regulations and policies for consistency with the 2016 MS4 Permit.

2.2 Statement of Responsibilities

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

3. Stormwater System Mapping

The Town originally developed mapping of its stormwater system to meet the mapping requirements of the 2003 MS4 Permit. The 2016 MS4 Permit requires a more detailed storm system map than was required by the 2003 MS4 Permit. The revised mapping is intended to facilitate the identification of key infrastructure, factors influencing proper system operation, and the potential for illicit discharges.

The 2016 MS4 Permit requires the storm system map to be updated in two phases as outlined below. The Department of Public Works is responsible for updating the stormwater system mapping pursuant to the 2016 MS4 Permit. The Town will report on the progress towards completion of the storm system map in each annual report. The Town's current map is included in **Appendix B**.

3.1 Phase I Mapping

Phase I mapping must be completed within two (2) years of the effective date of the permit (July 1, 2020) and include the following information:

- Outfalls and receiving waters (previously required by the MS4-2003 permit);
- Open channel conveyances (swales, ditches, etc.);
- Interconnections with other MS4s and other storm sewer systems;
- Municipally owned stormwater treatment structures;
- Water bodies identified by name and indication of all use impairments as identified on the most recent EPA approved Massachusetts Integrated List of Waters report; and
- Initial catchment delineations. Topographic contours and drainage system information may be used to produce initial catchment delineations.

The Town has updated its stormwater mapping to include the remaining Phase I information.

3.2 Phase II Mapping

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); and
- Municipal combined sewer system (if applicable).

The Town will update its stormwater mapping by July 1, 2028 to include the remaining following Phase II information.

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.

The Town's only sanitary sewers at this time are located in the eastern portion of Town on the border with Danvers, and this sanitary flow is directed to Danvers system. The remainder of the Town disposes sewage through the use of private septic systems. There are no potential SSOs in Middleton, so there is no SSO inventory needed.

5. Assessment and Priority Ranking of Outfalls

The 2016 MS4 Permit requires an assessment and priority ranking of outfalls in terms of their potential to have illicit discharges and SSOs and the related public health significance. The ranking helps determine the priority order for performing IDDE investigations and meeting permit milestones.

5.1 Outfall Catchment Delineations

A catchment is the area that drains to an individual outfall¹ or interconnection.² The catchments for each of the MS4 outfalls will be delineated to define contributing areas for investigation of potential sources of illicit discharges. Catchments are typically delineated based on topographic contours and mapped drainage infrastructure, where available. As described in **Section 3**, initial catchment delineations have been completed as part of the Phase I

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.

mapping, and refined catchment delineations will be completed as part of the Phase II mapping to reflect information collected during catchment investigations.

5.2 Outfall and Interconnection Inventory and Initial Ranking

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

The outfall and interconnection inventory will identify each outfall and interconnection discharging from the MS4, record its location and condition, and provide a framework for tracking inspections, screenings and other IDDE program activities.

Outfalls and interconnections will be classified into one of the following categories:

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

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

Dry weather screening and sampling, as described in **Section 6** of this IDDE Plan and Part 2.3.4.7.b of the MS4 Permit, is not required for Problem Outfalls.

2. **High Priority Outfalls:** Outfalls/interconnections that have not been classified as Problem Outfalls and that are:

- Discharging to an area of concern to public health due to proximity of public beaches, recreational areas, drinking water supplies or shellfish beds
- Determined by the permittee as high priority based on the characteristics listed below or other available information.

3. **Low Priority Outfalls:** Outfalls/interconnections determined by the permittee as low priority based on the characteristics listed below or other available information.

4. **Excluded outfalls:** Outfalls/interconnections with no potential for illicit discharges may be excluded from the IDDE program. This category is limited to roadway drainage in undeveloped areas with no dwellings and no sanitary sewers; drainage for athletic fields, parks or undeveloped green space and associated parking without services; cross-country drainage alignments (that neither cross nor are in proximity to sanitary sewer alignments) through undeveloped land.

Outfalls will be ranked into the above priority categories (except for excluded outfalls, which may be excluded from the IDDE program) based on the following characteristics of the defined initial catchment areas, where information is available. Additional relevant characteristics, including location-specific characteristics, may be considered but must be documented in this IDDE Plan.

- **Past discharge complaints and reports.**
- **Poor receiving water quality** – the following guidelines are recommended to identify waters as having a high illicit discharge potential:
 - Exceeding water quality standards for bacteria
 - Ammonia levels above 0.5 mg/l
 - Surfactants levels greater than or equal to 0.25 mg/l

- **Density of generating sites** – Generating sites are those places, including institutional, municipal, commercial, or industrial sites, with a potential to generate pollutants that could contribute to illicit discharges. Examples of these sites include, but are not limited to, car dealers; car washes; gas stations; garden centers; and industrial manufacturing areas.
- **Age of development and infrastructure** – Industrial areas greater than 40 years old 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.
- **Surrounding density of aging septic systems** – Septic systems thirty years or older in residential land use areas are prone to have failures and may have a high illicit discharge potential.
- **Culverted streams** – Any river or stream that is culverted for distances greater than a simple roadway crossing may have a high illicit discharge potential.
- **Water quality limited waterbodies** that receive a discharge from the MS4 or waters with approved TMDLs applicable to the permittee, where illicit discharges have the potential to contain the pollutant identified as the cause of the water quality impairment.

Table 5-1 is the outfall inventory and priority ranking matrix.

Table 5-1: Outfall Inventory and Priority Ranking Matrix – The Town of Middleton, Massachusetts – Revision Date: 06/30/20

Outfall ID	Receiving Water	Previous Screening Results Indicate Likely Sewer Input? ¹	Discharging to Area of Concern to Public Health? ²	Frequency of Past Discharge Complaints	Receiving Water Quality ³	Density of Generating Sites ⁴	Age of Development/Infrastructure ⁵	Aging Septic? ⁶	Culverted Streams? ⁷	Additional Characteristics	Score	Priority Ranking
Information Source		Outfall Inspections and Sample Results	GIS Maps	Town Staff	Impaired Waters List	Land Use/GIS Maps, Aerial Photography	Land Use Information, Visual Observation	Land Use, Town Staff	GIS and Storm System Maps	Are There Other Factors of Concern? ^{9,10,11}		
Scoring Criteria		Yes = 15 (Problem Outfall) No = 0	Yes = 3 No = 0	Frequent = 3 Occasional = 2 None = 0	Poor = 3 Fair = 2 Good = 0	High = 3 Medium = 2 Low = 1	High = 3 Medium = 2 Low = 1	Yes = 3 No = 0	Yes = 3 No = 0	Yes = 3 No = 0		
2-1	Unnamed Wetland	0	0	0	0	1	2	3	0	0	6	High Priority
9-1	Unnamed Wetland	0	0	0	0	1	0	0	0	0	1	Low Priority
13-1	Unnamed Wetland	0	0	0	0	1	0	0	0	0	1	Low Priority
14-1	Unnamed Wetland	0	0	0	0	1	0	0	0	0	1	Low Priority
17-1	Unnamed Wetland	0	3	0	0	1	2	3	0	0	9	High Priority
17-2	Unnamed Wetland	0	3	0	0	1	2	3	0	0	9	High Priority
17-3	Unnamed Wetland	0	3	0	0	1	2	3	0	0	9	High Priority
18-1	Unnamed Stream/Wetland	0	3	0	0	1	2	3	0	0	9	High Priority
18-2	Unnamed Stream/Wetland	0	3	0	0	1	2	3	0	0	9	High Priority
18-3	Unnamed Stream/Wetland	0	3	0	0	1	2	3	0	0	9	High Priority
24-1	Unnamed Stream/Wetland	0	3	0	0	1	2	0	0	0	6	High Priority
24-2	Unnamed Wetland	0	3	0	0	1	2	0	0	0	6	High Priority
25-1	Unnamed Stream	0	0	0	0	2	0	0	0	0	2	Low Priority
25-2	Unnamed Wetland	0	0	0	0	2	0	0	0	0	2	Low Priority
30-1	Unnamed Wetland	0	0	0	0	1	0	0	0	0	1	Low Priority
41-1	Unnamed Stream	0	0	0	0	1	0	0	0	0	1	Low Priority
42-1	Unnamed Stream/Wetland	0	0	0	0	1	0	0	0	3 ⁹	4	Low Priority
42-2	Unnamed Stream/Wetland	0	0	0	0	1	0	0	0	3 ⁹	4	Low Priority
42-3	Unnamed Stream/Wetland	0	0	0	0	1	0	0	0	3 ⁹	4	Low Priority
42-4	Unnamed Stream/Wetland	0	0	0	0	1	0	0	0	3	4	Low Priority
42-5	Unnamed Stream/Wetland	0	0	0	0	1	0	0	0	3 ⁹	4	Low Priority
43-1	Ipswich River MA92-06	0	0	0	2	2	2	3	0	3 ⁹	12	High Priority
44-1	Unnamed Wetland	0	0	0	0	1	0	0	0	0	1	Low Priority
45-1	Unnamed Stream	0	0	0	0	1	0	0	0	0	1	Low Priority
45-2	Unnamed Stream	0	0	0	0	1	0	0	0	0	1	Low Priority
46-1	Unnamed Stream/Wetland	0	0	0	0	1	1	0	0	3 ¹¹	5	High Priority
46-2	Unnamed Stream/Wetland	0	0	0	0	1	1	0	0	3 ¹¹	5	High Priority
47-1	Unnamed Wetland	0	0	0	0	1	1	0	0	3 ¹¹	5	Low Priority
48-1	Unnamed Tributary MA 92-12	0	3	0	3	2	0	0	0	3 ¹⁰	11	High Priority
48-2	Unnamed Tributary MA 92-12	0	3	0	3	2	0	0	0	3 ¹⁰	11	High Priority
49-1	Unnamed Tributary MA 92-12	0	3	0	3	1	0	0	0	3 ¹⁰	10	High Priority
56-2	Unnamed Stream	0	3	0	0	1	0	0	0	0	4	Low Priority

58-1	Unnamed Stream	0	0	0	0	1	2	3	0	0	6	High Priority
58-2	Unnamed Stream	0	0	0	0	1	2	3	0	3 ¹¹	9	High Priority
61-1	Unnamed Wetland	0	0	0	0	1	1	0	0	0	2	Low Priority
62-1	Unnamed Wetland	0	0	0	0	1	2	0	0	0	3	Low Priority
62-2	Unnamed Wetland	0	0	0	0	1	2	0	0	0	3	Low Priority
62-3	Unnamed Wetland	0	0	0	0	1	2	0	0	0	3	Low Priority
63-1	Unnamed Wetland	0	0	0	0	1	2	0	0	0	3	Low Priority
63-2	Unnamed Wetland	0	0	0	0	1	2	0	0	0	3	Low Priority
63-3	Unnamed Wetland	0	0	0	0	1	2	0	0	0	3	Low Priority
63-4	Unnamed Wetland	0	0	0	0	1	2	0	0	0	3	Low Priority
63-5	Unnamed Wetland	0	0	0	0	1	2	0	0	0	3	Low Priority
66-1	Unnamed Wetland	0	0	0	0	1	2	0	0	0	3	Low Priority
68-1	Unnamed Wetland adjacent to Ipswich River MA 92-06	0	3	0	0	2	0	0	0	3 ⁹	5	High Priority
78-1	Unnamed Wetland	0	0	0	2	2	0	0	0	0	4	Low Priority
78-2	Unnamed Conveyance discharging to unnamed wetland	0	0	0	2	2	0	0	0	0	4	Low Priority

¹ Previous screening results indicate likely sewer input if any of the following are true:

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

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

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

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

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

⁵ Age of development and infrastructure:

- High = Industrial areas greater than 40 years old and areas where the sanitary sewer system is more than 40 years old
- Medium = Developments 20-40 years old
- Low = Developments less than 20 years old

⁶ Aging septic systems are septic systems 30 years or older in residential areas.

⁷ Any river or stream that is culverted for distance greater than a simple roadway crossing.

⁹ The outfall is near the impaired Ipswich River

¹⁰ The outfall is near the impaired tributary

¹¹ The outfall is near a sanitary discharge

6. Dry Weather Outfall Screening and Sampling

Dry weather flow is a common indicator of potential illicit connections. The MS4 Permit requires all outfalls/interconnections (excluding Problem and excluded Outfalls) to be inspected for the presence of dry weather flow within three years of the 2018 permit effective date, which means that all outfalls should be screened by June 30, 2021. The Department of Public Works is responsible for conducting dry weather outfall screening, starting with High Priority outfalls, followed by Low Priority outfalls, based on the initial priority rankings described in the previous section. Middleton does not have any outfalls identified as "Problem" outfalls.

6.1 Weather Conditions

Dry weather outfall screening and sampling may occur when no more than 0.1 inches of rainfall has occurred in the previous 24-hour period and no significant snow melt is occurring. For purposes of determining dry weather conditions, program staff will use precipitation data from Middleton's weather station (Station ID: KMAMIDDL12). If the 'Middleton Weather' weather station is not available or not reporting current weather data, then either Falcon Ridge (KMAMIDDL26) or Upton Hills (KMAMIDDL23) will be used as a back-up.

6.2 Dry Weather Screening/Sampling Procedure

6.2.1 General Procedure

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

1. Identify outfall(s) to be screened/sampled based on initial outfall inventory and priority ranking.
2. Acquire the necessary staff, mapping, and field equipment (see **Table 6-1** for list of potential field equipment).
3. Conduct the outfall inspection during dry weather:
 - a. Mark and photograph the outfall.
 - b. Record the inspection information and outfall characteristics (using paper forms or digital form using a tablet or similar device) (see form in **Appendix C**).
 - c. Look for and record visual/olfactory evidence of pollutants in flowing outfalls including odor, color, turbidity, and floatable matter (suds, bubbles, excrement, toilet paper or sanitary products). Also observe outfalls for deposits and stains, vegetation, and damage to outfall structures.
4. If flow is observed, sample and test the flow following the procedures described in the following sections.
5. If no flow is observed, but evidence of illicit flow exists (illicit discharges are often intermittent or transitory), revisit the outfall during dry weather within one week of the initial observation, if practicable, to perform a second dry weather screening and sample any observed flow. Other techniques can be used to detect intermittent or transitory flows including conducting inspections during evenings or weekends and using optical brighteners.
6. Input results from screening and sampling into spreadsheet/database. Include pertinent information in the outfall/interconnection inventory and priority ranking.
7. Include all screening data in the annual report.

6.2.2 Field Equipment

Table 6-1 lists field equipment commonly used for dry weather outfall screening and sampling.

Table 6-1: Field Equipment – Dry Weather Outfall Screening and Sampling

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

6.2.3 Sample Collection and Analysis

If flow is present during a dry weather outfall inspection, a sample will be collected and analyzed for the required permit parameters³ listed in **Table 6-2**. The general procedure for collection of outfall samples is as follows:

1. Fill out all sample information on sample bottles and field sheets (see **Appendix C** for Field Sheets).
2. Put on protective gloves (nitrile/latex/other) before sampling.
3. Collect sample with dipper or directly in sample containers. If possible, collect water from the flow directly in the sample bottle. Be careful not to disturb sediments.
4. If using a dipper or other device, triple rinse the device with distilled water and then in water to be sampled (not for bacteria sampling).

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 6-2**).
6. Place laboratory samples on ice for analysis of bacteria and pollutants of concern.
7. Fill out chain-of-custody form for laboratory samples.
8. Deliver samples to Northeast Environmental Laboratory, Inc. of Danvers, Massachusetts.
9. Dispose of used test strips and test kit ampules properly.
10. Decontaminate all testing personnel and equipment.

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

Field test kits or field instrumentation are permitted for all parameters except indicator bacteria and any pollutants of concern. Field kits need to have appropriate detection limits and ranges. **Table 6-2** 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. Middleton's receiving waters are not impaired for any pollutants of concern other than fecal coliform. Analytic procedures and user's manuals for field test kits and field instrumentation are provided in **Appendix D**.

Table 6-2: Sampling Parameters and Analysis Methods

Analyte or Parameter	Instrumentation (Portable Meter)	Field Test Kit
Ammonia	CHEMetrics™ V-2000 Colorimeter Hach™ DR/890 Colorimeter Hach™ Pocket Colorimeter™ II	CHEMetrics™ K-1410 CHEMetrics™ K-1510 (series) Hach™ NI-SA Hach™ Ammonia Test Strips
Surfactants (Detergents)	CHEMetrics™ I-2017	CHEMetrics™ K-9400 and K-9404 Hach™ DE-2
Chlorine	CHEMetrics™ V-2000, K-2513 Hach™ Pocket Colorimeter™ II	NA
Conductivity	CHEMetrics™ I-1200 YSI Pro30 YSI EC300A Oakton 450	NA
Temperature	YSI Pro30 YSI EC300A Oakton 450	NA
Analyte or Parameter	Instrumentation (Portable Meter)	Field Test Kit
Salinity	YSI Pro30 YSI EC300A Oakton 450	NA
Temperature	YSI Pro30 YSI EC300A Oakton 450	NA
Indicator Bacteria: <i>E. coli</i> (freshwater)	EPA certified laboratory procedure (40 CFR § 136)	NA
Pollutants of Concern ¹ - Fecal Coliform is listed above	NA	NA

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

Testing for indicator bacteria 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. **Table 6-3** lists analytical methods, detection limits, hold times, and preservatives for laboratory analysis of dry weather sampling parameters.

Table 6-3: Analytical Methods for Laboratory Analysis of Dry Weather Sampling Parameters

Analyte or Parameter	Analytical Method	Detection Limit	Max. Hold Time	Preservative
Ammonia	EPA: 350.2 SM¹: 4500-NH3C	0.05 mg/L	28 days	Cool ≤6°C, H ₂ SO ₄ to pH <2, No preservative required if analyzed immediately.
Surfactants	SM: 5540-C	0.01 mg/L	48 hours	Cool ≤6°C
Chlorine	SM: 4500-Cl G	0.02 mg/L	Analyze within 15 minutes	None Required
Temperature	SM: 2550B	NA	Immediate	None Required
Specific Conductance	EPA: 120.1 SM: 2510B	0.2 µs/cm	28 days	Cool ≤6°C
Salinity	SM: 2520		28 days	Cool ≤6°C
Indicator Bacteria: <i>E. coli</i> Enterococcus	<i>E. coli</i> EPA: 1603 SM: 9221B, 9221F, 9223 B Other: Colilert®, Colilert-18® <i>Enterococcus</i> EPA: 1600 SM: 9230 C Other: Enterolert®	<i>E. coli</i> EPA: 1 cfu/100mL SM: 2 MPN/100mL Other: 1 MPN/100mL <i>Enterococcus</i> EPA: 1 cfu/100mL SM: 1 MPN/100mL Other: 1 MPN/100mL	8 hours	Cool ≤10°C, 0.0008% Na ₂ S ₂ O ₃
Analyte or Parameter	Analytical Method	Detection Limit	Max. Hold Time	Preservative
Total Nitrogen ²	EPA: Cadmium reduction (automated)-353.2 Rev. 2.0, SM: 4500-NO ₃ E-F	EPA: 0.05 mg/L SM: 0.05 mg/L	28 days	Cool ≤6°C, H ₂ SO ₄ to pH <2

¹ SM = Standard Method

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

6.3 Interpreting Outfall Sampling Results

Outfall analytical data from dry weather sampling can be used to help identify the major type or source of discharge. **Table 6-4** shows values identified by the U.S. EPA and the Center for Watershed Protection as typical screening values

⁴ 40 CFR § 136: <http://www.ecfr.gov/cgi-bin/text-idx?SID=b3b41fdea0b7b0b8cd6c4304d86271b7&mc=true&node=pt40.25.136&rqn=div5>

for select parameters. These represent the typical concentration (or value) of each parameter expected to be found in stormwater. Screening values that exceed these benchmarks may be indicative of pollution and/or illicit discharges.

Table 6-4: Benchmark Values for Sampling Parameters

Analyte or Parameter	Benchmark
Ammonia	>0.5 mg/L
Conductivity	>2,000 μ S/cm
Surfactants	>0.25 mg/L
Chlorine	>0.02 mg/L (detectable levels per the 2016 MS4 Permit)
Indicator Bacteria ⁵ : <i>E.coli</i> <i>Enterococcus</i>	<i>E. coli</i> : the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml <i>Enterococcus</i> : the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml

6.4 Follow-up Ranking of Outfalls and Interconnections

The Town 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 Investigations

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

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

- Catchment investigations where dry weather indicates sewer input or other illicit connection are to be completed within seven years of the permit effective date (i.e. completed by June 30, 2025). Middleton does not currently have any “Problem” outfalls.
- Investigations of all High and Low Priority outfalls must be completed within 10 years of the permit effective date (i.e., by June 30, 2028) and should follow the order as listed in the ranking table

⁵ Massachusetts Water Quality Standards: <http://www.mass.gov/eea/docs/dep/service/regulations/314cmr04.pdf>

7.1 System Vulnerability Factors

As explained above, most of Middleton does not have sanitary sewers. Therefore, there is limited opportunity for System Vulnerability Factors (SVF) to be present in the Town. None of the following SVFs are currently present in the Town:

- 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;
- 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); or
- 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).

If any SVFs are identified during the catchment investigations, these will be documented for the catchment that includes the portion of Town including sanitary sewers (which is on maps 46 and 47 in Appendix B), retained as part of this IDDE Plan, and included in the annual report.

7.2 Dry Weather Manhole Inspections

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

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

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

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

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

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

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

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

Inspection of key junction manholes will proceed as follows:

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

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

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

7.3 Wet Weather Outfall Sampling

Where a minimum of one (1) System Vulnerability Factor (SVF) is identified based on previous information or the catchment investigation, a wet weather investigation must also be conducted at the associated outfall. As indicated above in Section 7.1, Middleton does not currently have sanitary sewers. Therefore, there are no SVFs currently present in the Town and wet weather sampling is not required.

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 methods are described in the sections below. Instructions and Standard Operating Procedures (SOPs) for these and other IDDE methods are provided in [Appendix E](#).

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

7.4.1 Sandbagging

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

7.4.2 Smoke Testing

Smoke testing involves injecting non-toxic smoke into drain lines and noting the emergence of smoke illegally connected buildings or from cracks and leaks in the system itself. Typically, a smoke bomb or smoke generator is used

to inject the smoke into the system at a catch basin or manhole and air is then forced through the system. Test personnel are placed in areas where there are suspected illegal connections or cracks/leaks, noting any escape of smoke (indicating an illicit connection or damaged storm drain infrastructure). It is important when using this technique to make proper notifications to area residents and business owners as well as local police and fire departments.

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

7.4.3 Dye Testing

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

A team of two or more people is needed to perform dye testing (ideally, all with two-way radios). One person is inside the building, while the others are stationed at the appropriate storm sewer 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.

7.4.4 CCTV/Video Inspection

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

7.4.5 Optical Brightener Monitoring

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

7.4.6 IDDE Canines

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

7.5 Illicit Discharge Removal

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

- The location of the discharge and its source(s);
- A description of the discharge;
- The method of discovery;
- Date of discovery;
- Date of elimination, mitigation or enforcement action OR planned corrective measures and a schedule for completing the illicit discharge removal; and
- Estimate of the volume of flow removed.

7.5.1 Confirmatory Outfall Screening

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

7.6 Ongoing Screening

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

8. Training

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

9. Progress Reporting

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

- Number of illicit discharges identified and removed;

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

The success of the IDDE program will be measured by the IDDE activities completed within the required permit timelines.

Appendix A

Legal Authority (IDDE Bylaw or Ordinance)

ARTICLE II

ILLICIT DISCHARGES TO STORM DRAIN SYSTEM

§ 204-9. PURPOSE

The purpose of this section is to eliminate non-stormwater discharges to the Town of Middleton's Municipal Storm Drain System. Non-stormwater discharges contain contaminants and supply additional flows to the Town's storm drain system. Increased and contaminated stormwater runoff is a major cause of:

- (1) impairment of water quality and flow in lakes, ponds, streams, rivers, wetlands and groundwater;
- (2) contamination of drinking water supplies;
- (3) contamination of clam flats and other coastal areas;
- (4) alteration or destruction of aquatic and wildlife habitat; and flooding.

Regulation of illicit connections and discharges to the municipal storm drain system is necessary for the protection of the Town of Middleton's natural resources, municipal facilities, and to safeguard the public health, safety, welfare and the environment.

§ 204-10. OBJECTIVES

The objectives of this section are:

- (1) To prevent pollutants from entering the Town's municipal separate storm sewer system (MS4);
- (2) To prohibit illicit connections and unauthorized discharges to the MS4;
- (3) To require the removal of all such existing illicit connections, regardless of whether such connections were permitted or otherwise acknowledged prior to the implementation of this by-law;
- (4) To comply with state and federal statutes and regulations relating to stormwater discharges; and
- (5) To establish the legal authority to ensure compliance with the provisions of this by-law through inspection, monitoring, and enforcement.

§ 204-11. DEFINITIONS

Unless a different definition is indicated in other sections of Section 204, the following definitions and provisions shall apply throughout Section 204, also referred to as this by-law or Section.

AUTHORIZED ENFORCEMENT AGENCY: The Middleton Board of Health (hereafter "the BOH"), its employees or agents designated to enforce this by-law.

AUTHORIZED ADMINISTERING AGENCY: The Middleton Department of Public Works (hereafter "the Department" or "DPW"), its employees or agents designated to administer and implement this by-law.

BEST MANAGEMENT PRACTICE (BMP): An activity, procedure, restraint, or structural improvement that helps to reduce the quantity or improve the quality of stormwater runoff.

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

DISCHARGE OF POLLUTANTS: The addition from any source 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 this by-law.

ILLICIT DISCHARGE: Direct or indirect discharge to the municipal storm drain system that is not composed entirely of stormwater, except as exempted in Section 204-16.4.

IMPERVIOUS SURFACE: Any material or structure on or above the ground that prevents water infiltrating the underlying soil. Impervious surface includes without limitation roads, paved parking lots, sidewalks, and roof tops.

MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) or MUNICIPAL STORM DRAIN SYSTEM: 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 manmade or altered drainage channel, reservoir, and other drainage structure that together comprise the storm drainage system owned or operated by the Town of Middleton.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) STORM WATER 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.

PERSON: An individual, partnership, association, firm, company, trust, corporation, agency, authority, department or political subdivision of the Commonwealth or the federal government, to the extent permitted by law, and any officer, employee, or agent of such person.

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;
- (5) ordnances, 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.

PROCESS WASTEWATER: Water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any material, intermediate product, finished product, or waste product.

RECHARGE: The process by which groundwater is replenished by precipitation through the percolation of runoff and surface water through the soil.

STORMWATER: Runoff from precipitation or snow melt.

TOXIC OR HAZARDOUS MATERIAL or WASTE: Any material, which because of its quantity, concentration, chemical, corrosive, flammable, reactive, toxic, infectious or radioactive characteristics, either separately or in combination with any substance or substances, constitutes a present or potential threat to human health, safety, welfare, or to the environment. Toxic or hazardous materials include any synthetic organic chemical, petroleum product, heavy metal, radioactive or infectious waste, acid and alkali, and any substance defined as Toxic or Hazardous under G.L. Ch.21C and Ch.21E, and the regulations at 310 CMR 30.000 and 310 CMR 40.0000.

WATERCOURSE: A natural or man-made channel through which water flows or a stream of water, including a river, brook or underground stream.

WATERS OF THE COMMONWEALTH: all waters within the jurisdiction of the Commonwealth, including, without limitation, rivers, streams, lakes, ponds, springs, impoundments, estuaries, wetlands, coastal waters, and groundwater.

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.

§ 204-12. APPLICABILITY

This section shall apply to flows entering the municipally owned storm drainage system.

§ 204-13. AUTHORITY

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

§ 204-14. RESPONSIBILITY FOR ADMINISTRATION

The BOH shall enforce this by-law. The BOH will work with the Department of Public Works ("DPW") to administer and implement this by-law. Any powers granted to or duties imposed upon the BOH may be delegated in writing by the BOH to employees or agents of the BOH and/or the DPW. References to the BOH, Department or DPW within this by-law are understood to denote either or both of these agencies.

§ 204-15. REGULATIONS

The Department may promulgate rules and regulations to effectuate the purposes of this by-law. Failure by the Department to promulgate such rules and regulations shall not have the effect of suspending or invalidating this by-law.

§ 204-16. PROHIBITED ACTIVITIES

- (1) Illicit Discharges. No person shall dump, discharge, cause or allow to be discharged any pollutant or non-stormwater discharge into the municipal separate storm sewer system (MS4), into a watercourse, or into the waters of the Commonwealth.
- (2) Illicit Connections. No person shall construct, use, allow, maintain or continue any illicit connection to the municipal storm drain system, regardless of whether the connection was permissible under applicable law, regulation or custom at the time of connection.
- (3) Obstruction of Municipal Storm Drain System. No person shall obstruct or interfere with the normal flow of stormwater into or out of the municipal storm drain system without prior consent from the Department. 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 stormwater system.

(4) Exemptions

- A. Discharge or flow resulting from fire fighting activities;
- B. The following non-stormwater discharges or flows are exempt from the prohibition of non-stormwaters provided that the source is not a significant contributor of a pollutant to the municipal storm drain system:

1. Waterline flushing;
2. Flow from potable water sources;
3. Springs;
4. Natural flow from riparian habitats and wetlands;
5. Diverted stream flow;
6. Rising groundwater;
7. Uncontaminated groundwater infiltration as defined in 40 CFR 35.2005(20), or uncontaminated pumped groundwater (e.g. sump pump), provided that where a pump intake exists inside a structure, the operator seeks a permit from the Department prior to discharge, and thereafter discharges in accordance with the requirements of the permit and applicable laws and regulations to be issued by the Department;
8. Water from exterior foundation drains, footing drains (not including active groundwater dewatering systems), crawl space pumps, or air conditioning condensation;
9. Discharge from landscape irrigation or lawn watering;
10. Water from individual residential car washing;
11. Discharge from dechlorinated swimming pool water (less than one ppm chlorine) provided the water is allowed to stand for one week prior to draining and the pool is drained in such a way as not to cause a nuisance;
12. Discharge from street sweeping;
13. Dye testing, provided verbal notification is given to the Department prior to the time of the test;
14. Non-stormwater discharge permitted under an NPDES permit, waiver, or waste discharge order administered under the authority of the United States Environmental Protection Agency, provided that the discharge is in full compliance with the requirements of the permit, waiver, or order and applicable laws and regulations; and

15. Discharge for which advanced written approval is received from the Department as necessary to protect public health, safety, welfare or the environment.

(5) Other Prohibited Activities

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.

Drains – No one shall tie any pump, cellar, yard, roof or area drain directly into the storm water drainage system, or add any new ties to an already permitted 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, grease 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.

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.

§ 204-17. EMERGENCY SUSPENSION OF STORM DRAINAGE SYSTEM ACCESS

The Department may suspend municipal storm drain system access to any person or property without prior written notice when such suspension is necessary to stop an actual or threatened discharge of pollutants that presents imminent risk of harm to the public health, safety, welfare or the environment. In the event any person fails to comply with an emergency suspension order, the Authorized Enforcement Agency may take all reasonable steps to prevent or minimize harm to the public health, safety, welfare or the environment.

§ 204-18. 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.

§ 204-19. MONITORING OF DISCHARGES

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

- (1) Access to Facilities – The BOH and DPW (or other enforcement agency/delegated enforcement partner) 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, subject to applicable 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.
- (2) Facility operators shall allow the BOH and 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 laws.
- (3) The BOH and 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.
- (4) The BOH and DPW have 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 they are accurate.
- (5) 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 BOH and DPW and shall not be replaced. The costs of clearing such access shall be borne by the operator.
- (6) Unreasonable delay in allowing the BOH or DPW access to a permitted facility constitutes 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 violates this Section. 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.
- (7) If the BOH or 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.

§ 204-20. 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. Compliance with this by-law does not waive the responsibility of the property owner or lessee for applying for and receiving any other required Town, State or Federal permits associated with activities or uses otherwise regulated under other regulatory jurisdiction (e.g. Wetlands Protection Act).

§ 204-21. NOTIFICATION OF SPILLS

Notwithstanding other requirements of local, state or federal law, as soon as a person responsible for a facility or operation, or responsible for emergency response for a facility or operation has information of or suspects a release of materials at that facility or operation resulting in or which may result in discharge of pollutants to the municipal drainage system or waters of the Commonwealth, the person shall take all necessary steps to ensure containment, and cleanup of the release. In the event of a release of oil or hazardous materials, the person shall immediately notify the municipal fire and police departments. In the event of a release of non-hazardous material, the reporting person shall notify the Authorized Enforcement Agency no later than the next business day. The reporting person shall provide to the Authorized Enforcement Agency written confirmation of all telephone, facsimile or in-person notifications within three business days thereafter. If the discharge of prohibited materials is from a commercial or industrial facility, the facility owner or operator of the facility shall retain on-site a written record of the discharge and the actions taken to prevent its recurrence. Such records shall be retained for at least three years.

§ 204-22. ENFORCEMENT

The BOH or an authorized agent of the BOH shall enforce this by-law, regulations, orders, violation notices, and enforcement orders, and may pursue all civil and criminal remedies for such violations.

1. Civil Relief

If a person violates the provisions of this Section, regulations, permit, notice, or order issued thereunder, the BOH may seek injunctive relief in a court of competent jurisdiction restraining the person from activities which would create further violations or compelling the person to perform abatement or remediation of the violation.

2. Orders

The BOH or an authorized agent of the BOH may issue a written order to enforce the provisions of this section or the regulations thereunder, which may include: (a) elimination of illicit connections or discharges to the MS4; (b) performance of monitoring, analyses, and reporting; (c) that unlawful discharges, practices, or operations shall cease and desist; and (d) remediation of contamination in connection therewith.

A. If the enforcing person determines that abatement or remediation of contamination is required, the order shall set forth a deadline by which such abatement or remediation must be completed. Said order shall further advise that, should the violator or property owner fail to abate or perform remediation within the

specified deadline, the Town may, at its option undertake such work, and expenses thereof shall be charged to the violator.

- B. Within thirty (30) days after completing all measures necessary to abate the violation or to perform remediation, the violator and the property owner will be notified of the costs incurred by the Town, including administrative costs. The violator or property owner may file a written protest objecting to the amount or basis of costs with the Department within thirty (30) days of receipt of the notification of the costs incurred. If the amount due is not received by the expiration of the time in which to file a protest or within thirty (30) days following a decision of the Department affirming or reducing the costs, or from a final decision of a court of competent jurisdiction, the costs shall become a special assessment against the property owner and shall constitute a lien on the owner's property for the amount of said costs pursuant to M.G.L. Ch. 40, §58. Interest shall begin to accrue on any unpaid costs at the statutory rate provided in G.L. Ch. 59, § 57 after the thirty-first day at which the costs first become due.

3. Non-Criminal Disposition

As an alternative to criminal prosecution or civil action, the Town may elect to utilize the non-criminal disposition procedure set forth in G.L. Ch. 40, §21D and in which case the Health Director and DPW Director of the Town shall be the enforcing person. The penalty for the 1st and all subsequent violations shall be \$300.00. Each day or part thereof that such violation occurs or continues shall constitute a separate offense.

4. Criminal Penalty

Any person who violates any provision of this by-law, regulation, order or permit issued thereunder, shall be punished by a fine of \$300.00. Each day or part thereof that such violation occurs or continues shall constitute a separate offense.

5. Entry to Perform Duties Under this Section

To the extent permitted by applicable law, or if authorized by the owner or other party in control of the property, the BOH and DPW, its agents, officers, and employees may enter upon privately owned property for the purpose of performing their duties under this by-law and regulations and may make or cause to be made such examinations, surveys or sampling as the BOH and DPW deems reasonably necessary.

6. Appeals

The decisions or orders of the BOH and DPW shall be final. Further relief shall be to a court of competent jurisdiction.

7. Remedies Not Exclusive

The remedies listed in this section are not exclusive of any other remedies available under any applicable federal, state or local law.

§ 204-23. SEVERABILITY

The provisions of this section are hereby declared to be severable. If any provision, paragraph, sentence, or clause, of this section 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 section or by-law.

Appendix B

Storm System Mapping

GRID INDEX

Legend

Stormwater Outfall

- Field-Confirmed
- Field-Likely
- Likely

BMP-Infiltration Basin

- Field-Confirmed
- Field-Likely
- Likely

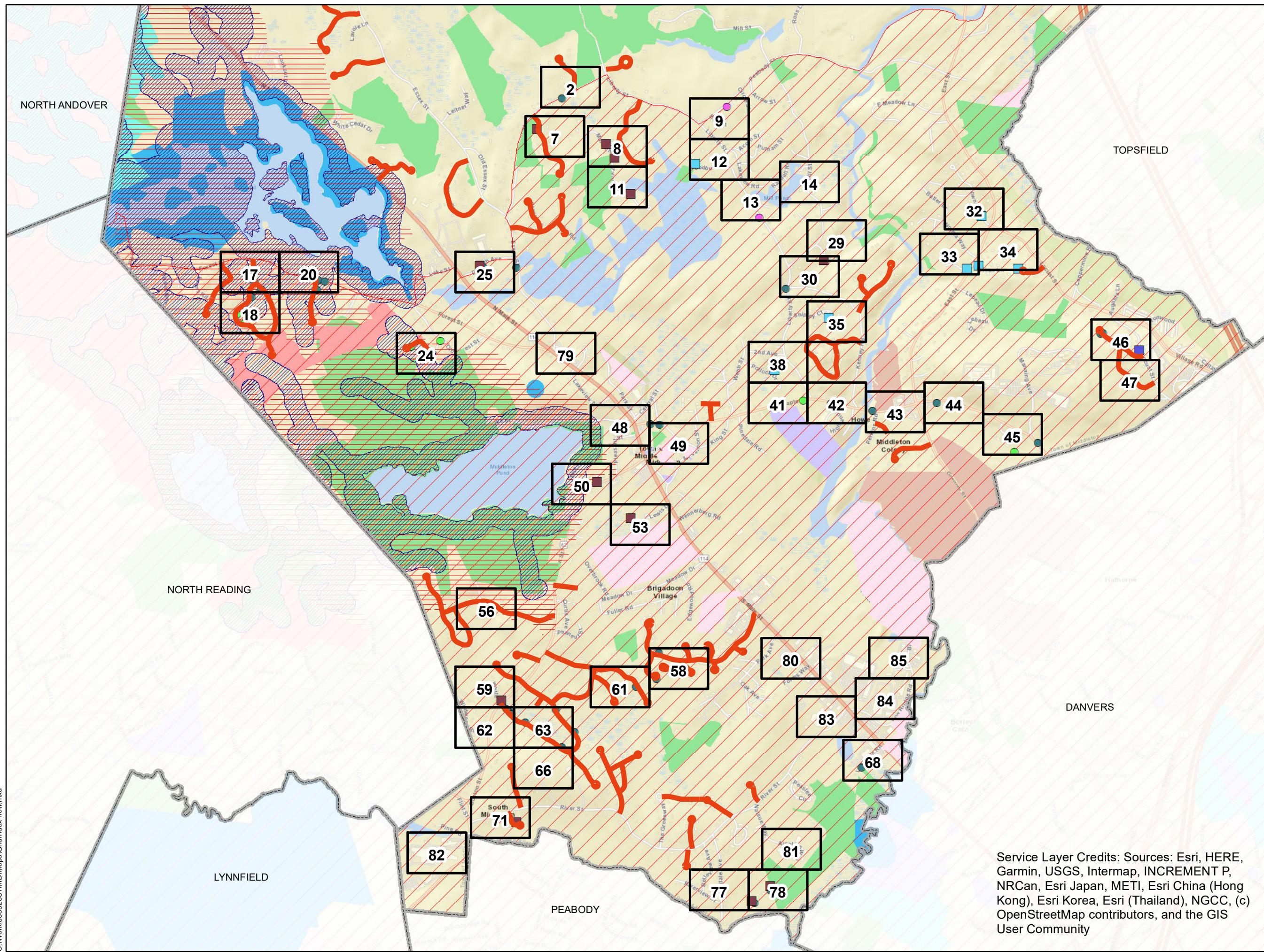
Grid

2010 Census Urban Area

Old Roads

Protected/Recreational

- Conservation
- Recreation
- Recreation and Conservation
- Agriculture
- Historical/Cultural
- Water Supply
- Surface Water Protection ZONE A
- Surface Water Protection ZONE B
- Surface Water Protection ZONE C



1 inch = 2,000 feet

0 1,000 2,000
Feet

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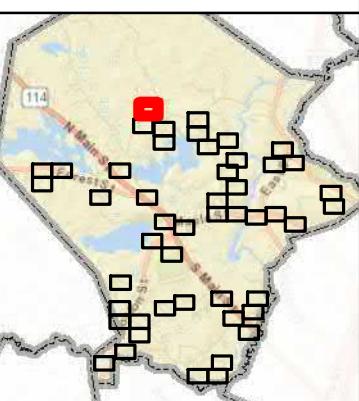
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- Legend**
- Stormwater Outfall
 - 2014 Impaired Waters 303d**
 - 2 - Attaining some uses
 - Approximate Drainage Area
 - DEP Wetlands**
 - Hydrologic Connection
 - Wetland Limit
 - Closure Line
 - Marsh/Bog
 - Wooded Marsh
 - 2-ft Contours**
 - Index
 - Intermediate
 - Protected/Recreational**
 - Conservation
 - Older Residential Street



1 inch = 100 feet

0 50 100 Feet



GRID MAP

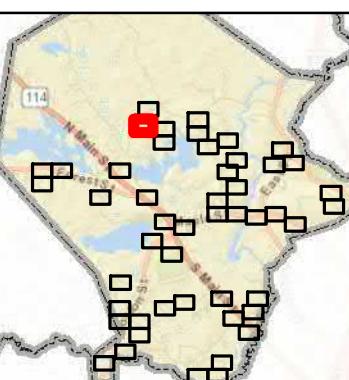
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- Legend**
- BMP - Infiltration Basin
 - DEP Wetlands
 - Hydrologic Connection
 - Wetland Limit
 - Marsh/Bog
 - Wooded Marsh
- 2-ft Contours**
- Index
 - Intermediate
- Protected/Recreational**
- Conservation
 - Older Residential Street



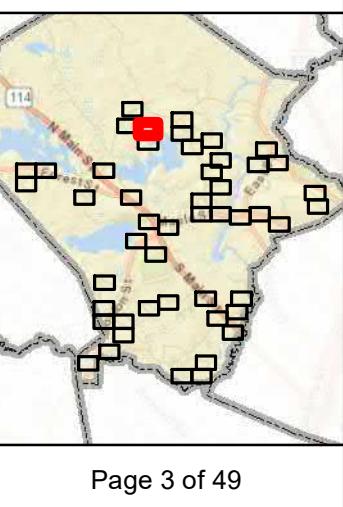
1 inch = 100 feet

0 50 100 Feet



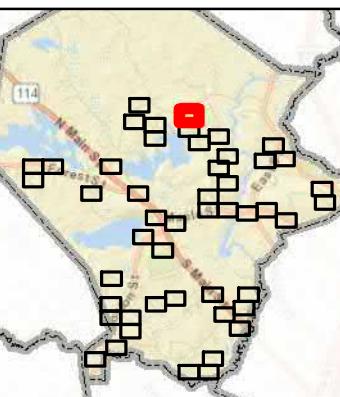
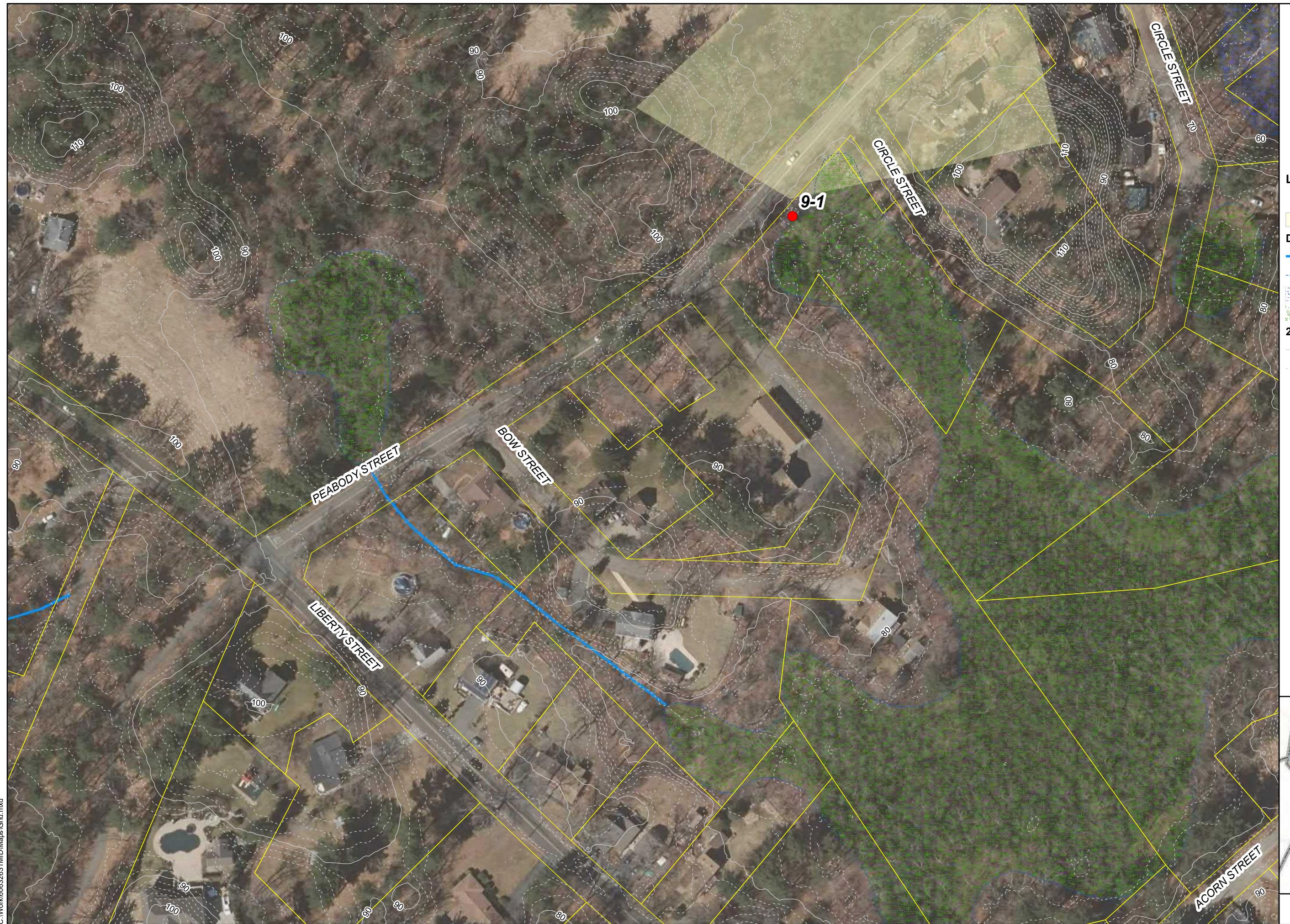
GRID MAP

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GRID MAP

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GRID MAP

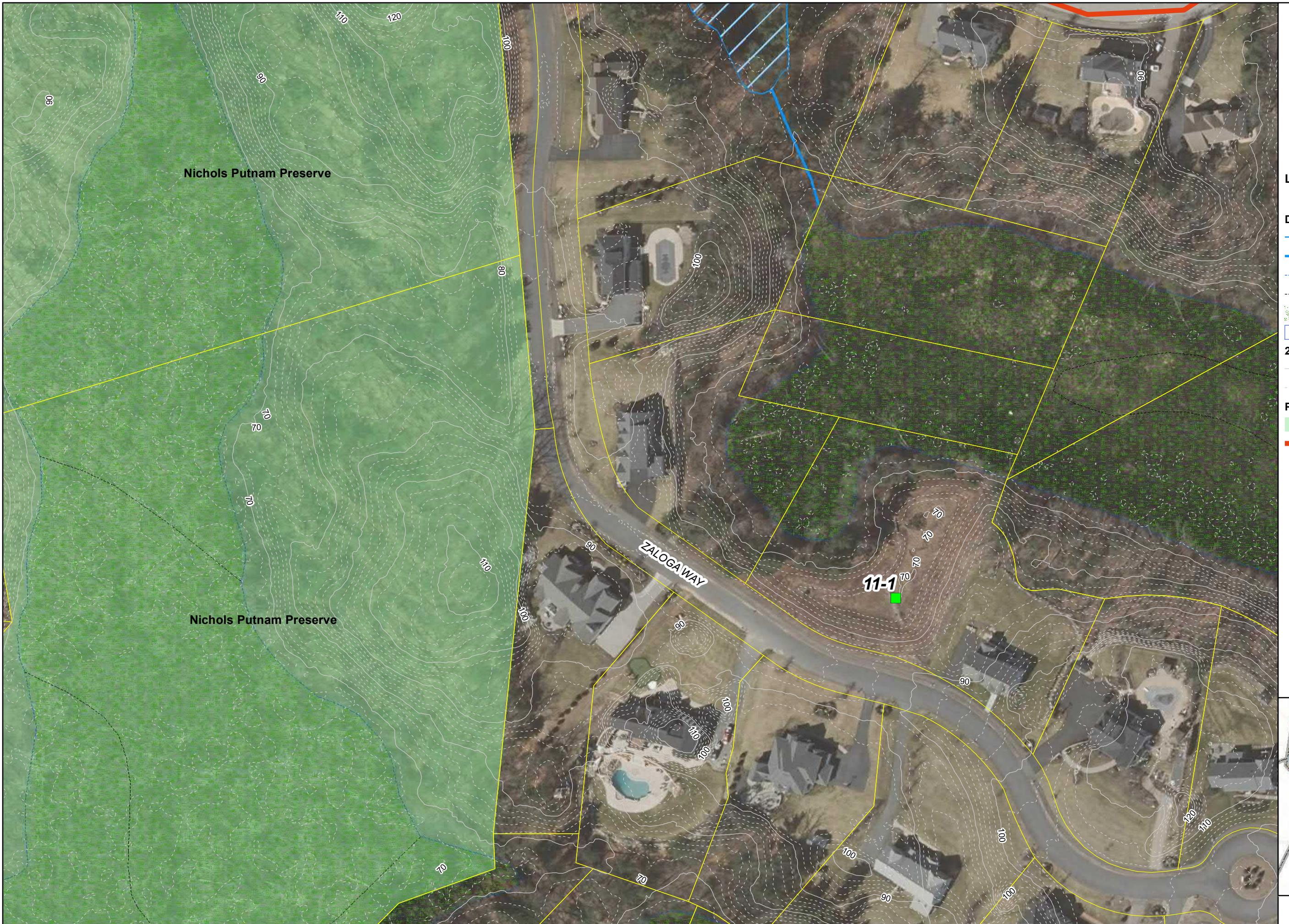
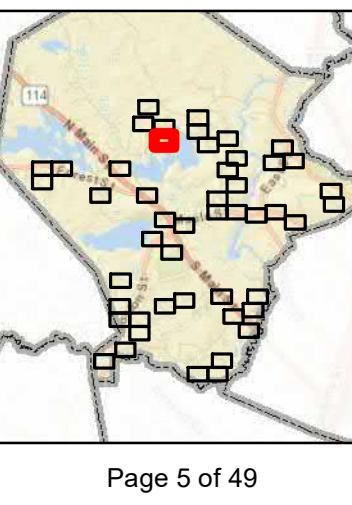
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- Legend**
- BMP - Infiltration Basin
 - DEP Wetlands**
 - Shoreline
 - Hydrologic Connection
 - Wetland Limit
 - Closure Line
 - Wooded Marsh
 - Open Water
 - 2-ft Contours**
 - Index
 - Intermediate
 - Protected/Recreational**
 - Conservation
 - Older Residential Street



1 inch = 100 feet

0 50 100 Feet



GRID MAP

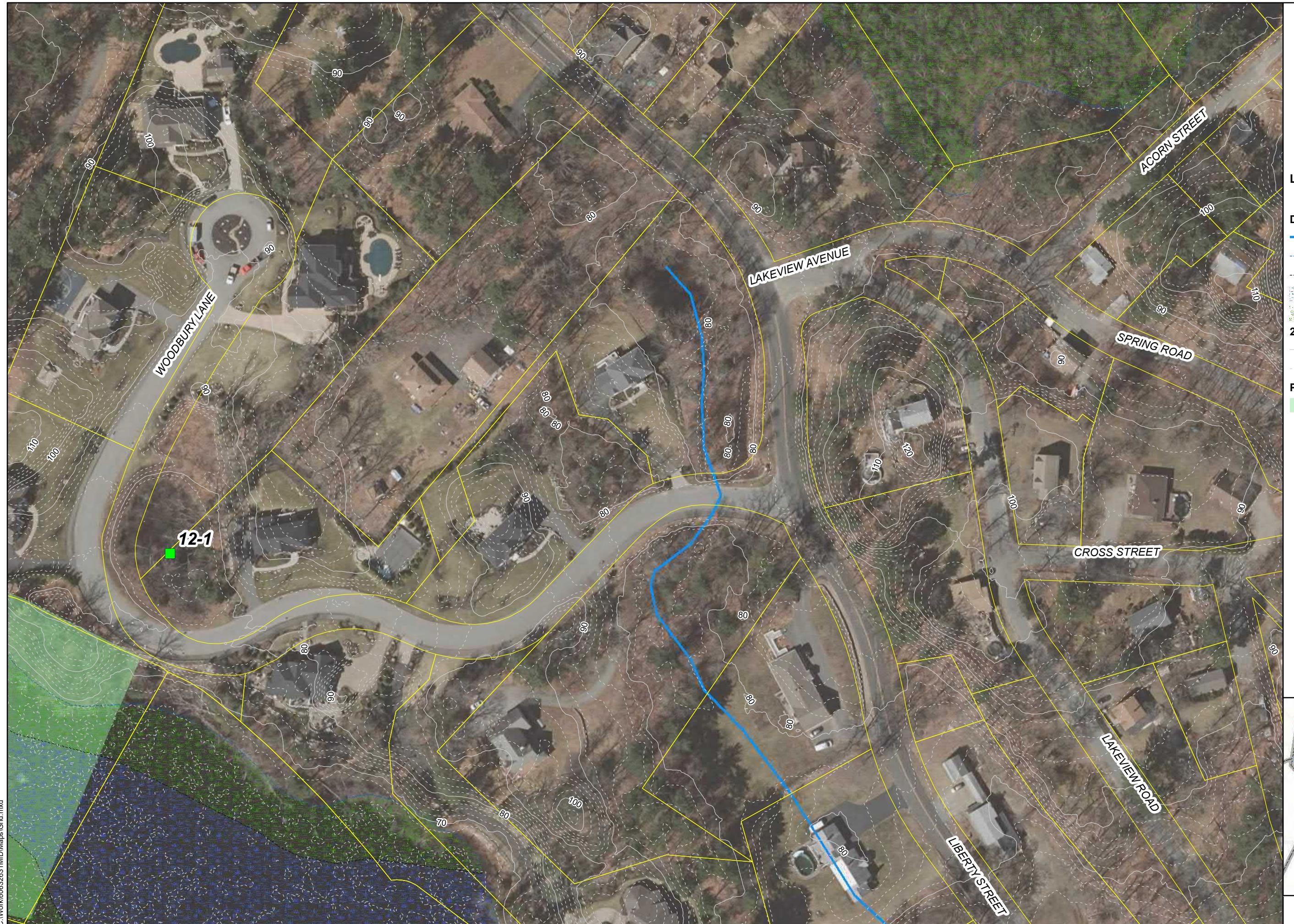
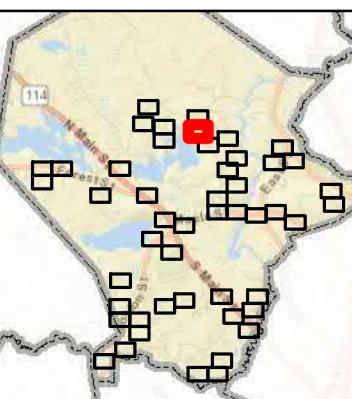
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- Legend**
- BMP - Infiltration Basin
 - DEP Wetlands
 - Hydrologic Connection
 - Wetland Limit
 - Closure Line
 - Marsh/Bog
 - Wooded Marsh
 - 2-ft Contours**
 - Index
 - Intermediate
 - Protected/Recreational**
 - Conservation



1 inch = 100 feet

0 50 100 Feet



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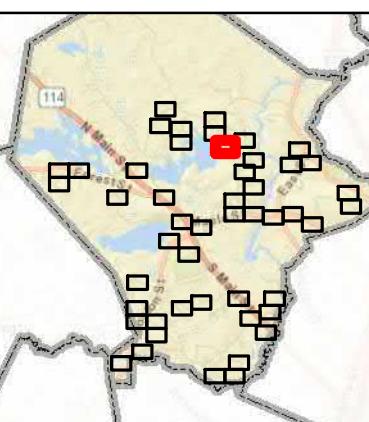
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- Legend**
- Stormwater Outfall
 - Approximate Drainage Area
 - DEP Wetlands**
 - Shoreline
 - Hydrologic Connection
 - Wetland Limit
 - Closure Line
 - Marsh/Bog
 - Wooded Marsh
 - Open Water
 - 2-ft Contours**
 - Index
 - Intermediate



1 inch = 100 feet

0 50 100 Feet



13-1



GRID MAP

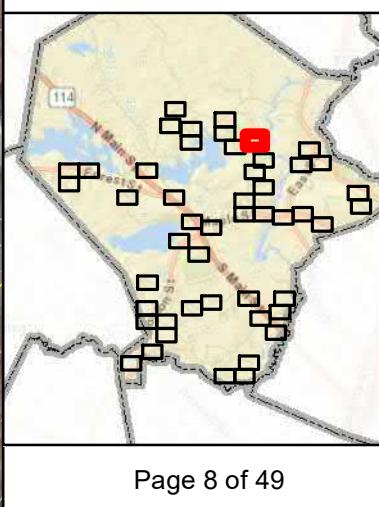
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- Legend**
- Stormwater Outfall
 - Approximate Drainage Area
 - DEP Wetlands**
 - Shoreline
 - Hydrologic Connection
 - Wetland Limit
 - Closure Line
 - Marsh/Bog
 - Wooded Marsh
 - Open Water
 - 2-ft Contours**
 - Index
 - Intermediate



1 inch = 100 feet

0 50 100 Feet



GRID MAP

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GRID MAP

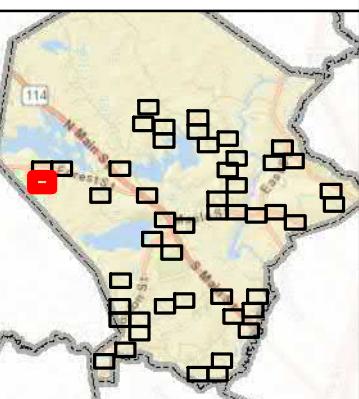
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- Legend**
- Stormwater Outfall
 - Approximate Drainage Area
 - DEP Wetlands**
 - Hydrologic Connection
 - - - Wetland Limit
 -  Wooded Marsh
- 2-ft Contours**
- Index
 - Intermediate
 - Surface Water ZONE A
 - Surface Water ZONE B
 - Surface Water ZONE C
 - Older Residential Street



1 inch = 100 feet

0 50 100 Feet



GRID MAP

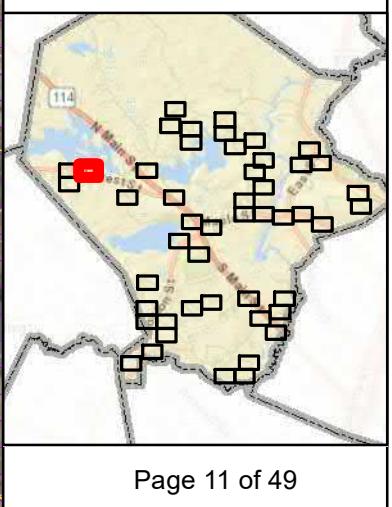
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Legend	
●	Stormwater Outfall
■	Approximate Drainage Area
DEP Wetlands	
—	Shoreline
—	Hydrologic Connection
---	Wetland Limit
---	Closure Line
Marsh/Bog	
Wooded Marsh	
Open Water	
2-ft Contours	
—	Index
---	Intermediate
Protected/Recreational	
Water Supply	
Surface Water ZONE A	
Surface Water ZONE B	
Older Residential Street	



1 inch = 100 feet

0 50 100 Feet



GRID MAP

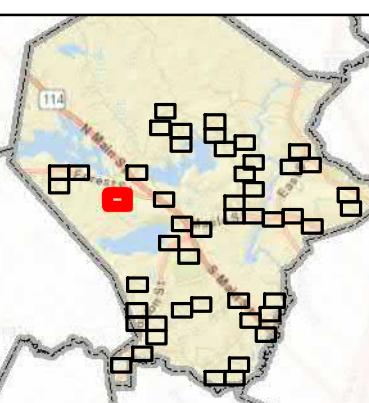
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- Legend**
- Stormwater Outfall
 - Approximate Drainage Area
 - DEP Wetlands**
 - Hydrologic Connection
 - - - Wetland Limit
 - - - Closure Line
 -  Wooded Marsh
 - 2-ft Contours**
 - Index
 - - - Intermediate
 - Protected/Recreational**
 - Conservation
 - Surface Water ZONE A
 - Surface Water ZONE B
 - Surface Water ZONE C
 - Older Residential Street



1 inch = 100 feet

0 50 100 Feet



GRID MAP

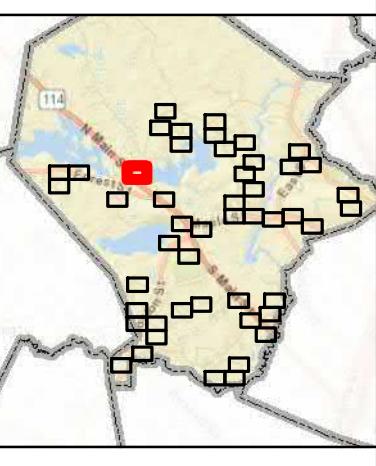
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- Legend**
- BMP - Infiltration Basin
 - Stormwater Outfall
 - Approximate Drainage Area
- DEP Wetlands**
- Hydrologic Connection
 - Wetland Limit
 - Closure Line
 - Marsh/Bog
 - Wooded Marsh
- 2-ft Contours**
- Index
 - Intermediate



1 inch = 100 feet

0 50 100 Feet



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GRID MAP

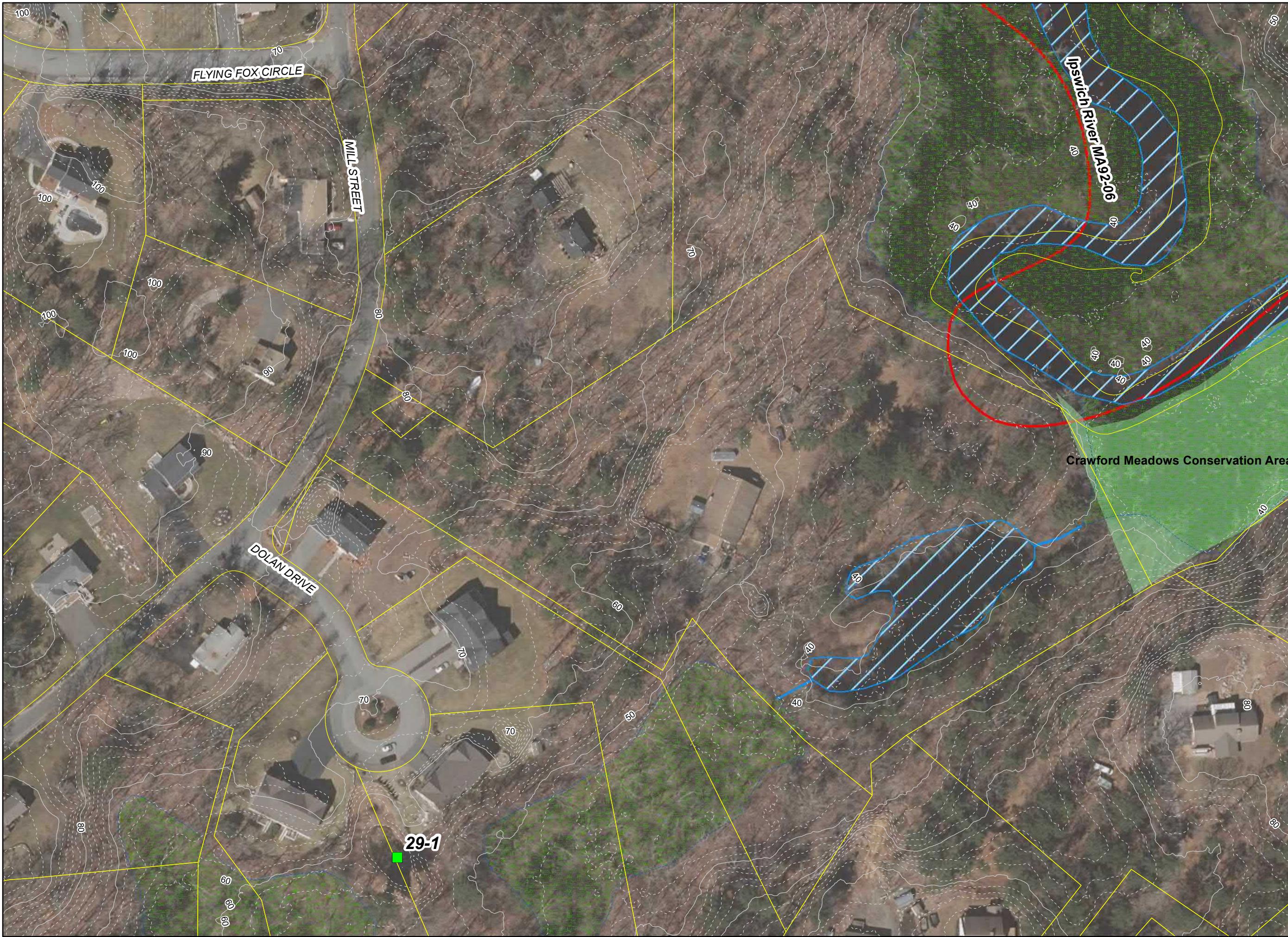
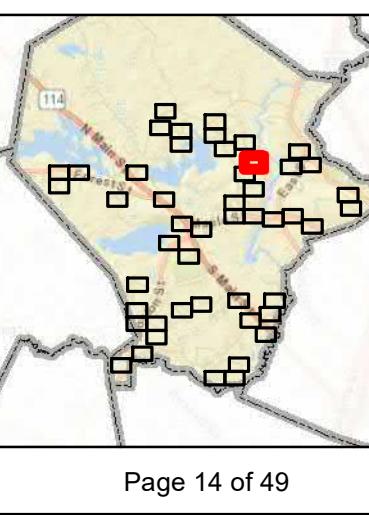
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- Legend**
- BMP - Infiltration Basin
 - 2014 Impaired Waters 303d**
 - 5 - Impaired TMDL req'd
 - DEP Wetlands**
 - Shoreline
 - Hydrologic Connection
 - Wetland Limit
 - Wooded Marsh
 - Open Water
 - 2-ft Contours**
 - Index
 - Intermediate
 - Protected/Recreational**
 - Conservation



1 inch = 100 feet

0 50 100 Feet



GRID MAP

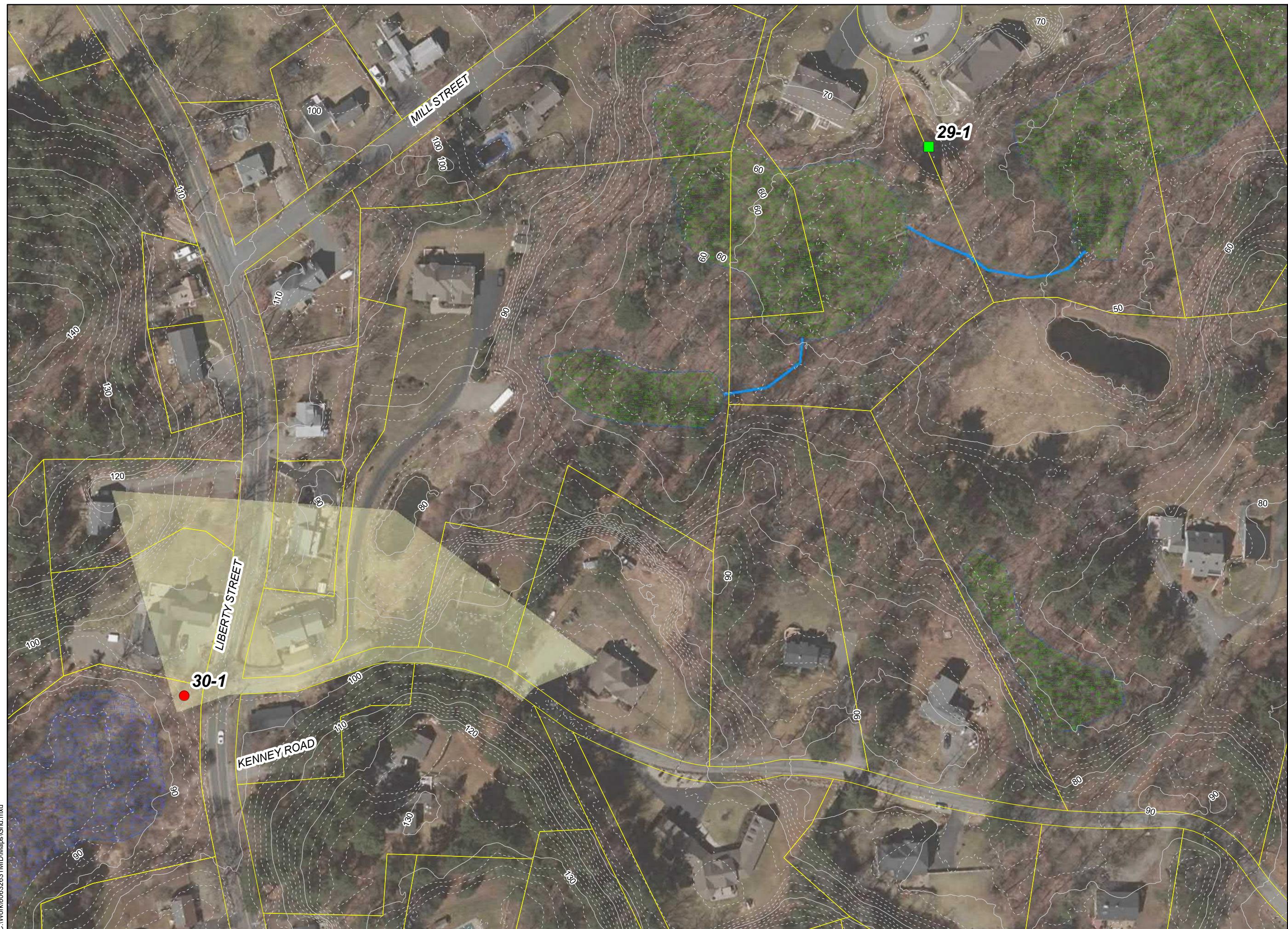
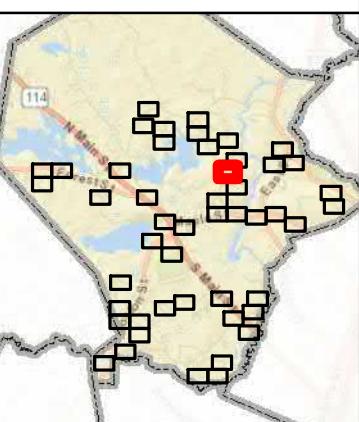
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- Legend**
- BMP - Infiltration Basin
 - Stormwater Outfall
 - Approximate Drainage Area
- DEP Wetlands**
- Hydrologic Connection
 - Wetland Limit
 - Marsh/Bog
 - Wooded Marsh
- 2-ft Contours**
- Index
 - Intermediate



1 inch = 100 feet

0 50 100 Feet



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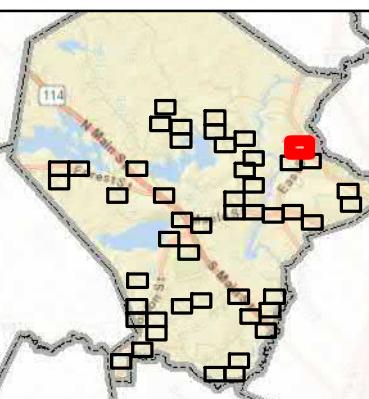
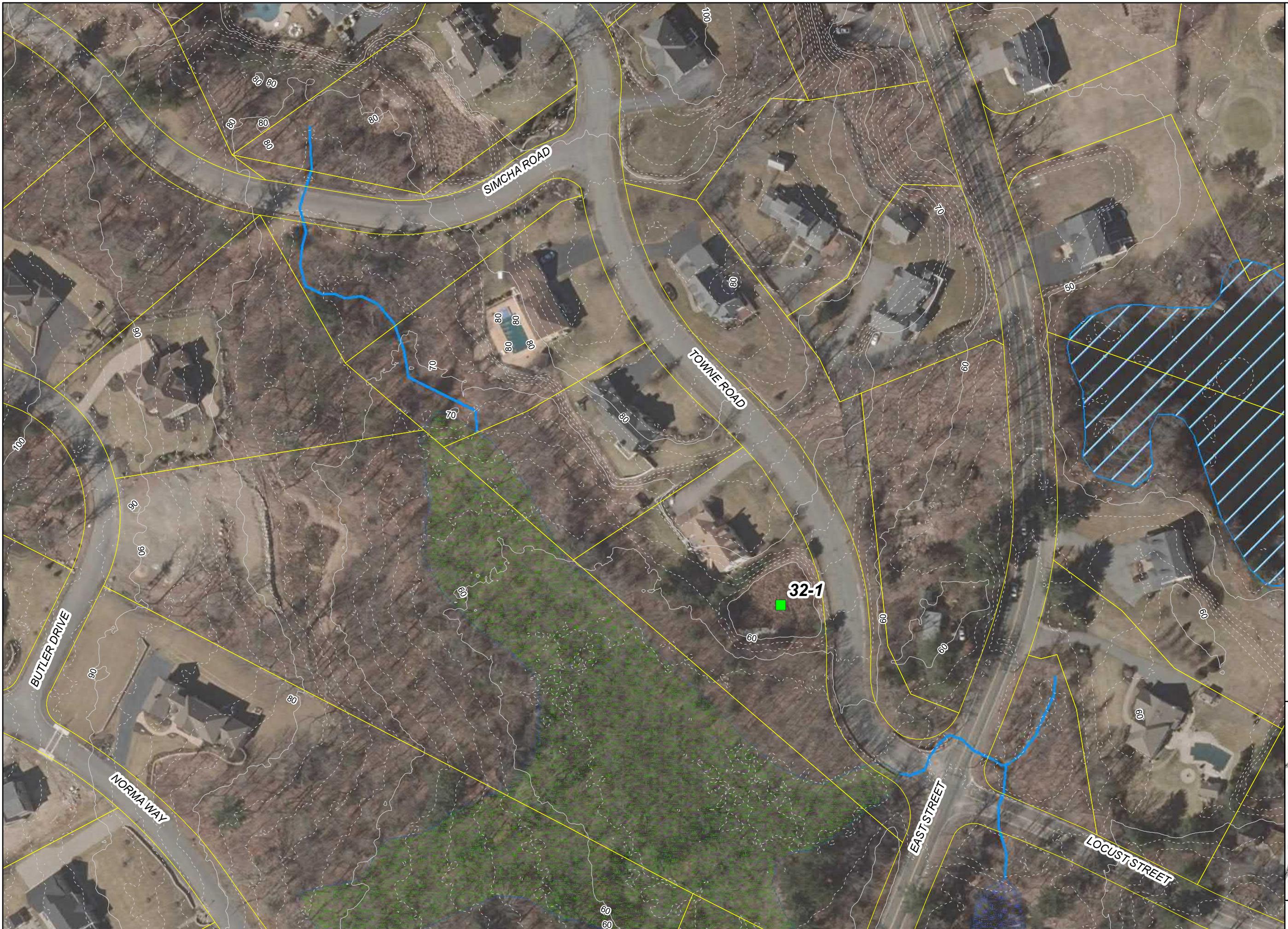
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- Legend**
- BMP - Infiltration Basin
 - DEP Wetlands
 - Shoreline
 - Hydrologic Connection
 - Wetland Limit
 - Marsh/Bog
 - Wooded Marsh
 - Open Water
 - 2-ft Contours
 - Index
 - Intermediate



1 inch = 100 feet

0 50 100 Feet



GRID MAP

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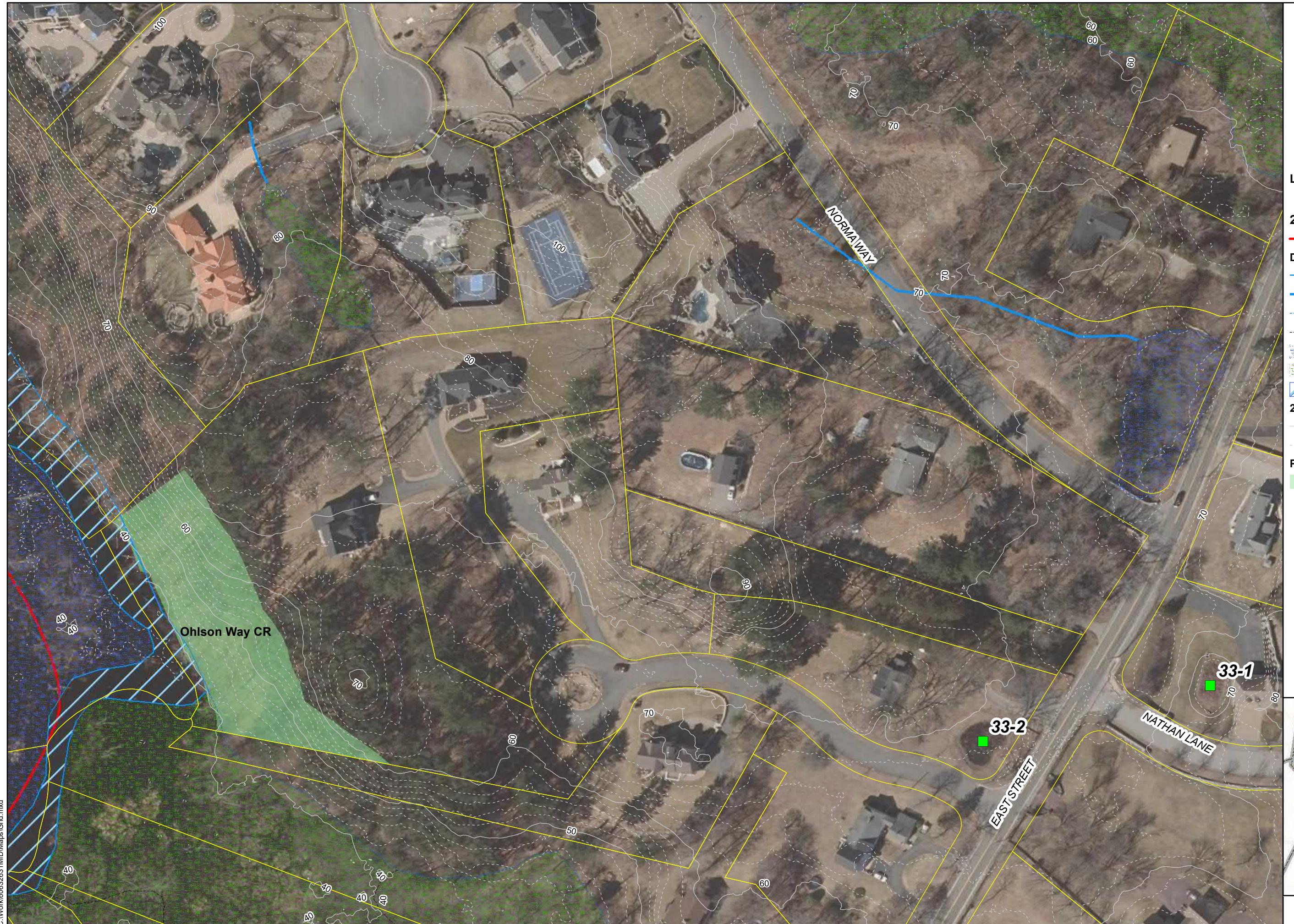
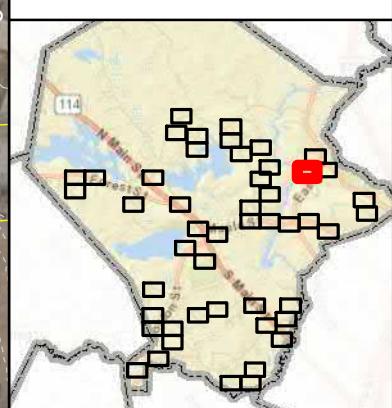
Legend

- BMP - Infiltration Basin
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- Open Water**
- 2-ft Contours**
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 - Intermediate
- Protected/Recreational**
 - Conservation



1 inch = 100 feet

0 50 100 Feet



GRID MAP

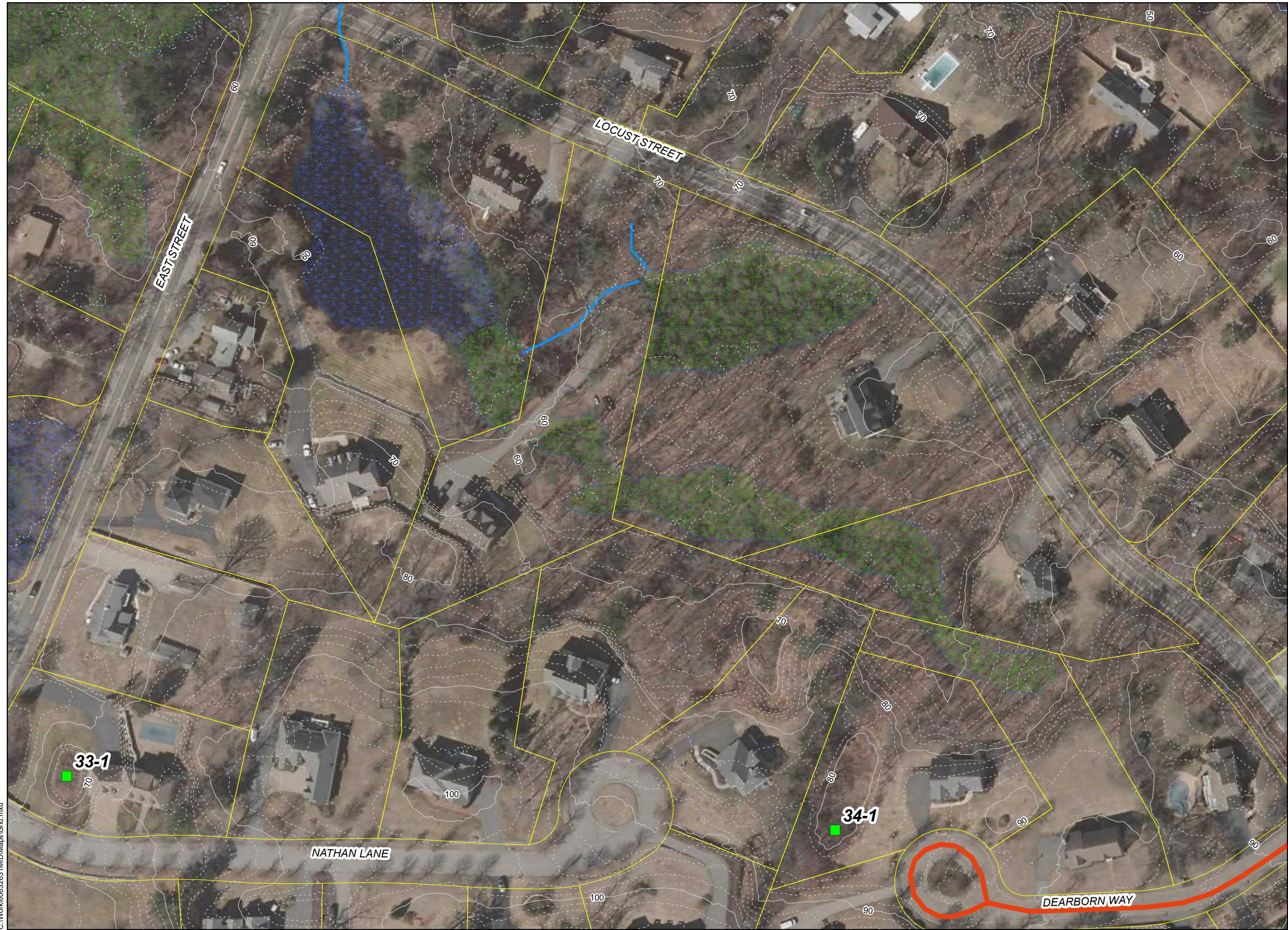
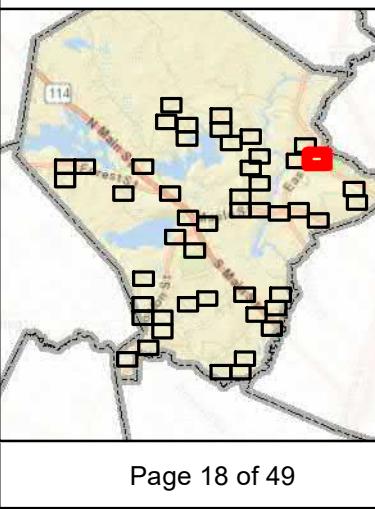
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- Legend**
- BMP - Infiltration Basin
 - DEP Wetlands
 - Hydrologic Connection
 - Wetland Limit
 - Closure Line
 - Marsh/Bog
 - Wooded Marsh
 - 2-ft Contours**
 - Index
 - Intermediate
 - Older Residential Street



1 inch = 100 feet

0 50 100 Feet



GRID MAP

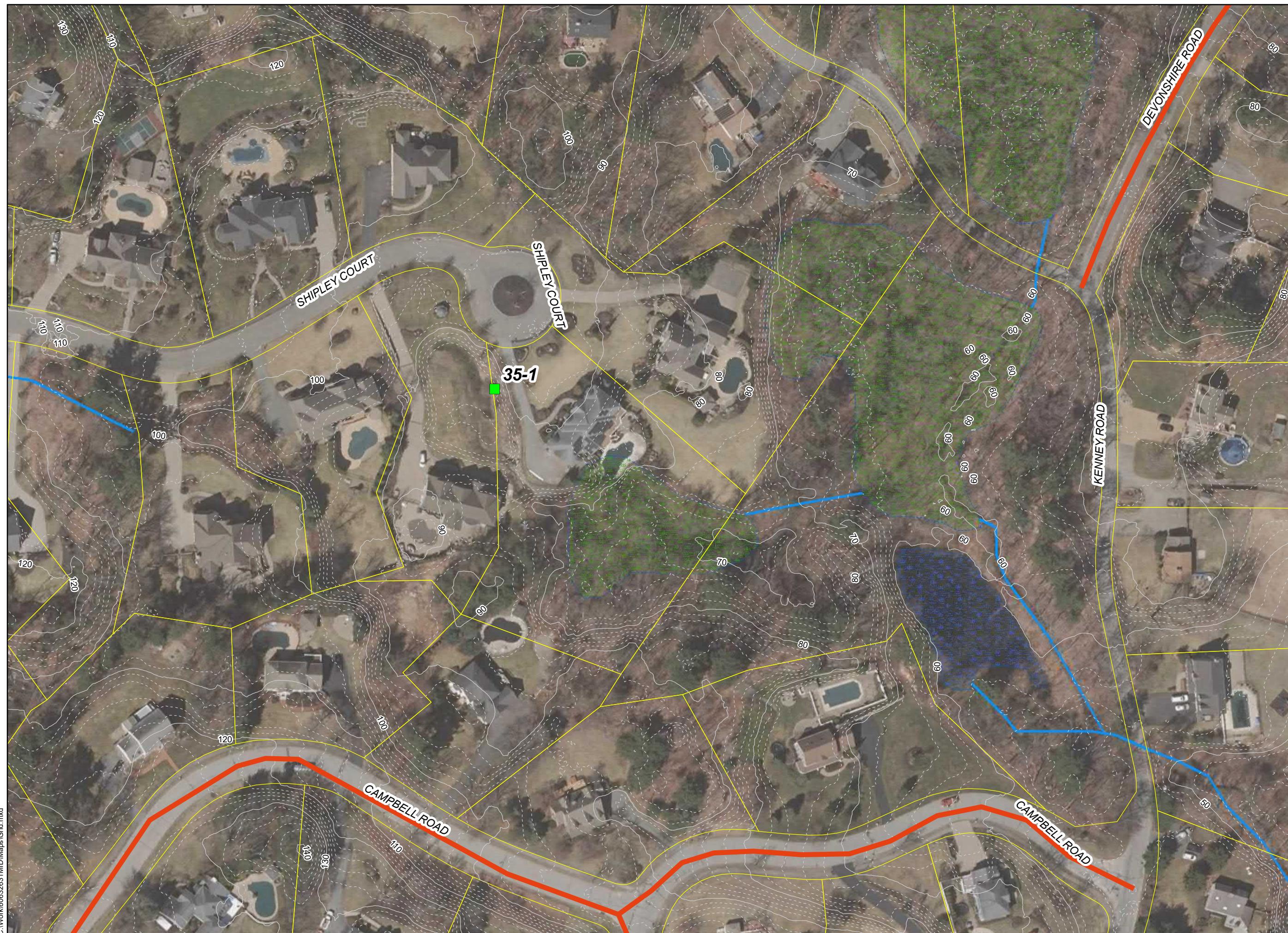
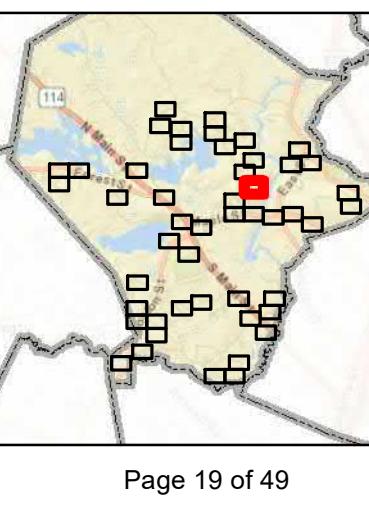
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- Legend**
- BMP - Infiltration Basin
 - DEP Wetlands**
 - Hydrologic Connection
 - Wetland Limit
 - Marsh/Bog
 - Wooded Marsh
 - 2-ft Contours**
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 - Intermediate
 - Older Residential Street



1 inch = 100 feet

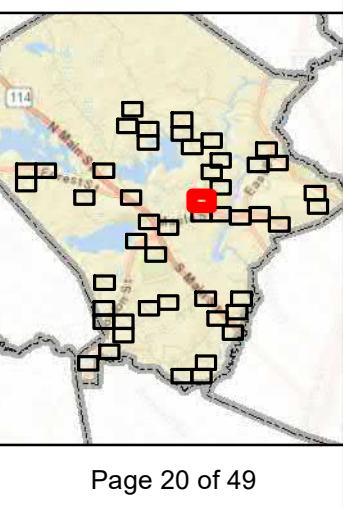
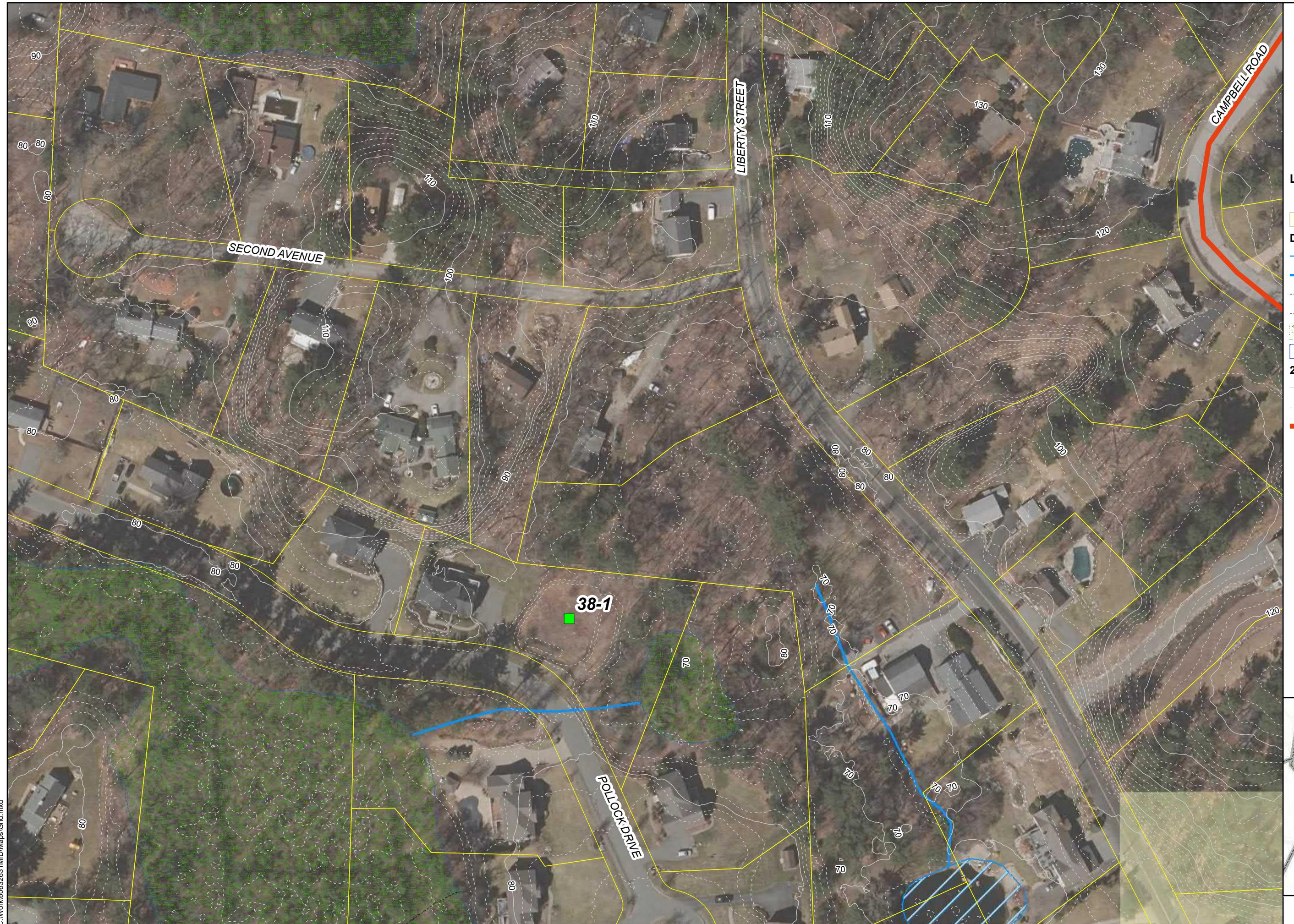
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GRID MAP

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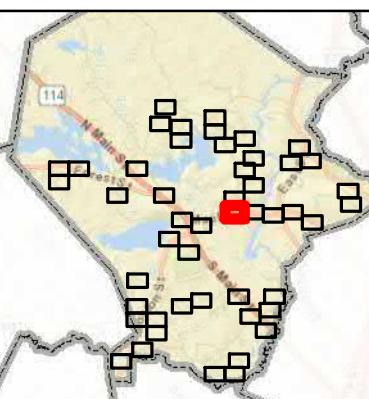
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- Legend**
- Stormwater Outfall
 - Approximate Drainage Area
 - DEP Wetlands**
 - Shoreline
 - Hydrologic Connection
 - Wetland Limit
 - Closure Line
 - Wooded Marsh
 - Open Water
 - 2-ft Contours**
 - Index
 - Intermediate
 - Protected/Recreational**
 - Historical/Cultural



1 inch = 100 feet

0 50 100 Feet



Oakdale Cemetery



GRID MAP

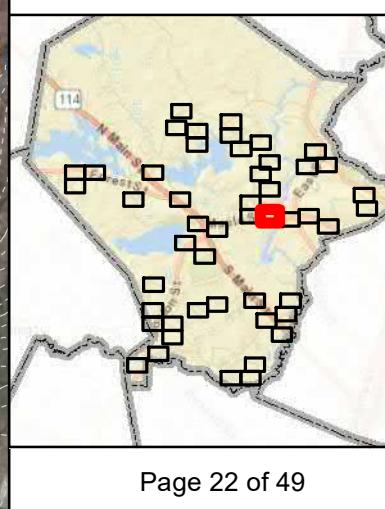
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- Legend**
- Stormwater Outfall
 - 2014 Impaired Waters 303d**
 - Impaired TMDL req'd
 - Approximate Drainage Area
 - DEP Wetlands**
 - Shoreline
 - Hydrologic Connection
 - Wetland Limit
 - Marsh/Bog
 - Wooded Marsh
 - Open Water
 - 2-ft Contours**
 - Index
 - Intermediate
 - Protected/Recreational**
 - Agriculture
 - Historical/Cultural



1 inch = 100 feet

0 50 100 Feet



GRID MAP

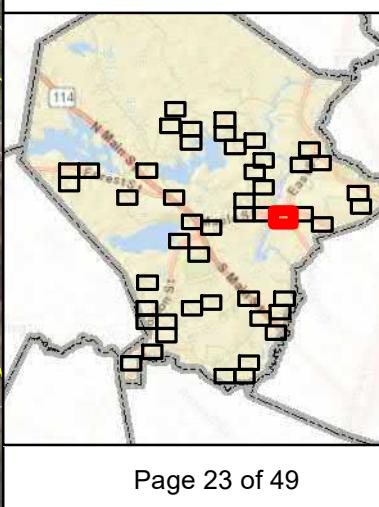
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- Legend**
- Stormwater Outfall
 - ✚ DEP BWP Major Facilities
 - 2014 Impaired Waters 303d**
 - 5 - Impaired TMDL req'd
 - Approximate Drainage Area
 - DEP Wetlands**
 - Shoreline
 - Wetland Limit
 - Closure Line
 - Marsh/Bog
 - Wooded Marsh
 - Open Water
 - 2-ft Contours**
 - Index
 - Intermediate
 - Protected/Recreational**
 - Agriculture
 - Older Residential Street

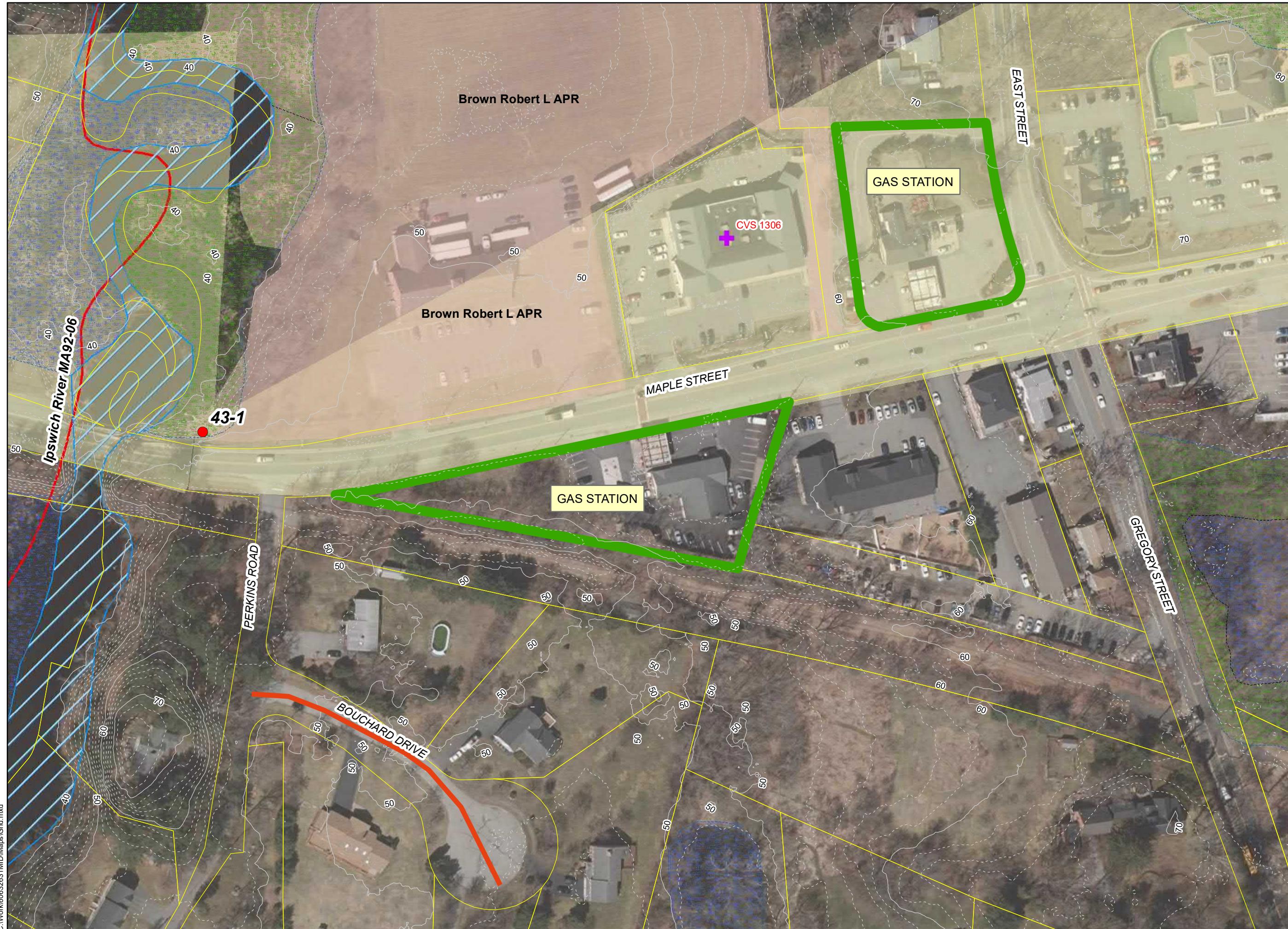


1 inch = 100 feet

0 50 100
Feet



Page 23 of 49



GRID MAP

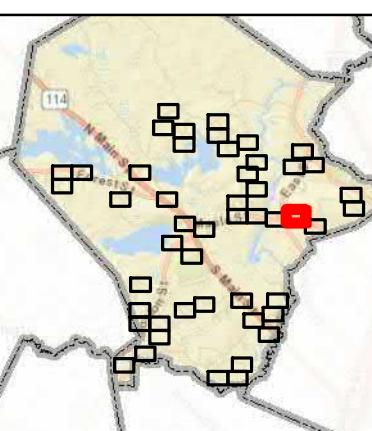
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- Legend**
- Stormwater Outfall
 - Approximate Drainage Area
 - DEP Wetlands**
 - Wetland Limit
 - - - Closure Line
 - Marsh/Bog
 - Wooded Marsh
 - 2-ft Contours**
 - Index
 - - - Intermediate



1 inch = 100 feet

0 50 100 Feet



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GRID MAP

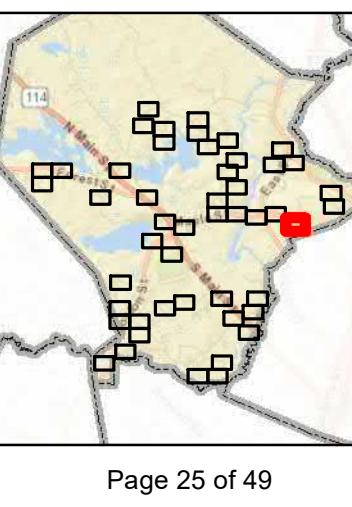
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- Legend**
- Stormwater Outfall
 - Approximate Drainage Area
 - DEP Wetlands**
 - Hydrologic Connection
 - - - Wetland Limit
 -  Marsh/Bog
 -  Wooded Marsh
 - 2-ft Contours**
 - Index
 - - - Intermediate



1 inch = 100 feet

0 50 100 Feet



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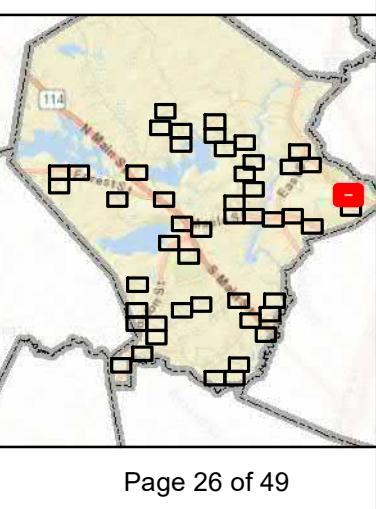
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- Legend**
- BMP - Infiltration Basin
 - Stormwater Outfall
 - Approximate Drainage Area
- DEP Wetlands**
- Hydrologic Connection
 - Wetland Limit
 - Wooded Marsh
- 2-ft Contours**
- Index
 - Intermediate
 - Older Residential Street



1 inch = 100 feet

0 50 100 Feet



GRID MAP

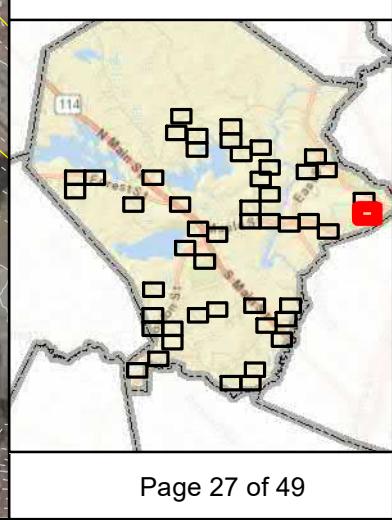
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- Legend**
- Stormwater Outfall
 - Approximate Drainage Area
 - DEP Wetlands**
 - Hydrologic Connection
 - - - Wetland Limit
 - Wooded Marsh
 - 2-ft Contours**
 - Index
 - Intermediate
 - Older Residential Street



1 inch = 100 feet

0 50 100
Feet



GRID MAP

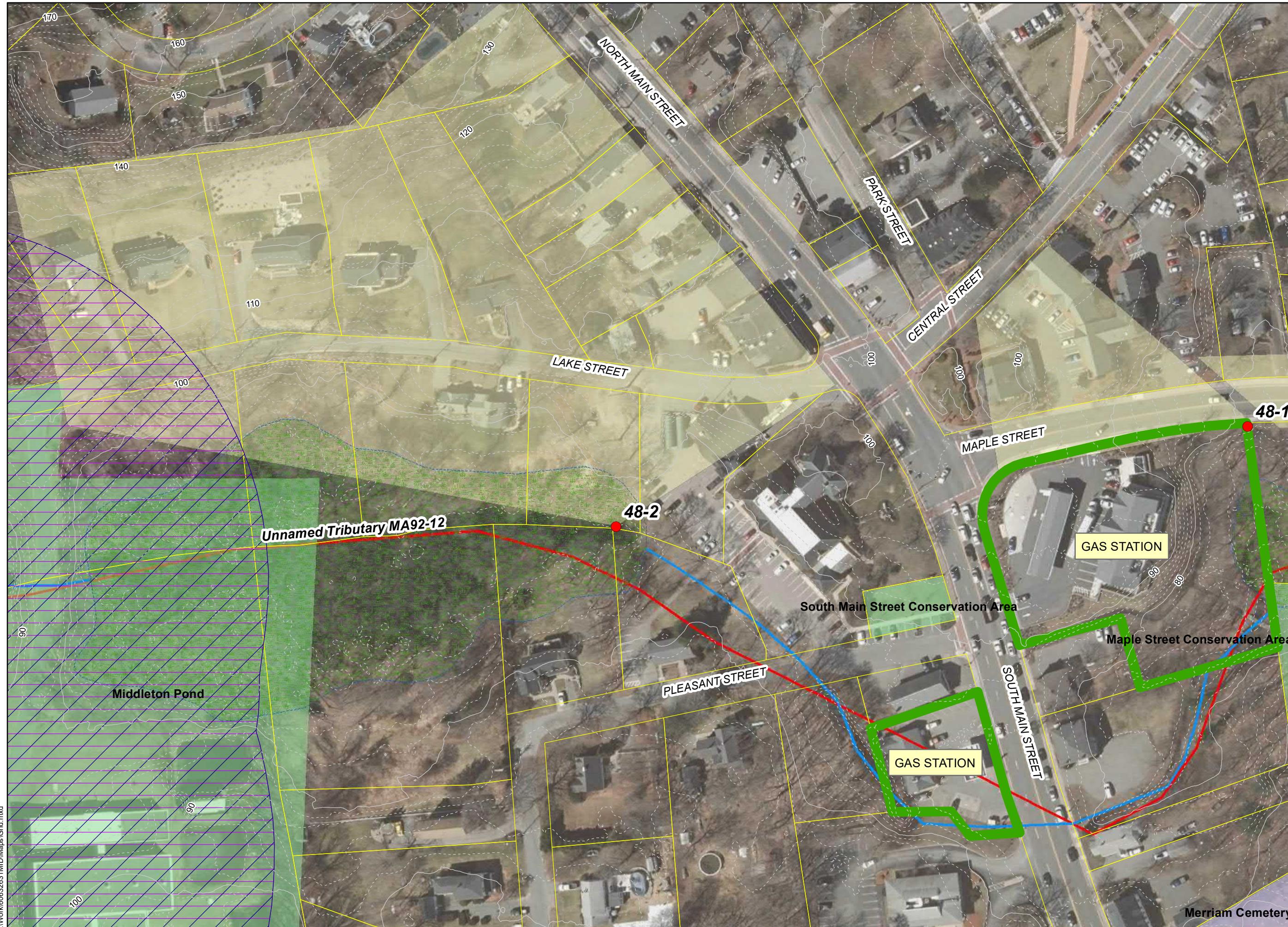
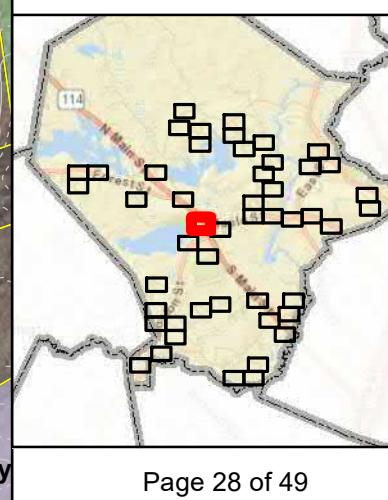
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- Legend**
- Stormwater Outfall
 - 2014 Impaired Waters 303d**
 - 5 - Impaired TMDL req'd
 - Approximate Drainage Area
 - DEP Wetlands**
 - Hydrologic Connection
 - Wetland Limit
 - Wooded Marsh
 - 2-ft Contours**
 - Index
 - Intermediate
 - Protected/Recreational**
 - Conservation
 - Historical/Cultural
 - Surface Water ZONE A
 - Surface Water ZONE B



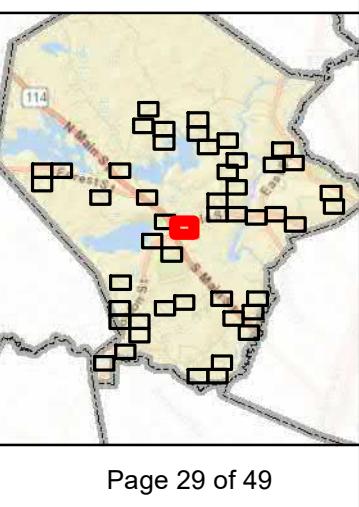
1 inch = 100 feet

0 50 100 Feet



GRID MAP

49



GRID MAP

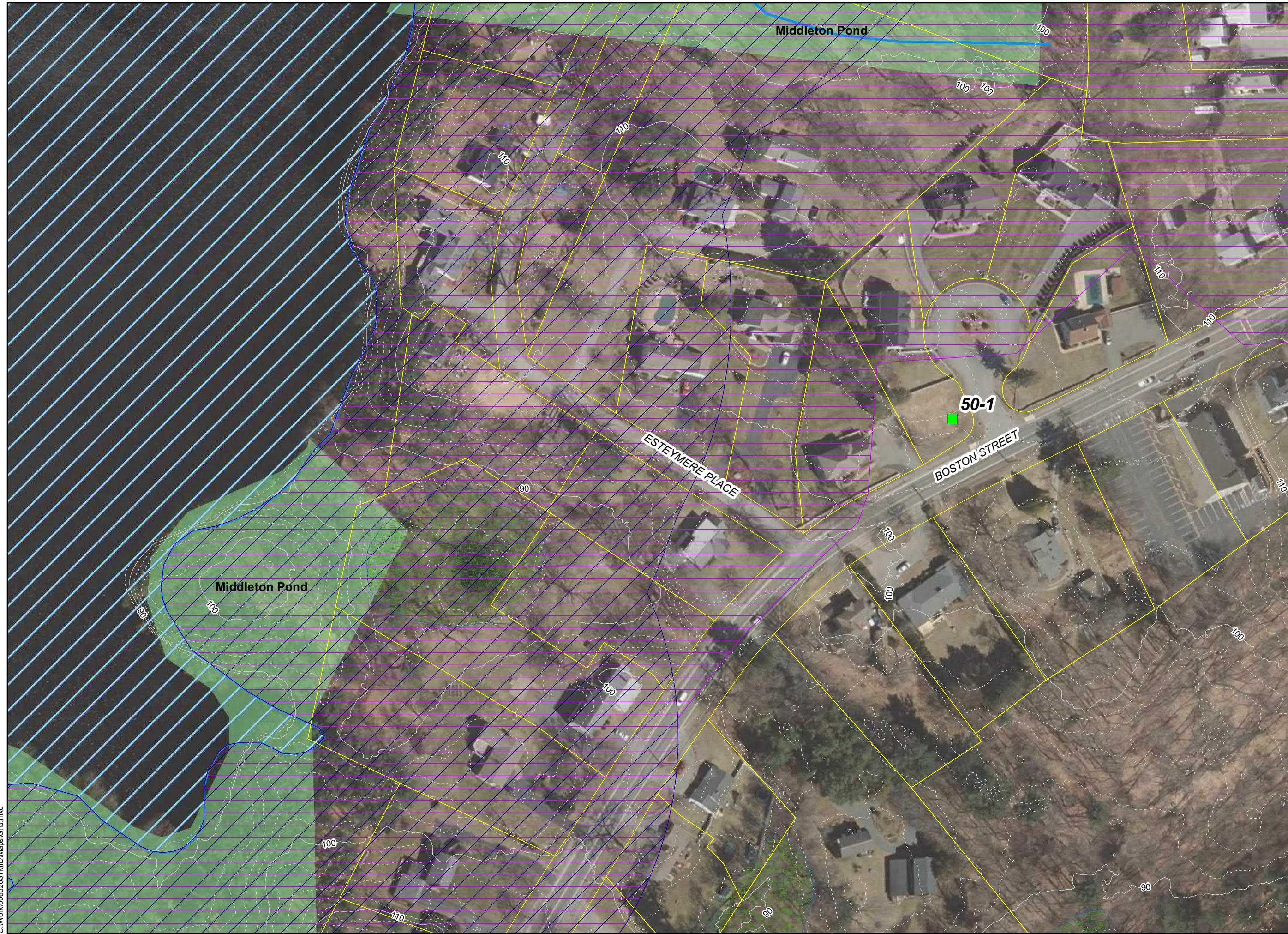
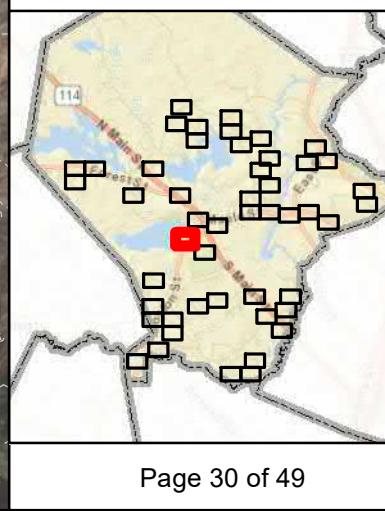
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- Legend**
- BMP - Infiltration Basin
 - DEP Wetlands
 - Shoreline
 - Hydrologic Connection
 - Wetland Limit
 - Wooded Marsh
 - Open Water
- 2-ft Contours**
- Index
 - Intermediate
- Protected/Recreational**
- Conservation
 - Surface Water ZONE A
 - Surface Water ZONE B



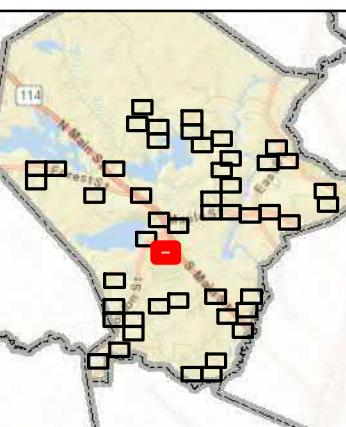
1 inch = 100 feet

0 50 100
Feet



GRID MAP

53



GRID MAP

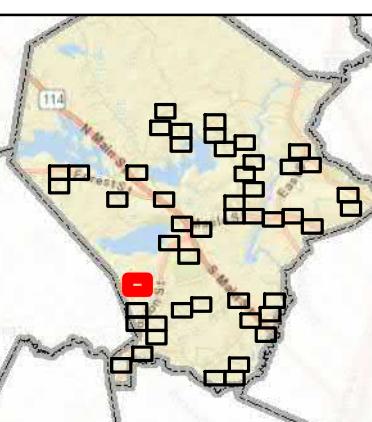
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- Legend**
- BMP - Infiltration Basin
 - Stormwater Outfall
 - Approximate Drainage Area
 - DEP Wetlands**
 - Wetland Limit
 - Wooded Marsh - 2-ft Contours**
 - Index
 - Intermediate - Protected/Recreational**
 - Conservation
 - Surface Water ZONE B
 - Older Residential Street



1 inch = 100 feet

0 50 100 Feet



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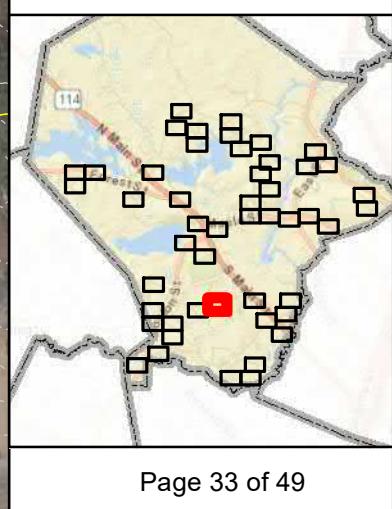
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- Legend**
- Stormwater Outfall
 - Sanitary Discharge
 - Approximate Drainage Area
 - DEP Wetlands**
 - Shoreline
 - Hydrologic Connection
 - Wetland Limit
 - Wooded Marsh
 - Open Water
 - 2-ft Contours**
 - Index
 - Intermediate
 - Older Residential Street



1 inch = 100 feet

0 50 100 Feet



GRID MAP

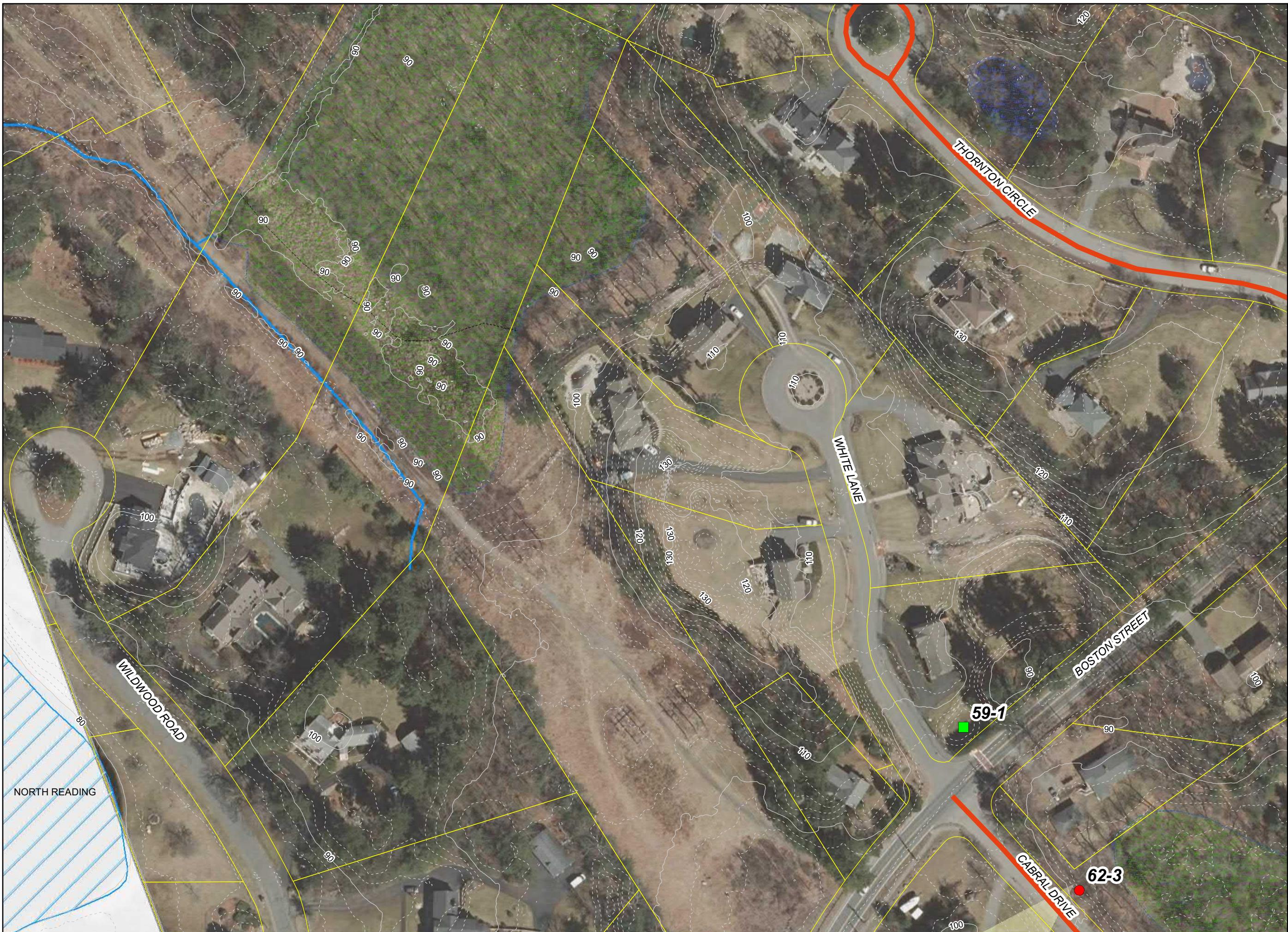
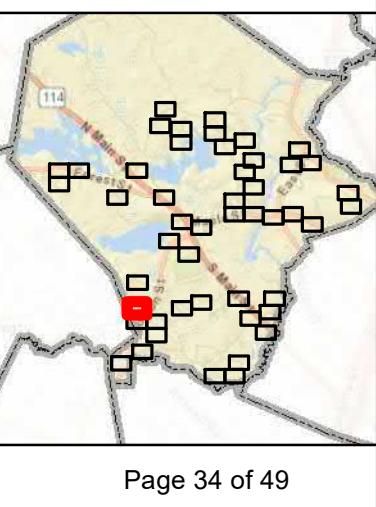
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- Legend**
- BMP - Infiltration Basin
 - Stormwater Outfall
 - Approximate Drainage Area
- DEP Wetlands**
- Shoreline
 - Hydrologic Connection
 - Wetland Limit
 - Closure Line
 - Marsh/Bog
 - Wooded Marsh
 - Open Water
- 2-ft Contours**
- Index
 - Intermediate
 - Older Residential Street



1 inch = 100 feet

0 50 100 Feet



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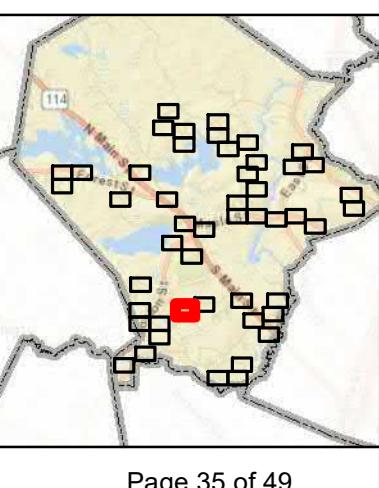
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- Legend**
- Stormwater Outfall
 - Approximate Drainage Area
 - DEP Wetlands**
 - Hydrologic Connection
 - - - Wetland Limit
 - Wooded Marsh
 - 2-ft Contours**
 - Index
 - Intermediate
 - Older Residential Street



1 inch = 100 feet

0 50 100 Feet



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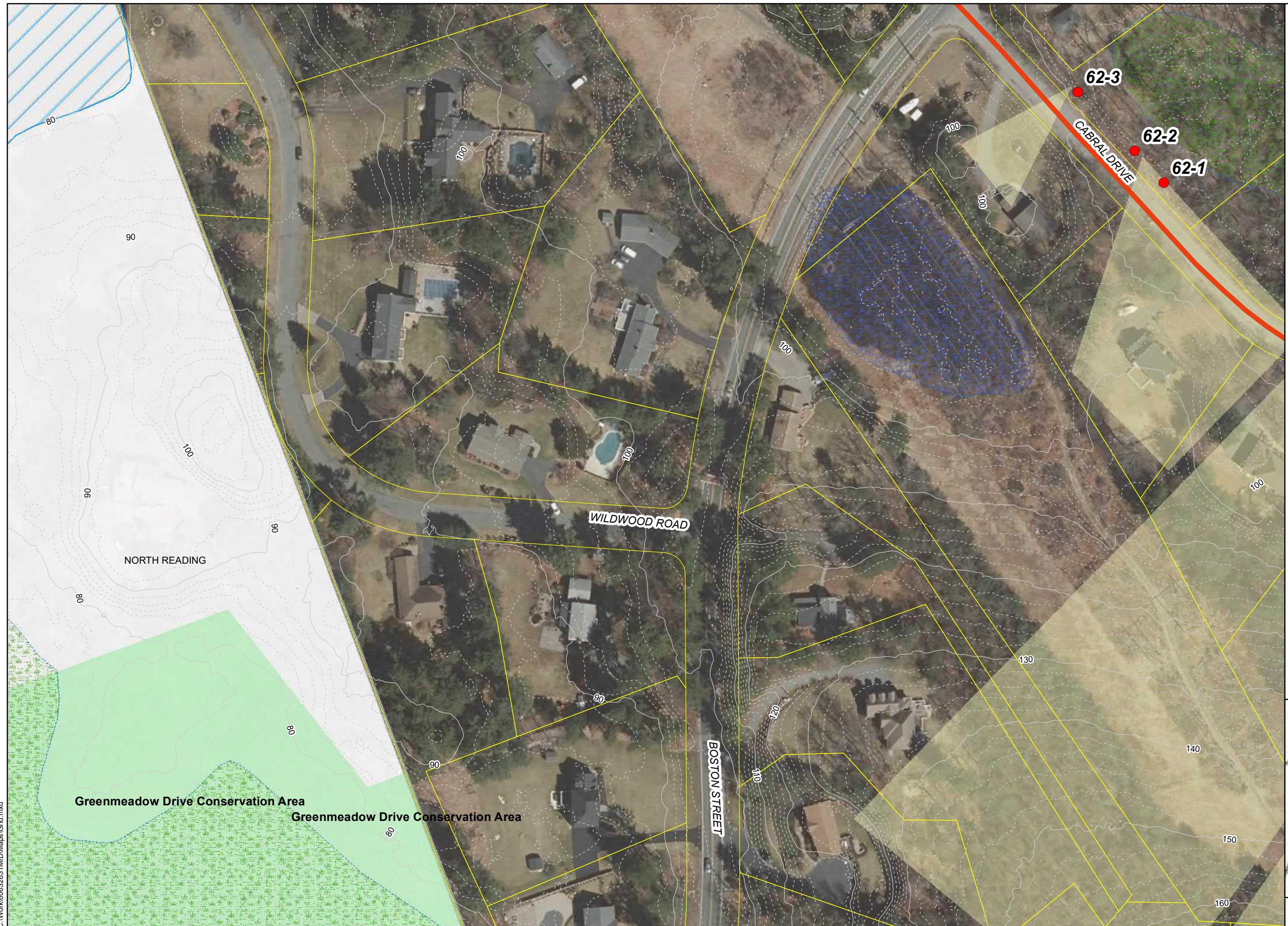
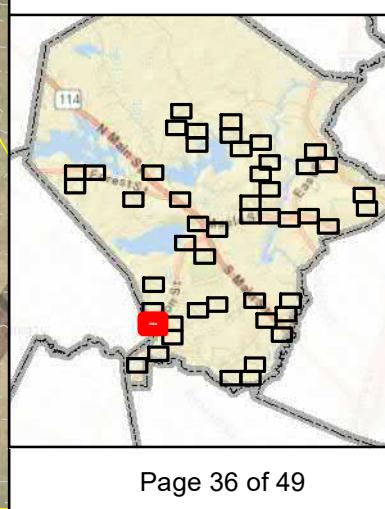
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- Legend**
- Stormwater Outfall
 - Approximate Drainage Area
 - DEP Wetlands**
 - Shoreline
 - - - Wetland Limit
 - Marsh/Bog
 - Wooded Marsh
 - Open Water
 - 2-ft Contours**
 - Index
 - - - Intermediate
 - Protected/Recreational**
 - Conservation
 - Older Residential Street



1 inch = 100 feet

0 50 100 Feet



GRID MAP

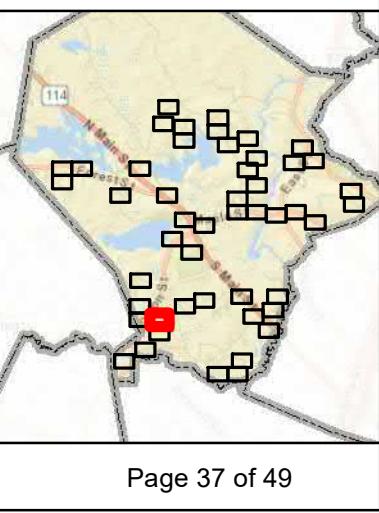
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- Legend**
- Stormwater Outfall
 - Approximate Drainage Area
 - DEP Wetlands**
 - Hydrologic Connection
 - - - Wetland Limit
 - Wooded Marsh
- 2-ft Contours**
- Index
 - Intermediate
 - Older Residential Street



1 inch = 100 feet

0 50 100 Feet



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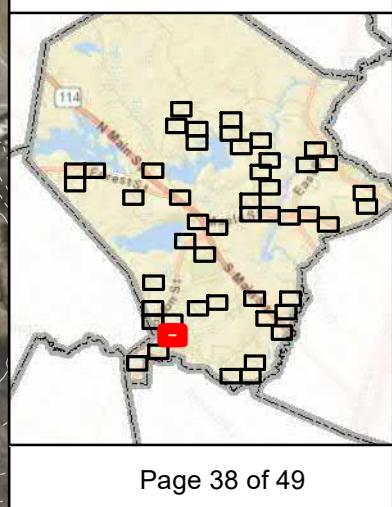
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- Legend**
- Stormwater Outfall
 - Approximate Drainage Area
 - DEP Wetlands**
 - Wetland Limit
 - Wooded Marsh
 - 2-ft Contours**
 - Index
 - Intermediate
 - Older Residential Street



1 inch = 100 feet

0 50 100 Feet



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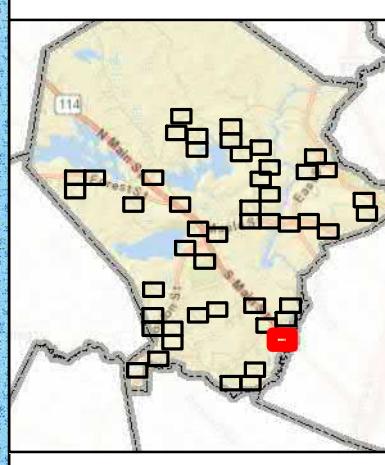
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- Legend**
- Stormwater Outfall
 - 2014 Impaired Waters 303d**
 - 5 - Impaired TMDL req'd
 - Approximate Drainage Area
 - DEP Wetlands**
 - Shoreline
 - Hydrologic Connection
 - Wetland Limit
 - Closure Line
 - Marsh/Bog
 - Wooded Marsh
 - Open Water
 - 2-ft Contours**
 - Index
 - Intermediate
 - Protected/Recreational**
 - Conservation
 - Recreation
 - Water Supply



1 inch = 100 feet

0 50 100 Feet



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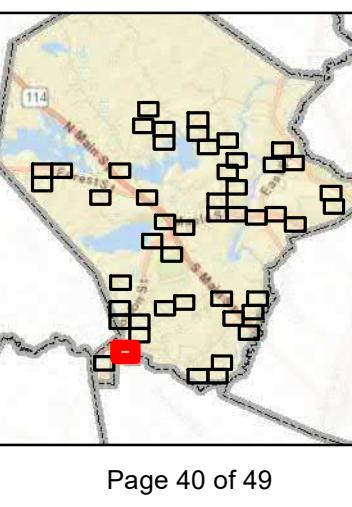
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- Legend**
- BMP - Infiltration Basin
 - 2014 Impaired Waters 303d**
 - 5 - Impaired TMDL req'd
 - DEP Wetlands**
 - Shoreline
 - Hydrologic Connection
 - Wetland Limit
 - Wooded Marsh
 - Open Water
 - 2-ft Contours**
 - Index
 - Intermediate
 - Older Residential Street



1 inch = 100 feet

0 50 100 Feet



GRID MAP

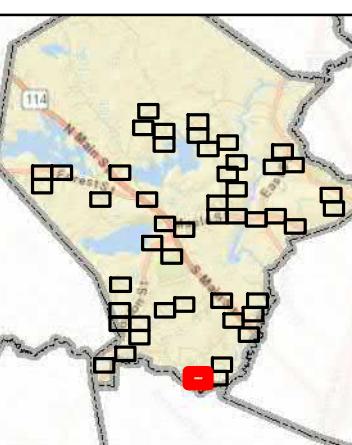
77

- Legend**
- BMP - Infiltration Basin
 - Stormwater Conveyances
 - Registered Compost Sites
 - Landfills
 - 2014 Impaired Waters 303d
 - 5 - Impaired TMDL req'd
 - Approximate Drainage Area
- DEP Wetlands**
- Shoreline
 - Wetland Limit
 - Closure Line
 - Wooded Marsh
 - Open Water
- 2-ft Contours**
- Index
 - Intermediate
 - Older Residential Street



1 inch = 100 feet

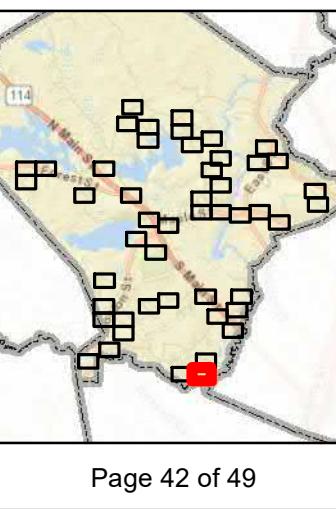
0 50 100 Feet



GRID MAP

78

78



GRID MAP

79

Legend

DEP Wetlands

- Hydrologic Connection
- Wetland Limit
- Wooded Marsh

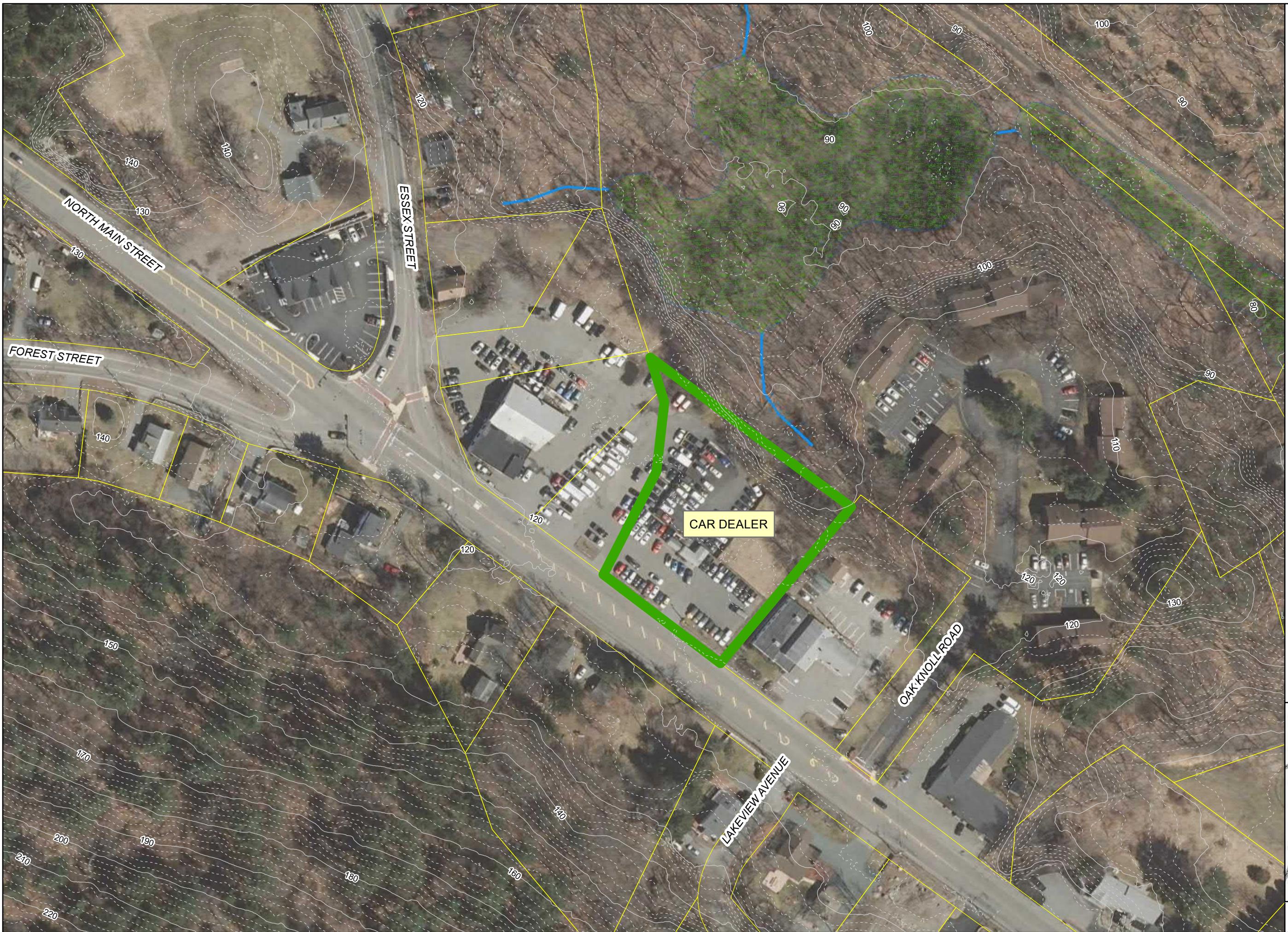
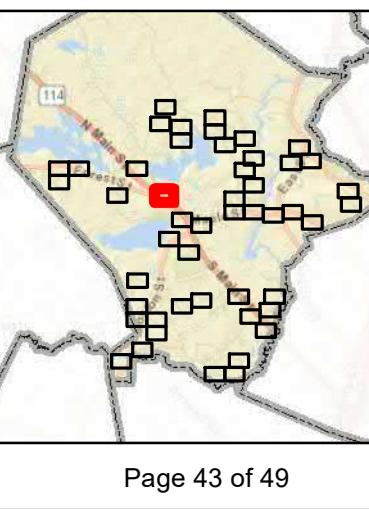
2-ft Contours

- Index
- Intermediate



1 inch = 100 feet

0 50 100
Feet



GRID MAP

80

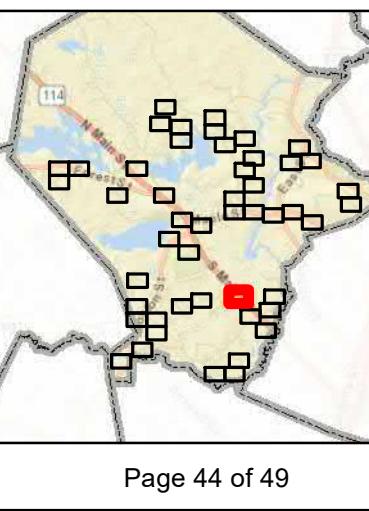
Legend

- DEP BWP Major Facilities
- DEP Wetlands
 - Wetland Limit
 - Closure Line
 - Marsh/Bog
 - Wooded Marsh
- 2-ft Contours
 - Index
 - Intermediate



1 inch = 100 feet

0 50 100
Feet



GRID MAP

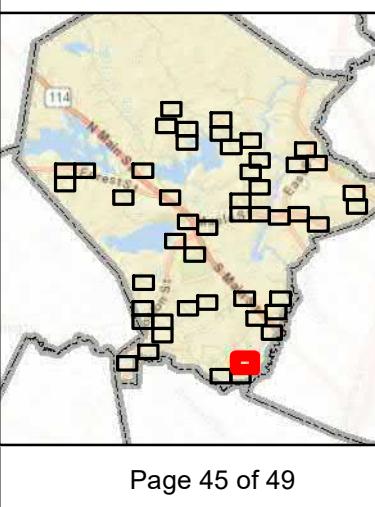
81

- Legend**
- Landfills
 - Approximate Drainage Area
 - DEP Wetlands**
 - Shoreline
 - Hydrologic Connection
 - Wetland Limit
 - Marsh/Bog
 - Wooded Marsh
 - Open Water
 - 2-ft Contours**
 - Index
 - Intermediate
 - Protected/Recreational**
 - Conservation



1 inch = 100 feet

0 50 100
Feet



Natsue Way Conservation Area



GRID MAP

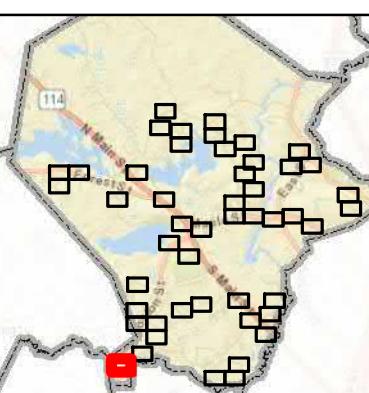
82

- Legend**
- DEP BWP Major Facilities
 - 2014 Impaired Waters 303d
 - 5 - Impaired TMDL req'd
 - DEP Wetlands**
 - Shoreline
 - Hydrologic Connection
 - Wetland Limit
 - Marsh/Bog
 - Wooded Marsh
 - Open Water
 - 2-ft Contours**
 - Index
 - Intermediate



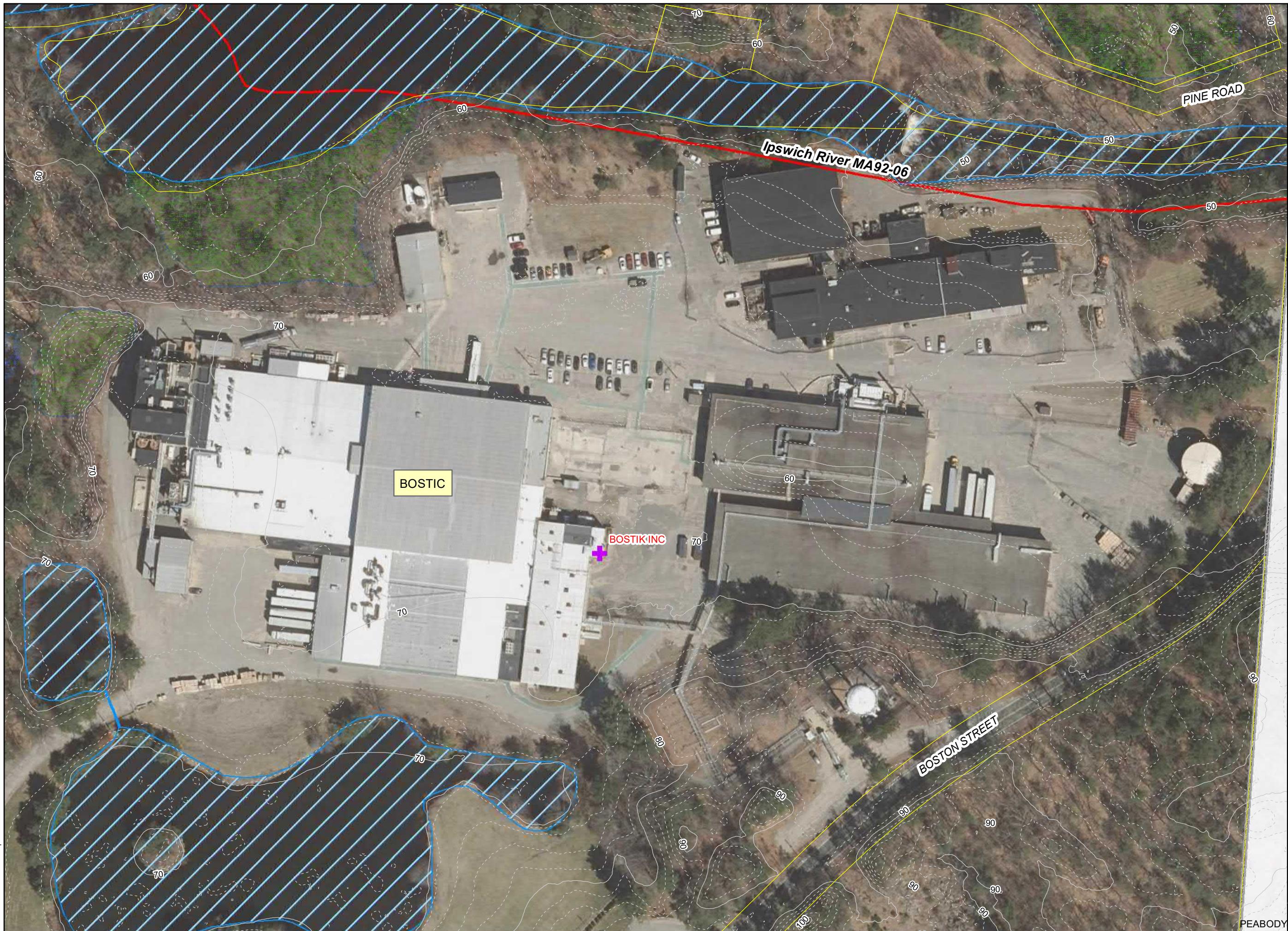
1 inch = 100 feet

0 50 100
Feet



PEABODY

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GRID MAP

83

Legend

DEP Wetlands

- Shoreline
- Hydrologic Connection
- Open Water

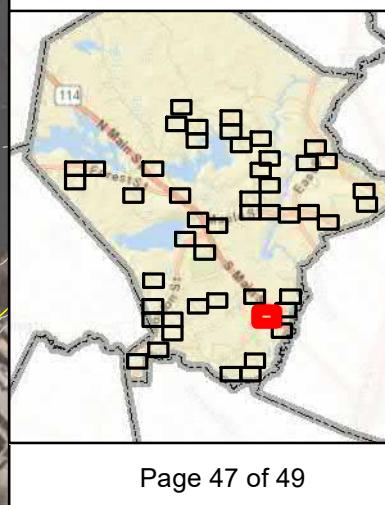
2-ft Contours

- Index
- Intermediate



1 inch = 100 feet

0 50 100
Feet



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GRID MAP

84

Legend

2014 Impaired Waters 303d

- 5 - Impaired TMDL req'd
- DEP Wetlands**
- Shoreline
- Wetland Limit
- Closure Line
- Marsh/Bog
- Wooded Marsh
- Open Water

2-ft Contours

- Index
- Intermediate

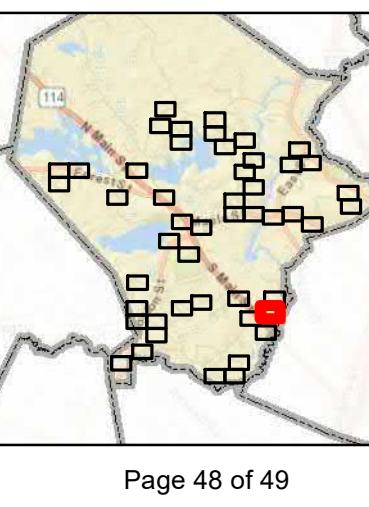
Protected/Recreational

- Conservation
- Recreation



1 inch = 100 feet

0 50 100
Feet



GRID MAP

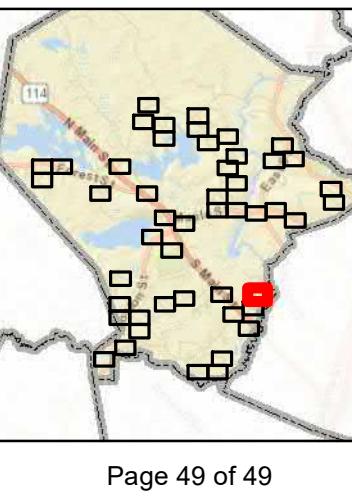
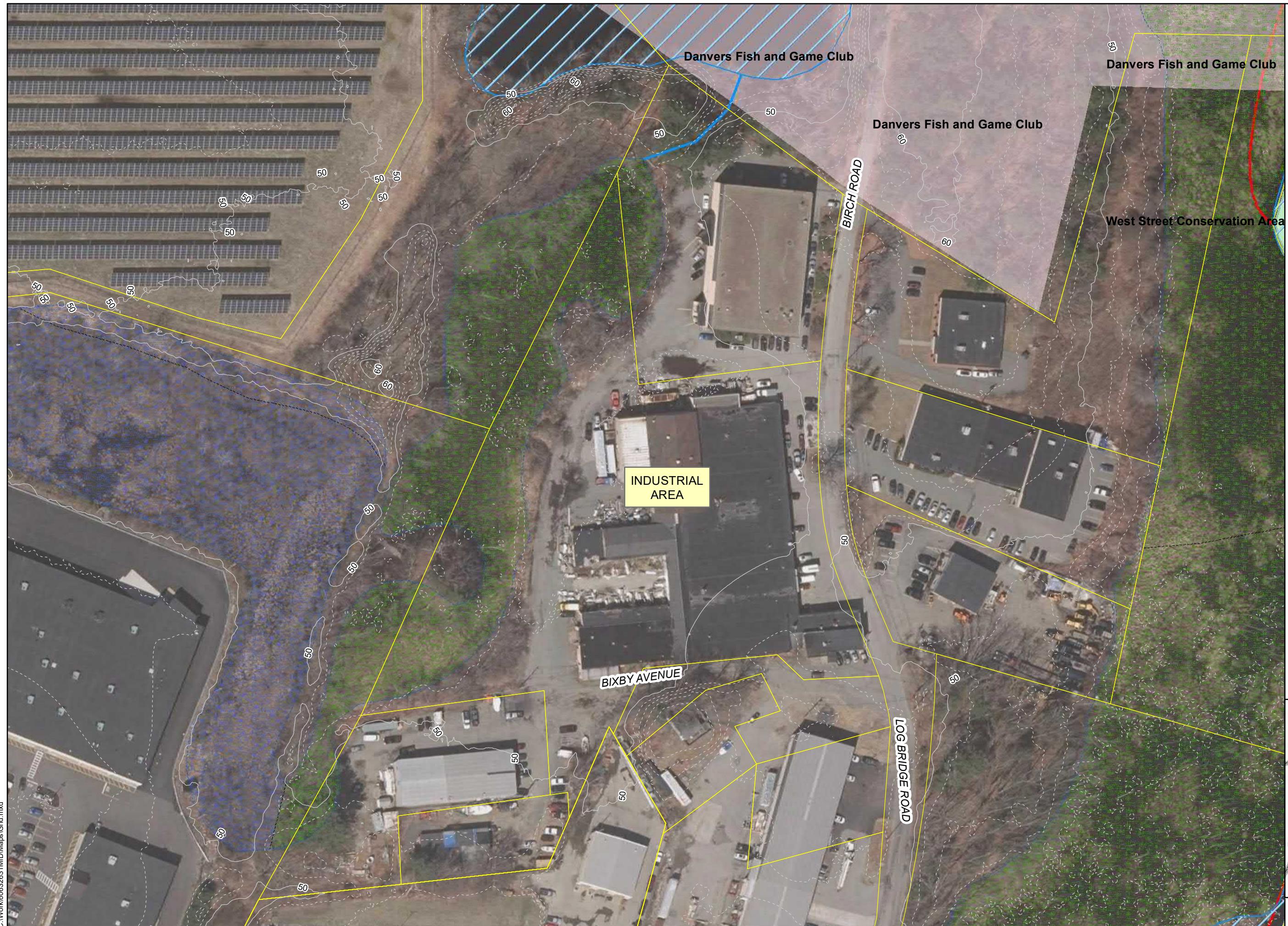
85

- Legend**
- 2014 Impaired Waters 303d**
 - 5 - Impaired TMDL req'd
 - DEP Wetlands**
 - Shoreline
 - Hydrologic Connection
 - Wetland Limit
 - Closure Line
 - Marsh/Bog
 - Wooded Marsh
 - Open Water
 - 2-ft Contours**
 - Index
 - Intermediate
 - Protected/Recreational**
 - Conservation
 - Recreation



1 inch = 100 feet

0 50 100
Feet



Appendix C

Field Forms and Inspection SOPs

SOP 1: DRY WEATHER OUTFALL INSPECTION

Introduction

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

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

Objectives of Dry Weather Inspections

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

Visual Condition Assessment

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

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

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

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

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

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

Conditional and Qualitative Considerations

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

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

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

Some of the indicators can have multiple causes or sources. For example, both bacteria and petroleum can create a sheen on the water surface. The source of the sheen can be differentiated by disturbing it, such as with a pole. A sheen caused by oil will remain intact and move in a swirl pattern; a sheen caused by bacteria will separate and appear “blocky”. Bacterial or naturally occurring sheens are usually silver or relatively dull in color and will break up into a number of small patches of sheen. The cause may be

presence of iron, decomposition of organic material or presence of certain bacteria. Bacterial sheen is not a pollutant but should be noted.

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

Measuring Water Quality

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

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

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

Analytical Sample Collection

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

Protocols for collecting a grab sample shall include the following:

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

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

Analytical Sample Quality Control and Assurance

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

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

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

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

Attachments

1. Dry Weather Outfall Inspection Survey

Related Standard Operating Procedures

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

Outfall ID: _____

Town: _____

Inspector: _____

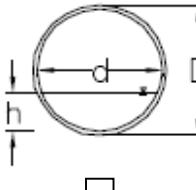
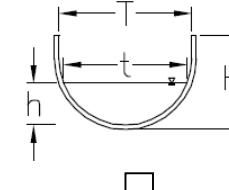
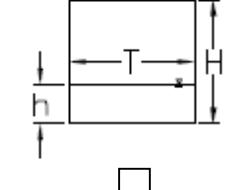
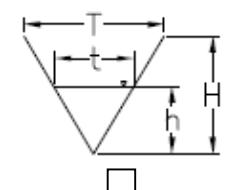
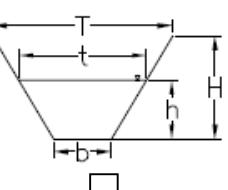
Date: _____

Street Name _____

Last rainfall event _____



DRY WEATHER OUTFALL INSPECTION SURVEY

Type of Outfall (check one):		Pipe Outfall <input type="checkbox"/>	Open Swale Outfall <input type="checkbox"/>			
Outfall Label:		Stencil <input type="checkbox"/>	Ground Inset <input type="checkbox"/>	Sign <input type="checkbox"/>	None <input type="checkbox"/>	Other _____
Pipe Material:	Concrete <input type="checkbox"/>	Pipe Condition:			Good <input type="checkbox"/>	Poor <input type="checkbox"/>
	Corrugated metal <input type="checkbox"/>				Fair <input type="checkbox"/>	Crumbling <input type="checkbox"/>
	Clay Tile <input type="checkbox"/>					
	Plastic <input type="checkbox"/>					
	Other: _____ <input type="checkbox"/>					
Swale Material:	Paved (asphalt) <input type="checkbox"/>	Swale Condition:			Good <input type="checkbox"/>	Poor <input type="checkbox"/>
	Concrete <input type="checkbox"/>				Fair <input type="checkbox"/>	Crumbling <input type="checkbox"/>
	Earthen <input type="checkbox"/>					
	Stone <input type="checkbox"/>					
	Other: _____ <input type="checkbox"/>					
Shape of Pipe/Swale (check one)						
 <input type="checkbox"/>		 <input type="checkbox"/>	 <input type="checkbox"/>	 <input type="checkbox"/>	 <input type="checkbox"/>	
Rounded Pipe/Swale		Rectangular Pipe/Swale	Triangular Swale	Trapezoidal Swale		
Pipe Measurements:		Swale Measurements:		Is there a headwall?		Location Sketch
Inner Dia. (in): d= _____		Swale Width (in): T= _____		Yes <input type="checkbox"/> No <input type="checkbox"/>		
Outer Dia. (in): D= _____		Flow Width (in): t = _____		Condition:		
Pipe Width (in): T= _____		Swale Height (in): H= _____		Good <input type="checkbox"/> Poor <input type="checkbox"/>		
Pipe Height (in): H= _____		Flow Height (in): h= _____ *		Fair <input type="checkbox"/> Crumbling <input type="checkbox"/>		
Flow Width (in): h= _____ *		Bottom Width (in): b= _____				
Description of Flow: Heavy <input type="checkbox"/> Moderate <input type="checkbox"/> Trickling <input type="checkbox"/> Dry <input type="checkbox"/>						
If the outlet is submerged check yes and indicate approximate height of water above the outlet invert. h above invert (in):						
Circle All Materials Present:						
Odor:		Yes <input type="checkbox"/> No <input type="checkbox"/>		Rip rap		
Optical enhancers suspected?		Yes <input type="checkbox"/> No <input type="checkbox"/>		Sheen: Bacterial		
Has channelization occurred?		Yes <input type="checkbox"/> No <input type="checkbox"/>		Excessive sediment		
Has scouring occurred below the outlet?		Yes <input type="checkbox"/> No <input type="checkbox"/>		Petroleum		
Required Maintenance:		Tree Work Ditch Work Structural Corrosion N/A		Remove Trash/Debris Blocked Pipe Erosion at Structure Other		Foam
Comments:						

OUTFALL INSPECTION FORM

OUTFALL RECONNAISSANCE INVENTORY/ SAMPLE COLLECTION FIELD SHEET

Section 1: Background Data

Subwatershed:	Outfall ID:			
Today's date:	Time (Military):			
Investigators:	Form completed by:			
Temperature (°F):	Rainfall (in.):	Last 24 hours:	Last 48 hours:	
Latitude:	Longitude:	GPS Unit:	GPS LMK #:	
Camera:	Photo #: _____			
Land Use in Drainage Area (Check all that apply):				
<input type="checkbox"/> Industrial <input type="checkbox"/> Ultra-Urban Residential <input type="checkbox"/> Commercial <input type="checkbox"/> Open Space <input type="checkbox"/> Suburban Residential <input type="checkbox"/> Institutional				
Other: _____		Known Industries: _____		
Notes (e.g., origin of outfall, if known): _____				

Section 2: Outfall Description

LOCATION	MATERIAL	SHAPE	DIMENSIONS (IN.)	SUBMERGED
<input type="checkbox"/> Closed Pipe	<input type="checkbox"/> RCP <input type="checkbox"/> CMP	<input type="checkbox"/> Circular <input type="checkbox"/> Single	Diameter, circular: _____	In Water: <input type="checkbox"/> No <input type="checkbox"/> Partially* <input type="checkbox"/> Fully*
	<input type="checkbox"/> PVC <input type="checkbox"/> HDPE	<input type="checkbox"/> Elliptical <input type="checkbox"/> Double	Box: h - _____ w - _____	With Sediment: <input type="checkbox"/> No <input type="checkbox"/> Partially <input type="checkbox"/> Fully
<input type="checkbox"/> Manhole	<input type="checkbox"/> Steel	<input type="checkbox"/> Box	Elliptical: h - _____ w - _____	
	<input type="checkbox"/> Other: _____	<input type="checkbox"/> Other: _____	<input type="checkbox"/> Triple <input type="checkbox"/> Other: _____	
<input type="checkbox"/> Open drainage	<input type="checkbox"/> Concrete <input type="checkbox"/> rip-rap <input type="checkbox"/> Earthen	<input type="checkbox"/> Trapezoid <input type="checkbox"/> Other: _____	Depth: _____	Bottom Width: _____
	<input type="checkbox"/> Other: _____	<input type="checkbox"/> Parabolic		Top Width: _____
<input type="checkbox"/> In-Stream	Complete Stream Discharge form			
Flow Present?	<input type="checkbox"/> Yes <input type="checkbox"/> No	If No, Skip to Section 5	Flow Description	<input type="checkbox"/> Trickle <input type="checkbox"/> Moderate <input type="checkbox"/> Substantial
*Tidal?	<input type="checkbox"/> Yes <input type="checkbox"/> No	If yes, stage	<input type="checkbox"/> Flood <input type="checkbox"/> Ebb	Time: _____

Section 3: Quantitative Characterization

FIELD DATA FOR FLOWING OUTFALLS				
PARAMETER		RESULT	UNIT	EQUIPMENT
<input type="checkbox"/> Flow #1	Volume		Liter	Bottle
	Time to fill		Sec	Stopwatch
<input type="checkbox"/> Flow #2 (only for free-flowing outfalls)	Flow depth		In	Tape measure
	Wetted width		ft	Tape measure
<input type="checkbox"/> Flow #3	Flow width	_____ " _____ "	Ft, In	Tape measure
	Flow depth		In	Tape measure
	Time of travel (avg)	1. _____ 2. _____ 3. _____	Sec	Stop watch
	Measured length	_____ " _____ "	Ft, In	Tape measure
Ammonia		mg/L	Specific ion probe Type: _____	

Outfall Reconnaissance Inventory Field Sheet

Section 4: Physical Indicators for Flowing Outfalls Only

Are Any Physical Indicators Present in the flow? Yes No *(If No, Skip to Section 5)*

INDICATOR	CHECK if Present	DESCRIPTION	RELATIVE SEVERITY INDEX (1-3)		
Odor	<input type="checkbox"/>	<input type="checkbox"/> Sewage <input type="checkbox"/> Rancid/sour <input type="checkbox"/> Petroleum/gas <input type="checkbox"/> Sulfide <input type="checkbox"/> Other:	<input type="checkbox"/> 1 – Faint	<input type="checkbox"/> 2 – Easily detected	<input type="checkbox"/> 3 – Noticeable from a distance
Color	<input type="checkbox"/>	<input type="checkbox"/> Clear <input type="checkbox"/> Brown <input type="checkbox"/> Gray <input type="checkbox"/> Yellow <input type="checkbox"/> Green <input type="checkbox"/> Orange <input type="checkbox"/> Red <input type="checkbox"/> Other:	<input type="checkbox"/> 1 – Faint colors in sample bottle	<input type="checkbox"/> 2 – Clearly visible in sample bottle	<input type="checkbox"/> 3 – Clearly visible in outfall flow
Turbidity	<input type="checkbox"/>	See severity	<input type="checkbox"/> 1 – Slight cloudiness	<input type="checkbox"/> 2 – Cloudy	<input type="checkbox"/> 3 – Opaque
Floatables -Does Not Include Trash!!	<input type="checkbox"/>	<input type="checkbox"/> Sewage (Toilet Paper, etc.) <input type="checkbox"/> Suds <input type="checkbox"/> Petroleum (oil sheen) <input type="checkbox"/> Other:	<input type="checkbox"/> 1 – Few/ slight; origin not obvious	<input type="checkbox"/> 2 – Some; indications of origin (e.g., possible suds or oil sheen)	<input type="checkbox"/> 3 – Some; origin clear (e.g., obvious oil sheen, suds, or floating sanitary materials)

Section 5: Physical Indicators for Both Flowing and Non-Flowing Outfalls

Are physical indicators that are not related to flow present? Yes No *(If No, Skip to Section 6)*

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

Section 6: Overall Outfall Characterization

Unlikely Potential (presence of two or more indicators) Suspect (one or more indicators with a severity of 3) Obvious

Section 7: Data Collection

1. Sample for external lab?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	2. Sample for CWP?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	3. Sterile sample for bacteria analysis?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
4. Sample(s) collected from:	<input type="checkbox"/> Flow	<input type="checkbox"/> Pool						
5. Duplicate collected?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<i>If yes, check appropriate:</i>	<input type="checkbox"/> External lab	<input type="checkbox"/> CWP	<input type="checkbox"/> Sterile		

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

SOP 2: WET WEATHER OUTFALL INSPECTION

Introduction

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

Definition of Wet Weather

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

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

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

Visual Condition Assessment

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

- Oil sheen
- Discoloration
- Trash and debris

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

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

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

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

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

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

Conditional and Qualitative Considerations

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

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

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

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

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

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

Measuring Water Quality

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

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

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

Analytical Sample Collection

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

Protocols for collecting a grab sample shall include the following:

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

Analytical Sample Quality Control and Assurance

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

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

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

Chain of custody forms are designed to provide sample submittal information and document transfers of sample custody. The forms are typically provided by the laboratory and must be completed by the field sampling personnel for each sample submitted to the lab for analysis. The document must be signed by both the person releasing the sample and the person receiving the sample every time the sample changes hands. The sampling personnel shall keep one copy of the form and send the remaining copies to the

laboratory with the samples. Custody seals, which are dated, signed and affixed to the sample container, may be used if the samples are shipped in a cooler via courier or commercial overnight shipping.

Attachments

1. Wet Weather Outfall Inspection Survey

Related Standard Operating Procedures

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

Outfall I.D.: _____ Date: _____

Inspector: _____

Time of Inspection: _____

Street Name _____

Last rainfall event _____



WET WEATHER OUTFALL INSPECTION SURVEY

Visual Inspection:	Yes	No	Comments (Include probable source of observed contamination):
Color	<input type="checkbox"/>	<input type="checkbox"/>	
Odor	<input type="checkbox"/>	<input type="checkbox"/>	
Turbidity	<input type="checkbox"/>	<input type="checkbox"/>	
Excessive Sediment	<input type="checkbox"/>	<input type="checkbox"/>	
Sanitary Waste	<input type="checkbox"/>	<input type="checkbox"/>	
Pet Waste	<input type="checkbox"/>	<input type="checkbox"/>	
Floatable Solids	<input type="checkbox"/>	<input type="checkbox"/>	
Oil Sheen	<input type="checkbox"/>	<input type="checkbox"/>	
Bacterial Sheen	<input type="checkbox"/>	<input type="checkbox"/>	
Foam	<input type="checkbox"/>	<input type="checkbox"/>	
Algae	<input type="checkbox"/>	<input type="checkbox"/>	
Orange Staining	<input type="checkbox"/>	<input type="checkbox"/>	
Excessive Vegetation	<input type="checkbox"/>	<input type="checkbox"/>	
Optical Enhancers	<input type="checkbox"/>	<input type="checkbox"/>	
Other	<hr/>		

WET WEATHER OUTFALL INSPECTION SURVEY



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

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

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

³ – *Appendix I – Field Measurements, Benchmarks and Instrumentation*, Draft Massachusetts North Coastal Small MS4 General Permit, 2009.

Outfall Reconnaissance Inventory/ Sample Collection Lab Sheet

Subwatershed:	Outfall ID:
Today's date:	Duplicate? (yes/no):
Analysis Technician:	Form completed by:

LAB DATA FOR FLOWING OUTFALLS

PARAMETER	RESULT		UNIT	EQUIPMENT
Ammonia QC check (10% of samples)			mg/L	Colorimeter
Fluoride			mg/L	Specific ion probe
Potassium			ppm	Compact Ion Meter
Conductivity			µs	Conductivity Meter
<i>Bacteria</i>	<i>Count</i>	<i>Dilution (1:1 or 1:100)</i>		
Red w/ gas			CFUs	Petrifilm plate
Blue w/ gas			CFUs	Petrifilm plate

MANHOLE INSPECTION LOG**Manhole
ID No.**

Inspection Date: _____

Tributary Area: _____

Street: _____

Manhole Type: _____

Inspection: Not Found _____ Surface _____ Internal _____

Storm Drain _____

Follow Up Inspection _____

High Outlet _____ Lovejoy _____

Time Since Last Rain: _____

Inspector: _____

< 48 hours _____ 48 - 72 hours _____ > 72 hours _____

Observations:

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

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

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

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

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

Odor: None _____ Sewage _____ Oil _____ Soap _____ Other _____

Field Testing:

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

Contamination:Found During Inspection Yes _____ Check one: Observation _____ Positive Test Kit Result
No _____ Sandbagged Placed No _____ Yes _____ Give Date _____

Sandbag Checked (Date): _____ and Flow was _____ Captured _____ Not Captured: _____

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

Condition of Manhole:**Common Manholes:**

Grade: At _____ Above _____ Below _____

High Outlet: Blocked Yes _____ No _____ NA _____

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

Good _____ Fair _____ Poor _____ Comments _____

Pavement _____

Construction Material:

Cover _____

Brick _____ Precast _____ Other _____

Frame _____

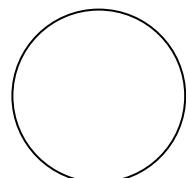
Corbel _____

Walls _____

Floor _____

Comments: Manhole Correct as Mapped Yes _____ No _____

N↑

**Plan of Manhole**

Continue on back if necessary

SOP 3: CATCH BASIN INSPECTION AND CLEANING

Introduction

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

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

- Oil sheen
- Discoloration
- Trash and debris

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

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

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

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

Cleaning Procedure

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

Catch basin inspection and cleaning procedures include the following:

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

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

Disposal of Screenings

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

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

Attachments

1. Catch Basin Inspection Form

Related Standard Operating Procedures

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



Job No.: _____

Town: _____

Inspector: _____

Date: _____

CATCH BASIN INSPECTION FORM

Catch Basin I.D.			Final Discharge from Structure? Yes <input type="checkbox"/> No <input type="checkbox"/> If Yes, Discharge to Outfall No.: _____
Catch Basin Label:	Stencil <input type="checkbox"/>	Ground Inset <input type="checkbox"/>	Sign <input type="checkbox"/> None <input type="checkbox"/> Other _____
Basin Material:	Concrete <input type="checkbox"/> Corrugated metal <input type="checkbox"/> Stone <input type="checkbox"/> Brick <input type="checkbox"/> Other: <input type="checkbox"/>	Catch Basin Condition:	Good <input type="checkbox"/> Fair <input type="checkbox"/> Poor <input type="checkbox"/> Crumbling <input type="checkbox"/>
Pipe Material:	Concrete <input type="checkbox"/> HDPE <input type="checkbox"/> PVC <input type="checkbox"/> Clay Tile <input type="checkbox"/> Other: <input type="checkbox"/>	Pipe Measurements:	Inlet Dia. (in): d= _____ Outlet Dia. (in): D= _____
Required Maintenance/ Problems (check all that apply):		<input type="checkbox"/> Tree Work Required <input type="checkbox"/> New Grate is Required <input type="checkbox"/> Pipe is Blocked <input type="checkbox"/> Frame Maintenance is Required <input type="checkbox"/> Remove Accumulated Sediment <input type="checkbox"/> Pipe Maintenance is Required <input type="checkbox"/> Basin Undermined or Bypassed	
<input type="checkbox"/> Cannot Remove Cover <input type="checkbox"/> Ditch Work <input type="checkbox"/> Corrosion at Structure <input type="checkbox"/> Erosion Around Structure <input type="checkbox"/> Remove Trash & Debris <input type="checkbox"/> Need Cement Around Grate		Other: _____	
Catch Basin Grate Type :		Sediment Buildup Depth :	Description of Flow:
Bar: <input type="checkbox"/> Cascade: <input type="checkbox"/> Other: _____		0-6 (in): _____ 6-12 (in): _____ 12-18 (in): _____ 18-24 (in): _____ 24+ (in): _____	Heavy <input type="checkbox"/> Moderate <input type="checkbox"/> Slight <input type="checkbox"/> Trickling <input type="checkbox"/>
Properly Aligned: Yes <input type="checkbox"/> No <input type="checkbox"/>			Street Name/ Structure Location: _____
*If the outlet is submerged check yes and indicate approximate height of water above the outlet invert. h above invert (in): _____			Yes <input type="checkbox"/> No <input type="checkbox"/>
<input type="checkbox"/> Flow <input type="checkbox"/> Standing Water (check one or both)		Observations: Color: _____ Odor: _____	
Weather Conditions : _____		Dry > 24 hours <input type="checkbox"/> Wet <input type="checkbox"/>	
Sample of Screenings Collected for Analysis? Yes <input type="checkbox"/> No <input type="checkbox"/>			
Comments: _____			
		Foam _____ Oil Sheen _____ Sanitary Waste _____ Bacterial Sheen _____ Orange Staining _____ Floatables _____ Excessive sediment _____ Pet Waste _____ Optical Enhancers _____ Other: _____	

Appendix D

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

SOP 13: WATER QUALITY SCREENING IN THE FIELD

Introduction

Outfalls from an engineered storm drain system can be in the form of pipes or ditches. Under current and pending regulations, it is important to inspect and document water quality within the MS4 system under both dry weather and wet weather conditions. SOP 1, “Dry Weather Outfall Inspection” and SOP 2, “Wet Weather Outfall Inspection”, cover the objectives of these activities and how water quality parameters can be collected during both types of inspections. SOP 3, “Catch Basin Inspection and Cleaning”, describes how this operations and maintenance activity can serve as an additional opportunity to collect water quality data.

SOP 2 included detailed information on how to collect discrete analytical samples to be processed by a laboratory. In contrast, this SOP addresses screening-level measurements than can be collected at outfalls, catch basins, receiving waters, or other water bodies. The measurements can be collected with field test kits or with portable meters.

Water quality screening data collected in this manner can feed into an illicit discharge detection and elimination investigation, like the process described in SOP 10, “Locating Illicit Discharges”.

Visual Condition Assessment

SOP 1, SOP 2, and SOP 3 describe a Visual Condition Assessment to collect observations related to the quality of stormwater conveyed by an engineered storm drain system. These observations may include such visual evidence and/or potential pollutants as:

- Foaming (detergents)
- Discoloration
- Evidence of sanitary waste
- Optical enhancers (fluorescent dyes added to laundry detergent); and
- Turbidity

If a Visual Condition Assessment indicates the presence of these pollutants, it may be necessary to quantify the extent of each, and gather data on other parameters that cannot be visually observed but can be measured using field kits or meters. These parameters include:

- Ammonia
- Chloride (present in treated drinking water but not groundwater)
- Conductivity
- Fluoride
- Hardness
- pH
- Potassium

Field Kits and Sampling Methods Available

In recent drafts of new MS4 Permits, U.S. EPA Region 1 has identified several test kits that are acceptable for use in the field, and other regulatory agencies have also completed similar reviews. The following table shows field test kits and portable meters that can be used for screening parameters.

Table SOP 13-1
Field Measurements, Test Kits, and Instrumentation

Analyte or Parameter	Instrumentation (Portable meter)	Field Test Kit
Ammonia	CHEMetrics TM V-2000 Colorimeter Hach TM DR/890 Colorimeter Hach TM Pocket Colorimeter TM II	CHEMetrics TM K-1410 CHEMetrics TM K-1510 (series) Hach TM NI-SA Hach TM Ammonia Test Strips
Bacteria		Bacteria field test kits require 24-hour window
Boron	N/A	Hanna TM HI 38074 Taylor TM K-1541
Chloride	CHEMetrics TM V-2000 Colorimeter Hach TM Pocket Colorimeter TM II LaMotte TM DC1200 Colorimeter	CHEMetrics TM K-2002 through K-2070 Hach TM CDS-DT Hach TM Chloride QuanTab® Test Strips
Color		Hach TM ColorDisc
Conductivity	CHEMetrics TM I-1200	N/A
Detergents (Surfactants)	CHEMetrics TM I-2017	CHEMetrics TM K-9400 and K-9404 Hach TM DE-2
Fluoride	CHEMetrics TM V-2000 Colorimeter Hach TM Pocket Colorimeter TM II	N/A
Hardness	N/A	CHEMetrics TM K-1705 and K-1710 CHEMetrics TM K-4502 through K-4530 Hach TM HA-DT Hach TM Hardness Test Strips
Optical enhancers		Field tests still under development
pH	CHEMetrics TM I-1000	Hach TM 17J through 17N Hach TM pH Test Strips
Potassium	Horiba TM Cardy C-131	LaMotte TM 3138 KIW
Turbidity	CHEMetrics TM I-1300	N/A

Each field test kit will include instructions specific to that test kit, and most kits are available in configurations that detect different ranges of the parameter. For example, the CHEMetrics™ detergents kit K-9400 shown above detects concentrations of 0 to 3 milligrams per liter (mg/L) while the K-9404 kit detects concentrations of 0 to 1,400 mg/L.

The table below shows values identified by the U.S. EPA and the Center for Watershed Protection as typical screening values for select parameters. These represent the typical concentration (or value) of each parameter expected to be found in stormwater. Screening values that exceed these benchmarks may be indicative of pollution and/or illicit discharges.

Table SOP 13-2
Benchmark Field Measurements for Select Parameters

Analyte or Parameter	Benchmark
Ammonia	>0.5 mg/L
Conductivity	>2,000
Detergents (Surfactants)	> 0.25 mg/L
Fluoride	>0.25 mg/L
pH	<5
Potassium	>20 mg/L

If and when water quality screening samples, whether using field test kits or portable meters, exceed these benchmark concentrations, the inspector should consider collecting analytical samples for laboratory analysis.

Advantages and Disadvantages of Field Testing

Field test kits can be convenient for use as a screening tool, initial purchase costs are low (typically \$0.50 to \$5.00 for the kits included in Table SOP 13-1), and the costs are far less than full analyses at a laboratory. However, some disadvantages of this screening method include:

- Limited shelf life
- Labor cost associated with inspector's time
- Generation of wastes, including glass vials and used reagent
- Steps and processes for each kit can vary widely, resulting in errors
- Trained staff are required in order to effectively utilize kits
- Not all kits are accepted by all regulatory agencies
- Limited useful detection range

Portable instrumentation such as the colorimeters shown in Table SOP 13-1 have the benefit of providing accurate readings, measure to low detection limits, and can be purchased pre-programmed to measure concentrations of most parameters required. Disadvantages of portable instrumentation include:

- High initial purchase cost
- Requirement for ongoing calibration and maintenance
- Individual probes require periodic replacement
- Specific storage requirements to maintain calibration
- Trained staff are required in order to effectively utilize meters

Related Standard Operating Procedures

1. SOP 1, Dry Weather Outfall Inspection
2. SOP 2, Wet Weather Outfall Inspection
3. SOP 3, Catch Basin Cleaning and Inspection
4. SOP 10, Locating Illicit Discharges

WATER QUALITY SCREENING FORM

Outfall I.D.			
Outfall Location			
Inspector's Name			
Date of Inspection		Date of Last Inspection	
Start Time		End Time	
Type of Inspection:	Regular <input type="checkbox"/>	Pre-Storm Event <input type="checkbox"/>	During Storm Event <input type="checkbox"/>
Post-Storm Event <input type="checkbox"/>			
Most Recent Storm Event			

FIELD WATER QUALITY SCREENING RESULTS

Sample Parameter	Field Test Kit or Portable Instrument Meter	Benchmark	Field Screening Result	Full Analytical Required?
Ammonia ¹		> 0.5 mg/L		<input type="checkbox"/> Yes <input type="checkbox"/> No
Boron ¹		> 0.35 mg/L		<input type="checkbox"/> Yes <input type="checkbox"/> No
Chloride ²		230 mg/L		<input type="checkbox"/> Yes <input type="checkbox"/> No
Color ¹		> 500 units		<input type="checkbox"/> Yes <input type="checkbox"/> No
Specific Conductance ¹		> 2,000 μ S/cm		<input type="checkbox"/> Yes <input type="checkbox"/> No
Detergents & Surfactants ³		> 0.25 mg/L		<input type="checkbox"/> Yes <input type="checkbox"/> No
Fluoride ³		> 0.25 mg/L		<input type="checkbox"/> Yes <input type="checkbox"/> No
Hardness ¹		< 10 mg/L or > 2,000 mg/L		<input type="checkbox"/> Yes <input type="checkbox"/> No
pH ¹		< 5		<input type="checkbox"/> Yes <input type="checkbox"/> No
Potassium ¹		> 20 mg/L		<input type="checkbox"/> Yes <input type="checkbox"/> No
Turbidity ¹		> 1,000 NTU		<input type="checkbox"/> Yes <input type="checkbox"/> No

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

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

³ – *Appendix I – Field Measurements, Benchmarks and Instrumentation*, Draft Massachusetts North Coastal Small MS4 General Permit, 2009.

FULL ANALYTICAL TESTING WATER QUALITY RESULTS

Sample Parameter	Analytical Test Method	Sample Collection (Time/Date)	Testing Lab	Analytical Testing Result
Ammonia	EPA 350.2/SM4500-NH3C			
Bacteria	E coli: 1103.1; 1603 Enterococcus: 1106.1; 1600			
Boron	EPA 212.3			
Chloride	EPA 9251			
Color	EPA 110.2			
Specific Conductance	SM 2510B			
Detergents & Surfactants	EPA 425.1/SM5540C			
Fluoride	EPA 300.0			
Hardness	EPA 130.1/SM 2340B			
Optical Enhancers	N/A*			
pH	EPA 150.1/SM 4500H			
Potassium	EPA 200.7			
Turbidity	SM 2130B			

*- There is presently no USEPA Standard Method for analysis of optical enhancers. Typically, sample pads are described as with "Present" or "Not Present" for fluorescing dye when exposed to UV light or a fluorometer.



EcoSense® EC300A
EcoSense® EC300M
Portable Conductivity, Salinity and
Temperature Instruments

USER MANUAL
English

WARRANTY

The EcoSense® EC300A/EC300M Instrument is warranted for one year from date of purchase by the end user against defects in materials and workmanship. EC300A/EC300M probes and cables are warranted for one year from date of purchase by the end user against defects in material and workmanship. 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, write or call your local YSI representative, or contact YSI Customer Service in Yellow Springs, Ohio. 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: (i) failure to install, operate or use the product in accordance with YSI's written instructions; (ii) abuse or misuse of the product; (iii) failure to maintain the product in accordance with YSI's written instructions or standard industry procedure; (iv) any improper repairs to the product; (v) use by you of defective or improper components or parts in servicing or repairing the product; or (vi) 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

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SAFETY INFORMATION

Please follow the guidelines below, and read this manual in its entirety to ensure safe operation of the unit.

Avoiding Damage to the Instrument - Precautions

The Instrument Case

Though the instrument is housed in a water-proof IP67 case, DO NOT use it underwater. The cable connector is not waterproof unless the cap is installed. In case of submersion without the cap connected, follow these steps immediately:

1. Remove the battery and reinstall the battery cover.
2. Dry the connector if necessary, and replace the conductivity probe. Rinse unit carefully with distilled water. After rinsing and drying, inspect and clean connectors to remove all contaminants that may affect probe connections.
3. Wait for unit and all connections to dry before reinstalling the battery and resuming operation.
4. If the unit does not function correctly after step 3, contact YSI for possible repair or replacement.

PACKAGE CONTENTS

Item #	Contents
606079	EC300A meter, manual, and 9V battery
606068	EC300A meter, manual, 9V battery, transport case, probe with 1 meter cable
606069	EC300A meter, manual, 9V battery, transport case, probe with 4 meter cable
606047	EC300A meter, manual, 9V battery, transport case, probe with 10 meter cable
601034	EC300M meter, manual, USB cable, and 9V battery
601035	EC300M meter, manual, USB cable, 9V battery, transport case, probe with 1 meter cable
601036	EC300M meter, manual, USB cable, 9V battery, transport case, probe with 4 meter cable

Item #	Contents
601037	EC300M meter, manual, USB cable, 9V battery, transport case, probe with 10 meter cable

UNPACKING

Carefully unpack the unit and accessories, and inspect for shipping damages. Compare received parts with materials listed in the Package Contents section. Notify YSI immediately of any damage or missing parts. Save all packing materials until satisfactory operation is confirmed.

INSTALLATION

Battery Installation

An initial display of "BAT" on the LCD indicates approximately one hour of battery life for unit operation within specifications. Replace battery when "BAT" appears on the LCD.

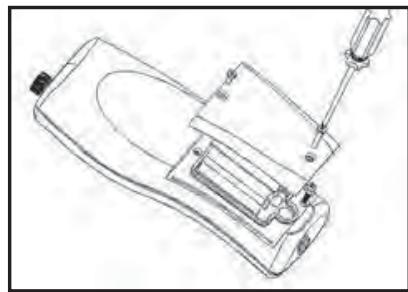


Figure 1

To replace battery, remove the two battery cover screws and the battery cover and o-ring (Figure 1). Replace the 9V battery. Replace the battery cover and o-ring (be sure to align the o-ring correctly to prevent a bad seal) and fasten the two battery cover screws.

Battery Disposal

This instrument is powered by a 9 volt battery, 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.

INTENDED USE AND GENERAL OVERVIEW

The YSI model EC300A/EC300M is a precise instrument that measures conductivity, salinity and temperature. A built-in microprocessor calculates and compensates for all parameters related to conductivity and temperature determinations.

This instrument is waterproof (IP67) when the connector cap is installed. The mechanical touch keys are highly reliable with tactile and audio feedback. This instrument uses one 9V battery. Recalibration is not required when power is restored.

The front of the instrument has a large LCD that displays temperature and either temperature compensated or non-temperature compensated conductivity, salinity or TDS simultaneously along with user prompts and mode indicators. The unit prompts users through calibration and measurement procedures.

The model EC300A/EC300M is available with a single four-electrode cell. Other features include automatic conductivity ranging, automatic temperature compensation, long battery life, and 50/60 Hz AC noise rejection. This meter is universal and user-friendly for field, industrial and laboratory applications.

Key differences between the YSI EC300A and EC300M include:

- EC300A can store 50 data sets, while the EC300M can store 250 data sets.
- A real-time clock is included on the EC300M for date/time stamp of saved data.
- The EC300M features a waterproof USB port with cover that will allow customers to download stored measurement data to a PC.
- A recal prompt on the EC300M allows users to select a recalibration interval.

DISPLAY DESCRIPTION

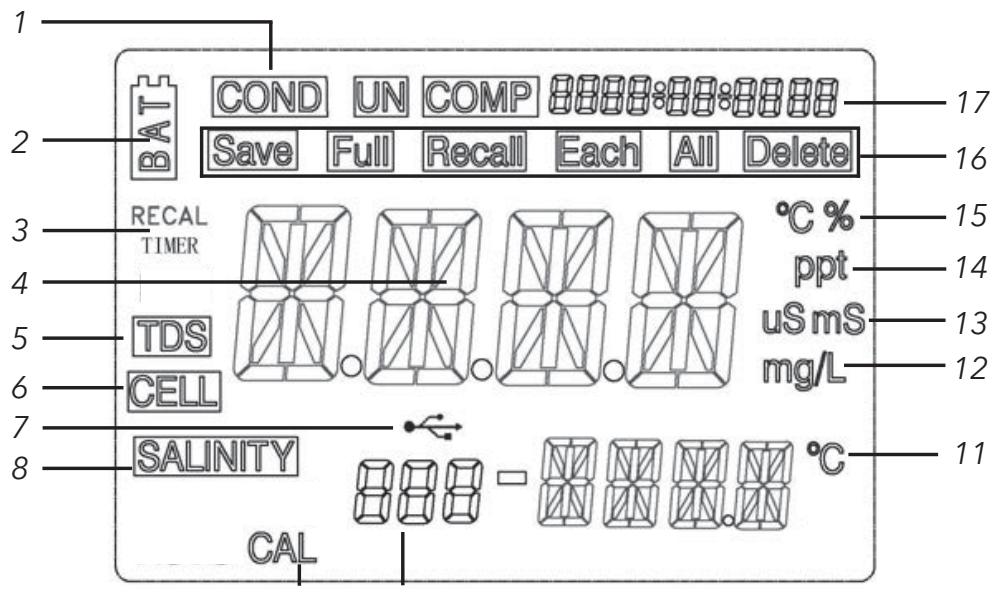


Figure 2

Number	Description
1	Displays when measuring conductivity.
2	Low battery indicator
3	Recal Timer indicator (EC300M only)
4	Main display for compensated and uncompensated conductivity, salinity and TDS values.
5	Displays when measuring total dissolved solids.
6	Indicates conductivity cell constant value.
7	USB/PC connection indicator (EC300M only)
8	Displays when measuring salinity.
9	Calibration mode indicator
10	Data set number
11	Temperature display
12	Indicates TDS measurement
13	Indicates conductivity measurement
14	Indicates salinity measurement
15	°C: Flashes during temperature compensated conductivity measurement. During calibration, indicates temperature reference unit. %: Displays during calibration; indicates temperature coefficient unit.

Number	Description
16	Save, Full, Recall, Each, All, Delete: Instrument's data storage indicators.
17	Date/Time display (EC300M only)

OPERATIONAL KEYS DESCRIPTION

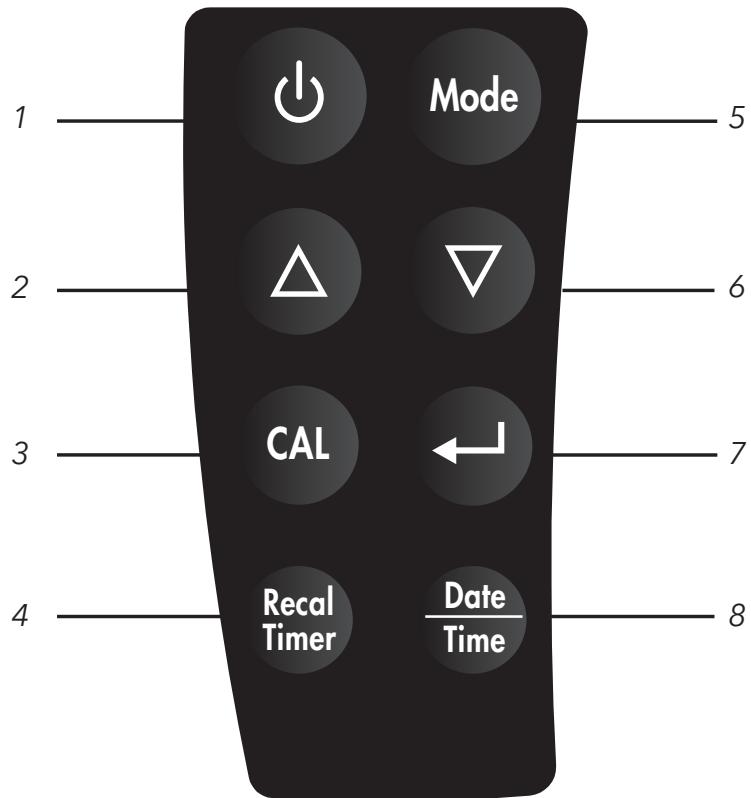
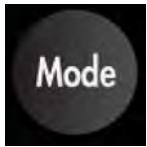


Figure 3

Number	Key	Description
1		Power key. Turns the unit on or off.
2, 6		Up and down arrow keys. Increases or decreases the display value as desired.
3		Calibration key. Press to enter the calibration mode.

4		Recal Timer key (EC300M only). Press to enter the Recal Timer input display.
5		Mode key. Selects display mode. In Normal operation, press Mode to switch the display between uncompensated conductivity, temperature compensated conductivity, salinity, total dissolved solids (TDS), Recall and Delete. In calibration mode, this key exits the current calibration and displays the next calibration parameter.
7		Enter key. Pressing Enter saves the current measurement into memory, confirms mode selection (rcl/delete), confirms calibration steps, and confirms data deletion. On the EC300M, this key confirms recal timer entry and date/time selections.
8		Date/Time key (EC300M only). A short press (i.e. key is not held) of the Date/Time key changes the display in the upper right corner to be either Date or Time. Pressing and holding for 3 seconds will allow date and time information to be updated. Pressing and holding for 6 seconds will allow for the date (e.g. MM/DD/YYYY) and time format (12 or 24 hour) settings to be changed.

OPERATIONAL PROCEDURES

Measurement Modes

1. Temperature - Current solution temperature continually displays.
2. Temperature Compensated Conductivity - Measurement of conductivity, compensated to 25°C or another specified value between 15 and 25°C. Expressed as uS/cm or mS/cm with a flashing "°C".

3. Uncompensated Conductivity - Direct measurement of conductivity, not compensated to a specific temperature. Expressed as $\mu\text{S}/\text{cm}$ or mS/cm .
4. Salinity - Measurement of salinity; expressed in parts per thousand (ppt).
5. TDS - Measurement of total dissolved solids (TDS); expressed in milligrams per liter (mg/L)

Carefully observe the units displayed at the far side of the LCD to determine the desired mode.

Calibration

Calibration setup contains five sections: TDS, Cell, Temperature Coefficient, Temperature reference, and Conductivity Calibration. To access these sections:

1. Connect the conductivity probe and cable assembly to the unit and turn the unit on. The screen will display CELL and the cell constant of the conductivity probe.
2. Allow temperature readings to stabilize, then press **CAL** to enter the calibration mode; CAL appears on the LCD. Press **MODE** to sequentially display the following sections:

Note: Press **Enter**  to accept any values changes in each section and automatically advance to the next section. If there are no changes, the unit accepts the current value and proceeds to the next section.

TDS

TDS is determined by multiplying conductivity (mS) by a TDS factor. The default factor value is 0.65. To change the TDS factor, use the up and down keys to adjust the value between 0.30 and 1.00. Press **Enter**  to save the new value, or press **MODE** to cancel the change and display the CELL screen.

CELL

The second screen will display CELL and the current cell value. The default cell value is 5.00 and is displayed in the lower right of the screen. The unit allows a variance of ± 0.50 before displaying an error message. The cell value cannot be adjusted at this screen; calibrating conductivity is the only way to adjust the cell constant. Press **Enter**  to reset the cell constant to 5.00 and display the Temperature Coefficient screen.

Note: Be certain to press **Enter**  to reset the cell constant to 5.00. If **MODE** is pressed, the unit retains the previous cell constant and calibrates from a value that is already offset.

Temperature Coefficient

The unit uses the temperature coefficient to calculate temperature compensated conductivity. The default value is 1.91%. To change the temperature coefficient, use the up and down keys to adjust the value between 0 and 4.00%. Press **Enter**  to save the new value, or press **MODE** to cancel the change and display the Temperature Reference screen.

Temperature Reference

The unit uses the temperature reference value to calculate temperature compensated conductivity. The default value is 25°C. To change the temperature coefficient, use the up and down keys to adjust the value between 15 and 25°C. Press **Enter**  to save the new value, or press **MODE** to cancel the change and display the Conductivity Calibration screen.

Conductivity Calibration

1. Immerse the probe in a standard of known conductivity, preferably a standard in the middle range of the solutions to be measured. Completely submerge the probe without touching the sides of the calibration container. Shake the probe lightly to remove any air bubbles trapped in the conductivity cell.
2. Allow temperature to stabilize. The message 'rAng' (range) may display briefly to indicate unit auto-ranging; this is normal. After temperature stabilization, use the up and down keys to adjust the conductivity value to that of the conductivity standard at 25°C. Press **Enter**  to calibrate. The unit beeps twice to indicate a successful calibration, then automatically switches to normal operation mode.

Conductivity Measurements

1. Turn the unit on. Place the probe in the solution to be measured. Completely submerge the probe. Shake the probe lightly to remove any trapped air bubbles in the conductivity cell.
2. Press **MODE** to enter the desired measurement mode. The message 'rAng' (range) may appear briefly on the display indicate auto-ranging; this is normal. Allow temperature to stabilize before taking measurements.

Saving, Viewing and Deleting Data

The EC300A can save 50 data records, while the EC300M can save 250 data records. When in measurement mode, press Enter  to save a record. The instrument will confirm saving the data by displaying "Save" and the data record number for one second. "Full" is displayed when trying to save data and memory is full.

To view saved data, press Mode until "Recall" is displayed and then press Enter . Use the Up or Down arrow keys to review different saved records. Press Mode to escape back to measurement mode.

To delete data records, press Mode while in measurement mode until "Delete" is displayed. Press Enter . "All" will be displayed and blinking. Press the Up or Down arrow key to switch between delete 'All' or 'Each' options. Select either 'All' or 'Each' by pressing Enter  while that option is displayed.

If 'All' is selected, all records will be deleted from memory and 'None' will be displayed. Press Mode twice to return to the measurement mode.

If 'Each' is selected, the Up and Down arrow keys will allow you to scroll through the saved data records. Press Enter to delete the selected record. All records after the deleted record will shift up to keep the records in sequential order. For example, if record 3 is deleted, record 4 will become record 3 and record 5 will become record 4. Press Mode twice to return to the measurement mode.

Downloading Data to a Computer - EC300M Only

The EC300M features a micro USB connection that allows the instrument to be connected to a computer with Windows 7 or Windows 10 as the operating system. Once connected, data saved to the meter can be downloaded to the computer.

1. A USB cable is included with all EC300M instruments. Plug the micro USB connector into the EC300M instrument and the USB connector into a computer.
2. Turn the EC300M instrument on. A driver will install from the instrument to the computer.
3. Open Windows Explorer. The PC will recognize the instrument as a removable drive.



Windows
Explorer Icon

4. Copy and paste the .csv file from the instrument to a location on the computer. This file can be opened in Excel®.

Note: The original .csv file should be left on the EC300M instrument. Do not try to modify this file.

Note: If the .csv file is opened with Excel® and the data is not formatted correctly (e.g. a temperature reading is interpreted as a date), please refer to the Troubleshooting section.

5. The instrument can be disconnected from the computer. The original .csv file should still be located on the EC300M instrument.

Recal Timer - EC300M Only

The Recal Timer feature provides a reminder to recalibrate the DO probe. If enabled, 'Recal' will be displayed when the user-defined interval has elapsed.

After pressing the **Recal Timer** key, use the Up and Down arrow keys to adjust the value for the recal prompt in number of days. Press **Enter**  to confirm. The instrument will return to the run screen.

Any value between 0 and 60 days can be selected. Set the value to 0 to disable the Recal Timer.

Date/Time Settings - EC300M Only

A short press (i.e. key is not held) of the **Date/Time** key changes the display in the upper right corner to be either Date or Time.

Press and hold the **Date/Time** key for 3 seconds to set date and time information. Use the up and down arrow keys to adjust Hour, Minute (Min) and Second (Sec). Press **Enter**  to confirm each selection. After adjusting time, adjust date information by using the up and down arrow key to adjust the MM (month), DD (Day) and YYYY (Year) information. Press **Enter**  to confirm each selection.

Press and hold the **Date/Time** key for 6 seconds to set the date/time format. Use the Up and Down arrow keys to display the desired Date format (MM/DD/YYYY, DD/MM/YYYY, or YYYY/MM/DD), followed by **Enter**  to confirm the selection. Next, use the Up and Down arrow keys to display the desired Time format (12-hour or 24-hour), followed by **Enter**  to confirm the selection.

TROUBLESHOOTING

Error Messages on Display

Main Display	Problem	Possible Solution
OvEr	<ul style="list-style-type: none">Conductivity is >200.0 mSSalinity is > 70.00 ppt	<ul style="list-style-type: none">Completely submerge the probe.Allow sufficient time for the electrode and Temp probe stabilization.Recalibrate with correct value for the conductivity standard.Replace conductivity standard.Clean cell.Return for service.
OvEr/Undr during calibration	<ul style="list-style-type: none">Cell Constant Calibration is out of range	

Main Display	Secondary Display	Problem	Possible Solution
OvEr/Undr	OvEr	Temperature >90.0 °C	<ul style="list-style-type: none">Decrease/Increase the sample temperature.Return for service.
	Undr	Temperature < -10.0 °C	

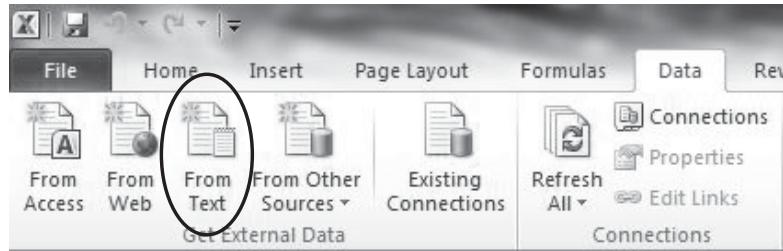
Opening the Data File with Excel®

Depending on the region and language setting of your PC, measurement data might be formatted incorrectly by Excel® when the data file is opened.

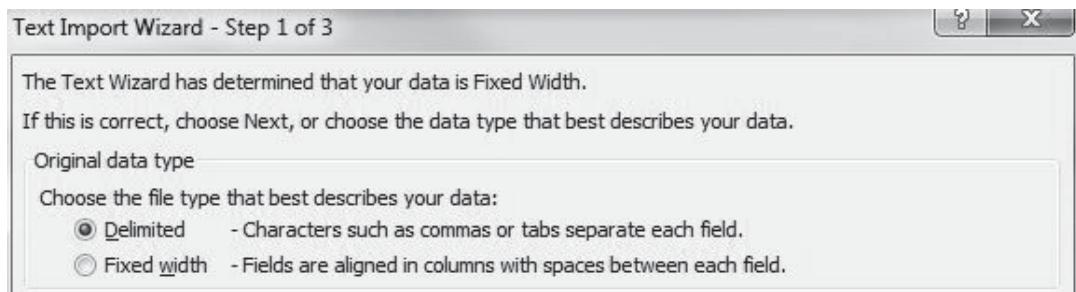
This is sometimes encountered with German set as the PC language, as a German date format typically utilizes a decimal (DD.MM.YYYY). The EC300M utilizes a decimal as the radix, so a temperature of **31.1** is sometimes interpreted by Excel® as **31. Jan** when German is set as the PC language.

If a data file is opened in Excel® and measurement data is incorrectly interpreted as something other than a number, please follow these steps:

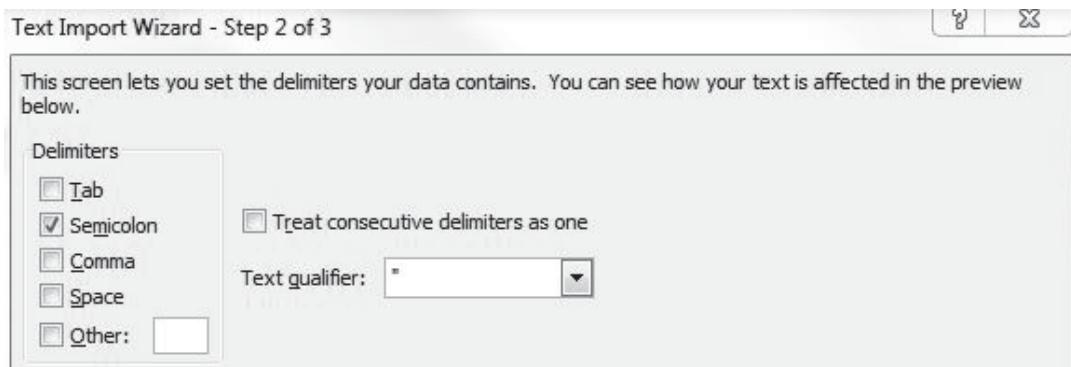
1. Open a blank Excel® spreadsheet.
2. Go to the **Data** tab and select **From Text**.



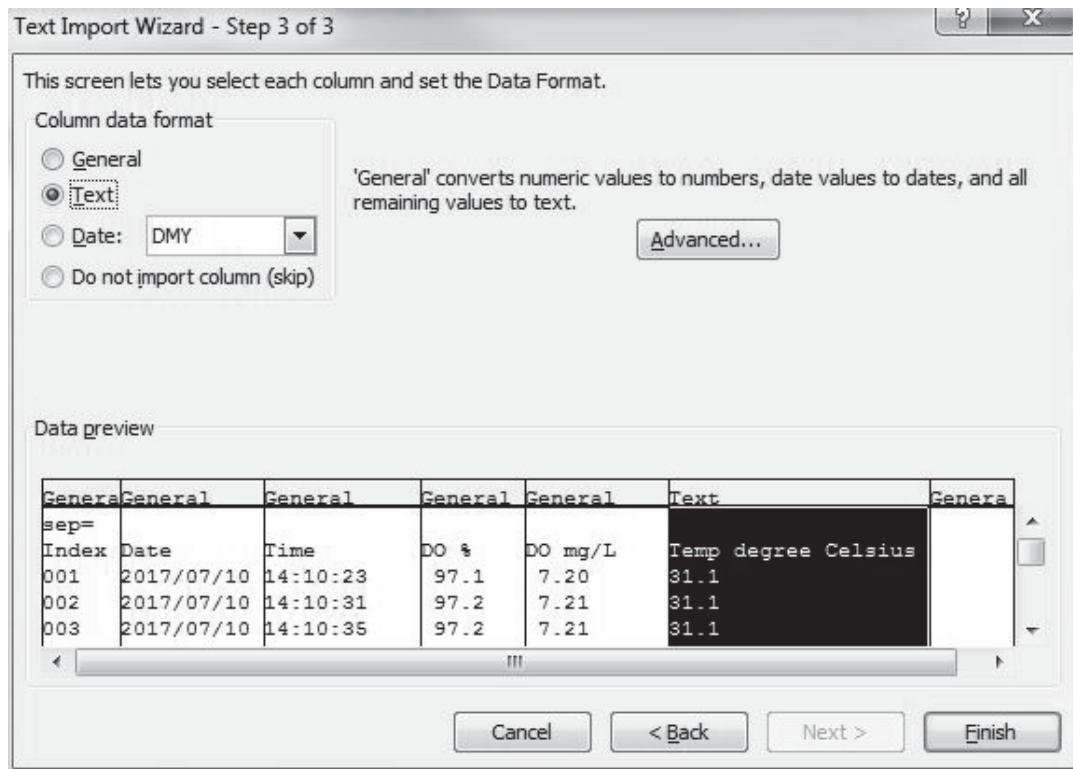
3. Choose to **Import** the data file you have copied to your PC. Don't select the original data file that is still on the instrument.
4. Under Step 1 of the Text Import Wizard, choose **Delimited**.



5. Under Step 2 of the Text Import Wizard, choose **Semicolon**.



6. Under Step 3, click on the column with the incorrectly formatted data. This column should be highlighted in black. Choose **Text** under **Column data format**. Do this for each column with incorrectly formatted data.



7. Select **Finish**, then choose where you want the data to be placed on your opened spreadsheet.

MAINTENANCE

The most important requirement for accurate and reproducible conductivity measurements is a clean cell. A dirty cell changes the conductivity of a solution through contamination. Clean the cell thoroughly before storing it. To clean the conductivity cell:

1. Dip the cell in cleaning solution and agitate for two to three minutes. Any foaming acid tile cleaner, such as Dow Chemical Bathroom Cleaner, should clean adequately. For a stronger cleaner, use a solution of 1:1 isopropyl alcohol and 1 N HCl. Remove the cell from the cleaning solution.
2. Use the nylon brush (supplied) to dislodge any contaminants from inside the electrode chamber.
3. Repeat steps one and two until the cell is completely clean. Rinse the cell thoroughly in deionized, or clean tap water.



ACCESSORIES / PART NUMBERS

Part Number	Description
606044	1 meter probe and cable assembly
605395	4 meter probe and cable assembly
605396	10 meter probe and cable assembly
606043	Carrying case, hard sided
605139	Carrying case, soft sided

TECHNICAL SERVICES

Telephone: 800 897 4151 (USA)

+1 937 767 2762 (Globally) Monday through Friday, 8 AM to 5 PM ET

Email: info@ysi.com

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

Internet: ysi.com.

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 ysi.com or contact YSI Tech Support.

Parameter	Range	Resolution	Accuracy
Temperature	-10 to +90 °C (14 to 194 °F)	0.1 °C	±0.2 °C or ±0.4%, whichever is greater
Conductivity	0 to 499.9 µS/cm	0.1 µS/cm	± 1% of reading + 2 µS/cm
	500 to 4999 µS/cm	1 µS/cm	± 1% of reading + 5 µS/cm
	5.0 to 49.99 mS/cm	0.01 mS/cm	± 1% of reading + 0.05 mS/cm
	50 to 200 mS/cm	0.1 mS/cm	± 2.5% of reading + 0.5 mS/cm
Salinity	Calculated; 0.0 to 70.0 ppt	0.1 ppt	±0.2% FS

Reference Temperature (Input during calibration)	15.0 to 25.0°C (59 to 77°F)
Temperature Coefficient (Input during calibration)	0.0% to 4.0%
TDS Constant (Input during calibration)	0.3 to 1.00
Cell Constant Range	4.50 to 5.50
ATC Probe	Thermistor, 10KΩ, at 25 °C
Calibration Backup	Yes
Audio Feedback	Yes, on all keys
Power Source	One 9V battery (included with meter) Real time clock (RTC) on the EC300M also powered by CR2032 coin battery (3V)
Operating Range - Temperature	0 to 50 °C (32 to 122 °F)
Operating Range - Relative Humidity	Up to 95%
Instrument Casing	Waterproof IP-67 with cable connector cap installed
Weight (with battery)	272 grams (.6 lbs)
Dimensions (L x W x H)	18.7 cm x 7.6 cm x 3.8 cm (7.37 in x 3 in x 1.5 in)
Memory	50 data sets on the EC300A 250 data sets on the EC300M
Auto Shutoff	Automatically powers off after 30 minutes of inactivity
Recal Timer	EC300M only - Customer selects recalibration interval; from 0 to 60 days
Real-Time Clock (RTC) for Date/Time Stamp of Saved Data	EC300M only
Waterproof USB for Downloading Data to PC	EC300M only

Conforms to the following:	
Directives:	EMC 2014/30/EU RoHS 2011/65/EU WEEE 2012/19/EU
Harmonized Standards:	EN61326-1:2013 (IEC 61326-1:2012) IEC 61000-3-2:2005 IEC 61000-3-3:2008 IEC 61000-4-2:2008 IEC 61000-4-3:2006 IEC 61000-4-4:2004 IEC 61000-4-6:2008 IEC 61000-4-8:2009

AquaChek®

25 Test Strips
27553-25

Ammonia

Water Quality
Test Strips for

HACH®

Total Ammonia (NH₃-N) ppm



DIRECTIONS:

1. Fill sample vial to top line with water.
2. Dip the strip into water sample. Vigorously move the strip up and down in water sample for 30 seconds, making sure both pads are always submerged.
3. Remove the test strip and shake off excess water.
4. Hold the test strip level, with pad side up, for 30 seconds.
5. To read result, turn test strip over so that both pads are facing away from you.
6. Compare the color of the small pad to the color chart above.
Read the result through the clear plastic of the test strip.
7. Rinse sample vial with tap water after each use.

IMPORTANT: KEEP CAP ON TIGHT BETWEEN USES. STORE AT ROOM TEMPERATURE. AVOID CONTACT WITH SKIN. IF CONTACT OCCURS, RINSE THOROUGHLY.

5059LB R2/18 MADE IN USA OF US AND IMPORTED CONTENT.

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(800) 227-4224 Outside U.S.A. (970) 669-3050. EU contact: HACH LANGE GmbH
Willstätterstrasse 11 40549 Düsseldorf, Germany +49-(0)211-52880

USE BY DATE
ON BOTTOM



HAZARD SYMBOLS: <img alt="Hazard symbols: H314, H315, H317, H318, H319, H331, H332, H333, H334, H335, H336, H337, H338, H339, H331+H334, H332+H334, H333+H334, H335+H334, H336+H334, H337+H334, H338+H334, H339+H334, H314+H315, H314+H317, H314+H318, H314+H319, H314+H331, H314+H332, H314+H333, H314+H335, H314+H336, H314+H337, H314+H338, H314+H339, H314+H331+H334, H314+H332+H334, H314+H333+H334, H314+H335+H334, H314+H336+H334, H314+H337+H334, H314+H338+H334, H314+H339+H334, H314+H314, H314+H317+H317, H314+H318+H318, H314+H319+H319, H314+H331+H331, H314+H332+H332, H314+H333+H333, H314+H335+H335, H314+H336+H336, H314+H337+H337, H314+H338+H338, H314+H339+H339, H314+H314+H314, H314+H317+H317+H317, H314+H318+H318+H318, H314+H319+H319+H319, H314+H331+H331+H331, H314+H332+H332+H332, H314+H333+H333+H333, H314+H335+H335+H335, H314+H336+H336+H336, H314+H337+H337+H337, H314+H338+H338+H338, H314+H339+H339+H339, H314+H314+H314+H314, H314+H317+H317+H317+H317, H314+H318+H318+H318+H318, 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Chlorine, Free and Total, Low Range

DOC316.53.01450

USEPA DPD Method

0.02 to 2.00 mg/L Cl₂ (LR)

Method 8021 (free)¹ 8167 (total)^{1,2}

Powder Pillows or AccuVac[®] Ampuls

Scope and application: For testing free chlorine (hypochlorous acid and hypochlorite ion) in water and treated waters. For testing total chlorine in water, treated waters and wastewater. USEPA accepted for reporting for drinking water analyses.

¹ USEPA accepted for drinking water reporting and equivalent to Standard Method 4500-Cl G for drinking water.

² USEPA accepted for wastewater reporting, USEPA method 330.5.



Test preparation

Before starting

Analyze the samples immediately. The samples cannot be preserved for later analysis.

Always do tests in sample cells or AccuVac[®] Ampuls. Do not put the instrument in the sample or pour the sample into the cell holder.

Make sure that the sample cells are clean and there are no scratches where the light passes through them.

Rinse the sample cell and cap with the sample three times before the sample cell is filled.

Make sure that there are no fingerprints or liquid on the external surface of the sample cells or AccuVac[®] Ampuls. Wipe with a lint-free cloth before measurement.

Cold waters can cause condensation on the sample cell or bubbles in the sample cell during color development. Examine the sample cell for condensation or bubbles. Remove condensation with a lint-free cloth. Invert the sample cell to remove bubbles.

Install the instrument cap over the cell holder before ZERO or READ is pushed.

After the test, immediately empty and rinse the sample cell. Rinse the sample cell and cap three times with deionized water.

Do not use the same sample cells for free and total chlorine. If trace iodide from the total chlorine reagent is carried over into the free chlorine determination, monochloramine will interfere. It is best to use separate, dedicated sample cells for free and total chlorine measurements.

If the test result is over-range, or if the sample temporarily turns yellow after the reagent addition, dilute the sample with a known volume of high quality, chlorine demand-free water and do the test again. Some loss of chlorine may occur due to the dilution. Multiply the result by the dilution factor. Additional methods are available to measure chlorine without dilution.

For the best results, measure the reagent blank value for each new lot of reagent. Replace the sample with deionized water in the test procedure to determine the reagent blank value. Subtract the reagent blank value from the sample results.

The AccuVac Ampul Snapper makes AccuVac Ampul tests easier to do. The AccuVac Ampul Snapper keeps the broken tip of the ampul, prevents exposure to the sample and provides controlled conditions for filling the ampule.

An AccuVac Ampul for Blanks can be used to zero the instrument in the AccuVac test procedure.

The SwifTest Dispenser for Free Chlorine or Total Chlorine can be used in place of the powder pillow in the test procedures. One dispensation equals one powder pillow for 10-mL samples.

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

Dispose of reacted solutions according to local, state and federal regulations. Refer to the Safety Data Sheets for disposal information for unused reagents. Refer to the environmental, health and safety staff for your facility and/or local regulatory agencies for further disposal information.

Items to collect

Powder pillows

Description	Quantity
Chlorine, Free: DPD Free Chlorine Reagent Powder Pillows, 10-mL	1
Chlorine, Total: DPD Total Chlorine Reagent Powder Pillows, 10-mL	1
Sample cells, 25-mm (10 mL)	2

Refer to Consumables and replacement items on page 7 for order information.

AccuVac Ampuls

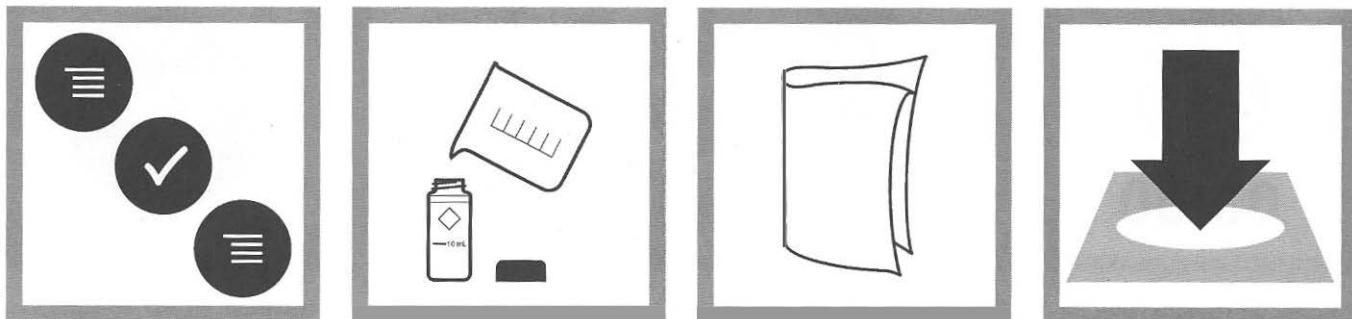
Description	Quantity
Chlorine, Free: DPD Free Chlorine Reagent AccuVac Ampuls	1
Chlorine, Total: DPD Total Chlorine Reagent AccuVac Ampuls	1
Beaker, 50-mL	1
Stopper for 18-mm tubes and AccuVac Ampuls	1
Sample cells, 25-mm (10 mL)	1

Refer to Consumables and replacement items on page 7 for order information.

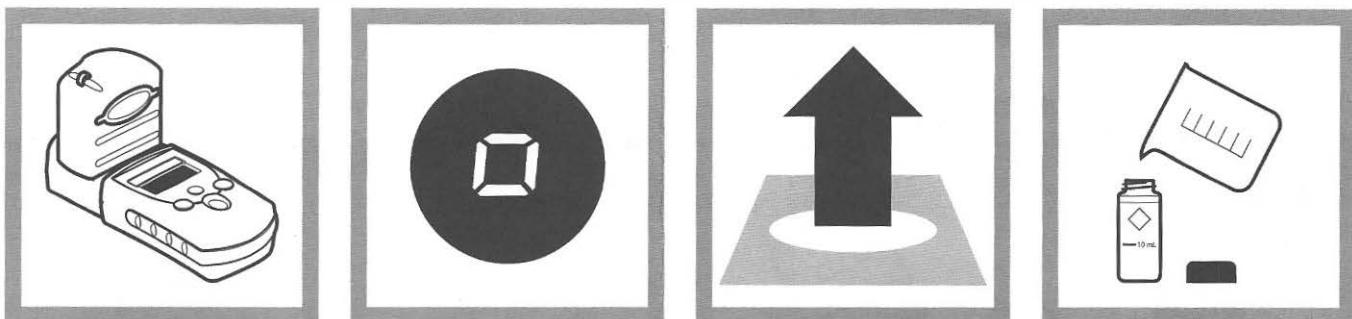
Sample collection

- Analyze the samples immediately. The samples cannot be preserved for later analysis.
- Chlorine is a strong oxidizing agent and is unstable in natural waters. Chlorine reacts quickly with various inorganic compounds and more slowly with organic compounds. Many factors, including reactant concentrations, sunlight, pH, temperature and salinity influence the decomposition of chlorine in water.
- Collect samples in clean glass bottles. Do not use plastic containers because these can have a large chlorine demand.
- Pretreat glass sample containers to remove chlorine demand. Soak the containers in a weak bleach solution (1 mL commercial bleach to 1 liter of deionized water) for at least 1 hour. Rinse fully with deionized or distilled water. If sample containers are rinsed fully with deionized or distilled water after use, only occasional pretreatment is necessary.
- Make sure to get a representative sample. If the sample is taken from a spigot or faucet, let the water flow for at least 5 minutes. Let the container overflow with the sample several times and then put the cap on the sample container so that there is no headspace (air) above the sample.

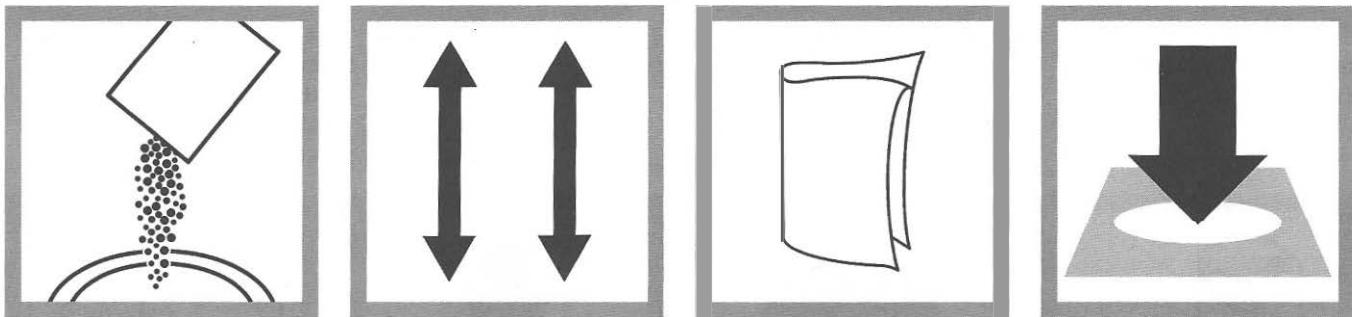
Powder pillow procedure



1. Set the instrument to low range (LR). Refer to the instrument documentation.
2. **Prepare the blank:** Fill a sample cell to the 10-mL mark with sample. Close the sample cell.
3. Clean the blank sample cell.
4. Insert the blank into the cell holder. Point the diamond mark on the sample cell toward the keypad.



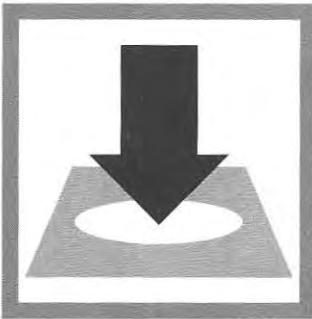
5. Install the instrument cap over the cell holder.
6. Push **ZERO**. The display shows "0.00".
7. Remove the sample cell from the cell holder.
8. **Prepare the sample:** Fill a second sample cell to the 10-mL mark with sample.



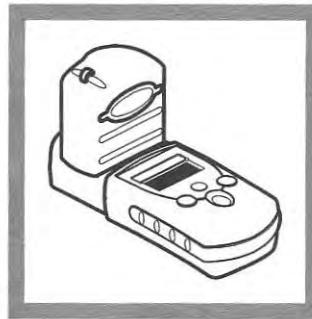
9. Add one 10-mL DPD Free Chlorine Reagent Powder Pillow or one 10-mL DPD Total Chlorine Reagent Powder Pillow to the second sample cell.
10. Close the sample cell. Shake the sample cell for about **20 seconds** to dissolve the reagent. Undissolved power will not affect accuracy. A pink color will show if chlorine is in the sample.
11. Clean the prepared sample cell.
12. **Free chlorine measurement:** Within 1 minute of the reagent addition, insert the prepared sample into the cell holder. Point the diamond mark on the sample cell toward the keypad.
Go to step 15.



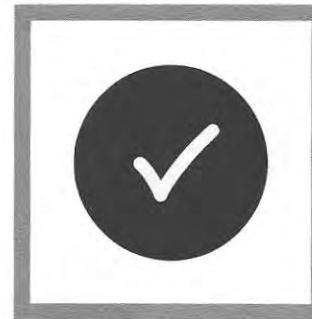
13. Set and start a timer for 3 minutes. A 3-minute reaction time starts.



14. **Total chlorine measurement:** After 3 minutes and within 6 minutes of the reagent addition, insert the prepared sample into the cell holder. Point the diamond mark on the sample cell toward the keypad.



15. Install the instrument cap over the cell holder.

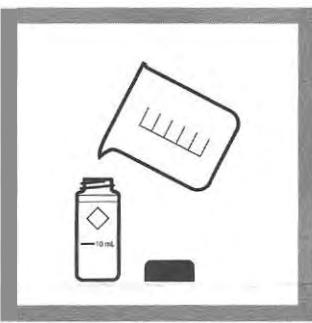


16. Push **READ**. Results show in mg/L Cl₂.

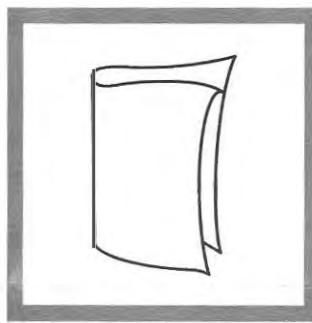
AccuVac® Ampul procedure



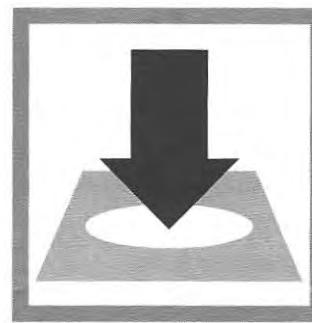
1. Set the instrument to low range (LR). Refer to the instrument documentation.



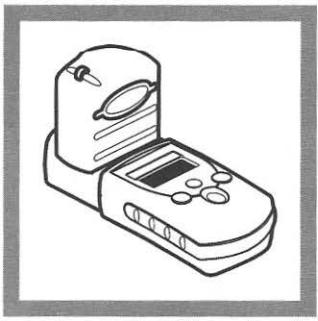
2. **Prepare the blank:** Fill a sample cell to the 10-mL mark with sample. Close the sample cell.



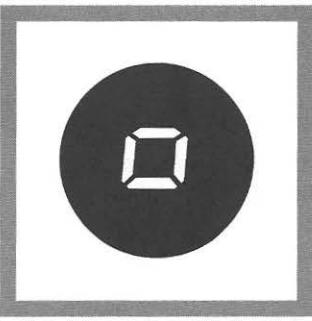
3. Clean the blank sample cell.



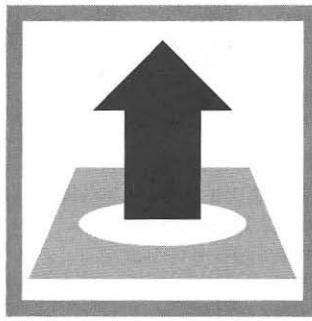
4. Insert the blank into the cell holder. Point the diamond mark on the sample cell toward the keypad.



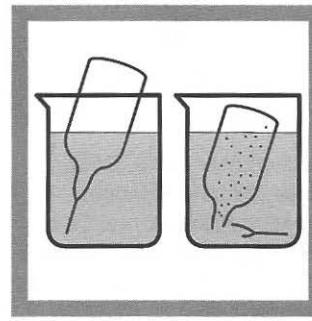
5. Install the instrument cap over the cell holder.



6. Push **ZERO**. The display shows "0.00".



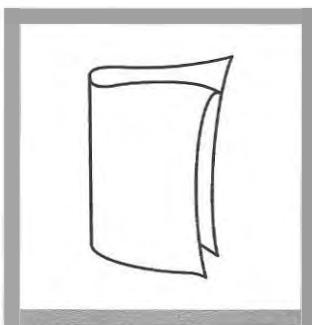
7. Remove the sample cell from the cell holder.



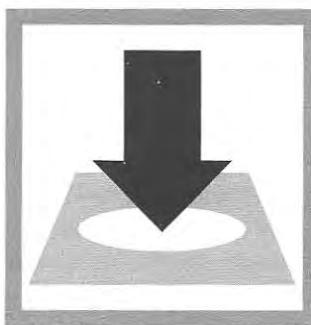
8. **Prepare the sample:** Collect at least 40 mL of sample in a 50-mL beaker. Fill a DPD Free Chlorine Reagent AccuVac Ampul or a DPD Total Chlorine Reagent AccuVac Ampul with sample. Keep the tip immersed while the AccuVac Ampul fills completely.



9. Quickly invert the AccuVac Ampul several times to mix.



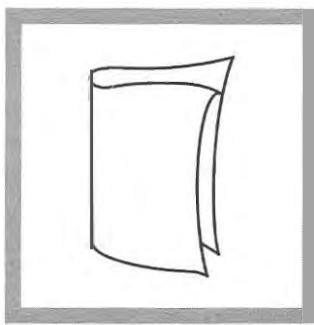
10. Clean the AccuVac Ampul.



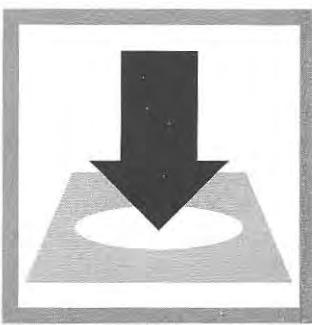
11. **Free chlorine measurement:** Within 1 minute of the reagent addition, insert the prepared sample AccuVac Ampul into the cell holder.
Go to step 15.



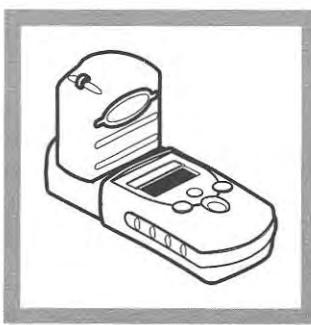
12. Set and start a timer for 3 minutes. A 3-minute reaction time starts.



13. When the timer expires, clean the prepared sample cell.



14. **Total chlorine measurement:** Within 6 minutes of the reagent addition, insert the prepared sample AccuVac Ampul into the cell holder.



15. Install the instrument cap over the cell holder.



16. Push READ. Results show in mg/L Cl₂.

Interferences

Interfering substance	Interference level
Acidity	More than 150 mg/L CaCO ₃ . The full color may not develop or the color may fade instantly. Adjust to pH 6–7 with 1 N Sodium Hydroxide. Measure the amount to add on a separate sample aliquot, then add the same amount to the sample that is tested. Correct the test result for the dilution from the volume addition.
Alkalinity	More than 250 mg/L CaCO ₃ . The full color may not develop or the color may fade instantly. Adjust to pH 6–7 with 1 N Sulfuric Acid. Measure the amount to add on a separate sample aliquot, then add the same amount to the sample that is tested. Correct the test result for the dilution from the volume addition.
Bromine, Br ₂	Positive interference at all levels
Chlorine Dioxide, ClO ₂	Positive interference at all levels
Inorganic chloramines	Positive interference at all levels
Chloramines, organic	May interfere
Hardness	No effect at less than 1000 mg/L as CaCO ₃

Interfering substance	Interference level
Manganese, Oxidized (Mn ⁴⁺ , Mn ⁷⁺) or Chromium, Oxidized (Cr ⁶⁺)	Pre-treat the sample as follows: <ol style="list-style-type: none"> 1. Adjust the sample pH to 6–7. 2. Add 3 drops of Potassium Iodide (30-g/L) to 10 mL of sample. 3. Mix and wait 1 minute. 4. Add 3 drops of Sodium Arsenite (5-g/L) and mix. 5. Use the test procedure to measure the concentration of the treated sample. 6. Subtract this result from the result without the treatment to obtain the correct chlorine concentration.
Monochloramine	Causes a gradual drift to higher readings. When read within 1 minute after reagent addition, 3 mg/L monochloramine causes less than a 0.1 mg/L increase in the reading.
Ozone	Positive interference at all levels
Peroxides	May interfere
Highly buffered samples or extreme sample pH	Can prevent the correct pH adjustment (of the sample) by the reagents. Sample pretreatment may be necessary. Adjust to pH 6–7 with acid (Sulfuric Acid, 1 N) or base (Sodium Hydroxide, 1 N). Correct the test result for the dilution caused by the volume additions.

Pollution prevention and waste management

If sodium arsenite was added to the sample for manganese or chromium interferences, the reacted samples will contain arsenic and must be disposed of as a hazardous waste. Dispose of reacted solutions according to local, state and federal regulations. must be disposed of as a hazardous waste. Dispose of reacted solutions according to local, state and federal regulations.

Accuracy check

Standard additions method

Use the standard additions method to validate the test procedure, reagents and instrument and to find if there is an interference in the sample.

Items to collect:

- Chlorine Standard Solution, 2-mL PourRite® Ampule, 25–30 mg/L (use mg/L on label)
- Ampule breaker
- Pipet, TenSette®, 0.1–1.0 mL and tips

1. Prepare three spiked samples: use the TenSette pipet to add 0.1 mL, 0.2 mL and 0.3 mL of the standard solution, respectively, to three 10-mL portions of fresh sample. Mix well.

Note: For AccuVac® Ampuls, add 0.4 mL, 0.8 mL and 1.2 mL of the standard solution to three 50-mL portions of fresh sample.

2. Use the test procedure to measure the concentration of each of the spiked samples. Start with the smallest sample spike. Measure each of the spiked samples in the instrument.
3. Compare the expected result to the actual result. The expected increase in the chlorine concentration is the Cl₂ mg/L concentration from the label of the standard solution multiplied by 0.1 mL for every 10 mL of standard solution added.

Standard solution method

If the Standard Calibration Adjust feature is used to adjust the calibration curve of the Pocket Colorimeter II, the concentration of the chlorine standard must be between 0.50 and 1.50 mg/L chlorine for the LR procedure.

Verification of on-line analyzers

This procedure can be used to meet the requirements of USEPA Method 334.0 - Determination of Residual Chlorine in Drinking Water Using an On-line Chlorine Analyzer.

The procedure and requirements for compliance with EPA Method 334.0 can be downloaded directly from <http://www.hach.com/method334>

Method performance

The method performance data that follows was derived from laboratory tests that were measured on a Pocket Colorimeter II during ideal test conditions. Users can get different results under different test conditions.

Precision (95% confidence interval)
1.00 ± 0.05 mg/L Cl ₂

Summary of method

Chlorine can be in water as free chlorine and as combined chlorine. Both forms can be in the same solution and can be determined together as total chlorine. Free chlorine is in a solution as hypochlorous acid or hypochlorite ion. Combined chlorine represents a combination of chlorine-containing compounds, including monochloramine, dichloramine, nitrogen trichloride and other chloro derivatives. The combined chlorine oxidizes iodide (I⁻) to iodine (I₂). The iodine and free chlorine reacts with DPD (N,N-diethyl-p-phenylenediamine) to form a red solution. The color intensity is proportional to the chlorine concentration. To determine the concentration of combined chlorine, complete a free chlorine test and a total chlorine test. Subtract the results of the free chlorine test from the total chlorine test to get the combined chlorine concentration.

Consumables and replacement items

Required reagents

Description	Quantity/test	Unit	Item no.
DPD Free Chlorine Reagent Powder Pillow, 10 mL	1	100/pkg	2105569
DPD Total Chlorine Reagent Powder Pillow, 10 mL	1	100/pkg	2105669
OR			
DPD Free Chlorine Reagent AccuVac® Ampul	1	25/pkg	2502025
DPD Total Chlorine Reagent AccuVac® Ampul	1	25/pkg	2503025

Required apparatus (powder pillows)

Description	Quantity/test	Unit	Item no.
Sample cells, 10-mL round, 25 mm x 60 mm	2	6/pkg	2427606

Required apparatus (AccuVac Ampul)

Description	Quantity/Test	Unit	Item no.
Sample cell, 10-mL round, 25 mm x 60 mm	1	6/pkg	2427606
Beaker, 50 mL	1	each	50041H
Stoppers for 18-mm tubes and AccuVac Ampuls	2	6/pkg	173106

Recommended standards and apparatus

Description	Unit	Item no.
Chlorine Standard Solution, 2-mL PourRite® Ampules, 25–30 mg/L	20/pkg	2630020
PourRite® Ampule Breaker, 2-mL	each	2484600

Optional reagents and apparatus

Description	Unit	Item no.
AccuVac® Ampul Snapper	each	2405200
Mixing cylinder, graduated, 25-mL	each	2088640
Potassium Iodide, 30-g/L	100 mL	34332
Sodium Arsenite, 5-g/L	100 mL	104732
Sodium Hydroxide Standard Solution, 1.0 N	100 mL MDB	104532
Sulfuric Acid Standard Solution, 1 N	100 mL MDB	127032
Pipet, TenSette®, 0.1–1.0 mL	each	1970001
Pipet tips for TenSette® Pipet, 0.1–1.0 mL	50/pkg	2185696
Pipet tips for TenSette® Pipet, 0.1–1.0 mL	1000/pkg	2185628
Paper, pH, 0–14 pH range	100/pkg	2601300
DPD Free Chlorine Reagent Powder Pillows, 10 mL	1000/pkg	2105528
DPD Total Chlorine Reagent Powder Pillows, 10 mL	1000/pkg	2105628
SwifTest™ dispenser for free chlorine ¹	each	2802300
SwifTest™ dispenser for total chlorine ²	each	2802400
DPD Free Chlorine Reagent, 10-mL, SwifTest™ Dispenser refill vial	250 tests	2105560
DPD Total Chlorine Reagent, 10-mL, SwifTest™ Dispenser refill vial	250 tests	2105660
SpecCheck™ Secondary Standard Kit, Chlorine DPD, 0–2.0 mg/L Set	each	2635300
Water, organic-free	500 mL	2641549

¹ Includes one vial of 2105560 for 250 tests.

² Includes one vial of 2105660 for 250 tests.



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HACH COMPANY
 WORLD HEADQUARTERS
 Telephone: (970) 669-3050
 FAX: (970) 669-2932

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 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 (fig. 2). 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. Remove the flexible tubing from the CHEMet ampoule and wipe all liquid from the exterior of the ampoule. Place an ampoule cap firmly onto the tip of the CHEMet ampoule. Invert the ampoule several times, allowing the bubble to travel from end to end.

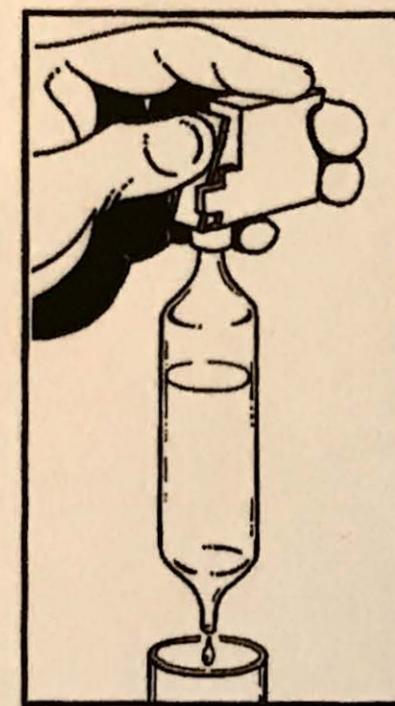


Figure 1

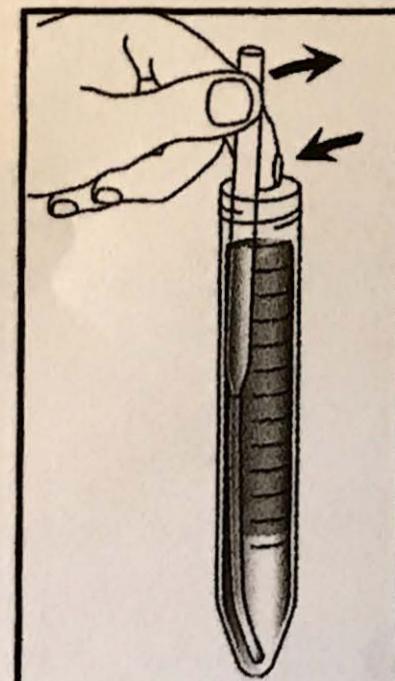


Figure 2

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 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 (fig. 2). 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. Remove the flexible tubing from the CHEMet ampoule and wipe all liquid from the exterior of the ampoule. Place an ampoule cap firmly onto the tip of the CHEMet ampoule. Invert the ampoule several times, allowing the bubble to travel from end to end.

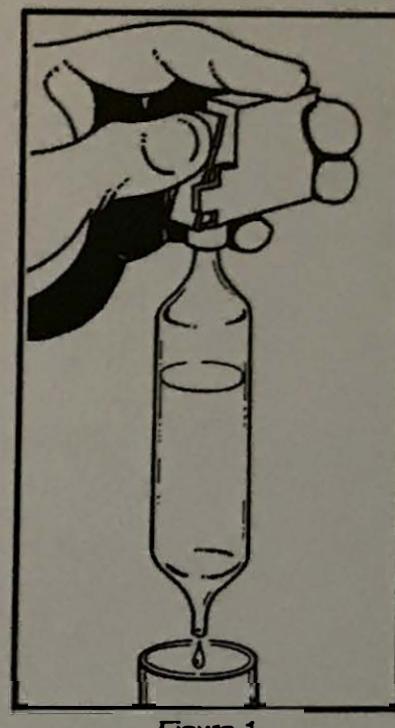


Figure 1

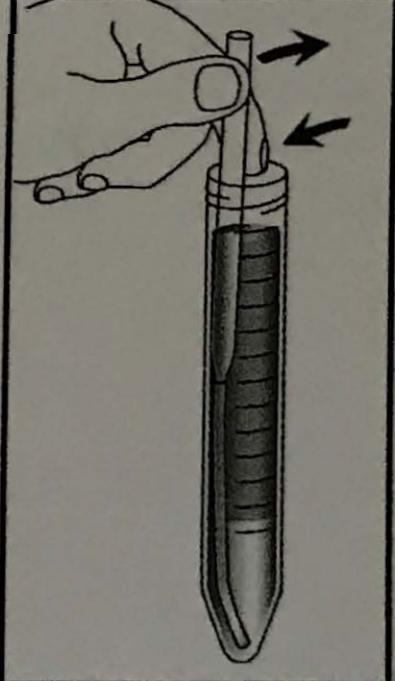


Figure 2

Appendix E

Source Isolation and Confirmation Methods: Instructions and SOPs

SOP 10: LOCATING ILLICIT DISCHARGES

Introduction

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

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

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

Identifying Illicit Discharges

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

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

Both bacteria and petroleum can create a sheen on the water surface. The source of the sheen can be differentiated by disturbing it, such as with a pole. A sheen caused by oil will remain intact and move in

a swirl pattern; a sheen caused by bacteria will separate and appear “blocky”. Bacterial sheen is not a pollutant but should be noted.

Citizen Call in Reports

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

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

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

Tracing Illicit Discharges

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

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

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

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

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

Dye Testing

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

Smoke Testing

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

Closed Circuit Television Inspection (CCTV)

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

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

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

Removing Illicit Discharges

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

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

Attachments

1. Illicit Discharge Incident Tracking Sheet

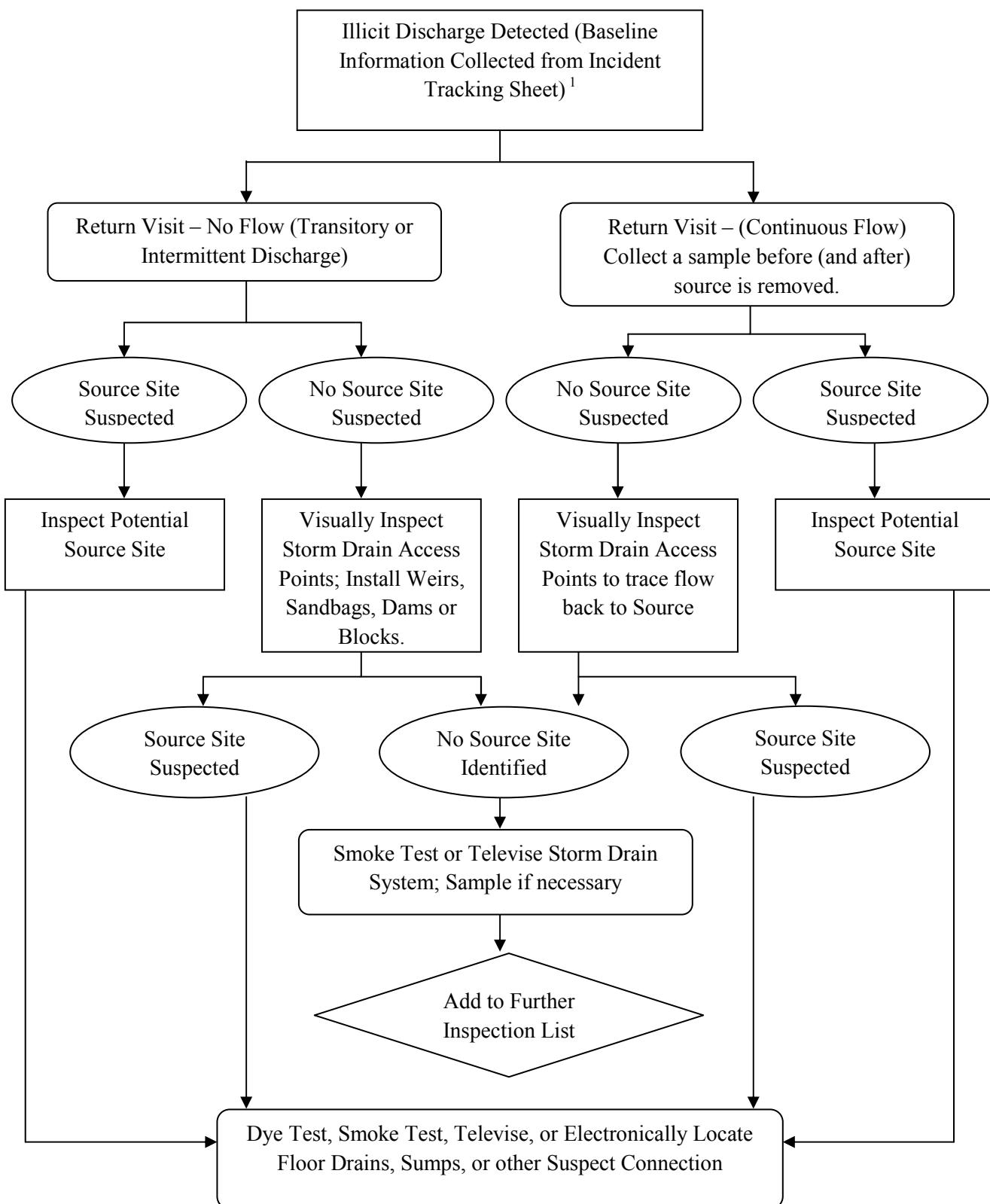
Related Standard Operating Procedures

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

Table SOP 10-1

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

Financially Responsible	Source Identified	Enforcement Authority	Procedure to Follow
Private Property Owner	One-time illicit discharge (e.g. spill, dumping, etc.)	Ordinance enforcement authority (e.g. Code Enforcement Officer)	<ul style="list-style-type: none"> • Contact Owner • Issue Notice of Violation • Issue fine
Private Property Owner	Intermittent or continuous illicit discharge from legal connection	Ordinance enforcement authority (e.g. Code Enforcement Officer)	<ul style="list-style-type: none"> • Contact Owner • Issue Notice of Violation • Determine schedule for removal • Confirm removal
Private Property Owner	Intermittent or continuous illicit discharge from illegal connection or indirect (e.g. infiltration or failed septic)	Plumbing Inspector or ordinance enforcement authority	<ul style="list-style-type: none"> • Notify Plumbing Inspector or ordinance enforcement authority
Municipal	Intermittent or continuous illicit discharge from illegal connection or indirect (e.g. failed sewer line)	Ordinance enforcement authority (e.g. Code Enforcement Officer)	<ul style="list-style-type: none"> • Issue work order • Schedule removal • Remove connection • Confirm removal
Exempt 3 rd Party	Any	USEPA	<ul style="list-style-type: none"> • Notify exempt third party and USEPA of illicit discharge



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

Illicit Discharge Incident Tracking Sheet

Incident ID:													
Responder Information (for Citizen-Reported issues)													
Call Taken By:	Call Date:												
Call Time:	Precipitation (inches) in past 24-48 hours:												
Observer Information													
Date and Time of Observation:	Observed During Regular Maintenance or Inspections? <input type="checkbox"/> Yes <input type="checkbox"/> No												
Caller Contact Information (optional) or Municipal Employee Information:													
Observation Location: (complete one or more below)													
Latitude and Longitude:													
Stream Address or Outfall #:													
Closest Street Address:													
Nearby Landmark:													
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Primary Location Description</th> <th colspan="3">Secondary Location Description:</th> </tr> <tr> <td><input type="checkbox"/> Stream Corridor (In or adjacent to stream)</td> <td><input type="checkbox"/> Outfall</td> <td><input type="checkbox"/> In-stream Flow</td> <td><input type="checkbox"/> Along Banks</td> </tr> <tr> <td><input type="checkbox"/> Upland Area (Land not adjacent to stream)</td> <td><input type="checkbox"/> Near Storm Drain</td> <td colspan="2"><input type="checkbox"/> Near other water source (stormwater pond, wetland, ect.):</td> </tr> </table>		Primary Location Description	Secondary Location Description:			<input type="checkbox"/> Stream Corridor (In or adjacent to stream)	<input type="checkbox"/> Outfall	<input type="checkbox"/> In-stream Flow	<input type="checkbox"/> Along Banks	<input type="checkbox"/> Upland Area (Land not adjacent to stream)	<input type="checkbox"/> Near Storm Drain	<input type="checkbox"/> Near other water source (stormwater pond, wetland, ect.):	
Primary Location Description	Secondary Location Description:												
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<input type="checkbox"/> Upland Area (Land not adjacent to stream)	<input type="checkbox"/> Near Storm Drain	<input type="checkbox"/> Near other water source (stormwater pond, wetland, ect.):											
Narrative description of location:													
Upland Problem Indicator Description													
<input type="checkbox"/> Dumping	<input type="checkbox"/> Oil/Solvents/Chemicals	<input type="checkbox"/> Sewage											
<input type="checkbox"/> Detergent, suds, etc.	<input type="checkbox"/> Other: _____												
Stream Corridor Problem Indicator Description													
Odor	<input type="checkbox"/> None	<input type="checkbox"/> Sewage	<input type="checkbox"/> Rancid/Sour	<input type="checkbox"/> Petroleum (gas)									
	<input type="checkbox"/> Sulfide (rotten eggs); natural gas	<input type="checkbox"/> Other: Describe in "Narrative" section											
Appearance	<input type="checkbox"/> "Normal"	<input type="checkbox"/> Oil Sheen	<input type="checkbox"/> Cloudy	<input type="checkbox"/> Foam									
	<input type="checkbox"/> Optical enhancers	<input type="checkbox"/> Discolored	<input type="checkbox"/> Other: Describe in "Narrative" section										
Floatables	<input type="checkbox"/> None	<input type="checkbox"/> Sewage (toilet paper, etc)	<input type="checkbox"/> Algae	<input type="checkbox"/> Trash or debris									
	<input type="checkbox"/> Other: Describe in "Narrative" section												
Narrative description of problem indicators:													
Suspected Source (name, personal or vehicle description, license plate #, address, etc.):													

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

Chapter 13: Tracking Discharges To A Source

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

Storm Drain Network Investigation

Field crews strategically inspect manholes within the storm drain network system to measure chemical or physical indicators that can isolate discharges to a specific segment of the network. Once the pipe segment has been identified, on-site investigations are used to find the specific discharge or improper connection.

Drainage Area Investigation

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

On-site Investigation

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

Septic System Investigation

Low-density residential watersheds may require special investigation methods if

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

13.1 Storm Drain Network Investigations

This method involves progressive sampling at manholes in the storm drain network to narrow the discharge to an isolated pipe segment between two manholes. Field crews need to make two key decisions when conducting a storm drain network investigation—where to start sampling in the network and what indicators will be used to determine whether a manhole is considered clean or dirty.

Where to Sample in the Storm Drain Network

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

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

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

can help identify manholes, pipes and junctions, and establish a new map of the storm drain network.

Option 1: Move up the Trunk

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

Table 53: Methods to Attack the Storm Drain Network

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

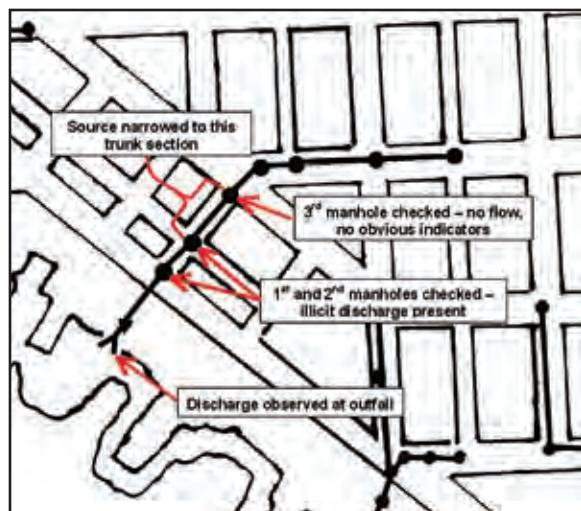


Figure 50: Example investigation following the source up the storm drain system

Option 2: Split the storm drain network

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

The method for splitting the trunk is as follows:

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

Option 3: Move down the storm drain network

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

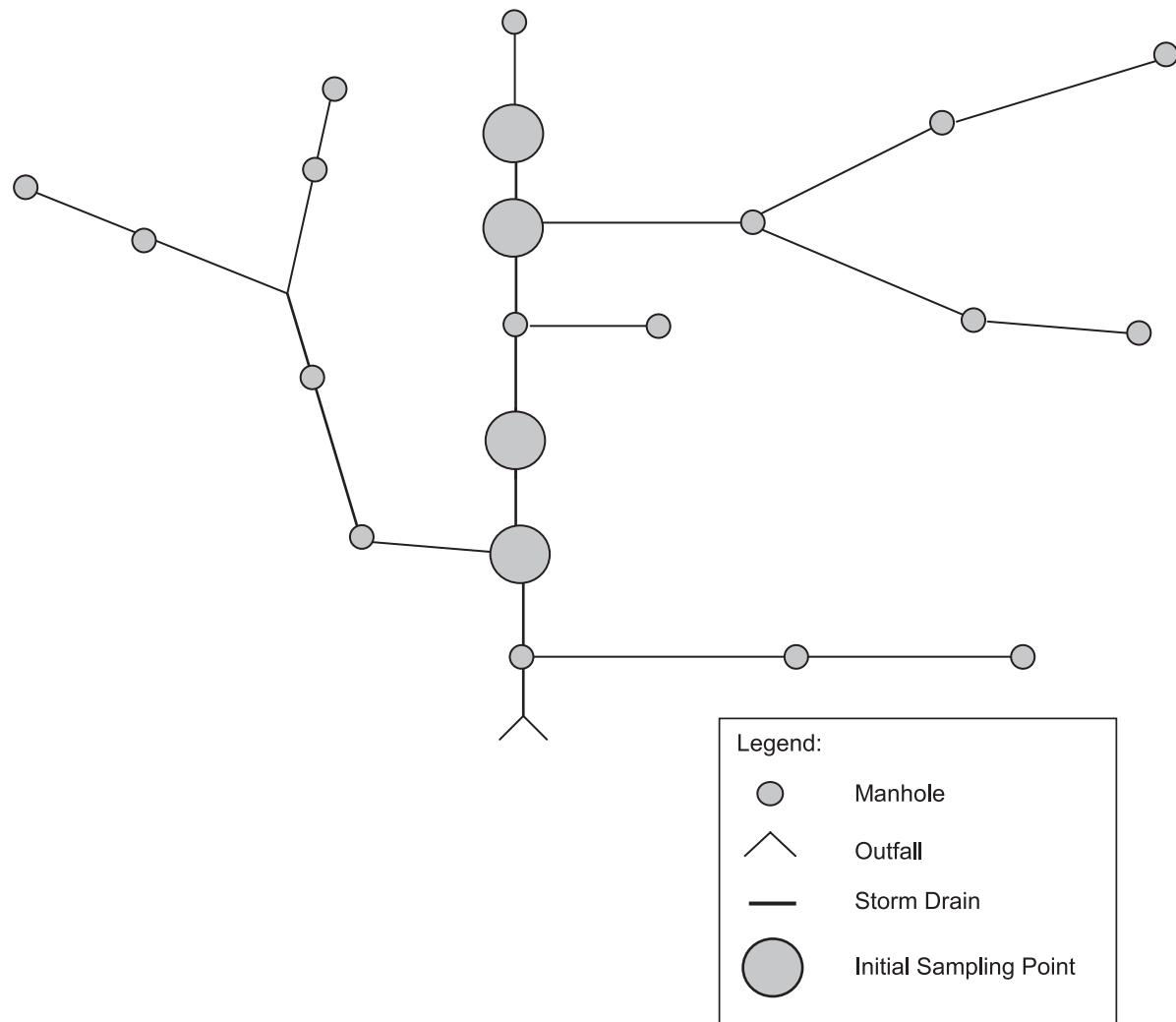


Figure 51: Key initial sampling points along the trunk of the storm drain

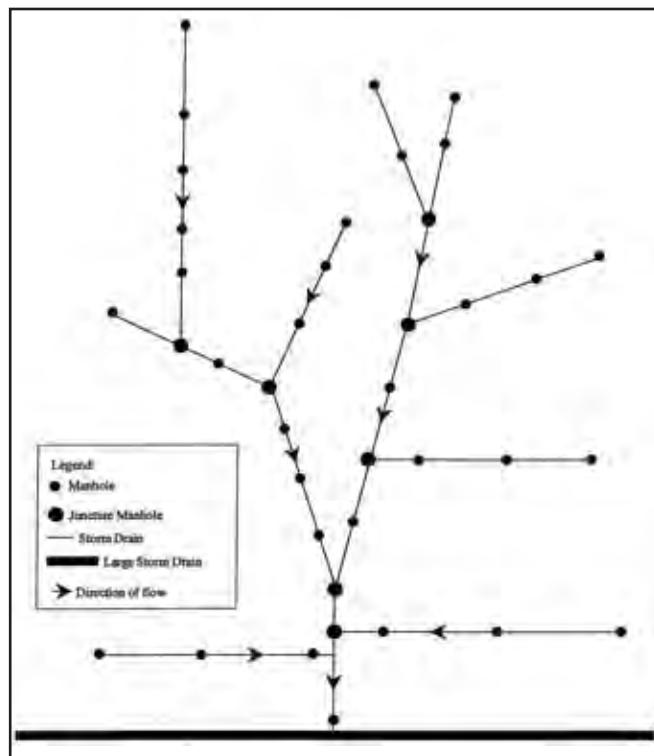


Figure 52: Storm Drain Schematic Identifying “Juncture Manholes” (Source: Jewell, 2001)

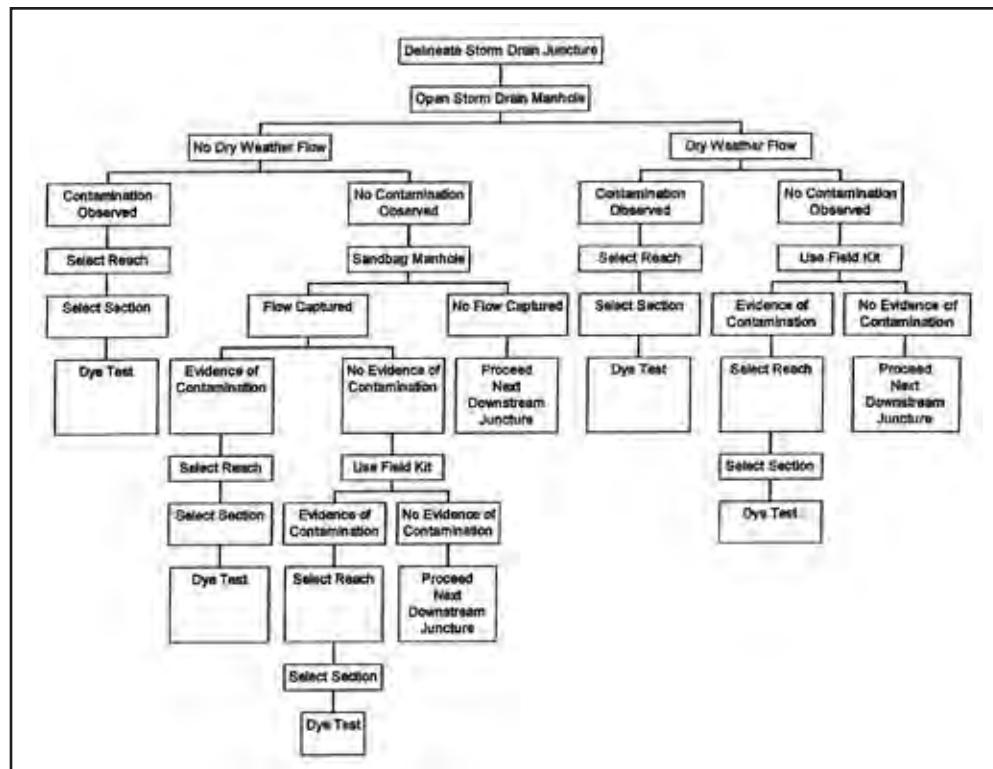


Figure 53: A Process for Following Discharges Down the Pipe (Source: Jewell, 2001)

Dye Testing to Create a Storm Drain Map

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

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

Manhole Inspection: Visual Observations and Indicator Sampling

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

Basic field equipment and safety procedures required for manhole inspections are outlined

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

Table 54: Basic Field Equipment Checklist

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



Figure 54: Traffic cones divert traffic from manhole inspection area

Table 55: Field Procedure for Removal of Manhole Covers
(Adapted from: Pomeroy et al., 1996)

Field Procedures:

1. Locate the manhole cover to be removed.
2. Divert road and foot traffic away from the manhole using traffic cones.
3. Use the tip of a crowbar to lift the manhole cover up high enough to insert the gas monitor probe. Take care to avoid creating a spark that could ignite explosive gases that may have accumulated under the lid. Follow procedures outlined for the gas monitor to test for accumulated gases.
4. If the gas monitor alarm sounds, close the manhole immediately. Do not attempt to open the manhole until some time is allowed for gases to dissipate.
5. If the gas monitor indicates the area is clear of hazards, remove the monitor probe and position the manhole hook under the flange. Remove the crowbar. Pull the lid off with the hook.
6. When testing is completed and the manhole is no longer needed, use the manhole hook to pull the cover back in place. Make sure the lid is settled in the flange securely.
7. Check the area to ensure that all equipment is removed from the area prior to leaving.

Safety Considerations:

1. Do not lift the manhole cover with your back muscles.
2. Wear steel-toed boots or safety shoes to protect feet from possible crushing injuries that could occur while handling manhole covers.
3. Do not move manhole covers with hands or fingers.
4. Wear safety vests or reflective clothing so that the field crew will be visible to traffic.
5. Manholes may only be entered by properly trained and equipped personnel and when all OSHA and local rules a.

Visual Observations During Manhole Inspection

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

flows. Key visual observations that are made during manhole inspections include:

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



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

Indicator Sampling

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

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



Figure 56: Techniques to sample from the storm drain

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

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

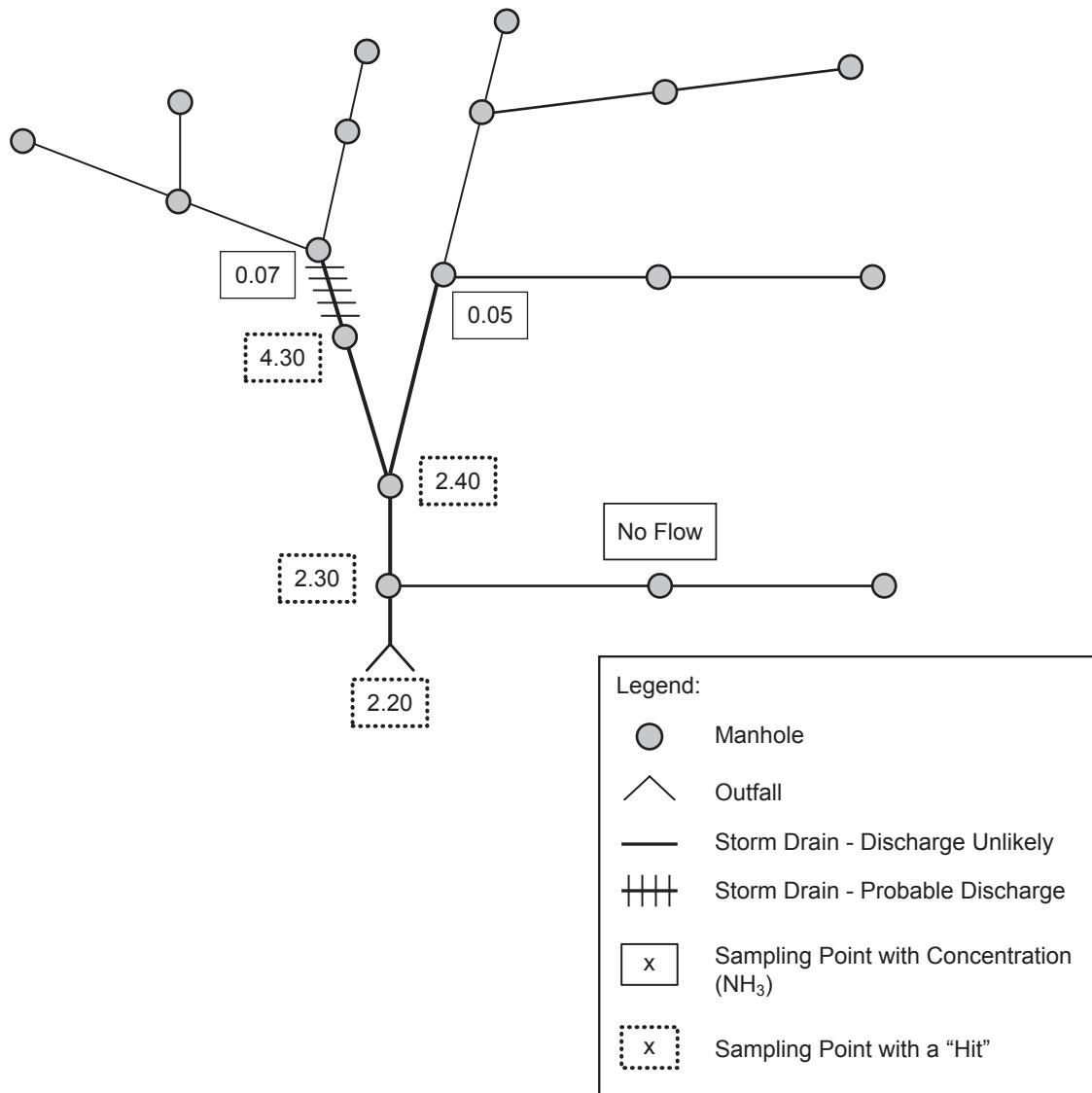


Figure 57: Use of ammonia as a trace parameter to identify illicit discharges

 BOSTON WATER AND SEWER COMMISSION MANHOLE INSPECTION LOG		Manhole ID No. <input type="text"/>																				
Inspection Date: <input type="text"/>	Tributary Area: <input type="text"/>																					
Street: <input type="text"/>	Manhole Type: <input type="text"/>																					
Inspection: Not Found <input type="checkbox"/> Surface <input type="checkbox"/> Internal <input type="checkbox"/>	Sanitary Sewer <input type="checkbox"/>	Storm Drain <input type="checkbox"/>																				
Follow Up Inspection <input type="text"/>	High Outlet <input type="checkbox"/>	Lovejoy <input type="checkbox"/>																				
Time Since Last Rain: <input type="text"/>																						
Inspector: <input type="text"/>	< 48 hours <input type="checkbox"/>	48 - 72 hours <input type="checkbox"/>	> 72 hours <input type="checkbox"/>																			
Observations: Standing Water in Manhole: Yes <input type="checkbox"/> No <input type="checkbox"/> Color of Water: Clear <input type="checkbox"/> Cloudy <input type="checkbox"/> Other <input type="checkbox"/> Flow in Manhole: Yes <input type="checkbox"/> No <input type="checkbox"/> Velocity: Slow <input type="checkbox"/> Medium <input type="checkbox"/> Fast <input type="checkbox"/> Depth of Flow: <input type="text"/> in. Color of Flow: No Flow <input type="checkbox"/> Clear <input type="checkbox"/> Cloudy <input type="checkbox"/> Suspended Solids <input type="checkbox"/> Other <input type="checkbox"/> Blockages: Yes <input type="checkbox"/> No <input type="checkbox"/> Sediment in Manhole: Yes <input type="checkbox"/> No <input type="checkbox"/> If Yes: Percent of Pipe Filled: <input type="text"/> % Floatables: None <input type="checkbox"/> Sewage <input type="checkbox"/> Oily Sheen <input type="checkbox"/> Foam <input type="checkbox"/> Other <input type="checkbox"/> Odor: None <input type="checkbox"/> Sewage <input type="checkbox"/> Oil <input type="checkbox"/> Soap <input type="checkbox"/> Other <input type="checkbox"/>																						
Field Testing: pH <input type="text"/> Temp <input type="text"/> Spec. Cond. <input type="text"/> Surfactants: Yes <input type="checkbox"/> No <input type="checkbox"/> Ammonia: Yes <input type="checkbox"/> No <input type="checkbox"/>																						
Contamination: Found During Inspection: Yes <input type="checkbox"/> Check one: <input type="checkbox"/> Observation <input type="checkbox"/> Positive Test Kit Result No <input type="checkbox"/> Sandbagged Placed No <input type="checkbox"/> Yes <input type="checkbox"/> Give Date <input type="text"/> Sandbag Checked (Date): <input type="text"/> Flow was <input type="checkbox"/> Captured <input type="checkbox"/> Not Captured <input type="checkbox"/>																						
Condition of Manhole: Grade: At <input type="checkbox"/> Above <input type="checkbox"/> Below <input type="checkbox"/> High Outlet: Blocked <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA <input type="checkbox"/> Lovejoy: Cover Plate in Place <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA <input type="checkbox"/> <table border="0"> <tr> <td>Good <input type="checkbox"/></td> <td>Fair <input type="checkbox"/></td> <td>Poor <input type="checkbox"/></td> <td>Comments: <input type="text"/></td> </tr> </table> <table border="0"> <tr> <td>Pavement <input type="text"/></td> <td>Cover <input type="text"/></td> <td>Construction Material: <input type="text"/></td> </tr> <tr> <td>Frame <input type="text"/></td> <td>Brick <input type="checkbox"/> Precast <input type="checkbox"/> Other <input type="checkbox"/></td> <td></td> </tr> <tr> <td>Corbel <input type="text"/></td> <td></td> <td></td> </tr> <tr> <td>Walls <input type="text"/></td> <td></td> <td></td> </tr> <tr> <td>Floor <input type="text"/></td> <td></td> <td></td> </tr> </table>				Good <input type="checkbox"/>	Fair <input type="checkbox"/>	Poor <input type="checkbox"/>	Comments: <input type="text"/>	Pavement <input type="text"/>	Cover <input type="text"/>	Construction Material: <input type="text"/>	Frame <input type="text"/>	Brick <input type="checkbox"/> Precast <input type="checkbox"/> Other <input type="checkbox"/>		Corbel <input type="text"/>			Walls <input type="text"/>			Floor <input type="text"/>		
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Comments: Manhole Correct as Mapped Yes <input type="checkbox"/> No <input type="checkbox"/> <div style="text-align: center;">  Plan of Manhole </div>																						

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

Methods to isolate intermittent discharges in the storm drain network

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

Sandbags

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

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

Optical Brightener Monitoring (OBM) Traps

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

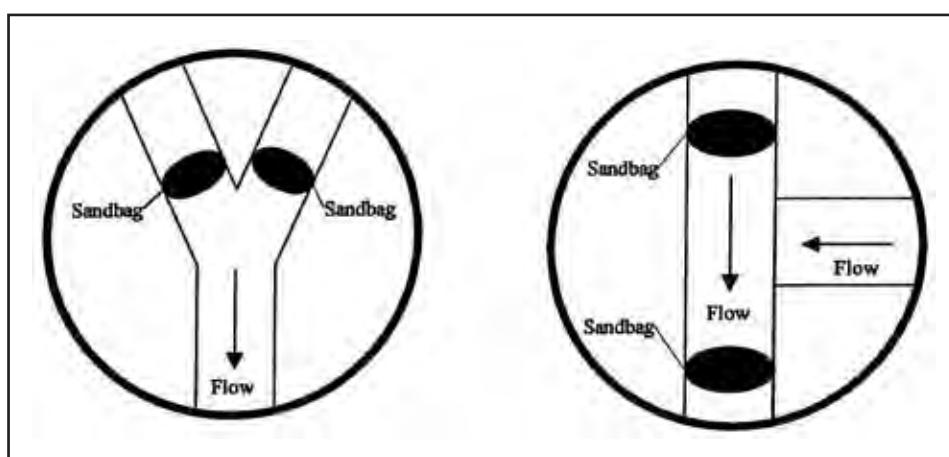


Figure 59: Example sandbag placement (Source: Jewell, 2001)



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

Automatic Samplers

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

Observation of Deposits or Stains

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

13.2 Drainage Area Investigations

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

Rapid Windshield Survey

A rapid drive-by survey works well in small drainage areas, particularly if field crews are already familiar with its business operations. Field crews try to match the characteristics of the discharge to the most likely type of generating site, and then inspect all of the sites of the same type within the drainage area until the culprit is found. For example, if fuel is observed at an outfall, crews might quickly check every business operation in the catchment that stores or dispenses fuel. Another example is illustrated in Figure 61 where extremely dense algal growth was observed in a small stream during the winter. Field crews were aware of a fertilizer storage site in the drainage area, and a quick inspection identified it as the culprit.



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

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

Detailed Drainage Area Investigations

In larger or more complex drainage areas, GIS data can be analyzed to pinpoint the source of a discharge. If only general land use data exist, maps can at least highlight suspected industrial areas. If more detailed SIC code data are available digitally, the GIS can be used to pull up specific hotspot

operations or generating sites that could be potential dischargers. Some of the key discharge indicators that are associated with hotspots and specific industries are reviewed in Appendix K.

13.3 On-site Investigations

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



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

Table 56: Techniques to Locate the Discharge

Technique	Best Applications	Limitations
Dye Testing	<ul style="list-style-type: none"> Discharge limited to a very small drainage area (<10 properties is ideal) Discharge probably caused by a connection from an individual property Commercial or industrial land use 	<ul style="list-style-type: none"> May be difficult to gain access to some properties
Video Testing	<ul style="list-style-type: none"> Continuous discharges Discharge limited to a single pipe segment Communities who own equipment for other investigations 	<ul style="list-style-type: none"> Relatively expensive equipment Cannot capture non-flowing discharges Often cannot capture discharges from pipes submerged in the storm drain
Smoke Testing	<ul style="list-style-type: none"> Cross-connection with the sanitary sewer Identifying other underground sources (e.g., leaking storage techniques) caused by damage to the storm drain 	<ul style="list-style-type: none"> Poor notification to public can cause alarm Cannot detect all illicit discharges

TIP

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

**Figure 63: Dye Testing Plumbing (NEIWPCC, 2003)****Dye Testing**

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

Before commencing dye tests, crews should review storm drain and sewer maps to identify lateral sewer connections and how they can be accessed. In addition, property owners must be notified to obtain entry permission. For industrial or commercial properties, crews should carry a letter to document their legal authority to gain

access to the property. If time permits, the letter can be sent in advance of the dye testing. For residential properties, communication can be more challenging. Unlike commercial properties, crews are not guaranteed access to homes, and should call ahead to ensure that the owner will be home on the day of testing.

Communication with other local agencies is also important since any dye released to the storm drain could be mistaken for a spill or pollution episode. To avoid a costly and embarrassing response to a false alarm,

crews should contact key spill response agencies using a “quick fax” that describes when and where dye testing is occurring (Tuomari and Thomson, 2002). In addition, crews should carry a list of phone numbers to call spill response agencies in the event dye is released to a stream.

At least two staff are needed to conduct dye tests – one to flush dye down the plumbing fixtures and one to look for dye in the downstream manhole(s). In some cases,

three staff may be preferred, with two staff entering the private residence or building for both safety and liability purposes.

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

Table 57: Key Field Equipment for Dye Testing
(Source: Wayne County, MI, 2000)

Maps, Documents

- Sewer and storm drain maps (sufficient detail to locate manholes)
- Site plan and building diagram
- Letter describing the investigation
- Identification (e.g., badge or ID card)
- Educational materials (to supplement pollution prevention efforts)
- List of agencies to contact if the dye discharges to a stream.
- Name of contact at the facility

Equipment to Find and Lift the Manhole Safely (small manhole often in a lawn)

- Probe
- Metal detector
- Crow bar
- Safety equipment (hard hats, eye protection, gloves, safety vests, steel-toed boots, traffic control equipment, protective clothing, gas monitor)

Equipment for Actual Dye Testing and Communications

- 2-way radio
- Dye (liquid or “test strips”)
- High powered lamps or flashlights
- Water hoses
- Camera



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

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

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

Table 58: Dye Testing Options

Product	Applications
Dye Tablets	<ul style="list-style-type: none"> • Compressed powder, useful for releasing dye over time • Less messy than powder form • Easy to handle, no mess, quick dissolve • Flow mapping and tracing in storm and sewer drains • Plumbing system tracing • Septic system analysis • Leak detection
Liquid Concentrate	<ul style="list-style-type: none"> • Very concentrated, disperses quickly • Works well in all volumes of flow • Recommended when metering of input is required • Flow mapping and tracing in storm and sewer drains • Plumbing system tracing • Septic system analysis • Leak detection
Dye Strips	<ul style="list-style-type: none"> • Similar to liquid but less messy
Powder	<ul style="list-style-type: none"> • Can be very messy and must dissolve in liquid to reach full potential • Recommended for very small applications or for very large applications where liquid is undesirable • Leak detection
Dye Wax Cakes	<ul style="list-style-type: none"> • Recommended for moderate-sized bodies of water • Flow mapping and tracing in storm and sewer drains
Dye Wax Donuts	<ul style="list-style-type: none"> • Recommended for large sized bodies of water (lakes, rivers, ponds) • Flow mapping and tracing in storm and sewer drains • Leak detection

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

Dye Selection

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

Selecting Fixtures to Test

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

Selecting a Sewer Manhole for Observations

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

Communications Between Crew Members

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

Locating Missing Dye

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

Video Testing

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

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

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

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

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

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

When inspecting the storm sewer, the CCTV is oriented to keep the lens as close as possible to the center of the pipe. The camera can be self-propelled through the pipe using a tractor or crawler unit or it may be towed through on a skid unit (see Figures 65 and 66). If the storm drain



Figure 65: Camera being towed

has ponded water, the camera should be attached to a raft, which floats through the storm sewer from one manhole to the next. To see details of the sewer, the camera and lights should be able to swivel both horizontally and vertically. A video record of the inspection should be made for future reference and repairs (see Figure 67).

Smoke Testing

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



Figure 66: Tractor-mounted camera



Figure 67: Review of an inspection video

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

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

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

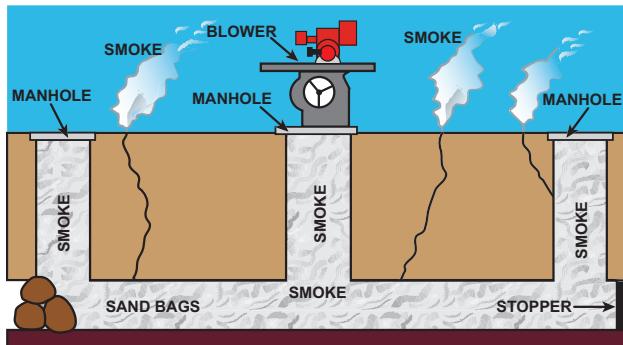


Figure 68: Smoke Testing System Schematic

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

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

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

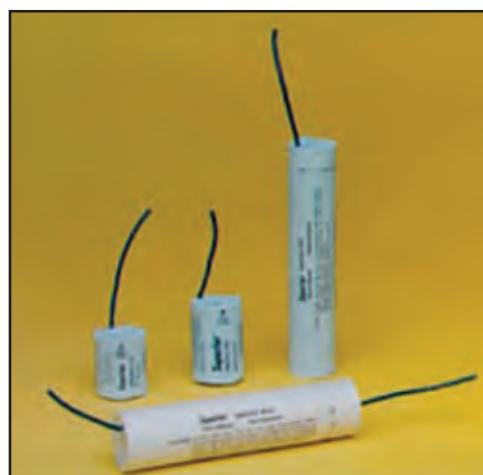


Figure 69: Smoke Candles



Figure 70: Smoke blower

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

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

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

One of three methods can be used to seal off the storm drain. Sandbags can be lowered into place with a rope from the street surface. Alternatively, beach balls that have a diameter slightly larger than the drain can be inserted into the pipe. The beach ball is then placed in a mesh bag with a

rope attached to it so it can be secured and retrieved. If the beach ball gets stuck in the pipe, it can simply be punctured, deflated and removed. Finally, expandable plugs are available, and may be inserted from the ground surface.

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

13.4 Septic System Investigations

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

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

On-Site Septic Investigations

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

Detailed system inspections may occur at time of sale of a property, or be triggered by poor scores on the rapid homeowner survey or surface condition analysis.

Homeowner Survey

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

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

Surface Condition Analysis

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

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

Table 60: Septic System Homeowner Survey Questions
(Adapted from Andrews *et al.*, 1997 and Holmes Inspection Services)

- How many people live in the house?¹
- What is the septic tank capacity?²
- Do drains in the house empty slowly or not at all?
- When was the last time the system was inspected or maintained?
- Does sewage back up into the house through drain lines?
- Are there any wet, smelly spots in the yard?
- Is the septic tank effluent piped so it drains to a road ditch, a storm sewer, a stream, or is it connected to a farm drain tile?

¹ Water usage ranges from 50 to 100 gallons per day per person. This information can be used to estimate the wastewater load from the house (Andrews *et. al.*, 1997).

² The septic tank should be large enough to hold two days' worth of wastewater (Andrews *et. al.*, 1997).

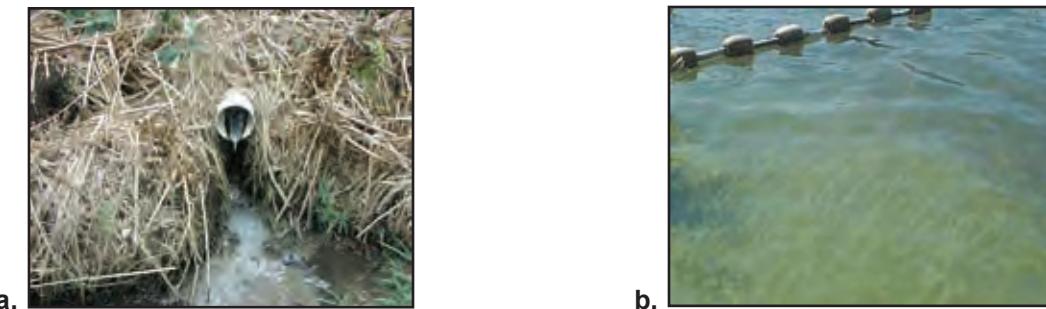


Figure 71: (a) Straight pipe discharge to nearby stream. (b) Algal bloom in a nearby pond.

(Sources: a- Snohomish County, WA, b- King County, WA)

Detailed System Inspection

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

Although not always incorporated into the inspection, dye testing can sometimes point to leaks from broken pipes, or direct discharges through straight pipes that might be missed during routine inspection. Dye can be introduced into plumbing fixtures in the home, and flushed with sufficient running water. The inspector then watches the septic field, nearby ditches, watercourses and manholes for any signs of the dye. The

dye may take several hours to appear, so crews may want to place charcoal packets in adjacent waters to capture dye until they can return later to retrieve them.

Infrared Imagery

Infrared imagery is a special type of photography with gray or color scales that represent differences in temperature and emissivity of objects in the image (www.stocktoninfrared.com), and can be used to locate sewage discharges. Several different infrared imagery techniques can be used to identify illicit discharges. The following discussion highlights two of these: aerial infrared thermography¹³ and color infrared aerial photography.

Infrared Thermography

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

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

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

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

Late fall, winter, and early spring are typically the best times of year to conduct these investigations in most regions of the



Figure 72: Aerial thermography showing sewage leak

country. This allows for a bigger difference between receiving water and discharge temperatures, and interference from vegetation is minimized (Stockton, 2004b). In addition, flights should take place at night to minimize reflected and direct daylight solar radiation that may adversely affect the imagery (Stockton, 2004b).

Color Infrared Aerial Photography

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

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

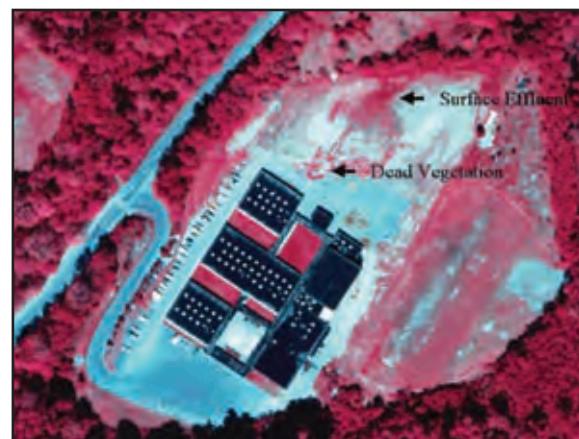


Figure 73: Dead vegetation and surface effluent are evidence of a septic system surface failure.

(Source: U.S. EPA, 1999)

13.5 The Cost to Trace Illicit Discharge Sources

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

Costs for Dye, Video, and Smoke Testing

The cost of smoke, dye, and video testing can be substantial and staff intensive, and

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

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

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

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

Table 62: Equipment Costs for Dye Testing

Product	Water Volume	Cost
Dye Strips	1 strip/500 gallons	\$75 – \$94 per 100 strips
Dye Tablets	0 – 50,000 gallons	\$40 per 200 tablets
Liquid Concentrate (Rhodamine WT)	0 – 50,000 gallons	\$80 – \$90 per gallon \$15 – \$20 per pint
Powder	50,000 + gallons	\$77 per lb
Dye Wax Cakes	20,000 – 50,000 gallons	\$12 per one 1.25 ounce cake
Dye Wax Donuts	50,000 + gallons	\$104 – \$132 per 42 oz. donut

Price Sources:
Aquatic Eco-Systems <http://www.aquaticeco.com/>
Cole Parmer <http://www.coleparmer.com>
USA Blue Book <http://www.usabluebook.com>

Table 63: Equipment Costs for Video Testing

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

Sources: USA Blue Book and Envirotech

Table 64: Equipment Costs for Smoke Testing

Equipment	Cost
Smoke Blower	\$1,000 to \$2,000 each
Liquid Smoke	\$38 to \$45 per gallon
Smoke Candles, 30 second (4,000 cubic feet)	\$27.50 per dozen
Smoke Candles, 60 Second (8,000 cubic feet)	\$30.50 per dozen
Smoke Candles, 3 Minute (40,000 cubic feet)	\$60.00 per dozen

Sources: Hurco Tech, 2003 and Cherne Industries, 2003

Costs for Septic System Investigations

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

Homeowner Survey and Surface Condition Analysis

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

Detailed System Inspection

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

Aerial Infrared Thermography

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

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

Appendix F

IDDE Employee Training Record

Illicit Discharge Detection and Elimination (IDDE) Employee Training Record

Middleton, MA

Date of Training: _____

Duration of Training: _____