Village of Menands
MCM 7 Stormwater Program Management
BMP 7- 7 Procedures and Forms Compendium

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NOTE: *Throughout this document there are references to Best Management Practices (BMPs) which are described in greater detail in the Coalition Joint Storm Water Management Program Plan (SWMP Plan). The SWMP Plan is posted on the Coalition website (www.stormwateralbanycounty.org).*

I. Village Facts
A. CDRPC Fact Sheets

II. Administrative Information
A. Stormwater Management Program Organizational Chart *(BMP 7-2 Local MS4/Municipal Mgmt)*
B. Enforcement Measures and Tracking – Enforcement Plan *(Anticipated in MS4 Permit GP 0-17-002)*
(*BMP 3-8 IDDE Program and BMP 4-5 Construction Enforcement Procedures)*
Attachments:
Chapter 143 Stormwater Mgmt & Erosion & Sediment Control "Construction Activity Local Law"
Chapter 144 Storm Sewers "IDDE Local Law"

III. MCM 3 Illicit Discharge Detection & Elimination Program Procedures *(BMP 3-8 IDDE Program Procedures)*
Information and Background
A. Identification of areas contributing to the MS4 with high illicit discharge potential
B. Detection of illicit discharges
C. Track down to identify source of illicit discharges
D. Procedures to eliminate discharges
E. Acronyms and Definitions
F. Chapter 13 Tracking Discharges To A Source (excerpt EPA IDDE Guidance Manual)

IV. MCM 4/5: MS4 Oversight of Construction Activity Permit
A. SWPPP Review Procedures and Check List (*BMP 4-2 and 5-1 SWPPP Review Procedures)*
Attachments:
Chapter 140 Site Plan Review
Chapter A172 Site Plan Review Regulations
SW Coalition Oversight of the New York State Department of Environmental Conservation Construction Activity Permit (GP-0-15-002) – A Guidance Document for MS4s
Construction Activity Permit Forms and Permit GP-0-15-002
B. Complaint Procedures *(BMP 4-4 Complaint Procedures)*
C. Construction Inspection Procedures *(BMP 4-5 Construction Inspection Procedures)*
D. Pre-Construction Meeting Procedures and Check List *(BMP 4-6 Education Construction Procedures)*
E. SWPPP Record Keeping Procedures *(BMP 4-8 SWPPP Record Keeping Procedures)*
F. Inventory Post Construction Procedures *(BMP 5-8 Inventory Procedures)*
G. Post Construction Practices - Long Term Maintenance Procedures
(BMP 5-9 Long Term Maintenance and O & M Procedures)

Minimum Control Measure 3
Illicit Discharge Detection and Elimination (IDDE)
BMP 3-8 IDDE Program Procedures
Village of Menands
(September, 2017)

Introduction and Background

Below is a list of written IDDE program procedures named in the current “old” MS4 Permit GP-0-15-003 which expired April 30, 2017, but is still in effect and procedures named in the “new” DRAFT MS4 Permit released October, 2016.

Procedures named in the “old” MS4 Permit GP-0-15-005 Part VII.A.3.g (pg. 35) and for Newly Regulated MS4s (pg. 26)

1. Procedures for identifying priority areas of concern (geographic, audiences, or otherwise) for the IDDE program; description of priority areas of concern, available staffing, funding, etc.
2. Procedures for identifying and locating illicit discharges (trackdown)
3. Procedures for eliminating discharges
4. Procedures for enforcing against illicit dischargers
5. Procedures for documenting actions.

Procedures named in the “new” MS4 Permit DRAFT GP-0-17-005 (October, 2016)

1. MS4 Operator outfall inspection procedures (pg. 23)
2. Track down procedures to identify the source of the illicit discharges and the responsible party, specifying: provisions for annual training; track down methods described in Chapter 13 of IDDE Guidance Manual; how progress with track down will be documented; time frames for initiating track down. (pg. 24)
3. Written procedures to eliminate discharges, specifying: time frames for elimination; provisions for escalating enforcement and tracking consistent with Enforcement Response Plan; provisions to confirm and verify that corrective action is complete; annual evaluation of time frames to eliminate illicit discharges and identify how efficiencies with elimination procedures may be improved. (pg. 25)

Eventually the new FINAL MS4 Permit will itemize which procedures must be written by MS4s. Until then, IDDE program procedures included in this BMP are those thought to be relevant to the Village of Menands and likely to be included in the FINAL MS4 Permit.

To help prioritize program activities, areas contributing to the MS4 with a high illicit discharge potential are identified at the outset. For reference an acronym list and definitions are provided. A table of contents is provided to help describe and locate all items included in these procedures.

Together these procedures serve to detect, track down, and eliminate illicit discharges.

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BMP 3-8 IDDE Program Procedures
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    e. Stormwater Outfalls and Wetlands
3. WIPWL Fact Sheet Minor Tribs West of Hudson

B. Detection of illicit discharges

1. MS4 Operator outfall inspection procedures

C. Track down to identify the source of illicit discharges and the responsible party.
The procedures include:

1. Provisions for annual training
2. Track down methods described in Chapter 13 of IDDE Guidance Manual
3. Description of how progress with track down will be documented
4. Time frames for initiating track down

D. Procedures to eliminate discharges.
The procedures include:

1. Time frames for elimination
2. Provisions for escalating enforcement
3. Tracking of enforcement escalation consistent with the Enforcement Response Plan
4. Provisions to confirm and verify that corrective action is completed.
5. Annual evaluation of elimination procedures which
    -includes time frames to eliminate illicit discharges
    -identifies how efficiencies with elimination procedures may be improved.

E. Acronyms and Definitions

F. Chapter 13 Tracking Discharges To A Source (excerpt EPA IDDE Guidance Manual)

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A. Identification of areas contributing to the MS4 with a high illicit discharge potential

1. Description of Menands

The Village of Menands is a 3.4 sq mile municipality on the west bank of the tidal Hudson River. It borders the Town of Colonie to the north and west and the City of Albany to the south. The village resides within the Town of Colonie and was incorporated in 1924. According to the 2010 census, the population is 3,990.

The original Erie Canal passed through what was to become Menands and later two islands in the Hudson River (Cuyler and Pleasure) were connected to the mainland and are now the site of Interstate 787 exits 6 and 7. The same interstate runs north-south throughout the entire village as does the D and H rail line.

Along the Hudson River there's a FEMA 1% annual chance flood zone which includes both undeveloped and developed land. The same flood zone abuts and sometimes includes a commercial corridor (Broadway Ave) which supports multiple businesses, including commercial and industrial development. Adjacent to the commercial corridor and further to the west at higher elevations, there are multi -family and single family residential properties. To the north, the St. Agnes Cemetery resides primarily in the Village, along with a small portion of the Albany Rural Cemetery. There are steep slopes towards the western portion of the Village and along a scattering of ravines, some of which are in the cemetery.

All of the mapped stream segments are impaired (see WIPWL Fact Sheet for Minor Tribs to West of Hudson - Segment ID 1301-0027) and the thirty-three (33) Village owned stormwater outfalls are concentrated in residential areas; along the commercial corridor (Broadway); and along the rail line. Anticipated updates and corrections to the outfall map may change this assessment of outfall clusters.

Currently areas with high illicit discharge potential are located along the commercial corridor where there is both a concentration of outfalls and a variety of commercial operations potentially generating a variety of pollutants. These commercial operations include:

AAA of the Hudson Valley 10 Broadway	Auto towing, minor repairs
Capital Car Cleaning 12 Broadway	Car washing and cleaning
Stewarts 14 Broadway	Gas dispensing, food sales
Cranesville Block 45 Broadway	Concrete block sales (abandoned)
Simmons Machine Tool 55, 87 Broadway	Railroad car wheel manufacturing

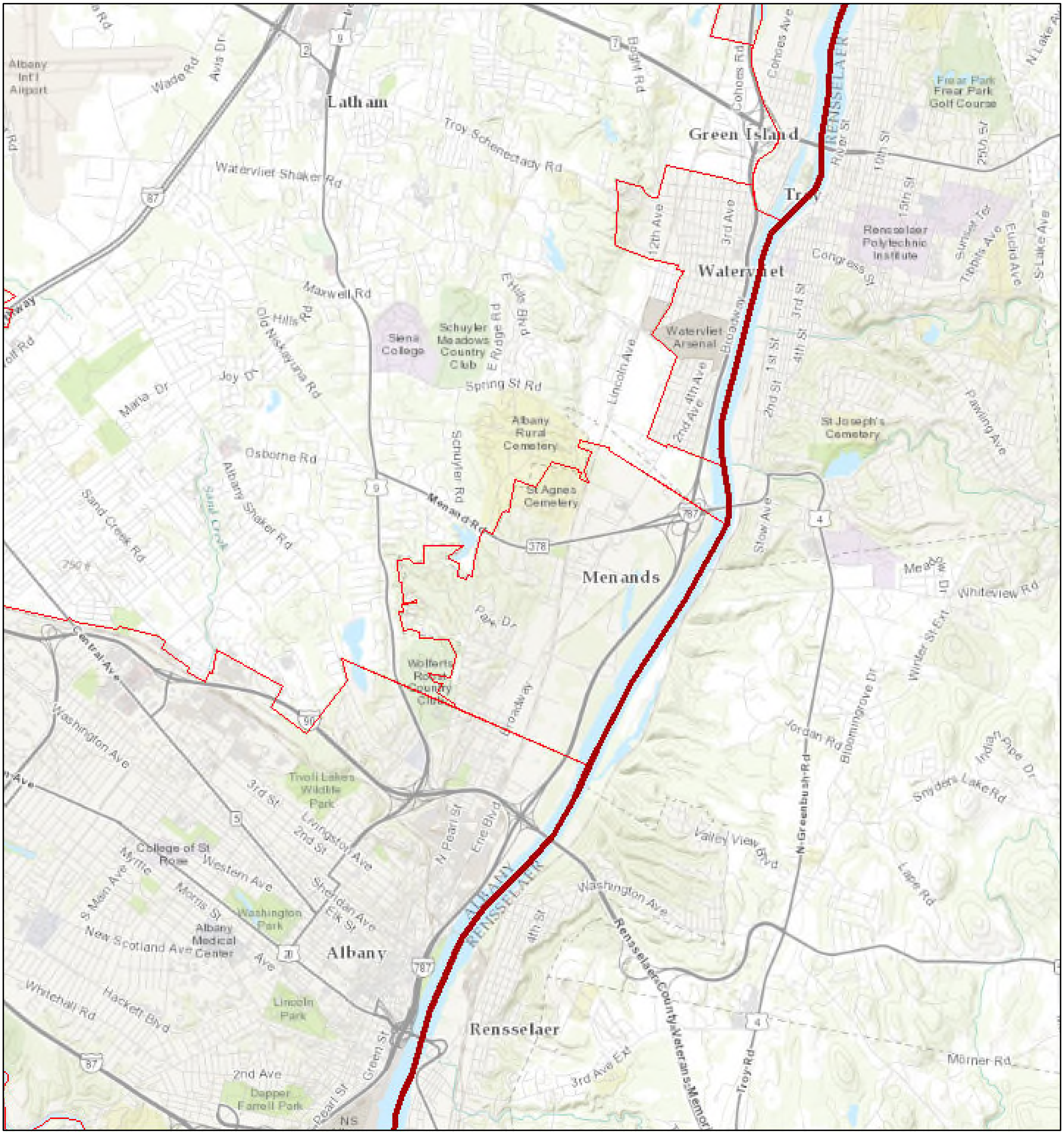
Gerome Technologies 73 Broadway	Manufacture of specialty steel products
125 Broadway, LLC 125 Broadway	Abandoned former printing building
Bildo Car Wash 228 Broadway	Abandoned former car wash
Hoods Up Auto Repair 245 Broadway	Auto repair and servicing
Midland Farms 375 Broadway	Milk processing plant

The developer community has also taken an interest in the Village, such that poorly managed sediment at construction sites could generate pollution. Catch basins and outfalls near these sites are at risk.

2. Village of Menands Maps

a. Village boundaries, places of interest, topography
b. Stormwater Outfalls and Waterbodies (Stream Classifications)
c. Stormwater Outfalls and Waterbodies (Impaired Segments)
d. Stormwater Outfalls and FEMA Flood Hazard Zone
e. Stormwater Outfalls and Wetlands

Village of Menands



August 2, 2017

1:91,484

0 0.75 1.5 3 mi

0 1.25 2.5 5 km

Counties

Municipal Boundaries

Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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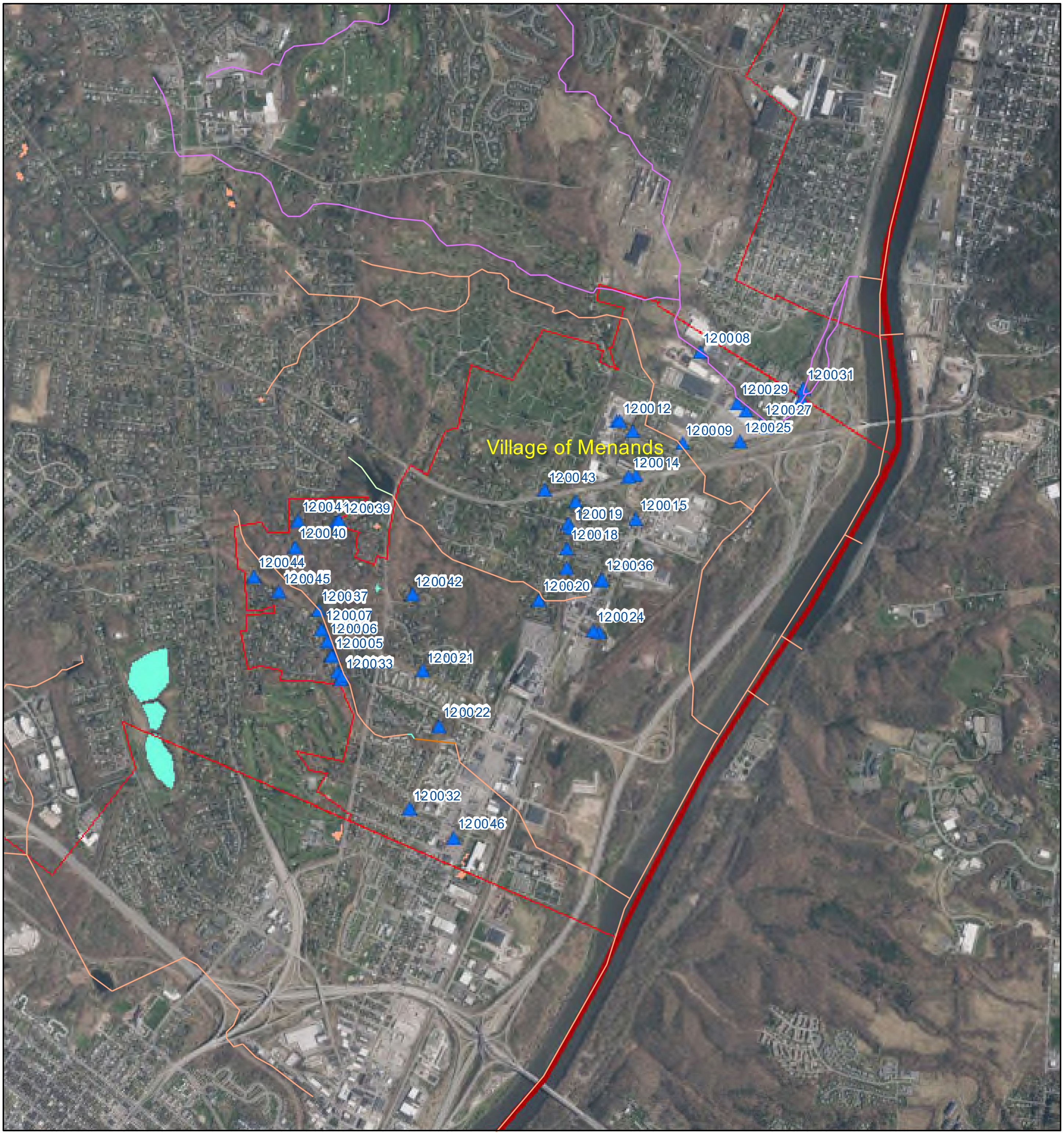
Village of Menands - SW Outfalls (8/2017 - Stream Classifications)



August 2, 2017

1:45,742

0 0.375 0.75 1.5 mi

0 0.5 1 2 km

Classified Streams AC

- B Contact Recreation (Swimming)
- C Non Contact Activities (Fishing)
- C(T) Non Contact Activities/Trout Habitat
- D Lowest Classification
- Not Classified

Village of Menands Stormwater Outfalls

Counties

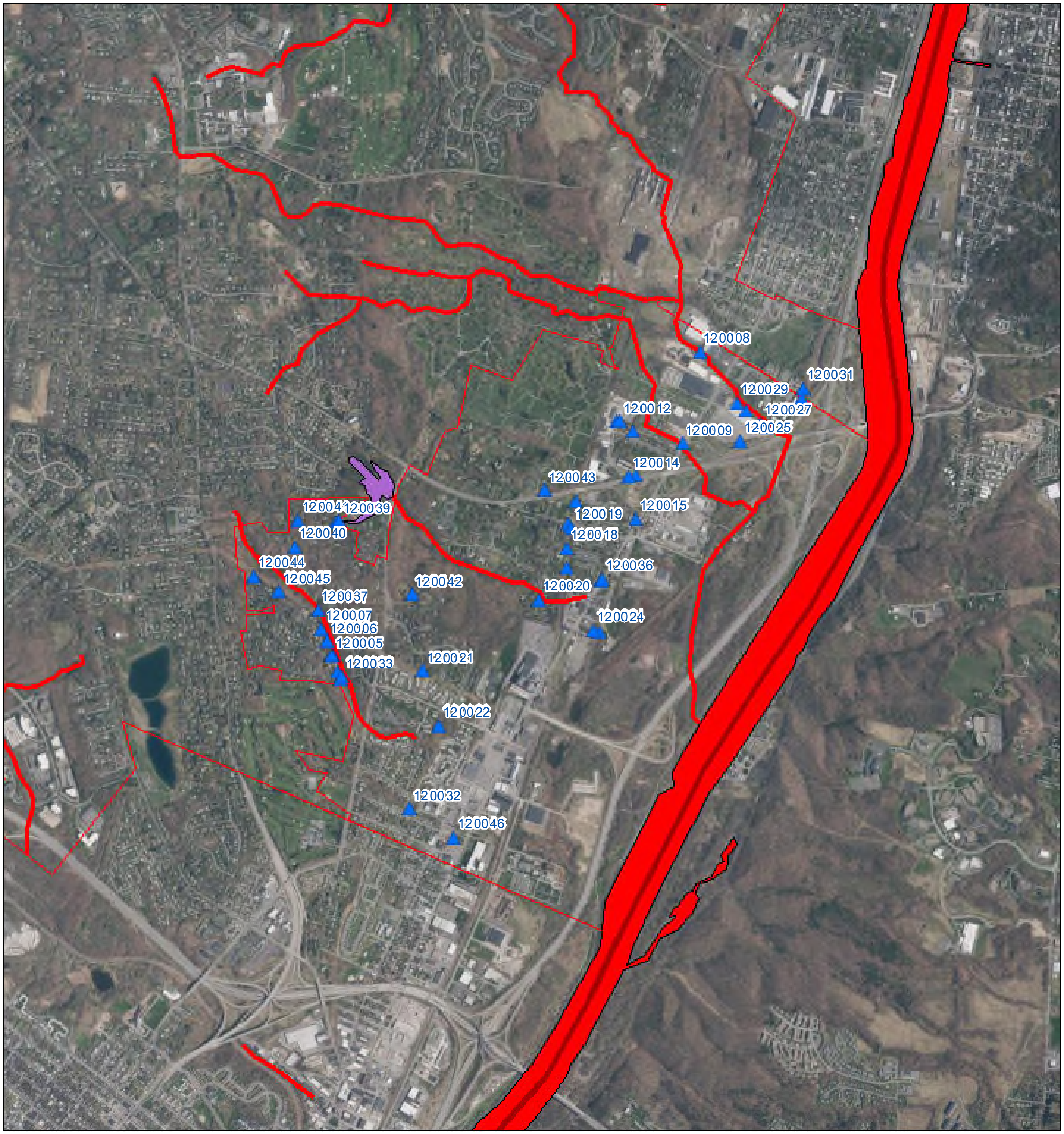
Municipal Boundaries

Classified Lakes AC

- C Non Contact Activities (Fishing)
- Not Classified

Heinzen

Village of Menands - SW Outfalls (8/2017) - WIPWL Inventory



August 2, 2017

1:45,742

0 0.375 0.75 1.5 mi

0 0.5 1 2 km

Village of Menands Stormwater Outfalls

Counties

Municipal Boundaries

WI PWL Lake Reservoir AC

UnAssessed

WI PWL Estuary AC

Impaired Segment (303d)

WI PWL Streams AC

Impaired Segment (303d)

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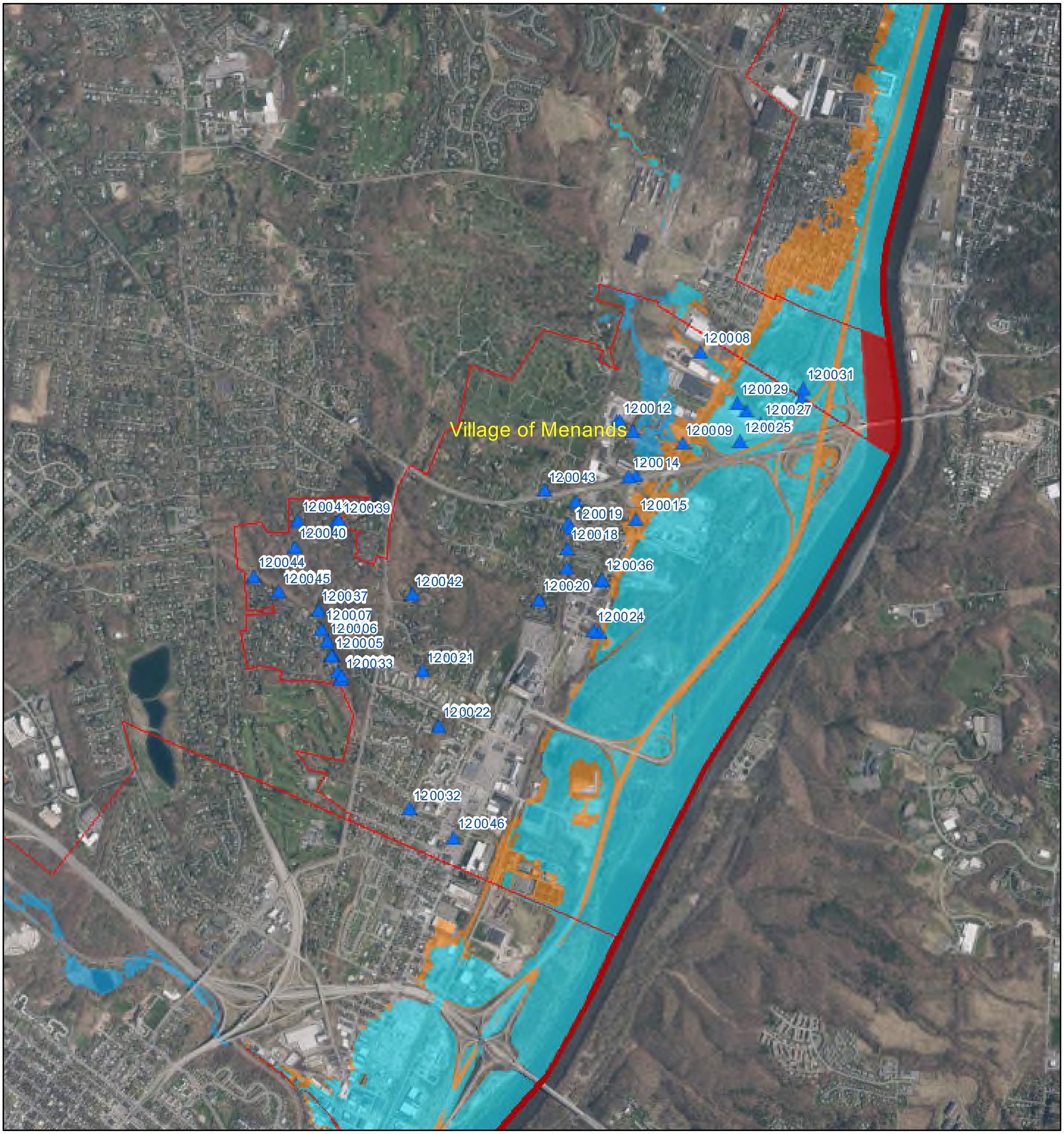
Village of Menands - SW Outfalls (8/2017) - FEMA Flood Hazard Zones



August 2, 2017

1:45,742

0 0.375 0.75 1.5 mi

0 0.5 1 2 km

Village of Menands Stormwater Outfalls

Counties

Municipal Boundaries

FEMA Flood Hazard Zones

1% Annual Chance Flood Hazard (100yr Approximate Method)

1% Annual Chance Flood Hazard (100yr Detailed Hydraulic Analysis)

Floodway

0.2% Annual Chance Flood Hazard

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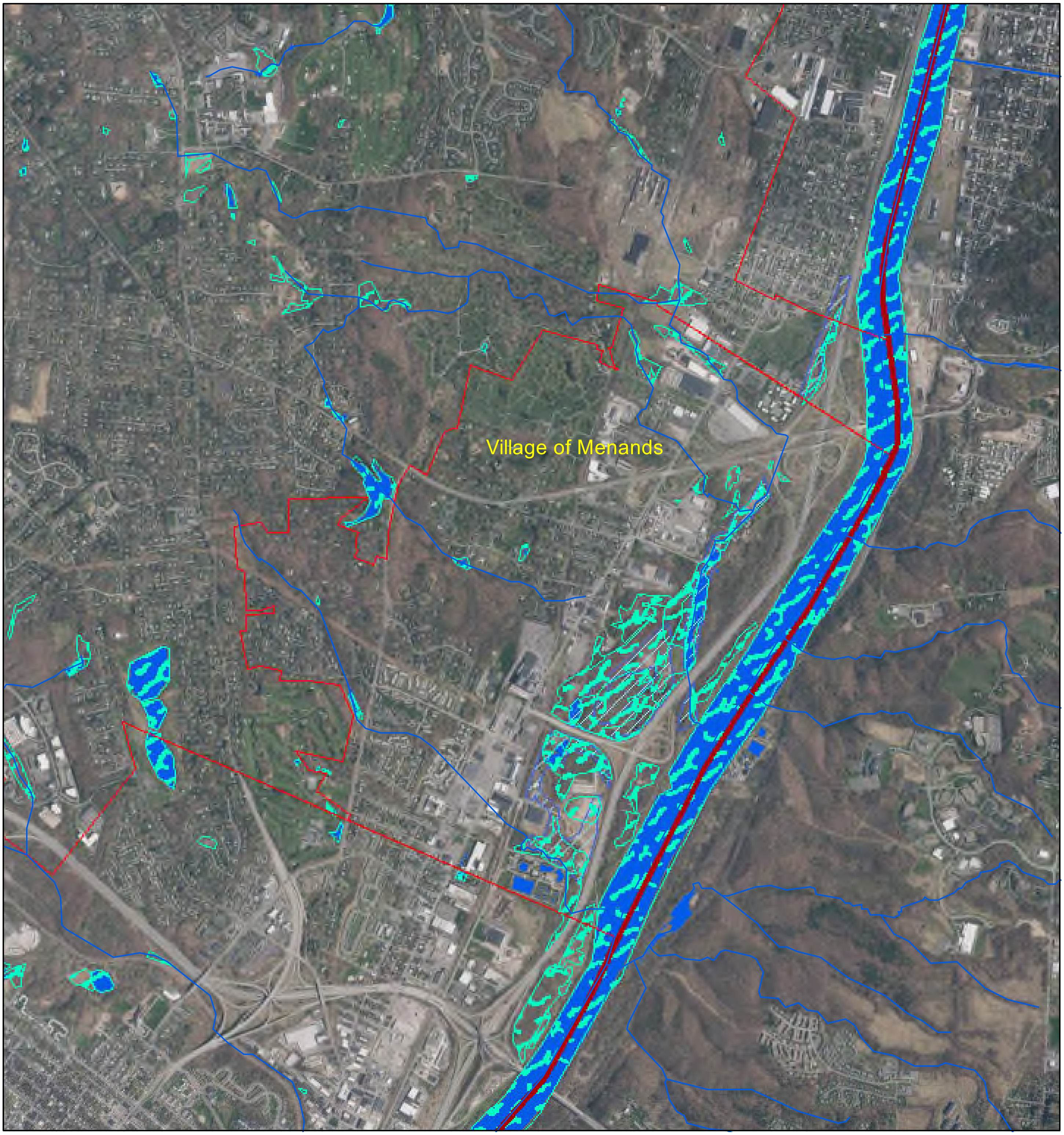
Village of Menands - Wetlands - Streams



August 2, 2017

1:45,742

0 0.375 0.75 1.5 mi
0 0.5 1 2 km

Streams (NHD)
Counties
Municipal Boundaries
NWI Wetlands
DEC Regulated Wetlands
Lakes and Reservoirs (NHD)
Estuaries and Larger Streams (NHD)

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3. WIPWL Fact Sheet Minor Tribs West of Hudson

Minor Tribs to West of Hudson (1301-0027) Impaired Seg

Waterbody Location Information

Revised: 05/30/2008

Water Index No:	H-228a thru 237, WOH	**Drain Basin:**	Lower Hudson River
Hydro Unit Code:	02020006/030 **Str Class:** C		Middle Hudson River
Waterbody Type:	River	**Reg/County:**	4/Albany Co. (1)
Waterbody Size:	25.6 Miles	**Quad Map:**	TROY SOUTH (K-26-1)
Seg Description:	total length of select tribs, from Albany to Green Isl		

Water Quality Problem/Issue Information

(CAPS indicate MAJOR Use Impacts/Pollutants/Sources)

Use(s) Impacted	Severity	Problem Documentation
AQUATIC LIFE	Impaired	Known
RECREATION	Impaired	Known

Type of Pollutant(s)

Known: UNKNOWN TOXICITY
Suspected: Metals
Possible: - - -

Source(s) of Pollutant(s)

Known: INDUSTRIAL (Al Tech)
Suspected: TOX/CONTAM. SEDIMENT, URBAN/STORM RUNOFF
Possible: - - -

Resolution/Management Information

Issue Resolvability: 1 (Needs Verification/Study (see STATUS))
Verification Status: 4 (Source Identified, Strategy Needed)
Lead Agency/Office: DOW/Reg4 **Resolution Potential:** Medium
TMDL/303d Status: 3a->1

Further Details

Overview
Aquatic life and recreational uses in the Kromma Kill are considered to be impaired by unspecified toxicity attributed to industrial sources.

Water Quality Sampling
A biological (macroinvertebrate) assessment of Kromma Kill in Watervliet (at Route 32) was conducted in 1997, 98, 99 and 2002. Sampling results indicated moderately impacted water quality conditions. The fauna was very limited and dominated by toxic-tolerant midges. Impacts have been attributed to the Al Tech Specialty Steel operation. Runoff and waste discharges from the two sites - neither of which were in compliance with permits conditions and were under Consent Orders - were considered the likely sources of contamination. Macroinvertebrate tissue samples showed elevated levels of copper, nickel and selenium. The plant has now closed but metals and toxicity in stream sediments remain a concern. (DEC/DOW, BWAM/SBU, June 2005)

Section 303(d) Listing
The Kromma Kill is currently included on the NYS 2008 Section 303(d) List of Impaired Waters. The lake is included on Part 3a of the List as a Water Requiring Verification of Impairment, however this updated assessment suggests that the suspected impairments to water quality and uses are verified and it is recommended that this listing for unknown

toxics in the stream be moved to Part 1 of the List, indicating a waterbody with an impairment requiring TMDL development. (DEC/DOW, BWAM/WQAS, May 2008)

Segment Description

This segment includes the total length of selected/smaller tribs to the West of Hudson from Patroon Creek (-226) in Albany to Salt Kill (-239) in Green Island. Tribs within this segment, including Kromma Kill (-234), are primarily Class C with some portions designated as Class C(T). Patroon Creek, and Salt Kill are listed separately. Lower tidal portions of these tribs are included with the Hudson Main Stem.

B. Detection of illicit discharges

1. MS4 Operator outfall inspection procedures

Outfall inspections follow procedures detailed in the EPA publication entitled: Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessment, in particular Chapter 11 Outfall Reconnaissance Inventory. The purpose of the inspection is to use observations at the outfall to determine what if any pollutants are entering into the storm system and to help track down the source of the pollution.

How frequently and which outfalls to inspect is currently set at once every 5 years, or 20% each year (MS4 Permit GP-0-15-003). Future permits may have different requirements. The inspection itself is guided by an inspection form included in the EPA publication and adapted somewhat to include requirements developed by NYSDEC.

Early in the MS4 Permit, the Stormwater Coalition developed a standard ORI Inspection Form; purchased materials to complete the inspections (ORI Kit); and laminated "How To" guides for use in the field when filling out the form. As a member of the Stormwater Coalition, Village staff have access to these materials and the network of Coalition members absent more formal training opportunities can provide guidance in how to proceed with the inspections. Village staff also have a copy of the Coalition "ORI" binder which contains detailed, "How To" instructions and blank forms.

A copy of the form, list of kit materials, and "How To" guide is included in this BMP.

For someone new to the inspection process, here are the sequence of steps to follow:

1. Contact Coalition staff to check on status of ORI Kits

2. Contact Albany County Sewer District (north plant) to set up a time to pick up kit

3. Pick up kit from ACSD Lab, North Plant

4. Go to the Coalition website and make copies of the ORI Field Sheet. It is posted in Plan and Program tab, scroll to MCM 3 BMP 3-5 ORI
http://www.stormwateralbanycounty.org/programs/

5. Review the ORI Field Sheet and identify materials in the ORI kit used to collect data (ex. ping pong balls and stop watch to measure flow; for nitrogen testing, test strips; etc.)

6. Study the laminated "How To" Guides. Outfall terminology is explained and photos of outfalls and illicit discharges describe what to look for at an outfall and how to record these observations on the form.

7. Obtain from the Village Storm Water Management Program Coordinator a map of municipal outfalls and list of outfalls inspected. Review archive of outfall inspection forms and available photos, if any. (Vent at your predecessor if all records were tossed….!)

8. Decide which outfalls to inspect by when. Secure username and password to access the Stormwater Coaliton web mapper (SwIM). Locate the Village outfalls posted on SwIM. Print a copy of the field map with outfall numbers. Use this to find the outfalls you plan on inspecting. Make a map which includes roads and aerial images, location of waterways.

9. Check the weather. Outfalls are inspected during dry weather. There can be no more than ¼" of rain in the last 48 hours. Avoid late spring inspections when the water table is high.

10. On inspection day, assemble all materials, dress for the outdoors, remember tick protection

11. If using paper form, pre-load inspection form data with Section 2a "static" info (ex. name of MS4; name of receiving water body). Make copies of pre-loaded form for the outfalls you'll be inspecting.

11. Find outfalls, inspect outfalls, take pictures. If electronic tablet is available, use tablet to enter data, take pictures. If chemical tests are necessary (flowing outfall) conduct tests. Record water chemistry data. Compare results to parameter thresholds. If results are above average, retest. If same elevated results, collect a water sample to bring back to ACSD lab for further testing.

12. On form, record if illicit discharge is indicated. If obvious, take notes, take pictures. Look around, consider who or what might be the source, what were they doing. Review maps, consider a plan to track down the source.

13. Back at the office, organize inspection forms. Review written notes, make sure they're readable Label photos with outfall ID number; print photos, store with inspection forms. Save forms electronically with photos, date and label form. Record which outfalls were inspected by whom. Carefully store data sheets and record of inspections, remember where you put them. Binders helpful.

14. If illicit discharge, notify other staff, develop a track down plan.

15. Although outfall inspections are based on a routine schedule, outfall inspections can be conducted at any time. Use the same ORI Field Sheet to capture the data.

Stormwater Coalition ORI Field Sheet adapted from EPA manual

OUTFALL RECONNAISSANCE INVENTORY/SAMPLE COLLECTION FIELD SHEET
Adapted for use by the Stormwater Coalition of Albany County (July 10, 2009)

Section 1: Background Data

Subwatershed:		Outfall ID:
Today's date:		Time:
Investigators:		Form completed by:
Temperature (°C)	Rainfall (in.): Last 24 hours:	Last 48 hours:
Latitude:	Longitude:	GPS Unit:
Camera:		Photo #s:

Land Use in Drainage Area (Check all that apply):

- ☐ Industrial
- ☐ Ultra-Urban Residential
- ☐ Suburban Residential
- ☐ Commercial
- ☐ Open Space
- ☐ Institutional
- Other: ____________________
- Known Industries: ____________________

Notes:

Section 1a: Additional Background Data
(Recommended by NYSDEC and incorporated into the Albany Internet Mapping System)

AIMS Field Name	Write or Check Off	Explanation
MS4Permit	Permit No: NYR	Enter the MS4 Permit number of the regulated MS4 for which this outfall information is being collected
Outfall ID	Already recorded in Section 1	Outfall_ID (When creating AIMS each outfall made available to the system by participating MS4s was assigned a unique id number. The first two digits are coded for each municipality, and the remaining four digits describe all of the outfalls within that MS4. New outfalls can be added, but to benefit from the AIMS system, they need to conform to the AIMS labeling protocol)
XY_Source		Method of data collection used to locate outfall (Enter GPS unit, hard copy of map, CAD derived)
HUC_No		Hydrologic Unit Code number, use most recent HUC available (Enter 11 digits)
Water_Name		Waters of NY name; Stream name, From NHD Dataset, if not available reference local names or note as, unnamed stream
Water_ID		Waters of NY ID; NHD reh-code (Enter best guess of stream segment(s) receiving stormwater discharge at outfall location.) This info is from the Waterbody Inventory/Priority Waterbodies List. Also known as Waterbody Index Number or WIN
Rec_MS4	o None	Rec_MS4 (Receiving MS4) None=Outfall discharges within the MS4
	o Permit No: NYR	Outfall Discharges to another regulated MS4 (Enter Permit No of receiving MS4)
	o SWIS code no:	Outfall discharges to a non-regulated MS4 (Enter SWIS code of non-regulated MS4-5 digits)
OF_Type		OF_Type =Outfall Type (Enter Open Drainage, Closed Pipe, Culvert, Catch Basin, Manhole, Swale)
MOE	o Direct	MOE (Mode of Entry) Check off one. Direct=Discharge to identified NY water
	o MS4	MS4=Discharge to another regulated MS4
	o Indirect	Indirect=Discharge via overland flow, intermittent/unidentified stream (no WIN), no obvious hydraulic connection such as wetlands
Confidence	o Verified	Confidence-Describes degree of confidence in outfall location info. Verified=Verified with field observation
	o Calculated	Calculated= Educated guess or desk calculated
	o Historical data	Historical data=Existing records or previous knowledge
	o None	None=No records of outfall
Photo		Record the location of photo file (if possible) and photo number(s). Attached print of photo to data sheets
Owner		Owner of MS4 (Enter owner name listed on MS4 Permit)
Owner_ID		Each Stormwater Coalition member has been assigned a unique number (Enter 1st two digits of outfall id)

(1)

Outfall ID: ______________ **Date:** ______________

Section 2: Outfall Description

LOCATION	MATERIAL		SHAPE		DIMENSIONS (IN.)	SUBMERGED
☐ Closed Pipe	☐ RCP ☐ PVC ☐ Steel ☐ Other: ________	☐ CMP ☐ HDPE	☐ Circular ☐ Elliptical ☐ Box ☐ Other: ____	☐ Single ☐ Double ☐ Triple ☐ Other: ____	Diameter/Dimensions: ________	In Water: ☐ No ☐ Partially ☐ Fully With Sediment: ☐ No ☐ Partially ☐ Fully
☐ Open drainage	☐ Concrete ☐ Earthen ☐ rip-rap ☐ Other: ____		☐ Trapezoid ☐ Parabolic ☐ Other: ____		Depth: ____ Top Width: ____ Bottom Width: ____	
☐ In-Stream	(applicable when collecting samples)					
Flow Present?	☐ Yes ☐ No *If No, Skip to Section 5*					
Flow Description (If present)	☐ Trickle ☐ Moderate ☐ Substantial					

Section 3: Quantitative Characterization

FIELD DATA FOR FLOWING OUTFALLS				
PARAMETER		RESULT	UNIT	EQUIPMENT
☐ Flow #1	Volume		Liter	Bottle
	Time to fill		Sec	
☐ Flow #2	Flow depth		In	Tape measure
	Flow width	___' ___"	Ft, In	Tape measure
	Measured length	___' ___"	Ft, In	Tape measure
	Time of travel		S	Stop watch
Temperature			°F	Thermometer

Section 3a: Additional Quantitative Characterization
BOXES 1, 2, and 3: Contain DR890 Calorimeter and Multi-Parameter Tester

FIELD DATA FOR FLOWING OUTFALLS				
PARAMETER		RESULT	UNIT	EQUIPMENT
pH	1 to 14		pH Units	Probe
pH	7.5 to 14.0		pH Units	Test strip (Dispenser)
pH	4, 5, 6, 7, 8, 9		pH Units	Test strip (pH bottle)
Total Ammonia	0, 0.25, 0.5, 1.0, 3.0, 6.0		ppm (NH_3-N)	Test strip (Ammonia bottle)
Nitrate	0, 1, 2, 5, 10, 20, 50		ppm Nitrate Nitrogen	Test strip (Nitrate bottle)
Nitrite	0, 0.15, 0.3, 1.0, 1.5, 3.0		ppm Nitrite Nitrogen	Test strip (Nitrate bottle)
Phosphate	0, 5, 15, 30, 50		ppm PO_4^{-}	Test strip (Phosphate bottle)
Nitrogen, Ammonia	0 to .50 mg/L NH3-N		mg/L NH3-N	DR 890 (Method 8155)
Nitrogen, Ammonia	0 to 2.50 mg/L NH3-N		mg/L NH3-N	DR 890 (Method 10023)
Nitrate, Low Range	0 to .50 mg/L NO_3^{-}-N		mg/L NO_3^{-}-N	DR 890 (Method 8192)
Nitrate, Mid Range	0 to 5.0 mg/L NO_3^{-}-N		mg/L NO_3^{-}-N	DR 890 (Method 8171)
Phosphorus, Reactive	0 to 2.50 mg/L PO_4^{3-}		mg/L PO_4^{3-}	DR 890 (Method 8048)
Conductivity			µS/cm	Multi-Parameter Tester
Salinity			ppt	Multi-Parameter Tester
Total Dissolved Solids (TDS)			mg/L	Multi-Parameter Tester
Turbidity			NTU	2100P Portable Turbidity Meter

(2)

Laminated “How To” Field Sheet Guide (inside of ORI Kit)

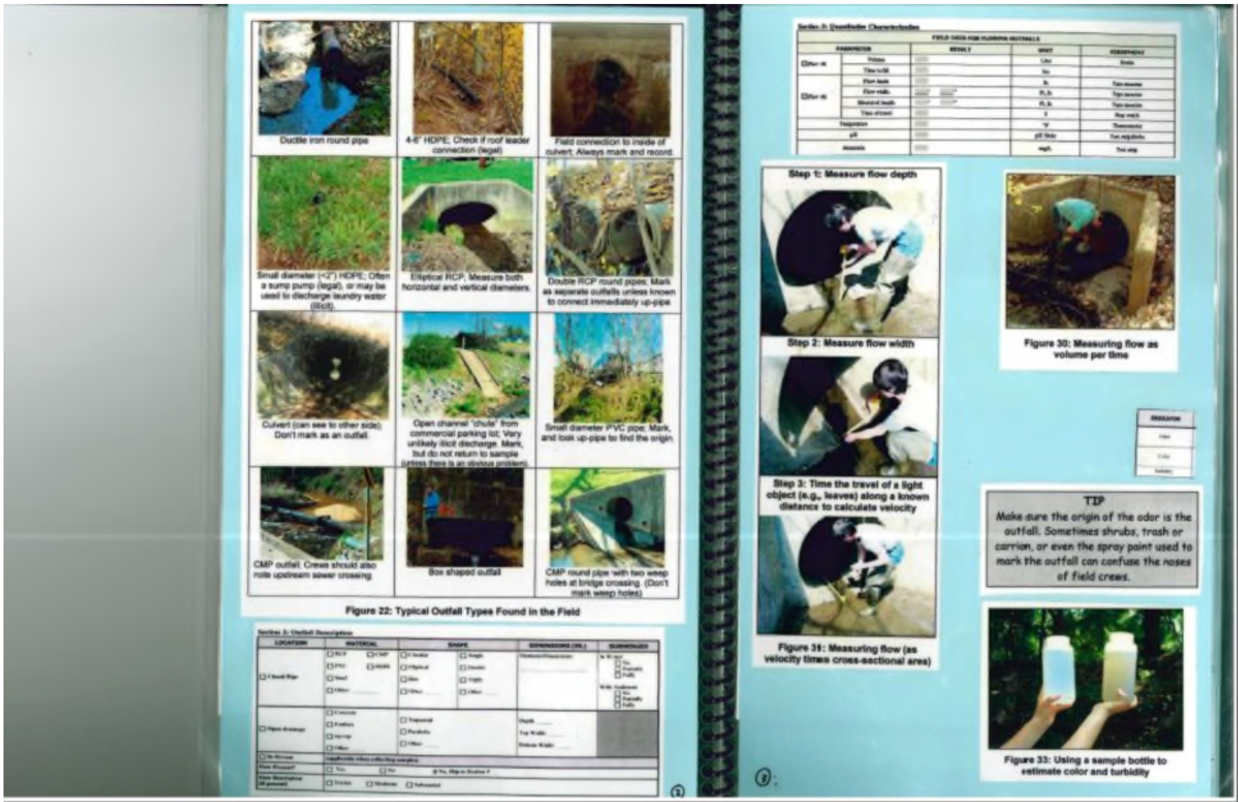
Getting Started

OUTFALL RECONNAISSANCE INVENTORY
Field Sheet Guide for
Sections 2, 3, 4, 5, and 6

Figure 19: Walk all streams and constructed open channels

Table 31: Preferred Climate/Weather Considerations for Conducting the ORI		
Preferred Condition	**Reason**	**Notes/Regional Factors**
Low groundwater (e.g., very few flowing outfalls)	High groundwater can confound results	In cold regions, do not conduct the ORI in the early spring, when the ground is saturated from snowmelt.
No runoff-producing rainfall within 48 hours	Reduces the confounding influence of storm water	The specific time frame may vary depending on the drainage system.
Dry Season	Allows for more days of field work	Applies in regions of the country with a "wet/dry seasonal pattern." This pattern is most pronounced in states bordering or slightly interior to the Gulf of Mexico or the Pacific Ocean.
Leaf Off	Dense vegetation makes finding outfalls difficult	Dense vegetation is most problematic in the southeastern United States. This criterion is helpful but not required.

Table 32: Outfalls to Include in the Screening	
Outfalls to Record	**Outfalls to Skip**
• Both large and small diameter pipes that appear to be part of the storm drain infrastructure • Outfalls that appear to be piped headwater streams • Field connections to culverts • Submerged or partially submerged outfalls • Outfalls that are blocked with debris or sediment deposits • Pipes that appear to be outfalls from storm water treatment practices • Small diameter ductile iron pipes • Pipes that appear to only drain roof downspouts but that are subsurface, preventing definitive confirmation	• Drop inlets from roads in culverts (unless evidence of illegal dumping, dumpster leaks, etc.) • Cross-drainage culverts in transportation right-of-way (i.e., can see daylight at other end) • Weep holes • Flexible HDPE pipes that are known to serve as slope drains • Pipes that are clearly connected to roof downspouts via above-ground connections



Ductile iron round pipe

4-6" HDPE; Check if roof leader connection (legal)

Field connection to inside of culvert; Always mark and record.

Small diameter (<2") HDPE; Often a sump pump (legal), or may be used to discharge laundry water (illicit).

Elliptical RCP; Measure both horizontal and vertical diameters.

Double RCP round pipes; Mark as separate outfalls unless known to connect immediately up-pipe

Culvert (can see to other side); Don't mark as an outfall.

Open channel "chute" from commercial parking lot; Very unlikely illicit discharge. Mark, but do not return to sample (unless there is an obvious problem).

Small diameter PVC pipe; Mark, and look up-pipe to find the origin.

CMP outfall; Crews should also note upstream sewer crossing

Box shaped outfall

CMP round pipe with two weep holes at bridge crossing. (Don't mark weep holes)

Figure 22: Typical Outfall Types Found in the Field

Step 1: Measure flow depth

Step 2: Measure flow width

Step 3: Time the travel of a light object (e.g., leaves) along a known distance to calculate velocity

Figure 31: Measuring flow (as velocity times cross-sectional area)

Figure 30: Measuring flow as volume per time

TIP
Make sure the origin of the odor is the outfall. Sometimes shrubs, trash or carrion, or even the spray paint used to mark the outfall can confuse the noses of field crews.

Figure 33: Using a sample bottle to estimate color and turbidity

Figure 27: Measuring Outfall Diameter

Submerged: More than ½ below water

Partially submerged: Bottom is below water

Fully submerged: Can't see outfall

Outfall fully submerged by debris

Fully submerged from downstream trees trapping debris

Partially submerged by leaf debris "back water"

Trickle Flow: Very narrow stream of water

Moderate Flow: Steady stream, but very shallow depth

Significant flow (Source is a fire hydrant discharge)

Figure 28: Characterizing Submersion and Flow

Color: Brown; Severity: 2
Turbidity Severity: 2

Chromium Spill
Color: Green; Severity: 3
Turbidity Severity: None

Highly Turbid Discharge
Color: Brown; Severity: 3
Turbidity Severity: 3

Sewage Discharge
Color: 3
Turbidity: 3

Paint
Color: White; Severity: 3
Turbidity: 3

Industrial Discharge
Color: Green; Severity: 3
Turbidity Severity: 3

Blood
Color: Red; Severity: 3
Turbidity Severity: None

Failing Septic System
Turbidity Severity: 3

Turbidity in Downstream Plume
Turbidity Severity: 2
(also confirm with sample bottle)

High Turbidity in Pool
Turbidity Severity: 2
(Confirm with sample bottle)

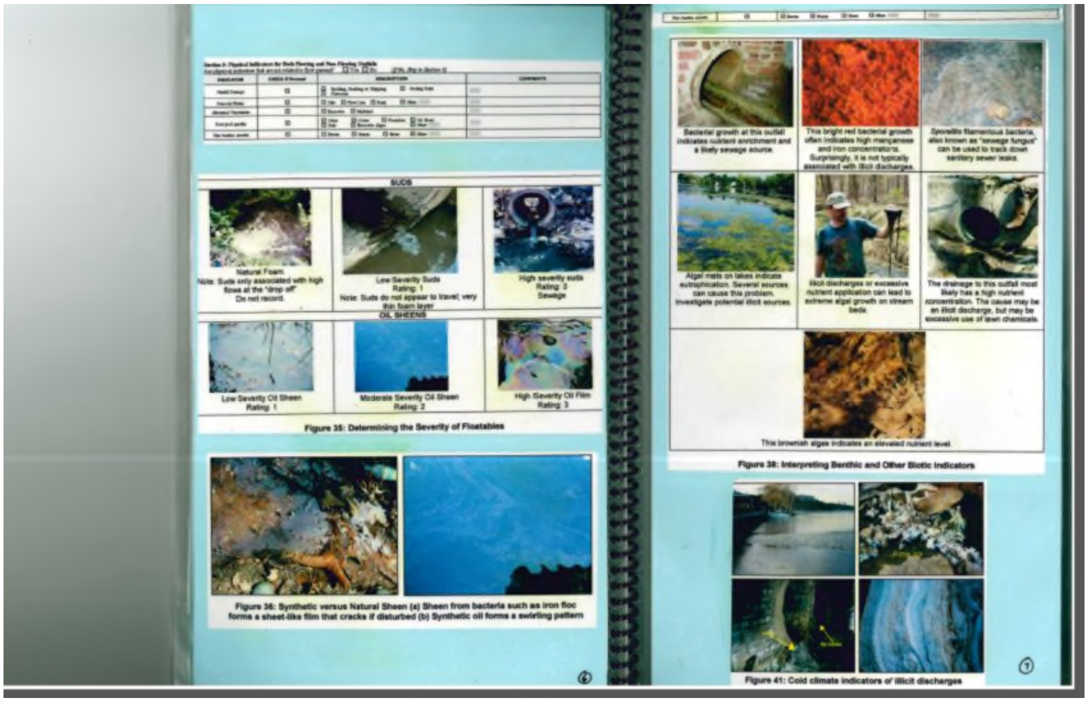
Iron Floc
Color: Reddish Orange; Severity: 3
(Often associated with a natural source)

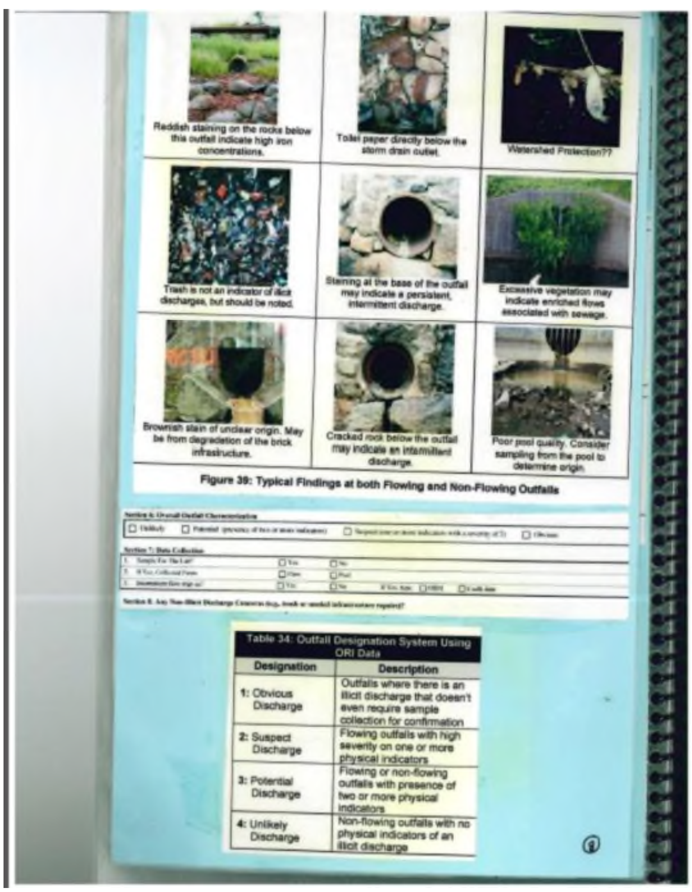
Slight Turbidity
Turbidity: 1
(Difficult to interpret this observation. May be natural or an illicit discharge)

Construction Site Discharge
Turbidity Severity: 3

Discharge of Rinse from Floor Sanding (Found during wet weather)
Turbidity Severity: 3

Figure 34: Interpreting Color and Turbidity


SUDS
Natural Foam
Note: Suds only associated with high flows at the "drop off"
Do not record.
Low Severity Suds
Rating: 1
Note: Suds do not appear to travel; very thin foam layer
High severity suds
Rating: 3
Sewage
OIL SHEENS
Low Severity Oil Sheen
Rating: 1
Moderate Severity Oil Sheen
Rating: 2
High Severity Oil Film
Rating: 3
Figure 35: Determining the Severity of Floatables
Figure 36: Synthetic versus Natural Sheen (a) Sheen from bacteria such as iron floc forms a sheet-like film that cracks if disturbed (b) Synthetic oil forms a swirling pattern
Bacterial growth at this outfall indicates nutrient enrichment and a likely sewage source.
This bright red bacterial growth often indicates high manganese and iron concentrations. Surprisingly, it is not typically associated with illicit discharges.
Sporalitis filamentous bacteria, also known as "sewage fungus" can be used to track down sanitary sewer leaks.
Algal mats on lakes indicate eutrophication. Several sources can cause this problem. Investigate potential illicit sources.
Illicit discharges or excessive nutrient application can lead to extreme algal growth on stream beds.
The drainage to this outfall most likely has a high nutrient concentration. The cause may be an illicit discharge, but may be excessive use of lawn chemicals.
This brownish algae indicates an elevated nutrient level.
Figure 38: Interpreting Benthic and Other Biotic Indicators
Figure 41: Cold climate indicators of illicit discharges


Reddish staining on the rocks below this outfall indicate high iron concentrations.
Toilet paper directly below the storm drain outlet.
Watershed Protection??
Trash is not an indicator of illicit discharges, but should be noted.
Staining at the base of the outfall may indicate a persistent, intermittent discharge.
Excessive vegetation may indicate enriched flows associated with sewage.
Brownish stain of unclear origin. May be from degradation of the brick infrastructure.
Cracked rock below the outfall may indicate an intermittent discharge.
Poor pool quality. Consider sampling from the pool to determine origin.
Figure 39: Typical Findings at both Flowing and Non-Flowing Outfalls
Table 34: Outfall Designation System Using ORI Data
Designation
Description
1: Obvious Discharge
Outfalls where there is an illicit discharge that doesn't even require sample collection for confirmation
2: Suspect Discharge
Flowing outfalls with high severity on one or more physical indicators
3: Potential Discharge
Flowing or non-flowing outfalls with presence of two or more physical indicators
4: Unlikely Discharge
Non-flowing outfalls with no physical indicators of an illicit discharge

Content of ORI Kits Located in the Albany County Water Purification District (North Plant)

BOX CHECK LIST File Name: 2017_9-1_BoxCkList_BasicFull90_15BlackLites_FINAL.xlsx

Community Using Box (Name):	Item Present	Item Missing	Community Using Box & Other Equipment	Item Present	Item Missing
Inventory By (ACSDT MS4?):	Circle box #	Circle box #		Circle box #	Circle box #
Box Inventory Check List	Box 1 2 3	Box 1 2 3	Box Inventory Check List	Box 4 5 6	Box 4 5 6
TOP TRAY			TOP TRAY		
Hach Dr/890					
GPS					
Multi-Parameter Tester					
Checker Portable pH meter					
HACH 890 sample adapter					
6 HACH Sample cells (round)					
2 HACH Sample cells (square)					
10 ml pipet			* * *		
1 ml pipet			* * *		
Pipet Bulb			* * *		
Pen			* * *		
Sharpie			* * *		
Tape Measure			* * *		
Hach pH test strips			* * *		
Thermometer			* * *		
Funnel			* * *		
Small screw driver			* * *		
Stop Watch			* * *		
Clip Board			* * *		
Scissors			* * *		
2 Ping Pong Balls			* * *		
Dr/890 Laminated Instructions					
GPS Laminated Instructions			* * *		
Field Work Laminated Instructions			* * *		
LOWER BOX			LOWER BOX		
10 Ammonia Tubes					
Graduated Cylinder					
HACH Chemical Packet Box			* * *		
1 Phosphate test strip bottle (50ea)			* * *		
1 Nitrite/Nitrate test strip bottles (25ea)			* * *		
1 Hach Ammonia test strip bottles (25ea)			* * *		
1 HACH pH Test Strip bottle (50ea)			* * *		
Squirt Bottle			* * *		
1 Waste Bottle					
3 Small Plastic Tubes					
Disposable gloves			* * *		
Kim Wipes			* * *		
Lab Soap			* * *		
Nalgene sample bottles (6)			* * *		
Fishing line (1 rolls)			* * *		
Hammer			* * *		
10 Light intensity cages			* * *		
10 Light intensity yellow nets			* * *		
Rag			* * *		

Rag			" " "		
Large Ziploc Bag for Garbage			" " "		
Distilled Water			" " "		
1 Gallon Pail			" " "		
Optical Pads			" " "		
10 Ziplock Bags			" " "		
pH Buffer 4			" " "		
pH Buffer 7			" " "		
pH Buffer 10			" " "		
7 Nails			" " "		
10 popsicle sticks			" " "		
10 Zip ties			" " "		
Wire clippers			" " "		
Pieces of cardboard			" " "		
OTHER EQUIPMENT			OTHER EQUIPMENT		
1 Black Light					
~~1 Turbidity Meter~~ [illegible] [illegible]					
~~Waders~~					
~~[illegible]~~					

Inventory completed by (name): ______________________________ Date ____________

ORI Field Sheet Section 7: Data Collection Question 3 Intermittent Flow Trap Set? Data Sheet

The optical brightener test is used to identify laundry effluent, a possible indicator of intermittent discharges of septic system waste.

ORI Kit Materials

Optical Brightener
Field Sheet
(From Eight Towns and The Bay Water Quality Sampling An Optical Brightener Handbook)

As of 6/29/09

Sub Watershed (Drainage Area and/or Stream Name):		Collected By:
Sewershed Name (If available):		Page ___ of ___
Remarks:		

Location	Date Placed	Date Pulled	No days	Flow Volume (liters/sec)	O.B. +/-	Total Rain

6/30/2009 8:14 AMOpticalbrighter_FieldSheet.xls

1 of 1

C. Track down to identify the source of illicit discharges and the responsible party.

The procedures include:

1. Provisions for annual training
2. Track down methods described in Chapter 13 of IDDE Guidance Manual
3. Description of how progress with track down will be documented
4. Time frames for initiating track down

1. Provisions for annual training

MS4/municipal and others assisting MS4s (ex. Coalition, Soil and Water, sewer district) need to be trained in all aspects of IDDE program implementation. An outfall inspection may trigger track down activities and the process of eliminating the discharge could trigger legal action. If these individual steps are carried out by different individuals and there's minimal or strained communication within the municipality, it's likely that the discharge will go unintended. An active familiarity will all steps helps to engage all involved, increasing the chances of removing the discharge.

For small MS4s, where staff typically wear multiple hats, potentially responsible for inspections, track down, and elimination the training can be directed to one individual. For larger municipalities, more staff need to be trained and individuals responsible for the entire IDDE program need to ensure that staff know both their individual jobs and how it fits in with all aspects of IDDE.

For the Village of Menands, IDDE responsibilities reside primarily with one or two staff and given the small size of the municipality (geographic area and population) IDDE issues are quickly identified and communicated to others. Consequently, the benefits of training disperse to others within the Village relatively quickly. The Coalition also provides ongoing training informally at monthly meetings or intentionally by supporting others to attend courses elsewhere. As needed Coalition members will develop and/or participate in Coalition organized IDDE training events.

Currently, absent free training trainings, or online training developed by NYSDEC, there are few venues for hands-on IDDE training relevant to all MS4/municipal staff. Consequently provisions for annual training are likely to be met by the Coalition.

2. Track down methods described in Chapter 13 of EPA IDDE Guidance Manual

<u>Chapter 13 Tracking Discharges to A Source</u> is a well written and clear description of track down methods. For this procedure, the first step is to read Chapter 13. It is attached, see F. Chapter 13 Tracking Discharges To A Source (from EPA IDDE Guidance Manual)

Four investigation methods are described in Chapter 13. They are: Storm Drain Network Investigation; Drainage Area Investigation; On-Site Investigation; and Septic System

Investigation. Of these, given that the Village storm system mapping is partially complete and there are no septic systems, a combination of Drainage Area and On-Site Investigations tend to be the track down approach.

As needed and depending on available trucks, staffing, and equipment investigating the storm drain network by tracking the presence/absence of pollutants at various manhole junctures is sufficiently complicated that Village DPW crews may not have the resources to do the work. As directed by the Village of Menands Stormwater Program Coordinator others may step in to help, such as Albany County Water Purification District as part of their pre-treatment program or the Town of Colonie Department of Public Works. This is an evolving relationship implemented on a case-to-case basis.

On site/drainage area investigations typically involve a site visit to the outfall where an illicit discharge has been observed then walking up drainage to the possible source. Typically, the Stormwater Management Officer then reaches out to the resident or business owner for help in identifying the discharge source; making arrangements as needed to dye test or to further investigate behaviors possibly associated with the discharge.

As needed discharge samples are collected and tested for various parameters by the Albany County Water Purification District. This data may help to isolate which commercial operation is associated with the discharge. Given the complexity of some of the businesses based in Menands, the Water Purification District certified lab is well suited to analyze a variety of parameters all helpful when honing in on the source of pollution.

In addition to walking the area, the Village as a member of the Coalition has access to web based GIS application (SwIM) which includes multiple stormwater related data layers helpful when analyzing drainage flow, the proximity of water bodies, the name and address of property owners, and location of outfalls. Some of the Village storm system infrastructure is posted on the web mapper.

Currently the web mapper is a work-in-progress of evolving value, likely to be more important to the Village once their entire storm system is mapped and posted on the application. Until then the mapper has some value, but more typically walking the neighborhood and talking with DPW crew about storm system connections provides the necessary information to track down illicit discharges. Given the small size of the Village, this more informal approach works well, provided too that institutional knowledge about the storm system infrastructure is accessible and up to date.

3. Description of how progress with track down will be documented

All track down steps are documented by the Village of Menands Stormwater Management Officer. These are recorded in a log which notes date, action, by whom, and result.

4. Time frames for initiating track down

The track down time frame is generally based on the severity of the issue, the impact on public health, the immediate impact on the environment, and the availability of Village staff to respond. In general, track down is immediate for sanitary waste and typically the Albany County Department of Health is brought in to determine both the severity of issue and track down the source using tools available to their staff.

As described to Coalition staff, usually Health Department staff are on site investigating within 1 – 3 days. From there remediation may have a financial angle, but usually issues are resolved within 30 days or less.

Intermittent illicit discharge require a sustained, deliberate approach and track down is typically stretched out over multiple dates, as needed.

A potential track down time frame is now included in the proposed "new" permit (DRAFT NYSDEC MS4 Permit GP-0-17-002, released October, 2016, pg. 25). This may be the prescribed time frame and is included here as a potential scenario.

<u>From Pg. 25 DRAFT MS4 Permit</u>

d. Time frames for initiating track down:

i. Initiate track down procedures for flowing outfalls with obvious illicit *discharges* (a severity score of 3 for any physical indicator as described in Section 11.7 of the IDDE Guidance) immediately but no later than 24 hours of discovery;

ii. Initiate track down procedures for obvious *discharges* of sanitary wastewater that would affect bathing areas during bathing season, shell fishing areas or public water intakes and report orally or electronically to the Regional Water Engineer and local health department within 2 hours of discovery of the *discharge*; and

iii. Initiate track down procedures for all other illicit *discharges* no later than 5 days of discovery.

D. Procedures to eliminate discharges.

The procedures include:

1. Time frames for elimination
2. Provisions for escalating enforcement
3. Tracking of enforcement escalation consistent with the Enforcement Response Plan
4. Provisions to confirm and verify that corrective action is completed.
5. Annual evaluation of elimination procedures which
   - -includes time frames to eliminate illicit discharges
   - -identifies how efficiencies with elimination procedures may be improved.

1. Time frames for elimination

The time frame for eliminating discharges typically varies depending on the type of risk associated with the discharge; the legal clarity of applicable environmental and/or public health laws at all levels of government (local, county, state, and federal); the capacity of various agencies to respond; and the capacity of Village staff to guide and/or advocate for a response.

A potential elimination time frame is now included in the proposed "new" permit (DRAFT NYSDEC MS4 Permit GP-0-17-002, released October, 2016). This may be the prescribed time frame and is included here as a potential scenario.

From Pg. 25-26 DRAFT MS4 Permit

a. Time frames for elimination:

i. *Discharges* that pose a significant threat to human or environmental heath shall be eliminated immediately but no later than 24 hours;

ii. Initiate elimination procedures for all other illicit *discharges* no later than 5 days of identification of responsible party; and

iii. Where identification of a responsible party or when elimination of an illicit *discharge* within 60 days of its identification is not possible, the MS4 Operator shall provide advanced written notice to the Regional Water Engineer within 30 days of becoming aware of the illicit *discharge*.

In general, the Village Stormwater Program Coordinator/Officer responds as quickly as possible and typically makes an effort to engage all of the relevant public entities who may have a legal role to play; or resources to establish the significance of the threat; and/or the trucks and equipment to quickly eliminate the discharge.

The contacted public entities may include staff from NYSDEC Region 4; the NYSDEC Spill Response Program; it; Albany County Department of Health; Albany County Water Purification District; and/or the Town of Colonie Department of Public Works.

While elimination procedures can be initiated quickly, as in establishing the presence/absence of a discharge, the elimination time frame may involve any combination of action steps some more difficult to implement than others.

Actions which require rebuilding storm system infrastructure, sanitary/stormwater cross connections for example are expensive and it may take months, possibly years to eliminate. Actions which depend on changes in behavior are likely to be less expensive and easier to resolve.

For example, a business or resident notified that dumping kitchen grease or motor oil into a catch basin is illegal has options for dumping this waste elsewhere. They need to be taught that what used to be a common practice is now illegal. If clearly within the jurisdiction of the Village, these discharges can be eliminated with 60 days.

2. Provisions for escalating enforcement
3. Tracking of enforcement escalation consistent with the Enforcement Response Plan (ERP)

The Village Enforcement Response Plan explains in detail provisions for escalating enforcement. This includes a description of various written documents generated when implementing the plan and what information needs to be tracked as part of the case history.

4. Provisions to confirm and verify that corrective action is completed.

Corrective actions are verified by the Village SMO based on an on-site visit with the owner and/or his or her representative. The Village SMO reviews the list of corrective actions and confirms that all have been addressed adequately. Photos are taken as needed and dated to help document compliance.

The Village SMO acknowledges in writing and by signature that the discharge has been eliminated and that all violations have been addressed. A date is set for when the violation was resolved, usually at time of signature.

5. Annual evaluation of elimination procedures which
   - includes time frames to eliminate illicit discharges
   - identifies how efficiencies with elimination procedures may be improved.

When preparing the MS4 Permit Annual Report, the Village SMO routinely reviews the status of illicit discharges, past and present. To the extent possible, when preparing the Annual Report, issues related to enforcement action procedures are acknowledged. This is a good opportunity to identify strengths and weaknesses of Village enforcement procedures and to initiate Village level changes with the appropriate staff.

If there's a significant need to improve procedures, establishing specific, attainable, measurable goals related to these enforcement procedures for the upcoming year or two years can be helpful.

E. Acronyms and Definitions

From NYSDEC MS4 Permit (GP-0-15-002) and Other DEC documents

ACRONYMS

BMP*-Best Management Practice*
IDDE*-Illicit Discharge Detection and Elimination*
MS4*-Municipal Separated Storm Sewer System*
POC*-Pollutant of Concern*
ORI*-Outfall Reconnaissance Inventory*
WIPWL*-Waterbody Inventory Priority Waterbody List*

DEFINITIONS

Outfall-is defined as any point where a municipally owned and operated separated storm sewer system discharges to either the surface waters of the State or to another MS4. Outfalls include discharges from pipes, ditches, swales, and other points of concentrated flow. However, areas of non-concentrated (sheet) flow which drain to surface waters of the State or to another MS4's system are not considered outfalls and should not be identified as such on the system map.
Illicit Discharge-discharges not entirely composed of stormwater into the small MS4, except those identified in Part I. A. 2. Examples of illicit discharges not permitted sanitary sewage, garage drain effluent, and waste motor oil. However an illicit discharge could be any other non-permitted discharge which the covered entity or Department has determined to be a substantial contributor of pollutants to the small MS4.

Pollutants of Concern-there are POCs that are primary (comprise the majority) sources of stormwater pollutants and others that are secondary (less likely).
-The POCs that are primarily of concern are: nitrogen, phosphorus, silt and sediment, pathogens, flow, and floatables impacting impaired watebodies listed on the Priority Waterbody List known to come into contact with stormwater that could be discharged to that water body.

-The POCs that are secondarily of concern include but are not limited to petroleum hydrocarbons, heavy metals, and polycyclic aromatic hydrocarbons (PAHs), where stormwater or runoff is listed as the source of this impairment.

-The primary and secondary POCs can also impair waters not on the 303(d) list. Thus it is important for the covered entity to assess known and potential POCs within the area served by their small MS4. This will allow the covered entity to address POCs appropriate to their MS4.

From NYSDEC document titled, "Outfall and System Mapping for Illicit Discharge Detection and Elimination" – Responsiveness Summary

Storm System Mapping-a map of all surface and subsurface conveyances within an MS4

F. Chapter 13 Tracking Discharges To A Source (from EPA IDDE Guidance Manual)

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

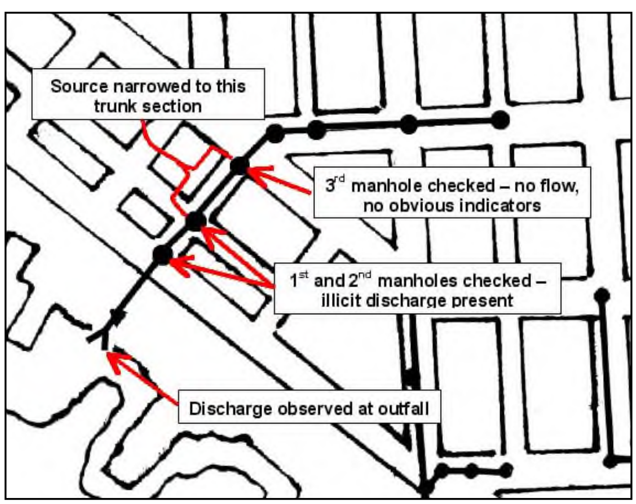


Figure 50: Example Investigation Following the Source up the Storm Drain System

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.

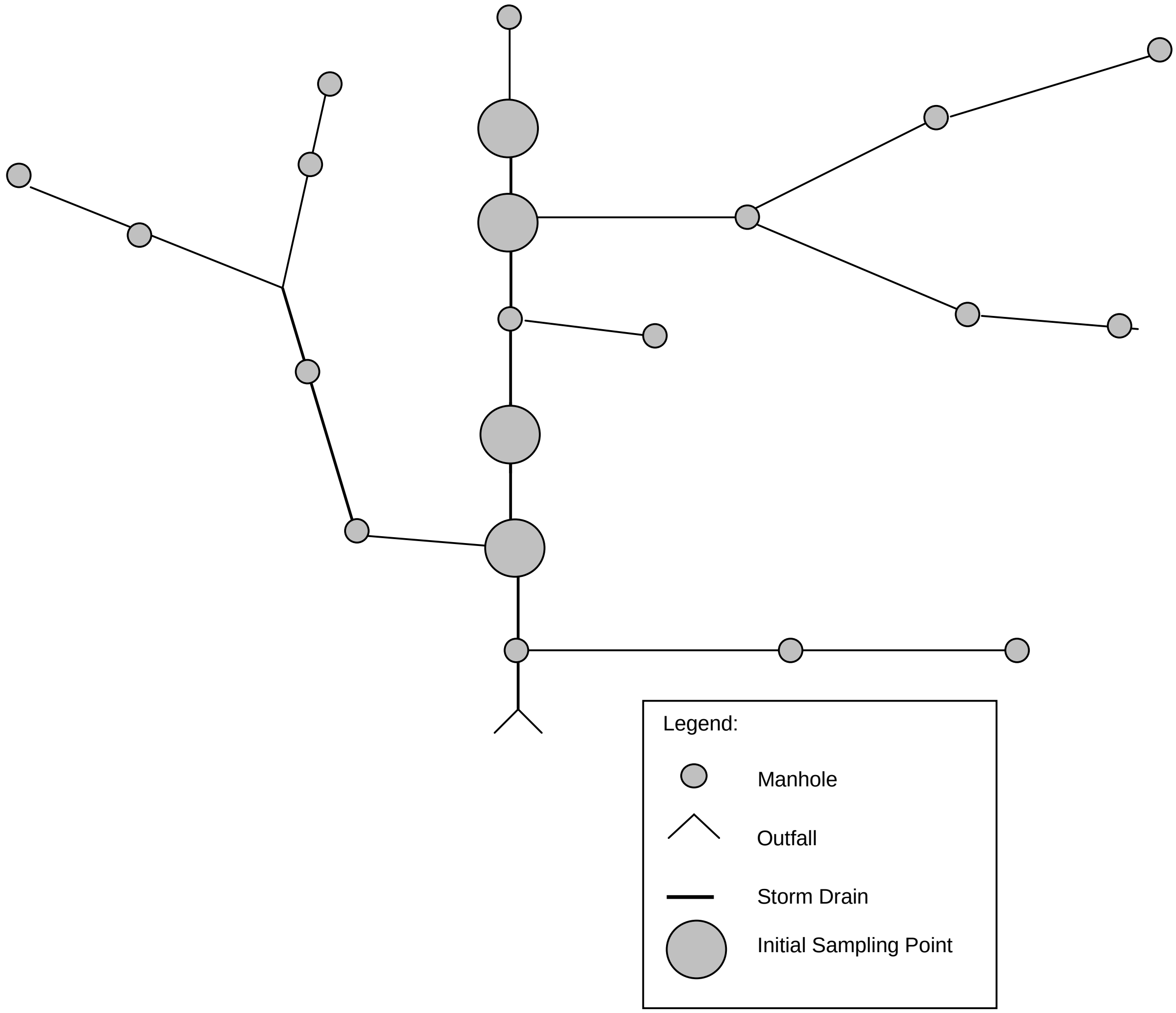


Figure 51: Key initial sampling points along the trunk of the storm drain

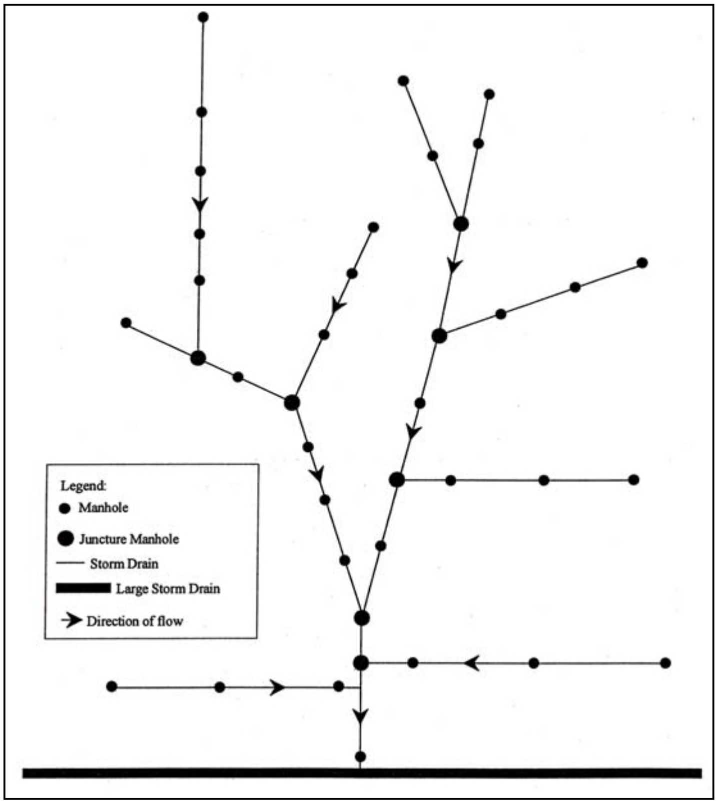


Figure 52: Storm Drain Schematic Identifying "Juncture Manholes" (Source: Jewell, 2001)

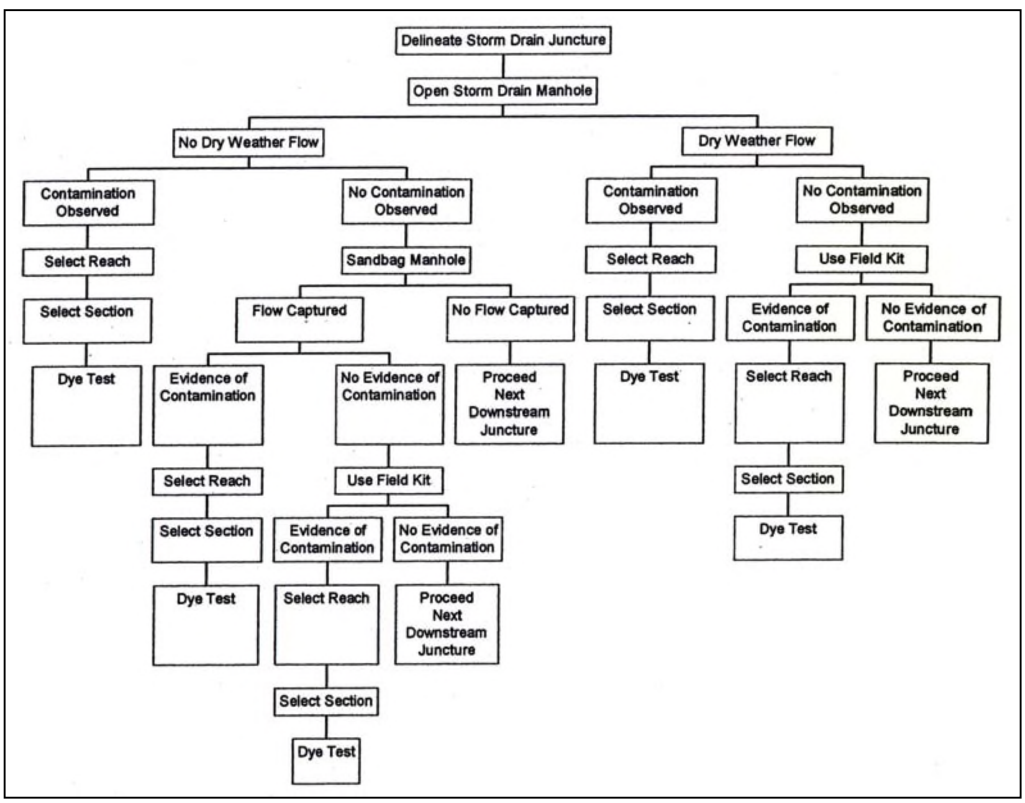


Figure 53: A Process for Following Discharges Down the Pipe (Source: Jewell, 2001)

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 are followed.

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.

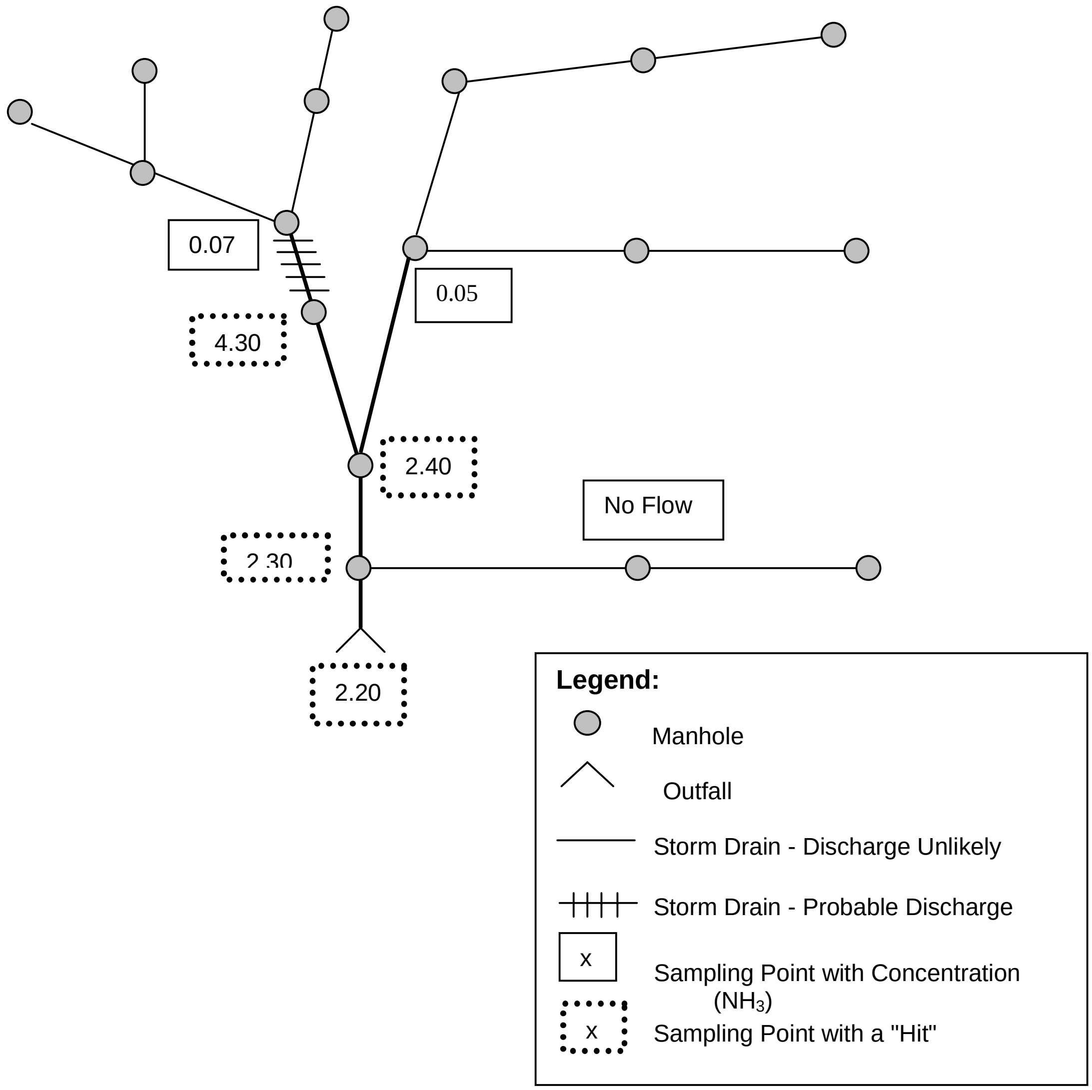


Figure 57: Use of Ammonia as a Trace Parameter to Identify an Illicit Discharge

BOSTON WATER AND SEWER COMMISSION
MANHOLE INSPECTION LOG

Manhole ID No.

Inspection Date: ____________________ Tributary Area: ______________________________

Street: __________________________ Manhole Type:

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

Follow Up Inspection _________ High Outlet _______ Lovejoy _______

Time Since Last Rain:

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

Observations:

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

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

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

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

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

Odor: None _____ Sewage _____ Oil _____ Soap _____Other _________________________________

Field Testing:

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

Contamination:

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

No __ Sandbagged Placed No __ Yes ____ Give Date ________

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

Condition of Manhole:

Grade: At _____ Above_____ Below _____

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

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

Construction Material:

	Brick	Precast	Other
Corbel	___	___	_______________
Walls	___	___	_______________
Floor	___	___	_______________

Comments: Manhole Correct as Mapped Yes _____ No _____

N↑

Plan of Manhole

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

Methods to isolate intermittent discharges in the storm drain network

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

Sandbags

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

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

Optical Brightener Monitoring (OBM) Traps

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

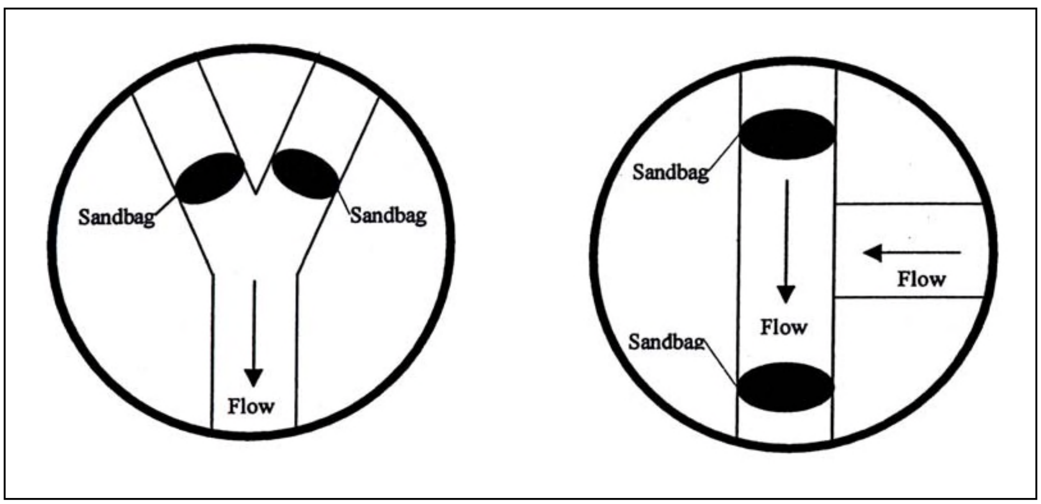


Figure 59: Example Sandbag Placement (Source: Jewell, 2001)

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

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

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

13.2 Drainage Area Investigations

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

Rapid Windshield Survey

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

Figure 61: Symptom (left): Extreme algal growth; Diagnosis (right): Cracked fertilizer storage is the phosphorus source

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

Detailed Drainage Area Investigations

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

13.3 On-site Investigations

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

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

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

TIP

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

Figure 63: Dye Testing Plumbing (NIWPC, 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).

Table 57: Key Field Equipment for Dye Testing *(Source: Wayne County, MI, 2000)*
<u>Maps, Documents</u> • 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
<u>Equipment to Find and Lift the Manhole Safely (small manhole often in a lawn)</u> • Probe • Metal detector • Crow bar • Safety equipment (hard hats, eye protection, gloves, safety vests, steel-toed boots, traffic control equipment, protective clothing, gas monitor)
<u>Equipment for Actual Dye Testing and Communications</u> • 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)

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

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

Table 58: Dye Testing Options

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

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

Dye Selection

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

Selecting Fixtures to Test

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

Selecting a Sewer Manhole for Observations

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

Communications Between Crew Members

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

Locating Missing Dye

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

Video Testing

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

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

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

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

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

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

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

Figure 65: Camera being towed

Smoke Testing

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

Figure 66: Tractor-mounted Camera

Figure 67: Review of an Inspection Video

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

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

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

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

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

The second smoke source is liquid smoke, which is a petroleum-based product that is injected into the hot exhaust of a blower where it is heated and vaporized (Figure 70). The length of smoke production can vary depending on the length of the pipe being tested. In general, liquid smoke is not as consistently visible and does not travel as far as smoke from bombs (USA Blue Book).

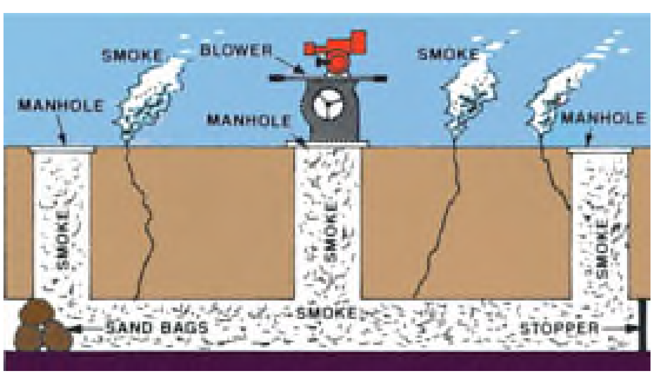


Figure 68: Smoke Testing System Schematic

Figure 69: Smoke Candles

Figure 70: Smoke Blower

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 (Figure 71). Sewer vents extend upward from the sewer lateral to release gas buildup, and are not supposed to be connected to the storm drain system.

Figure 71: Smoke Rising from Sewer Vent

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 72). 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 72: (a) Wet, spongy ground. Grass may be bright green or burnt due to high nutrient loading. (b) Straight pipe discharge to nearby stream. (c) Algal bloom in a nearby pond.
(Sources: a- Anish Jantrania; b- Snohomish County, WA c- King County, WA)

Detailed System Inspection

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

Although not always incorporated into the inspection, dye testing can sometimes point to leaks from broken pipes, or direct discharges through straight pipes that might be missed during routine inspection. Dye can be introduced into plumbing fixtures in the home, and flushed with sufficient running water. The inspector then watches the septic field, nearby ditches, watercourses and manholes for any signs of the dye (Figure 73). 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.

Figure 73: Dye surfacing in a septic field

Infrared Imagery

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

Infrared Thermography

Infrared thermography is increasingly being used to detect illicit discharges and failing septic systems. The technique uses the

[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.

temperature difference of sewage as a marker to locate these illicit discharges. Figure 74 illustrates the thermal difference between an outfall discharge (with a higher temperature) and a stream.

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

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

Color Infrared Aerial Photography

Color infrared aerial photography looks for changes in plant growth, differences in soil moisture content, and the presence of standing water on the ground to primarily identify failing septic systems (Figure 75).

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 74: Aerial Thermography Showing Sewage Leak

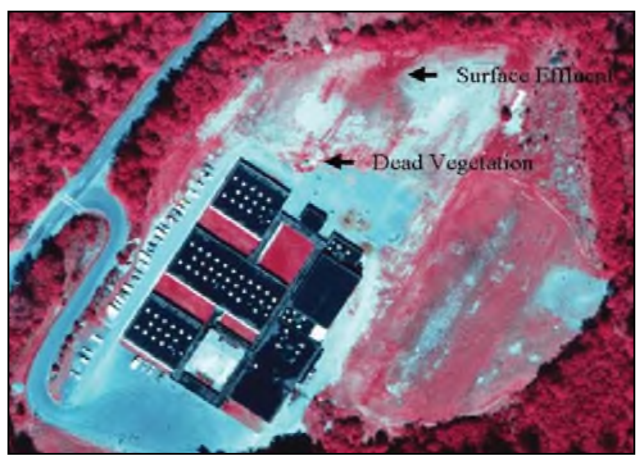


Figure 75: Dead vegetation and surface effluent are evidence of a septic system surface failure.
(Source: U.S. EPA, 1999)

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 SmokeTesting

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

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

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

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

Costs for Septic System Investigations

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

Homeowner Survey and Surface Condition Analysis

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

Detailed System Inspection

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

Aerial Infrared Thermography

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

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