Appendix A:

Outfall Reconnaissance Inventory/ Sample Collection Field Sheet

Section 1: Background Data

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

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

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

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

Section 2: Outfall Description

LOCATION	MATERIAL	SHAPE		DIMENSIONS (IN.)	SUBMERGED
☐ Closed Pipe	☐ RCP ☐ CMP ☐ PVC ☐ HDPE ☐ Steel ☐ Other ________	☐ Circular ☐ Eliptical ☐ 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
pH			pH Units	Test strip/Probe
Ammonia			mg/L	Test strip

Outfall Reconnaissance Inventory Field Sheet

Section 4: Physical Indicators for Flowing Outfalls Only
Are Any Physical Indicators Present in the flow? ☐ Yes ☐ No *(If No, Skip to Section 5)*

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

Section 5: Physical Indicators for Both Flowing and Non-Flowing Outfalls
Are physical indicators that are not related to flow present? ☐ Yes ☐ No *(If No, Skip to Section 6)*

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

Section 6: Overall Outfall Characterization

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

Section 7: Data Collection

1. Sample for the lab?	☐ Yes	☐ No	
2. If yes, collected from:	☐ Flow	☐ Pool	
3. Intermittent flow trap set?	☐ Yes	☐ No	If Yes, type: ☐ OBM ☐ Caulk dam

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

Illicit Discharge Hotline Incident Tracking Sheet

Incident ID:	
Responder Information	
Call taken by:	Call date:
Call time:	Precipitation (inches) in past 24-48 hrs:
Reporter Information	
Incident time:	Incident date:
Caller contact information (*optional*):	

Incident Location *(complete one or more below)*
Latitude and longitude:
Stream address or outfall #:
Closest street address:
Nearby landmark:

Primary Location Description	**Secondary Location Description:**		
☐ Stream corridor *(In or adjacent to stream)*	☐ Outfall	☐ In-stream flow	☐ Along banks
☐ Upland area *(Land not adjacent to stream)*	☐ Near storm drain	☐ Near other water source (storm water pond, wetland, etc.):	

Narrative description of location:

Upland Problem Indicator Description		
☐ Dumping	☐ Oil/solvents/chemicals	☐ Sewage
☐ Wash water, suds, etc.	☐ Other: ______________	

Stream Corridor Problem Indicator Description				
Odor	☐ None	☐ Sewage	☐ Rancid/Sour	☐ Petroleum (gas)
	☐ Sulfide (rotten eggs); natural gas	☐ Other: Describe in "Narrative" section		
Appearance	☐ "Normal"	☐ Oil sheen	☐ Cloudy	☐ Suds
	☐ Other: Describe in "Narrative" section			
Floatables	☐ None:	☐ Sewage (toilet paper, etc)	☐ Algae	☐ Dead fish
	☐ Other: Describe in "Narrative" section			

Narrative description of problem indicators:

Suspected Violator (name, personal or vehicle description, license plate #, etc.):

Investigation Notes	
Initial investigation date:	Investigators:
☐ No investigation made	Reason:
☐ Referred to different department/agency:	Department/Agency:
☐ Investigated: No action necessary	
☐ Investigated: Requires action	Description of actions:
Hours between call and investigation:	Hours to close incident:
Date case closed:	
Notes:	

IDDE – Call List

Title: **Sewer Dye Testing Procedure**

Sewer dye testing is used to study the flow or migration of water from one area to another. Examples are to verify discharge locations of storm sewer lines, check for illicit connections between storm and sanitary sewers, or verify the integrity of sewer lines. Because of the brilliant colors used, they often cause concern to the general public when they show up down stream. Sewer dyes used by City employees and contractors shall be non-toxic and biodegradable. A current MSDS sheet should be readily available during its use. Sewer dye comes in tablets, liquids, powders, and wax. It also comes in many florescent/brilliant colors including red, green, yellow, and blue. Sewer dyes shall be used in accordance to the manufactures instructions.

The following people will be notified by telephone (at least 1 hour) on each day prior to dying a pipeline, catch basin, manhole, roof drain, etc. Sewer dye testing notification is required to be done by the person (or direct supervisor) doing the testing.

1. **Emergency Management Coordinator @ (308) 233-3225**
2. **City of Kearney Police Department @ (308) 237-2104**
3. **City of Kearney Fire Department @ (308) 233-3203**
4. **City of Kearney Utility Department @ (308) 233-3268**
5. **City of Kearney WWTP Superintendent @ (308) 233-3715**
6. **City of Kearney Transportation/Street Department @ (308) 233-3218**

The following information should be relayed:

- **Date, Time and Location of Testing**
- **Reason for Testing**
- **Color of Dye**
- **Anticipated Surface Water or System to be Affected**
  (NPPD Canal / N. Channel Platte River / Wood River / Specify any local water body: Kearney Lake, Light House Point Lake / etc)
- **On-site Contact Information**
  (Name / Company / Telephone Number)

When notified, these people will be able to respond to concerned citizen's calls in regard to dye testing. They will be able to say that it is routine water testing and the dyes, although colorful, pose no harm to the environment.

Any conclusions drawn from storm sewer dye testing can be reviewed at City Hall, in the Storm Water Program Managers office.

Responsible Party: City of Kearney, Public Works Department
Contact: Storm Water Program Manager (308) 233-3273

Appendix B:

Chapter 11: The Outfall Reconnaissance Inventory

This chapter describes a simple field assessment known as the Outfall Reconnaissance Inventory (ORI). The ORI is designed to fix the geospatial location and record basic characteristics of individual storm drain outfalls, evaluate suspect outfalls, and assess the severity of illicit discharge problems in a community. Field crews should walk all natural and man-made streams channels with perennial and intermittent flow, even if they do not appear on available maps (Figure 19). The goal is to complete the ORI on every stream mile in the MS4 within the first permit cycle, starting with priority subwatersheds identified during the desktop analysis. The results of the ORI are then used to help guide future outfall monitoring and discharge prevention efforts.

11.1 Getting Started

The ORI requires modest mapping, field equipment, staffing and training resources. A complete list of the required and optional resources needed to perform an ORI is presented in Table 30. The ORI can be combined with other stream assessment tools, and may be supplemented by simple indicator monitoring. Ideally, a Phase II community should plan on surveying its entire drainage network at least once over the course of each five-year permit cycle. Experience suggests that it may take up to three stream walks to identify all outfalls.

Figure 19: Walk all streams and constructed open channels

Best Times to Start

Timing is important when scheduling ORI field work. In most regions of the country, spring and fall are the best seasons to perform the ORI. Other seasons typically have challenges such as over-grown vegetation or high groundwater that mask illicit discharges, or make ORI data hard to interpret[9].

Prolonged dry periods during the non-growing season with low groundwater levels are optimal conditions for performing an ORI. Table 31 summarizes some of the regional factors to consider when scheduling ORI surveys in your community. Daily weather patterns also determine whether ORI field work should proceed. In general, ORI field work should be conducted at least 48 hours after the last runoff-producing rain event.

Field Maps

The field maps needed for the ORI are normally generated during the desktop assessment phase of the IDDE program described in Chapter 5. This section

[9] Upon initial program start-up, the ORI should be conducted during periods of low groundwater to more easily identify likely illicit discharges. However, it should be noted that high water tables can increase sewage contamination in storm drain networks due to infiltration and inflow interactions. Therefore, in certain situations, seasonal ORI surveys may be useful at identifying these types of discharges. Diagnosis of this source of contamination, however, can be challenging.

Table 30: Resources Needed to Conduct the ORI		
Need Area	**Minimum Needed**	**Optional but Helpful**
Mapping	• Roads • Streams	• Known problem areas • Major land uses • Outfalls • Specific industries • Storm drain network • SIC-coded buildings • Septics
Field Equipment	• 5 one-liter sample bottles • Backpack • Camera (preferably digital) • Cell phones or hand-held radios • Clip boards and pencils • Field sheets • First aid kit • Flash light or head lamp • GPS unit • Spray paint (or other marker) • Surgical gloves • Tape measure • Temperature probe • Waders (snake proof where necessary) • Watch with a second hand	• Portable Spectrophotometer and reagents (can be shared among crews) • Insect repellant • Machete/clippers • Sanitary wipes or biodegradable soap • Wide-mouth container to measure flow • Test strips or probes (e.g., pH and ammonia)
Staff	• Basic training on field methodology • Minimum two staff per crew	• Ability to track discharges up the drainage system • Knowledge of drainage area, to identify probable sources. • Knowledge of basic chemistry and biology

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.

provides guidance on the basic requirements for good field maps. First, ORI field maps do not need to be fancy. The scale and level of mapping detail will vary based on preferences and navigational skills of field crews. At a minimum, maps should have labeled streets and hydrologic features (USGS blue line streams, wetlands, and lakes), so field crews can orient themselves and record their findings spatially.

Field maps should delineate the contributing drainage area to major outfalls, but only if they are readily available. Urban landmarks such as land use, property boundaries, and storm drain infrastructure are also quite useful in the field. ORI field maps should be used to check the accuracy and quality of pre-existing mapping information, such as the location of outfalls and stream origins.

Basic street maps offer the advantage of simplicity, availability, and well-labeled road networks and urban landmarks. Supplemental maps such as a 1": 2000' scale USGS Quad sheet or finer scale aerial photograph are also recommended for the field. USGS Quad sheets are readily available and display major transportation networks and landmarks, "blue line" streams, wetlands, and topography. Quad maps may be adequate for less developed subwatersheds, but are not always accurate in more urban subwatersheds.

Recent aerial photographs may provide the best opportunity to navigate the subwatershed and assess existing land cover. Aerial photos, however, may lack topography and road names, can be costly, and are hard to record field notes on due to their darkness. GIS-ready aerial photos and USGS Quad sheets can be downloaded from the internet or obtained from local planning, parks, or public works agencies.

Field Sheets

ORI field sheets are used to record descriptive and quantitative information about each outfall inventoried in the field. Data from the field sheets represent the building blocks of an outfall tracking system allowing program managers to improve IDDE monitoring and management. A copy of the ORI field sheet is provided in Appendix D, and is also available as a Microsoft Word™ document. Program managers should modify the field sheet to meet the specific needs and unique conditions in their community.

Field crews should also carry an authorization letter and a list of emergency phone numbers to report any emergency leaks, spills, obvious illicit discharges or other water quality problems to the appropriate local authorities directly from the field. Local law enforcement agencies may also need to be made aware of the field work. Figure 20 shows an example of a water pollution emergency contact list developed by Montgomery County, MD.

Equipment

Basic field equipment needed for the ORI includes waders, a measuring tape, watch, camera, GPS unit, and surgical gloves (see Table 30). GPS units and digital cameras are usually the most expensive equipment items; however, some local agencies may already have them for other applications. Adequate ranging, water-resistant, downloadable GPS units can be purchased for less than $150. Digital cameras are preferred and can cost between $200 and $400, however, conventional or disposable cameras can also work, as long as they have flashes. Hand-held data recorders and customized software can be used to record text, photos, and GPS coordinates electronically in the field. While these technologies can eliminate field sheets and data entry procedures, they can be quite expensive. Field crews should always carry basic safety items, such as cell phones, surgical gloves, and first aid kits.

Staffing

The ORI requires at least a two-person crew, for safety and logistics. Three person crews provide greater safety and flexibility, which helps divide tasks, allows one person to assess adjacent land uses, and facilitates tracing outfalls to their source. All crew members should be trained on how to complete the ORI and should have a basic understanding of illicit discharges and their water quality impact. ORI crews can be staffed by trained volunteers, watershed groups and college interns. Experienced crews can normally expect to cover two to three stream miles per day, depending on stream access and outfall density.

11.2 Desktop Analysis to Support the ORI

Two tasks need to be done in the office before heading out to the field. The major ORI preparation tasks include estimating the total stream and channel mileage in the subwatershed and generating field maps. The total mileage helps program managers scope out how long the ORI will take and how much it will cost. As discussed before, field maps are an indispensable navigational aid for field crews working in the subwatershed.

Delineating Survey Reaches

ORI field maps should contain a preliminary delineation of **survey reaches**. The stream network within your subwatershed should be delineated into discrete segments of relatively uniform character. Delineating survey reaches provides good stopping and starting points for field crews, which

WATER POLLUTION PHONE NUMBERS TO CALL WHEN A WATER QUALITY PROBLEM IS OBSERVED or TO OBTAIN FURTHER INFORMATION ABOUT WATER QUALITY ISSUES
Spring 2001

COUNTY AGENCIES			INTER-COUNTY AGENCIES			
DEP		Department of Environmental Protection	MNCPPC	Maryland-National Capital Park & Planning Commission	WSSC	Washington Suburban Sanitary Commission
	DEPC	Division of Environmental Policy & Compliance				
	WMD	Watershed Management Division				
DPS		Department of Permitting Services	DHCD	Department of Housing & Community Development		
	LDS	Land Development Services				
	SWM	Stormwater Management				
	WS	Wells & Septic	DPWT	Department of Public Works & Transportation		

PROBLEM/QUESTION	AGENCY	TELEPHONE NUMBER
ILLEGAL DUMPING HOTLINE	DEPC:	240-777-7700 Daytime hours
	Nighttime hours	240/777-DUMP (3867) or 240-777-7780
Blocked storm drain, inlet or pipe or erosion from public storm drain	DPWT	240/777-ROAD (7623) Highway Maintenance)
Discolored public drinking water, odor to drinking water		301/206-4002
Erosion, flooding, drainage problems between private properties	DHCD:	240/777-3600 (Code Enforcement)
Erosion - stream banks on park land	MNCPPC	301/495-2535
Fire & Rescue Services (emergencies, 911)	(Non-Emergencies):	240/777-0744
Recycling Programs/Special pick up services	DPWT.	240/777-6400 or 6466
Sanitary sewer problems	WSSC	301/206-4002
Sediment (mud) from construction site entering streams	LDS:	240/777-6366
Septic Leaks/ Septic Tanks	WS:	240/777-6300
Stormwater Management, pond safety and maintenance	DEPC	240/777-7744
Stormwater Management and Sediment Control Plan Review issues	SWM	240/777-6320
Stream Clean-ups	WMD:	240/777-7712
Swimming Pool Discharges	DEPC:	240/777-7770
Trash and debris in parks and streams	MNCPPC	301/495-2535
Water main break	WSSC	301/206-4002
Water pollution (discharging, dumping, chemical spills into streams or storm drains)	DEPC: LDS:	240/777-7770 240/777-6280
Water quality monitoring programs for schools (Stream Teams)	WMD:	240/777-7714
Wells and Well Inspections	WS	240/777-6300

askDEP.com

Figure 20: Example of a comprehensive emergency contact list for Montgomery County, MD

is useful from a data management and logistics standpoint. Each survey reach should have its own unique identifying number to facilitate ORI data analysis and interpretation. Figure 21 illustrates some tips for delineating survey reaches, and additional guidance is offered below:

- Survey reaches should be established above the confluence of streams and between road crossings that serve as a convenient access point.
- Survey reaches should be defined at the transition between major changes in land use in the stream corridor (e.g. forested land to commercial area).
- Survey reaches should generally be limited to a quarter mile or less in length. Survey reaches in lightly developed subwatersheds can be longer than those in more developed subwatersheds, particularly if uniform stream corridor conditions are expected throughout the survey reach.
- Access through private or public property should be considered when delineating survey reaches as permission may be required.

It should be noted that initial field maps are not always accurate, and changes may need to be made in the field to adjust survey reaches to account for conditions such as underground streams, missing streams or long culverts. Nevertheless, upfront time invested in delineating survey reaches makes it easier for field crews to perform the ORI.

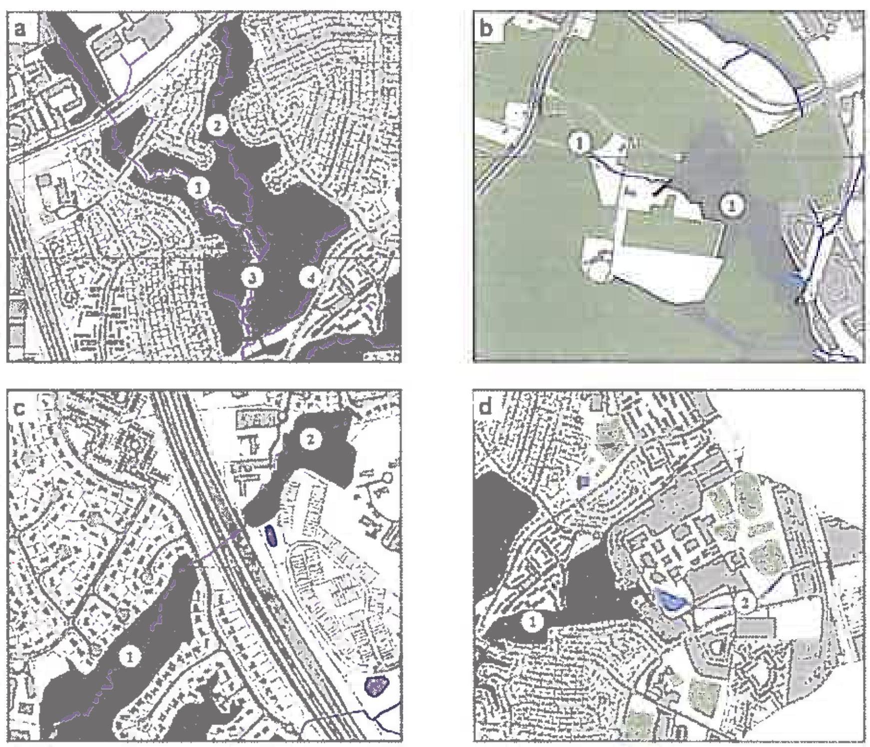


Figure 21: Various physical factors control how survey reaches are delineated. (a) Survey reaches based on the confluence of stream tributaries. (b) A long tributary split into ¼ mile survey reaches. (c) Based on a major road crossing (include the culvert in the downstream reach). (d) Based on significant changes in land use (significant changes in stream features often occur at road crossings, and these crossings often define the breakpoints between survey reaches).

11.3 Completing the ORI

Field crews conduct an ORI by walking all streams and channels to find outfalls, record their location spatially with a GPS unit and physically mark them with spray paint or other permanent marker. Crews also photograph each outfall and characterize its dimensions, shape, and component material, and record observations on basic sensory and physical indicators. If dry weather flow occurs at the outfall, additional flow and water quality data are collected. Field crews may also use field probes or test strips to measure indicators such as temperature, pH, and ammonia at flowing outfalls.

The ORI field sheet is divided into eight sections that address both flowing and non-flowing outfalls (Appendix D). Guidance on completing each section of the ORI field sheet is presented below.

Outfalls to Survey

The ORI applies to all outfalls encountered during the stream walk, regardless of diameter, with a few exceptions noted in Table 32. Common outfall conditions seen in communities are illustrated in Figure 22 As a rule, crews should only omit an outfall if they can definitively conclude it has no potential to contribute to a transitory illicit discharge. While EPA's Phase I guidance only targeted major outfalls (diameter of 36 inches or greater), documenting all outfalls is recommended, since smaller pipes make up the majority of all outfalls and frequently have illicit discharges (Pitt *et al.*, 1993 and Lalor, 1994). A separate ORI field sheet should be completed for each outfall.

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

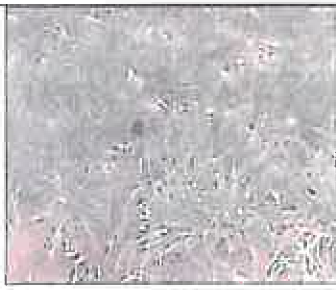
 Ductile iron round pipe	 4-6" HDPE; Check if roof leader connection (legal)	 Field connection to inside of culvert: Always mark and record
 Small diameter (<2") HDPE: Often a sump pump (legal), or may be used to discharge laundry water (illicit)	 Elliptical RCP: Measure both horizontal and vertical diameters	 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

Obvious Discharges

Field crews may occasionally encounter an obvious illicit discharge of sewage or other pollutants, typified by high turbidity, odors, floatables and unusual colors. When obvious discharges are encountered, field crews should STOP the ORI survey, track down the source of the discharge and immediately contact the appropriate water pollution agency for enforcement. Crews should photo-document the discharge, estimate its flow volume and collect a sample for water quality analysis (if this can be done safely). All three kinds of evidence are extremely helpful to support subsequent enforcement. Chapter 13 provides details on techniques to track down individual discharges.

11.4 ORI Section 1 - Background Data

The first section of the ORI field sheet is used to record basic data about the survey, including time of day, GPS coordinates for the outfall, field crew members, and current and past weather conditions (Figure 23). Much of the information in this section is self-explanatory, and is used to create an accurate record of when, where, and under what conditions ORI data were collected.

Every outfall should be photographed and marked by directly writing a unique identifying number on each outfall that serves as its subwatershed "address" (Figure 24). Crews can use spray paint or another temporary marker to mark outfalls, but may decide to replace temporary markings with permanent ones if the ORI is repeated later. Markings help crews confirm outfall locations during future investigations, and gives citizens a better way to report the location of spills or discharges when calling a water pollution hotline. Crews should mark the spatial location of all outfalls they encounter directly on field maps, and record the coordinates with a GPS unit that is accurate to within 10 feet. Crews should take a digital photo of each outfall, and record photo numbers in Section 1 of the field sheet.

Section 1: Background Data

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

Figure 23: Section 1 of the ORI Field Sheet

Figure 24: Labeling an outfall (a variety of outfall naming conventions can be used)

The land use of the drainage area contributing to the outfall should also be recorded. This may not always be easy to characterize at large diameter outfalls that drain dozens or even hundreds of acres (unless you have aerial photographs). On the other hand, land use can be easily observed at smaller diameter outfalls, and in some cases, the specific origin can be found (e.g., a roof leader or a parking lot; Figure 25). The specific origin should be recorded in the "notes" portion of Section 1 on the field sheet.

11.5 ORI Section 2 - Outfall Description

This part of the ORI field sheet is where basic outfall characteristics are noted (Figure 26). These include material, and presence of flow at the outfall, as well as the pipe's dimensions (Figure 27). These measurements are used to confirm and supplement existing storm drain maps (if they are available). Many communities only map storm drain outfalls that exceed a given pipe diameter, and may not contain data on the material and condition of the pipe.

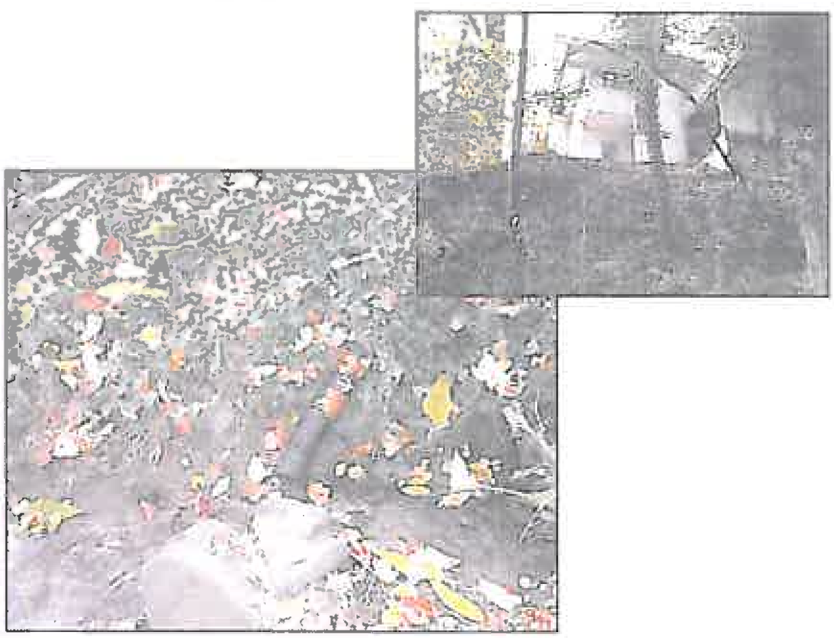


Figure 25: The origin of this corrugated plastic pipe was determined to be a roof leader from the house up the hill.

Section 2 of the field sheet also asks if the outfall is submerged in water or obstructed by sediment and the amount of flow, if present. Figure 28 provides some photos that illustrate how to characterize relative submergence, deposition and flow at outfalls. If no flow is observed at the outfall, you can skip the next two sections of the ORI field sheet and continue with Section 5.

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			

Figure 26: Section 2 of the ORI Field Sheet

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

11.6 ORI Section 3 - Quantitative Characterization for Flowing Outfalls

This section of the ORI records direct measurements of **flowing outfalls**, such as flow, temperature, pH and ammonia (Figure 29). If desired, additional water quality parameters can be added to this section. Chapter 12 discusses the range of water quality parameters that can be used.

Field crews measure the rate of flow using one of two techniques. The first technique simply records the time it takes to fill a container of a known volume, such as a one liter sample bottle. In the second technique,

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
pH			pH Units	Test strip/Probe
Ammonia			mg/L	Test strip

Figure 29: Section 3 of the ORI Field Sheet

the crew measures the velocity of flow, and multiplies it by the estimated cross sectional area of the flow.

To use the flow volume technique, it may be necessary to use a "homemade" container to capture flow, such as a cut out plastic milk container that is marked to show a one liter volume. The shape and flexibility of plastic containers allows crews to capture relatively flat and shallow flow (Figure 30). The flow volume is determined as the volume of flow captured in the container per unit time.

The second technique measures flow rate based on velocity and cross sectional area, and is preferred for larger discharges where containers are too small to effectively capture the flow (Figure 31). The crew measures and marks off a fixed flow length (usually about five feet), crumbles leaves or other light material, and drops them into the discharge (crews can also carry peanuts or ping pong balls to use). The crew then measures the time it takes the marker to travel across the length. The velocity of flow is computed as the length of the flow path (in feet) divided by the travel time (in seconds). Next, the cross-sectional flow area is measured by taking multiple readings of the depth and width of flow. Lastly, cross-sectional area (in square feet) is multiplied by flow velocity (feet/second) to calculate the flow rate (in cubic feet/second).

Crews may also want to measure the quality of the discharge using relatively inexpensive probes and test strips (e.g., water temperature, pH, and ammonia). The choice of which indicator parameters to measure is usually governed by the overall IDDE monitoring framework developed by the community. Some communities have used probes or test strips to measure additional indicators such as conductivity, chlorine, and hardness. Research by Pitt (for this project) suggests that probes by Horiba for pH and conductivity are the most reliable and

Figure 30: Measuring flow (as volume per time)

accurate, and that test strips have limited value.

When probes or test strips are used, measurements should be made from a sample bottle that contains flow captured from the outfall. The exact measurement recorded by the field probe should be recorded in Section 3 of the field sheet. Some interpolation may be required for test strips, but do not interpolate further than the mid-range between two color points.

11.7 ORI Section 4 – Physical Indicators for Flowing Outfalls Only

This section of the ORI field sheet records data about four sensory indicators associated with **flowing outfalls** — odor, color, turbidity and floatables (Figure 32). Sensory indicators can be detected by smell or sight, and require no measurement equipment. Sensory indicators do not always reliably predict illicit discharge, since the senses can be fooled, and may result in a "false negative" (i.e., sensory indicators fail to detect an illicit discharge when one is actually present). Sensory indicators are important, however, in detecting the most severe or obvious discharges. Section 4 of the field sheet asks whether the sensory indicator is present, and if so, what is its severity, on a scale of one to three.

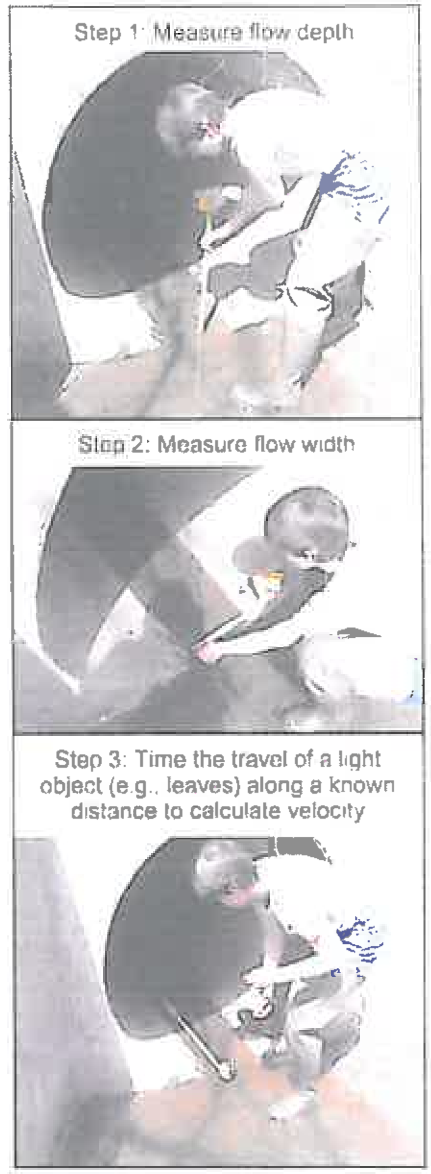


Figure 31: Measuring flow (as velocity times cross-sectional area)

Section 4: Physical Indicators for Flowing Outfalls Only

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

INDICATOR	CHECK if Present	DESCRIPTION	RELATIVE SEVERITY INDEX (1-3)		
Odor	☐	☐ [illegible] ☐ [illegible] ☐ [illegible] ☐ [illegible] ☐ Other	☐ 1 – Faint	☐ 2 – Easily detected	☐ 3 – Noticeable from a distance
Color	☐	☐ [illegible] ☐ [illegible] ☐ [illegible] ☐ [illegible] ☐ Green ☐ [illegible] ☐ Red ☐ Other	☐ 1 – Faint colors in sample bottle	☐ 2 – Clearly visible in sample bottle	☐ 3 – Clearly visible in outfall flow
Turbidity	☐	See severity	☐ 1 – Slight cloudiness	☐ 2 – Cloudy	☐ 3 – Opaque
Floatables -Does Not Include Trash!!	☐	☐ Sewage (Toilet Paper, etc.) ☐ Suds ☐ Petroleum (oil sheen) ☐ Other	☐ 1 – Few/slight; origin not obvious	☐ 2 – [illegible]	☐ 3 – [illegible]

Figure 32: Section 4 of the ORI Field Sheet

Odor

Section 4 asks for a description of any odors that emanate from the outfall and an associated severity score. Since noses have different sensitivities, the entire field crew should reach consensus about whether an odor is present and how severe it is. A severity score of one means that the odor is faint or the crew cannot agree on its presence or origin. A score of two indicates a moderate odor within the pipe. A score of three is assigned if the odor is so strong that the crew smells it a considerable distance away from the outfall.

> **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.**

Color

The color of the discharge, which can be clear, slightly tinted, or intense is recorded next. Color can be quantitatively analyzed in the lab, but the ORI only asks for a visual assessment of the discharge color and its intensity. The best way to measure color is to collect the discharge in a clear sample bottle and hold it up to the light (Figure 33). Field crews should also look for downstream plumes of color that appear to be associated with the outfall. Figure 34 illustrates the spectrum of colors that may be encountered during an ORI survey, and offers insight on how to rank the relative intensity or strength of discharge color. Color often helps identify industrial discharges; Appendix K provides guidance on colors often associated with specific industrial operations.

Turbidity

The ORI asks for a visual estimate of the turbidity of the discharge, which is a measure of the cloudiness of the water. Like color, turbidity is best observed in a clear sample bottle, and can be quantitatively measured using field probes. Crews should also look for turbidity in the plunge pool below the outfall, and note any downstream turbidity plumes that appear to be related to the outfall. Field crews can sometimes confuse turbidity with color, which are related but are not the same. Remember, turbidity is a measure of how easily light can penetrate through the sample bottle, whereas color is defined by the tint or intensity of the color observed. Figure 34 provides some examples of how to distinguish turbidity from color, and how to rank its relative severity.

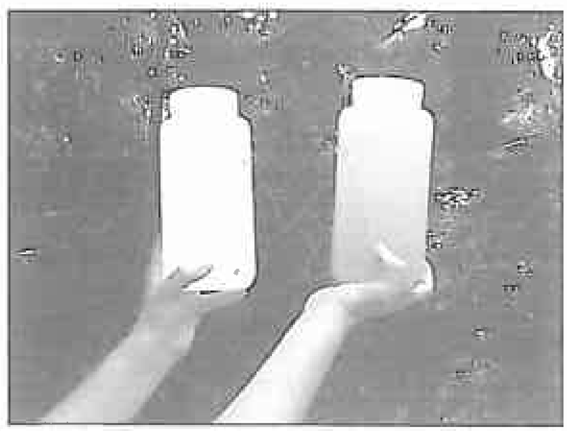


Figure 33: Using a sample bottle to estimate color and turbidity

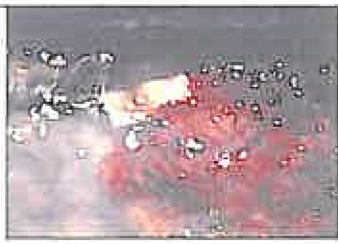
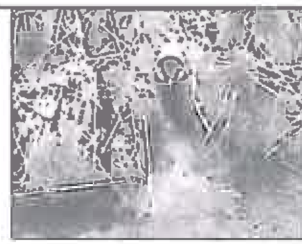
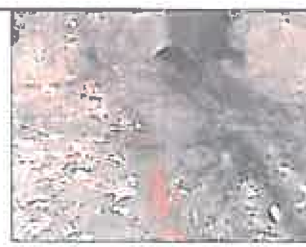
 Color: Brown. Severity: 2 Turbidity Severity: 2	 Color: Blue-green: Severity: 3 Turbidity Severity: 2	 Highly Turbid Discharge Color: Brown; Severity: 3 Turbidity Severity: 3
 Sewage Discharge Color: 3 Turbidity: 3	 Paint Color: White: Severity: 3 Turbidity: 3	 Industrial Discharge Color. Green; Severity: 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

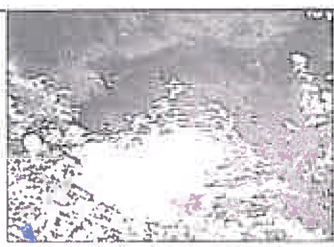
Floatables

The last sensory indicator is the presence of any floatable materials in the discharge or the plunge pool below. Sewage, oil sheen, and suds are all examples of floatable indicators; trash and debris are generally not in the context of the ORI. The presence of floatable materials is determined visually, and some guidelines for ranking their severity are provided in Figure 35, and described below.

If you think the floatable is sewage, you should automatically assign it a severity score of three since no other source looks quite like it. Surface oil sheens are ranked based on their thickness and coverage. In some cases, surface sheens may not be related to oil discharges, but instead are created by in-stream processes, such as shown in Figure 36. A thick or swirling sheen associated with a petroleum-like odor may be diagnostic of an oil discharge.

Suds are rated based on their foaminess and staying power. A severity score of three is designated for thick foam that travels many feet before breaking up. Suds that break up quickly may simply reflect water turbulence, and do not necessarily have an illicit origin. Indeed, some streams have naturally occurring foams due to the decay of organic matter. On the other hand, suds that are accompanied by a strong organic or sewage-like odor may indicate a sanitary sewer leak or connection. If the suds have a fragrant odor, they may indicate the presence of laundry water or similar wash waters.

SUDS



Natural Foam
Note. Suds only associated with high flows at the "drop off"
Do not record.

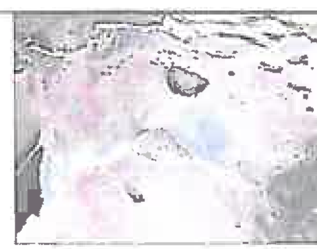
Low Severity Suds
Rating 1
Note Suds do not appear to travel; very thin foam layer

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

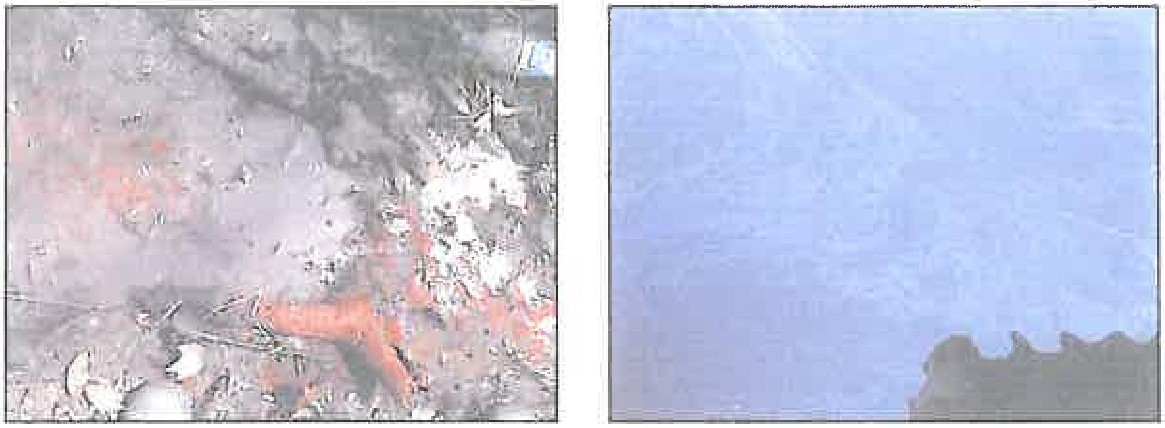


Figure 36: Synthetic versus Natural Sheen (a) Sheen from bacteria such as iron floc forms a sheet-like film that cracks if disturbed (b) Synthetic oil forms a swirling pattern

11.8 ORI Section 5 - Physical Indicators for Both Flowing and Non-Flowing Outfalls

Section 5 of the ORI field sheet examines physical indicators found at both **flowing and non-flowing** outfalls that can reveal the impact of past discharges (Figure 37). Physical indicators include outfall damage, outfall deposits or stains, abnormal vegetation growth, poor pool quality, and benthic growth on pipe surfaces. Common examples of physical indicators are portrayed in Figures 38 and 39. Many of these physical conditions can indicate that an intermittent or transitory discharge has occurred in the past, even if the pipe is not currently flowing. Physical indicators are not ranked according to their severity, because they are often subtle, difficult to interpret and could be caused by other sources. Still, physical indicators can provide strong clues about the discharge history of a storm water outfall, particularly if other discharge indicators accompany them.

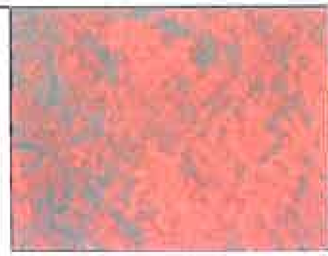
Section 5: Physical Indicators for Both Flowing and Non-Flowing Outfalls

[illegible] ☐ Yes ☐ No [illegible]

INDICATOR	CHECK if Present	DESCRIPTION	COMMENTS
[illegible]	☐	[illegible]	
[illegible]	☐	[illegible]	
[illegible]	☐	[illegible]	
[illegible]	☐	[illegible]	
[illegible]	☐	[illegible]	

Figure 37: Section 5 of the ORI Field Sheet

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

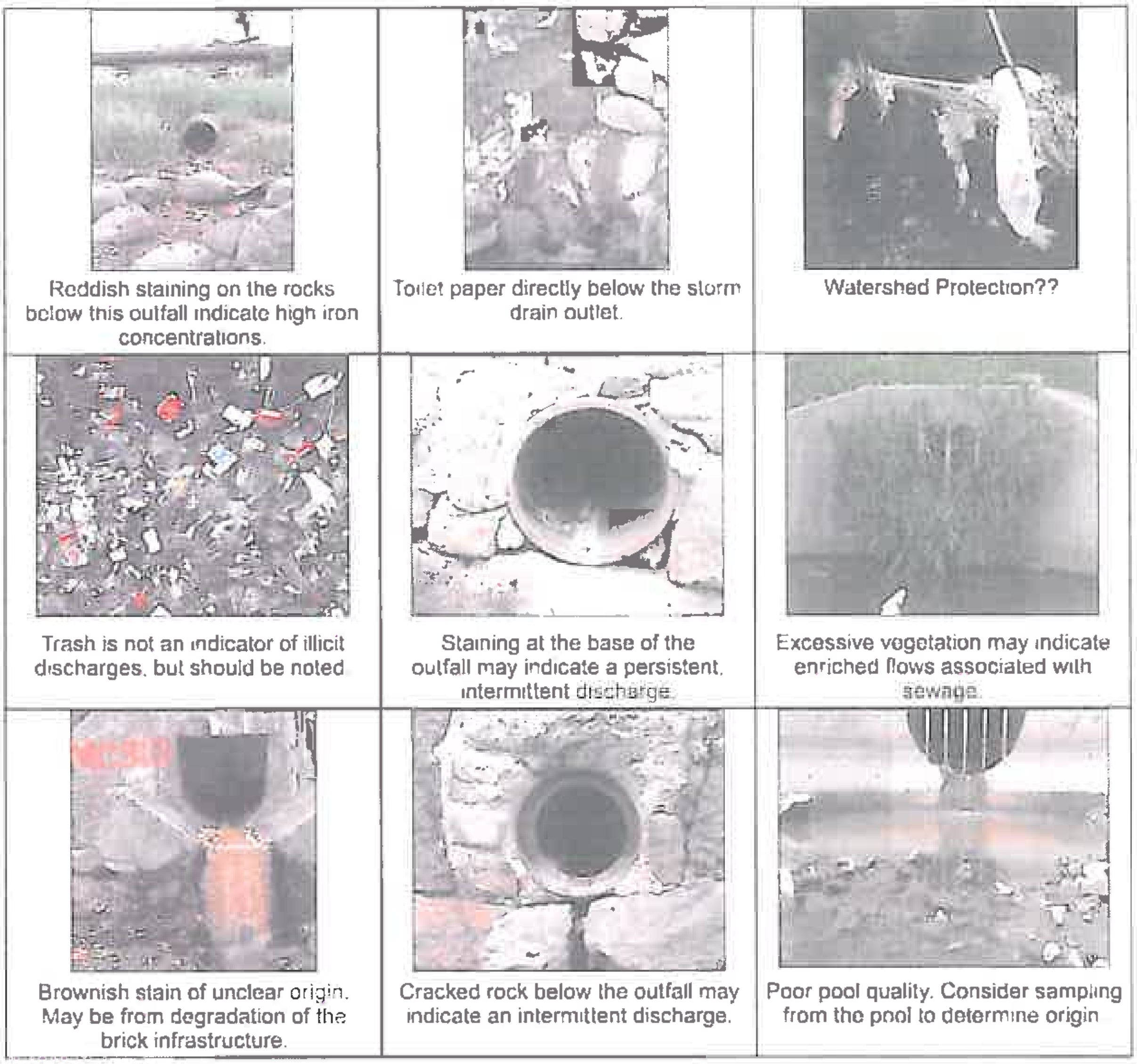
Algal mats on lakes indicate eutrophication. Several sources can cause this problem. Investigate potential illicit sources

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



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

11.9 ORI Sections 6-8 - Initial Outfall Designation and Actions

The last three sections of the ORI field sheet are where the crew designates the illicit discharge severity of the outfall and recommends appropriate management and monitoring actions (Figure 40). A discharge rating is designated as obvious, suspect, potential or unlikely, depending on the number and severity of discharge indicators checked in preceding sections.

It is important to understand that the ORI designation is only an initial determination of discharge potential. A more certain determination as to whether it actually is an illicit discharge is made using a more sophisticated indicator monitoring method. Nevertheless, the ORI outfall

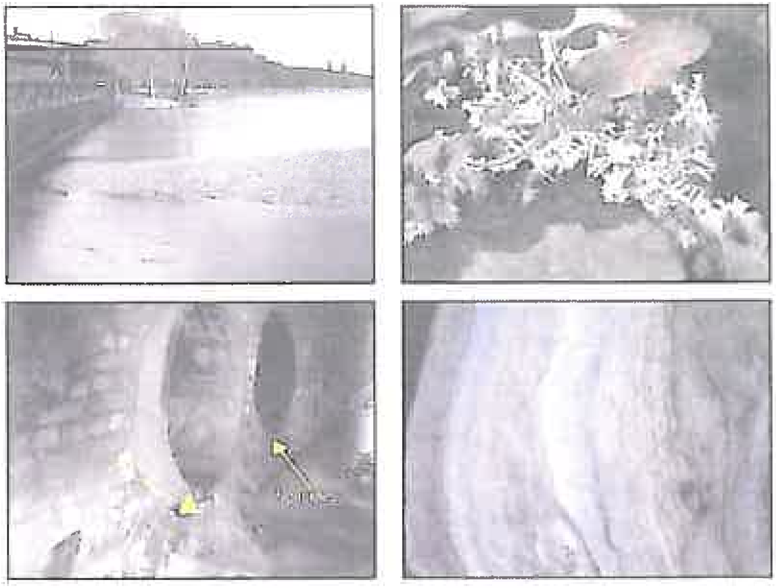


Figure 41: Cold climate indicators of illicit discharges

Figure 42: One biological indicator is this red-eared slider turtle

11.11 Interpreting ORI Data

The ORI generates a wealth of information that can provide managers with valuable insights about their illicit discharge problems, if the data are managed and analyzed effectively. The ORI can quickly define whether problems are clustered in a particular area or spread across the community. This section presents a series of methods to compile, organize and interpret ORI data, including:

1. Basic Data Management and Quality Control
2. Outfall Classification
3. Simple Suspect Outfall Counts
4. Mapping ORI Data
5. Subwatershed and Reach Screening
6. Characterizing IDDE Problems at the Community Level

The level of detail for each analysis method should be calibrated to local resources, program goals, and the actual discharge problems discovered in the stream corridor. In general, the most common conditions and problems will shape your initial monitoring strategy, which prioritizes the subwatersheds or reaches that will be targeted for more intensive investigations.

Program managers should analyze ORI data well before every stream mile is walked in the community, and use initial results to modify field methods. For example, if initial results reveal widespread potential problems, program managers may want to add more indicator monitoring to the ORI to track down individual discharge sources (see Chapter 12). Alternatively, if the same kind of discharge problem is repeatedly found, it may be wise to investigate whether there is a common source or activity generating it (e.g., high turbidity observed at many flowing outfalls as a result of equipment washing at active construction sites).

Basic Data Management and Quality Control

The ORI produces an enormous amount of raw data to characterize outfall conditions. It is not uncommon to compile dozens of individual ORI forms in a single subwatershed. The challenge is to devise a system to organize, process, and translate this data into simpler outputs and formats that can guide illicit discharge elimination efforts. The system starts with effective quality control procedures in the field.

Field sheets should be managed using either a three-ring binder or a clipboard. A small field binder offers the ability to quickly flip back and forth among the outfall forms. Authorization letters, emergency contact lists, and extra forms can also be tucked inside.

At the end of each day, field crews should regroup at a predetermined location to compare notes. The crew leader should confirm that all survey reaches and outfalls of interest have been surveyed, discuss initial findings, and deal with any logistical problems. This is also a good time to check whether field crews are measuring and recording outfall data in the same way, and are consistent in what they are (or are not) recording. Crew leaders should also use this time to review field forms for accuracy and thoroughness. Illegible handwriting should be neatened and details added to notes and any sketches. The crew leader should also organize the forms together into a single master binder or folder for future analysis.

Once crews return from the field, data should be entered into a spreadsheet or database. A Microsoft Access database is provided with this Manual as part of Appendix D (Figure 43), and is supplied on a compact disc with each hard copy. It can also be downloaded with Appendix D from http://www.stormwatercenter.net. Information stored in this database can easily be imported into a GIS for mapping purposes. The GIS can generate its own database table that allows the user to create subwatershed maps showing outfall characteristics and problem areas.

Once data entry is complete, be sure to check the quality of the data. This can be done quickly by randomly spot-checking 10% of the entered data. For example, if 50 field sheets were completed, check five of the spreadsheet or database entries. When transferring data into GIS, quality control maps that display labeled problem outfalls should be created. Each survey crew is responsible for reviewing the accuracy of these maps.

Outfall Classification

A simple outfall designation system has been developed to summarize the discharge potential for individual ORI field sheets. Table 34 presents the four outfall designations that can be made.

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

11.12 Budgeting and Scoping the ORI

Many different factors come into play when budgeting and scoping an ORI survey: equipment needs, crew size and the stream miles that must be covered. This section presents some simple rules of thumb for ORI budgeting.

Equipment costs for the ORI are relatively minor, with basic equipment to outfit one team of three people totaling about $800 (Table 37). This cost includes one-time expenses to acquire waders, a digital camera and a GPS unit, as well as disposable supplies.

The majority of the budget for an ORI is for staffing the desktop analysis, field crews and data analysis. Field crews can consist of two or three members, and cover about two to three miles of stream (or open channel) per day. Three staff-days should be allocated for pre- and post-field work for each day spent in the field.

Table 38 presents example costs for two hypothetical communities that conduct the ORI. Community A has 10 miles of open channel to investigate, while Community B has 20 miles. In addition, Community A has fewer staff resources available and therefore uses two-person field crews, while Community B uses three-person field crews. Total costs are presented as annual costs, assuming that each community is able to conduct the ORI for all miles in one year.

Table 37: Typical Field Equipment Costs for the ORI	
Item	**Cost**
100 Latex Disposable Gloves	$25
5 Wide Mouth Sample Bottles (1 Liter)	$20
Large Cooler	$25
3 Pairs of Waders	$150
Digital Camera	$200
20 Cans of Spray Paint	$50
Test Kits or Probes	$100-$500
1 GPS Unit	$150
1 Measuring Tape	$10
1 First Aid Kit	$30
Flashlights, Batteries, Labeling tape, Clipboards	$25
Total	**$785-$1185**

Table 38: Example ORI Costs		
Item	Community A	Community B
Field Equipment[1]	$700	$785
Staff Field Time[2]	$2,000	$6,000
Staff Office Time[3]	$3,000	$6,000
Total	**$5,700**	**$12,785**

[1] *From Table 44*
[2] *Assumes $25/hour salary (2 person teams in Community A and three- person teams in Community B) and two miles of stream per day.*
[3] *Assumes three staff days for each day in field.*

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

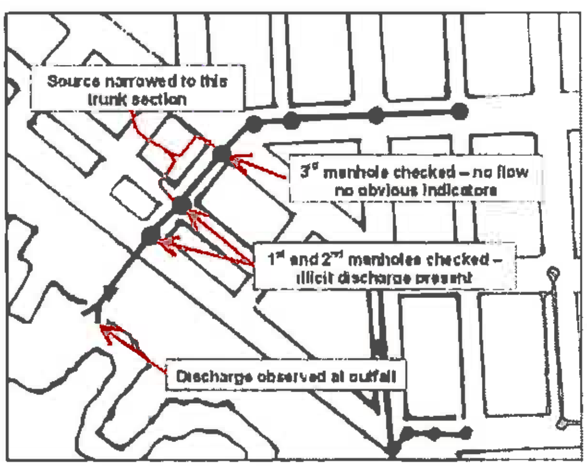


Figure 50: Example Investigation Following the Source up the Storm Drain System

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.

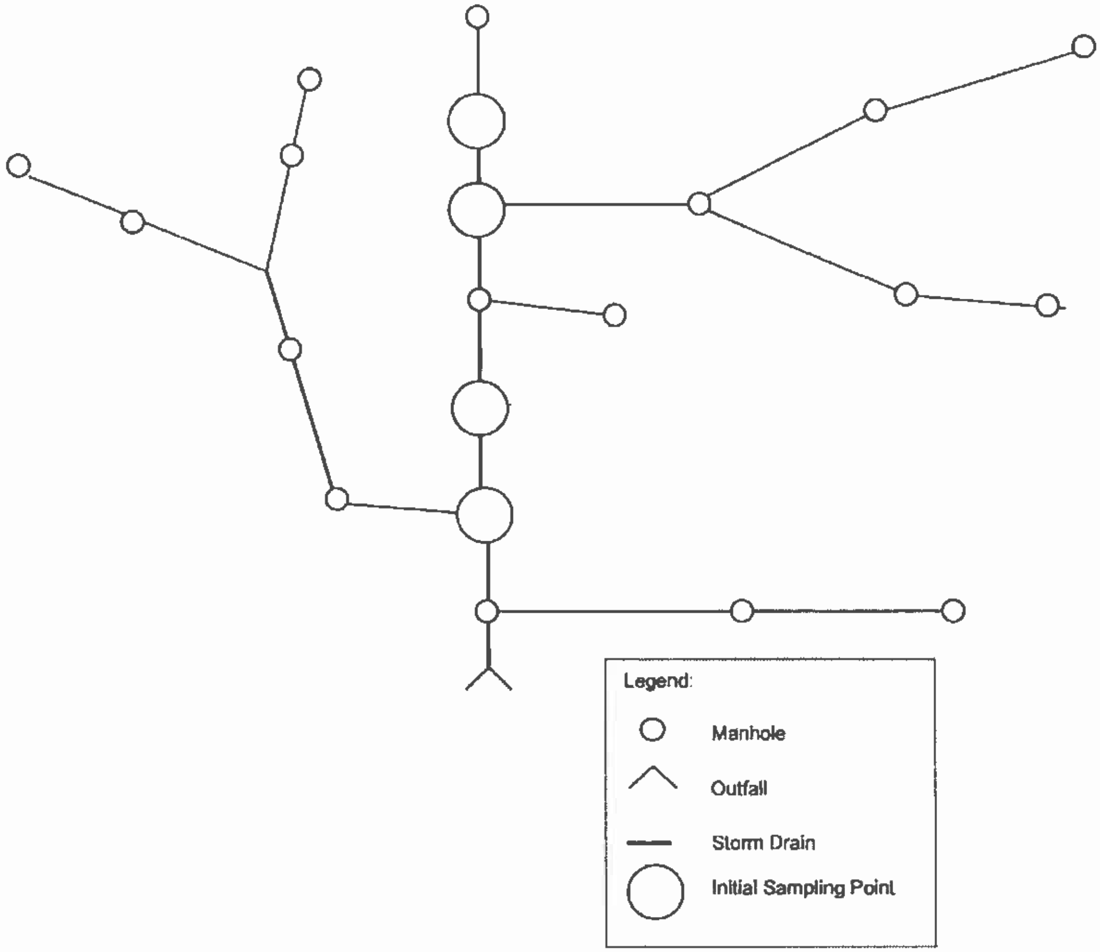


Figure 51: Key initial sampling points along the trunk of the storm drain

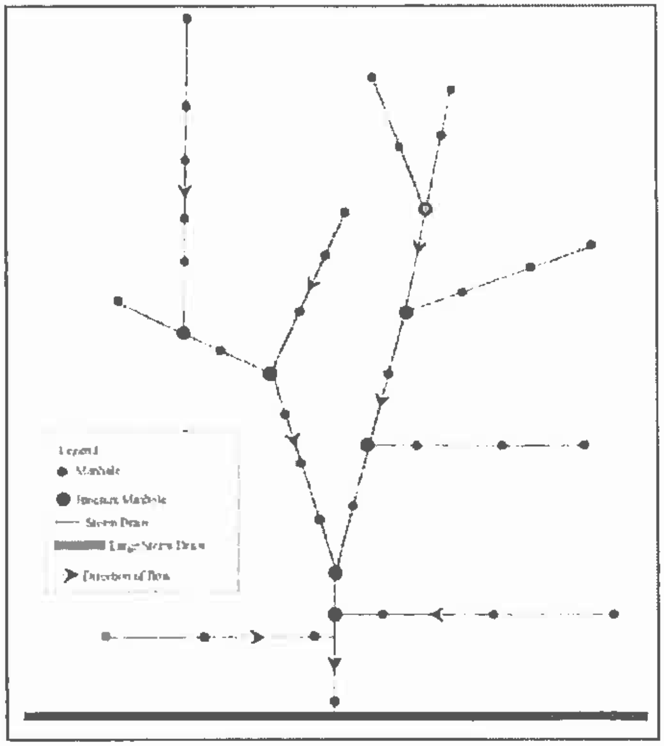


Figure 52: Storm Drain Schematic Identifying "Juncture Manholes" (Source: Jewell, 2001)

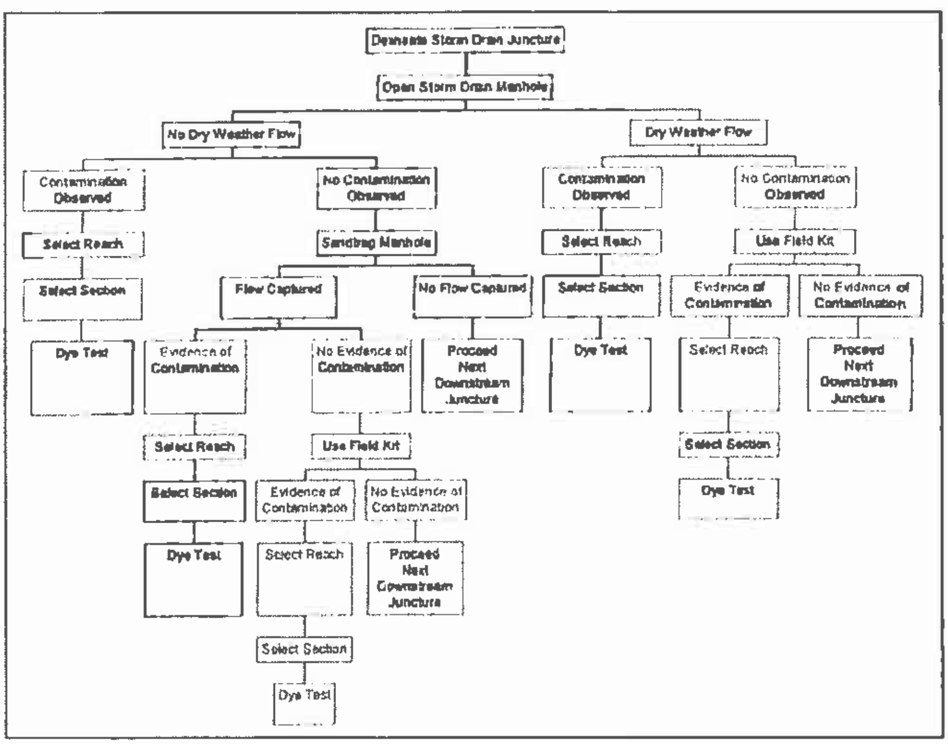


Figure 53: A Process for Following **Discharges Down the Pipe (Source:** Jewell, **2001)**

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 are 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.

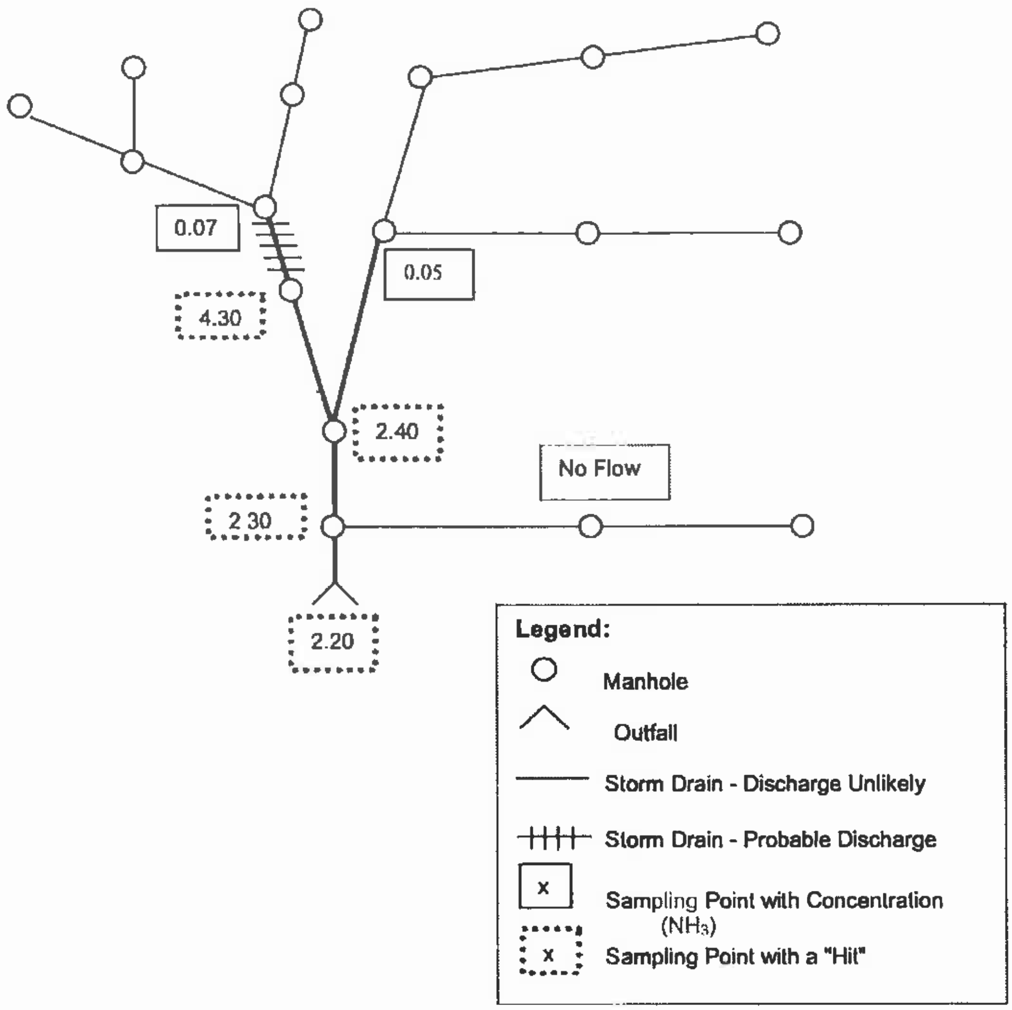


Figure 57: Use of Ammonia as a Trace Parameter to Identify an Illicit Discharge

BOSTON WATER AND SEWER COMMISSION
MANHOLE INSPECTION LOG

Manhole ID No. ____________

Inspection Date. ____________ Tributary Area ____________

Street: ____________

Inspection: Not Found __ Surface __ Internal __

Follow Up Inspection ______

Manhole Type

Sanitary Sewer ____ Storm Drain ____

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 Sheet ____ Foam ____ Other ______

Odor. None ____ Sewage ____ Oil ____ Soap ____ Other ______

Field Testing:

pH ____ Temp ____ Spec Cond ____ Surfactants: Yes ____ No __ Ammonia Yes ____ No __

Contamination:

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

No __ Sandbagged Placed No __ Yes ___ Give Date ______

Sandbag Checked (Date): ______ Flow was ___ Captured ___ Not Captured

Condition of Manhole

Grade. At ____ Above ____ Below ____

High Outlet Blocked

Lovejoy: Cover Plate in Place

Common Manholes:

Yes __ No __ NA __

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).

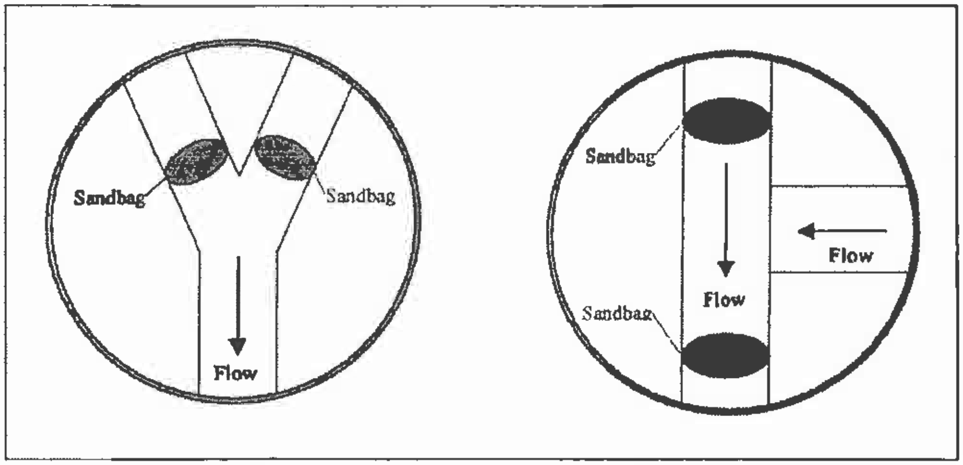


Figure 59: Example Sandbag Placement (Source: Jewell, 2001)

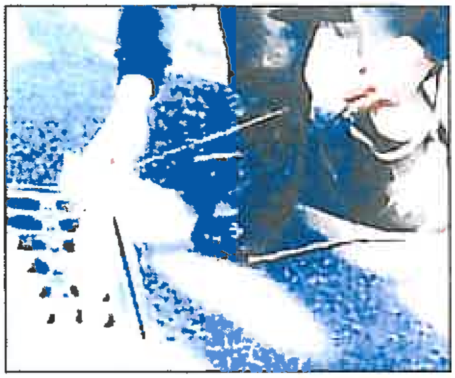


Figure 60: Optical Brightener Placement in the Storm Drain
(Source: Sargent and Castonguay, 1998)

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 (Figure 65). 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 Figure 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).

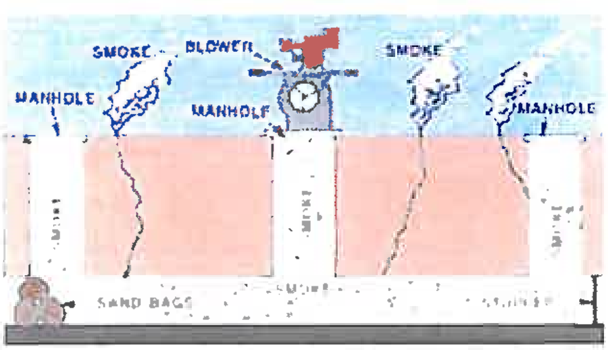


Figure 68: Smoke Testing System Schematic

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).

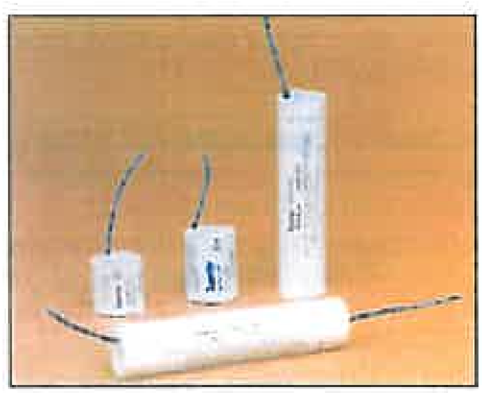


Figure 69: Smoke Candles

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).

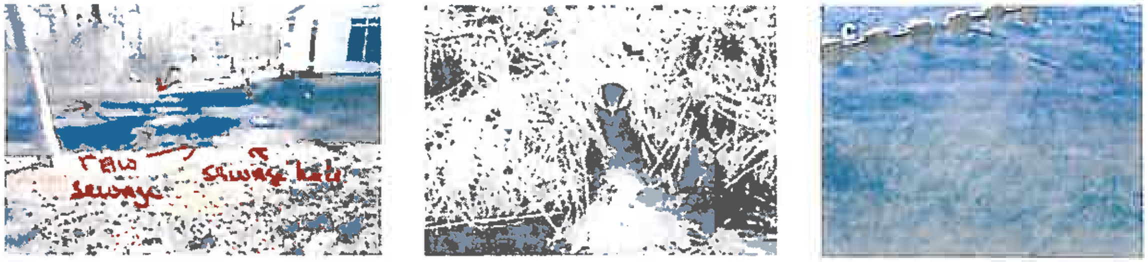


Figure 72: (a) Wet, spongy ground. Grass may be bright green or burnt due to high nutrient loading. (b) Straight pipe discharge to nearby stream. (c) Algal bloom in a nearby pond.
(Sources: a- Anish Jantrania; b- Snohomish County, WA c- King County, WA)

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).

Figure 74: Aerial Thermography Showing Sewage Leak

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).

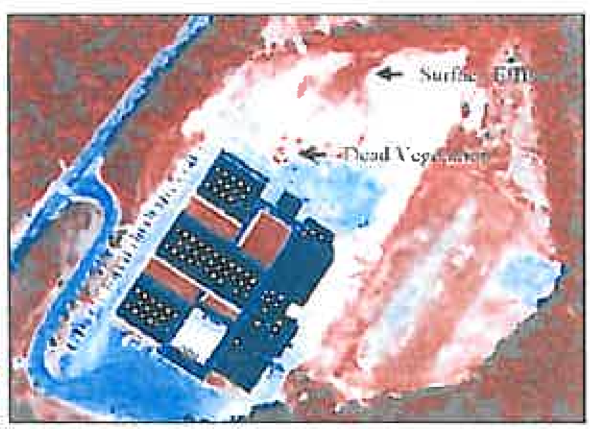


Figure 75: Dead vegetation and surface effluent are evidence of a septic system surface failure.
(Source. U.S. EPA, 1999)

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 Permer http:/www.coleparmer.com* *USA Blue Book http:/www.usabluebook.com*		

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

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

Costs for Septic System Investigations

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

Homeowner Survey and Surface Condition Analysis

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

Detailed System Inspection

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

Aerial Infrared Thermography

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

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

Appendix C:

Stormwater Program Manager
City of Kearney
1919 15th Avenue
P. O. Box 1180
Kearney, NE 68848-1180

CITY OF KEARNEY

TELEPHONE · (308) 233-3273
FAX · (308) 233-3209
E-MAIL · aharter@kearneygov.org
WEBSITE · www.cityofkearney.org

October 6, 2010

Name
Address
City, State, Zip

RE: Case # (?)

Dear Name:

An illicit discharge code violation was reported at (Property). The Public Works Department has determined that the property violates Kearney City Code. City Code Chapter 9-1523 prohibits a person from throwing, depositing or leaving any discarded waste that may cause or contribute to pollution. The discharge or accumulation of hazardous liquids which have a probability of contributing to pollution is prohibited.

This letter is your notice to cease any further oil spills or deposits in the area adjacent to the alley and to remove any used or spilled oils.

Liquid waste from the vehicles needs to be deposited in a properly covered waste receptacle for the purpose of collection so it does not leak out into the ground and into the sewer system. For your convenience and in an effort to reduce local pollution, the City of Kearney provides three used oil disposal stations free of charge. These stations are located at the Landfill, the Public Works Department, and the Recycling Center

If violations are not corrected within 10 days of receipt of this letter, the City will forward this case to the City Attorney's office. Violations of this code may be punishable by a fine up to $300.00 in accordance with Chapter 1-111 of the City Code. In addition the County Attorney's office may seek criminal prosecution for uncorrected code violations.

A Code Enforcement Officer will check the property to make certain all violations have been corrected. If you have any questions, please call the Public Works Department at 308-233-3273. The City of Kearney looks forward to working with you to make Kearney a more desirable community in which to live and work in.

Sincerely yours,

CITY OF KEARNEY

Andy Harter
Stormwater Program Manager

Code Enforcement Coordinator
City of Kearney
18 East 22nd Street
P. O. Box 1180
Kearney, NE 68848-1180

CITY OF KEARNEY

TELEPHONE · (308) 233-3272
FAX · (308) 233-3223
E-MAIL · slewis@kearneygov.org
WEBSITE · www.cityofkearney.org

October 6, 2010

Name
Address
City, State Zip Code

Dear (property owner):

The City of Kearney has received complaints and concerns regarding the property at (location). It has been brought to our attention that fallen leaves from the trees on your property are being intentionally raked or blown into the street. Chapter 5-402 of Kearney City Code declares that throwing, depositing or placing any grass, leaves or worthless vegetation in the public street is considered littering and can be subject to a $100.00 fine.

In addition, leaves which are swept or blown into the street can freeze and cause extensive drainage problems throughout the neighborhoods. Accumulation of fallen leaves will also clog up storm sewers which can result in extensive flooding throughout your neighborhood.

The City encourages you to take advantage of the Kearney Area Solid Waste Landfill where yard waste can be taken. The yard waste is then composted and made available to the public. This program gives Kearney residents the option of recycling their leaves while helping the environment.

This is your notice to cease any future activity where leaves are intentionally blown, raked or swept from the yard into the public street. If you have any questions regarding this matter feel free to contact me at 308-233-3272.

Sincerely yours,

CITY OF KEARNEY

Stephanie Lewis
Code Enforcement Division

Public Works Department
City of Kearney
18 East 22nd Street
P. O. Box 1180
Kearney, NE 68848-1180

CITY OF KEARNEY

TELEPHONE · (308) 233-3273
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E-MAIL · aharter@kearneygov.org
WEBSITE · www.cityofkearney.org

April 4, 2008

[redacted]
Kearney, NE 68847

RE: Inadequate controls to prevent sediment from exiting property; causing excessive track-out into the City of Kearney Right-of-Way.

Dear: [redacted] Management

In response to complaints received by the City of Kearney a site visit inspection to Antelope Ave was conducted. Complaints issued to the city stated that excessive amounts of mud and gravel have been tracked into the roadway. Per our inspection it was confirmed that track-out from your business has contributed to the excessive amounts of sediment, mud and gravel covering Antelope Avenue and creating a possible hazard to the community.

In order to avoid the continued hazards created by the gravel track-out it may be in your best interest to evaluate ways to reduce the amount of material that can exit you business and what materials you are using at a base near your entrance/exits. Although Antelope Avenue is part of the City of Kearney street sweeping program it is not the intent of the program to clean such a large amount of track-out from businesses. It is for that reason the City of Kearney requests that measures be taken to help reduce if not eliminate the amount of gravel and mud tracked from your business. Furthermore, if this is allowed to continue city sweepers will not detour from their scheduled routes to remedy excessive track-out from your business. It is the ultimate responsibility of all businesses to maintain their properties in such a way to prevent track-out related problems.

It must also be noted that when large amounts of gravels and dirt are allowed to enter the storm drain systems, the probability for flooding increase greatly do to the capacities of the system being reduced. For this reason the city tries to make every effort in reducing the amount of debris allowed to enter the systems.

Much like construction sites; track-out from businesses within the City of Kearney is in violation of city code (Article 4 Nuisance). Please be advised that should gravel and sediment continue to exit your site the Public Works Department will be forced to take further actions to protect public ROW and infrastructure.

If you have any questions regarding this matter please feel free to contact me.

Sincerely yours,

CITY OF KEARNEY

Andy Harter
Storm Water Program Manager

Public Works Department
City of Kearney
18 East 22nd Street
P. O. Box 1180
Kearney, NE 68848-1180

CITY OF KEARNEY

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10/12/07

[redacted]
Kearney, NE 68847

RE: Continued Discharges to the City of Kearney Storm Sewer System

Dear [redacted] Management:

In response to continued complaints received from the public, an inspection was performed of the alley storm drainage system adjacent to the referenced property. The complaints indicated that your business continues to dispose of waste into the storm drain grate inlet. Obvious accumulation in the bottom of and surrounding the inlet indicated the improper disposal of wastes since the initial inspections in August which resulted in the city cleaning the system. The storm drains located throughout the city are designed to directly carry rain water to the Platte River for discharge. All items allowed to enter the system are discharged directly into the environment. Allowing these solids to enter the system can also contribute to flooding by reducing the capacity of our conveyance system. The only thing allowed to enter storm sewers is rain water runoff; all other waste materials must be disposed of in responsible manners, whether it is the garbage, sanitary sewer system, or properly recycled. Along with direct dumping, washing equipment is also in violation to the city code of ordinance.

Furthermore, the disposal of any waste into the storm sewer system violates many federal, state, and local laws. Specifically, Section 5-402, Article 4 Nuisances, Health and Sanitation, of the City of Kearney Codes of Ordinance. The City of Kearney requests that any practices currently allowing discharge into the storm drains be ceased immediately and the proper disposal procedures be implemented.

This letter is your notice and order to cease all disposal waste to the storm sewer system.

The City of Kearney, Public Works Department will be happy to meet with you in order to find a solution to the continued problems in order to avoid future violations. Please be advised that should illegal dumping continue, your business will be in violation of this order, the Public Works Department will then forward this matter to the City Attorney, as a violation of the Codes of the City of Kearney. Any person violating any provision of the UDO as adopted by the City of Kearney, shall be deemed guilty of a misdemeanor and shall be punished as provided by the provisions of Section 1-111 of the Kearney City Code. The City Attorney may file complaints seeking relief for each day the violation continues or seek an injunction or both to correct the violation.

Please address the concerns associated with this letter immediately. Your cooperation in maintaining your property, following proper disposal practice, and being aware of the adverse impacts pollution has on our local environment, is greatly appreciated. Please contact me at 308-233-3273, prior to October 22nd 2007, to discuss your future disposal practices.

Sincerely yours,

CITY OF KEARNEY

Andrew L. Harter
Engineering Assistant, Storm Water Program Manager

Public Works Department
City of Kearney
18 East 22nd Street
P. O. Box 1180
Kearney, NE 68848-1180

CITY OF KEARNEY

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8/28/07

[redacted]
Kearney, NE 68847

RE: Allowable Discharges to the City of Kearney Storm Sewer System

Dear [redacted] Management:

On August 22, 2007, acting on complaints received from the public, an inspection was performed of the alley storm drainage system adjacent to the referenced property. The complaints indicated a foul, and an obvious holding ground for excessive amounts of flies, putrid odor was coming from the storm drain grate inlets and obvious accumulation in the bottom of the inlet indicated the improper disposal of wastes. The Storm Water Program Manager, and the Streets Superintendent, performed an inspection of the property.

The inspection determined the odor was coming from excess waste being improperly disposed of into the City of Kearney storm drainage system. The storm drains located throughout the city are designed to directly carry rain water to the Platte River and surrounding water bodies for discharge. These systems **do not** direct flows from the inlets into a treatment facility. All items allowed to enter the system are discharged directly into local lakes, rivers, and streams.

In addition to this the dumping of any waste into the storm sewer system violates many federal, state, and local laws. Specifically, Section 5-402, Article 4 Nuisances, Health and Sanitation, of the City of Kearney Codes of Ordinance. As part of the City of Kearney's Storm Water Management Program new regulation must be developed as directed by the Nebraska Department of Environmental Quality. These regulations will directly focus on illicit connection and illegal dumping to the storm drainage systems. The City of Kearney requests that any practices currently allowing discharge or dumping into the storm drains be ceased immediately and the proper disposal procedures be implemented.

This letter has been distributed to a multitude of businesses located in the area with the intention of educating owners that proper disposal practices must be followed. The only thing allowed to enter storm sewers is rain water runoff; all other waste materials must be disposed of in responsible manners, whether it is the garbage or sanitary sewer system. The City of Kearney encourages all business owners to review and correct any practices that have the possibility of discharging pollutants to the storm sewer system, before enforcement by the city is required.

Please address the concerns associated with this letter. Your cooperation in maintaining your property, following proper disposal practice, and being aware of the adverse impacts pollution has on our local environment, is greatly appreciated. If you have questions concerning the content of this letter feel free to call me at 233-3273, to discuss your concerns.

Sincerely yours,
CITY OF KEARNEY

Andrew L. Harter
Engineering Assistant, Storm Water Program Manager

Appendix D:

Did You Know?

- Grass clippings are 85% water and 5% nitrogen. When left on the lawn, they return water and nutrients to the soil.
- Grass clippings can provide up to 30% of your fertilizer requirements.
- For every eighth of an inch that a lawn mower blade is raised, there is a 30% increase in a grass blade's surface area improving the ability to take in water and nutrients.
- Any mower can recycle grass clippings; you don't need to purchase a special mower. Simply remove the bagging attachment. If you have trouble using your mower without the bagger, contact your dealer for assistance.
- There are "recycling" or "mulching" mowers manufactured for leaving clippings on the lawn. They are specifically designed to grind up the pieces of grass. With a bagging attachment, they can pick up the clippings when they are wet and heavy in the spring. They're also excellent for shredding and collecting leaves, which you can then add to your compost pile (see "Other Alternatives").

Other Alternatives

If you are unable to leave clippings on the lawn because of long periods of rain, or grass that has grown too high, use one of the following options to keep grass out of the storm sewers:

Mulch: Grass clippings can provide an effective mulch around garden plants and between rows of flowers, vegetables, and small fruits. Mulching helps to reduce weeds, conserve moisture, and modify the soil temperature. However, care should be taken to avoid mulching too thickly. Excessive mulch can inhibit moisture and oxygen penetration into the soil, and may produce offensive odors.

Backyard compost: Add clippings to your compost pile, they are an excellent source of nitrogen. When composting grass clippings, it is advisable to mix them with other yard wastes such as leaves or wood chips as a bulking agent to increase free air space. Otherwise, the grass clippings may compact and restrict air flow.

CITY OF KEARNEY

CITY OF KEARNEY

City of Kearney, Public Works
1919 15th Ave.
Kearney, NE 68845

Phone: 308-233-3273
Fax: 308-233-3209
E-mail: aharter@kearneygov.org

FOR MORE INFORMATION ON LAWN WASTE DISPOSAL VISIT:
WWW.CITYOFKEARNEY.ORG

Leave it on the Lawn!

Not on the Street!

Our Water. Our Responsibility

WWW.NEBRASKAH2O.ORG

Keep grass clippings and fallen leaves off the street and other paved areas.

Tips of Healthy Lawns and Rivers

- When you mow your yard or rake leaves, please do not allow grass clippings or leaves to blow into the street or gutter. Please take a little extra time to clean up paved areas.
- Grass clippings in the street are being washed down the storm sewers and will end up in area lakes and rivers where they have the potential to cause algae blooms.
- Mowing into the street is a VIOLATION of the City of Kearney ordinances. A violation may result in legal action.

- Grass clippings contain phosphorus, the nutrient that turns lakes green with algae.
- One bushel of fresh grass clippings can contain 0.1 lbs of phosphorus—enough to produce 30 to 50 pounds of algae growth if it finds its way to a lake or river.
- When mowing, grass clippings should be directed away from the street, driveways, sidewalks, or other paved areas. Curbside storm sewers can transport grass clippings (along with other street debris and dirt) to nearby lakes, rivers, and wetlands.
- Grass clippings and leaves blown into the street, driveways, sidewalks or other paved areas should be swept up and returned to the lawn or composted.

Tips to Help You "Leave it on the Lawn"

- Regular mowing with a sharp blade set at the proper height keeps grass growing vigorously so it covers the soil surface. For most lawns, a grass height of two to three inches provides good quality turf. Continually scalping turf seriously weakens grass plants and incites pests and weeds. Grass clippings can be left on your lawn when it is mowed regularly at the recommended height.
- During the summer, raise the mower blade 1/2 inch to help your lawn tolerate stress. Taller grass screens light from the soil surface, providing some weed control. It limits the establishment of weed seeds—such as crabgrass—that need light to germinate. It also encourages a slightly deeper root system, so roots can gather moisture and nutrients from a larger soil volume. This gives the grass plants a greater degree of stress tolerance. When grass has grown very tall, it's better to lower the cutting height gradually, rather than cutting back all at once, to avoid unnecessary stress on the plants.
- Leave grass clippings on your lawn whenever possible. They won't contribute significantly to thatch build-up. As they decompose, they're a valuable organic source of nutrients, especially nitrogen. In fact, yearly nitrogen applications may be reduced by 1/3 to 1/2 when grass clippings are returned to the lawn. Mulching mowers and mulching attachments for standard power mowers can reduce clipping size, increasing the rate at which grass clippings decompose. Removing about an inch of grass blade usually produces clippings that decompose fairly quickly.

Reprinted from: "Recommended Mowing Techniques" Minnesota Department of Agriculture

WHAT GOES IN THE DRAIN...GOES IN THE RIVER

Please Support Your Local Water Quality Programs!

CITY OF KEARNEY


Garbage Dumped Here...
Ends Up Here.
CITY OF KEARNEY
NEBRASKA
H2O
Keep litter OUT of storm drains & rivers!

NEBRASKA H_2O

MUNICIPAL OPERATIONS
STORM WATER POLLUTION PREVENTION

City of Kearney

Volume 1, Issue 6

May 2008

Illegal Dumping and Spill Control BMPs

Illegal dumping and spills can cause irreversible damage to City of Kearney properties and the environment. Accessible Kearney properties, such as public parks, drainage canals, and recycle drop off stations, provide tempting places for illegal dumping. Illegally dumped and spilled materials have potential to flow into receiving waters. This bulletin reviews Best Management Practices (BMP's), for minimizing the impact of illegal dumping and spills.

Put Your Detective Skills to Work

Inspecting for, and reporting illegally dumped substances can protect storm water quality. Keep open eyes for potential dumping at drain inlets, open channels, and other municipal storm drain systems. Warning signs can include:

- Visible signs of staining or unusual colors to the pavement or surrounding adjacent soils.
- Pungent odors coming from the drainage system.
- Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes.
- Dumping of debris or medical waste at a particular location, where the proximity to the drain system could impact water quality.

Assess and Report

When any field employees witnesses or discovers a suspected illegal dumping situation to a city storm drain system, they should report it to their supervisor.

- If the substance is known to be hazardous, suspected of being hazardous, or cannot be identified, follow outlined procedures of the City of Kearney Spill Response Procedures located in the Runoff Control Plan at your facility.
- If an illegally dumped substance within City of Kearney right-of-way has the potential of entering a municipal drain system, notify your supervisor and the Storm Water Program Manager so that a quick response can begin to minimize the effects of potential contaminations.

Isolate the Problem

If the illegally dumped substance has been identified and has potential for entering the City of Kearney storm drain system, contain the material, after a positive identification and if it is safe to do so. Provide protection for adjacent drain inlets to prevent entry of the illegally dumped substance.

Cleanup, Removal and Disposal

Perform all cleanup and corrective actions for illegal dumping and spills on City of Kearney right-of-way in accordance with Spill Response Plan Procedures, and follow Buffalo County *HazMat Spill Contingency Plan.*

Drainage canals and ditches are hot spots for illegal dumping activities. However, floatables are not the only concern. Keep a close watch out for liquids present in water bodies.

Follow Up Corrective Actions

All supervisors are required to follow up on the incident to ensure the appropriate agencies have been contacted and corrective actions have taken place. If the spill is a direct result of city operations steps must be taken to prevent a reoccurrence in the future.

For additional information on the City of Kearney Storm Water Program, or if you have questions contact:

Andy Harter

Public Works

308-233-3273

CITY OF KEARNEY

MUNICIPAL OPERATIONS

STORM WATER POLLUTION PREVENTION

City of Kearney

Volume 1, Issue 5

April 2008

Storm Water Good Housekeeping Practices

Good housekeeping is such a routine, everyday task, that its contribution to storm water pollution prevention is sometimes forgotten. This bulletin reviews housekeeping Best Management Practices (BMPs) and the potential for reducing polluting discharges to the storm water drainage system.

Maintenance Yards

A well-organized, neat yard reduces exposure of unwanted pollutants to storm water *and* presents a professional and responsible image to the public. Housekeeping practices for yard and grounds maintenance include common sense practices to reduce the potential for pollutant accumulation or discharge, such as:

- Maintain clean, orderly material and equipment storage areas; provide covers for materials as needed. Organized storage not only improves the yard's appearance, but allows better inventory control and avoids waste.
- Use the first in first out policy for material storage and control. Avoid ordering quantities of materials greater than can be stored properly or used in a reasonable amount of time.
- Properly dispose of empty containers, excess materials, and unused and obsolete equipment and parts that are not likely to be used.
- Maintain equipment and buildings to avoid peeling paint, rust, and degradation.
- Implement a regular sweeping program to remove litter and dirt subject to wind and tracking.
- Designate stockpile areas *away* from the storm water drain inlets and outside of storm water flow paths.
- Regularly inspect and clean drainage inlets, ditches and flow lines.

Shop Areas and Equipment Parking

Following Best Management Practices for shop areas and equipment parking reduces the potential for pollutants to be discharged and introduced into storm water.

- Follow storm water BMPs for handling used vehicle/equipment fluids.
- Promptly clean up minor leaks and spills using proper absorbents. Use drip pans or absorbent material under leaking vehicles and equipment to capture fluids.
- Avoid storing equipment on unpaved areas that are not easily cleaned.
- Promptly pick up spill cleanup materials and absorbents to avoid tracking throughout the yard or building. Allowing spill cleanup materials to become litter and sources of pollutants defeats the spill and leak cleanup effort!
- Use dry clean up methods. Hosing down the pavement can wash pollutants directly to the storm water system.
- *Never dispose of mop water into the parking lot, street, gutter, or storm drain.*

Debris and litter clog the drainage inlet and mix with storm water runoff.

For additional information on the City of Kearney Storm Water Program, or if you have questions contact:

Andy Harter

Public Works

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CITY OF KEARNEY

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Preventing Water Pollution

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Water Pollution Prevention Tips For The Auto Repair Industry.

Prepared by
Oregon Department of Environmental Quality
Oregon Association of Clean Water Agencies

In the past the idea of pollution prevention was commonly thought of as keeping polluted substances out of the air and water. Communities built sewage treatment plants and put scrubbers on smokestacks with the hope of reducing released pollutants.

Today, pollution prevention means much more. It means looking at every action to determine:

- How we can use fewer and less harmful substances;
- How we can create fewer waste products;
- How we can reuse or recycle substances; and

What disposal alternatives are available to keep these substances out of the sewer systems, landfills, water bodies and air.

Many business activities have the potential to pollute air, water or soil. This booklet focuses on ways to prevent water pollution by conscious reduction, reuse or recycling of chemicals and hazardous substances. Information about other types of pollution prevention is available from the Department of Environmental Quality and your local recycler.

Why Is Water Pollution Prevention Important?

It's in everyone's best interest to reduce the amount of chemicals and hazardous substances that flow into the sewer system. It's good for the earth, it's good for our pocketbooks and it's good for our communities.

Sanitary Sewers. The fundamental reason we have to be careful about what goes into sanitary sewers is that even the best sewage treatment facility has limitations. Nebraska's sewage treatment systems are designed primarily to handle sanitary sewage. Bacteria provide "treatment" by breading down organic matter in the water. We need to remember that:

- Treatment facilities can't treat many chemicals, so the substances may pass untouched into the environment. This threatens fish, wildlife and vegetation, as well as people using polluted water sources for drinking or recreation.
- Some chemicals can destroy the bacteria in the treatment process—leaving the facility useless. This not only endangers the environment—it means a tremendous expense to community ratepayers.

Recycle motor oil, batteries, solvents, paints, oil filters, antifreeze, and lubricants. Be aware of any materials you use that are considered hazardous substances, and follow all regulations related to their storage, use or disposal.

Keep dust from sanding and Bondo out of the sewers by:

Sweeping up, not hosing down, dust;

Allowing debris from wet sanding to dry out overnight before sweeping it up;

Purchasing sanders with an attached vacuum to reduce clean-up time;

Disposing non-hazardous dust in the garbage.

Use only as much paint and thinner as necessary. Calculate the amount of paint necessary to cover a surface and use the best sized spray cup for the job. When you clean the spray gun, don't release the waste water to either sewer systems. Use an enclosed "gun washer."

Keep batteries and chemical containers dry and off the ground to prevent leads into stormwater.

Drain and collect fluids from stored vehicles that are being dismantled. Reuse or recycle collected fluids.

Inspect, maintain and clean all pretreatment equipment regularly. Separators and grease traps should be cleaned at least every three months.

Dry-sweep areas around fuel-dispensing islands.

After pollution prevention techniques, the best way to assure that pollutants stay out of the pollutants stay out of the sewer system is to invest in a self-contained wastewater recycling system. Ultimately, this cuts down water and sewer bills and guarantees that businesses are not contributing to water quality.

Know where your waste water goes—does the drain lead to a sanitary sewer and a wastewater treatment facility, or does the water flow directly to a natural body of water? In either case, you will want to reduce pollutants, but if you are sending wastewater directly to a river, stream or lake, you will want to take extra precautions. Direct discharge of wastewater without a permit may be illegal.

Keep vehicle fluids and other hazardous wastes out of the sewer systems. Storm them in well-marked containers for recycling or for disposal at an appropriate facility. Be sure not to include them with you garbage unless you waste facility is aware of them and approves them.

Prevent spills, leaks and drips. Keep oil, grease, solvents and other chemicals out of storm and sanitary drains.

Use solvents only over self contained sinks or tanks. Don't allow solvents to drip onto the floors.

Prevent leaks in solvent tanks; inspect tanks for leaks and repair any immediately.

Keep tanks covered when not in use.

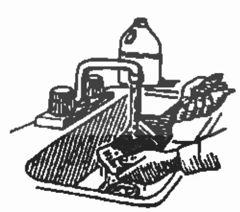
Allow cleaned engines and parts to dry over the hot tank.

Catch fluid from leaking vehicles in a drip pan, and use drip pans whenever you are changing fluids in a car.

Recycle wash water from engine and parts cleaning or exterior washing as much as possible.

Do not allow wastewater from steam-cleaning to flow into storm drains. It must be diverted to the sanitary sewer system with proper pretreatment.

Do you need floor drains? If you are not washing parts or vehicles, or have other uses for the drain, consider plugging the shop floor sewer drains, thereby preventing discharges to sewers.



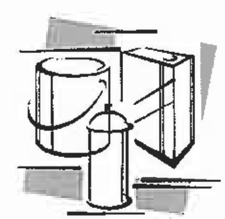
- If the facility receives too much of one type of waste at a time, it will not be able to process the organic matter. Again, this creates environmental hazards, and the community may need to invest in greater treatment capacity.
- Chemicals in the sewage treatment system put system employees at risk. Exposure to chemicals can cause health problems.

Storm Sewers. In most Nebraska communities, storm drains flow directly into rivers and streams, without passing through a treatment plant. It is for this reason that anything stormwater runoff is allowed to come in contact with will eventually wash into our local rivers and lakes. Improper disposal and storage of waste material creates a very high risk situation for contaminating stormwater runoff. It is everyone's responsibility to be mindful of the possible contamination risk their day to day businesses can create. The proper storage, disposal and recycling are key factors in reducing these risks.

How Can pollution Prevention Help Businesses' Bottom Line?

Many businesses find that taking steps to prevent pollution actually saves money.

- Cutting back on chemical use can reduce material costs as well as waste disposal fees.
- Reducing water use means less water down the drain—and lower service fees.
- Reducing chemical use can create a safer workplace, with fewer accidents and lower insurance costs.
- Ultimately, we will all pay if we need to build advance treatment systems. We all save by keeping harmful materials out of our lakes and rivers.



Be conscious of chemical use.

Even the least toxic chemicals can be harmful if used incorrectly. Chemicals can be dangerous to employees and customers, as well as to the environment Don't be careless about any aspect of chemicals, from initial use to disposal.

Reduce chemical use whenever possible.

Many businesses have found that they have saved money by adopting new procedures that require less chemical use.

Whenever possible—substitute. Many manufacturers are creating new products with less environmental impact. Avoid taking free product samples unless you are certain what's in them.

Use good housekeeping practices.

- Sweep, vacuum and mop floors rather than hosing them down, and don't leave sweepings outside where rain can wash them into storm drains. Do not send wash water down storm drains.
- Clean up spills immediately.
- Sweep parking lots I the fall, before the rains come. Be aware that rubber from tires and other products from automobiles contribute to water pollution.

Store chemicals and liquids sensibly.

- Store chemicals so they can be found and identified easily.
- Follow manufacturers' directions for all product storage.
- Consider requirements for temperature, air circulation, length of time and other storage factors.
- Make sure products are sealed properly and stored safely.
- Buy smaller quantities, more frequently. Avoid purchasing products that won't be used.
- Provide secondary containment for all liquids. Place original containers inside a pan, jar or bottle capable of capturing all the contents in case of a leak. Place large containers on spill control pallets or totes.

Spill prevention and control.

- Use chemicals only in designated areas where spills can be contained.
- Avoid moving chemicals long distances from storage to use.
- When cleaning up spills, remove liquids with rags and sweep the floor with a dry absorbent; pour mop water into an oil/water separator before sending it down the drain. Keep absorbent materials on hand to handle different types of substances. Properly dispose of rags and absorbents.

Train employees.

All employees—whether or not they work with chemicals—should receive training about the products in use, storage requirements, spill procedures and potential hazards.

Next to our physicians and our TV repair folks, Americans revere their auto mechanics above all service providers. Service stations and auto repair shops are essential to the American way of life.

But because of the nature of these businesses, they also can contribute significant amounts of water pollution to local rivers and streams. Automotive products like motor oil and solvents endanger water quality and cannot be treated by sewage treatment facilities. Material that collects in parking lots—leaves, mud, rubber from tires, leaked oil—add to pollution problems when collected in rain water or hosed into storm drains.

Responding to environmental concerns can be done with simple everyday practices. Keeping cars tuned up and by recycling motor oil are just a few. In addition, the automotive industry has been working aggressively to reduce its impact on the environment by promoting recycling and reuse of chemicals and by promoting other actions that keep toxins out of the environment. Yet the sheer number of cars on the roads today and those receiving repairs and maintenance represents a threat to clean water, so that each person working around automobiles must be doubly cautious to keep pollutants out of the storm and sanitary sewers.

The following pages outline steps that can help auto repair shops work more efficiently, reduce costs and contribute to improved water quality.

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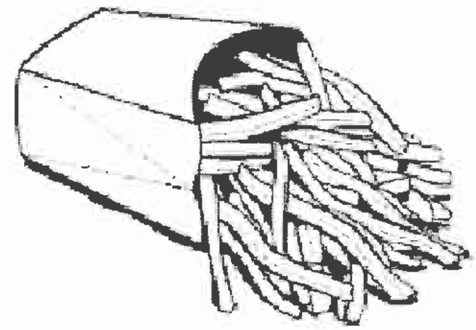
PREVENTING WATER POLLUTION

PROPER HANDLING OF FATS, OILS AND GREASE



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WATER POLLUTION PREVENTION TIPS FOR THE FOOD SERVICE INDUSTRY.

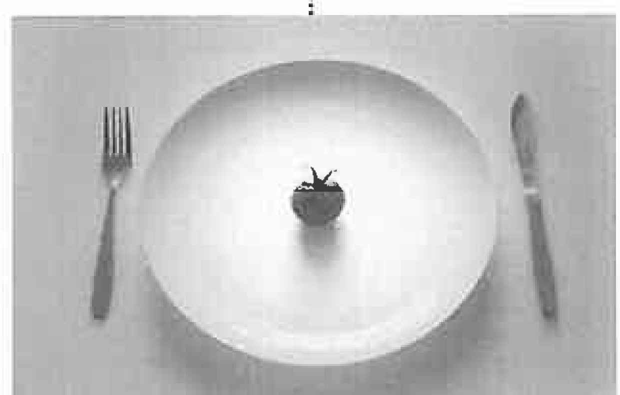
Prepared by Oregon Department of Environmental Quality
Oregon Association of Clean Water Agencies

It's in everyone's best interest to reduce the amount of chemicals, hazardous substances and food wastes that flow into the sewer system. It's good for the earth, it's good for our pocketbooks and it's good for our communities. Nebraska's waterways are fragile environmental systems that need our care and protection. Over the last 50 years, local governments and businesses have made tremendous investments in sewage treatment to keep pollution out of lakes, streams and rivers. But just because the facilities are in place doesn't mean we can ignore our responsibilities toward our waterways. It's critical that in homes and businesses we pay attention to the impact of our actions on water quality.

Sanitary Sewers. The fundamental reason we have to be careful about what goes into sanitary sewers is that ***even the best sewage treatment facility has limitations.*** Nebraska's sewage treatment systems are designed primarily to handle sanitary or domestic sewage. Bacteria provide "treatment" by breaking down organic matter in the water. We need to remember that:

- Treatment facilities can't treat many chemicals, so the substances may pass untouched into the environment. This may threaten fish, wildlife and vegetation, as well as people using polluted water sources for drinking and recreation.
- Some chemicals can destroy the bacteria in the treatment process – leaving the facility useless. This not only endangers the environment – it means tremendous expense to community ratepayers.
- If the facility receives too much of one type of waste at a time, it will not be able to process the organic matter. Again, this creates environmental hazards, and the community may need to invest in greater treatment capacity.

- Keep kitchen exhaust filters clean. Grease and oil escaping through the exhaust system can accumulate on the roof, ultimately getting washed into the storm sewers. Establish a routine schedule and a record-keeping system for cleaning exhaust filters.
- Make sure that wastewater from washing is routed into the interceptor, where oil and grease can be collected before it reaches the sewer system.
- Be cautious about outside cleaning. Do not conduct outside cleaning activities where wastes can flow into storm drains.
- Don't throw wastewater down storm drains. Train employees and contractors to dispose of wastewater appropriately. Water used for mopping, for carpet cleaning and for washing hood filters should be disposed of through the sanitary sewer system – never in storm drains. To protect the municipal treatment system, limit cleaning chemicals and use the least hazardous products available.



Have interceptors cleaned at least twice a year. It may be necessary to have interceptors cleaned more often. If more frequent cleanings are needed, consider installing a better trap or an interceptor with larger capacity or using other techniques to keep FOG out of the drains.

Make sure maintenance is done correctly. At least one employee in each facility should be knowledgeable about cleaning procedures for traps and interceptors. That employee should observe maintenance contractors, haulers and recyclers to make sure all procedures are carried out fully and effectively.

- Cover any grease and oil storage containers kept outdoors. Open containers can collect rainwater and overflow, sending grease and oil into the stormwater system and ultimately polluting local waterways.

- Keep grease dumpsters and storage containers an adequate distance from storm drains. The farther away you keep these units from a catch basin, the more time there will be for someone to clean up a spill or leak before it reaches the sewer system.

- Use absorbent pads inside storm drains to catch FOG that may leak into the catch basins. If grease dumpsters or containers are within 20 feet of the catch basin, or if you detect signs of FOG near the basin, line the basin with an absorbent cloth or pad. Do not use materials like kitty litter to absorb grease or oil. This can be washed into the sewer system. Use absorbent pads or clothes to clean up any spills or leaks.

How to Keep FOG out of the Sewer System:

- Some chemicals in the sewage treatment system put system employees at risk. Exposure to chemicals can cause health problems, and some substances may cause explosions and fires.

How the Food Service Industry can Affect Sewer Systems.

Every commercial cooking operation produces waste products of fats, oils and grease (FOG). On a small scale, we all know what can happen when heated grease congeals in kitchen pipes – the pipes plug up, blocking passage of liquid and creating unsanitary backups into the kitchen.

On a larger scale, the same thing can happen to sewer systems. Most blockages in wastewater collection systems can be traced to FOG. The result can have damaging effects throughout the system, creating sewage spills, manhole overflows or back-ups into homes and businesses. Too much grease and oil also can create the need for increased maintenance of sanitary lines, increasing costs to all customers.

Restaurant personnel often use chemicals during clean-up that can impact the sewage treatment system – and ultimately lakes, streams or rivers. It's always best to reduce chemical use, and make sure those chemicals you do use are friendly to the environment.

Storm Sewers. In all Nebraska communities, storm drains flow directly into waterways without passing through a treatment plant. Anything in the storm drain – from leaves to motor oil – can contribute to water pollution.

Whenever grease or oil receptacles are stored outside, there is a chance of spills or overflows that will be collected by storm drains. Food product contamination in rivers and streams can interfere with the water's nutrient balance and affect the health of vegetation and wildlife.

Cleaning chemicals washed into storm drains can also impact water quality, as can debris from outdoor eating areas. Leaves, grass and motor oil from parking lots can also be washed into the storm drains and have a negative impact on rivers and streams.

Grease and oil escaping through the exhaust system will be collected in rain water and carried into the sewers and waterways.

How Can Pollution

Prevention Help Businesses'

Bottom Line?

Many businesses find that taking steps to prevent pollution – including keeping FOG materials out of the sewer system – saves money.

- Keeping FOG out of your drains will reduce the likelihood of grease related plumbing problems.
- An establishment causing a FOG spill to the storm sewer may be eligible for fines.
- Fats, oils and grease can often be recycled, reducing garbage costs.
- Some agencies will bill a business for excess sewer line maintenance if the agency can trace the source of the problem to that establishment.
- Ultimately, we all pay if we need to build more treatment system capacity. We all save by keeping materials out of the sewer system.

- Post "No Grease" signs above sinks and in front of dishwashers. Frequent reminders can help educate employees about the importance of keeping FOG out of sinks and drains.
- Dry wipe pots, pans and dishes. Get as much oil and grease as possible off the cookware before it hits the water. Send it into the trash for disposal in the solid waste system.
- Recycle waste cooking oil and other food wastes. Call your local sewerage agency for businesses in your area that collect and recycle cooking oil.
- Use lower water temperatures. Water over 140 degrees will dissolve grease, sending it down the drain in wastewater. Inevitably, this grease will congeal – either in your pipes or in the public sewer system.
- Use a three-sink dishwashing system. Design a series of sinks for washing, rinsing and sanitizing with a 50-10 ppm. bleach solution. How to Keep FOG out of the Sewer System This system allows you to use water temperatures below 140 degrees, lowering your water heating cost, and better controlling the amount of FOG and food wastes that are washed down the drain.
- Install and properly maintain grease traps and interceptors. State and local laws require restaurants to install and maintain grease traps, interceptors or both, depending on the size and type of the food service. Contact your local health department or your local sewerage agency to find out local requirements and to make sure you are in compliance with all regulations.

<u>Some rules for maintenance are:</u>

Clean under sink grease traps weekly. If grease traps are more than 50 percent full after one week, increase how frequently you clean the trap. You also may want to consider ways to reduce the amount of FOG reaching the sink drain.

Appendix E: