



Town of WESTFORD

Stormwater Sampling Training



PURPOSE

- Westford dedicated to compliance with Clean Water Act
- Prepare for “next generation” MS4 General Permit
- Prepare staff and project partners for dry and wet-weather stormwater sampling procedures
- Enhance/Support Lake and Pond Sampling Programs



WHO ARE WE?

Zach Henderson

- Certified Professional in Stormwater Quality
- 17 years municipal stormwater management and planning
- Friend of urban waters



Ken Wagner

- Associate Editor of Lake and Reservoir Management
- 30 years of lakes, river and stream analysis
- Colorado River Runner





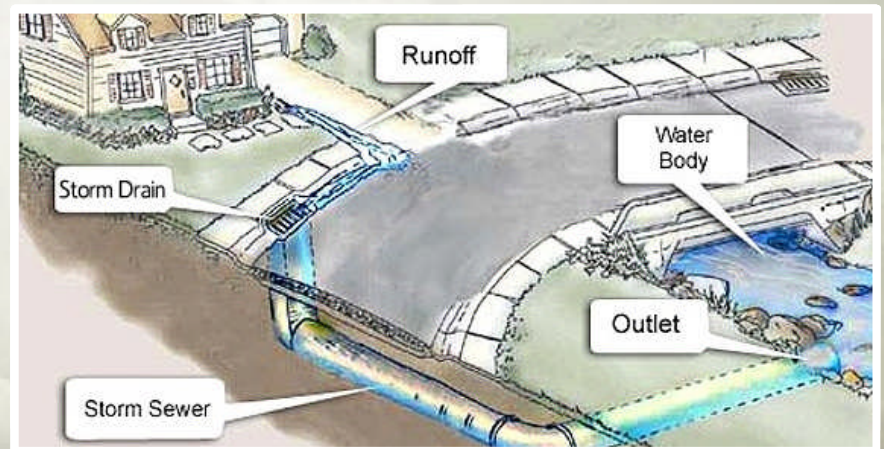
PRESENTATION OVERVIEW

- Why Are We Sampling?
- What Are We Sampling?
- What Are Our Tools?
- General Sampling Procedure
- Field Safety and Public Relations
- Outdoor Sampling Demo



DRAINAGE

- Drainage is not the sewer we often think of, but it is an underground system of pipes that maintains our developed areas.
- Drainage systems convey rainwater and snowmelt, or stormwater, from paved streets, parking lots, our lawns and basements (via sump pump) to prevent pooling and flooding.

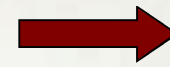




DRAINAGE PREVENTS DAMAGE

Stormwater is drained away to prevent expensive damage to our infrastructure.

basements



cracking

streets



erosion

beneath roadways



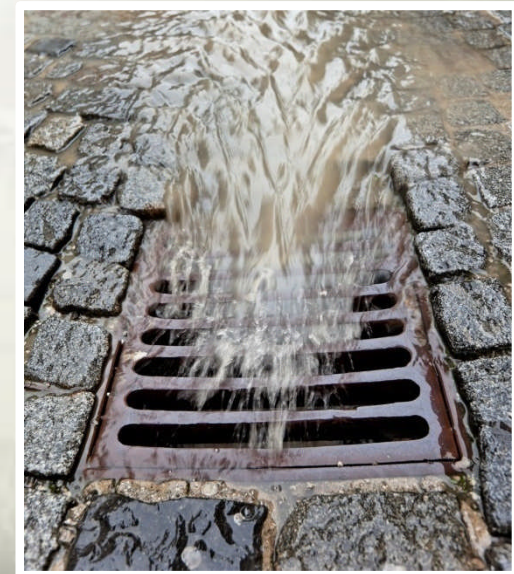
road heaving





POLLUTED STORMWATER

- Unfortunately, our drainage systems also carry pollutants like oil, fertilizers, sediment and trash.
- Rainwater that falls on paved streets, lawns, parking lots and sidewalks becomes polluted stormwater.



[illegible]



WHAT IS AN MS4?

A municipal separate storm sewer system is:

- A conveyance or system of conveyances owned by a state, city, town, or other public entity that discharges to waters of the U.S and is
 - ✓ Designed or used for collecting or conveying stormwater
 - ✓ Not a combined sewer
 - ✓ Not part of a publicly owned treatment works



WHAT IS AN MS4 PERMIT?

Clean Water Act requires EPA to regulate discharges from the MS4

- In MA, EPA administers this permit
- Every five years a new permit is drafted and issued (in theory)
- Each permittee (city) is required to develop and submit a Stormwater Plan consistent with the general permit
- Westford is a permittee



CONSEQUENCES FOR FAILURE TO COMPLY WITH MS4 PERMIT

- Enforcement Action
 - Notice of Violation, fines, or other penalties
 - Consent Order
 - Prosecution
- Permit Termination or Revocation
 - Permit Modification
 - Stricter permit limits
 - Denial of Permit Renewal

Jeopardizing Public Health & Safety





RESULTS OF SWIMMING OR CONTACT WITH CONTAMINATED WATER



Pink Eye



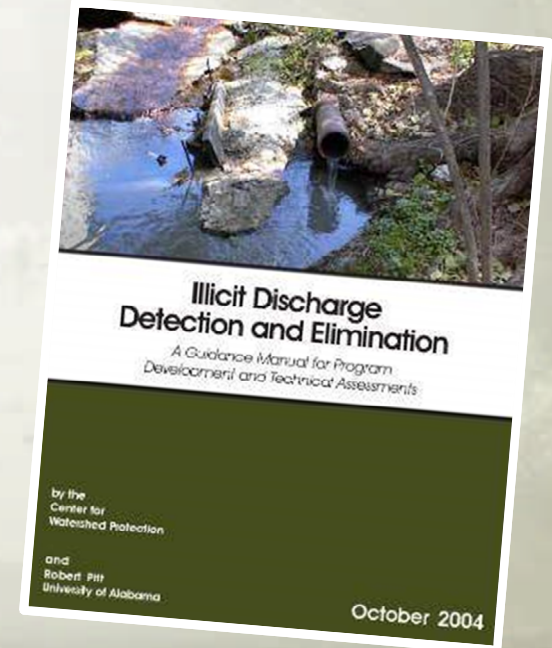
Skin Rashes





ILLICIT DISCHARGE DETECTION & ELIMINATION (IDDE) PROGRAM

- Complete drainage system map
- Ordinance requirements
- **Systematic procedure for locating and removing illicit connections**
- Septic system inventory & evaluation
- Prevent illicit discharges and SSOs (public education, hotline)
- Track program success
- Annual employee training



www.cwp.org



WHAT ARE ILLICIT DISCHARGES?

The EPA says “any discharge to a MS4 that is not composed entirely of stormwater”.

Indirect Discharge

May come from a variety of sources

- Failed septic system
- Hazardous waste spills
- Illegal Dumping
- Grass clippings, leaf litter, pet waste or other solid material dumped into catch basin



Direct Connection

A non-stormwater pipe connected to the Drain

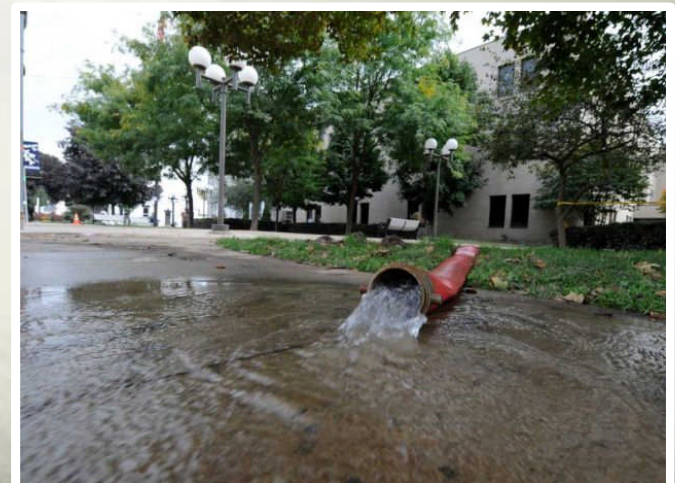
- Washing machine
- Floor drain
- Sewer line or septic system





WHAT ARE PERMITTED DISCHARGES?

- Waterline/hydrant flushing
- Dechlorinated swimming pool water
- Water from individual vehicle washing
- Landscape irrigation/lawn watering
- Groundwater
- Diverted stream flows
- Air conditioning compressor condensate
- Uncontaminated footer drains





PRELIMINARY SCREENING: WHAT ARE YOU LOOKING FOR?

- Follow your nose!
 - ✓ Sewage, sulfur, sour, rancid, petroleum/gas smells
 - ✓ Catch basins, outfalls, manholes, ditches
- Visuals
 - ✓ Pipe entering catch basin from direction of private building?
 - ✓ What color is the water?
 - ✓ Turbidity (how cloudy is the water?)
 - ✓ Floatables? (suds, toilet paper, oil sheen)
 - ✓ Growth in the pipe or sump (grey slime, algae)?
 - ✓ Seepage into ditch with excessive algal growth





**MOST OF THE TIME YOU WILL KNOW
IT WHEN YOU SEE IT...OR SMELL IT**





SOMETIMES MORE SUBTLE...





SOMETIMES EVEN MORE SUBTLE...



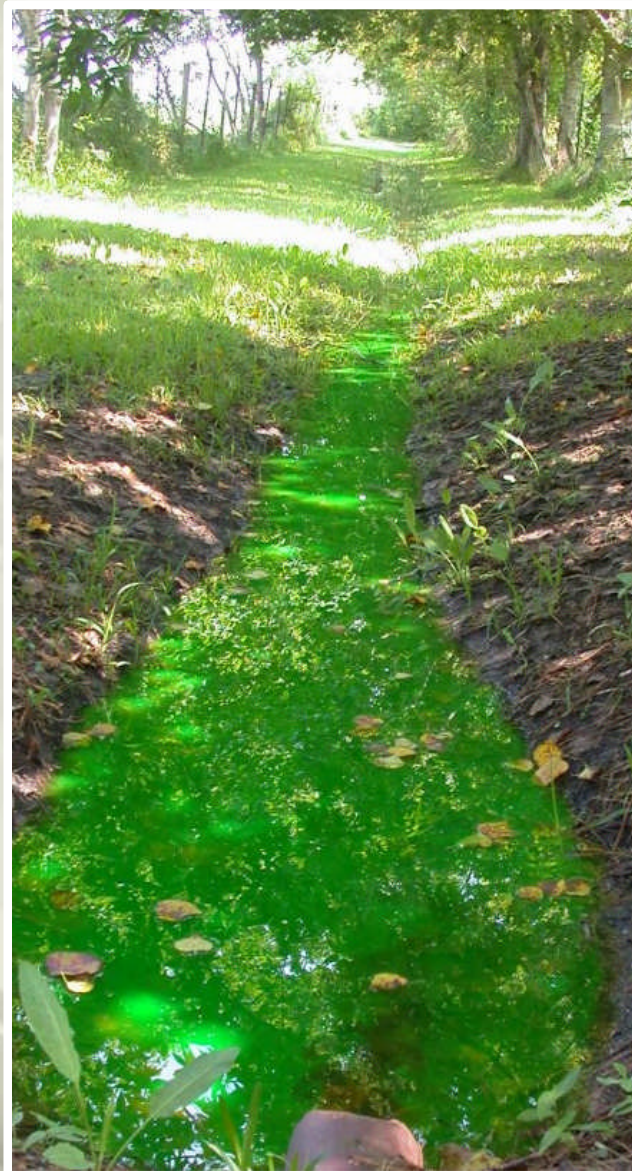


DUMPING, TOO...



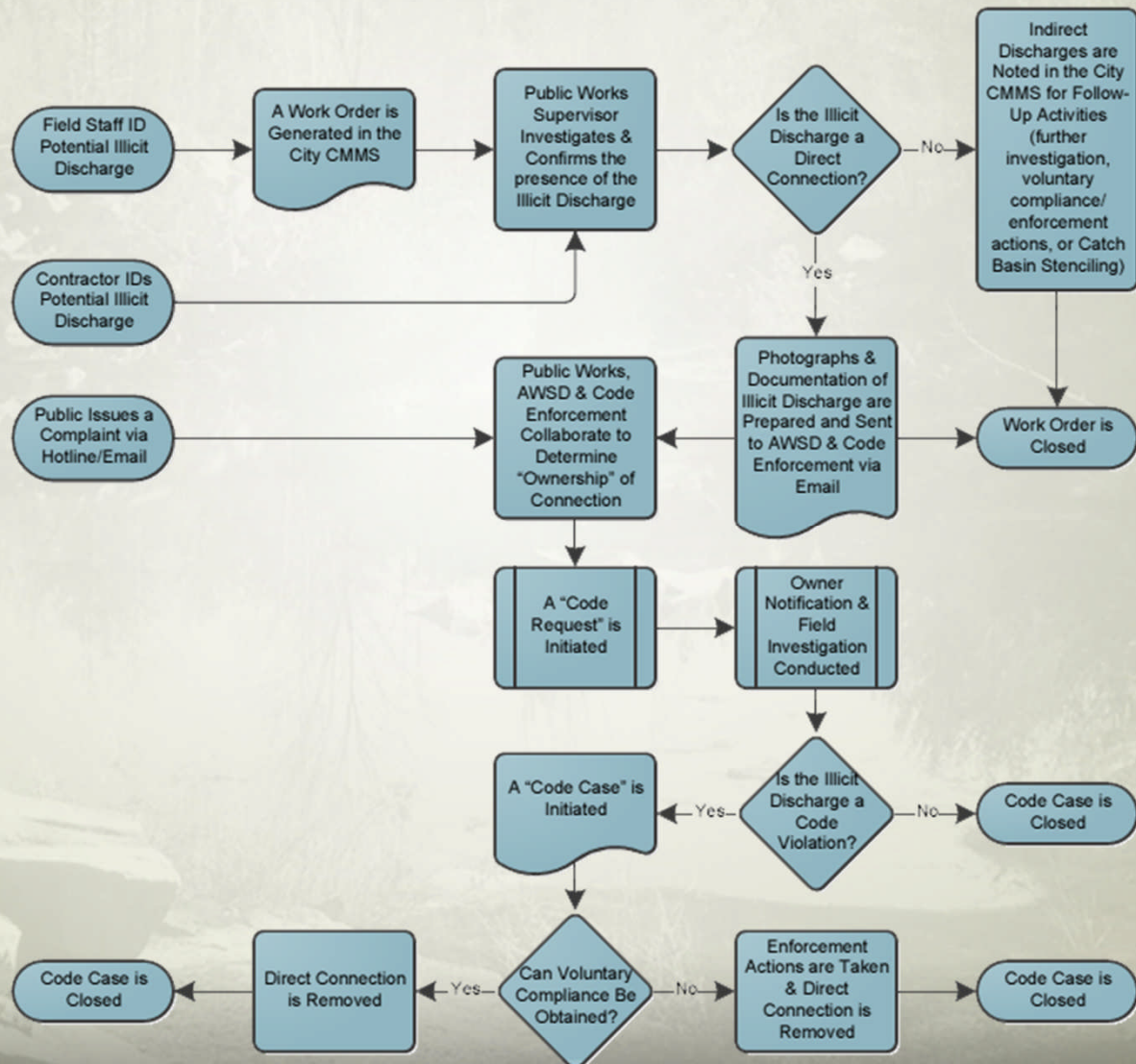


SEPTIC, TOO...





ILLICIT DISCHARGE ELIMINATION – EXAMPLE WORKFLOW PROCESS





IT'S ONLY FILED IF YOU CAN FIND IT

- Good Record Keeping throughout the year is essential
 - ✓ Calls & Complaints (name, date, time, complaint)
 - ✓ Work Orders, Location/observations, Photos
 - ✓ Code Request/Code Case





WHAT ABOUT OUR PONDS, LAKES, AND OTHER WATER BODIES?

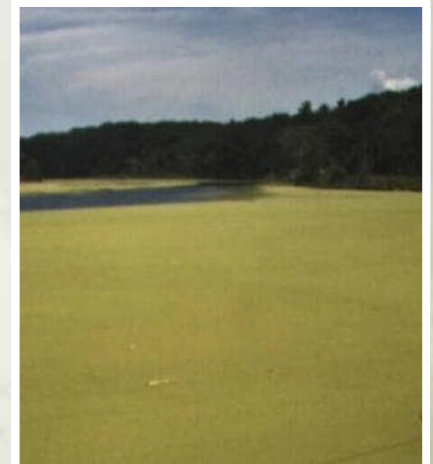
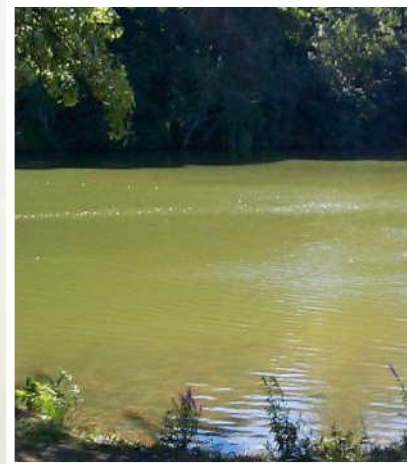
Table 1: Impaired Waters – 2012 Integrated List of Impaired Waters

Waterbody Name	Impairment Cause (Pollutant of Concern)
Forge Pond	Nutrient / Eutrophication Biological Indicators, Turbidity, Escherichia Coli, Phosphorous (total)
Nabnasset Pond	Non-Native Aquatic Plants, TMDL Completed for Mercury in fish tissue
Beaver Brook	TSS, Escherichia Coli, Phosphorous (total) Organic Enrichment (sewage) Biological Indicators, Dissolved Oxygen
Stony Brook	Escherichia Coli, Turbidity Aquatic Macroinvertebrate Bioassessments
Deep Brook	Habitat Assessment (Streams), Aquatic Macroinvertebrate Bioassessments Escherichia coli, Sedimentation/Siltation
Heart Pond	Escherichia coli
Nashoba Brook	Low flow alterations, Fishes Bioassessments



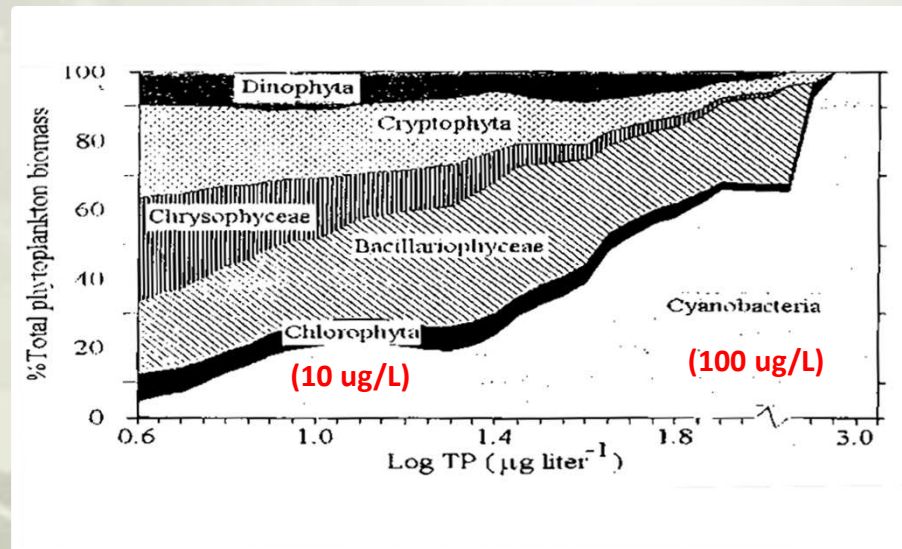
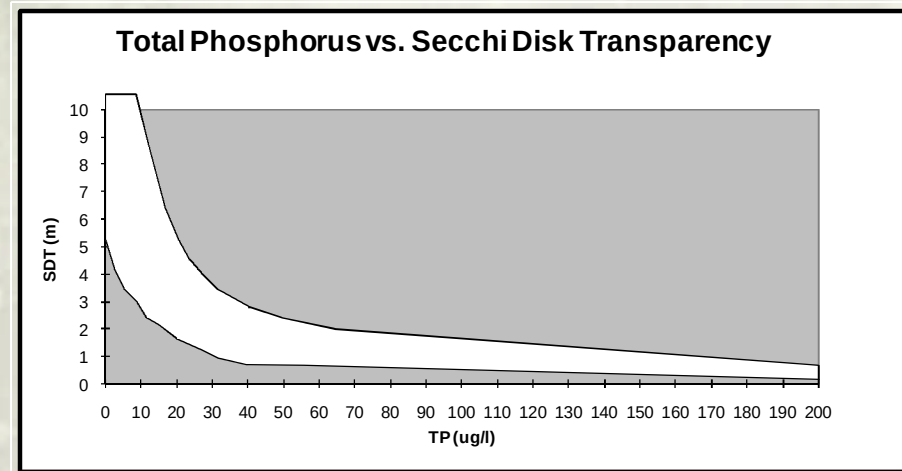
WHY DO WE NEED TO MONITOR STORM WATER?

According to the NLAP, about half of our lakes are in less than good shape nationwide as a consequence of nutrient pollution, mostly from urban and agricultural runoff





THE IMPACT OF PHOSPHORUS



- More P leads to more algae and also to more cyanobacteria
- Low water clarity, possible health effects linked to high P, but not directly



THE IMPACT OF DEVELOPMENT

- Latest study by USGS indicates 33% change in insect community of streams with 10% impervious cover in watershed (<http://water.usgs.gov/nawqa/urban/>)
- Study in CT demonstrated observable changes in stream quality at impervious surfaces >6%
- Older CWP study suggested observable impact at 10%, severe degradation at 25%; other estimates: severe degradation threshold at 20-30% imperviousness
- Impervious surface:development ratio varies, but roughly 1:2, so when a watershed is 20% developed, we observe impacts, and conditions can be very poor beyond development of 50%
- What is the % development in your watersheds?



DESIRABLE VS. STORM WATER WQ

- Background concentrations for P tend to range from 5-50 ppb, with the desirable level <10 and a tolerable threshold around 20 ppb
- Runoff P concentrations tend to range from 50 to 5000 ppb, with medians between 370 and 470 ppb for TP and 130 to 170 ppb for soluble P.
- If a watershed with no development is producing a P concentration of 5 ppb, then becomes 20% developed, the expected new P concentration would be 78 – 98 ppb.
- Natural attenuation might lower that from 10 – 50%, but 40 – 90 ppb is still high for P in any lake.
- If the watershed was 75% developed, P expected to be >140 ppb – way over any rational threshold
- Similar situation for nitrogen, often for metals and hydrocarbons. Bacteria represent a different scenario.



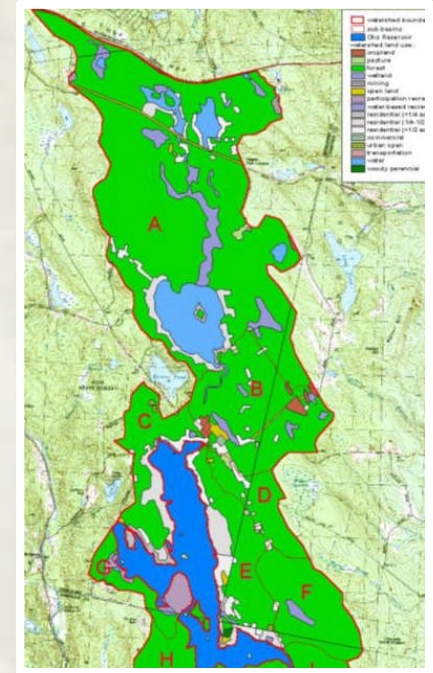
HOW DO WE COUNTER STORM WATER IMPACTS?

- Source and Activity Controls - Eliminate or reduce sources which generate pollutants
- Transport Reduction - Capture and remove or convert pollutants before they enter target resource
- Instream/Inlake Treatments— enhancing internal processes for pollutant inactivation
- Ecosystem Restoration- Repair damage to resources when controls fail
- The first two are preferable to the second two



SOURCE CONTROLS

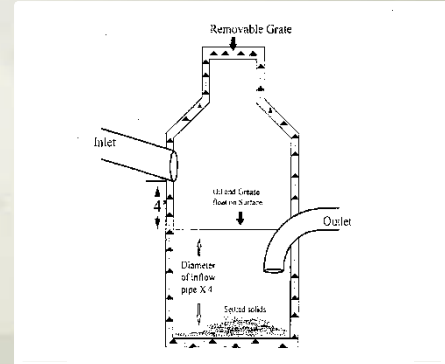
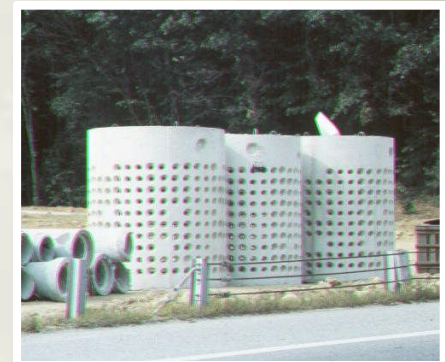
- Land use restrictions
- Material storage restrictions
- Product formulation
- Education
- Fertilizer
- IDDE





POLLUTANT TRAPPING

Wide range of structural options – construction aids like silt fence, passive guards like swales, range of stormwater processing devices





POLLUTANT TRAPPING

Detention systems, infiltration basins, filtration systems, buffers





INSTREAM / INLAKE TREATMENT

Creating detention within a lake or chemically treating runoff or streamflows





DOING THE MATH ON WATERSHED CONTROLS

- Can we get the land on the right to act like it is land on the left?
- Not likely, but need to do the best we can; monitor to find the “hot spots” and address them





WHAT ARE WE SAMPLING?

Current MS4 Permit Obligates “Program to Detect and Eliminate Illicit Discharges”

- Visual and Opportunistic

Draft MS4 Permit Specifies Wet and Dry Weather Sampling

- Prioritization
- Advanced Screening
 - ✓ Surfactants
 - ✓ Ammonia
 - ✓ Total Chlorine
 - ✓ Bacteria



WHAT ARE WE SAMPLING?

Draft MS4 Permit Obligates Impaired Waters Sampling

Waterbody Name	Impairments Dictate Sampling Parameters
Forge Pond	Turbidity, Bacterial Indicators, Phosphorus
Nabnasset Pond	Mercury
Beaver Brook	TSS, Escherichia Coli, Phosphorous (total) Biological Indicators, Dissolved Oxygen
Stony Brook	Escherichia Coli, Turbidity Aquatic Macroinvertebrate Bioassessments
Deep Brook	Habitat Assessment (Streams), Aquatic Macroinvertebrate Bioassessments Escherichia coli, Sedimentation/Siltation
Heart Pond	Escherichia coli
Nashoba Brook	Low flow alterations, Fishes Bioassessments



WHAT ARE WE SAMPLING?

Table 1 – Freshwater Water Quality Criteria, Threshold Levels, and Example Instrumentation ¹

Analyte/ Indicator	Threshold Levels/ Single Sample ³	Instrumentation
E. coli ²	235 cfu/100ml	Laboratory via approved method
Enterococci ²	61 cfu/100ml	Laboratory via approved method
Surfactants (as MBAS)	≥ 0.25 mg/l	MBAS Test Kit (e.g. CHEMetrics K-9400)
Ammonia (NH ₃)	≥ 0.5 mg/l	Ammonia Test Strips (e.g. Hach brand)
Chlorine	> Reporting Limit	Field Meter (e.g. Hach Pocket Colorimeter II)
Temperature	See Respective State Regulations	Temperature/Conductivity/Salinity Meter (e.g. YSI Model 30)

¹ The mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. EPA

² 314 CMR 4.00 MA - Surface Water Quality Standards - Class B Waters.

³ Levels that may be indicative of potential wastewater or washwater contamination

- Total Phosphorus (for Ponds and covers most Impaired Waters)
- More may be required?



SAMPLING EQUIPMENT

General Equipment

- Pry bar or pick for manhole or catch basin removal
- Sandbags and 50' cord for damming flow
- Watch
- Field notebook
- IDDE inspection forms (as applicable)
- Pen/ pencil and permanent marker
- Safety glasses and other applicable Personal Protection Equipment



SAMPLING EQUIPMENT

- Tape for labeling
- Nitrile gloves
- Utility knife
- Flashlight and appropriate batteries
- Measuring Tape
- Safety Cones
- Reflective vest/jacket
- Cooler for transporting sample bottles
- Digital camera for documentation
- Commercial hand disinfectant
- Waste container and plastic baggies for holding used testing strips
- Distilled Water



STORMWATER SAMPLING EQUIPMENT

- **Clean Testing Container** (i.e. small plastic / glass beaker) to hold water samples being tested using test kits
- Sample **Lab Containers** for samples to be delivered to the laboratory
- **EPA approved cleaning / disinfecting agent** (Rubbing alcohol based cleaning agent) for cleaning and disinfecting all containers and bottles.
- **Sampling Pole/Dipper**



TEST KITS

Ammonia Test Strips

Hach 'AquaCheck' Water Quality Test Strips

- For best results store Ammonia testing strips in a cool dry place with no exposure to moisture as this will ruin the strips.
- Carefully read all instructions and abide by all safety- warning labels.



Chlorine Test Strips

Hach 'AquaCheck' Water Quality Test Strips for Total and Free Chlorine

- For best results, store chlorine testing strips in a cool dry place with no exposure to moisture as this will ruin the strips.
- Carefully read all instructions and abide by all safety-warning labels.





TEST KITS

Surfactants Test Kit

CHEMetrics K-9400 Detergents Test Kit



- For best results, store the surfactants testing kit in a cool, dry, dark place.
- Carefully read all instructions and abide by all safety-warnings.
- Use extreme caution when using testing materials to avoid skin and eye contact as well as inhalation or ingestion of testing substance.
- Properly dispose of all used testing materials.



SAMPLING EQUIPMENT

pH & Conductivity Testing

The Town of Westford maintains and uses a YSI Professional Plus Meter for pH and Conductivity.



YSI Professional Plus meter





LABORATORY SAMPLES

E. Coli & Phosphorus Testing

- Sample Lab Containers delivered from the laboratory and picked up at sample drop off location (Engineering Office).
- Sample Lab Containers must stay clean and dry.
- Chain of Custody forms document “delivery and receipt” for all “owners”.
- Store filed samples lab containers on ice.
- Hold time for Bacteria is no more than 6 hours.
- Hold time for TP is 28 days with acid addition.



FIELD PREPARATION

- ✓ Notify Field Sampling Coordinator of plans for sampling.
- ✓ Obtain Lab Containers and Equipment Package from Pick-Up Point.
- ✓ Fill Out Paperwork.
- ✓ Review Site Maps.
- ✓ Prep Ice and Cooler.
- ✓ Check Weather.



BASIC SAMPLING PROCEDURES

1. Locate Outfall.
2. Identify **safe and stable** workspace.
3. Mark-up Laboratory Containers with Sample Location ID.
4. Conduct Visual and Olfactory Investigation (if applicable).
5. **Don Nitrile Gloves.**
6. Triple Rinse Dipper in distilled water and then in water to be sampled.
7. Collect sample with dipper or directly in lab sample containers. **Do Not Disturb Sediments.**
8. Place collected sample in Lab Containers.
9. **Place Samples on Ice.**
10. Collect additional sample and place in Testing Container.
11. Conduct Test Strip and Test Kit Samples.





BASIC SAMPLING PROCEDURES

Important!

1. Safety First.
2. Always collect stormwater sample directly from outfall before it enters into receiving water body.
3. A new pair of gloves must be worn at each site.
4. Avoid all possible cross-contamination.
5. Read and Understand ALL instructions on test kit and sampling manual before entering the field.



BEST PRACTICES FOR MONITORING WET-WEATHER

- Put a person at a discharge site to sample as needed; expensive and inefficient, but effective.
- Put out automated samplers that collect water on a programmed time scale; also expensive, malfunctions common, time scale may not match problem input times, but generally a useful approach if done often enough.
- Have someone check the discharge point during dry weather (sample if flowing), install passive first flush sampler, retrieve after storm and sample again if still flowing. This approach is efficient and cost effective.



PASSIVE SAMPLING PROCEDURES

Passive Sampler Set-Up Procedure .



Passive Sampler Set-Up Procedure.

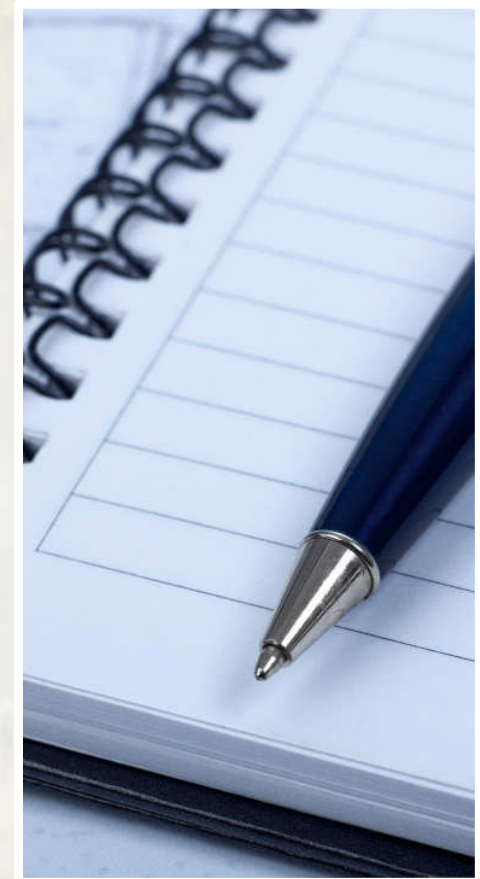


Sampling outfall using Passive Sampler .



RECORD KEEPING

- Always keep records!
 - ✓ Field Notebook
 - ✓ Sampling Forms
 - ✓ IDDE Inspection Forms
- Westford Program Coordinator keeps records
- If updates to drainage system map are found, indicate in field notes and notify coordinator





DROP OFF PROCEDURES

- At drop-off point, fill out Chain of Custody form (provided with laboratory containers)
- Make sure lab containers are marked with sample collection time and your initials
- Review field notebook and data sheet to make sure all information is present
- Inform Program Coordinator of any equipment failures or replacement needs



PUBLIC OUTREACH THROUGH SAMPLING PROGRAM

- Public Notification
- Frequently Asked Questions (FAQs) for field crew to distribute as needed.
- Sampling provides opportunity for good-will.
 - ✓ Mindful of public perceptions
 - ✓ Do Not Obstruct
 - ✓ Do Not Destruct



GENERAL SAFETY PRECAUTIONS

Standard Operating Safety

Hazard	Standard Operating Procedure
Heat Stress	Wear breathable protective clothing. Take frequent breaks in hot weather and ensure that you have adequate amount of drinking water on hand.
Slips/trips/falls	Personnel will wear boots or waders that provide suitable mobility and traction.
Drowning	Personnel will not enter fast-flowing water that is greater than knee-deep.
Caught-in Mud	Personnel will not enter into areas of thick or deep mud along shorelines where it is possible to be stuck. Test all areas with pole/stick prior to entering.
Confined Space Entry	Permitted for trained employees only. No volunteer or untrained staff will enter a confined space. Confined space is a term from labor-safety regulations that refers to an area which is enclosed with limited access which make it dangerous. An example is the interior of a storage tank, manhole, culvert, which workers may enter for maintenance but which is not ordinarily a habitable space.
Insects – General Hazards	Personnel will wear long-sleeved shirts and pants during fieldwork. Insect repellent will be applied prior to field work and reapplied as needed throughout duration of work.
Mosquitos	DEET – recommended mosquito repellent. 50% concentration recommended reapplication as needed.



GENERAL SAFETY PRECAUTIONS

Standard Operating Safety Procedures

Hazard	Standard Operating Procedure
Wasps & Bees	Remain calm; try not to disturb nest areas. If stung, remove stinger with tweezers or other blunt object (such as credit card) against sting site.
Ticks	Wear light-colored protective clothing such as long sleeve pants, shirts & head coverings. Tuck pants into socks and tape at seam to keep ticks away from skin. Wear permethrin-based gators or spray onto clothes and shoes to repel ticks (do not apply directly to skin). Do a thorough tick-check following field-based work.
Noxious Plants (poison ivy, poison oak, poison sumac)	Personnel will wear long-sleeved shirts and pants during fieldwork. Use commercially available pre-contact skin protectant towelettes or barrier cream. Exposed skin will be washed as soon as possible with dish soap & water or commercially available post exposure scrub wash products to remove the oil. Use gloves to remove exposed clothes & shoes. Seek medical attention if conditions worsen.
Water Quality	Water sampled may be contaminated with a variety of pollutants. Use nitrile gloves during sampling. Be careful to avoid splashing water or ingestion. Use hand disinfectant after sampling.



WORKING ON, OVER, OR NEAR WATER

In the event of any work over or near water, it is important to exercise due care around water hazards.

If employees and/or volunteers will be working over or near water where a risk of drowning could occur (per OSHA > 2 feet deep), then employees and volunteers must take the following precautions:

- Employees/Volunteers must be provided with and use United States Coast Guard (USCG) approved personal flotation devices (PFDs, i.e., life jackets).
- Before and after each use, inspect the PFDs for defects.
- Provide ring buoys with at least 90 feet of line if working from a boat or skiff.





WEATHER-RELATED HAZARDS

Given the multi-season work schedule and unpredictable New England weather, adverse weather should be anticipated.

Always check the weather forecast for the site locale before heading out.

- **Lightning:** Do not work during electrical storms. Stay off high areas (e.g., top of the landfill) and hazardous areas (e.g., on water) that attract lightning.
- **Snow:** Snow squalls, whiteouts, blizzards, and nor'easters: Do not schedule work when weather reports indicate potential snowstorm watches or warnings. Send personnel home early in advance of an approaching storm.



WEATHER-RELATED HAZARDS

- **Hurricane / Tornado:** Take appropriate shelter. Do not schedule work when weather reports indicate potential hurricane or tornado watches or warnings. Send personnel home early in advance of an approaching storm.
- **Hail:** Take appropriate shelter. Do not schedule work when weather reports indicate potential hail watches or warnings.
- **Flash Flooding:** Take appropriate shelter. Do not schedule work when weather reports indicate potential flash flooding watches or warnings. Have workers vacate low-lying areas and seek higher ground. Do not attempt to navigate across flooded areas or waterways.



SAMPLING SAFELY

Ammonia, Chlorine, and Surfactant test kits

- Keep test kits and test strips in a cool dry place.
- Avoid contact with water/ moisture until individual test strip is to be used for sampling.
- Carefully read and abide by all instructions and safety warnings on the test kit before use.

Sampling Pole and Power Lines

- The sampling pole must be kept a minimum of 10 ft. from power lines at all times.
- Prior to deploying the sampling pole, visually scan your surroundings to identify the location of all power lines.
- If the sampling pole cannot be safely deployed, do not collect a sample.



SAMPLING SAFELY

Manholes & Catch Basins

- When removing manhole and catch basin covers, use extreme caution.
- These covers are very heavy require a pick or lifting device and can crush fingers and toes.
- If sampling sites indicate the need to sample in manholes or catchbasins steel-toed boots should be worn.
- During sampling, always have a partner to supervise the sampling process as well as watch for and direct traffic if needed.



DATA EVALUATION AND INTERPRETATION

- This is preliminary screening only!
- Each of the parameters should be looked at together.
- Individual high levels of pollutant concentration may not be sufficient indicator to warrant additional investigation.



DATA EVALUATION

Appendix H: Two Alternative Flow Charts

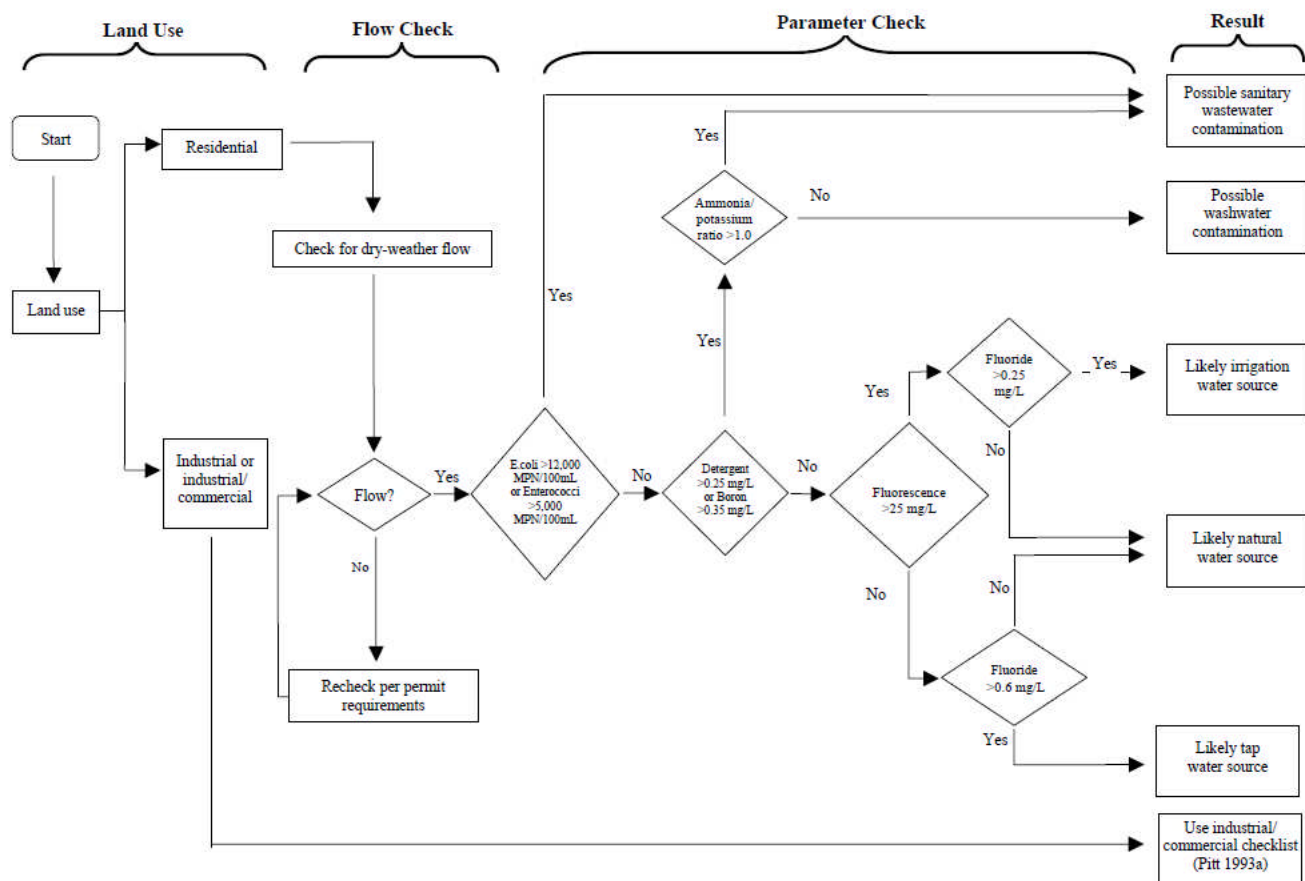


Figure H.1 Complete Flow Chart (Including Additional Confirmatory Parameters) from Tuscaloosa, Alabama

Source: Pitt (2004)





DATA INTERPRETATION

Test	EPA Benchmark	Further Investigation Likely Warranted	Remarks
E. coli	> 235 E. coli/100 mL	>4000 E. Coli/100 mL	Bacteria is Ubiquitous! Can vary from sample to sample, field duplicates or left hand and right hand.
Ammonia	> 0.5 mg/L	>0.5 mg/L	Decomposing vegetation in drains can trigger ammonia readings above 0.5 mg/L.
Surfactants	>0.25 mg/L	>0.25 mg/L	Low level of surfactants may be common in urban areas due to car, house washing. etc .



DATA INTERPRETATION

Test	EPA Benchmark	Further Investigation Warranted	Remarks
Total Chlorine	> Reporting Limit	>0.10 mg/L	Treated drinking water flushing, bleeds or leaks can contribute to elevated levels of chlorine in sample.
Specific Conductance	N/A	>600 μ S/cm	Conductance can be elevated due to drainage pipe type, road salt leaching.
Total Phosphorus	N/A	>0.3 mg/l	Treated drinking water, general urban runoff and other stormwater only sources may contribute to elevated levels of TP.



LABORATORY ANALYTICAL METHODS

Parameter	Standard Method	Minimum Detection Limit	Resolution
pH	EPA 150.1	0 Std Units	0.01 Std Units
Conductivity	EPA 120.1	1.5 μ S/cm	0.3 μ S/cm
Turbidity	EPA 180.1	0.1 NTU	0.01 NTU
Total Phosphorus	EPA 365.1	0.010 mg/L	0.002 mg/L
Dissolved phosphorus	EPA 365.1	0.010 mg/L	0.002 mg/L
Bacteria	EPA 1103.1; 1603	4 colonies/100mL	100 colonies/100 mL



Questions?

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