2001 Massachusetts Envirothon Current Issue

Stormwater Management

Questions and Resources for Team Preparation

Stormwater is the most serious and widespread water pollution problem in Massachusetts today. It is a factor in surface water pollution in every Massachusetts community, although it is more significant in developed areas. Every school roof, parking lot, and playing field can be a case study in stormwater issues. The 2001 Current Issue problem will ask each Envirothon team to investigate stormwater issues in their community, then to choose the highest priority problem, defend its significance, and propose a plan to reduce or eliminate it.

These pages are intended to provide a framework and resources to guide teams as they prepare for this year's Envirothon problem. If you have questions about the problem, start by contacting Will Snyder at UMass Extension (413/545-3876 or wsnyder@umext.umass.edu).

The following persons provided major help in shaping the question, suggesting resources, and providing feedback on drafts of this guide: Faith Burbank (UMass Extension/Mass Bays), Eben Cheseborough (DEP), Ginny Scarlet (DEP), Thelma Murphy (USEPA), Molly Schauffler (University of Maine), Debi Hogan (Mass Envirothon), and Clif Read (MDC).

What is Stormwater?

Stormwater is the transportation system for pollutants to get into our lakes, rivers, streams, and estuaries. When precipitation falls on the land, some evaporates or is taken up by plants, some infiltrates the ground, and some runs off. Water runoff from rain and melting snow is a natural part of the hydrologic cycle. Runoff becomes a stormwater problem when it picks up pollutants that have been deposited on the land and carries them into nearby rivers, streams, and lakes,

and when it causes flooding and erosion.

Stormwater runoff, including discharges from stormwater drain pipes, is the the most significant source of pollution in Massachusetts' rivers, streams, lakes, ponds, and marine waters. In its simplest form, managing stormwater is a twofold task: keeping contaminants out of the water, and reducing flooding. Effective stormwater management can offer the added benefit of recharging depleted groundwater.

Stormwater is in many ways a classic example of nonpoint source (NPS) pollution, defined by the Environmental Protection Agency as "pollution of surface water and groundwater supplies originating from land use activities and/or the atmosphere, having no well-defined point of entry" into bodies of water. However, when stormwater is channeled into a pipe, ditch, or other structure, as often happens in developed areas, it becomes a point source of pollution. Under new Federal regulations, much Massachusetts stormwater will be treated as a point source of pollution by the time it reaches surface bodies of water.

The phenomenon itself is not new, but the term "stormwater" represents a relatively new and useful way of thinking about a large portion of nonpoint source pollution issues. The term makes sense in terms of everyday experience: we have all seen stormwater floods and the pollutants they carry.

The threat posed by stormwater depends on a variety of interacting factors:

> *Expectations for the water quality in the receiving water bodies*: Our expectations for water in Quabbin are different, for example, than for water in Boston Harbor.
>
> *The nature of the land surface*: Imperviousness of the land surface - due to rooftops, pavement, or compacted soils - increases runoff. Steeper slopes and sparser vegetation also increase runoff, as do natural and human-made features that channel water.
>
> *The kinds of pollutant*: Toxicity, persistence, transport, fate, capacity to bond with sediment, and compounding effects when combined with other pollutants, all affect the threat's severity.
>
> *Frequency and intensity of precipitation events*: While more water in the system can dilute a pollutant, heavy precipitation increases runoff, and especially when it arrives after a long dry period during which pollutants have accumulated, more is carried to the receiving water body.

History

When the Federal Water Pollution Control Act (1972) and Clean Water Act (1977) were enacted, the most obvious and pressing need was to address point sources of pollution such as industrial discharges and sewage outfalls. These were addressed through permitting and monitoring programs administered by the EPA, and in the case of municipal sewage, major public investment in new waste treatment facilities. Today, rivers in Massachusetts, and the nation as a whole, run much cleaner than they did a generation ago. This is a major success story of collective action, through government, to address a problem.
As point sources of pollution were identified and controlled, the relative importance of nonpoint source pollution increased. Today, these sources are estimated to be responsible for more than 75% of all water pollution nationwide.

Nonpoint source pollution was recognized in the 1987 reauthorization of the Clean Water Act. Section 319 of the CWA (see extensive information at http://www.epa.gov/owow/nps/sec319cwa.html) requires states to assess their NPS pollution problems - how much, where it is, and where it is coming from - and to develop a management plan stating what the state will do, when, and at what cost. The 1987 amendments mandated that EPA develop a phased-in implementation strategy for stormwater. Phase 1, implemented in the early 1990's, targeted medium and large municipal separate storm sewer systems and eleven categories of industrial activity, including large construction projects. EPA is currently moving into Phase II of the stormwater program, which targets smaller scale activities, particularly in urban areas (see http://www.epa.gov/owm/sw/phase2/).

The Massachusetts Department of Environmental Protection (DEP) is the state agency with lead responsibility for compliance with the Clean Water Act. In 1996, the Commonwealth of Massachusetts instituted a Stormwater Management Policy which set performance standards for stormwater management.

Stormwater Management

Stormwater presents both water quality and water quantity issues. While most stormwater management focuses on its impact on humans, it is also important to remember that changes in water quality and quantity can have a major impact on ecological communities.

Quality. The contaminants carried by stormwater are as varied and numerous as the land uses in the contributing watershed. They are often grouped into the following categories:

Nutrients - Too much of naturally-occurring nutrients necessary for life, such as nitrogen and phosphorous, can promote algae blooms and aquatic weed growth that deplete oxygen, alter habitat and reduce aesthetic and recreational value, and increase treatment costs for drinking water.

Sediments (solids) - These contaminants are associated in urban and developing areas with construction operations and highway maintenance. In more rural locations it can derive from erosion associated with agriculture, logging, and gravel mining operations. Sediments suspended in water and deposited on stream and river bottoms can have a wide variety of effects: decreasing transmission of light affects aquatic plants, and in turn food and cover for fish, and in turn recreational and aesthetic values. Sediments that settle out can reduce flood storage capacity and increase stormwater discharges.

Pathogens - Microbial pollutants are most commonly associated with livestock, waterfowl, and pet waste. Introduction of disease-causing organisms to surface or ground water can force shellfish bed closures and swimming restrictions, and affect drinking water.

Various Toxics - These include metals, oil, and grease from industrial processes and normal use of automobiles, organic compounds, such as pesticides and herbicides from landscaping and agriculture operations, and salt from road deicing and uncovered salt storage. Many toxics can accumulate in sediments and bioaccumulate in fish tissue. All can adversely affect wetland plants and animals and cause human public health risks.

Seldom does one kind of pollution occur in isolation. Usually several kinds are associated with a particular land use, and the combinations create new problems. For example, toxic substances may adhere to sediment particles and thus persist longer in the environment. A change in acidity can lead to increased leaching of metals.

Quantity. Development generally increases the impervious surface on a site, and thus the amount of stormwater runoff, and can cause erosion and flooding. The figure below from the DEP's Stormwater Technical Handbook illustrates the relationship of runoff, infiltration, and evaporation with various degrees of impervious surface. A shopping center would be likely to have 95-100% impervious cover; medium density residential areas would have 35-45% impervious cover.

The impact of development on hydrology may include

- increased peak discharges of runoff
- increased volume of runoff produced by each storm
- decreased time in which runoff reaches the stream, particularly if extensive drainage changes are made
- increased frequency and severity of downstream flooding
- reduced streamflow and lower water tables during long dry spells
- loss of wetlands and aquatic habitat due to lower water tables
- greater runoff velocity and volume
- increased stream channel erosion due to higher stream flow velocity
- increased water temperatures, affecting aquatic life, due to warming of water as it flows over warm pavement.

Stormwater Management

Best Management Practices, or BMPs, are methods for controlling nonpoint source pollution. A variety of methods are available, including structural controls that rely on actual physical structures, and nonstructural controls that rely on actions. Addressing a particular NPS problem effectively invariably requires a mixture of structural and nonstructural approaches. There are many listings and descriptions of BMPs on line. Start with http://www.epa.gov/owm/sw/bmps/ but also see DEP's Stormwater Technical Handbook (volume 2 of its publication on Stormwater Management), viewable on line at http://www.state.ma.us/dep/brp/ww/wwpubs.htm#storm. Briefly, BMPs include the following:

Site Planning. Stormwater management is most effective when integrated into the site development process from the outset. BMPs added later are often more costly and likely to fail. Some planning techniques that minimize runoff include maintaining pre-development vegetation and hydrologic conditions, fitting the development to the terrain, and reducing the horizontal footprint of buildings and parking areas.

Source Controls and Pollution Prevention. The best way to control pollution is to minimize contact of stormwater with potential pollutants in the first place. Nonstructural controls implemented effectively can reduce the size and expense of required BMPs and their maintenance. Effective source controls include frequent street sweeping, especially immediately following winter snowmelt, catch basin cleaning, particularly during the winter months, and proper use and storage of salt and and salt alternatives for de-icing roads. Pollution prevention plans, which identify potential sources of pollution and describe practices to prevent and minimize pollutant contact with stormwater, can reduce BMP maintenance and prolong the life of BMP structures.

Local bylaws are one of the best mechanisms to institute nonstructural controls. Zoning and land management by laws are commonly used to institute nonpoint pollution controls. Stormwater bylaws establish requirements for site planning and pollution prevention, and earth removal or erosion and sediment control bylaws focus specifically on construction activity. Pet waste control bylaws have been put in place by Boards of Health.

Public education on how to minimize impact of pollution-causing activity can also significantly reduce NPS pollution. Some activities to be addressed include lawn and garden activities (such as disposal of lawn and garden care products, leaves, and trimmings, proper fertilizer and pesticide application, low water landscaping, and composting), turf management on golf courses and parks, proper storage, use, and disposal of household hazardous chemicals, water conservation, and litter control.

Who Is Responsible for Control and Prevention of Nonpoint Source Pollution?

Since NPS pollution arises from diverse human activities on the land, addressing NPS pollution requires implementing land use controls that protect water quality. Most of the time it is impossible to point a single finger of blame; we are all to some extent responsible. There are many things that individuals can do, and also many solutions that require collective action.

Since land use decision-making is the province of local government, there is much that can be done at the town level to address this issue:

Departments of Public Works (DPWs) - These are the people who deal with the practical issues of getting quantities of snow and stormwater off the road. Typically they are less concerned with issues of contaminants. However, they will be on the front lines of implementing new stormwater BMPs.

Boards of Health - In their role of ensuring the protection of the community's health and safety, the local Board of Health (BoH) has broad powers to address NPS pollution. The BoH has authority to deny a plan for a subdivision because of inadequate drainage, for example.

Conservation Commissions - In their role of protecting natural resources, particularly wetlands, town Conservation Commissions are now required to include stormwater management standards in their orders of conditions for developments affecting wetlands.

Planning Boards - In their role of studying and planning for the development of the community and its natural resources, and proposing zoning ordinance, Planning Boards will play an important role in reviewing site plans for new development anywhere in town under new stormwater performance standards.

In theory, through a mix of zoning and by-laws, municipalities can place restrictions on land use and treat stormwater and other pollution proactively and comprehensively, if only locally. Most of the impetus for addressing pollution problems in recent decades, however, has come from the federal government. Congress amended the Clean Water Act in 1987 because it recognized the need for greater federal leadership to help focus state and local NPS control efforts. The impetus has come in the form of requirements placed on the state to protect water quality in bodies of water, and in the form of grants of money to states to implement these protections. The Environmental Protection Agency is the major federal player. The federal enforcement role takes the form of responding to impaired waters: once a pollution problem has been identified, EPA can require cleanup, including a whole range of best management practices. Federal funding is the main driver of what gets done to address pollution.

The federal requirement for states to develop plans for managing nonpoint source pollution was a major impetus for Massachusetts' major statewide initiative to address environmental issues, the Watershed Initiative. This initiative - a comprehensive approach to addressing environmental concerns on a watershed basis - is in many ways a proactive strategy to get at the diffuse problem of nonpoint source pollution, using community knowledge, resources, and energy as well as those of state government agencies.

Preparing for Your Stormwater Management Presentation

1. Survey your town for potential stormwater problems: what particular land uses in your town might be contributing pollution to your watershed or causing flooding problems? Might stormwater conveyance systems might be robbing your groundwater of valuable recharge water?

a. Start with your own backyard. Investigate school and schoolyard activities and conditions that might prevent, reduce, or contribute to nonpoint source pollution via stormwater. For example, look for and ask about:

- landscaping and turf practices - ask about materials used to maintain playing fields
- construction
- parking lot(s) - inventory the substances on this surface that could be carried away
- dumpsters - are they open to rain? do they have holes for drainage? what will the water be carrying with it when it drains?
- storm drains - where do they drain to?
- where are these activities in relation to the town water supply? other important water resources such as wetlands, streams, rivers, estuaries?

Measure what fraction of the land surface is impervious to water infiltration. Note that there are degrees of perviousness. What slopes are present, and what sorts of vegetation are holding them? What soils are present? What happens to the stormwater when you have a heavy rain? Are there signs of erosion? Can you measure the volume of rain draining from your school roof?

Do you see evidence of the impact of school practices in the waterways that drain your school grounds? What management practices are already in place to manage contamination and flooding and/or increase infiltration? What nonstructural BMPs could you invent and institute right now to reduce the threat from stormwater?

b. Study your map. Become familiar with where your town fits into Massachusetts' major watersheds. What towns and land uses are upstream? downstream?

Look for land uses in your town that tend to be associated with nonpoint source pollution, that is, "messy" land uses that could produce materials that can be easily picked up and moved by water. What pollutants might

you expect to find?

Look for land uses associated with impervious surfaces. What water bodies do their stormwaters contribute to? Where might you expect to find flooding during a large rain event?

c. Get out and visit these some of these lands and waters in town. Visit at least once during a major rain or snowmelt event. Take pictures! Do you see any

- land use activities that are major potential sources of contamination?
- direct discharges of stormwater into a water body?
- signs of pollution in the water body?

Are there simple BMPs you could invent right now to address any of these problems? List your questions.

2. Make some predictions. Based on what you have seen and what you know about NPS pollution, what pollution problems would you expect to find in surface waters in your town, and in which water bodies would you expect to find them?

3. Check your predictions.

a. See the EPA web site for information about impaired waters in your watershed (http://www.epa.gov/owowwtr1/tmdl/states/matmdltables.html). What waters are not meeting standards for use established by the state under the Federal Clean Water Act (303d waters)? How do these match with your predictions? What causes and sources are listed? Which of these are related to stormwater?

b. Contact your Watershed Team and get a local perspective on the information you found on the web. What water bodies draining your town are impaired? What areas are listed as sensitive, needing extra protection? How do we know there is a problem? What scientific data have been collected and analyzed? What sources are associated with the problem? What are the highest priorities for action?

c. Contact town officials (particularly your DPW, Conservation Commission, Planning Board, and Board of Health). Talking first with your town administrator might help you learn quickly which officials are currently most involved with stormwater issues. Get the perspectives of at least two of these boards. What is the problem? How is it being addressed? What policies and regulations guide local boards in addressing stormwater pollution threats? What best management practices have been implemented? What practices are planned? What is the timetable? What

is the cost to the town, and how is it being paid? What more can/should be done? What (if anything) stands in the way?

5. Based on your investigations, determine the highest priority stormwater management issue for your town. Be ready to justify your choice. How does it square with official statewide priorities for protection of surface waters? What difference will a solution make to the quality of life - for people and ecosystems - in your town?

NOTE: In your Envirothon presentation, it will be very important to
1) define clearly the geographic scope of the problem you choose (that is, which specific water bodies and lands are involved?),
2) place the problem you choose in context of larger nonpoint source pollution picture in your watershed (For example, will your proposed actions improve water quality to the point that the water body can be removed from the 303d list?), and
3) justify its importance in terms of established priorities and your own judgment.

6. Develop a set of recommendations to address this stormwater management problem. Your recommendations should answer the following questions:

- What do we already know about the problem, and how do we know it?
- What additional information is needed (for example, scientific data) and how can it be collected?
- What combination of measures do you propose?
  - best management practices
  - public education strategies to change behavior
  - new bylaw(s)
  - ongoing monitoring tasks
- Who will be responsible for implementing these recommendations?
- What do you estimate the cost will be? What are the potential sources of assistance? What are the priorities among those that will cost money?
- What realistic schedule do you propose for getting this done?

How will Envirothon teams be judged?

As in past years, teams will have 15 minutes to present their recommendations to a panel of judges at the Envirothon. This will be followed by a 10 minute period for formal questions from the panel.

Judging criteria will include:

- Evidence of first-hand community investigation, including both field exploration and interviews with officials and stakeholders. Judges will want to know: Did you really get out into the field and take a look at the problems first hand? Did you talk to a number of local officials and watershed advocates? Did you encounter differing perspectives on the issues?
- Geographic knowledge, especially the "lay of the land" and significant water resources - which lands lie in which sub-subwatersheds, and what land uses are where.
- Specific knowledge of 303d impaired waters draining lands in your community, and what is needed to bring them up to standards.
- A convincing case for the importance of the stormwater problem you have chosen to address.
- Appropriate recommendations, convincingly presented.
- Quality of presentation, including organization, public speaking skills, teamwork, effective use of maps and other visuals, time management, and response to questions.
- Overall quality, including curiosity, critical thinking, effort, depth, honesty, and creativity.

Resources

Excellent, up to date information is available on the world wide web, particularly if you are able to download documents in PDF format.

The U.S. Environmental Protection Agency's Office of Water Management maintains an extensive site with information for the general public. For stormwater issues, start with: http://www.epa.gov/owm/sw/

> Click on "resources" and look for "web links" for a huge listing of relevant, informative web sites by state governments and NGOs.
>
> For general nonpoint source pollution information, see http://www.epa.gov/owow/nps

The Massachusetts Department of Environmental Protection's web site includes several publications on stormwater management that can be read on line or downloaded at http://www.state.ma.us/dep/brp/ww/wwpubs.htm#storm

For a look at nonpoint source pollution from a less urban perspective, see the USDA

site at http://www.cleanwater.gov.