Mapping, Identifying and Protecting Vulnerable Wetlands from Stormwater Pollution

Introduction

Some types of wetlands are visible and their ability to protect a critical resource for the public is obvious, such as drinking water supplies where even a small amount of contamination can have serious environmental public impacts. Other wetlands are smaller, less visible, and are more vulnerable than larger ecosystems to degradation and loss because of their size or their location. In 2010, MassDEP was awarded a Wetland Program Development Grant from the Environmental Protection Agency (EPA) to better protect vulnerable wetlands from stormwater pollution. The grant was also used to provide technical assistance to Towns evaluating municipal stormwater utilities for Total Maximum Daily Load (TMDL) compliance. The grant includes provisions to develop a series of maps to assist the communities in identifying the locations of existing stormwater outfalls in proximity to vulnerable wetlands. To implement the grant, MassDEP has defined "vulnerable wetlands" to be:

a. Headwater Streams
b. Certified and Potential Vernal Pools
c. Vernal Pool Clusters; and
d. Critical Areas as defined by the MA Wetlands Regulations' Stormwater Standards

Vulnerable Wetlands

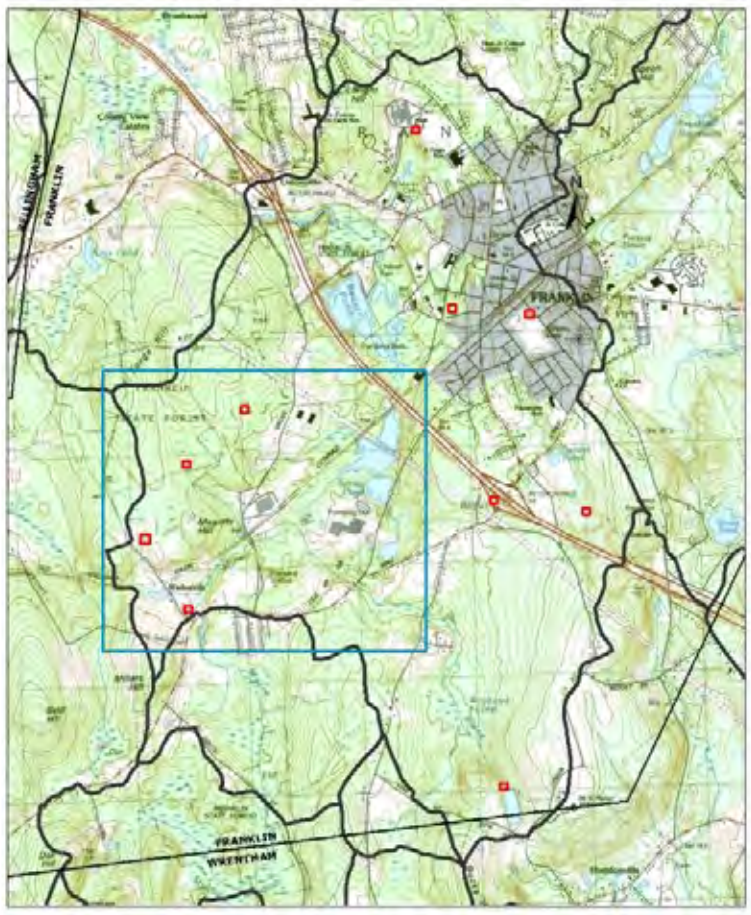
In August of 2007, the Center for Watershed Protection prepared a series of articles on Wetlands and Watersheds. Article 6 of the Wetlands and Watershed series, entitled *The Importance of Protecting Vulnerable Streams and Wetlands at the Local Level*, (Cappiella, K., Fraley-McNeal, 2007) defines vulnerable wetlands to include "the very smallest streams and wetlands that do not have a permanent surface water connection to larger water bodies yet are still vital parts of the ecosystem." While all wetland types are vulnerable to changes in hydrology and water quality resulting from increased impervious surfaces and impacts of stormwater, the 'vulnerable wetlands' defined by this project are considered to be sensitive in that they respond quickly to small changes in hydrology and adverse water quality impacts. As such, small wetland systems are particularly vulnerable to loss and degradation by pollutants from impervious surfaces and stormwater discharges.

Small wetland depressions, such as vernal pools may be considered vulnerable wetlands. They are topographically isolated from other surface water bodies, making them inaccessible to predatory aquatic organisms (e.g. fish) dependent on streams. As such, they provide critical habitat for breeding amphibians. Intermittent headwater streams are also vulnerable wetlands. They can be as small as seeps or springs which represent an interface between groundwater and surface flows that is critical to sustain stream flows and public water supplies. Degradation of vulnerable wetlands can occur very quickly. It can be caused by changes in pH, dissolved oxygen, temperature, and turbidity in receiving waters, increased flows containing excess nutrients and other pollutants, and reductions in groundwater discharges resulting in decreased base flows. Maintenance of an undisturbed, naturally vegetated buffer around wetland resources is one of the best methods to protect vulnerable wetlands from degradation and to improve or maintain water quality in the resources. Specific types of vulnerable wetlands are described as follows.

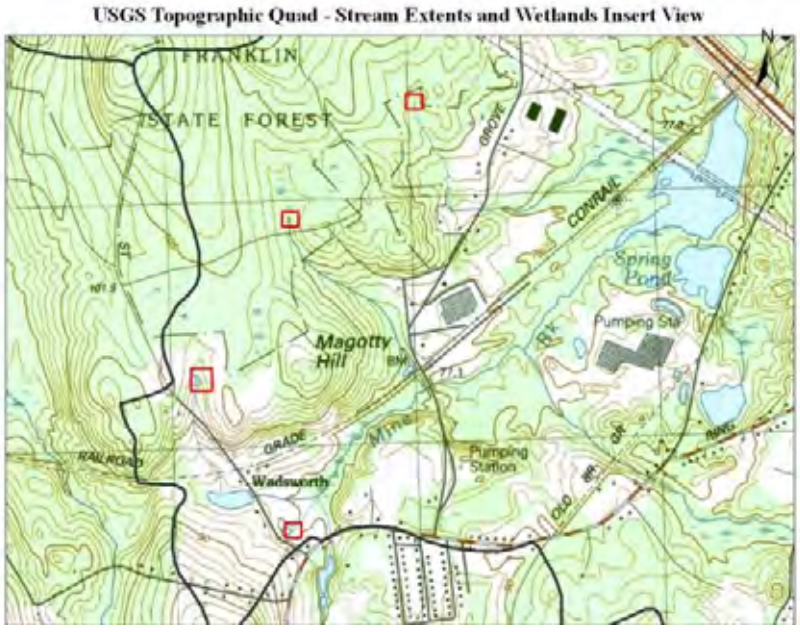
1. Headwater Streams

Headwater streams are up-gradient of the first order streams depicted on the 1:24,000 scale USGS maps. These may include ephemeral streams that flow only in response to storm events and lack base flow, or small intermittent streams that are unmapped and up-gradient of all bogs, swamps, wet meadows and marshes or otherwise fail to meet the regulatory definition of a stream (310 CMR 10.04). These streams can be defined by topography or digital elevation landscape models and do not include stormwater conveyances. The MassDEP Wetland data layer represents an expansion of the number of streams and hydrologic connections shown on the USGS Topographic Quadrangles and as such highlight headwater streams. See methodology illustrated below.

USGS Topographic Quad - Stream Extents and Wetlands

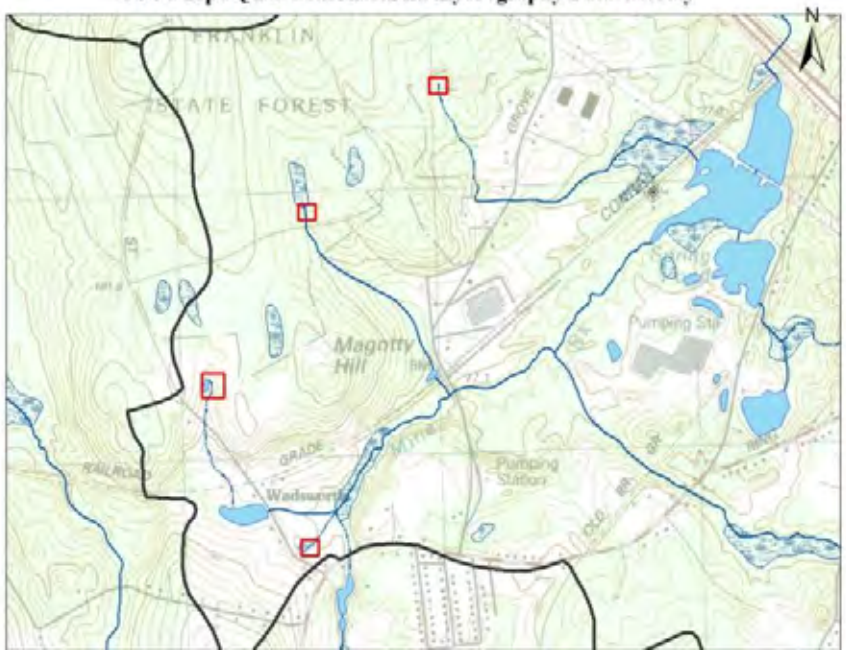


USGS Topographic Quad - Stream Extents and Wetlands Insert View



The MassDEP Wetland data layer represents an expansion of the number of streams and hydrologic connections shown on the USGS Topographic Quadrangles and as such highlight headwater streams.

USGS Topo Quad with MassDEP Hydrography Data Overlay



USGS Topo Quad with MassDEP Hydrography and MassDEP Wetlands Overlays

2. Certified and Potential Vernal Pools

The Massachusetts Natural Heritage and Endangered Species Program (NHESP) has certified over 3100 vernal pools (CVP) and identified nearly 30,000 potential vernal pools (PVP) across the state. The potential vernal pools have not been extensively field-validated but their locations are relevant to town planners contemplating preservation actions and undertaking stormwater remediation. The CVPs and PVPs referenced as sensitive wetlands for this grant are those mapped by the NHESP. Vernal pools that have been certified are afforded protection under the WPA regulations (310 CMR 10.00) if they are located within a jurisdictional wetland resource area. Vernal pools that are not yet certified (i.e. PVP's) but are documented during the application review process with evidence of a competent source are also protected if within a jurisdictional wetland resource area. Certified vernal pools are protected under the Massachusetts 401 Water Quality regulations (314 CMR 9.00) as Outstanding Resource Waters (ORWs) independent of other resource areas.

3. Vernal Pool Clusters

The importance of protecting undisturbed upland habitat adjacent to and between vernal pools is widely recognized in the literature (McGarigal, K.,Compton, B. W.,Gamble, L, 2008), (Compton, Bradley, W., Cushman, S., McGarigal, K., 2003), (Gibbons J. W., 2003), (NHESP, 2006), (.Vasconcelos, D., Calhoun, A.J.K., 2004). Projects altering wetland resource areas can disrupt existing migration routes of amphibians and reptiles between vernal pools, or between vernal pool habitat and other wetlands or upland nesting areas. The wetland regulations limit jurisdiction to vernal pools and the 100-foot habitat zone around the vernal pool that are within a wetland resource area. Studies have documented, however, that areas beyond the 100-foot habitat zone are biologically important for breeding amphibians and other vernal pool-using species. Studies demonstrate the importance of preserving habitat connectivity between pools to support viable populations of amphibians. Habitat surrounding vernal pools contribute to the maintenance of the vernal pool hydroperiod and the quality of the aquatic habitat to ensure successful breeding. Avoiding new stormwater impacts, remediating existing stormwater impacts to vernal pools, and preserving undisturbed habitat around clusters of vernal pools will foster the continued viability of these ecosystems. Knowing the location of vernal pools and vernal pool clusters in their community can help ensure that municipal land use planning efforts incorporate appropriate stormwater management designs, consistent with TMDL requirements, that can best preserve, protect, and restore these essential ecosystems. The criteria used to define vernal pool clusters on these planning maps include:

- The presence of two or more vernal pools (certified or mapped by NHESP);
- Good connectivity between pools with few obstacles to amphibian migration (i.e. roadways, buildings, etc.); and
- A requirement that the pools be within 400 m of each other to protect migratory and dispersal distances for juvenile and adult pool breeding amphibians.

4. Critical Areas

Critical areas are defined in the wetland regulations (310 CMR 10.04) and include Outstanding Resource Waters (314 CMR 4.00), Special Resource Waters (314 CMR 4.00), recharge areas for public water supplies (310 CMR 22.02 -Zone Is, Zone IIs and Interim Wellhead Protection Areas for groundwater sources and Zone As for surface water sources), bathing beaches (105 CMR 445.000), cold-water fisheries (310 CMR 10.04 and 314 CMR 9.02), and shellfish growing areas (310 CMR 10.04 and 314 CMR 9.02). Critical areas are included as vulnerable wetlands since they are areas that merit special protection or where restoration efforts would be most beneficial.

Total Maximum Daily Load (TMDL)

The *Massachusetts Year 2010 Integrated List of Waters* (and subsequent updates) describes the Total Maximum Daily Load (TMDL) Program and the designation of Massachusetts' waters relative to Sections 305(b) and 303(d) of the Clean Water Act.

> *"Section 303(d) of the Clean Water Act and the EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting designated uses under technology-based controls. The TMDL process establishes the maximum allowable loading of pollutants that a waterbody can receive and still meet the SWQS established for protecting public health and maintaining the designated beneficial uses of those waters. Through this process states implement water quality-based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources. TMDL implementation is accomplished through adherence to prevailing regulations and program requirements such as those governing the NPDES permits for point source control and the stormwater management performance standards maintained by conservation commissions under the Wetlands Protection Act."*

For additional information pertaining to Massachusetts' TMDL Program see http://www.mass.gov/dep/water/resources/tmdlfs.htm.

Massachusetts Stormwater Standards

Stormwater is a key consideration in any effort to protect and restore vulnerable wetlands. Stormwater control is also integral to the federal and state requirements for protection and restoration of water quality in the Charles River and other watersheds. Where applicable, the Massachusetts Stormwater Standards, 310 CMR 10.05(6)(k-q), require that stormwater discharges:

a. are setback from Outstanding Resource Waters,
b. near critical areas employ specific source control and pollution prevention measures for managing the quality and quantity of the water being discharged,
c. to land uses with higher potential pollutant loads comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26 through 53 and the associated regulations,
d. Are prohibited from critical areas such as a Zone I or Zone A of a public water supply.

All of these measures to manage stormwater contribute to the ecological health of vulnerable wetlands.

Vulnerable Wetland Maps

MassDEP has developed an Atlas of "vulnerable wetland maps" to assist the communities of Bellingham, Franklin and Milford to identify vulnerable wetlands in their community. The maps provide baseline information for conducting preliminary assessments to protect or restore vulnerable wetlands while achieving compliance with stormwater requirements. These maps cover areas in the Town that are within the Upper Charles River Watershed and serve to:

a. Locate approximate boundaries of:
   - MassDEP delineated wetlands and streams,
   - Vulnerable wetlands (e.g. headwater streams, vernal pools),
   - Critical areas as defined by MassDEP stormwater standards (e.g. water supplies),
   - Areas with high Index of Ecological Integrity (IEI) as identified by the Conservation Assessment and Prioritization System (CAPs) model www.masscaps.org (i.e. low stress, high resiliency),
   - 303(d) listed impaired waters,
   - Land use types with high Phosphorus export loading rate (i.e. industrial, commercial, high density residential),
   - Mapped stormwater outfalls,
   - Hydrologic soil groups A and B (greater potential to promote stormwater infiltration).
b. Identify subwatersheds that are most impacted by Phosphorus loading.
c. Identify sites that are suitable for stormwater Best Management Practices (BMPs).
d. Identify, protect, and restore wetlands & streams, vulnerable wetlands, critical areas and areas of high IEI.

The maps do NOT include floodplains and riverfront areas (310 CMR 10.57 and 10.58) which may also contain vernal pools subject to jurisdiction under the Wetland Protection regulations.

Special Note: The MassDEP wetland and waterway boundaries shown on the maps are for planning purposes only. They have been interpreted from stereo color-infrared (CIR) photography by staff at UMASS Amherst with selected field verification by MassDEP. They do not represent, and should not be used as wetlands delineations under the Massachusetts Wetlands Protection Act (WPA), M.G.L. c.131, §40 and its regulations. Wetland boundary delineation for permitting under the WPA must use ground surveys and follow the procedures and criteria defined in the WPA regulations at 310 CMR 10.00.

The wetland and other data on these maps represent the best data available at the time of printing. These maps include the NHESP Certified and NHESP Potential Vernal Pool data layers. Please note that NHESP Potential Vernal Pools are not equivalent to Certified Vernal Pools.

Map Contents

Each Atlas of Town maps includes the following: (See Images below).

1. Overview Map

The Overview shows the Charles River subwatersheds that fall entirely or partially within individual Town boundaries. Subwatersheds are confined drainage areas that typically have a single outflow and provide a convenient and discreet land use planning unit within a Town. Each subwatershed is named by the main water feature in that subwatershed. If two (or more) subwatersheds have the same water feature, one will have an additional identifying feature added to the name. For example, Mine Brook is used in two subwatershed names. One is named Mine Brook Subwatershed and the other is named Mine Brook/Beaver Pond Subwatershed.

The Overview Map also identifies waters in the Town that are categorized as impaired in the *Massachusetts Integrated List of Waters* [303(d) list]. "Impaired" means that a water body segment is not attaining one or more designated uses (e.g. public water supply; fish, other aquatic life and wildlife) as defined in the Massachusetts Surface Water Quality Standards (314 CMR 4.00). Water quality categories include:

Category 1: Attaining all designated uses.

Category 2: Attaining some of the designated uses but insufficient information to determine if the remaining uses are attained.

Category 3: Insufficient information to determine if any designated uses are attained.

Category 4a: Impaired for one or more designated uses and for which a TMDL has been completed.

Category 4b: Impaired for one or more designated uses but does not require the development of a TMDL: Other pollution control requirements are reasonably expected to result in the attainment of designated uses.

Category 4c: Impaired for one or more designated uses but does not require the development of a TMDL: Impairment is not caused by a "pollutant" (e.g. nutrients, metals, pesticides) but instead, is caused by other types of "pollution" (e.g. low flow, habitat alterations or non-native species infestations).

Category 5: Impaired for one or more designated uses and requires the development of a TMDL because impairment is caused by a pollutant

Categories 4 and 5 are included on these maps for planning purposes. They allow the Town to easily focus on subwatersheds with the greatest impairment and on subwatersheds where the Town can most effectively address TMDL requirements and Stormwater related issues. The maps depict Categories 4a, 4c, and 5 to facilitate identification of subwatersheds with impaired waters (Note: There are no waters listed as Category 4b, so this category is not displayed on the maps).
This map serves as a Map Index to the 'Subwatershed of Interest' maps described below.

2. Subwatershed of Interest Map

This map contains the subwatershed boundaries and impaired water categories as in the Overview map, but narrows the focus from the Overview Map to a subwatershed (highlighted) for which additional maps have been developed.

3. Additional Map Types for Each Subwatershed of Interest

In addition to the Subwatershed of Interest Map, the following set of maps provides further detail on each subwatershed.

Map Type 1 - 2008/2009 Orthophotos with Index of Ecological Integrity, plus:

Map 1a. Vernal pools, vernal pool clusters, headwater streams, mapped stormwater outfalls,

Map 1b. Public water supplies and other critical areas, mapped stormwater outfalls,

Map 1c. Land use types with high Phosphorus export loading rates, mapped stormwater outfalls.

Map Type 2 – 2008/2009 Orthophotos with Hydrologic Soil Groups, plus:

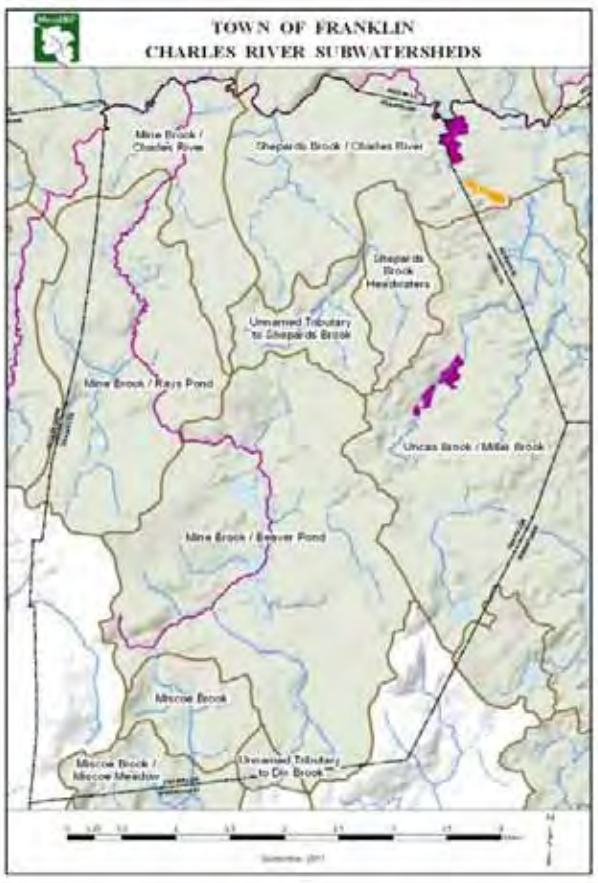
Map 2a. Vernal pools, vernal pool clusters, headwater streams, mapped stormwater outfalls,

Map 2b. Public water supplies and other critical areas, mapped stormwater outfalls,

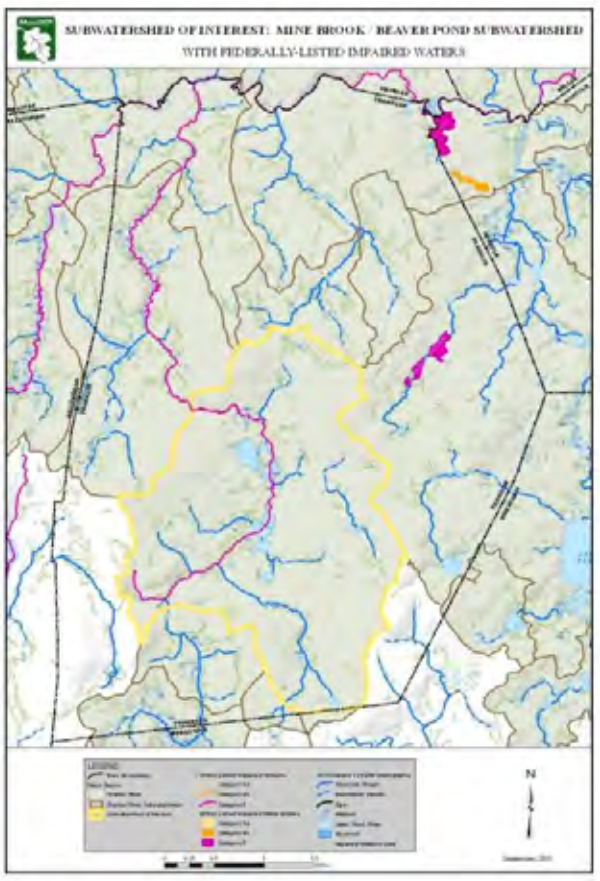
Map 2c. Land use types with high Phosphorus export loading rates, mapped stormwater outfalls.

It is important to note that the maps may include wetland types or upland habitat areas not regulated under the Wetland Protection Act, but are important to protect nonetheless. For example, vernal pool "clusters" may contain upland areas between vernal pools that are beyond the 100-foot buffer zone; and water supply protection zones may contain areas of upland. The maps also depict wetland areas that are regulated under the Massachusetts Wetland Protection Act.

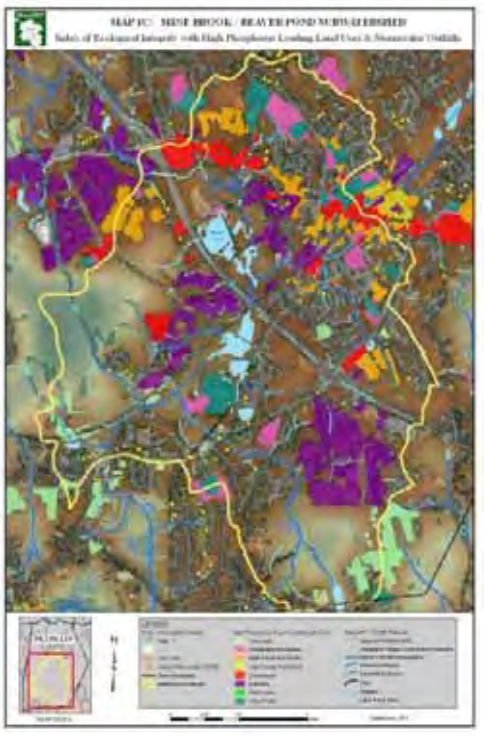
Overview Map



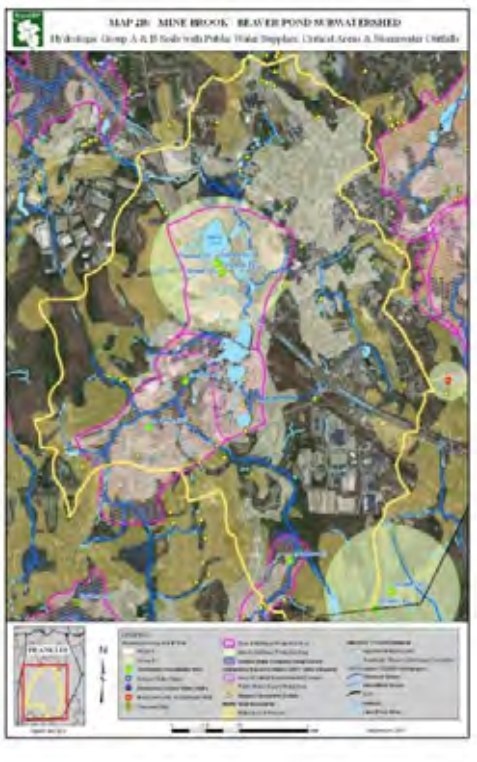
Subwatershed of Interest Map

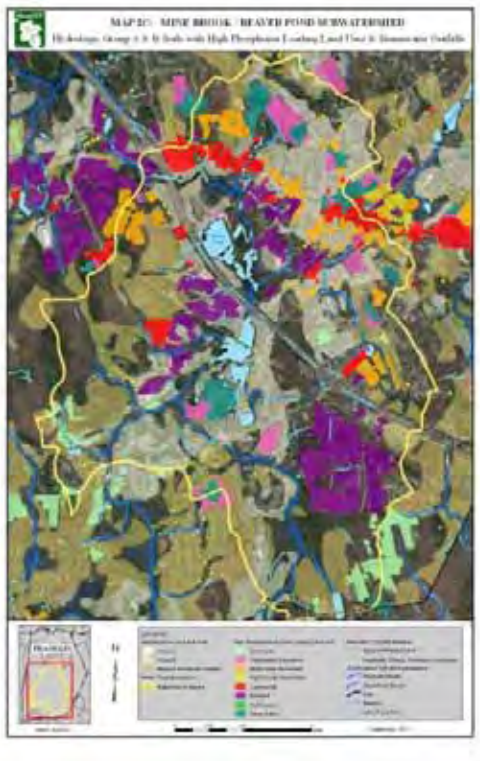


Map Type 1 - 2008/2009 Orthophotos with Index of Ecological Integrity



Map Type 2 – 2008/2009 Orthophotos with Hydrologic Group A and B Soils





How to Use the Maps

Map Type 1 – 2008/2009 Orthophotos with Index of Ecological Integrity (IEI)

These maps identify high quality wetland areas where efforts should focus on protection and preservation (i.e. Intact Wetlands). When using these maps to protect resources, look for land areas with **high IEI** value that:

- Contain or are near vulnerable wetlands such as headwater streams, vernal pools or vernal pool clusters,
- Contain or are near critical areas such as public water supplies, bathing beaches, ORWs, Zone I's, cold water fisheries, etc.
- Are ***far removed from*** stormwater outfalls and from land use types with high Phosphorus loading rates,
- Contain wetlands with intact, undisturbed vegetated buffer zones.

These maps also identify degraded wetland areas where efforts should focus on wetland restoration and mitigation of stormwater impacts. When using these maps to restore impaired waters, look at land areas with **low IEI** value for:

- Vulnerable wetlands such as headwater streams, vernal pools, vernal pool clusters or critical areas that are in close proximity to stormwater outfalls,
- Vulnerable wetlands with limited or no surrounding vegetated buffer zone,
- Vulnerable wetlands that are in close proximity to land use types that are known to have high Phosphorus loading rates in cases where TMDL requirements apply.

When using these maps, follow the "10 Rules of Thumb" (see inside covers).

Map Type 2 – 2008/2009 Orthophotos with Hydrologic Group A and B Soils

These maps identify locations to site structural and Low Impact Development (LID) stormwater BMPs to most effectively treat stormwater, restoring degraded wetland areas, and provide the greatest protection for intact wetlands. When using these maps:

- Look for areas with hydrologic group A and B type soils (as defined by U.S Natural Resources Conservation Service (NRCS)) in which to setback stormwater outfalls or locate LID BMPs – these soils generally are well drained and have higher potential to provide recharge and infiltration treatment.
- Consult the following documents for selection of stormwater treatment options:
  - MassDEP Stormwater Handbook, Vol. 2, Ch. 2
    http://www.mass.gov/dep/water/laws/v2c2.pdf
- Follow the "10 Rules of Thumb" (see inside covers).

10 Rules of Thumb to Protect Vulnerable Wetlands from Stormwater Pollution

1. *Preserve all healthy, unfragmented wetlands and restore degraded wetlands - but consider protecting vulnerable wetlands first (e.g. headwater streams, vernal pools, water supplies).*
2. *Preserve open space in areas of high ecological integrity (IEI);*
3. *Adopt local policies, incentives, and regulations to improve inadequate drainage systems. (e.g. roads, water and sewer lines);*
4. *Protect or Restore vegetated buffers around wetlands – (at least 100' if possible!);*
5. *Use low impact development techniques (i.e. reduce, infiltrate & evaporate volume) to remove pollutants, replenish stream base-flow, and minimize flooding and erosion.*
6. *Keep water local! When reconstructing drainage systems - disconnect and distribute. When building new drainage systems – recharge and infiltrate on site. Maintain existing hydrology.*
7. *No **new** discharges/treatment in wetlands, and avoid 100-foot buffer zones for best pollutant removal (remember 50' setback minimum, but the farther the better!);*
8. *Set back or treat **existing** discharges in wetlands, especially near water supplies (e.g. Zone 1, Zone A).*
9. *Avoid direct discharges near vernal pools that can pollute habitat and lengthen hydroperiods thus impacting vernal pool populations;*
10. *Treat for pollutant of concern and consider soil conditions – remember, not all discharges are created equal (A&B soils best for infiltration, alternate treatment for soils with poor drainage);*

Next Steps

Due to the success of this project, MassDEP received another Wetland Program Development grant from the U.S. EPA to develop vulnerable wetlands GIS maps for three communities in the Neponset River Watershed. They are Canton, Sharon and Walpole.

For more information and to obtain CD copies of the vulnerable wetlands atlas maps for Bellingham, Milford and/or Franklin

Contact: Nancy.Lin@state.ma.us or
Alice.Smith@state.ma.us

Citations

McGarigal, K., Compton, B. W., Gamble, L, 2008. *Marbled Salamander (Ambystoma opacum) Conservation Plan for Massachusetts.* September 1, 2008**.**

Compton, Bradley, W., Cushman, S., McGarigal, K., 2003. *A Model of Vernal Pool Connectivity for Amphibians in Western Massachusetts,* Landscape Ecology Program, Department of Natural Resources Conservation, UMASS, Amherst. Presented at the 10th Annual Meeting of The Wildlife Society, Burlington, Vermont, USA; September 6-10, 2003.

Gibbons J. W., 2003. Terrestrial Habitat: A vital Component for Herpetofauna of Isolated Wetlands. WETLANDS*,* Vol. 23, No. 3, September 2003, pp. 630–635, University of Georgia, Savannah River Ecology Laboratory Aiken, South Carolina, USA 29802, q 2003, The Society of Wetland Scientists.

NHESP, 2006, *Forestry Conservation Management Practices for Rare Mole Salamanders.* Massachusetts Natural Heritage and Endangered Species Program: Mole Salamander Forestry CMP Draft – March 2006.

Cappiella, K., Fraley-McNeal, 2007. *The Importance of Protecting Vulnerable Streams and Wetlands at the Local Level: Wetlands & Watersheds Article #6.* Center for Watershed Protection, 8390 Main Street, 2nd Floor, Ellicott City, MD 21043; August 2007. www.cwp.org; www.stormwatercenter.net;

Additional References

Brooks, R.T., 2004. *Weather Related Effects on Woodland Vernal Pool Hydrology and Hydroperiod*. *WETLANDS,* Vol. 24, No. 1, March 2004, pp. 104–114. q 2004, The Society of Wetland Scientists.

Brooks, R. T., 2005. *A Review of Basin Morphology and Pool Hydrology of Isolated Ponded Wetlands: Implications for Seasonal Forest Pools of the Northeastern United States,* USDA Forest Service, Northeastern Research Station, University of Massachusetts, 201 Holdsworth Natural Resources Center, Amherst, MA 01003, USA.

Compton, B. W., Cushman, S.A., Gamble, L.R., McGarigal, K., *A Resistant-Kernel Model of Connectivity for Amphibians that Breed in Vernal Pools.* Department of Natural Resources Conservation, 160 Holdsworth Way, University of Massachusetts, Amherst, MA 01003.

Gamble, L.R., Jenkins, C. L., McGarigal, K.R., Timm, B.C.**,** 2006**.** *Limitations of Regulated "Buffer Zones" for the Conservation of Marbled Salamanders*; Department of Natural Resources Conservation University of Massachusetts, Amherst, Massachusetts*, USA 01003-92852*, June 2006, pp. 298–306. 2006, The Society of Wetland Scientist. lgamble@forwild.umass.edu

Patrick, D. A., Calhoun, J.K., Hunter, M.L. Jr. *The importance of understanding spatial population structure when evaluating the effects of silviculture on spotted salamanders (Ambystoma maculatum),* Department of Wildlife Ecology, University of Maine, Orono, ME 04469, USA.

Calhoun A.J.K., Hunter, M.L. Jr., Patrick D.A., 2006. *Effects of Experimental Forestry Treatments on a Maine Amphibian Community.* Department of Wildlife Ecology, University of Maine, 242 Nutting Hall, Orono, ME 04469, USA, Department of Plant, Soil, and Environmental Sciences, USA USA; Received 28 March 2006; received in revised form 17 July 2006; accepted 17 July 2006.

Skidds D.E. Golet, F.C.2004. *Estimating Hydroperiod Suitability for Breeding Amphibians in Southern Rhode Island Seasonal Forest Ponds*. Wetlands Ecology and Management (2005) 13: 349–366, Department of Natural Resources Science, University of Rhode Island, Room 105, Coastal Institute in Kingston, Kingston, RI 02881, USA;

Calhoun, A.J.K., Vasconcelos, D., 2004 *Movement Patterns of Adult and Juvenile Rana sylvatica (LeConte) and Ambystoma maculatum (Shaw) in Three Restored Seasonal Pools in Maine.* Department of Plant, Soil, and Environmental Sciences, University of Maine, Orono, Maine 04469, USA. Journal of Herpetology, Vol. 38, No. 4, pp. 551–561, 2004.

Semlitsch, R. D., Bodie, J. R. 1998. *Are Small, Isolated Wetlands Expendable?* Conservation Biology 12**:**1129–1133. Division of Biological Sciences, University of Missouri, Columbia, MO 65211-7400, U.S.A. rays@biosci.mbp.missouri.edu

Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs Ian A. Bowles, Secretary, Massachusetts Department of Environmental Protection, Laurie Burt, Commissioner, Bureau of Resource Protection Glenn Haas, Acting Assistant Commissioner, Division of Watershed Management,Glenn Haas, Director, April, 2010*. Massachusetts Year 2010 Integrated List of Waters Proposed Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act.*

Data Sources for Vulnerable Wetlands Maps

Questions regarding these maps should be directed to the MassDEP Wetlands Program at (617) 292-5500. Also see below for information on specific data layers.

Data Distributed through MassGIS (http://www.mass.gov/mgis)

State List of Impaired Waters *DEP 2002 Integrated List of Waters (305(b)/303(d)) - January 2005* http://www.mass.gov/mgis/wbs2002.htm. Under Massachusetts General Law (MGL) chapter 21 MassDEP is responsible for monitoring the waters of the Commonwealth, identifying those waters that are impaired, and developing a plan to bring them back into compliance with the Massachusetts Surface Water Quality Standards. The list of impaired waters, better known as the "303d list," identifies river, lake, and coastal waters and the reasons for impairment. For questions regarding the programmatic content of this data contact the MassDEP Watershed Planning Program at (508) 767-2744.

2008/2009 OrthoPhotos *USGS Color Ortho Imagery (2008/2009) - April 2008/2009* http://www.mass.gov/mgis/colororthos2008.htm. In spring 2008, the U.S. Geological Survey, as part of its Boston 133 Cities Urban Area mapping program, contracted for true-color imagery covering metropolitan Boston and beyond. In spring 2009, USGS continued the project imagery was obtained for the remainder of the state. The datalayer is maintained by MassGIS.

MassDEP Wetlands *DEP Wetlands Layer (1:12,000) – January 2009* http://www.mass.gov/mgis/wetdep.htm. Wetlands are interpreted from 1:12,000 scale, stereo color-infrared (CIR) photography by staff at UMASS Amherst, with selected field verification by the MassDEP Wetlands Conservancy Program (WCP). This data layer is developed by the MassDEP GIS Program and the WCP. Questions about this layer may be directed to the WCP at 617-292-5907.

MassDEP Hydrography (USGS-based) *MassDEP Hydrography (1:25,000) - March 2010* http://www.mass.gov/mgis/hd.htm. This layer is an enhanced version of the older U.S. Geological survey 1:25,000 Hydrography datalayer. It is a hybrid of data from USGS Digital Line Graphs (DLGs), scanned mylar separates obtained from the USGS, digitized hydrographic features from paper USGS 1:25,000 Topographic Quadrangle maps and data extracted from the MassDEP Wetlands datalayer. It is maintained by the MassDEP GIS Program.

Subwatersheds *Drainage Sub-basins - December 2007* http://www.mass.gov/mgis/subbas.htm. MassGIS produced a statewide datalayer of the approximately 2500 sub-basins as defined and used by the USGS Water Resources Division and the Mass Water Resources Commission, and as modified by Executive Office of Environmental Affairs (EOEA) agencies. These sub-basins were aggregated together to make the 28 basins of the Major Basins Datalayer. This datalayer is maintained by MassGIS and the MassDEP GIS Program. For information regarding this data layer, contact the MassDEP GIS Program at (617) 292-5500.

NHESP Certified Vernal Pools *NHESP Certified Vernal Pools - February 2011* http://www.mass.gov/mgis/cvp.htm. This datalayer contains points for all vernal pools that have been certified by the Natural Heritage & Endangered Species Program (NHESP) according to the Guidelines for Certification of Vernal Pool Habitat (MA Division of Fisheries & Wildlife, 2009). Questions about the creation of this datalayer should be directed to NHESP at 508-389-6375. For questions relating to the certification of Vernal Pools, please call 508-389-6365.

NHESP Potential Vernal Pools *NHESP Potential Vernal Pools - December 2000* http://www.mass.gov/mgis/pvp.htm. This datalayer identifies the locations of potential, unverified, vernal pool habitats. Questions on this datalayer should be directed to NHESP at 508-389-6375.

Public Water Supplies *- July 2011* http://www.mass.gov/mgis/pws.htm. The Public Water Supply (PWS) datalayer contains the locations of public community surface and groundwater supply sources and public non-community supply sources as defined in 310 CMR 22.00. The MassDEP GIS Program, in cooperation with MassDEP Drinking Water Program (DWP) maintains this datalayer.

Zone II and Interim Wellhead Protection Areas *DEP Wellhead Protection Areas (Zone II, IWPA) - July 2011* http://www.mass.gov/mgis/ziis.htm. A Zone II is a wellhead protection area that has been determined by hydro-geologic modeling and approved by MassDEP's Drinking Water Program (DWP). In cases where hydro-geologic modeling studies have not been performed and there is no approved Zone II, an Interim Wellhead Protection Area (IWPA) is established based on well pumping rates or default values. These data layers are maintained by the MassDEP GIS Program in cooperation with the MassDEP DWP Technical Services group.

Surface Water Supply Protection Areas *Zone A,B,C – July 2011 http://www.mass.gov/mgis/swp.htm.* Surface Water Supply Protection Areas delineate those areas included in 310 CMR 22.00, the Massachusetts Drinking Water Regulations, as Surface Water Supply Protection Zones. The MassDEP GIS Program maintains this datalayer.

Outstanding Resource Waters (ORWs) *Outstanding Resource Waters - March 2010* http://www.mass.gov/mgis/orw.htm. This datalayer delineates those watershed areas in which most waters are afforded Outstanding Resource Waters classification under the Massachusetts Surface Water Quality Standards of 2007. The MassDEP GIS Program maintains this datalayer.

Land Use 2005 *Land Use (2005) - June 2009* http://www.mass.gov/mgis/lus2005.htm. The Land Use (2005) datalayer is a Massachusetts statewide, seamless digital dataset of land cover/land use, created using semi-automated methods, and based on 0.5 meter resolution digital ortho imagery captured in April 2005. MassGIS maintains this layer. For more information contact Philip John at philip.john@state.ma.us.

Soils *NRCS SSURGO-Certified Soils - November 2010* http://www.mass.gov/mgis/soi.htm. The Soils datalayer was automated from published soils surveys provided by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). All soils data released by MassGIS have been "SSURGO-certified," which means they have been reviewed and approved by the NRCS and meet all standards and requirements for inclusion in the national release of county-level digital soils data. These datalayers are maintained by NRCS.

USGS Topographic Maps *USGS Topographic Quadrangle Images - December 1995, June 2001* http://www.mass.gov/mgis/im_quad.htm.

Data Not Distributed through MassGIS

Massachusetts Index of Ecological Integrity Conservation Assessment and Prioritization System (CAPS) Maps, March 2011. Developed by UMASS Amherst, Mass Landscape Ecology Lab, www.masscaps.org with participation by MassDEP. CAPS has been adopted by MassDEP for use in wetland monitoring and assessment. For questions on the CAPS results please contact Scott Jackson (sjackson@umext.umass.edu).

Mapped Stormwater Outfalls The towns of Franklin, Bellingham, and Milford mapped drainage data and provided it to MassDEP for this project. Questions on the creation of the data should be directed to the towns.

Vernal Pool Clusters were developed by MassDEP Wetlands and Waterways staff for this project, using the criteria listed in the text.