■ MONROE COUNTY ENVIRONMENTAL HEALTH LABORATORY AND THE U.S. GEOLOGICAL SURVEY ■

MONROE COUNTY
John D. Doyle, County Executive

Working together to *Improve Water Quality* in Monroe County

USGS science for a changing world

Issue 5 Summer 1999

The following articles highlight three monitoring programs conducted by the Monroe County Environmental Health Laboratory and the U.S. Geological Survey (USGS) to provide data needed to measure improvements in surface-water quality in Monroe County

PHOSPHORUS DECREASES IN NORTHRUP CREEK AND LONG POND

Long Pond is one of many small, shallow embayments along the southern edge of Lake Ontario that have become eutrophic (overly enriched with nutrients) as a result of elevated nitrogen and phosphorus concentrations. These nutrients are transported to Long Pond by Northrup Creek, which drains 23.5 square miles in the Towns of Ogden, Parma, and Greece **(fig. 1).** The Northrup Creek drainage basin contains agricultural land, several housing developments, and the village of Spencerport.

In 1989, the USGS, in cooperation with Monroe County and the Town of Greece, began a water-quality-monitoring program at a site on Northrup Creek near North Greece, about 5 miles north (downstream) from the Village of Spencerport and the Spencerport wastewater-treatment plant. The monitoring program includes (1) the frequent collection of water samples for analysis for nutrients, and (2) collection of stream-discharge data for use in calculation of phosphorus loads (pounds per year) at the site.

Phosphorus in aquatic environments occurs in two forms–orthophosphate, which can be taken up by aquatic organisms, and organic phosphorus, which is unavailable to these organisms because it is bound to sediment particles or detritus, or is in the bodies of other aquatic organisms. The term “total phosphorus” represents both forms. Generally, orthophosphate is the limiting nutrient in freshwater aquatic systems. Elevated concentrations of orthophosphate in freshwater aquatic systems allow plants to assimilate more nitrogen than they would otherwise and leads to accelerated plant growth and algal blooms.

Phosphorus can enter streams from nonpoint sources such as storm runoff from agricultural areas and from urban or residential areas, as well as from point sources such as sewage-treatment plants and septic systems.

Northrup Creek

Total phosphorus loads at the Northrup Creek monitoring site during water years[1] 1990-98 averaged 8,350 lb/yr (pounds per year), of which 3,430 lb/yr

Inside this Issue:

(41 percent) was orthophosphate. The months with the largest loads of total phosphorus were January Through April, which are usually the months with the greatest volume of streamflow. Orthophosphate loads, in contrast, were distributed fairly evenly throughout the year **(fig. 2)**.

The Spencerport sewage-treatment plant has added iron salts to the treatment process since August 1995 in an effort to reduce the amount of phosphorus discharged to Northrup Creek. Total phosphorus loads at the Northrup Creek monitoring site averaged 23.4 lb/d (pounds per day) in the 5 years before implementation of phosphorus-control measures and decreased only slightly, to 22.0 lb/d, in the 3 years thereafter (1996-98), a 6-percent reduction, whereas the orthophosphate loads, which averaged 11.0 lb/d before the phosphorus-control measures, decreased to 6.22 lb/d thereafter—a 43-percent reduction.

Long Pond

Long Pond has a surface area of about 0.75 square miles and an average depth of about 7 feet; it is connected to Lake Ontario by a narrow channel (**fig. 1**). Phosphorus-laden sediments transported by Northrup Creek accumulate in the pond (**fig. 3**). This phosphorus becomes resuspended

Continued on page 2

Figure 1.--Pertinent geographic features of Monroe County.

[1] Water year: The 12-month period from October 1 through September 30 of the following year. Thus, the water year ending September 30, 1996 is the 1996 water year.

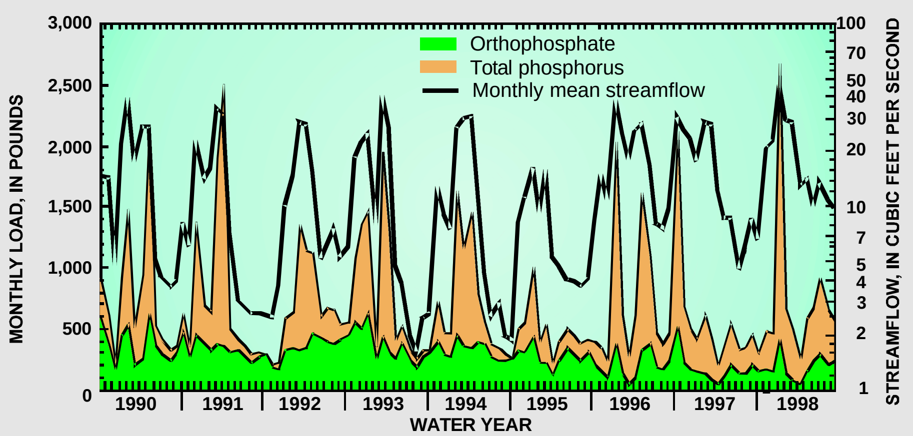


Figure 2. Monthly mean loads of total phosphorus and orthophosphate, with monthly mean streamflow of Northrup Creek, water years 1990-98.

Continued from page 1

slowly under calm conditions and rapidly when the sediment is disturbed, such as during a storm or floodflow. Phosphorus is expected to persist in Long Pond sediments for decades.

"Potential" phosphorus loading in Long Pond is an estimate of the amount of available phosphorus in the Long Pond sediments as calculated from the annual loads from Northrup Creek. The apparent decreases in potential phosphorus load in Long Pond during water years 1996-98 (**fig. 3**) resulted mostly from dilution as a result of the high mean discharges for those water years (because high flows dilute the phosphorus), but also, to a lesser extent, from the phosphorus controls at the wastewater-treatment plant.

Conclusion

The effect of reduced phosphorus loads in Northrup Creek on the water quality of Long Pond is difficult to assess. Even though the phosphorus loads in Northrup Creek have been reduced through improved treatment at the Spencerport wastewater-treatment plant, phosphorus in the bottom sediments in the stream channel and of Long Pond can be resuspended and recycled for many years after sources of phosphorus have been identified and controlled. Therefore, an analysis of options by which to address phosphorus already in the system may be needed in addition to the efforts to further decrease the discharges of phosphorus to the creek.

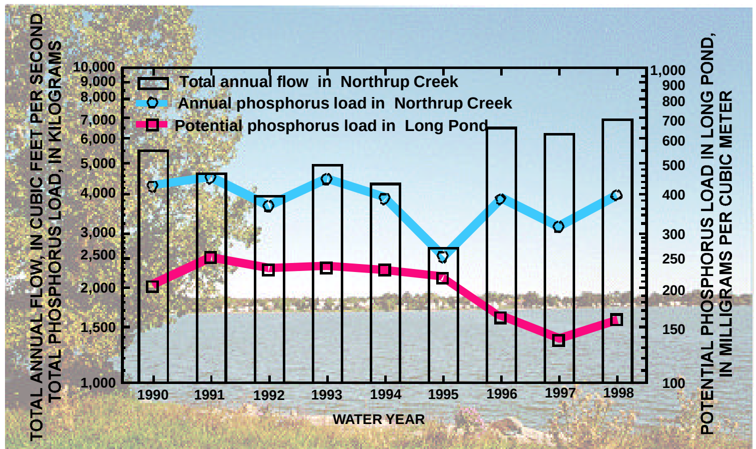


Figure 3. Annual phosphorous load and flow in Northrup Creek, and potential phosphorus load in Long Pond.

Quality of Water Entering Irondequoit Bay Improves

Two changes in the flow regime of Irondequoit Creek between Blossom Road and Empire Boulevard (Ellison Park, see fig.4) were made during 1997-99 to improve the quality of streamwater entering Irondequoit Bay. A study by the USGS in cooperation with the Monroe County Environmental Health Laboratory since 1990 has evaluated the potential of the cattail wetland between Browncroft Boulevard and Empire Boulevard (**fig. 4**) to decrease nutrient loads (primarily phosphorus) transported by Irondequoit Creek to Irondequoit Bay.

Two measures have been taken to maximize the filtering capacity of the wetland. First, during high flows water has been diverted from the main channel of Irondequoit Creek into a second channel that flows into the backwater area of the wetland north of Browncroft Boulevard, and second, adjustment of a flow-control structure that was installed at the Narrows (**fig. 4**) in the spring of 1997 has caused dispersal and short-term detention of stormflows in the wetland between the Narrows and Browncroft Boulevard.

Preliminary results indicate a measurable increase in the retention of most chemical constituents of stormwater within the wetland, where they become available to wetland vegetation and microbial communities. This retention is expressed as a percentage and is called "removal efficiency." A positive removal-efficiency value indicates that the amount of a given constituent entering the wetland is greater than the amount leaving, and a negative value indicates that the amount entering the wetland is less than the amount leaving. A comparison of the wetland's removal efficiency for selected constituents in 1997-98 with the efficiency values calculated for 1991-96 is given in **table 1** and **figure 5**. The removal efficiency for total phosphorus increased from 28 percent during 1991-96 to 55 percent during 1997-98, and the removal efficiency for total suspended solids increased from 47 percent during 1991-96 to 67 percent in 1997-98. The removal-efficiency values for total nitrogen were much lower than those for total phosphorus or suspended solids in both periods, but the percent increase in removal efficiency for nitrogen after 1996 (from 4 percent in 1991-96 to 10 percent in 1997-98) was substantial.

The amounts of orthophosphate and ammonia leaving the wetland usually exceeded the amounts entering, but the removal efficiency for orthophosphate

Continued on page 3

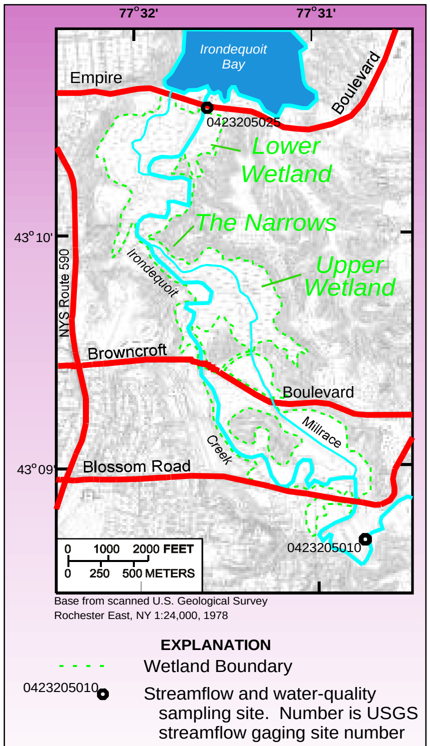


Figure 4. Prominent features in the Irondequoit Creek wetland area.

Continued from page 2

improved substantially (from -38 percent in 1991-98 to -18 percent) after 1996. The removal efficiency for ammonia (a component of total nitrogen) decreased from -84 percent in 1991-96 to -98 percent in 1997-98.

The increased removal efficiencies for the constituents listed in **table 1** (except ammonia) can be interpreted as improvements in the quality of water entering Irondequoit Bay. These improvements are attributed to the increased dispersal and short-term retention of stormwater in the wetland by the control structure at the Narrows, and to the hydrologic changes made upstream from, and within, the wetland.

Table 1. Removal efficiency for selected constituents of Irondequoit Creek in the Ellison park wetland between Browncroft Boulevard and Blossom Road, Monroe County, N.Y., Calculated for 1991-96 and 1997-98

	Removal efficiency*		
Constituent	1991-96	1997-98	Percent Improvement
Constituents generally retained in wetland			
Total phosphorus	28	55	98
Suspended solids	47	67	42
Total nitrrogen	4	10	67
Constituents normally exported from wetland			
Orthophosphate	-38	-18	53
Ammonia	-84	-98	-17

* Removal efficiency = $\frac{\text{(input - output)}}{\text{Input}} \times 100$

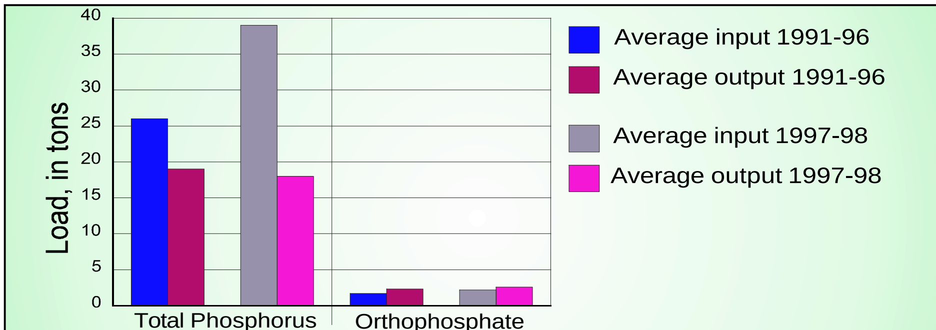


Figure 5. Average annual loads of total phosphorus and orthophosphate in the Ellison Park wetland south of Irondequoit Bay, 1991-96 and 1997-98.

SMALL CONSTRUCTED WETLAND IMPROVES STREAM-WATER QUALITY

Constructed (artificial) wetlands can be used to mitigate adverse effects of storm runoff by attenuating peak flows of the receiving stream and allowing the settling of particulate matter and the uptake of nutrients by resident flora and microbial communities. A 0.6-acre stormwater-detention basin in the Town of Pittsford (**fig. 1**) receives storm runoff from a residential development with a steeply sloping drainage area of about 39 acres. The wetland improves water quality by decreasing the amount of phosphorus and suspended solids that would otherwise be carried into Mill Creek, a tributary to Irondequoit Creek.

A wide diversity of natural vegetation has developed in the wetland. Large (10- to 16-inch diameter) willows are intermittently inundated during periods of storm runoff, and grasses, mosses, and woody shrubs grow in the slightly elevated, dry areas within the wetland and along its perimeter.

Storm inflows peak and recede quickly because the development contains large amounts of impervious surface area (roofs, roads, etc.) and because the contributing area is

Continued on page 4

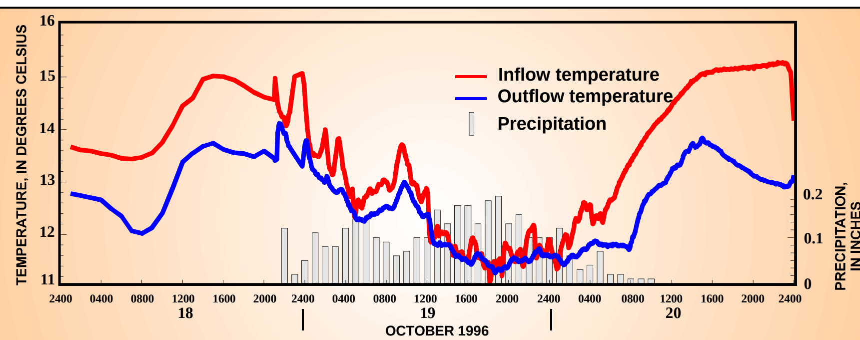
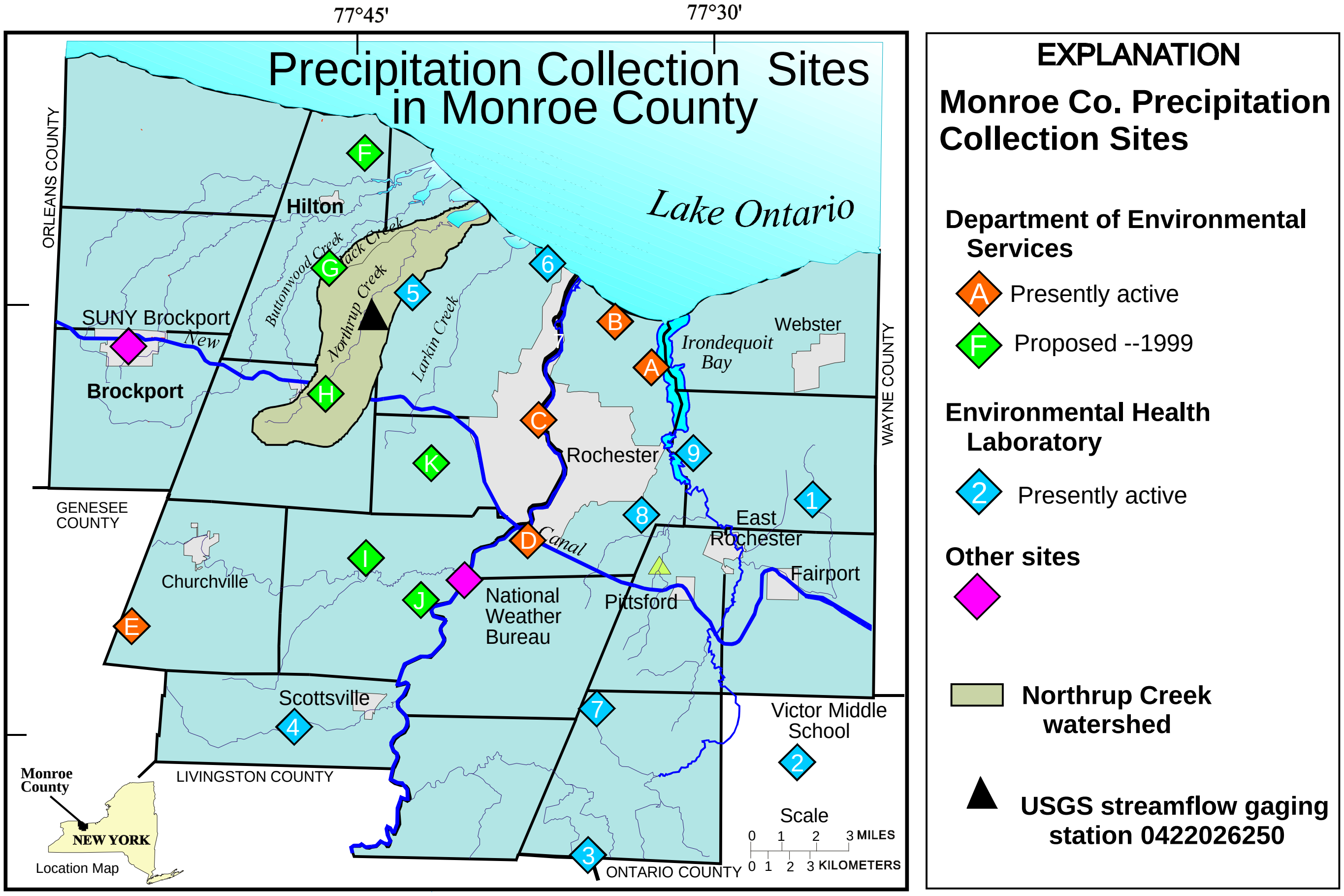


Figure 6. --Water temperature at inflow and outflow of a small constucted wetland near Pittsford, N.Y., October 18 - 20, 1996, and corresponding hourly precipitation.



This map features the locations of precipitation collection sites in Monroe County operated by Monroe County agencies and others. The data for sites operated by Monroe County Environmental Health Laboratory are published annually by the USGS in *Water Resource Data--New York (Vol. 3) Western New York*.

Continued from page 3

steeply sloped. Stormwater is detained in the wetland because the outflow pipe is smaller than the inflow pipe.

Water temperature in Wetland

The USGS, in cooperation with the Monroe County Environmental Health Laboratory, has monitored the effect of this constructed wetland on water temperature and chemistry since 1994 (**fig. 6**). Mean daily outflow temperatures are generally 1 to 3° C (2 to 5° F) lower than inflow temperatures except during the early summer, before the tree canopy is fully developed, when outflow temperatures rise slightly above inflow temperatures in response to the warming air temperatures. Shading of the wetland surface by mature willow trees presumably helps to lower the mid- to late-summer water temperatures. Water temperatures at the basin inlet and outlet generally decrease sharply during stormflows, as shown by a typical fall storm hydrograph for this wetland in **figure 6**. This sudden decrease may be preceded by a slight temperature rise at the inlet that results from the warming of the initial runoff as it flows over impervious surfaces within the development. Depending on the time of day and solar-radiation intensity, this rise in temperature also can occur at the outlet, but only briefly, before temperatures drop. During periods of intermittent rainfall, the inflow temperature may be characterized by a “spiky” pattern that is moderated by passage of the stormwater through the basin (**fig. 6**).

Chemical Quality of Water in Wetland

Stormwater samples were collected at the inflow and outflow of the wetland during 1994-97 and analyzed for phosphorus, nitrogen, suspended solids, chloride, and sulfate concentrations. No significant differences between the mean concentrations at the inflow and those at the outflow were found for the dissolved constituents (nitrogen, chloride, and sulfate), but significant decreases in the concentrations of phosphorus and suspended solids were noted—the median concentration of total phosphorus decreased from 0.15 milligrams per liter (mg/L) at the inflow to 0.11 mg/L at the outflow, and the median concentration of suspended solids decreased from 51 mg/L at the inflow to 26 mg/L at the outflow.

The results from this continuing study indicate that a mature and diversely vegetated constructed wetland that receives storm runoff from a small residential development has a moderating effect on water temperature and improves water quality.

For more information contact:

Monroe County Environmental Health Lab.
740 East Henrietta Road
Rochester, NY 14623
(716) 274-6820

For a list of Monroe County reports published by the U.S. Geological Survey

Subdistrict Chief
U.S. Geological Survey
30 Brown Road
Ithaca, NY 14850-1573
(607) 266-0217