Segment Analysis of Marsh Creek: The Location of Sources of Pollution

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SEGMENT ANALYSIS OF Marsh Creek
The Location of Sources of Pollution
Part of the Lake Ontario Watershed
Located in Orleans County, NY

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Funded by the Orleans County Soil and Water Conservation District

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EXECUTIVE SUMMARY

Marsh Creek is located in the southern portion of the Lake Ontario watershed, Orleans County, New York. The watershed flows into Oak Orchard Creek near its mouth on Lake Ontario at Point Breeze, New York. A branch of Marsh Creek, is known as Beardsley Creek, and was sampled as part of the study, Also Otter Creek, which also drains into Oak Orchard Creek, was sampled two times to access whether further segment analysis is warranted at another time. The purpose of this study was:

1. To identify sources of nutrients, soils and salts within the Marsh Creek watershed;
2. To identify the relative contribution of Otter Creek to Oak Orchard Creek compared to Marsh Creek; and
3. To determine whether sources of pollution in Otter Creek should be investigated further?

To answer these questions, the Soil and Water Conservation District of Orleans County along with the Center of Applied Aquatic Science and Aquaculture at SUNY Brockport undertook the process of identifying the point and non-point sources of nutrients and soils by stressed stream analysis or segment analysis. With this report, we provide evidence suggesting the location and the intensity of pollution sources in the Marsh Creek watershed including Beardsley Creek and give some indication of the magnitude of sources in Otter Creek. We have identified six areas/sources in the Marsh Creek watershed that have consistently had high levels of nutrients, soils or sodium. What follows is a synopsis of what pollutants are being lost and where the sources are located. Event specific saps are included in the narrative to locate these sites. In addition, Figure 2 is a map summarizing the source locations and parameters.

1. There are seven areas of Marsh Creek that are sources of non-point source pollution (Figure 2). These areas are:

   B5 Segment - Beardsley Creek branch south of route 104 and east of Eagle Harbor Road.
   B8 Segment - Beardsley Creek branch headwaters west of Gaines Basin Road
   B7 Segment – Beardsley Creek branch running along Gaines Basin Road south of Route 104.
   C2 Segment – South of Bills Road and Route 18.
   D2 Segment – Sawyer Road South of Route 18.
   E4 Segment – Agricultural area west of Lattin Road south of Route 104.
**E7 Segment** – Brown Road, northeast of the Village of Albion.

2. **Segment B5** was identified as having sources of pollution, especially during the two events in the late summer and fall of 2000. On 11 August 2000, total phosphorus (632%), total suspended solids (TSS) (385%) and total Kjeldahl nitrogen (151%) concentrations all increased greater than 100% over upstream sites in this segment. The land use in this area is primarily agriculture with some rural residences.

3. **Segment B8** contains sources of nitrate, phosphorus and total Kjeldahl nitrogen. An extremely high concentration of 14.35 mg N/L for nitrate was found during the 24 February 2000 event. Elevated concentrations of soluble and total phosphorus as well as TKN were detected during the 11 August 2000 event. The primary land use in this segment is agriculture.

4. During the 24 February 2000 event, the **C2 Segment** on Bills Road near Route 18 had the highest concentration of soluble phosphorus and also indicated that there was an upstream source of TKN, TP and TSS. Field notes indicate that there may have been recent water line construction nearby and that may have been the source of these constituents. By the subsequent event on 21 April 2000 the source had dissipated.

5. The **D2 Segment**, which is surrounded by agriculture, was a source of total Kjeldahl nitrogen, total suspended solids and total phosphorus during the February and April 2000 events.

6. The **E4 Segment** consists of the agricultural area to the west of Lattin Road south of Route 104. Site E4 was identified during numerous events as having high concentrations of nutrients and soil. Two additional sites were added upstream of Site E4 to further characterize the sources previously identified. It appears that the entire area of the subwatershed west of Lattin Road and adjacent to Site E4 is a source of soil and nutrients to Marsh Creek. There was an increase of TP, nitrate, TSS and TKN from the furthest upstream site (E4B) through Site E4A downstream to Site E4, which had the highest concentrations of all of these parameters during the 22 March 2001 event. Cornfields surrounded this area with no visible buffer strips present between the fields and the roadside ditches which collect the runoff.
7. The **E7 Segment** located adjacent to Brown Road, northeast of the Village of Albion, contained sources of nutrients and soil. Nonpoint sources of pollution measured as elevated concentrations of nutrients and total suspended solids at Site E7 were further characterized by the addition of sites upstream of Site E7. The nonpoint source is identified between Site E7A upstream to Site E7B. Concentrations of nitrate, total suspended solids, TKN, SRP and total phosphorus all increased substantially (> 40%) as the stream flowed from Site E7B to Site E7A. The dominant land use type in this area is agricultural.

8. **Otter Creek** (Site F) was sampled during the first two events. During the initial event, it had total suspended solids concentrations that were nearly twice as high as all sites in Marsh Creek except one. During the second event a relatively high nitrate concentration of 4.5 mg N/L was recorded this is comparable to the mouth of Marsh Creek at 4.3 mg N/L during the same event. These two examples may warrant further segment analysis of Otter Creek to locate the sources of pollution for future remediation.

**RECOMENDATIONS**

1. Land use in the Marsh Creek watershed is predominately agricultural in nature. Most of the areas identified as sources of pollution are agricultural. Agricultural practices should be reviewed with landowners in each identified area and appropriate Best Management Practices (BMP) discussed and implemented. A tour of the individual operations in the identified areas is warranted to address any agricultural practices that could be contributing nutrients and soil to Marsh Creek.

2. The use of the Agricultural Environmental Management (AEM) process is encouraged. Agricultural Environmental Management was developed by farmers, state, federal and local governments and farm conservation professionals to enhance the protection of important environmental resources, such as the state’s rivers, lakes and streams, while maintaining a healthy agricultural economy. Agricultural land makes an important contribution to the economy, diversity and beauty of Orleans County. Agricultural Environmental Management calls for a tiered approach to implement Best Management Practices (BMPs) on watershed farms. The tiered approach begins with the farmer’s self-
assessment, followed by a technical assessment by program personnel and implementation.

3. The results from Otter Creek should be reviewed and further segment analysis should be considered for locate pollution sources in that watershed.

INTRODUCTION

The Orleans County Soil and Water Conservation District has actively monitored watersheds in Orleans County beginning in 1997. The District and the Orleans County Water Quality Coordinating Committee in collaboration with the State University of New York at Brockport's Center for Applied Aquatic Science and Aquaculture (CAASA) have provided direction for the monitoring program. Two years of monitoring data indicated that the Johnson Creek watershed was a source of phosphorus, nitrate, organic nitrogen, sodium and soils to Lake Ontario (1, 2). That is, Johnson Creek and the watershed it drained are sources of nutrients and soil pollution to Lake Ontario. The next step was to identify the sources of nutrients, soils and salts within the Johnson Creek watershed? To accomplish this, the Soil and Water Conservation District's of both Niagara and Orleans Counties jointly completed a process called stressed stream analysis or segment analysis (3) where point and non-point sources were identified. Two reports suggesting the location of pollution sources in both the Orleans County portion and the Niagara County portion of the Johnson Creek watershed were completed (4, 5). By this process, we were able focus in and identify suspected areas of pollution. With the completion of this initial phase of monitoring of the Johnson Creek watershed, the Orleans County Watershed Management Plan called for the transfer of monitoring and identification of pollution sources to another priority watershed in the County.

Marsh Creek is located in the southern portion of the Lake Ontario watershed, Orleans County, New York. The watershed flows into Oak Orchard Creek near its mouth on Lake Ontario at Point Breeze, New York. A branch of Marsh Creek, is also known as Beardsley Creek, was also sampled as part of the study, in addition, Otter Creek, which also drains into Oak Orchard Creek, was sampled two times to access whether further segment analysis is warranted at another time.

The purpose of this study was:

1. To identify sources of nutrients, soils and salts within the Marsh Creek watershed;
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Marsh Creek; and

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To answer these questions, the Soil and Water Conservation District of Orleans County along with the Center of Applied Aquatic Science and Aquaculture at SUNY Brockport undertook the process of identifying the point and non-point sources of nutrients and soils by stressed stream analysis or segment analysis. With this report, we provide evidence suggesting the location and the intensity of pollution sources in the Marsh Creek watershed including Beardsley Creek and give some indication of the magnitude of sources in Otter Creek.

Stressed stream analysis is an approach that identifies impacted sub-watersheds and their associated streams (4,5,6,7,8). Within a watershed, stressed stream analysis is an approach for determining how and where a stream and its ecological community are adversely affected by a pollution source or other disturbances. Stressed stream analysis is an integrative, comprehensive approach for determining the environmental health of a watershed and its constituent streams. It is a technique that identifies the sources, extent, effects and severity of pollution in a watershed. In its fullest use, it combines elements of the sciences of hydrology, limnology, ecology, organismal biology and genetics in an integrated approach to analyze cause and affect relationships in disturbed stream ecosystems.

Within a sub-watershed, the stream(s) is used to monitor the "health" of the watershed. Because nutrients are easily transported by water, they can be traced to their source by systematic geographic monitoring of the stream. Stressed stream analysis is a technique that divides the impacted sub-watershed into small distinct geographical units. Samples are taken at the beginning and end of each unit of the stream to determine if a nutrient source occurs within that reach. At completion, the cause and extent of pollution have been identified. If needed, the severity of the pollution within the impacted sub-watershed and or the entire watershed can then be evaluated by spatial analysis of the quantity and quality of biological indicators, such as fish and invertebrates, and by biological examination of structural and functional changes in individual organisms and populations in affected communities. Once identified, sources may be corrected using "Best Management Practices" (BMP).

We have identified seven areas/sources in the Marsh Creek watershed that have consistently had high levels of nutrients, soils or sodium.
DEFINITIONS

Total Phosphorus- A measure of all forms of the element phosphorus. Phosphorus is an element required for plant growth on land or in water. In lakes, phosphorus is often the limiting factor of phytoplankton growth and is the cause of eutrophication, or overproduction, of lakes. Phosphorus may enter a watershed in soluble or organic form from several sources including sewage, heavy-duty detergents, fertilizer and agricultural waste. Some forms of phosphorus are more available to, and cause more immediate activity in, plants.

Soluble Reactive Phosphorus- A measure of the most available and active form of phosphorus.

Nitrate + Nitrite- A measure of the soluble forms of nitrogen used readily by plants for growth. Sources of nitrates in the environment are many and include barnyard waste and fertilizer.

Total Kjeldahl Nitrogen- The Kjeldahl method is a convenient method of analysis for nitrogen but cannot be used for all types of nitrogen compounds. It is, however, a good measure of organic nitrogen, including ammonia. Manure, for example, contains a large amount of organic nitrogen.

Sodium- A measure of the mineral, most commonly found as sodium chloride (NaCl), dissolved in water. NaCl naturally occurs in deep layers of local bedrock. Mined, it is stored and spread as a de-icing agent on roads and other pavements.

Total Suspended Solids - A measure of the loss of soil and other materials suspended in the water from a watershed. Water-borne sediments act as an indicator, facilitator and agent of pollution. As an indicator, they add color to the water. As a facilitator, sediments often carry other pollutants, such as nutrients and toxic substances. As an agent, sediments smother organisms and clog pore spaces used by some species for spawning.

SAMPLING AND ANALYTICAL METHODS

Segment analysis was performed during seven events (4 January 2000, 24 February 2000, 21 April 2000, 11 August 2000, 6 October 2000, 30 January 2001 and 22 March 2001) on Marsh Creek, Otter Creek and Beardsley Creek in Orleans County, NY. The three watersheds flow into Oak Orchard Creek before flowing into Lake Ontario at Point Breeze, NY. All samples were analyzed for nitrate, soluble reactive phosphorus, total phosphorus, total Kjeldahl nitrogen,
sodium and total suspended solids. Specific locations of all sampling sites are shown in Figure 1. All sampling bottles were pre-coded so as to ensure exact identification of the particular sample and were routinely cleaned with phosphate free RBS between sampling dates. Containers were rinsed prior to sample collection with the water being collected. In general, all procedures followed EPA standard methods (9) or Standard Methods for the Analysis of Water and Wastewater (10). Sample water for dissolved nutrient analyses (SRP, nitrate + nitrite) was filtered immediately with 0.45-µm MCI Magna Nylon 66 membrane and either frozen or analyzed within 48 hours of collection.

**Nitrate+Nitrite**: Dissolved nitrate+nitrite nitrogen analyses were performed by the automated (Technicon autoanalyser) cadmium reduction method (10).

**Soluble Reactive Phosphorus**: Sample water was filtered through a 0.45-µm membrane filter. The filtrate was analyzed for orthophosphate using the automated (Technicon) colorimetric ascorbic acid method (10). The formation of the phosphomolybdenum blue complex was read colorimetrically at 880nm.

**Total Phosphorus**: The persulfate digestion procedure was used prior to analysis by the automated (Technicon autoanalyser) colorimetric ascorbic acid method (10).

**Total Kjeldahl Nitrogen**: Analysis was performed using a modification of the Technicon Industrial Method 329-74W/B. The following modifications were made:

- In the sodium salicylate-sodium nitroprusside solution, sodium nitroprusside was increased to 0.4 gm/L.
- The reservoir of the autoanalyser was filled with 2M H₂SO₄ instead of distilled water.
- Other reagents were made fresh prior to analysis.

**Sodium**: Sodium analysis was performed by Atomic Absorption Spectrophotometry (10).

**Total Suspended Solids**: APHA (11) Method 2540D was employed for this analysis.

### QUALITY CONTROL

The Water Chemistry Laboratory at SUNY Brockport is State and Nationally certified through the New York State Department of Health's Environmental Laboratory Approval Program (ELAP - # 11439) and the National Environmental Laboratory Accreditation Conference (EPA Lab Code NY 01449). These programs include bi-annual proficiency audits, annual inspections.
and good laboratory practices documentation of all samples, reagents and equipment. The results of the proficiency audits are presented in Tables 1 and 2.

**RESULTS**

*Chronological Account of Stressed Stream Analysis:*

**4 January 2000 (Figures 1,3,4)**

The purpose behind the initial sampling event was to sample Marsh Creek in its entirety (near the mouth at Oak Orchard Creek) and to separate each major branch of the creek to determine its contribution of nutrients and soil to the total loss from the watershed. Figure 1 depicts the location of sampling sites. One major branch is named Beardsley Creek, which was sampled at Site B2. Otter Creek, which also flows into Oak Orchard Creek, was also sampled (Site F). The Site C branch had insufficient water in it to collect a sample.

The Beardsley Creek branch of the Marsh Creek watershed, measured at site B2, had the highest concentrations of SRP, TP, nitrate, sodium and TKN on 4 January 2000. The nitrate concentration of 31.5 mg N/L is an extremely high level. The cutoff for safe drinking water is 10 mg N/L with health problems occurring with levels higher than this. Total suspended solids were nearly twice as high in Branch E and Otter Creek (Site F) than at the other sites sampled.

**24 February 2000 (Figures 1,5,6)**

Additional sites were added on the B, C and D branches of Marsh Creek for the sampling event on 24 February 2000 (Figures 1,5,6). The D Branch had the highest concentrations of TP, TKN and TSS during this sampling event.

Site D2, a small tributary directly draining an agricultural field, possessed high concentrations of TP (1316.1 µg P/L), TKN (2340 µg N/L) and TSS (451.7 mg/L).

The B branch (Beardsley Creek) had high concentrations of nitrate on 24 February. The highest concentration of nitrate (14.35 mg N/L) was found at Site B8 near Gaines Basin Road.

The area between Sites B3 on Waterport-Carlton Road and Site B2 on Route 18 also contained a source of nitrate as well as total phosphorus, TKN and TSS. This is an area in agriculture.
Site C2 on Bills Road near Route 18, had the highest concentration of soluble phosphorus at 213.7 µg P/L. An upstream source of TKN, TP SRP and TSS was evident by increases in concentrations at Site C2 versus Site C3. Field notes taken by District personnel indicate that water line construction had recently occurred in this vicinity. This may have been the source of these elevated constituents.

Also of note, the concentration of nitrate measured in Otter Creek (Site F) was a relatively high 4.5 mg N/L.

21 April 2000 Event (Figures 1, 7, 8)
Twenty sites were sampled during the 21 April 2000 hydrometeorological event. The area downstream of B8 but upstream of B7 around Eagle Harbor Road was identified as being a source of total and soluble reactive phosphorus (SRP). Total phosphorus increased 188% and SRP increased 103% in this reach of Marsh Creek. The area is a mix of residential and agricultural land use with the addition of runoff from roadside ditches. Total suspended solids also increased 35% between Site B7 to Site B6. This suggests that soil loss may be the cause of the elevated losses of phosphorus from the watershed at this location.

The highest TKN concentration was at Site D2A, a new site upstream from D2, at 1220 µg N/L. The land use in the area in proximity of Site D2A was agriculture.

No alarming sources of nitrate or sodium were revealed during the 21 April 2000 event.

11 August 2000 Event (Figures 1, 9, 10)
The area of Beardsley Creek between Site B11 and Site B5 was a source of TP, TSS, nitrate and TKN during the 11 August event. In this reach, TP increased 632%, TSS increased 385%, nitrate increased 29% and TKN increased 151% in this agricultural and residential area. The nutrient source appears to be primarily organic in nature tied in with soil loss (measured as TSS). Another area of Beardsley Creek, the B8 Site, near the headwaters of that branch showed elevated concentrations of SRP (363 µg P/L), TP (877 µg P/L), and TKN (1480 µg N/L).

Two additional sources of nitrate were found during this event. Once again in Beardsley Creek, nitrate increased 191% in the area upstream of Site B7 to Site B7A.
In the E branch of Marsh Creek, two elevated concentrations of nutrients were found in the headwater areas of different branches. The highest concentration of SRP found on 11 August was 406 µg P/L at Site E4 and the highest concentration of nitrate (4.95 mg N/L) was found at Site E7, north of the Village of Albion.

**06 October 2000 Event (Figures 1,11,12)**

Total phosphorus increased 61% and SRP increased 67% in the area of Beardsley Creek between sites B11 and B5. Also in Beardsley Creek, SRP increased 72% from 129 µg P/L to 222 µg P/L between Sites B8 and B7, respectively.

There were substantial increases of TP, SRP, TKN, TSS and sodium in the area between Sites D10 and D9. These increases are tempered by the fact that flow at Site D9 was very low to negligible during this event.

**30 January 2001 Event (Figures 1,13,14)**

The 30 January 2001 event was characterized by heavy rain and snowmelt. Despite the rain, many of the sampling sites were inaccessibly due to the heavy snow pack.

Additional sites were added upstream of Site E7 to further pinpoint sources in that reach. A source exists between Site E7A upstream to Site E7B. Concentrations of nitrate increased 43%, total suspended solids increased 50%, TKN increased 43%, SRP increased 155% and total phosphorus increased 76% as the stream flowed from Site E7B to Site E7A. There are agricultural fields in that area.

The other area that showed large increases during this event was the area of Beardsley Creek between Sites B7 and B7A. Total suspended solids increased 909% while nitrate increased 122%. Also of note is the nitrate concentration of 6.62 mg N/L found at Site E4, an area in agricultural land use.
22 March 2001 Event (Figures 1,15,16)

The area of Beardsley Creek near Gaines Basin Road continued to be a major source of nutrients and soil to the creek. From the upstream site at B7A downstream to Site B7 total phosphorus increased 129% (252 to 579 µg P/L), nitrate increased 65% (1.24 to 2.04 mg N/L), TSS increased 876% (23 to 229 mg/L) and TKN increased 101% (830 to 1670 µg N/L).

Two additional sites were added upstream of Site E4 on Lattin Road to further characterize the sources previously identified. It appears that the entire area of the subwatershed west of Lattin Road and adjacent to Site E4 is a source of soil and nutrients to Marsh Creek. There was an increase of TP, nitrate, TSS and TKN from the furthest upstream site (E4B) through Site E4A downstream to Site E4, which had the highest concentrations of all of these parameters during the 22 March 2001 event. Cornfields surrounded this area with no visible buffer strips present between the fields and the roadside ditches which collect the runoff.

In the E7 area of Marsh Creek, a source of TP was confirmed between Sites E7B and E7A in that TP increased 35%. Soluble reactive phosphorus also increased 113% from 26.0 to 55.3 µg P/L between E7A downstream to E7. Agriculture is the dominant land use type in this area.

DISCUSSION

Sources of Nutrients and Soil in Marsh Creek – A Summary
Several areas of the Marsh Creek watershed were identified as sources of nutrient, soil and salt loss from the watershed. Figure 2 provides a summary graphic highlighting the source locations of various pollutants. These areas are:

**B5 Segment** - Beardsley Creek branch south of route 104 and east of Eagle Harbor Road.

**B8 Segment** - Beardsley Creek branch headwaters west of Gaines Basin Road

**B7 Segment** – Beardsley Creek branch running along Gaines Basin Road south of Route 104.

**C2 Segment** – South of Bills Road and Route 18.

**D2 Segment** – Sawyer Road South of Route 18.
**E4 Segment** – Agricultural area west of Lattin Road south of Route 104.

**E7 Segment** – Brown Road, northeast of the Village of Albion.

**Segment B5** was identified as having sources of pollution, especially during the two events in the late summer and fall of 2000. On 11 August 2000, total phosphorus (632%), total suspended solids (385%) and total Kjeldahl nitrogen (151%) concentrations all increased greater than 100% over upstream sites in this segment. The land use in this area is primarily agriculture with some rural residences.

**Segment B8** contains sources of nitrate, phosphorus and total Kjeldahl nitrogen. An extremely high concentration of 14.35 mg N/L for nitrate was found during the 24 February 2000 event. Elevated concentrations of soluble and total phosphorus as well as TKN were detected during the 11 August 2000 event. The primary land use in this segment is agriculture.

During the 24 February 2000 event, the **C2 Segment** on Bills Road near Route 18 had the highest concentration of soluble phosphorus and also indicated that there was an upstream source of TKN, TP and TSS. Field notes indicate that there may have been recent water line construction nearby. This construction may have disturbed the soil and be the source of elevated nutrients. By the subsequent event on 21 April 2000 the source had dissipated.

The **D2 Segment**, which is surrounded by agriculture, was a source of total Kjeldahl nitrogen, total suspended solids and total phosphorus during the February and April 2000 events.

The **E4 Segment** consists of the agricultural area to the west of Lattin Road south of Route 104. Site E4 was identified during numerous events as having high concentrations of nutrients and soil. Two additional sites were added upstream of Site E4 to further characterize the sources previously identified. It appears that the entire area of the subwatershed west of Lattin Road and adjacent to Site E4 is a source of soil and nutrients to Marsh Creek. There was an increase of TP, nitrate, TSS and TKN from the furthest upstream site (E4B) through Site E4A downstream to Site E4, which had the highest concentrations of all of these parameters during the 22 March 2001 event. Cornfields surrounded this area with no visible buffer strips present between the fields and the roadside ditches which collect the runoff.

The **E7 Segment** located adjacent to Brown Road, northeast of the Village of Albion, contained sources of nutrients and soil. Nonpoint sources of pollution measured as elevated concentrations
of nutrients and total suspended solids at Site E7 were further characterized by the addition of sites upstream of Site E7. The nonpoint source is identified between Site E7A upstream to Site E7B. Concentrations of nitrate, total suspended solids, TKN, SRP and total phosphorus all increased substantially (> 40%) as the stream flowed from Site E7B to Site E7A. The dominant land use type in this area is agricultural.

**Otter Creek** (Site F) was sampled during the first two events. During the initial event, it had total suspended solids concentrations that were nearly twice as high as all sites in Marsh Creek except one. During the second event a relatively high nitrate concentration of 4.5 mg N/L was recorded. This value is comparable to the mouth of Marsh Creek at 4.3 mg N/L during the same event. These two examples may warrant further segment analysis of Otter Creek to locate the sources of pollution for future remediation.

**How do nutrients and soils move from the land to streams?**

The quality and quantity of runoff from a watershed into a stream are ultimately influenced by people. The amount of runoff is determined by the amount of excess precipitation, that which neither sinks into the ground nor is stored at the surface. Precipitation excess is determined primarily by climate, vegetation, infiltration capacity, surface storage and land use by people (10,11,12). Impervious landscapes (e.g., parking lots), removal of wetlands and vegetation in general, storm sewers, blockage of streams by debris, etc., all contribute to rapid rises in stream level and potential flooding. Similarly, land usage contributes to the quality of the water in the stream and ultimately Lake Ontario. For example, deicing salt spread on roads is easily dissolved and accumulates in streams raising the concentration of sodium in water. Another example is the spreading of manure on the land. If done properly, this can be a reasonable practice enriching the soil. If not, the result may be elevated levels of fecal coliform bacteria and increased levels of phosphorus, organic nitrogen and nitrates that cause health concerns or cause eutrophication of downstream systems. Land use practices initiated by people can and do affect stream water quality and stream discharge. If we can identify, as we have for Marsh Creek, the sources of pollution, remedial action plans and best management plans can be initiated that mitigate downstream and lake effects.
Are there programs that can help agricultural areas?

Agricultural Environmental Management (AEM) was developed by farmers, state, federal and local governments and farm conservation professionals to enhance the protection of important environmental resources, such as the state’s rivers, lakes and streams, while maintaining a healthy agricultural economy. Agricultural land makes an important contribution to the economy, diversity and beauty of Niagara County. Agricultural Environmental Management calls for a tiered approach to implement Best Management Practices (BMPs) on watershed farms. The tiered approach begins with the farmer’s self-assessment, followed by a technical assessment by program personnel and implementation.

Identified point and non-point sources of nutrients and solids can be remediated using Best Management Practices (BMP). Whether or not management practices include a reduction of cropland or fertilization, control of water movement can be a means of significantly reducing non-point source pollution. Since water must come in contact with the nutrient source and then be transported to the surface (or subsurface) water body, the nutrients in water bodies are functions of soil fertility and quantities of transporting water. Management practices, which reduce surface runoff, have been shown to dramatically decrease the magnitudes of sediment and chemical losses from land areas (9).

What are some management practices that may work?

Haith (9) and the NYSDEC (10) recommend use of buffer strips of forest or grass between the pollutant source and a stream to intercept the runoff, resulting in removal by deposition or filtering by the vegetative cover. Other cropland management practices include diversions, terraces contour cropping, strip cropping, waterways, minimum and no tillage. Livestock operation controls include barnyard runoff management, manure storage facilities and livestock exclusion from stream banks. They may also include structural devices such as grassed waterways, sediment retention basins, erosion control weirs and animal waste holding tanks. BMP's are designed to reduce sediment and nutrient transport to streams and lakes. They may benefit the farmer in the long term by decreasing fuel and fertilizer costs and by improving soil productivity. Furthermore, the advent of Concentrated Animal and Feed Operations (CAFO) permits, regulatory control of farms with large numbers of animals may be inevitable.
LITERATURE CITED


(4) Makarewicz, J.C. and T.W. Lewis. 2000. Segment Analysis of Johnson Creek, the Location of Sources of Pollution. Part of the Lake Ontario Watershed Located in Orleans County. Department of Biological Sciences, SUNY Brockport, Orleans County Soil and Water Conservation District, Available from Drake Memorial Library, SUNY Brockport, Brockport, NY.

(5) Makarewicz, J.C. and T.W. Lewis. 2001. Segment Analysis of Johnson Creek, the Location of Sources of Pollution. Part of the Lake Ontario Watershed Located in Niagara County. Department of Biological Sciences, SUNY Brockport, Niagara County Soil and Water Conservation District, Available from Drake Memorial Library, SUNY Brockport, Brockport, NY.


Albany, NY: NYS DEC.
Table 1. Results of the semi-annual New York State Environmental Laboratory Assurance Program (ELAP Lab # 11439, SUNY Brockport) Non-Potable Water Chemistry Proficiency Test, January 2000. Score Definition: Satisfactory, or Unsatisfactory.

**WADSWORTH CENTER**
**NEW YORK STATE DEPARTMENT OF HEALTH**
**ENVIRONMENTAL LABORATORY APPROVAL PROGRAM**

Proficiency Test Report

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<td>(TOTAL SUSPENDED)</td>
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<td><strong>Sample: Organic Nutrients</strong></td>
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<td>Phosphorus, Total</td>
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<td><strong>Sample: Inorganic Nutrients</strong></td>
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<td>ASTM D-1688-95C</td>
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353 passed out of 374 reported results.
Table 2. Results of the semi-annual New York State Environmental Laboratory Assurance Program (ELAP Lab # 11439, SUNY Brockport) Non-Potable Water Chemistry Proficiency Test, July 2000. Score Definition: Satisfactory, or Unsatisfactory.

**NEW YORK STATE DEPARTMENT OF HEALTH**  
**ENVIRONMENTAL LABORATORY APPROVAL PROGRAM**

Proficiency Test Report

<table>
<thead>
<tr>
<th>Lab 11439</th>
<th>SUNY BROCKPORT WATER LAB LENNON HALL BROCKPORT, NY 14420 USA</th>
<th>EPA Lab Id</th>
<th>NY01449</th>
<th>Page 1 of 1</th>
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Shipment 233  Non Potable Water Chemistry  
Shipment Date: 24-Jul-2000

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Sample ID</th>
<th>Result</th>
<th>Mean/Target</th>
<th>Satisfactory Limits</th>
<th>Method</th>
<th>Score</th>
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<td>Solids, Total Suspended</td>
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<td>22 – 27.6</td>
<td>ASTM D-1688-95 C</td>
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</table>

343 passed out of 361 reported results.

131 passed out of 136 reported results.

144 passed out of 160 reported results.

123 passed out of 127 reported results.

106 passed out of 116 reported results.
Figure 1. Summary of sites sampled on Marsh, Beardsley and Otter Creeks.
Figure 2. Summary of identified sources of pollution on Marsh Creek. The shaded areas indicate portions of the sub-watershed that have been identified as being sources of pollution and the constituents are also indicated near the shaded area.
Figure 3. TP, SRP and nitrate concentrations for the 4 January 2000 event.
Figure 4. TKN, TSS and Sodium concentrations for the 4 January 2000 event.
Figure 5. TP, SRP and nitrate concentrations for the 24 February 2000 event.
Figure 6. TKN, TSS and Sodium concentrations for the 24 February 2000 event.
Figure 7. TP, SRP and nitrate concentrations for the 21 April 2000 event.
Figure 8. TKN, TSS and Sodium concentrations for the 21 April 2000 event.
Figure 9. TP, SRP and nitrate concentrations for the 11 August 2000 event.
Figure 10. TKN, TSS and Sodium concentrations for the 11 August 2000 event.
Figure 11. TP, SRP and nitrate concentrations for the 6 October 2000 event.
Figure 12. TKN, TSS and Sodium concentrations for the 6 October 2000 event.
Figure 13. TP, SRP and nitrate concentrations for the 30 January 2001 event.
Figure 14. TKN, TSS and Sodium concentrations for the 30 January 2001 event.
Figure 15. TP, SRP and nitrate concentrations for the 22 March 2001 event.
Figure 16. TKN, TSS and Sodium concentrations for the 22 March 2001 event.