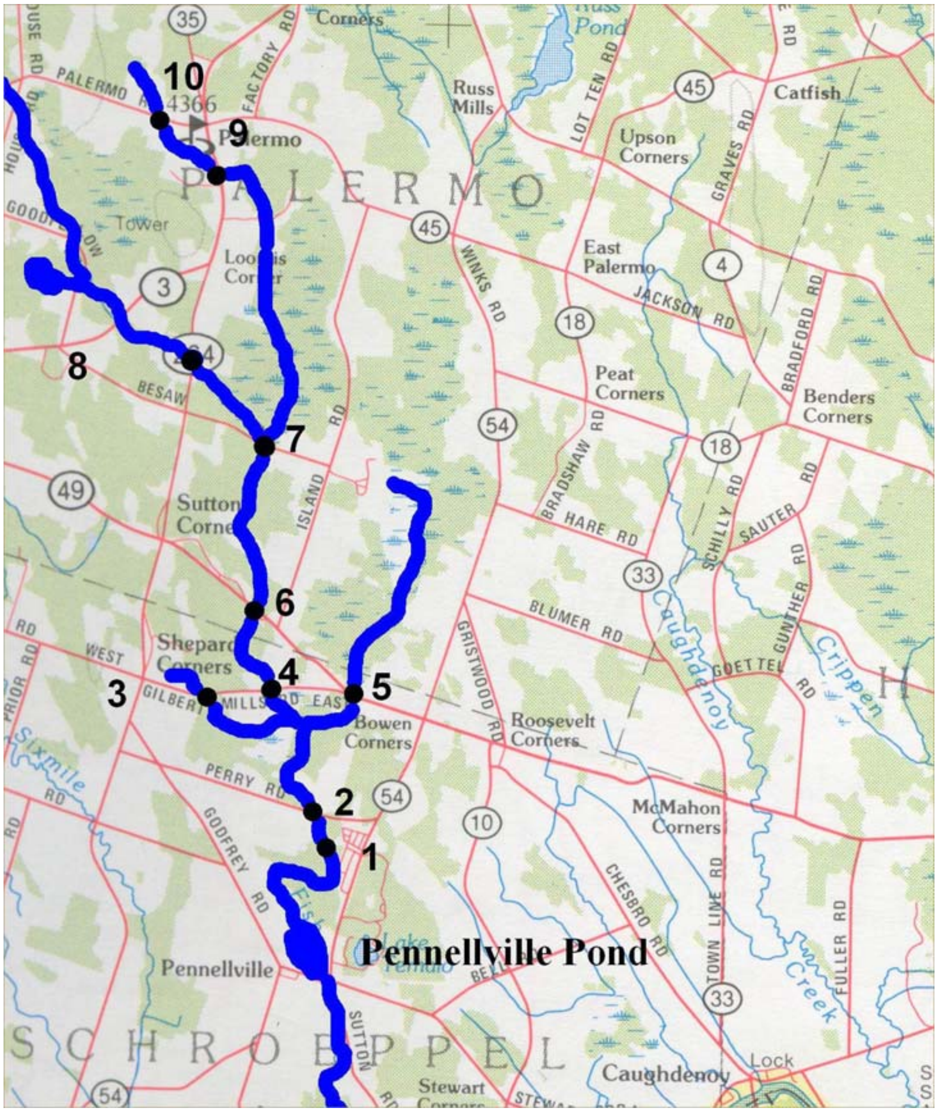
SEGMENT ANALYSIS OF
Fish Creek
North of Pennellville Pond
The Location of Sources of Pollution



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Funded by the Oswego Soil and Water Conservation District
by the Finger-Lakes- Lake Ontario Watershed Protection Alliance

August 2004

Table of Contents

SUMMARY

1. Point and non-point sources of nutrients, soils and salts within the Fish Creek watershed were identified through a process called “segment analysis”.

2. Concentrations of nutrients, sodium, and total suspended solids were variable from the headwaters of Fish Creek to Pennellville Pond. This variability of concentrations along Fish Creek suggests sources, non-point and point, existed within the watershed contributing nutrients and soil to Pennellville Pond.

3. The small western tributary represented by site 3 (Figure 1) is not contributing nutrient or soil to the main stem of Fish Creek. Small increases in sodium were observed but were not of major concern. The vegetative buffer strip separating 20 acres of cropland from the ponds probably plays an important role in the reduction of nutrient loss and soil from this segment.

4. The area around site 1, the trailer park, was not observed to have elevated levels of nutrients or soil during the first two sampling dates. On 21 May 2004, small increases (~28 to 35%) in nitrate, total Kjeldahl nitrogen, total phosphorus and dissolved phosphorus were observed from just above (site 1A) to just below (site 1) the trailer park.

5. On the first two sampling dates, “small” increases of total phosphorus (>38%) and total suspended solids (>186%) were observed from site 9 to 10 suggesting a loss of soil from this segment. Emerald Crest Golf Course exists in this segment.

6. On the first two sampling dates, a major increase in both total phosphorus and soluble reactive phosphorus, but not TSS, was evident from site 9, a headwater stream, and from site 8, a second headwater stream, to their confluence at site 7. A source exists in this area (Figure 1). A 50 acre muck farm is known to exist between segment 7 and 9 and is a likely source.

7. Site 5 is located at the base of a small first-order tributary that flows from the northeast to southwest into the main stem of Fish Creek (Figure1). On the first two sampling dates, elevated levels of nitrate, total Kjeldahl nitrogen, total phosphorus, soluble reactive phosphorus and suspended solids, but not sodium, were observed. These increases were substantial. Total phosphorus concentrations in this one small headwater stream were 10 to 20 times higher than at any other sites sampled on Fish Creek; soluble reactive

phosphorus levels were 10 to 40 times higher; nitrate was 10 to 50 times higher; TKN was 2 to 3 times higher; and TSS was 3 to 4 times higher (except site 9). All sampling sites downstream of site 5 on the main stem of Fish Creek, including Pennellville Pond, had elevated nutrient levels caused by losses from segment 5. Further sampling of this segment in May of 2004 suggested a muck land farm was the likely source.

RECOMMENDATIONS

1. Likely locations of sources of elevated levels of nutrients and soil loss are identified. A visual inspection of these areas with landowners is suggested to pinpoint potential sources.
2. In particular, just above site 7, segment 7-8 should be visually investigated to identify sources within these segments.
3. Identified point and non-point sources of nutrients and solids can be remediated using Best Management Practices (BMP), the Agriculture Environmental Management (AEM) process and common sense. 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. The problem of losses from areas cultivated in muck lands is vexing. Work by the Oswego Soil and Water Conservation District has demonstrated the use of artificial wetlands can reduce the loss of nutrients to down stream systems (Makarewicz and Lewis 1999) - in this case Pennellville Pond. Initial costs of developing such removal systems can be high.

INTRODUCTION

Pennellville Pond is located in Oswego County and concerns have arisen about the water quality, blooms of duckweed and the aesthetically unappealing condition of the pond. Basic information on the water quality status of this pond was lacking. Two preliminary studies on water quality of Pennellville Pond and vicinity have been completed by the Oswego Soil and Water Conservation District. The initial round of sampling occurred from August 1999 to September 2000 and was reported on in Makarewicz and Lewis (2001b). A second report (Makarewicz and Lewis 2003) considers samples taken from July 2001 to February 2002, and summarizes the results, discusses some likely causes of the degraded water quality and offers some potential solutions.

The second report (Makarewicz and Lewis 2003) confirms the previous limited sampling of the first year. Pennellville Pond is suffering from an overabundance of plants. In June, July and August, duckweed (*Lemna* spp.) covered over 80% of the surface area of Pennellville Pond. This overabundance of plants is an impairment to recreational use and is aesthetically unpleasing to people living in the vicinity. Duckweed is a plant associated with high nutrient concentrations. The high concentrations of phosphorus observed in the stream entering Pennellville Pond is the likely cause of the overabundance of duckweed and other plants. The high abundance of plant and nutrients is known as eutrophication.

To identify sources of the elevated levels of nutrients observed in Pennellville Pond, a recommendation of the Makarewicz and Lewis Report (2003) was to initiate water quality sampling in the area north of Penneville Pond in the Fish Creek watershed. To accomplish this task, the Soil and Water Conservation District of Oswego County contracted with the Water Quality Laboratory at SUNY Brockport to systematically identify, during baseline and hydrometeorological events, the sources of nutrients, soils and salts within the Fish Creek watershed north of Pennellville Pond. Point and non-point sources were identified through a process called stressed stream analysis or segment analysis (Makarewicz 1999). With this report, we provide evidence suggesting the location and the intensity of pollution sources in the Fish Creek watershed north of Pennellville Pond.

The Segment Analysis Approach:

Point and non-point sources of nutrients, soils and salts within a watershed may be identified through a process called "segment analysis" or in its fullest development "stressed stream analysis" (Makarewicz 1999). Stressed stream analysis is an integrative, comprehensive approach for determining the environmental health of a watershed and its constituent streams. Within a subwatershed, 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. 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 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. Segment 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. For example, high levels of a nutrient at the down-stream portion of a segment indicates a source within that segment. By systematically narrowing the size of the segment, a source can be identified. 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 of chemical pollutants may be corrected using "Best Management Practices" (BMP). In this report, stressed stream analysis is limited to a spatial analysis of chemical sources of Fish Creek. Examples of the successful application of the segment analysis process in identifying impacted sub-watersheds and their associated streams may be found in the following Makarewicz and Lewis (1993, 2000, 2001, 2001a, 2002, 2002a) and Makarewicz *et al*. (1994).

DEFINITIONS

<u>Total Phosphorus</u>- 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.

<u>Soluble Reactive Phosphorus</u>- 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 on four dates on Fish Creek (7 May 2003, 30 June 2003, 27 October 2003 and 21 May 2004). Sampling locations are shown on Figure 1 and Table 3. All samples were analyzed for nitrate, soluble reactive phosphorus, total phosphorus, total Kjeldahl nitrogen, sodium, and total suspended solids. During the initial stressed stream analysis on 7 May 2003, nine stations were sampled under non-event conditions covering the major segments of the tributary (Fig. 1). The same stations, plus station 1, were sampled on 27 October 2003 during a hydrometeorological event (0.72” at Fulton, NY). One sample was taken on 30 June 2003. Four additional sites were added during the event sampled on 21 May 2004 to further pinpoint sources identified during earlier sampling dates.

All sampling bottles were pre-coded so as to ensure exact identification of the particular sample. All sample bottles 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 (1979) or Standard Methods for the Analysis of Water and Wastewater (APHA 1999). 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 24 hours of collection.

Nitrate+Nitrite: Dissolved nitrate+nitrite nitrogen were performed by the automated (Technicon autoanalyser) cadmium reduction method (APHA 1999).

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 (APHA 1999). The formation of the phosphomolybdeum 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 (APHA 1999).

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 H_2SO_4 instead of distilled water.
- Other reagents were made fresh prior to analysis.

Sodium: Sodium analysis was performed by Atomic Absorption Spectrophotometry (APHA 1999).

Total Suspended Solids: APHA (1999) Method 2540D was employed for this analysis.

QUALITY CONTROL

The Water Chemistry Laboratory at SUNY Brockport is certified through the New York State Department of Health's Environmental Laboratory Approval Program (ELAP - # 11439). This program includes bi-annual proficiency audits, annual inspections and good laboratory practices documentation of all samples, reagents and equipment (Table 1).

RESULTS

Chronological Account of Stressed Stream Analysis:

7 May 2003 (Figures 2 and 3, Table 2)

The initial sampling event occurred during baseline conditions of 7 May 2003. The purpose of this sampling event was to initiate the program and to determine the variability of nutrient concentrations along the major segments of Fish Creek. Nine stations were sampled in the Fish Creek watershed and results are presented in Table 2 and Figures 2 and 3. In general, concentrations of nutrients, sodium, and total suspended solids (TSS) were quite variable from the headwaters of Fish Creek to Pennellville Pond. This variability of analyte concentrations along this segment of Fish Creek north of Pennellville Pond suggests that sources, both non-point and point, existed within the watershed.

Two first-order, headwater tributaries (north of segment 8 and north of segment 9, were sampled in Fish Creek at Route 264 (site 8) and near Palermo, NY (Sites 9 and 10). These sites generally had relatively low concentrations of nutrients (soluble reactive phosphorus [less than 4 µg/L], total phosphorus [< 40 µg/L], nitrate [<0.30 mg/L]) compared to downstream sites suggesting no major sources of nutrient upstream of these sites on this date. However, there was some evidence for a source(s?) of soil loss and total Kjeldahl nitrogen within the eastern first-order tributary (sites 10 to 9). Small, but elevated levels of total phosphorus (TP), total Kjeldahl nitrogen (TKN), and total suspended solids (TSS) were observed. Since soluble reactive phosphorus did not increase and soil loss did increase, this small increase (39.5% for TKN, 62% for TP) suggests a loss of soil or perhaps manure from this segment. In fact, the loss of TSS (soil) from site 10 to 9 was over 300% (6 to 24 TSS mg/L).

A major increase in both total phosphorus and soluble reactive phosphorus is evident from sites 9, a headwater stream, and from site 8, a second headwater stream, to their confluence at site 7. It is not possible to isolate which of these streams, or if both, was contributing to the elevated levels. Between sites 7 and 9, there exists a muck farm that is the likely cause of the elevated phosphorus levels observed.

Site 5 is located at the base of a small first-order tributary that flows from the northeast to southwest into the main stem of Fish Creek. Elevated levels of nitrate, total Kjeldahl nitrogen, total phosphorus and soluble reactive phosphorus, but not suspended solids or sodium, were observed. A source, other than soil erosion, is suggested.

The small western tributary sampled at site 3 and locations below site 4 on the main stem of Fish Creek did not have elevated levels of TKN, nitrate, sodium or total suspended solids. However, a 70% (80 to 136 µg/L) in total phosphorus and a 176% increase in soluble reactive phosphorus were observed from site 4 to site 2 suggesting a source within this segment. The first-order tributary draining site 5 into the main stem of Fish Creek is the likely cause of elevated phosphorus levels observed at site 2. This site is directly above Pennellville Pond.

27 October 2003 (Figures 4 and 5, Table 2)

The next sampling effort by personnel from the Oswego Soil and Water Conservation District was during a rainfall event (0.72”) on 27 October 2003. Nine stations were sampled in the Fish Creek watershed on 7 May 2003 were sampled again. As previously, concentrations of nutrients, sodium, and total suspended solids (TSS) were quite variable from the headwaters of Fish Creek to Pennellville Pond. This variability of concentrations along this segment of Fish Creek suggests sources, non-point and point sources, existed within the watershed.

Within the first-order, headwater tributary (segment 9 and 10), relatively low concentrations of soluble nutrients (soluble reactive phosphorus [less than <20 µg/L], nitrate [<0.22 mg/L]) were observed compared to downstream sites suggesting no major sources of nutrient upstream of these sites. Similarly, sodium (<13 mg/L) was low while total Kjeldahl nitrogen (<810 µg/L) was elevated at site 10 compared to most downstream sites. A source of TKN may exist above site 10. Small increases from site 9 to 10 were observed for total phosphorus (>38%) and total suspended solids (>186%) suggesting a loss of soil from this segment. A similar loss of TP and TSS was observed in the May 2003 sampling effort. For example, the loss of TSS from site 10 to 9 was over 300% (6 to 24 TSS mg/L) in May.

As in May 2003, a major increase in both total phosphorus and soluble reactive phosphorus, but not TSS, was evident from site 9, a headwater stream, and from site 8, a second headwater stream to their confluence at site 7. It is not possible to isolate which of these streams, or if both, was contributing to the elevated levels. A source exists within this segment that is not likely soil erosion.

Site 5 is located at the base of a small first-order tributary that flows from the northeast to southwest into the main stem of Fish Creek. As in May, elevated levels of nitrate, total Kjeldahl nitrogen, total phosphorus, soluble reactive phosphorus and suspended solids, but not sodium, were observed. These increases were substantial. Total phosphorus concentrations in this one small headwater stream were 10 to 20 times higher than at any other sites sampled on Fish Creek; soluble reactive phosphorus levels were 10 to 40 times higher; nitrate was 10 to 50 times higher; TKN was 2 to 3 times higher; and, TSS was 3 to 4 times higher (except site 9). Water quality on the main stem of Fish Creek, including Pennellville Pond, downstream of site 5 are impacted by elevated nutrients and soil loss caused by the losses from this one segment. A forested area and a large active muck farm exists on this segment.

As in May, nutrient and soil concentrations were low suggesting no sources existed in the segment represented by site 3. Sodium was slightly elevated compared to other sites. The small western tributary is not contributing nutrient or soil to the main stem of Fish Creek.

21 May 2004 (Table 2)

Sampling was restricted to sites representative of segments 1, 3 and 5 in an attempt to identify more closely the sources of elevated nutrients or soils.

Site 5 is located at the base of a small first-order tributary that flows from the northeast to southwest into the main stem of Fish Creek. As in May and October, substantial increases in levels of nitrate, total Kjeldahl nitrogen, total phosphorus, soluble reactive phosphorus and suspended solids, but not sodium, were observed at the base of this tributary (site 5) compared to other sites. The perimeter ditch (site 5b) that drains an upland wetland had substantial levels of total Kjeldahl nitrogen (2,480 µg/L) and elevated levels of total phosphorus. Site 5A drains a muck land farm. However, concentrations are not incredibly high. Yet just downstream (few hundred yards) of site5A, levels of total phosphorus (~1,200%), soluble reactive phosphorus (~4,500%), nitrate (418%) and total Kjeldahl nitrogen (~300%) were remarkably elevated. Discussion with Soil and Water District personnel suggested that no other source was apparent except the muck land farm. Since the creek also runs through the muck land farm for approximately 0.5 mile, it would appear that the source is the muck land farm. A similar situation was observed on Sheldon Creek, Oswego County. At Sheldon Creek, muck farms were also observed to deliver elevated levels of nutrients to the stream (Makarewicz and Lewis 2002).

Site 3 was sampled higher upstream in an attempt to identify slightly elevated levels of sodium. Although not a major concern, it was of interest to try to determine a source since levels were surprisingly higher than other locations. Sodium levels were again high at all sites on this segment with a maximum of 37.33 mg/L at site 3A. Land use above site 3 includes a tree farm, a small vegetable farm (20 acres), electric line right of way and vacant land. Land use does not appear to be a cause of the slightly elevated levels observed. These small differences in sodium observed are likely related to the geology of the area and ground water intrusion. Slightly elevated levels of sodium have been observed elsewhere in Oswego County on the Sheldon Creek watershed (Makarewicz and Lewis 1999). Clearly, nutrients are not being lost from this site (site #3), probably because of the 200 to 300 feet of vegetative buffer between the crop fields and the pond that drains in the stream.

Small increases in nitrate, total Kjeldahl nitrogen, total phosphorus and dissolved phosphorus were observed from just above (site 1A) to just below (site 1) the trailer park. Increases were moderate (~28 to 35%) and may simply be due to fertilizer usage on lawns within the trailer park.

DISCUSSION

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.

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. 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 down stream systems. Land use practices initiated by people can and do affect stream water quality and stream discharge. If we can identify the sources of pollution, remedial action plans and best management plans can be initiated that mitigate downstream and lake effects.

Best Management Practices:

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 (Haith 1975).

Agriculture: Haith (1975) and Morton (1985, 1992) 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 woodlands. 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.

The problem of losses from areas cultivated in muck lands is vexing. Work by the Oswego Soil and Water Conservation District has demonstrated the use of artificial wetlands can reduce the loss of nutrients from muck farms to down stream systems (Makarewicz and Lewis 2000a). However, initial costs of developing such removal systems can be high.

ACKNOWLEDGEMENTS

We gratefully acknowledge the field work of John DeHollander, Matt Polniaszek and Erica Schreiner.

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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, July 2003. Score Definition: 4 (Highest) = Satisfactory, 3 = Marginal, 2 = Poor, 1 = Unsatisfactory.

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

Proficiency Test Report

Lab 11439 SUNY BROCKPORT EPA Lab Code NY01449 Page 1 of 1
WATER LAB LENNON HALL
BROCKPORT, NY 14420 USA

Shipment 265 Non Potable Water Chemistry Shipment Date: 21-Jul-2003

Analyte	Sample ID	Result	Mean/Target	Warning Limits	Method	Score
Sample: **Water Residue**						
Solids, Total Suspended 293 passed out of 304 reported results. EPA Code: 0072	6502	47.7	44.5	39.3-49.7	SM 18-20 2540D	Satisfactory
Sample: **Organic Nutrients**						
Kjeldahl Nitrogen, Total 102 passed out of 108 reported results. EPA Code: 0034	6504	14.37	14	11.5-16.5	EPA 351.3	Satisfactory
Phosphorus, Total 119 passed out of 132 reported results. EPA Code: 0035	6504	5.59	5.31	4.56-6.06	SM18-20 4500-P E	Satisfactory
Sample: **Inorganic Nutrients**						
Nitrate (as N) 123 passed out of 128 reported results. EPA Code: 0032	6507	34.10	34.7	30.2-39.3	SM18-20 4500-NO3 F	Satisfactory
Orthophosphate (as P) 88 passed out of 94 reported results. EPA Code: 0033	6507	3.96	4.15	3.73-4.56	SM18-20 4500-P F	Satisfactory
Sample: **Metals I and II**						
Sodium, Total 106 passed out of 120 reported results. EPA Code: 0025	6511	25.24	24.1	22.3-26	SM 18-20 2450D	Satisfactory

Table 2. Water chemistry results from Fish Creek, Oswego County. TP = total phosphorus, TSS = total suspended solids, TKN = total Kjeldahl nitrogen and SRP = soluble reactive phosphorus. ND = Non-detectable.

Sites	**Date** Collected	**TP** (µg P/L)	**Nitrate** (mg N/L)	**TSS** (mg/L)	**TKN** (µg N/L)	**Sodium** (mg/L)	**SRP** (µg P/L)
Fish Creek - #2	5/7/2003	136.0	0.10	10.5	580	13.72	102.1
Fish Creek - #3	5/7/2003	43.8	0.12	21.1	560	36.56	5.7
Fish Creek - #4	5/7/2003	80.4	0.02	11.2	560	22.72	37.4
Fish Creek - #5	5/7/2003	425.5	0.45	8.0	950	8.22	396.4
Fish Creek - #6	5/7/2003	79.8	0.05	2.5	600	22.41	59.7
Fish Creek - #7	5/7/2003	120.6	ND	1.2	530	21.56	94.4
Fish Creek - #8	5/7/2003	30.2	ND	3.0	510	14.96	6.0
Fish Creek - #9	5/7/2003	38.8	0.14	23.5	600	16.36	4.3
Fish Creek - #10	5/7/2003	24.3	0.29	5.7	430	15.88	4.3
Fish Creek - #1	6/30/2003	279.6	0.65	8.1	980	18.59	234.6
Fish Creek #1	10/27/2003	201.9	0.71	7.0	740	14.76	208.6
Fish Creek #2	10/27/2003	313.9	0.53	8.7	730	15.01	213.2
Fish Creek #3	10/27/2003	45.9	0.14	11.3	570	47.12	17.3
Fish Creek #4	10/27/2003	28.4	0.12	1.2	570	19.55	20.2
Fish Creek #5	10/27/2003	847.3	4.26	21.9	1600	6.83	765.9
Fish Creek #6	10/27/2003	58.2	0.15	4.4	560	17.72	36.9
Fish Creek #7	10/27/2003	84.0	0.10	1.3	570	16.61	62.6
Fish Creek #8	10/27/2003	43.9	0.17	5.8	320	10.03	17.9
Fish Creek #9	10/27/2003	53.6	0.13	14.3	670	13.04	10.8
Fish Creek #10	10/27/2003	38.9	0.22	5.0	810	12.33	19.6

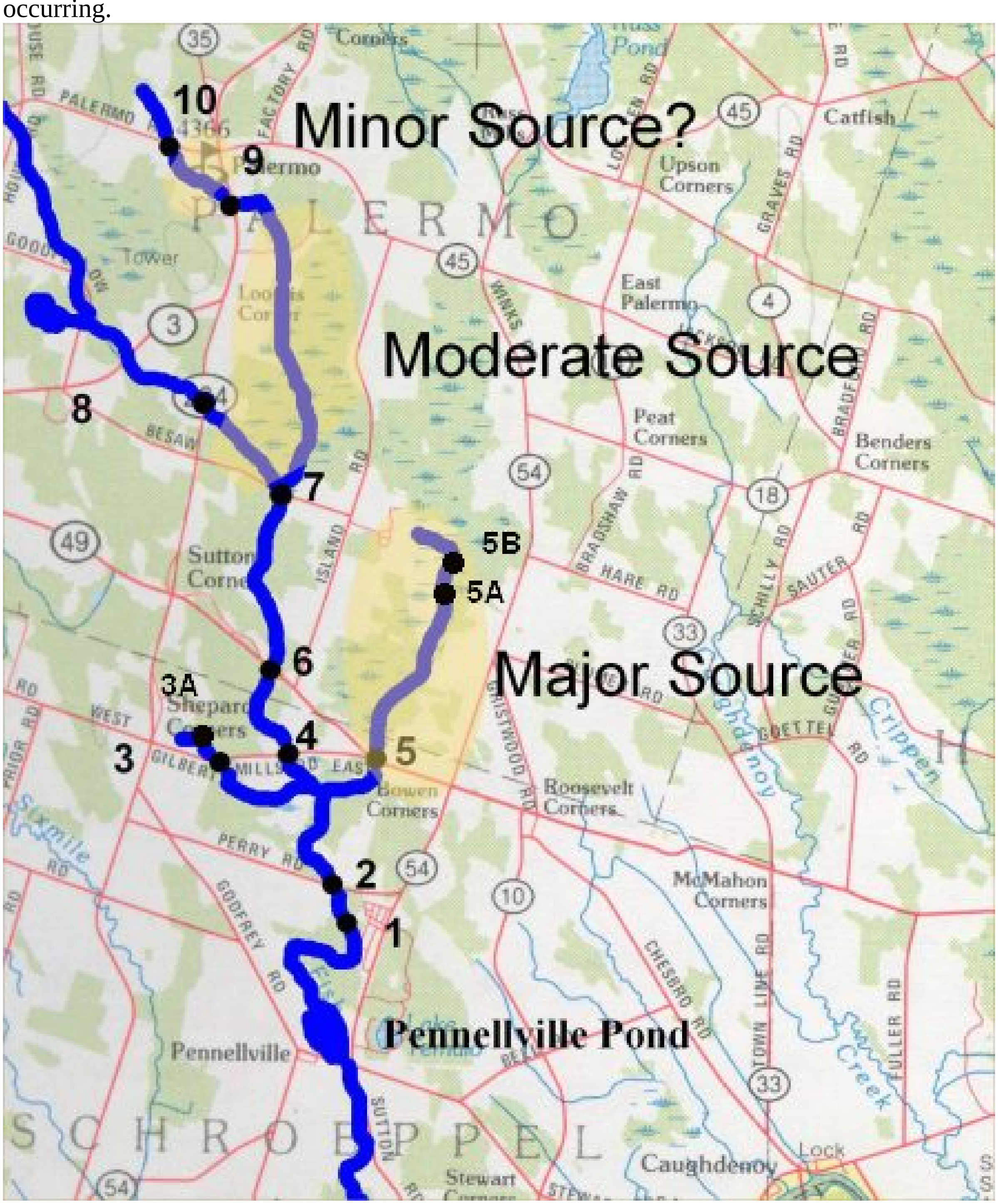
Table 2 (Continued). Water chemistry results from Fish Creek, Oswego County.

Station	**Date** Collected	**TP** (µg P/L)	**Nitrate** (mg N/L)	**TSS** (mg/L)	**TKN** (µg N/L)	**Sodium** (mg/L)	**SRP** (µg P/L)
Fish Creek #1	5/21/2004	276.8	0.87	9.5	930	15.69	247.9
Fish Creek #1A	5/21/2004	198.8	0.32	8.3	720	15.81	164.5
Fish Creek #2	5/21/2004	202.6	0.34	7.0	920	16.35	145.7
Fish Creek #3	5/21/2004	36.0	0.15	19.5	620	24.06	11.6
Fish Creek #3A	5/21/2004	22.5	0.33	6.0	780	37.33	22.3
Fish Creek #4	5/21/2004	129.5	0.10	7.5	690	20.33	46.7
Fish Creek #5	5/21/2004	571.3	0.57	15.7	1020	7.50	498.1
Fish Creek #5A	5/21/2004	44.1	0.11	22.0	390	5.51	10.8
Fish Creek #5B	5/21/2004	71.8	0.12	2.3	2,480	2.10	28.8

Table 3. Location of all stations sampled in the Fish Creek watershed as determined by Global Positioning System (GPS). Also see Figure 1

Station	Road	Latitude	Longitude
1	Below Trailer Park	43° 17' 39N	76° 15' 50W
1A	Above Trailer Park	43° 41' 11N	75° 58' 18W
2	Perry Road Bridge	43° 17' 49N	76° 15' 55W
3	Gilbert Mills Road East (west site)	43° 18' 32N	76°16' 55W
3A	Godfrey Pond	43° 18' 47N	76° 17' 03W
4	Gilbert Mills Road West (east site)	43° 18’ 35N	76° 16' 21W
5	Route 49, at Gilbert Mills Road	43° 17' 39N	76° 15' 50W
5A	DiSalvo muck ditch	43° 20' 09N	76° 15' 15W
5B	DiSalvo perimeter muck ditch	43° 20' 10N	76° 15' 14W
6	Route 49, east of Suttons Corner and west of Island Road	43° 19' 03N	76° 16' 29W
7	Besaw Road, east of Route 264	43° 20' 02N	76° 16' 25W
8	Route 264, south of Loomis Center	43° 20’ 26N'	76° 17’ 01W
9	Route 3, south of Palermo	43° 21’ 36N	76° 16’ 49W
10	Route 45, west of Palermo	43° 21’ 56N'	76° 17’ 21W

Figure 1. Map of sampling stations for the Fish Creek Stressed Stream Analysis. Areas in yellow indicate suspected segments where sources of nutrient and soil loss are occurring.



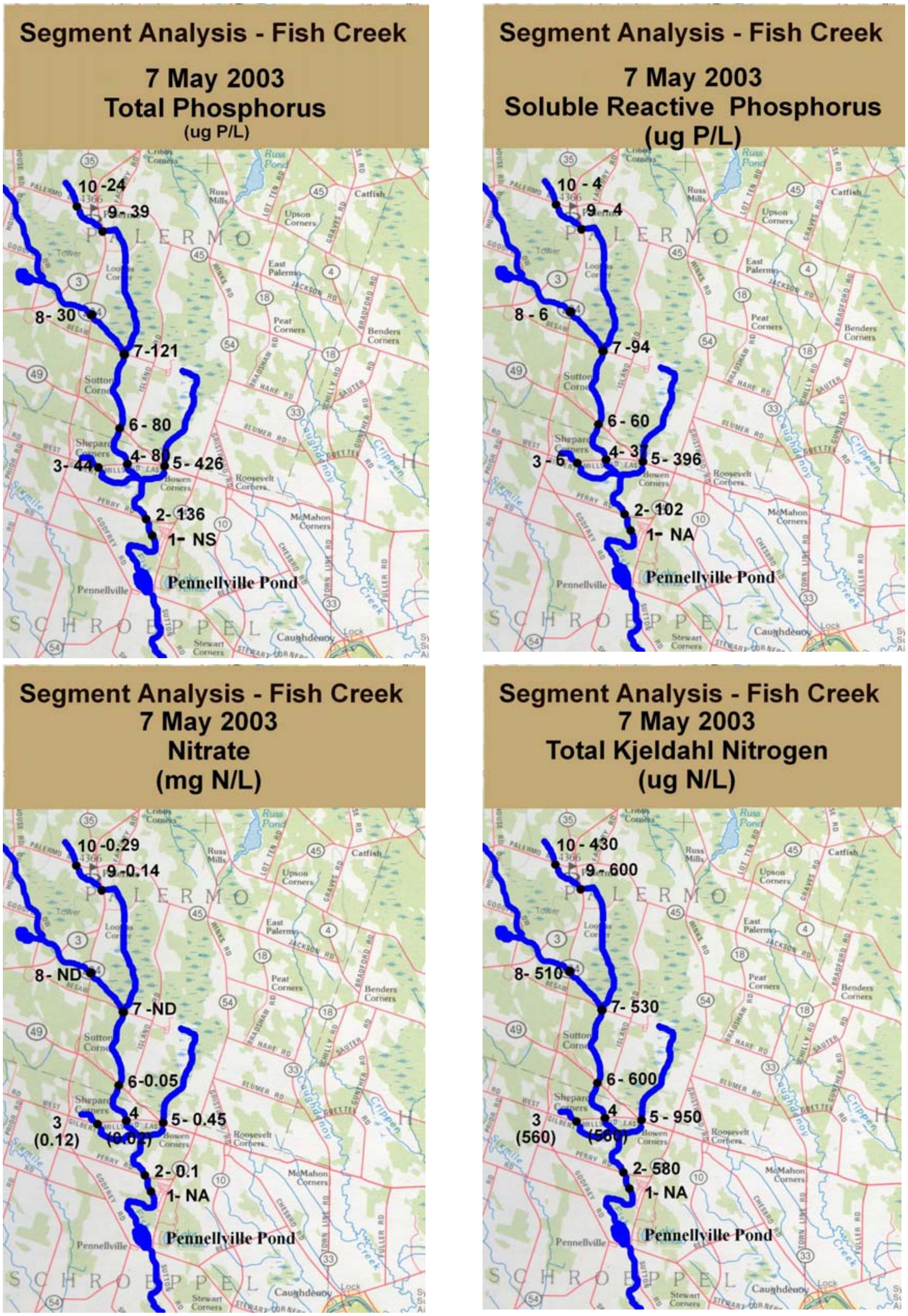
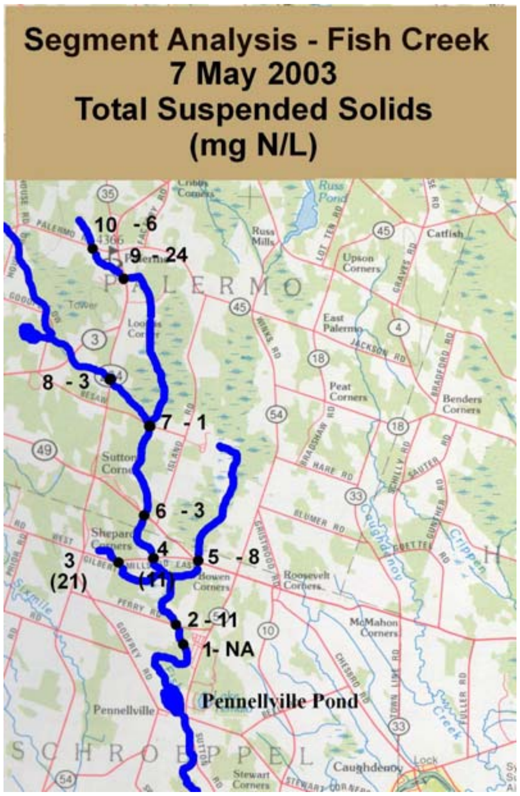


Figure 2. Water chemistry results for nutrients in Fish Creek on 7 May 2003. NS/NA = no sample available.



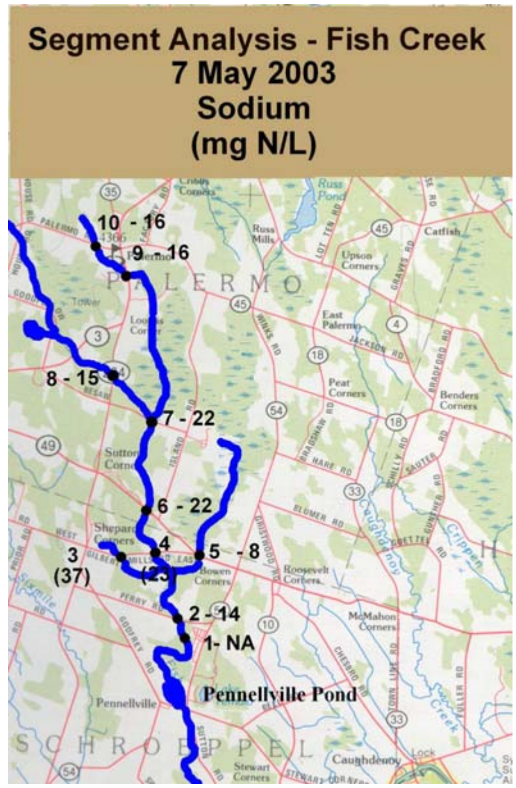


Figure 3. Water chemistry results for total suspended solids and sodium in Fish Creek on 7 May 2003. NA = no sample available.

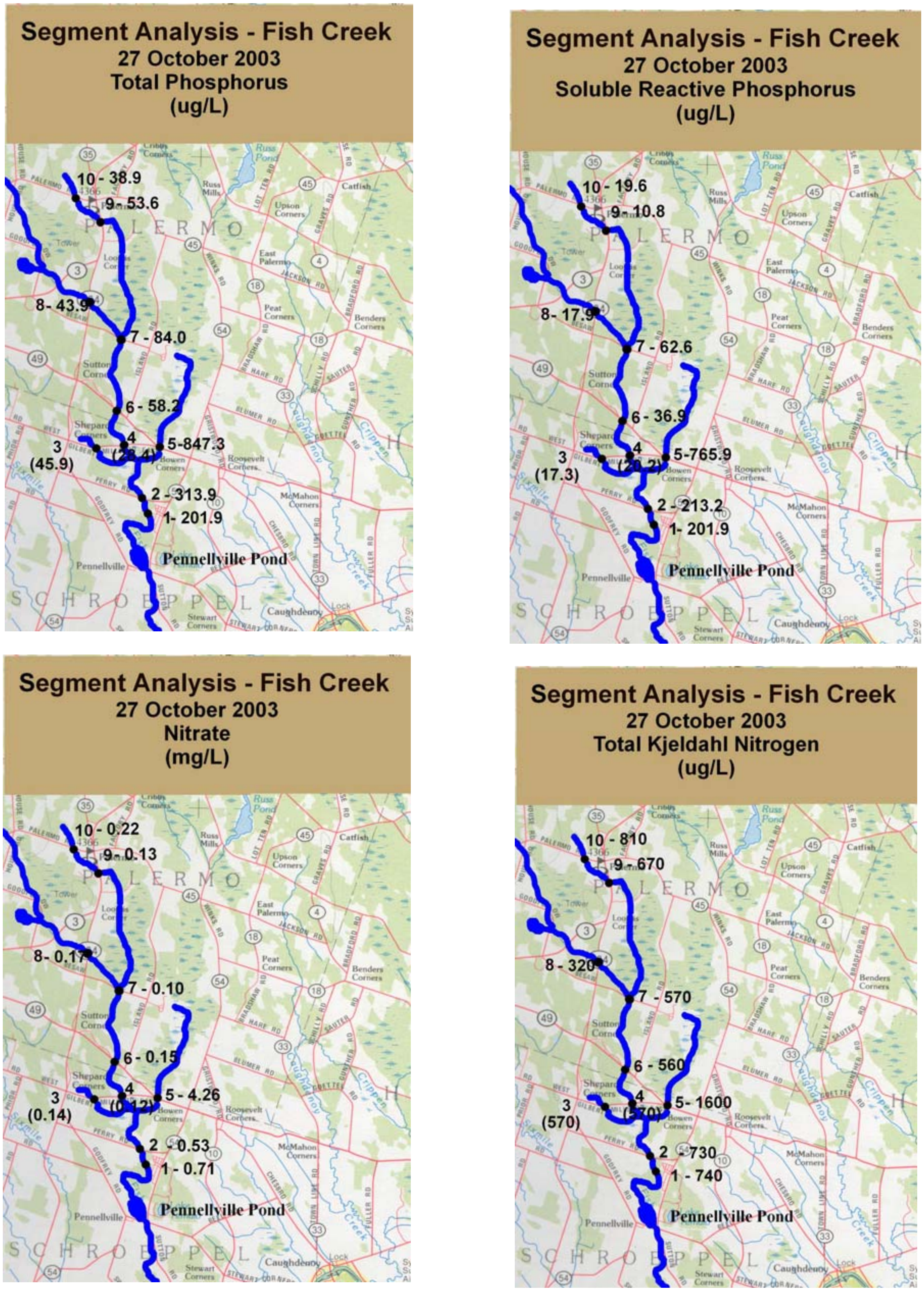


Figure 4. Water chemistry results for nutrients in Fish Creek on 27 October 2003.

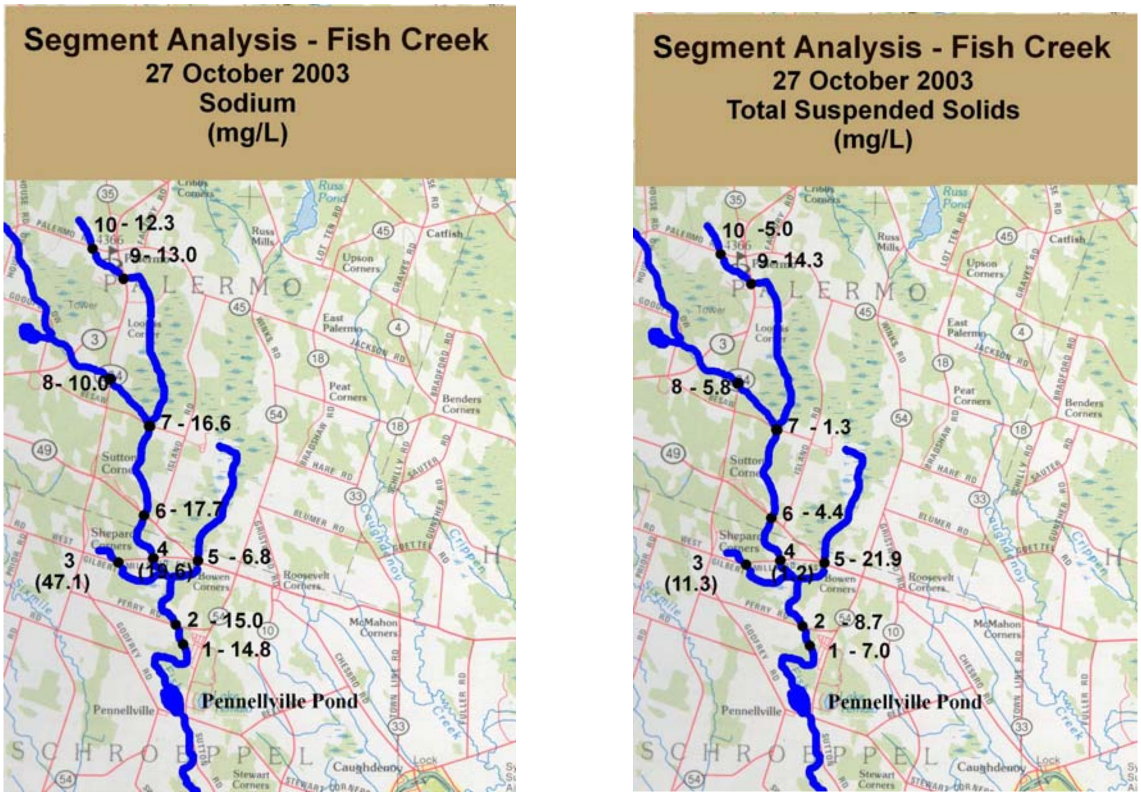


Figure 5. Water chemistry results for total suspended solids and sodium in Fish Creek on 27 October 2003.