FAIRVILLE CREEK
STRESSED STREAM ANALYSIS

WAYNE COUNTY SOIL & WATER CONSERVATION DISTRICT

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SUMMARY

Fairville Creek is located in the Town of Arcadia and is a tributary to Lower Ganargua Creek. A watershed assessment of Lower Ganargua Creek identified the east and the west branches of Fairville Creek as significant contributors of nutrients and sediment. A method called stressed stream analysis was apply to Fairville Creek to further evaluate the possible sources of nutrients and sediment loss with in the watershed. The stream system was sample during four hydrometeorological events in 2017. Concentrations of nutrients and total suspended solids were variable throughout the watershed and suggests that there are potential sources contributing to water quality impacts. Applying a segment analysis to stream reaches exhibiting elevated nutrient and soil loss would further pinpoint and identify sources of input. The mostly like sources attributed to results seen in this study were associated with various agricultural operations including row crops, muck farming, and small scale livestock production. A review of agricultural practices in the watershed is recommended for the proper implementation of best management practices.

INTRODUCTION

Wayne County Soil & Water Conservation District (SWCD) has been the lead agency in the conservation and management of water resources in Wayne County since being chartered. In recent years, SWCD has produced holistic assessments of watersheds in Wayne County as a tool to determine the impacts of upland actions on the health of the waterbodies. The watershed assessments serve as the basis for prioritizing corrective measures to address sources of pollution within the watershed and as a tool to find appropriate funding opportunities. The Lower Ganargua Creek Watershed Assessment, completed in 2013, identified Fairville Creek (0704-0032) as a major source of nutrients and sediment in Ganargua Creek, especially during precipitation/runoff events.

Stressed stream analysis is an approach used to identify and prioritize sub-watersheds based on their contributions to the receiving waterbody, and also to locate individual sources of pollution within that sub-watershed (Makarewicz, 1993). Stressed stream analysis is a technique that divides a watershed into smaller geographical units (Makarewicz, 1993). By systematically monitoring the water quality in the watershed, the nutrients and sediment can be traced to their source (Makarewicz, 1993). Once the sources are identified/located, corrective actions can be taken using Best Management Practices (BMPs).

In response to the data collected for Lower Ganargua Creek in 2013, an initial phase of stressed stream analysis was applied to Fairville Creek in 2017. The east and west branches of Fairville Creek were targeted primarily because of high concentrations of total phosphorus (TP), nitrate-nitrite (NO_x), total Kjeldahl nitrogen (TKN) and total suspended solids (TSS) during both non-event and hydrometeorological-event conditions.

METHODS

Eight sampling sites were selected within the Fairville Creek watershed (Figure 1). These sites were sampled for TP, NO_x, TN, and TSS during four (4) hydrometeorological events from May to October 2017. Samples were transported on ice to the NELAC/NELAP accredited laboratory at Upstate Freshwater Institute in Syracuse, NY. Total Kjeldahl nitrogen (TKN) was derived by subtracting the NO_x concentration from the TN concentration. Variability existed in the concentrations of nutrients from the eight sampling sites. This is due to differences in land uses as well as point and nonpoint sources across the watershed.

Phosphorus as phosphate is one of the major nutrients required for plant growth and is often considered the 'limiting' nutrient to aquatic plant production in New York freshwaters. Sources of phosphorus include animal wastes, sewage, detergent, fertilizer, and disturbed land. U.S. Environmental Protection Agency recommended TP water quality standard for flowing waters entering a lake is 50 µg/L, and 100 µg/L for all other streams (USEPA, 2012). Wisconsin Department of Natural Resources established a phosphorus water quality standard for flowing waters entering lakes at 75 µg/L, and 100 µg/L for all other streams and rivers (Wisconsin, 2010). The NYS DEC Stream Biomonitoring Team, in conjunction with the University of Albany, Department of Biological Sciences, suggests a phosphorus threshold limit of 65 µg/L between mesotrophic and eutrophic conditions in flowing streams (Smith et al., 2006).

Total Kjeldahl Nitrogen is the combination of organically-bound nitrogen and ammonia/ammonium. Sources of organic nitrogen include livestock manure, human wastes, and decaying plant material. Sources of ammonia-ammoniun include human and animal wastes, as well as certain fertilizers and industrial wastes. U.S. Environmental Protection Agency water quality criteria recommendations for this region provided data that un-impacted waterbodies have a TKN concentration of 200.0 µg/L (USEPA, 2000). TKN concentrations less than 600 µg/L can be considered low. For this report, TKN was calculated by finding the difference between the concentrations of Total Nitrogen (TN) and Nitrate + Nitrite (NO_x).

Nitrate is the form of nitrogen that is most readily available for plant uptake. It is more easily detected as Nitrate + Nitrite, or NO_x (Nitrite is not commonly found in surface waters but is created as nitrate converts to nitrogen gas during denitrification). Nitrate sources include soil, animal wastes (including birds and fish), sewage and septic systems, fertilizers and decaying vegetation. The NYS DEC water quality standard for nitrate in drinking water is 10 mg/L, or 10,000 µg/L. The United States Geological Survey (USGS) states that background nitrate concentrations for undeveloped watersheds is 0.6 mg/L, or 600 µg/L (USGS, 1999).

Total suspended solids (TSS) is a measure of soil particles and other materials suspended in water. Water-borne sediments act as an indicator, facilitator and agent of pollution (Makerawicz et al. 2011). As an indicator, TSS adds hue to water. As a facilitator, sediments transplant other pollutants such as nutrients and toxic substances. As an agent, sediments smother organisms and cover habitats used by some species for spawning. TSS concentrations less than 10 mg/L are considered low.

RESULTS

Table 1 and Figures 2 – 5.

All sampling sites in Fairville Creek watershed had total phosphorus concentrations that exceeded the previously stated recommendations (65 µg/L) at least once during the sampling time frame. Sampling site 17FC08 had the highest mean TP concentrations which measured over twice the upper limit of recommended threshold values. Five of the 8 sites had mean concentrations that exceeded 100 µg P/L.

All sites examined throughout the time frame of sampling had TKN concentrations that exceeded 200.0 µg/L, ranging from 272 to 1916 µg TKN/L. This would suggest a significant impact during hydrometeorlogical events. Sites 17FC05 and 17FC08 had the highest mean TKN concentrations observed. All other sites had moderate to low concentrations. Higher concentrations in the spring and early summer months suggest that the source is sewage or animal waste, or soil loss from areas high in organic matter.

Sites 17FC06 and 17FC04 had the highest mean NO_x concentrations observed, although no site had a concentration in significant range of 10,000 µg/L. Sites 17FC06, 17FC04, 17FC07, and 17FC02 had concentrations exceed 1,000 µg/L on 10/30/2017 that inflated their average concentrations.

Six of the eight sampling sites had TSS concentrations exceeding 10 mg/L. The highest concentration was observed at site 17FC07, 23.3 mg/L.

Sequential Interpretation

22 May 2017:

1. Total phosphorus (TP) was slightly high above site 17FC04 (93.2 µg/L), but relatively low at 17FC01, suggesting sources are present upstream of 17FC04.

2. The tributary associated with 17FC05, which joins the system between 17FC04 and 17FC01, displayed slightly high concentrations of TP (66.8 µg/L). This suggests that there are possible sources existing upstream of 17FC05.

3. For the reach of stream represented by (from upstream to downstream) 17FC08, 17FC06, and 17FC02, TP was excessively high in the upstream section of the stream and gradually decreasing towards downstream (243.7 to 161.2 to 81.0 µg/L). Tributaries represented by 17FC03 and 17FC07 did not show high levels of phosphorus being contributed to the stream system. This suggests that there are significant sources of phosphorus upstream of 17FC06 and 17FC08.

4. Total Kjeldahl nitrogen (TKN) was slightly high above site 17FC04 (711 µg/L) but showed some reduction at site 17FC01 (655 µg/L).

5. TKN was relatively high upstream of 17FC05 (1215 µg/L), which contributes to 17FC01, suggesting sources are present.

6. The TKN concentration at site 17FC08 was observed to be high (911 µg/L) while decreasing at 17FC06 (725 µg/L), which suggest that there is a source above 17FC08.

7. TKN results at 17FC07 were slightly high (613 µg/L) while lower concentrations were observed downstream at site 17FC02 (154 µg/L). This suggests that there is a source upstream of 17FC07.

8. Nitrate-Nitrite (NOx) concentrations between 17FC08 and 17FC06 increased by over 81% (205 to 372 µg/L), suggesting a possible source between the two sites, possibly from the tributary that originates from Minsteed Rd.

9. Total Suspended Solids (TSS) concentration at site 17FC05 was significantly high (32.1 mg/L), contributing between sites 17FC04 and 17FC01.

10. TSS results between 17FC08 and 17FC06 increased by over 130% (11.4 to 26.3 mg/L), suggesting a possible source between the two sites, possibly from the tributary that originates from Minsteed Rd.

Picture above: Confluence of tributaries represented by sampling sites 17FC06 (right) and 17FC07 (left). 17FC06 was visibly turbid. Further investigation found that a muck farm operation on Minsteed Rd. was performing wet weather ditch maintenance.

14 July 2017:

1. This date showed excessively high TP concentrations throughout the stream reach represented by sampling sites 17FC01 (115.6 µg/L) and 17FC04 (181.6). Concentrations decreased from upstream to downstream.

2. TP measured at 17FC07 (70.7 µg/L) depicted possible contributions from upstream.

3. Results showed the strong suggestion that sources above 17FC04 (181.6 µg/L) are contributing excess TP to the stream.

4. TP results for 17FC05 (118.9 µg/L) showed that there is a strong suggestion that this tributary is contributing to phosphorus loads between 17FC04 and 17FC01.

5. The main channel that includes sampling sites (from upstream to downstream) 17FC08, 17FC06, and 17FC02 displayed excessively high concentrations of TP throughout the reach. This suggests that there are significant sources of phosphorus upstream of 17FC06 (201.4 µg/L) and 17FC08 (270.8 µg/L).

6. Results for 17FC03 (54.1 µg/L) and 17FC07 (70.7 µg/L), which represent tributary streams between sites 17FC06 and 17FC02, showed possible upstream sources of phosphorus loading, but not in excessively high amounts. This scenario depicts that major sources of phosphorus occur upstream of 17FC06 (201.4 µg/L) and 17FC08 (270.8 µg/L).

7. TKN concentration increased over 91% from site 17FC04 to 17FC01 (462 to 885 µg/L), suggesting a source between the sites. TKN concentration at 17FC05 were significantly high (1119 µg/L), possibly being the source of the previously stated increase.

8. TKN concentration at site 17FC08 was significantly high (1089 µg/L) and decreased while progressing to site 17FC06 and 17FC02, showing that a significant source is located upstream of 17FC08.

9. TKN results for the tributary represented by 17FC03 were excessively high (1916 µg/L), but the results at 17FC02 (633 µg/L) did not show a significant impact. Still, there is a strong possibility of a source located above 17FC03.

10. NOx increased between sites 17FC04 and 17FC01 by 145% (51 to 125 µg/L), yet the NOx result from site 17FC05 (97 µg/L) does not display it as a possible source. Note that the concentrations observed are not considered excessive.

11. NOx concentrations between 17FC08 and 17FC06 increased by over 506% (122 to 704 µg/L), suggesting a possible source between the two sites, possibly from the tributary that originates from Minsteed Rd.

12. Both tributaries represented by sites 17FC07 and 17FC03 displayed slightly high NOx results (379 and 425 µg/L, respectively), suggesting possible sources upstream.

13. TSS increased between sites 17FC04 and 17FC01 by over 107% (3.8 to 7.9 mg/L), yet the TSS result from site 17FC05 does not display it as a possible source. Note that the concentrations observed are not considered excessive.

14. TSS results between 17FC08 and 17FC06 increased by over 130% (5.0 to 7.7 mg/L), suggesting a possible source between the two sites, possibly from the tributary that originates from Minsteed Rd.

15. TSS results from 17FC06 to 17FC02 increased by 61% (7.7 to 12.4 mg/L). The TSS concentration observed for the tributary represented by 17FC03 are considerably high (19.7 mg/L), suggesting that it may be the source of the increase between 17FC06 and 17FC02.

5 September 2017:

1. This date showed excessively high TP concentrations throughout the stream reach represented by sampling sites 17FC01 (155.3 µg/L) and 17FC04 (278.2 µg/L). Concentrations decreased from upstream to downstream.

2. For the reach of stream represented by (from upstream to downstream) 17FC08, 17FC06, and 17FC02, TP was excessively high in the upstream section of the stream and gradually decreasing towards 17FC06 and then increased again at 17FC02 (209.2 to 190.8 to 195.7 µg/L). This suggests that there are significant sources of phosphorus upstream of 17FC08 and 17FC02.

3. TP results for 17FC07 (200.5 µg/L), which represents a tributary stream between sites 17FC06 and 17FC02, showed a possible significant upstream source of phosphorus loading that caused the increase at 17FC02.

4. TKN concentration increased over 44% from site 17FC04 to 17FC01 (582 to 842 µg/L), suggesting a source between the sites. No data is available for this date from 17FC05 due to lack of stream flow.

5. The TKN concentration at site 17FC08 was observed to be high (847 µg/L) while decreasing at 17FC06 (476 µg/L), which suggest that there is a source above 17FC08.

6. NOx concentrations between 17FC08 and 17FC06 increased by over 44% (263 to 381 µg/L), suggesting a possible source between the two sites, possibly from the tributary that originates from Minsteed Rd.

7. TSS concentration at 17FC04 was considerably high (30.6 mg/L), suggesting a source is present upstream.

8. TSS concentration slightly increased between 17FC04 and 17FC01 (30.6 to 34.9 mg/L). No data is available for this date from 17FC05 due to lack of stream flow.

9. TSS results between 17FC08 and 17FC06 increased by over 112% (11.8 to 25.1 mg/L), suggesting a possible source between the two sites, possibly from the tributary that originates from Minsteed Rd.

10. TSS results between 17FC06 and 17FC02 increased slightly (25.1 to 31.5 mg/L), suggesting a possible source between the two sites. The TSS concentration observed for the tributary represented by 17FC07 are considerably high (62.8 mg/L), suggesting that it may be the source of the increase between 17FC06 and 17FC02.

30 October 2017:

1. This date showed excessively high TP concentrations throughout the stream reach represented by sampling sites 17FC01 and 17FC04. Concentrations decreased from upstream to downstream (139.1 to 71.4 µg/L).

Event-induced stream flow near Fairville Volunteer Fire Department.

2. The tributary associated with 17FC05, which joins the system between 17FC04 and 17FC01, displayed slightly high concentrations of TP (74.4 µg/L). This suggests that there are possible sources existing upstream of 17FC05.

3. TP was high at 17FC08 in the upstream section of the stream and gradually decreasing towards 17FC06 and then increased again at 17FC02 (117.3 to 66.6 to 223.4 µg/L). This suggests that there are significant sources of phosphorus upstream of both 17FC08 and 17FC02.

4. TP Results for 17FC03 (203.8 µg/L) and 17FC07 (107.8 µg/L), which represent tributary streams between sites 17FC06 and 17FC02, showed possible upstream sources of phosphorus loading. These tributary inputs may be the reason for the increase in TP concentrations from site 17FC06 to 17FC02.

5. TKN concentration increased over 86% from site 17FC04 (470 µg/L) to 17FC01 (875 µg/L), suggesting a source between the sites. TKN concentration at 17FC05 were significantly high (908 µg/L), possibly being the source of the previously stated increase.

6. TKN was high at 17FC08 in the upstream section of the stream and gradually decreasing towards 17FC06 and then increased again at 17FC02 (766 to 330 to 520 µg/L). This suggests that there are significant sources of phosphorus upstream of both 17FC08 and 17FC02.

7. TKN results at 17FC07 were slightly high (730 µg/L). This may be the possible source for the concentration increase between sites 17FC06 and 17FC02.

8. NOx concentrations at 17FC04 was extremely high (3280 µg/L) compared to other sites sampled. This suggests that there is a significant source upstream of this site.

9. NOx concentrations between 17FC08 and 17FC06 increased by over 3734% (109 to 4180 µg/L), suggesting a significant source between the two sites, possibly from the tributary that originates from Minsteed Rd. Concentrations remained high at site 17FC02.

10. The tributary represented by site 17FC07 displayed a slightly high NOx result (1870 µg/L), suggesting possible sources upstream, possibly contributing to the elevated concentration observed at site 17FC02.

11. TSS concentration at 17FC04 was considerably high (32.5 mg/L), suggesting a source is present upstream.

12. TSS results between 17FC08 and 17FC06 increased by over 310% (6.8 to 27.9 mg/L), suggesting a possible source between the two sites, possibly from the tributary that originates from Minsteed Rd.

13. The TSS concentration observed for the tributary represented by 17FC07 are considerably high (18.4 µg/L), suggesting that it may be a source contributing to results at 17FC02.

Observed Trends

1. Significant source(s) of TP upstream of 17FC04, with the concentrations remaining elevated throughout the 17FC04 – 17FC01 reach. Land uses include muck land, cropland, and forest.

Possible source(s): Fertilizer application on Row Crops and Hay (general field locations);
Muck land east of Route 88 (just south of old recycling facility).

2. Suspected source(s) of TP upstream of the tributary represented by 17FC05. Land uses include forest and cropland.

Possible source(s): Nutrient over-saturated wetland and high phosphorus water column levels; fed by upland drainage practices;
Spring fertilizer runoff of Row Crops and Hay (general field locations).

3. Significant source(s) of TP upstream of 17FC08 with concentrations remaining elevated throughout the 17FC08 – 17FC06 – 17FC02 reach. Land uses include muck land, cropland, forest, and livestock.

Possible source(s): Nutrient over-saturated wetland and high phosphorus water column levels;
Runoff of spring application fertilizer on Row Crops (general field locations);
Orchard and Tree Farm fertilizer on Fairville Maple Ridge Rd.;
Livestock on Skinner Rd. between Minsteed and Cauwels;
Livestock on Minsteed Rd.;
Livestock on Hyman Rd.;
Muck land straddling Decker Rd.

4. Possible source(s) of TP upstream of the tributary represented by 17FC07 are contributing downstream to elevated concentrations at 17FC02. Land uses includes orchards, forest, muck land, cropland, and livestock.

Possible source(s): Muck land on Buffalo Rd. (south of Austin Rd.);
Muck land on Austin Rd. (North of Buffalo Rd.);
Runoff from Row Crops on Rt. 88 (north of Austin Rd.);
Livestock on Buffalo Rd. (near Fairville Maple Ridge Rd.);
Livestock and Pasture on Martin Rd. (near Fairville Maple Ridge Rd.).

6. Possible source(s) of TKN between 17FC04 and 17FC01, suspected to be from source(s) upstream of the tributary represented by 17FC05. Land uses include forest and cropland.

Possible source(s): Manure application as fertilizer on Row Crops;
Runoff of spring application (Urea) fertilizer on Row Crops (general field locations);
Septic system failure(s).

7. Significant source(s) of TKN upstream of 17FC08 with the concentrations fluctuating throughout the 17FC08 – 17FC06 – 17FC02 reach. Land uses include muck land, cropland, forest, and livestock.

Possible source(s): Runoff of spring application (Urea) fertilizer on Row Crops (general field locations);
Orchard and Tree Farm (Urea) fertilizer on Fairville Maple Ridge Rd.;
Livestock on Skinner Rd. between Minsteed and Cauwels;
Livestock on Minsteed Rd.;
Livestock on Hyman Rd.

8. Suspected source(s) of TKN upstream of 17FC07 contributing downstream. Land uses includes orchards, forest, muck land, cropland, and livestock.

Possible source(s): Runoff of spring application (Urea) fertilizer on Row Crops (general field locations);
Runoff from Row Crops on Rt. 88 (north of Austin Rd.);
Livestock on Buffalo Rd. (near Fairville Maple Ridge Rd.);
Livestock and Pasture on Martin Rd. (near Fairville Maple Ridge Rd.).

9. Significant source(s) of NOx between 17FC08 and 17FC06 possibly from the tributary that originates from Minsteed Rd. Land uses include forest, muck land, and cropland

Possible source(s): Muck land on Minsteed Rd. (near Desmith and Ressue Rd.).

10. Possible source(s) of NOx upstream of the tributary represented by 17FC07. Land uses includes orchards, forest, muck land, cropland, and livestock.

Possible source(s): Runoff of spring application fertilizer on Row Crops (general field locations);
Muck land on Buffalo Rd. (south of Austin Rd.);
Muck land on Austin Rd. (North of Buffalo Rd.);
Runoff from Row Crops on Rt. 88 (north of Austin Rd.);
Livestock on Buffalo Rd. (near Fairville Maple Ridge Rd.);
Livestock and Pasture on Martin Rd. (near Fairville Maple Ridge Rd.).

11. Possible source(s) of TSS upstream of 17FC04 with concentrations remaining elevated throughout the 17FC04 – 17FC01 reach. Land uses include muck land, cropland, and forest.

Possible source(s): Muck land east of Route 88 (just south of old recycling facility);
Erosion from Row Crop fields along and north of Chapel St.

DISCUSSION / RECOMMENDATIONS

Land uses contribute to the quality and quantity of water in streams. Runoff from extreme precipitation that is not stored at the ground surface nor absorbed into the ground determines the amount of overland runoff. The intensity of precipitation is determined by climate, vegetation cover, soil infiltration capacity, and the land usage. Removal of vegetation, conversions to impervious landscapes, and stormwater conveyances increase how rapidly water moves to and through the stream. Similarly, land use contributes to the quality of stream water. Improper practices can result in elevated levels of nutrients, sediments, and pathogens in the receiving waterbody. If sources of pollution can be identified, best management practices can mitigate effects downstream.

Establishing a linear assessment protocol upstream of sampling sites that displayed elevated nutrient and sediment concentrations would be a method to further identify or pinpoint areas of inputs. Additional sampling sites added would further characterize the sources. This method uses systematically spaced sampling sites upstream and downstream of possible sites. A review and walkthrough of potential sites can help determine the best method of mitigating the water quality impact.

Best Management Practices (BMP) are techniques used to remedy nutrient and sediment sources. BMPs to control the movement of water can significantly reduce nonpoint source pollution on agricultural, residential, and commercial land uses.

Wayne County Soil & Water Conservation District uses Agricultural Environmental Management (AEM) program to addresses nonpoint source pollution associated with agriculture. AEM is a voluntary, incentive-based program that provides farmers with technical assistance to help plan and implement conservation practices to meet business objectives and that address natural resource concerns. Wayne County SWCD, the local AEM resource professional, has over 300 agricultural operations enrolled in the program since 2005. By participating in AEM, agricultural operations can document environmental stewardship and further improve contributions to the community, economy, and environment.

A review of the agricultural practices in the watershed is recommended. This would be similar to a Tier 3 evaluation in the AEM process. Soil testing could be instituted at the sites in agriculture to evaluate fertilizer application rates and timing. It is possible that a reduction in fertilizer application rates can reduce costs and maintain yields to the agriculture community while reducing losses to downstream systems.

There are numerous Best Management Practices (BMP) that can be tailored to remediate nutrient and soil loss on agricultural operations. Cropland BMPs include buffer strips, diversions, minimum/no tillage and strip cropping, and cover crops. BMPs for livestock operations include barnyard runoff management, waste storage facilities, exclusion fencing, and grazing management. Muck land BMPs are centered on drainage management, including tile drains, cleaned ditches, perimeter ditches, clear outlets, and properly sized culverts. Also muck land benefits from deep-rooting cover crops, companion crops, and minimum tillage. The use of artificial wetlands can reduce the loss of nutrients from muck farms to downstream systems (Makarewicz and Lewis 2000a).

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Figure 1. Fairville Creek watershed and sampling sites, 2017

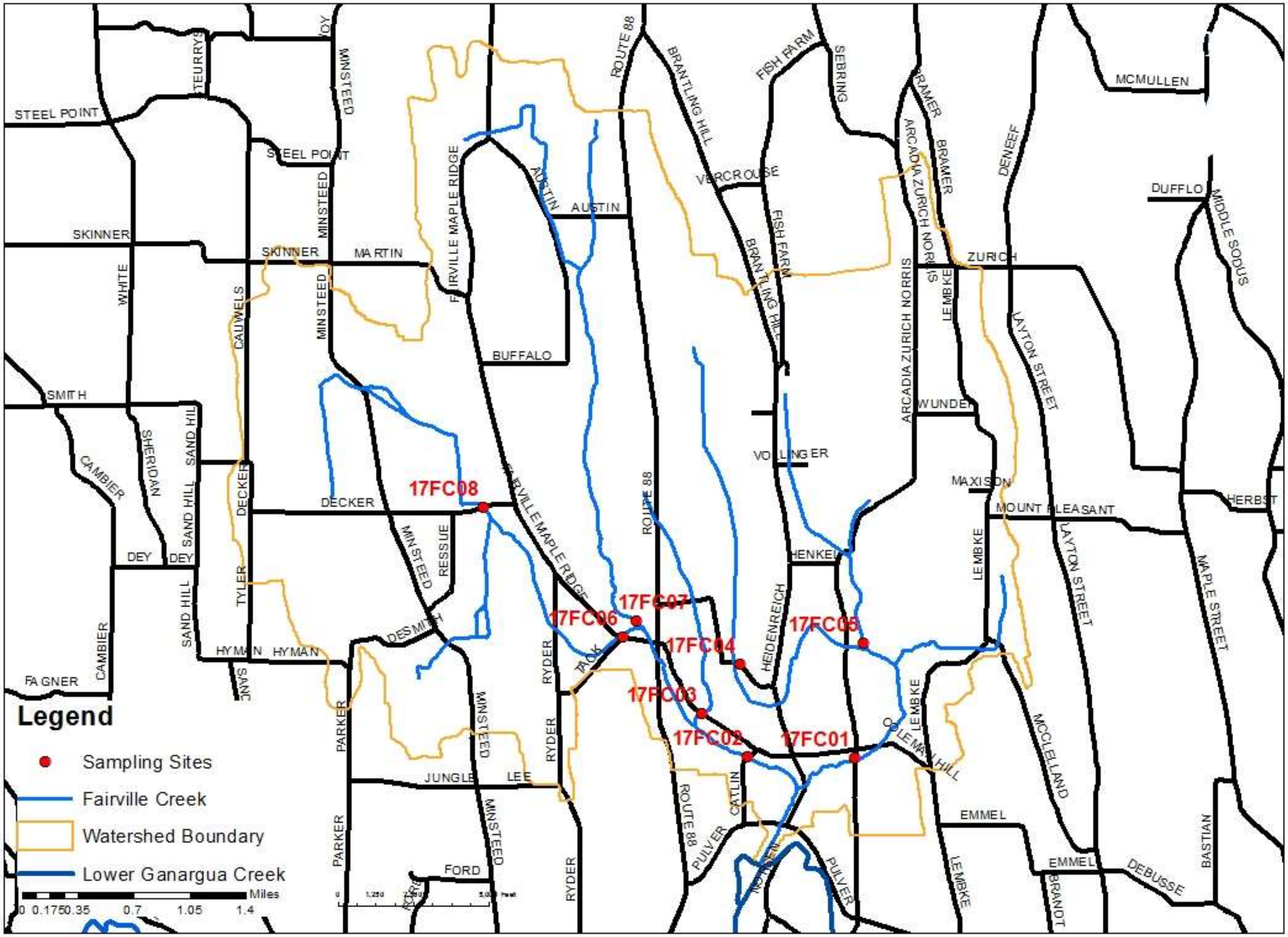

Table 1. Water chemistry results from Fairville Creek. TP = total phosphorus, TN = total nitrogen, NO_X = nitrate-nitrite, TKN = total Kjeldahl nitrogen and TSS = total suspended solids.

SITE	5/22/2017			7/14/2017			9/5/2017			10/30/2017			MEAN		
17FC01	TP	41.7	µg/L	TP	115.6	µg/L	TP	155.3	µg/L	TP	71.4	µg/L	TP	96.0	µg/L
	TN	774	µg/L	TN	1010	µg/L	TN	1080	µg/L	TN	1370	µg/L	TN	1059	µg/L
	NOx	119	µg/L	NOx	125	µg/L	NOx	238	µg/L	NOx	495	µg/L	NOx	244	µg/L
	TKN	655	µg/L	TKN	885	µg/L	TKN	842	µg/L	TKN	875	µg/L	TKN	814	µg/L
	TSS	2.3	mg/L	TSS	7.9	mg/L	TSS	34.9	mg/L	TSS	31	mg/L	TSS	19.0	mg/L
17FC02	TP	81	µg/L	TP	158.5	µg/L	TP	195.7	µg/L	TP	223.4	µg/L	TP	164.7	µg/L
	TN	681	µg/L	TN	1133	µg/L	TN	648	µg/L	TN	2070	µg/L	TN	1133	µg/L
	NOx	154	µg/L	NOx	500	µg/L	NOx	289	µg/L	NOx	1500	µg/L	NOx	611	µg/L
	TKN	527	µg/L	TKN	633	µg/L	TKN	359	µg/L	TKN	570	µg/L	TKN	522	µg/L
	TSS	4.2	mg/L	TSS	12.4	mg/L	TSS	31.5	mg/L	TSS	26.7	mg/L	TSS	18.7	mg/L
17FC03	TP	24.2	µg/L	TP	54.1	µg/L	TP	58.8	µg/L	TP	203.8	µg/L	TP	85.2	µg/L
	TN	446	µg/L	TN	2341	µg/L	TN	402	µg/L	TN	316	µg/L	TN	876	µg/L
	NOx	18.95	µg/L	NOx	425	µg/L	NOx	50	µg/L	NOx	44	µg/L	NOx	134	µg/L
	TKN	427	µg/L	TKN	1916	µg/L	TKN	352	µg/L	TKN	272	µg/L	TKN	742	µg/L
	TSS	2.3	mg/L	TSS	19.7	mg/L	TSS	5.3	mg/L	TSS	6.5	mg/L	TSS	8.5	mg/L
17FC04	TP	93.2	µg/L	TP	181.6	µg/L	TP	278.2	µg/L	TP	139.1	µg/L	TP	173.0	µg/L
	TN	915	µg/L	TN	513	µg/L	TN	778	µg/L	TN	3750	µg/L	TN	1489	µg/L
	NOx	204	µg/L	NOx	51	µg/L	NOx	196	µg/L	NOx	3280	µg/L	NOx	933	µg/L
	TKN	711	µg/L	TKN	462	µg/L	TKN	582	µg/L	TKN	470	µg/L	TKN	556	µg/L
	TSS	2.6	mg/L	TSS	3.8	mg/L	TSS	30.6	mg/L	TSS	32.5	mg/L	TSS	17.4	mg/L
17FC05	TP	66.8	µg/L	TP	118.9	µg/L	TP	N/A	µg/L	TP	74.4	µg/L	TP	86.7	µg/L
	TN	1324	µg/L	TN	1216	µg/L	TN	N/A	µg/L	TN	929	µg/L	TN	1156	µg/L
	NOx	18.95	µg/L	NOx	97	µg/L	NOx	N/A	µg/L	NOx	21	µg/L	NOx	46	µg/L
	TKN	1215	µg/L	TKN	1119	µg/L	TKN	N/A	µg/L	TKN	908	µg/L	TKN	1081	µg/L
	TSS	32.1	mg/L	TSS	3.4	mg/L	TSS	N/A	mg/L	TSS	8.7	mg/L	TSS	14.7	mg/L
17FC06	TP	161.2	µg/L	TP	201.4	µg/L	TP	190.8	µg/L	TP	66.6	µg/L	TP	155.0	µg/L
	TN	1097	µg/L	TN	1768	µg/L	TN	857	µg/L	TN	4510	µg/L	TN	2058	µg/L
	NOx	372	µg/L	NOx	740	µg/L	NOx	381	µg/L	NOx	4180	µg/L	NOx	1418	µg/L
	TKN	725	µg/L	TKN	1028	µg/L	TKN	476	µg/L	TKN	330	µg/L	TKN	640	µg/L
	TSS	26.3	mg/L	TSS	7.7	mg/L	TSS	25.1	mg/L	TSS	27.9	mg/L	TSS	21.8	mg/L
17FC07	TP	45.5	µg/L	TP	70.7	µg/L	TP	200.5	µg/L	TP	107.8	µg/L	TP	106.1	µg/L
	TN	650	µg/L	TN	1165	µg/L	TN	635	µg/L	TN	2600	µg/L	TN	1263	µg/L
	NOx	18.95	µg/L	NOx	379	µg/L	NOx	174	µg/L	NOx	1870	µg/L	NOx	610	µg/L
	TKN	631	µg/L	TKN	786	µg/L	TKN	461	µg/L	TKN	730	µg/L	TKN	652	µg/L
	TSS	4.8	mg/L	TSS	7.3	mg/L	TSS	62.8	mg/L	TSS	18.4	mg/L	TSS	23.3	mg/L
17FC08	TP	243.7	µg/L	TP	270.8	µg/L	TP	209.2	µg/L	TP	117.3	µg/L	TP	210.3	µg/L
	TN	1116	µg/L	TN	1211	µg/L	TN	1110	µg/L	TN	875	µg/L	TN	1078	µg/L
	NOx	205	µg/L	NOx	122	µg/L	NOx	263	µg/L	NOx	109	µg/L	NOx	175	µg/L
	TKN	911	µg/L	TKN	1089	µg/L	TKN	847	µg/L	TKN	766	µg/L	TKN	903	µg/L
	TSS	11.4	mg/L	TSS	5.0	mg/L	TSS	11.8	mg/L	TSS	6.8	mg/L	TSS	8.8	mg/L

Figure 2. Stressed stream analysis, Fairville Creek, May 22, 2017. TP = total phosphorus, TN = total nitrogen, NO_X = nitrate-nitrite, TKN = total Kjeldahl nitrogen and TSS = total suspended solids.

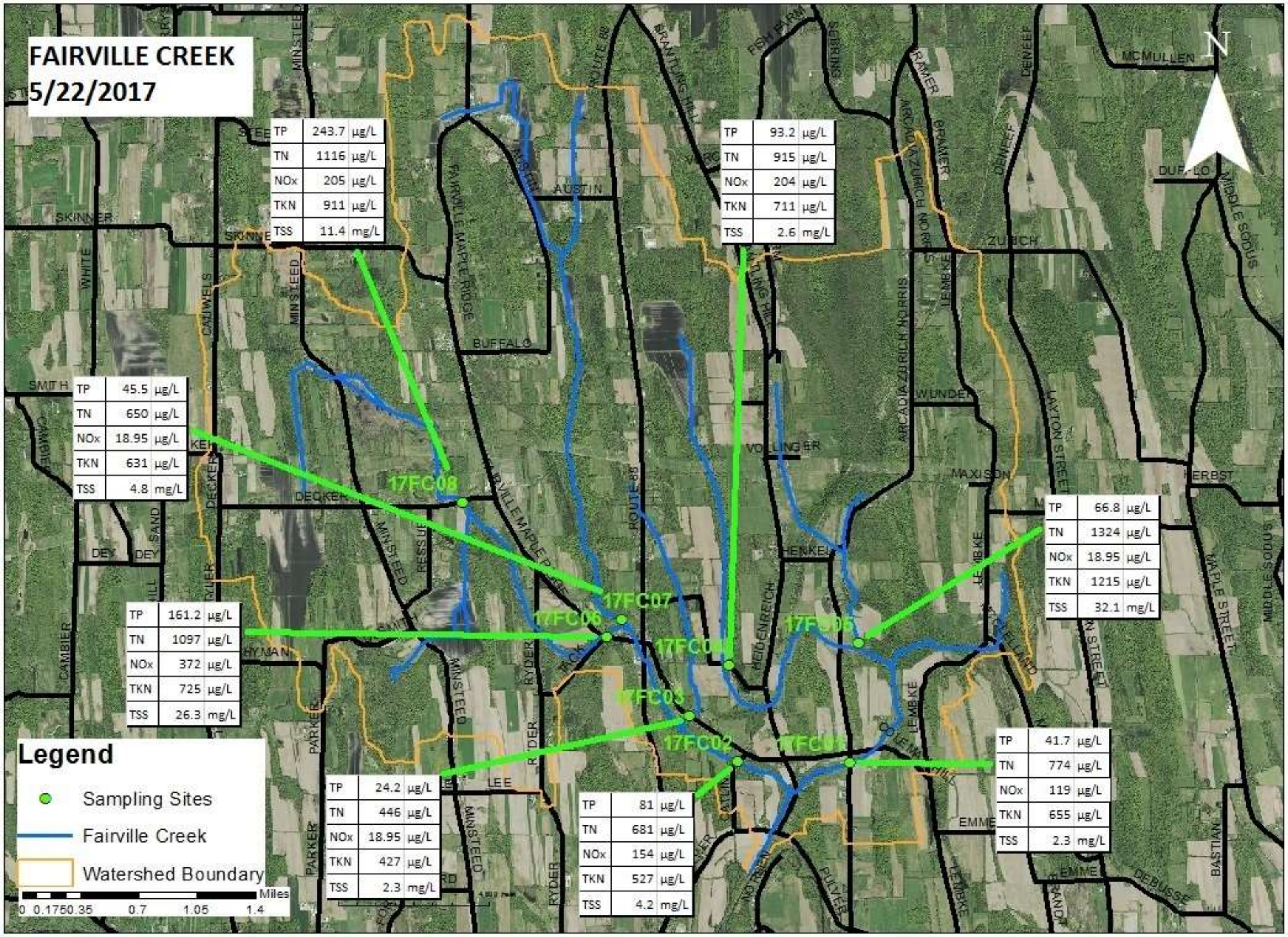

Figure 3. Stressed stream analysis, Fairville Creek, July 14, 2017. TP = total phosphorus, TN = total nitrogen, NO_X = nitrate-nitrite, TKN = total Kjeldahl nitrogen and TSS = total suspended solids.

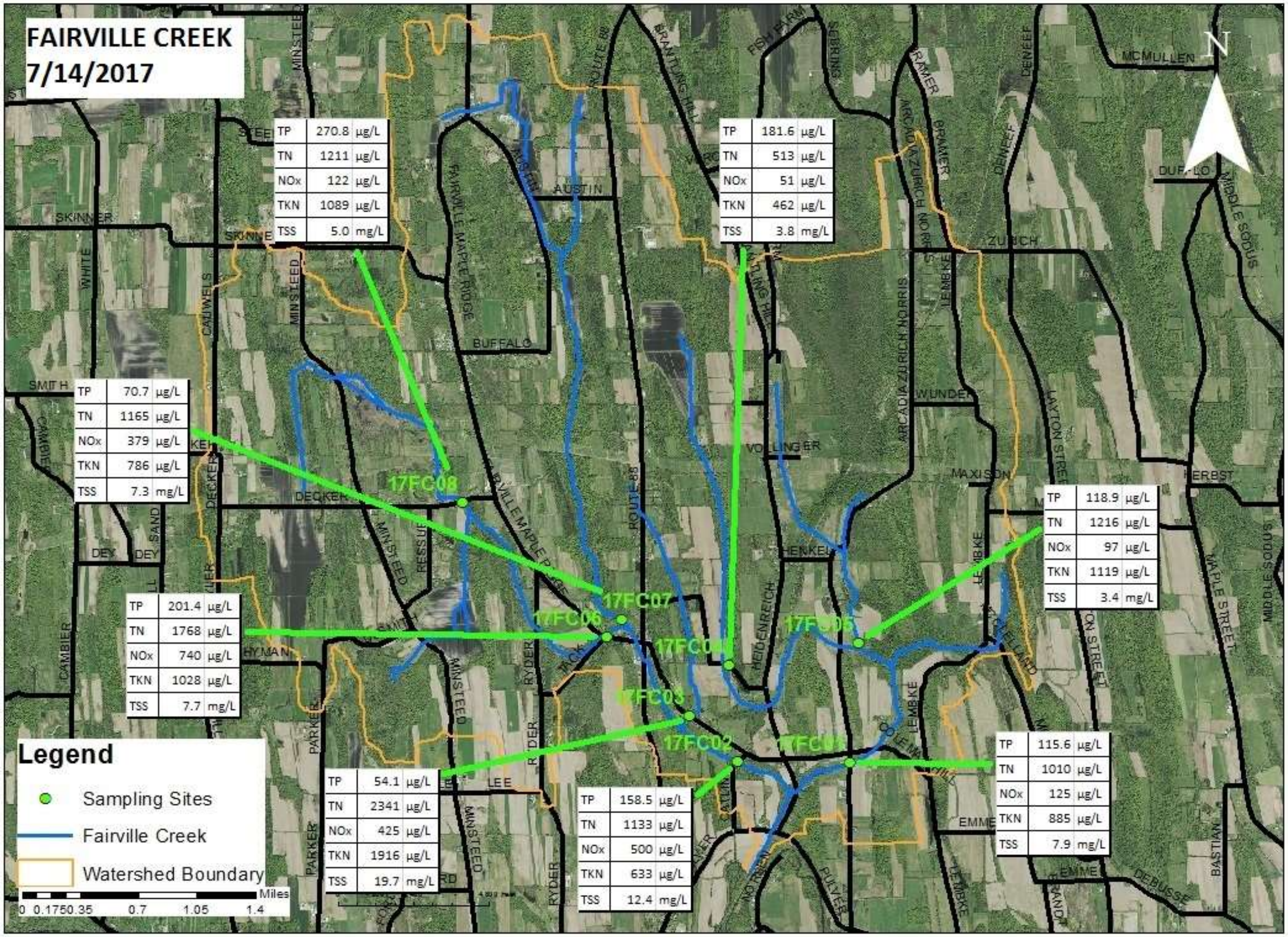

Figure 4. Stressed stream analysis, Fairville Creek, September 5, 2017. TP = total phosphorus, TN = total nitrogen, NO_X = nitrate-nitrite, TKN = total Kjeldahl nitrogen and TSS = total suspended solids.

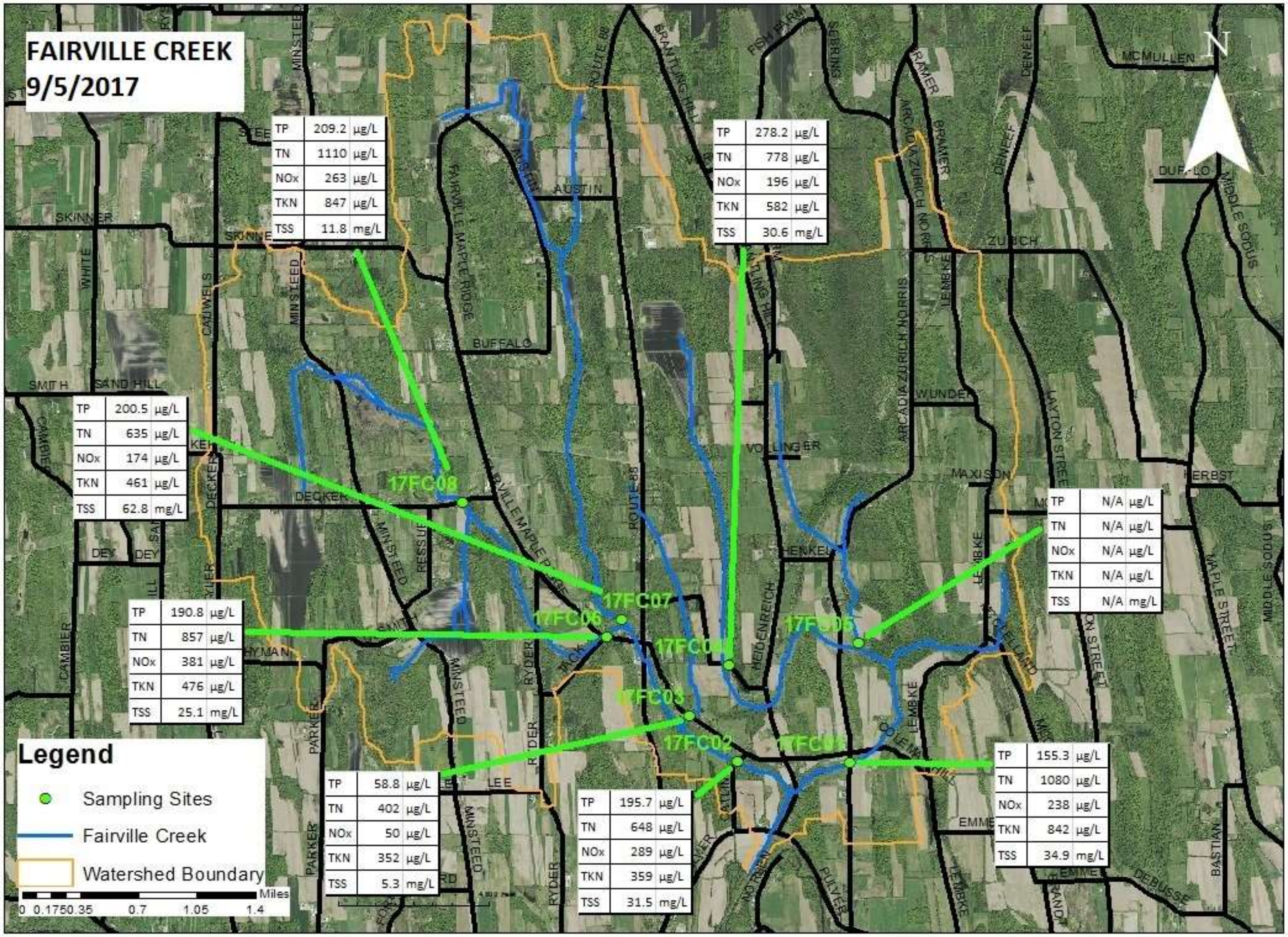

Figure 5. Stressed stream analysis, Fairville Creek, October 30, 2017. TP = total phosphorus, TN = total nitrogen, NO_X = nitrate-nitrite, TKN = total Kjeldahl nitrogen and TSS = total suspended solids.