Ompompanoosuc River Water Quality Study
Summer 2006

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A final report Submitted to the Connecticut River Joint Commission, November 8, 2006 from the Ompompanoosuc Watershed Council

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EXECUTIVE SUMMARY

1. A comprehensive water quality survey of the Eastern Branch and main stem of the Ompompanoosuc River and its major tributaries was conducted from June through August 2006.
2. Samples were collected by volunteers every two weeks at 19 different sites in the towns of Vershire, West Fairlee, Thetford, and Norwich Vermont.
3. All sites were monitored for levels of Escherichia coli (*E. coli*), temperature, pH, and dissolved oxygen. Five sites were monitored for levels of heavy metals.
4. The *E. coli* and metal analysis was conducted at the State of Vermont's LaRosa Laboratories in Waterbury, Vermont. Temperature, pH, and dissolved oxygen were measured *in situ*.
5. All samples were collected and measurements taken in accordance with a previously defined "Quality Assurance Project Plan" (QAPP) to ensure consistency and to limit errors (Ompompanoosuc River Watershed Council, 2006)
6. The average dissolved oxygen (DO) levels ranged from 8.4 to 9.5 mg/l on the Eastern Branch and main stem of the Ompompanoosuc and from 8.4 to 10.0 mg/l on the tributaries. The average DO for all sites met the tolerance of 6.0 mg/l as determined by the Vermont Water Quality Standards.
7. The average pH ranged from 7.5 to 8.0 on the Eastern Branch and main stem of the Ompompanoosuc and from 7.3 to 7.8 on the tributaries. The Vermont Water Quality Standards state that the pH should be between 6.5 and 8.5.
8. The average temperature ranged from 14.4 to 17.8 ^{o}C on the Eastern Branch and main stem of the Ompompanoosuc, and from 13. 1 to 18.1 ^{o}C on the tributaries.
9. Only two sites on the East Branch and main stem of the Ompompanoosuc River had average *E. coli* levels below the state of Vermont's acceptable limit of 77 colonies per 100 ml of sample.
10. All of the tributaries monitored in the study had average *E. coli* levels at or below Vermont's acceptable limit.
11. Individual samples with excessively high E. *coli* levels could be correlated with periods of heavy rainfall.
12. The levels of iron and manganese became elevated slightly downstream from former landfill sites. Only after an extended period of heavy rainfall did the level of iron exceed Vermont's Water Quality Standards.
13. The level of copper measured immediately downstream from the former Ely copper mine greatly exceeded the Vermont Water Quality Standards for both acute and chronic contamination levels throughout the sampling season.

1.0 INTRODUCTION

The Ompompanoosuc River Water Quality Survey monitored the water quality of the 18-mile Eastern Branch and 5-mile main section of the Ompompanoosuc River over a three month period in the summer of 2006. The Ompompanoosuc River, the principle waterway for the towns of Vershire, West Fairlee, Thetford, and Norwich Vermont, is an important natural and scenic resource. It provides numerous recreational activities for area residents and is designated by the state of Vermont as a Class B water and in some areas as a cold water fishery. Sections of the river have been classified by the state as an impaired surface water due to high levels of *E. coli* and heavy metals. At each location where a water sample was collected, levels of *E. coli*, temperature, pH, and dissolved oxygen were monitored. Five of those sites were monitored for levels of iron (Fe), copper (Cu), magnesium (Mg), manganese (Mn), calcium (Ca,) and overall hardness. Data generated from this project will quantify the level of river contamination and help pinpoint specific sources of pollution.

Approximately 15 volunteers helped conduct this survey. Volunteers included members of the West Fairlee Conservation Commission, Thetford Conservation Commission, Norwich Conservation Commission and the Friends of the Ompompanoosuc. Technical expertise and data management were provided by Ben Copans the Watershed Coordinator with the Vermont Department of Environmental Conservation.

2.0 SAMPLE SITES

Figure 1 is a map of the sampling area. Sampling sites are identified alphabetically from the northernmost site in Vershire, VT to the Connecticut River in the south. Sampling also occurred on eight of the Ompompanosuc's tributaries. A prominent feature in this sampling area is 900 acres of conserved land maintained by the Army Corps of Engineers at the Union Village Dam in Thetford. This land is open to the public and is used for many recreational activities including swimming and fishing. The Eastern Branch and the Western Branch of the Ompompanoosuc merge above the Union Village Dam.

Appendix A summarizes each site's GPS coordinates, relative position to the landscape around it, and the surrounding habitat. The sampling sites were primarily in wooded and residential areas. Heavy agricultural use was not in evidence at any of the sites. Two sites (G and H) are located near former landfills. Site E, at School House Brook in West Fairlee, is downstream from the former Ely Copper Mine, an EPA designated Super Fund site.

3.0 METHODOLOGY

Each site was sampled for *E. coli* levels, temperature, dissolved oxygen, and pH. Sites E, F, G, H, and I were monitored for levels of heavy metals. *E. coli* and heavy metal samples were sent to the State of Vermont La Rosa Analytical Laboratory in Waterbury, Vermont where each sample was analyzed under EPA qualified analytical methods. Hand held meters were used to obtain all other measurements. Each meter was calibrated prior to each sampling session.

Samples were collected every two weeks from June 8, 2006 to August 31, 2006. The technique for acquiring samples followed a pre-defined Quality Assurance Process Procedure (QAPP). The sampling sites were divided among the volunteers with different groups taking responsibility for a specific cluster of sites. Field data was regularly sent to Ben Copans for compilation.

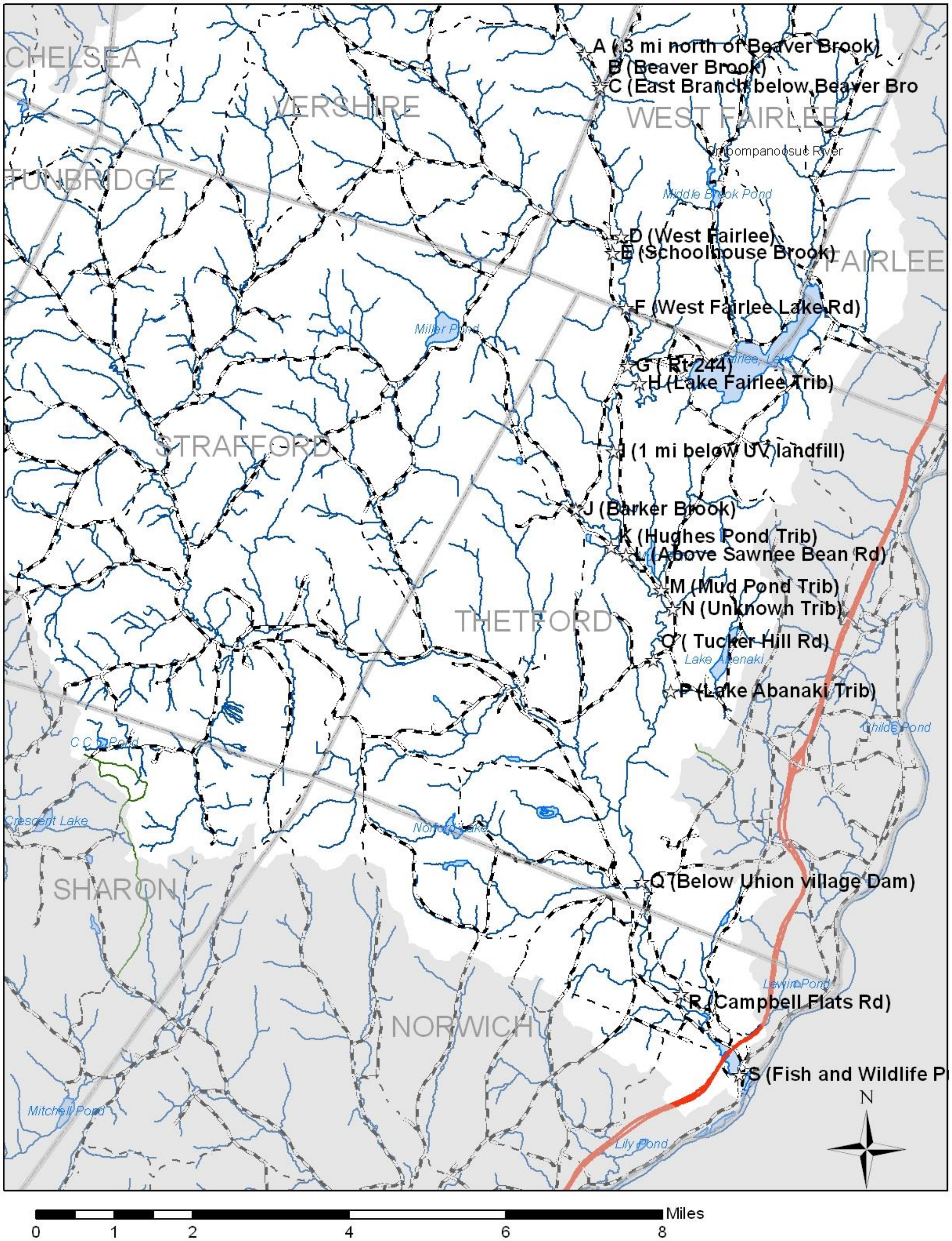


Figure 1: Map of the water sampling sites

4.0 RESULTS

The following sections summarize the data collected during the project. To ensure the accuracy of the results, groups utilized field blanks and field and laboratory duplicates. All samples were collected in accordance to methodologies described in the volunteer's QAPP.

4.1 *E. coli*

Figures 2 and 3 show the *E. coli* levels of the Ompompanoosuc River and its tributaries. Included in each figure is the geometric mean *E. coli* level for each site and Vermont's standard for *E. coli* contamination. (The geometric mean "smoothes" the data by limiting the impact of outlying data values; the EPA recommends using the geometric mean when analyzing data.)

The *E. coli* levels measured on June 8, 2006 were significantly higher than those measured at any other time in the summer. In some cases the level of *E. coli* in the Ompompanoosuc River was 30 times greater than the maximum level of *E. coli* contamination set forth in the state of Vermont's standards. This excessive level of *E. coli* contamination can be correlated with a period of extended heavy rainfall. The night before (June 7, 2006) and the day of sampling, the rain gauge at the Union Village Dam recorded 1" of rainfall. Overall, the rainfall in the two weeks prior to the sample date was 2.30".

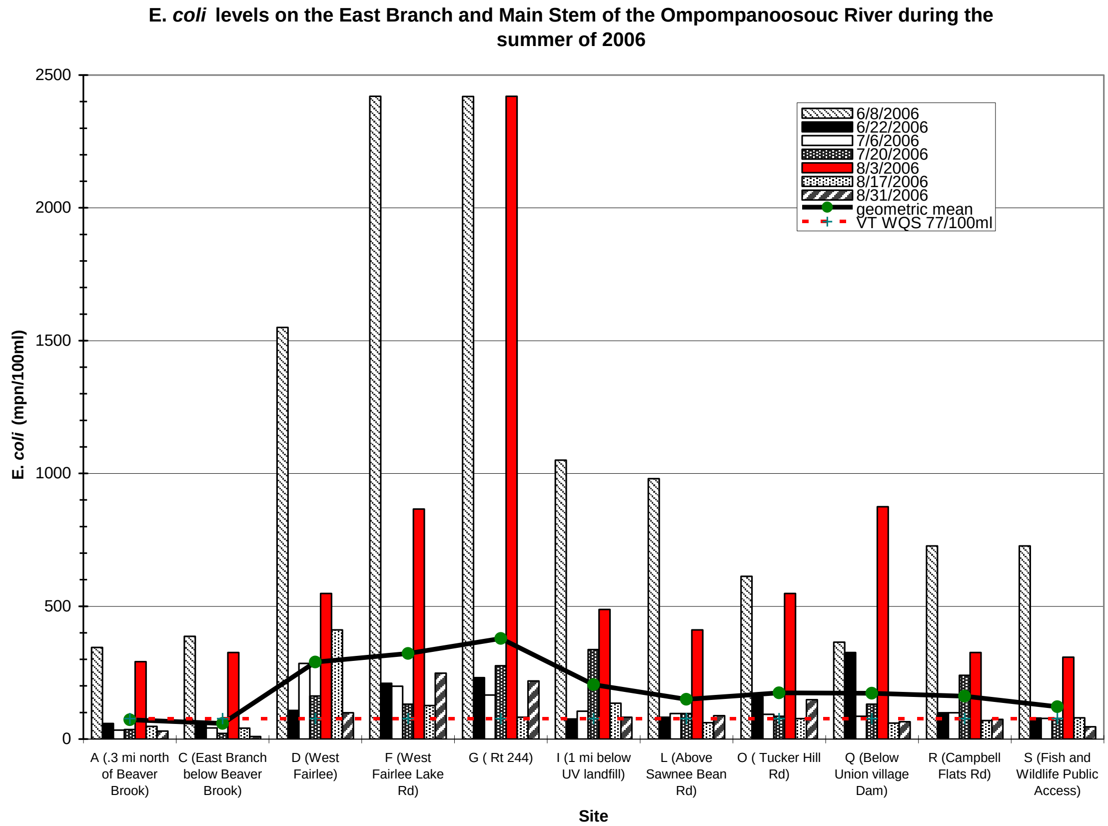


Figure 2: E. coli contamination on the Eastern Branch and main stem of the Ompompanoosuc River in the summer of 2006.

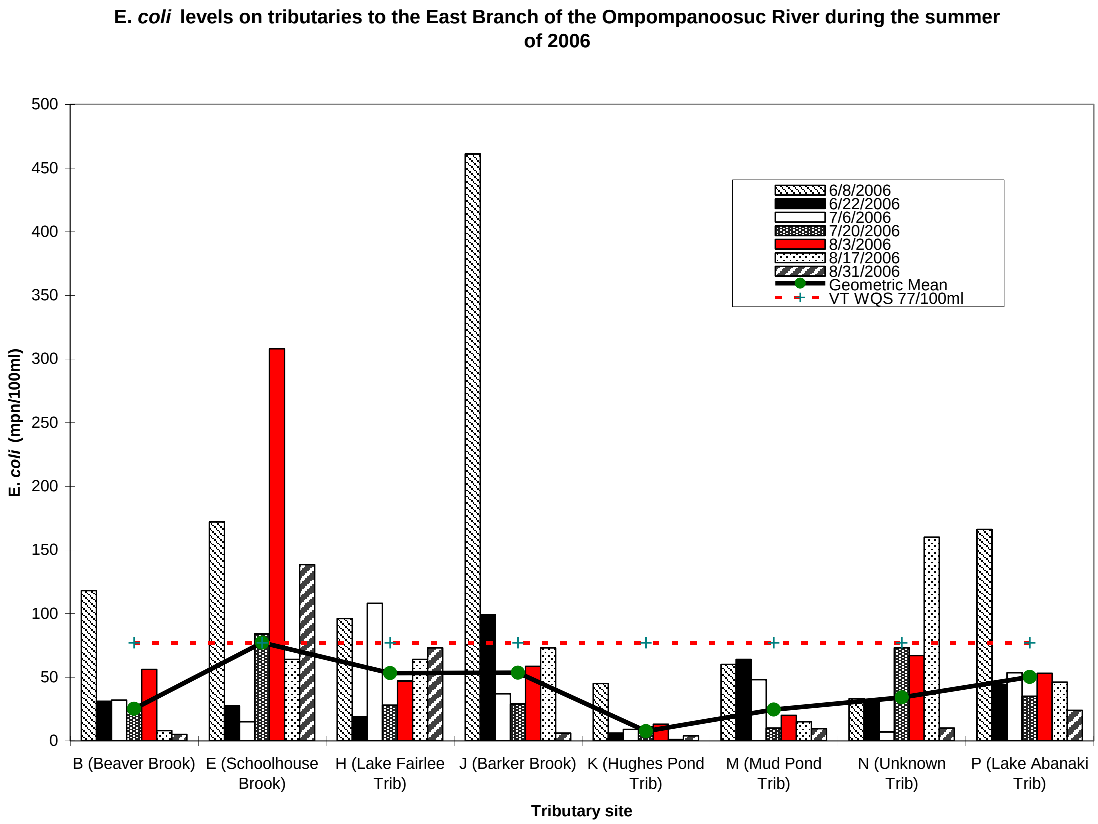


Figure 3: E. coli contamination in tributaries of the Ompompanoosuc River.

On average, the level of *E. coli* contamination in the Ompompanoosuc increases as the river passes through the town of West Fairlee (sites D and F in Figure 3). The high levels of *E. coli* also appear in the northern-most sample site in Thetford (site G). This section of the Ompompanoosuc flows through a relatively dense residential area. It is reasonable to expect that the high levels of *E. coli* are due primarily to leakage from people's septic systems. However, at this time the data can not pinpoint one or two specific sources of *E. coli* pollution. Other sources such as storm water runoff, pet waste and small agricultural operations could have an impact on the measured levels of *E. coli*. Site E, also located in West Fairlee, is on a tributary that feeds into the Ompompanoosuc, and did slightly exceed Vermont's standard, but did not show nearly the same level of *E. coli* contamination as sites D, F and G. The geometric means of *E. coli* levels at the other tributaries monitored in this study were below the Vermont Water Quality Standard for *E. coli*.

There is high confidence in the accuracy of the measured levels of *E. coli*. The average difference between field duplicates was well within the standards required for under the Quality Assurance Plan.

4.2 Heavy Metals

Five of the sample sites were monitored for levels of heavy metals and overall hardness. Figure 4 summarizes these findings. Site E on School House Brook which is a tributary of the

Ompompanoosuc River that links the river to the former Ely copper mine, an EPA superfund site. Sites G and H are located near the former West Fairlee landfill and the former Post Mills landfill.

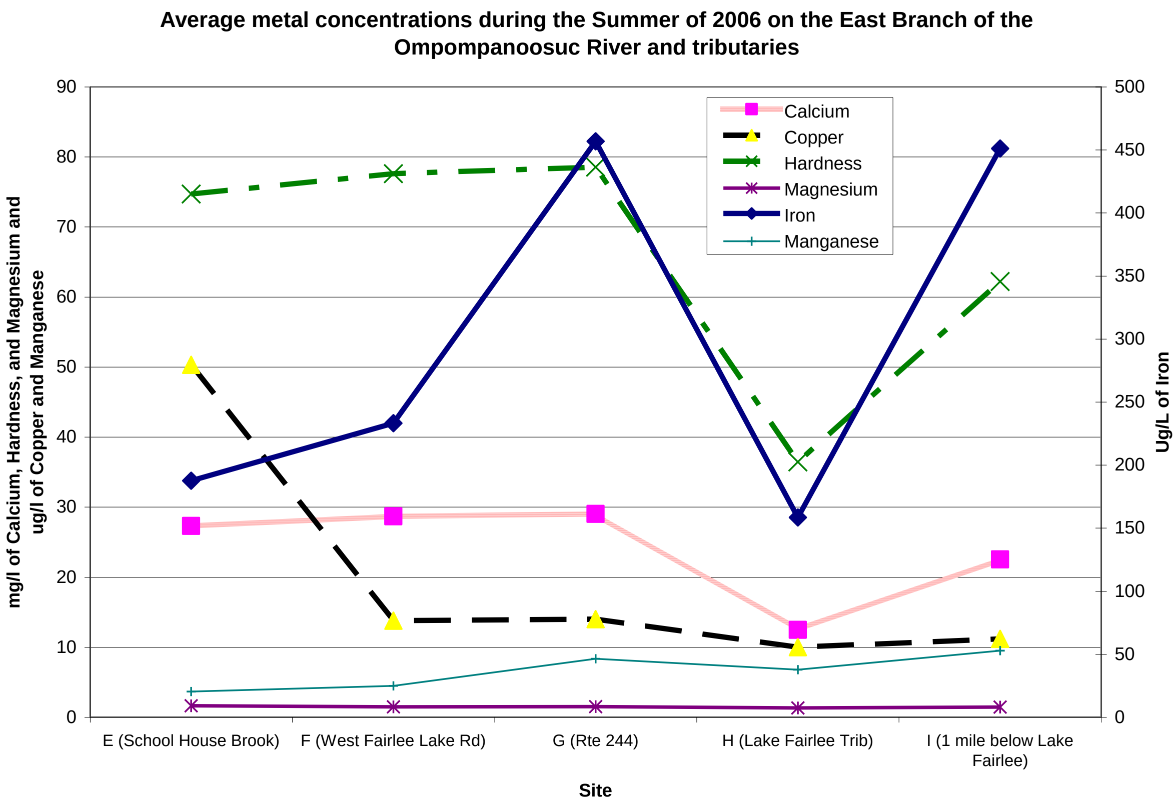


Figure 4: Summary of the level of metals measured in the Eastern Branch of the Ompompanoosuc River and some of its tributaries.

As seen in Figure 4, there is a large variability in the level of metals measured across the five sites. As expected, site E shows an excessively high level of copper. Using the water hardness as a factor in determining the acceptable level of copper allowed by Vermont's standard, water sampled at site E had anywhere from 1.9 to 7.3 times the allowed level of chronic copper levels and from 1.4 to 5.8 times the allowed level of acute copper contamination. Levels of copper in excess of Vermont Water Quality Standards could also be occasionally seen at sites F and G.

There appears to be a spike in the levels of manganese and iron at sites G and I. This may be attributable to their close proximity to landfills. Figure 5 shows the measurement of iron in more detail. In Figure 5, the concentration of iron measured throughout the summer is shown along with the average for each site. Vermont's Water Quality Standards state that the level of iron should not exceed 1000 μg/ml for four consecutive days more than once every three years. The standard is exceeded only once during the sampling period after a period of heavy rain (described previously). The average iron level is well within Vermont's standard. Due to the time intervals between sampling, it is difficult to determine whether the excessive iron level seen after a heavy rainfall persists for an extended period of time.

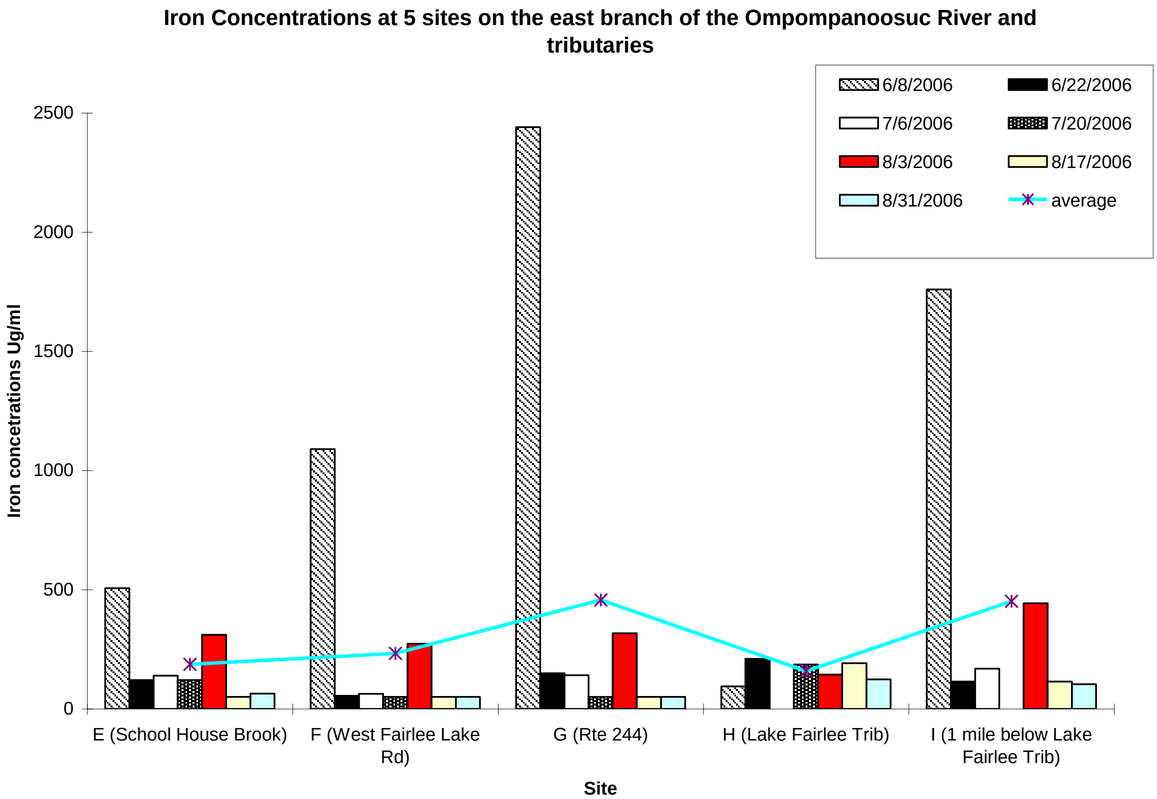


Figure5: Level of iron measured during the summer of 2006 along the Ompompanoosuc and selected tributaries.

4.3 Temperature, pH and Dissolved Oxygen

Figure 6 summarizes the average temperature, pH, and dissolved oxygen levels measured along the Ompompanoosuc. Water temperature at the upper test sites was low (average values of approximately 14.3-15^o C). However, when comparing the Ompompanoosuc before and after mixing with water from Lake Fairlee (at sites G and I, before and after the Lake Fairlee tributary, respectively), the approximate average temperatures climbed from 15 to 16.9 ^{o} C. This increased temperature was also evident at two further sites below the tributary from Lake Fairlee. Water temperatures declined somewhat to approximately 15.5 ^{o} C below the Union Village Dam but increased again, to an approximate mean of 17.3 ^{o} C at site S, above the confluence with the Connecticut River. The average water temperature of the Ompompanoosuc tributaries ranged from 13.1 to 18.1 ^{o}C. All of the measured temperatures meet the Vermont Water Quality Standards.

Dissolved oxygen levels tended to have an inverse correlation with water temperature. Thus, dissolved oxygen levels were highest at the test sites above the Lake Fairlee tributary and at the two sites below the Union Village dam. Dissolved oxygen levels were lower at the three sites immediately below the Lake Fairlee tributary and also at the site above the confluence with the Connecticut River. Similarly, dissolved oxygen levels were low in the Lake Fairlee tributary, which is the largest tributary on this section of the Eastern Branch. This tributary appeared to have the greatest effect on temperature and dissolved oxygen. Although the Mud Pond tributary had an average temperature of 18 º C, it is a small stream and did not appear to have a major effect on temperature of the Eastern Branch.

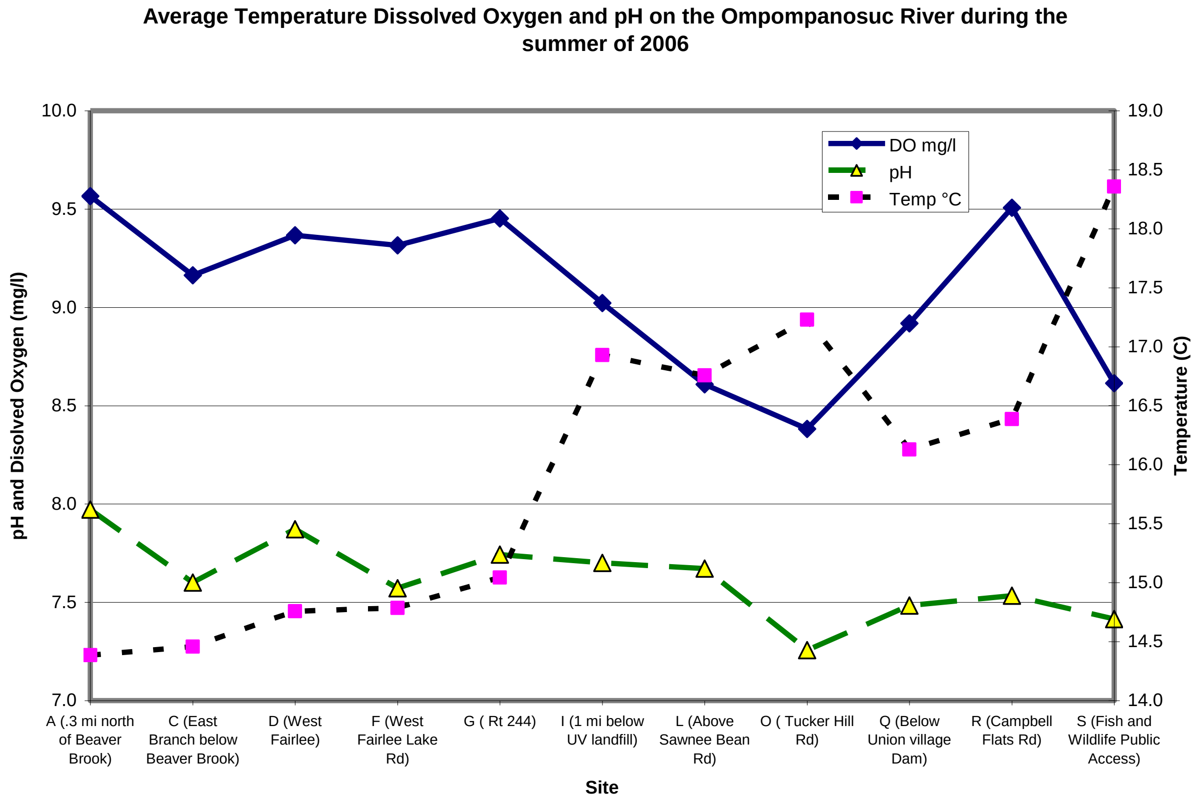


Figure 6: Summary of average temperature, dissolved oxygen, and pH along the Ompompanoosuc River.

The Water Quality Standards reference percent saturation in setting the acceptable level of dissolved oxygen for a body of water. Only one site did not meet the standard on one sampling date. At site K, (on a tributary of the Ompompanoosuc), there was a DO measurement of 6.8 mg/L and a temperature of 14.5 ºC. This corresponds to a saturation percentage of 67%. (The standard is for 6 mg/L DO or 70% saturation.) A dam on this tributary washed out midseason and may have increased the amount of organic material in the stream. This possibly contributed the low DO measurements during one sampling event.

The average pH values declined gradually from upper to lower sampling sites on the East Branch and main stem. All pH measurements were well within Vermont's standards.

5.0 DISCUSSION

The following sections describe the potential impact of the contaminants and environmental parameters measured in this study.

5.1 *E. coli*

Water-borne disease-causing microbes generally exist at very low levels and are difficult and expensive to detect. Therefore, indicator organisms have been used for more than a century to help identify where fecal contamination has occurred, and where there may be a risk of contracting disease-causing microbes. *E. coli,* a universal inhabitant of the intestines of warm-blooded animals, is the accepted indicator organism for freshwater.

Our results indicate that levels of *E. coli* are especially elevated in the East Branch of the Ompompanoosuc at sites D, F and G. These sites are not associated with livestock farms, rather they correspond to relatively dense housing in the village of West Fairlee and the northern part of Post Mills village. Thus it is highly probable that the source may be human fecal contamination from failed septic systems. Such contamination could pose a health risk to swimmers . In fact EPA studies indicate that a geometric mean value of 200 *E. coli* per 100 mL would cause 8 illnesses per 1000 swimmers. In addition, if high levels of fecal matter persist they would encourage growth of aquatic microorganisms and algae, resulting in increased water turbidity, reduced oxygen levels and an environment less suited to fish. Fish kills may even result from such increases in pollution, although dissolved oxygen levels measured during this study do not indicate levels reaching low enough for this to happen.

Of particular note were the very high levels of *E. coli* after heavy rains on 6/8/06 and 8/3/06, indicating *E. coli* running off the landscape. Even under low flow conditions, levels of *E. coli* were consistently elevated. For example, even if the rain event samples from 6/8/06 and 8/3/06 are removed, the geometric mean of the remaining *E. coli* samples on the East Branch and main stem would continue to exceed Vermont Water Quality Standards for *E. coli* at all sites except sites A, C, and S. This suggests a constant source of fecal contamination that is magnified by rain runoff. In addition to sources in the villages of West Fairlee and Post Mills, there may be other sources that prevent the *E. coli* levels from dropping at sites further downstream towards the Connecticut River.

In general, *E. coli* levels in the tributaries were low, with the exception of moderately raised levels in Barker Brook on 6/8/06 and in Schoolhouse Brook on 8/3/06, both following heavy rains. Schoolhouse Brook is the only tributary with a geometric mean of *E. coli* levels that exceeded the Vermont Water Quality standard. Although a couple of small livestock farms exist in the region of the headwaters of Barker Brook the *E. coli* levels were not elevated on 8/3/06 after the second heavy rain. Thus these farms do not appear to be a significant *E. coli* source.

5.2 Metals

Though all three metals investigated in this study are trace nutrients necessary for plant and animal life, these substances can also be toxic.

Copper is listed by the EPA as a priority toxic pollutant and can be damaging to aquatic life at concentrations only slightly higher than those at which it is a trace nutrient. According to EPA studies, non-polluted surface waters generally contain 1 to 10 micrograms per liter of copper. However industrial operations such as the Ely Copper Mine can greatly elevate surface water copper concentrations as exemplified by Schoolhouse Brook. The copper levels in the brook have potential to compromise the aquatic ecosystem there, even when water hardness, which mitigates some of the toxicity of copper, is taken into account. Average copper levels were lower at sites F, G and I on the Eastern Branch of the Ompompanoosuc, but were still slightly above the Vermont Water Quality Standard. It is unclear whether the copper detected at sites downstream of Schoolhouse Brook are entirely due to the effects of this tributary, or whether there are other sources of this pollutant. By contrast with copper, the other metals, iron and manganese, are not listed as priority toxic pollutants. The EPA health reference level for manganese is 300 micrograms /liter and there is also a non-enforceable but recommended Secondary Maximum Contaminant Level (SMCL) of 50 micrograms/liter. Our data show manganese levels slightly exceeded the SMCL at sites G, H and I. However, these values were well below the health reference level. Thus it appears unlikely that manganese in the East Branch is a cause for concern.

The levels of iron at sites G,H and I were approximately double that of the EPA drinking water standard of 300 micrograms /liter. However they were below the EPA recommended chronic level of 1000 micrograms per liter for freshwater. Apart from the elevated levels on 6/8/08 during heavy rains the iron levels were within normal range and did not exceed Vermont Water Quality Standards. Interestingly, both iron and manganese increase together at sites G, H and I, suggesting a common source that is different from the source of copper contamination. Possible sources may be the unofficial West Fairlee landfill, the closed Post Mills landfill or geologic formations.

The East Branch of the Ompompanoosuc River is a cold water fishery and is stocked with trout. The levels of metals in this portion of the river do not appear to be sufficient to accumulate in fish tissues. This conclusion is based on a comparison with studies of the West Branch of the Ompompanoosuc. Although the west branch is much more highly contaminated with metals due to runoff from the Elizabeth Copper mine, EPA studies found no evidence of metals accumulation in fish in these waters.

5.3 Temperature, Dissolved Oxygen and pH

Dissolved oxygen, temperature, and pH were all within Vermont Water Quality Standards for Class B waters. However, in some reaches of the river, the dissolved oxygen levels were below those ideal for trout that require dissolved oxygen levels between 9 and 11 milligrams/liter for embryo and larval survival, although adult trout can tolerate oxygen levels as low as 8 milligrams/liter without impairment. Decomposition of fecal waste may be one factor that reduces oxygen levels. Water temperature was also above the ideal for trout. Since oxygen becomes less soluble as water temperature increases these warm temperatures may also contribute to lower dissolved oxygen values. The lack of a shading, forested buffer along much of the East Branch would appear to contribute to this river warming. An additional significant factor may be warm water flowing from Lake Fairlee.

6.0 RECOMMENDATIONS AND CONCLUSIONS

A review of the data by the project volunteers and officials from the Department of Environmental Conservation resulted in several recommendations for action items regarding the Ompompanoosuc River. Recommendations fall into two categories: recommendations based on specific data collected in the study, and general recommendations for future work.

In response to the measured *E. coli* levels found in the Ompompanoosuc River, the recommended actions are:

- Conduct a septic survey around West Fairlee, VT.
- Survey for potential runoff sources of *E. coli* around West Fairlee, VT to explain high *E. coli* levels during rain events.
- In future sampling, add sites on the West Branch and East Branch above their confluence to determine which may be influencing high *E . coli* levels below the confluence and the Union Village Dam.

In response to the measured level of metals found in the Ompompanoosuc, the recommended actions are:

- Look for iron sources coming from the old West Fairlee landfill.
- Continue to follow the progress of the EPA's effort to clean up the former Ely Copper Mine.

Although the measured temperature and DO were generally within standards, some readings were at the low end and were outside the range recommended for trout species. Recommendations for improving the temperature and DO of the river are:

- Provide more riverside shade (this would also help control erosion).
- Reducing nutrient levels and biological oxygen demand to increase the DO.

The general recommended action at the end of this program is to continue with river sampling next year. Regular sampling of the river would be useful in solidifying our data and providing a historical record of the river's health that would indicate whether remediation activities were having an effect.

In conclusion, with the help of volunteers from several citizens groups and officials from the state of Vermont, the health of the Ompompanoosuc River was monitored over a three month period. Through careful planning and quality assurance procedures, participants in this project feel that their data accurately reflects the river's current state. Though parts of the Eastern Branch of the Ompompanoosuc River were previously designated as impaired, data from this project indicates that the entire stretch of the river from West Fairlee to the Connecticut River may now fall under this category. High levels of *E. coli* were especially evident in the town of West Fairlee, VT and these levels dramatically increased after heavy rainfall. The primary metal contaminating the river was copper, which was to be expected due to the river's close proximity to former copper mines. There was also some evidence to suggest that there may be some leakage of manganese and iron from former landfills. However, conclusions as to the source of this pollution cannot be made without further evidence. The temperature, pH, and dissolved oxygen levels in the river all fell within the range recommended by Vermont's Water Quality Standards. However, some action is recommended to improve these parameters. Data from this study is being made available to the public and will be presented in an open meeting of the Ompompanoosuc River Watershed Council.

REFERENCES

Ompompanoosuc River Watershed Council, 2006. *Vermont General Quality Assurance Project*

Plan for Volunteer, Educational and Local Community Monitoring and Reporting Activities- Ompompanoosuc River Water Quality Sampling. Submitted to the VT DEC June 2006.

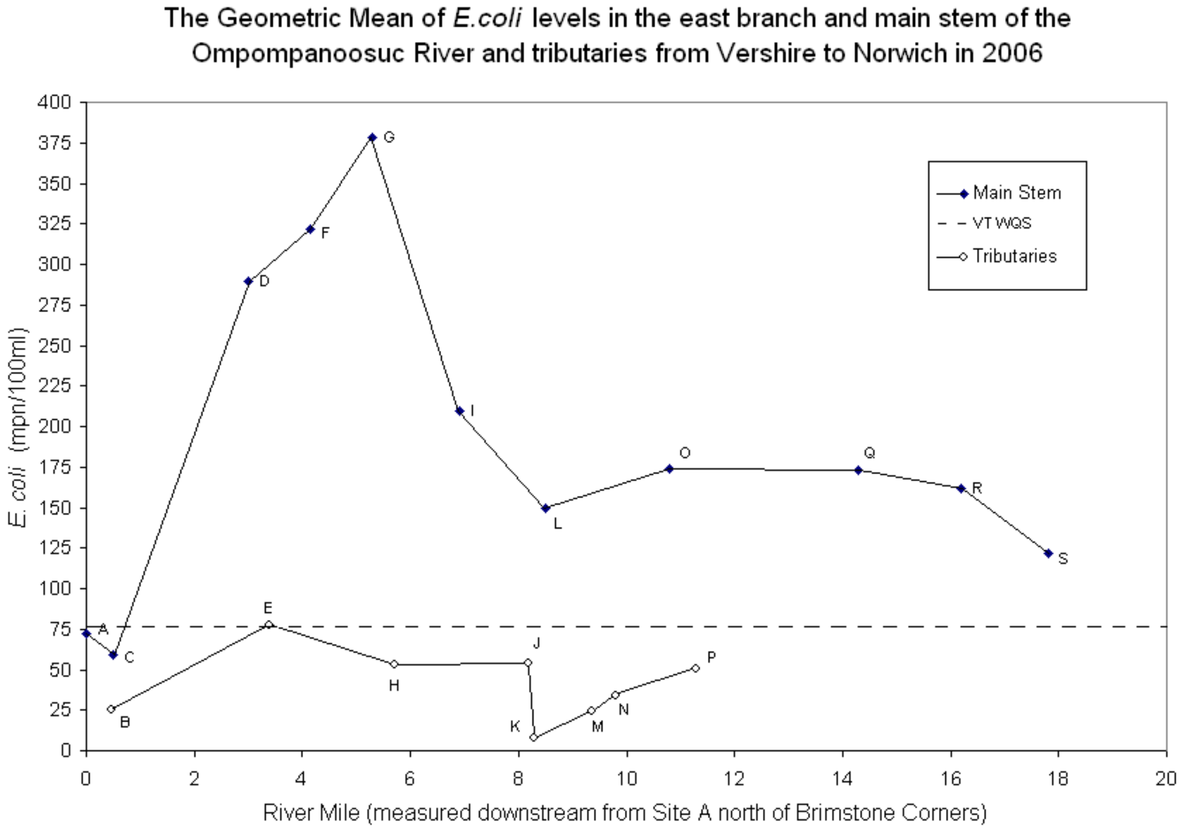
APPENDIX A – SITE DESCRIPTIONS

Site ID	GPS Location Latitude/Longitude		Site Description	Habitat
A	43.94383	72.26977	East Branch of the Ompompanoosuc River at the south downstream side of the Route 113 bridge .3 miles north of Beaver Meadow Rd.	Cobble Bottom, Small shrub buffer. Field and residence upstream
B	43.93837	72.26595	Beaver Meadow Brook Downstream of the culvert from Route 113, above ditch drainage	Below culvert and residential lawn with no buffer. Road and residences along river upstream
C	43.93772	72.26568	East Branch of the Ompompanoosuc River just below Beaver Meadow Rd. Downstream from Bridge (SE)	Cobble bottom. Farm upstream on left bank and forested buffer on right bank.
D	43.91002	72.26050	East Branch of the Ompompanoosuc River, 150 meters north of the Mill St Bridge. Site is accessed through private property down a trail to the river	Gravel/ sand bottom – Right bank open /residential, Left bank field. Small buffer both sides.
E	43.90702	72.26270	School House Brook in West Fairlee. Sample downstream of Rt 113 bridge from north side.	Cobble bottom, Steep gradient. Narrow shrub/forest buffer. Residential upstream
F	43.89687	72.25923	East Branch of the Ompompanoosuc River at Cross Road – north side of river (Upstream)	Mixed sand and cobble substrate. Open fields both sides with 25 foot forested buffer
G	43.88615	72.25902	East Branch of the Ompompanoosuc River- downstream side of Rte 244 Bridge.	Sandy Bottom with forested/ shrub buffer. Open fields on both sides with some residential development.
H	43.88298	72.2559	Lake Fairlee Brook just above the confluence with the East Branch of the Ompompanoosuc River. Hike in through Post Mills Natural Area along the ridge to the confluence. Sample is taken about 40 feet from the confluence to prevent any water mixing.	Predominantly hemlock trees on each side of the river with steep banks. Open field on both sides of the river upstream, with the dump on the left bank and the airport on the right. Sandy and Cobble Bottom.
I	43.87032	72.26264	Ompompanoosuc River accessed	Mixed Woodland with a

			from 921 Barker Road. Turn into the driveway of 921 Barker Rd and park at the second house. Hike down to the bottom of the field and there is a trail down to the river. Sample site is just below a bedrock outcrop.	predominance of evergreens. The river bottom has a lot of ledge here, with some smaller rocks, and there is a sand/silt 'beach' upstream of the site.
J	43.85963	72.27232	Barker Brook, on the upstream side of the Barker Brook Rd culvert-	High gradient stream with cobbles and large gravel. Steep wooded ravine with some housing on each side.
K	43.85278	72.26332	Sawnee Bean Rd Tributary upstream of culvert.	Steep Cobble/ Gravel Bottom stream with a forested watershed. Many ponds and wetlands upstream
L	43.85120	72.25942	East Branch of the Ompompanoosuc River upstream from the Sawanee Bean Bridge. The site is accessed .4 miles from Rt 113 at the sharp corner with parking near the driveway with the mailbox “OAK”. Follow a trail from the corner down to the river. Two small boulders at side of road mark trail head.	Cobble Bottom with mixed forested buffer on both sides. Houses along Sawanee Bean road a few hundred feet from the stream and some farm land upstream.
M	43.84467	72.25042	Mud Pond Tributary where it crosses Route 113. Park at Alden Palmer's house and sample at the downstream side of the culvert from the lawn.	Cobble bottom stream, Forested buffer both sides one side only 10 feet wide with lawns and residencies upstream
N	43.84120	72.24745	Small unnamed stream just south of site M and near transfer station. Stream goes though lawn.	Small Cobble Bottom stream. Forested upper watershed but mowed up to edge of stream just upstream of sampling site
O	43.83182	72.25260	East Branch of the Ompompanoosuc River at Tucker Hill Road. West Side of the covered bridge just above the falls and about 100 feet down stream from the bridge.	Sandy Bottom- Residential and open farm land (currently no farm animals) with a shrub and forested buffer.
P	43.82603	72.24812	Lake Abenaki Tributary at the Buzzelle Bridge Road- upstream of the culvert.	Small cobble stream. Forested banks. Rte 113 upstream with some development
Q	43.79093	72.25570	Ompompanoosuc River below Union Village Dam. Site is accessed from a trail which begins 100ft past the Army Corps gate and just below Avery Brook	A quarter mile below the outflow of the Union Village Dam. The site is forested on both sides but there is a field on the right bank and recreational use of the area.

R	43.77013	72.24580	Ompompanoosuc River from Campbell Flats Road 0.7 miles from Rt 132. This site is just before the road curves away from the river. Sample near white birch tree.	Sand and Cobble Bottom. Just above the confluence with the Connecticut River. Hay fields and residential on both side,s with horses and beef cow upstream
S	43.75517	72.23082	Ompompanoosuc River at the Department of Fish and Wildlife Access off of Rte 5 on Old Bridge Road. Sample from boat launch area.	Sandy Bottom. Residential, agricultural, and interstate upstream. Some forested buffer on both sides of river.

APPENDIX B – GRAPH OF GEOMETRIC MEANS OF E. *COLI* LEVELS AT ALL SITES



APPENDIX C – FIELD NOTES

6/8/06
Heavy rain fall during and before sampling.
West Fairlee: DO meter did not function properly so DO not reported for this date for sites A-G.

Thetford: Rechecked DO calibration @ 9:20: zero = 0.0; DO should be 9.57mg/l @ 17.4C @ 278 elev.; was reading 11.5-11.6 mg/l. Visual inspection of probe: air bubble under membrane - will replace before next sampling day(pbw). Site H was reported as a range of **6.4 -7.8** mg/l so not used in average calculations. Foamy bubbles seen at site I on this date (and all future sampling dates as well)

6/22/06
Samples were hand labeled due to mix up with label delivery. Site E Duplicate metals samples were reported back as Site I, but this has been fixed in the final results.

8/17/06
Norwich: DO meter was calibrated to 100% before I started as usual. When I finished sampling I checked zero and it read 1.5? I'm not sure if it's been off all along as I don't check zero each sampling time. Our meter is supposed to be stable and only need zero calibration when membrane is changed. Craig said to check level of fluid which I will. I'll work on this with Craig.

8/31/06
Thetford: Omit our meter's readings in RED. Our meters were inoperable: pH - dead batts; (Site I and J were not reported for DO and pH) DO probe not tightly capped=membrane problems. George and Peggy found us and let us use their equip(THANKS!) .

Norwich: pH meter not reading correctly. I tried recalibrating after first sampling and meter kept registering a fault code. No pH recorded for sites O-S. DO and temperature worked perfectly.

Data management: Metals data from Site H were pasted incorrectly for 6/22/06 but this has been corrected. pH, DO, and temperature data from sites O-S were pasted incorrectly for 7/6/06 but this has been corrected. On 6/22/06 metal duplicate samples from Site E were reported as Site I. This was corrected (see 6/22/06).

APPENDIX D – *E. COLI* RESULTS

Table 2 E. coli levels at each site on each date of the sampling season as MPN/100ml. Numbers in bold are averages of duplicate samples

	6/8/2006	6/22/2006	7/6/2006	7/20/2006	8/3/2006	8/17/2006	8/31/2006	Geometric Mean
A	345	59	34	36	291	48	30	72.4
B Trib	118	31	32	24	56	**8**	5	25.1
C	387	56	42	21	326	41	**9.5**	58.8
D	1550	108	285	162	548	411	99	290
E Trib	172	**27.5**	15	84	308	64	**138.5**	77.2
F	**2420**	210	199	131	866	**126.5**	248	322.1
G	2419.6	231	166	276	2420	82	219	378.5
H Trib	96	19	**108**	28	47	64	73	53.2
I	1050	**75.5**	105	**336.5**	488	135	82	204.8
J Trib	461	99	37	29	**58.5**	73	6	53.5
K Trib	45	6	9	11	13	1	4	7.5
L	980	82	96	96	411	62	88	149.4
M Trib	60	64	48	10	20	15	**9.5**	24.5
N Trib	**33**	30	7	73	67	160	10	34.1
O	613	159	93	86	548	77	**148**	174.2
P Trib	166	44	**53.5**	35	53	46	24	50.2
Q	365	326	86	131	**875**	60	65	172.7
R	727	99	99	240	326	70	74	161.7
S	727	79	78	78	308	**80**	46	121.7
Average	670	95	84	99	423	85	73	

APPENDIX E – METALS DATA

Average Levels	Iron	Calcium	Copper	Hardness	Magnesium	Manganese
E (School House Brook)	187.49	27.279	50.30	74.69	1.61	20.3
F (West Fairlee Lake Rd)	233.09	28.679	13.78	77.61	1.46	24.8
G (Rte 244)	456.86	29.000	14.00	78.54	1.50	46.3
H (Lake Fairlee Trib)	158.38	12.450	10.00	36.45	1.30	37.6
I (1 mile below Lake Fairlee)	451.00	22.517	11.17	62.20	1.45	52.8

Iron	6/8/06	6/22/06	7/6/06	7/20/06	8/3/06	8/17/06	8/31/06	average
E (School House Brook)	506	**121.5**	139	121	311	50	**63.9**	187
F (West Fairlee Lake Rd)	**1090**	55	63.6	50	273	**50**	50	233
G (Rte 244)	2440	150		50	317	50	50	457
H (Lake Fairlee Trib)	94.3	210		186	144	192	124	158
I (1 mile below Lake Fairlee)	1760	132	169		443	115	104	451

Calcium	6/8/06	6/22/06	7/6/06	7/20/06	8/3/06	8/17/06	8/31/06	average
E (School House Brook)	17.7	**23**	21.7	27.7	27.9	35.6	**37.35**	27.3
F (West Fairlee Lake Rd)	**20.2**	26.5	24.9	29.3	27.9	**35.15**	36.8	28.7
G (Rte 244)	20.7	26.8	25.5	30	27.9	35.8	36.3	29.0
H (Lake Fairlee Trib)	11.3	11.5		12.4	12.4	13.7	13.4	12.5
I (1 mile below Lake Fairlee)	18.6	19.7	19.4		22.8	27.2	27.4	22.5

Copper	6/8/06	6/22/06	7/6/06	7/20/06	8/3/06	8/17/06	8/31/06	average
E (School House Brook)	46.7	**63.5**	68.5	66.2	49.1	26.8	**31.3**	50.3
F (West Fairlee Lake Rd)	**16.55**	16.4	16.7	*15.1*	11.7	**10**	10	13.8
G (Rte 244)	25.1	*13.9*	15.9	*12.2*	10.9	10	10	14.0
H (Lake Fairlee Trib)	10	10		10	10	10	10	10.0
I (1 mile below Lake Fairlee)	17	10	10		10	10	10	11.2

Hardness	6/8/06	6/22/06	7/6/06	7/20/06	8/3/06	8/17/06	8/31/06	average
E (School House Brook)	48.6	**63.25**	59.7	75.9	76.2	97.2	**102**	74.7
F (West Fairlee Lake Rd)	**55.1**	71.5	67.4	79.3	75.6	**95**	99.4	77.6
G (Rte 244)	56.8	72.5	68.9	81.2	75.5	96.7	98.2	78.5
H (Lake Fairlee Trib)	33.1	33.8		36.4	36.1	40	39.3	36.4
I (1 mile below Lake Fairlee)	51.3	54.7	53.7		62.8	75.1	75.6	62.2

Magnesium	6/8/06	6/22/06	7/6/06	7/20/06	8/3/06	8/17/06	8/31/06	average
E (School House Brook)	1.11	**1.395**	1.32	1.66	1.62	2.02	**2.14**	1.61
F (West Fairlee Lake Rd)	**1.12**	1.32	1.26	1.48	1.42	**1.755**	1.85	1.46
G (Rte 244)	1.25	1.35	1.3	1.54	1.44	1.81	1.84	1.50
H (Lake Fairlee Trib)	1.21	1.21		1.30	1.24	1.44	1.39	1.30
I (1 mile below Lake Fairlee)	1.19	1.32	1.28		1.42	1.76	1.74	1.45

Manganese	6/8/06	6/22/06	7/6/06	7/20/06	8/3/06	8/17/06	8/31/06	average
E (School House Brook)	38.5	**16.4**	17.2	18.7	25.5	12.1	***13.5***	20.3
F (West Fairlee Lake Rd)	**89.5**	10.6	11.2	11.4	27.8	**12.2**	*10.7*	24.8
G (Rte 244)	168	20.3	20.4	21	36.8	29.3	28.4	46.3
H (Lake Fairlee Trib)	32.1	47.6		39	34.4	39.7	32.9	37.6
I (1 mile below Lake Fairlee)	124	32.6	31.4		48.5	43.2	36.9	52.8

Results in italics and underlined were reported as "may be biased high" ***Bold samples are averages of duplicate values***