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The health of a river depends upon the types of land uses and conditions within its watershed, especially those in close proximity to the river itself. Although in the past there were numerous industrial uses of the Hoosic River, and thus specific point sources of pollution, of primary concern today are nonpoint sources.

The Hoosic River Watershed Association has been conducting water quality monitoring within the Hoosic River and its tributaries for the past several years. The objectives of the monitoring program include identifying areas of concern, establishing baseline conditions, and following up on previous monitoring efforts. In 2002, the one year in five designated for data gathering by the State agencies, we focused on supplementing and complementing their monitoring program of the Hoosic River. Our program included a total of 20 sites.

There were five sites within the Cheshire Lake and Town of Cheshire area, including three also sampled in 2001. (See Fig. 1.)

CL02.48 at the outflow from the middle basin into the north basin of Cheshire Lake at Farnums Causeway. (2001 site).
CL00.00 at the outflow from the north basin at the north end of Cheshire Lake.
HR37.56 downstream of Cheshire Lake dam, just north of Route 8. (2001 site).
HR36.19 at the bridge over the Hoosic River near the U.S. Post Office in Cheshire.
HR30.53 at the abandoned railroad bridge (Ashuwillicook Trail crossing) in Cheshire Harbor. (2001 site).
The objectives for this cluster of sites were to assess the effects of Cheshire Lake on the Hoosic River (first three sites), and to determine how the wetland area known as "the Jungle" affects water quality (the second two sites).

Farther downstream in the Adams and North Adams area, we sampled at eight sites, including two also sampled in 2001. (See Fig. 2.)

PK00.21 on Peck's Brook just upstream of the Ashuwillicook Trail bridge.
HX00.33 on Hoxie Brook downstream of the pipe that carries the brook beneath Adams.
HX00.91 on Hoxie Brook off West St. and upstream of the pipe.
PC00.29 on Phillips Creek adjacent to the cemetery in North Adams.
HR14.37 at the Heritage Park bridge over the Hoosic River in North Adams.
HR08.96 just downstream of the roll dam and USGS gauging station in North Adams. (2001 site).
NB01.93 on the North Branch just downstream of the Eclipse Dam in North Adams.
NB00.40 on the North Branch at the Marshall St. bridge in North Adams. (2001 site).
There were several objectives for these eight sites. The two tributaries to the Hoosic River in Adams, Pecks and Hoxie Brooks, flow from the Greylock Glen area through Adams and into the flood control chutes. The objective was to obtain baseline conditions for them as well as to determine whether there were any concerns for the underground segment of Hoxie Brook. Phillips Creek was likewise a new site with little baseline information with combined flows from the Tunnel Brook and Phillips Creek watersheds in North Adams.


Figure 1. Locations of monitoring sites at Cheshire Lake and in Cheshire.


Figure 2. Monitoring sites in Adams and North Adams.

The Heritage Park and USGS gauge sites partly bracket the flood control structures on the Hoosic River in North Adams, Heritage Park being near the upstream end of the chutes on the Hoosic River and the USGS gauge site being downstream of the structures on both the Hoosic River and the North Branch of the Hoosic River. The USGS gauge site is a previously monitored site. The two North Branch sites bracket the flood control structures on the North Branch. The Marshall St. site was previously monitored and showed poorer water quality than a site well upstream at the confluence of Hudson Brook with the North Branch. The site just downstream of the Eclipse Dam was intended to help narrow the focus on potential areas of concern.

The final seven sites were on the Green River and Hemlock Brook, two tributaries to the Hoosic in Williamstown, and on Christmas Brook, a tributary to the Green River. They include five also sampled in 2001. (See Fig. 3.)

GW00.39 off Bloedel Park on the West Branch of the Green River upstream of an active farming operation (sampled in 2001).
GN10.62 opposite Southlawn Cemetery upstream of the active farm (sampled in 2001).
GN09.16 at Deer Run Rd. downstream of the active farm (sampled in 2001).
GC01.42 on Christmas Brook off Gale Rd. just downstream of a small pond.
GC00.34 on Christmas Brook downstream of Taconic Golf Course just before the brook enters its pipe to the Green River (sampled in 2001).
GN01.15 on Green River off Eastlawn Cemetery just upstream of Rt. 2 bridge (sampled in 2001). HM06.10 on Hemlock Brook at Margaret Lindley Park.

There were several objectives for these seven sites. The first three sites bracket an active farm and were included to follow up on previous monitoring on the Green River in the area of the active farming activities. The new upstream Christmas Brook site was paired with the downstream site measured in 2001 to determine what might be happening upstream on Christmas Brook. Site GN01.15 was included to assess the overall conditions on the Green River as well as being a site in common with the State's program, thus allowing for some comparisons with their results. A final objective was to obtain baseline data on Hemlock Brook.

## Background.

Both the middle basin and north basin of Cheshire Lake are classified as Class B, high quality waters. From the outlet of the lake downstream to the Adams wastewater treatment plant, the Hoosic River is classified as Class B, cold water fishery (Massachusetts Surface Water Quality Standards, 1995). From the WWTP downstream all the way to the Massachusetts/Vermont border in Williamstown, the river is a class B, warm water fishery. The North Branch from the Massachusetts/Vermont border in Clarksburg downstream to its confluence with the Hoosic is class B, cold water fishery. The tributaries are class B, high quality waters. Finally, the Green River is classified as Class B, cold water fishery (Massachusetts Surface Water Quality Standards, 1995). Hemlock Brook is Class B high quality water as is, by default, Christmas Brook.


Figure 3. Monitoring locations on the Green River, Hemlock Brook, and Christmas Brook.

Our monitoring consisted of two sampling sets of water quality variables. Set I variables include fecal coliform, E. coli, total phosphorous (TP) and total suspended solids (TSS). This set of variables was analyzed by the Berkshire Enviro Laboratory. Set II variables include dissolved oxygen (DO), water temperature, conductivity, pH , nitrate nitrogen, and turbidity. These variables are ones we could measure or analyze with HooRWA's equipment and facilities. Both sets of variables were collected at each of the 20 sites but on different days.

## Methods

Water samples for the set I data were collected from all 20 sites early on the sample day and delivered to the laboratory in Lee by noon the same day. Two samples were collected at each site using sample bottles provided by Berkshire Enviro-Labs. One sample was for bacteria (fecal coliform and E. coli) and the other was for total phosphorous and total suspended solids. Also, two sets of quality control samples (mainly replicate samples) were collected on each sample day. The sites for the replicate samples were varied from one sample day to the next. These samples were collected on 6 days, once per month from May through October (table 1).

The volunteers collecting the samples recorded the current, and recent past, weather conditions as clear, partly cloudy, or cloudy; light rain, moderate rain, or heavy rain; and hot, seasonable, or cool temperatures. They estimated the water level and flow as low, normal, or high. Also, we obtained the USGS gage records for each sample day from the Hoosic gage 01332500 "near Williamstown". Visual observations of turbidity were recorded as well as any unusual conditions or odors.

Table 1. Weather and flow conditions for set I samples.

|  | 0.5 in. Rain <br> last 24 hours $^{1}$ | Air <br> Temperature | Estimated <br> Flow $^{3}$ | Hoosic Gage <br> Reading |
| :--- | :--- | :--- | :--- | :--- |
| Date |  |  |  |  |

1/ "Wet weather" sample defined as one preceded by at least 0.5 in. of rain within the last 24 hours. 2/ Average temperature for the day in degrees F and (C).
3/ By observation in relation to what might be expected on that date.
4/ Flow in cubic feet per second for the date. 7Q10 flow at this gage is 37.4 cfs.
5/ Almost qualified as a "wet weather" sample.
Data and samples for set II were collected on Saturday mornings from the 5 Cheshire area sites by a two person team consisting of a volunteer and HooRWA's monitoring coordinator (table 2). Temperature and dissolved oxygen were measured with a YSI 55 meter and probe on site. Conductivity and pH were also measured on site, using an Extech Oyster meter and separate conductivity and pH probes. A water sample was collected in a Whirl-Pak bag and returned to our laboratory where nitrate nitrogen was determined using a Smart Colorimeter and Lamotte analysis kits, and turbidity was measured with a Lamotte 2020 Turbidity meter. One quality control sample was included on each occasion, either a replicate sample in the field and
laboratory or a split sample in the laboratory. These samples were collected on 7 occasions, once per month as above but on different days, plus one additional sample in August following a significant rain event.

Table 2. Weather and flow conditions for set II samples from the Cheshire area.

| Date | 0.5 in. Rain <br> last 24 hours $^{1}$ | Air <br> Temperature | Estimated <br> Flow $^{3}$ | Hoosic Gage <br> Reading $^{4}$ |
| :--- | :--- | :--- | :--- | :---: |
| $5 / 4 / 02$ | no | $52(11)$ | normal | 373 |
| $6 / 8 / 02$ | no | $65(18)$ | high | 590 |
| $7 / 13 / 02$ | no | $73(23)$ | normal | 89 |
| $8 / 10 / 02$ | no | $71(22)$ | low | 58 |
| $8 / 30 / 02$ | yes $^{5}$ | $63(17)$ | normal | 142 |
| $9 / 14 / 02$ | no | $68(20)$ | low | 48 |
| $10 / 5 / 02$ | no | $65(18)$ | normal | 142 |

1/ "Wet weather" sample defined as one preceded by at least 0.5 in . of rain within the last 24 hours.
2/ Average temperature for the day in degrees F and (C).
3/ By observation in relation to what might be expected on that date.
4/ Flow in cubic feet per second for the date. 7Q10 flow at this gage is 37.4 cfs .
5/ "Wet weather" sample for most of watershed, but appeared not to be from Adams and south.
Data and samples for set II were collected on Monday mornings by two person teams consisting of a volunteer and HooRWA's monitoring coordinator at the eight Adams and North Adams sites (table 3).

Table 3. Weather and flow conditions for set II samples from the Adams and North Adams.

| Date | 0.5 in. Rain <br> last 24 hours ${ }^{1}$ | Air Temperature ${ }^{2}$ | Estimated Flow $^{3}$ | Hoosic Gage Reading ${ }^{4}$ |
| :---: | :---: | :---: | :---: | :---: |
| 5/6/02 | no | 63 (17) | normal | 292 |
| 6/10/02 | no | 67 (19) | high | 369 |
| 7/15/02 | no | 75 (24) | normal | 87 |
| 8/12/02 | no | 78 (26) | low | 58 |
| 8/30/02 | yes ${ }^{5}$ | 63 (17) | normal | 142 |
| 9/16/02 | yes | 66 (19) | high | 341 |
| 10/7/02 | no | 55 (13) | normal | 98 |

1/ "Wet weather" sample defined as one preceded by at least 0.5 in . of rain within the last 24 hours.
2/ Average temperature for the day in degrees F and (C).
3/ By observation in relation to what might be expected on that date.
4/ Flow in cubic feet per second for the date. 7Q10 flow at this gage is 37.4 cfs .
5/ "Wet weather" sample for most of watershed, but appeared not to be from Adams and south.
Data and samples for set II were collected on Tuesday mornings by two person teams consisting of a volunteer and HooRWA's monitoring coordinator at the seven sites on the Green River, Hemlock Brook, and Christmas Brook (table 4).

Table 4. Weather and flow conditions for set II samples from the Green River, Hemlock Brook, and Christmas Brook.

| Date | 0.5 in. Rain <br> last 24 hours | Air <br> Temperature $^{2}$ | Estimated <br> Flow $^{3}$ | Hoosic Gage <br> Reading $^{4}$ |
| :--- | :--- | :--- | :--- | :---: |
| $5 / 7 / 02$ | no | $66(19)$ | normal | 263 |
| $6 / 11 / 02$ | no | $73(23)$ | high | 313 |
| $7 / 16 / 02$ | no | $69(21)$ | normal | 89 |
| $8 / 13 / 02$ | no | $79(26)$ | low | 58 |
| $8 / 30 / 02$ | yes | $63(17)$ | normal | 142 |
| $9 / 17 / 02$ | no | $63(17)$ | high | 119 |
| $10 / 8 / 02$ | no | $46(8)$ | normal | 92 |

1/ "Wet weather" sample defined as one preceded by at least 0.5 in . of rain within the last 24 hours.
2/ Average temperature for the day in degrees F and (C).
3/ By observation in relation to what might be expected on that date.
4/ Flow in cubic feet per second for the date. 7Q10 flow at this gage is 37.4 cfs .

## Results and Discussion

The target classification for the segment of the Hoosic River downstream of Cheshire Lake as far as the Adams Waste Water Treatment Plant would support primary contact recreation (swimming, wading, boating) and cold water fish habitat. Downstream of the Adams Waste Water Treatment Plant the Hoosic should meet the standards for a warm water fishery while the tributaries should be suitable for cold water fish habitat. All segments should support primary contact recreation. Of the water quality variables measured, the indicator bacteria (fecal coliform and $E$. coli) are of considerable value for assessing the suitability for recreational uses while temperature and dissolved oxygen are most closely related to the cold water fish habitat.

Indicator bacteria. Fecal indicator bacteria include several different types of bacteria that are common in the intestines and feces of both warm- and cold-blooded animals. Most are not pathogenic, but may indicate the presence of potentially harmful organisms. Sources include human (e.g. failing or improperly designed septic systems), domestic animals (e.g. cows, horses, dogs), and wild animals (e.g. geese, beavers, deer). The Massachusetts standards for fecal coliform are that they shall not exceed a geometric mean of 200 organisms per 100 ml in any representative set of samples nor shall more than $10 \%$ of the samples exceed 400 organisms per 100 ml . (Massachusetts Surface Water Quality Standards, 1995.) This criterion may be applied on a seasonal basis at the discretion of the Department. The Department of Environmental Protection (DEP) gives the following guidance in the Hudson River Basin 1997 Water Quality Assessment Report, 2000.
a. Dry weather guidance - for less than 5 samples within a 1 month period, less than or equal to 400 colonies per 100 ml sample. Dry weather can be defined as: no or trace antecedent precipitation that causes no more than a slight increase in stream flow.
b. Wet weather guidance - dry weather samples meet the above and wet samples less than or equal to 2000 colonies per 100 ml . Wet weather can be defined as; precipitation antecedent to sampling that results in a marked increase in stream flow.

Since our sampling was only once per month, the threshold of 400 colonies $/ 100 \mathrm{ml}$ was the appropriate standard.

Both of the Cheshire Lake outflow sites showed very low levels of the indicator bacteria (see tables in Appendix A for all the data for each of the variables measured). At all times samples were obtained, the levels were near or below the minimum detectable level of 10 colonies $/ 100 \mathrm{ml}$ for both fecal coliform and $E$. coli. The results at the outflow from the middle basin into the north basin are consistent with our 2001 results, which ranged from 20 colonies $/ 100 \mathrm{ml}$ to 10 colonies $/ 100 \mathrm{ml}$ (Schlesinger, 2001b) at the Farnums Causeway site. Note that our sampling was intended to characterize the outflow from the lake basins as to their effects on the water quality of the river and are neither intended nor sufficient to characterize the water quality of the basins themselves.

Downstream, however, the situation was quite different. The location just downstream of the dam (which is also downstream of a tributary that joins the lake outflow just above the dam) had fecal coliform levels above the acceptable level of 400 colonies $/ 100 \mathrm{ml}$ for two of the five samples, 2100 colonies $/ 100 \mathrm{ml}$ in July and 610 colonies $/ 100 \mathrm{ml}$ in September. The levels at this site in 2001 were likewise above the acceptable level on three of five occasions (Schlesinger 2001b), 1400 colonies $/ 100 \mathrm{ml}$ in July, 3300 colonies $/ 100 \mathrm{ml}$ in August, and 600 colonies $/ 100 \mathrm{ml}$ in September. At the new site in Cheshire (HR36.19), the acceptable level was also exceeded, in May ( 1900 colonies/100ml), July ( 1250 colonies/100ml) and September ( 520 colonies $/ 100 \mathrm{ml}$ ). There are other tributaries that join the river between HR37.56 and HR36.19. Finally, downstream at Cheshire Harbor (and downstream of the wetland area known as "the Jungle"), the levels were above those at the lake outflows but well below the threshold level. Our 2001 sampling showed from 90 to 250 colonies $/ 100 \mathrm{ml}$ for the four dry weather samples and 690 colonies $/ 100 \mathrm{ml}$ for the one wet weather sample, which is consistent with the 2002 results, and below the dry weather and wet weather thresholds.

Seven of the eight sites in Adams and North Adams showed at least one occasion when the bacteria levels exceeded the 400 colonies $/ 100 \mathrm{ml}$ threshold (Appendix A). The August sample at Pecks Brook, during a period of low flow was 500 colonies $/ 100 \mathrm{ml}$. The upstream site on Hoxie Brook was always below the threshold, but the downstream site was 480 colonies/100ml for the May sample, which was a wet weather event. It is worth noting that the downstream site, which is downstream of the pipe beneath Adams, had generally higher bacteria levels than the upstream site.

The Phillips Creek site exceeded the threshold on two dates, but not for the wet weather sample. The June date was close to a wet weather sample with normal flow, at which time 910 colonies $/ 100 \mathrm{ml}$ were present, while the August sample was a low flow day, with 930 colonies $/ 100 \mathrm{ml}$.

The Heritage Park site was quite high in May ( 2000 colonies $/ 100 \mathrm{ml}$ ), right at the maximum level for a wet weather sample, and just above the threshold for dry weather in June ( 410 colonies $/ 100 \mathrm{ml}$ ). At the downstream end of the flood control structures (HR08.96), the threshold was exceeded for 4 of the 6 samples, 720 colonies $/ 100 \mathrm{ml}$ in May, 530 colonies $/ 100 \mathrm{ml}$ in June, 480 colonies $/ 100 \mathrm{ml}$ in July, and 510 colonies $/ 100 \mathrm{ml}$ in September. The results for this latter site in 2001 were similar, with 2400 colonies $/ 100 \mathrm{ml}$ for June's wet weather sample, 610 colonies $/ 100 \mathrm{ml}$ in July and 430 colonies $/ 100 \mathrm{ml}$ in August (Schlesinger 2001b).

On the North Branch, on the three dates with low flow conditions, the Marshall St. site exceeded the 400 colonies $/ 100 \mathrm{ml}$ threshold, having 570 colonies $/ 100 \mathrm{ml}$ in July, 3000 colonies $/ 100 \mathrm{ml}$ in August, and 410 colonies $/ 100 \mathrm{ml}$ in September, while the location just downstream of the dam had 760 colonies $/ 100 \mathrm{ml}$ in August. In 2001 at the Marshall St. site, the bacteria levels were above the threshold for all 5 samples (Schlesinger 2001b). The levels in 2001 were 1460 colonies/ 100 ml in May, 870 colonies $/ 100 \mathrm{ml}$ in June, 1100 colonies $/ 100 \mathrm{ml}$ in July, 1300 colonies $/ 100 \mathrm{ml}$ in August, and 2100 colonies $/ 100 \mathrm{ml}$ in September.

The two sites upstream of the farm on the Green River had bacteria levels well below the critical threshold of 400 colonies $/ 100 \mathrm{ml}$ on all six days. However, the July sample from downstream was 490 colonies $/ 100 \mathrm{ml}$, slightly above the threshold. The flow conditions were listed as low on this date. These results are similar to those from 2001 (Schlesinger 2001c). The two upstream sites had levels ranging from 10 colonies $/ 100 \mathrm{ml}$ to 120 colonies $/ 100 \mathrm{ml}$, while the downstream site was 500 colonies $/ 100 \mathrm{ml}$ in August, and from 20 colonies $/ 100 \mathrm{ml}$ to 230 colonies $/ 100 \mathrm{ml}$ otherwise. These results indicate that the improved conditions found in 2001, compared with our 2000 results (Schlesinger 2001a), were holding steady. In 2000, our samples at those two sites were 810 colonies/100ml in May, "too numerous to count" (TNTC) in June, 918 colonies $/ 100 \mathrm{ml}$ in August and 1073 colonies $/ 100 \mathrm{ml}$ in September at the Southlawn site and 2380 colonies $/ 100 \mathrm{ml}$ in May and 1780 colonies $/ 100 \mathrm{ml}$ in September at the Bloedel Park site.

The upstream site on Christmas Brook exceeded the bacteria threshold of 400 colonies $/ 100 \mathrm{ml}$ during the May high flow conditions ( 1900 colonies $/ 100 \mathrm{ml}$ ) and the July low flow conditions ( 1100 colonies $/ 100 \mathrm{ml}$ ), while the downstream site (GC00.34) was above the threshold in May ( 560 colonies $/ 100 \mathrm{ml}$ ) , a wet weather sample, and June ( 880 colonies $/ 100 \mathrm{ml}$ ), almost wet weather ( 0.40 in . rain on June 17 and 0.19 in . rain on June 18). In 2001, the downstream site exceeded the threshold for the one wet weather sample ( 3300 colonies $/ 100 \mathrm{ml}$ ) and was below for the dry weather samples, ranging from 20 colonies $/ 100 \mathrm{ml}$ to 120 colonies/100ml (Schlesinger 2001c).

Site GN01.15, which is downstream of the confluence of Christmas Brook with the Green River, was above the 400 colonies $/ 100 \mathrm{ml}$ threshold on the same two days as GC00.34. May's samples was 480 colonies $/ 100 \mathrm{ml}$, while June's samples was 690 colonies $/ 100 \mathrm{ml}$. Our wet weather sample in 2001 showed 500 colonies $/ 100 \mathrm{ml}$ while the dry weather samples ranged from 60 colonies $/ 100 \mathrm{ml}$ to 310 colonies $/ 100 \mathrm{ml}$. The samples in 2000 were considerably higher, the August sample at 194 colonies $/ 100 \mathrm{ml}$ being the only one below the threshold. The other four ranged from 405 colonies $/ 100 \mathrm{ml}$ to 4000 colonies $/ 100 \mathrm{ml}$. As noted for the active farm area, the results in 2002 confirm the improvement in conditions found in 2001 compared with 2000.

Hemlock Brook had, without exception, the lowest levels of bacteria on all days for this group of sites, ranging from 10 colonies $/ 100 \mathrm{ml}$ to 90 colonies $/ 100 \mathrm{ml}$.

Total phosphorous. Natural sources of phosphates include the soil, phosphate-containing rocks, animal wastes, and decomposing plants. The main human, industrial and agricultural sources include sewage, fertilizers, detergents, disturbed lands, and wastes from barnyard and other domesticated animals. Together with nitrates, phosphorous in excess amount accelerates eutrophication, and decreases dissolved oxygen. Phosphorous is generally the nutrient in shortest supply in fresh water systems and thus the limiting factor for the growth of aquatic plants. It is likely to be more of a concern in lakes and ponds than in rivers and streams.

Massachusetts does not have a specific standard for phosphorous. The EPA's Volunteer Stream monitoring: a Methods Manual (1997) states that any concentration over $0.05 \mathrm{mg} / \mathrm{L}$ will likely have an impact while concentrations over 0.1 almost certainly will. We selected $>0.05 \mathrm{mg} / \mathrm{L}$ as an alert value for our use.

One sample from the north basin outflow exceeded our "alert" threshold of $0.05 \mathrm{mg} / \mathrm{L}$, being $0.09 \mathrm{mg} / \mathrm{L}$ in July. The September sample from just downstream of the dam was $0.06 \mathrm{mg} / \mathrm{L}$ and in Cheshire, the July and October samples were $0.06 \mathrm{mg} / \mathrm{L}$ and $0.07 \mathrm{mg} / \mathrm{L}$ respectively. Our program in 2001 was limited to fecal coliform so we have no comparable data for any other variable. Samples in 1997 by the Department of Environmental Protection (DEP) (Hudson River Basin 1997 Water Quality Assessment Report, 2000) at the site downstream of the dam were all below our alert level.

Samples from the next segment of the watershed, in Adams and North Adams, had 4 samples that exceeded our "alert" threshold of $0.05 \mathrm{mg} / \mathrm{L}$. One was from Phillips Creek during the low flow in August ( $0.06 \mathrm{mg} / \mathrm{L}$ ), two at the Heritage Park site ( $0.08 \mathrm{mg} / \mathrm{L}$ in May and $0.09 \mathrm{mg} / \mathrm{L}$ in July), and one at the USGS gauge site ( $0.06 \mathrm{mg} / \mathrm{L}$ in May).

Within the final segment in Williamstown, the two sites on Christmas Brook were the only ones to exceed our alert threshold of $0.05 \mathrm{mg} / \mathrm{L}$, upstream on 4 of 6 days, and downstream on 3 of 6 days. The upstream samples were $0.09 \mathrm{mg} / \mathrm{L}, 0.23 \mathrm{mg} / \mathrm{L}, 1.42 \mathrm{mg} / \mathrm{L}$, and $0.08 \mathrm{mg} / \mathrm{L}$, respectively, in June, July, August, and September, while the downstream samples were $0.10 \mathrm{mg} / \mathrm{L}, 0.11 \mathrm{mg} / \mathrm{L}$, and $0.07 \mathrm{mg} / \mathrm{L}$, respectively, in May, June, and July. The August sample at the upstream site was very high. The sample site is within a few feet of the dam that forms the pond, with no other inflows between the site and the pond. This day had very little outflow from the pond. The pond is well on its way to becoming a marsh, may have received overflow from failing septic systems in the past, and thus could be the source the high level of phosphorous.

Total suspended solids Suspended solids include silt and clay particles, plankton, algae, fine organic debris, and other particulate matter. Suspended solids can serve as carriers of toxins. They can affect water clarity, which in turn may result in heating of the water. Sources of total solids include industrial discharges, sewage, fertilizers, urban runoff, and soil erosion.

Massachusetts does not have a specific standard for total suspended solids. The EPA’s Volunteer Stream monitoring: a Methods Manual (1997) states that concentrations are likely to increase during rainfall or if earth-disturbing activities are occurring without adequate erosion control. We selected a threshold of $>10$ $\mathrm{mg} / \mathrm{L}$ as an alert value.

Our samples in the Cheshire area included four that exceeded our alert threshold of $10 \mathrm{mg} / \mathrm{L}$. The site just downstream of the dam was just above the threshold in September, at $12 \mathrm{mg} / \mathrm{L}$. In October, the north basin outflow and the downstream site were both slightly above the threshold ( $13 \mathrm{mg} / \mathrm{L}$ and $12 \mathrm{mg} / \mathrm{L}$ respectively) while the site farther downstream in Cheshire was $73 \mathrm{mg} / \mathrm{L}$, well above the threshold. Downstream of the "Jungle", the level was below the threshold.

The Adams/North Adams area samples included five that exceeded our alert threshold. Three of these were associated with the wet weather sampling in May, the other two with the low flow conditions in July. The high levels in May are not surprising as increased suspended solids would be expected from storm runoff. These occurred at Heritage Park ( $26 \mathrm{mg} / \mathrm{L}$ ), Marshall St. ( $14 \mathrm{mg} / \mathrm{L}$ ), and the USGS gauge site ( $24 \mathrm{mg} / \mathrm{L}$ ). The high levels at Phillips Creek ( $12 \mathrm{mg} / \mathrm{L}$ ) and Heritage Park ( $17 \mathrm{mg} / \mathrm{L}$ ) in July are not easily explained, especially since the levels at the other sites were quite low. Construction activities without adequate erosion control barriers can be a source of particulate matter even during low flow conditions.

Of the 42 samples collected in the Williamstown segment, 10 were above our alert threshold while 14 were below the minimum detectable limit. The wet weather samples in May showed four sites above the threshold, all three of the main Green River sites (Southlawn Cemetery at $14 \mathrm{mg} / \mathrm{L}$, Deer Run at $12 \mathrm{mg} / \mathrm{L}$, and Eastlawn Cemetery at $24 \mathrm{mg} / \mathrm{L}$ ) and the downstream Christmas Brook site at $19 \mathrm{mg} / \mathrm{L}$. The upstream Christmas Brook site was below the minimum detectable limit on this date, but above the alert threshold on the next three dates, at $14 \mathrm{mg} / \mathrm{L}$ in June, $60 \mathrm{mg} / \mathrm{L}$ in July, and especially high at $519 \mathrm{mg} / \mathrm{L}$ in August. A possible explanation for the results at this site is that algae from the pond are the primary suspended particles. Algae may not yet have been present in May, but in August, the sample collectors noted the presence of "pond scum" on their field notes.

Conductivity Conductivity is a measure of the ability of water to pass an electrical current. It is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). Organic compounds like oil, phenol, alcohol, and sugar do not conduct electrical current very well and therefore have a low conductivity when in water. Provides a very general measure of overall water quality. The EPA's Volunteer Stream monitoring: a Methods Manual (1997) states that fresh water streams supporting good mixed fisheries generally have a range between 150 and 500 microsiemens $/ \mathrm{cm}$. We used $>500$ for our alert value.

None of our sites showed conductivity levels above our alert threshold of 500 microsiemens $/ \mathrm{cm}$. All of our measurements from the Cheshire area were below 350. In the Adams/North Adams segment, the Heritage Park site did stand out as the lowest quality (highest level) on all sample dates based on this measurement. In the Williamstown segment, the downstream Christmas Brook site always had the highest readings, and was consistently higher than the upstream site.
$p H$ The pH of a water body indicates the alkalinity or acidity of the water. It affects many chemical and biological processes. The largest variety of aquatic animals prefer a range of 6.5-8.0 standard units (SU). A pH value outside this range reduces the diversity in the stream because it stresses the physiological systems of most organisms and can reduce reproduction. Low pH can also allow toxic elements and compounds to become mobile and "available" for uptake by aquatic plants and animals. This can produce conditions that are toxic to aquatic life, particularly to sensitive species like rainbow trout. Changes in acidity can be caused by atmospheric deposition (acid rain), surrounding rock, and certain wastewater discharges. The Massachusetts standard states that pH shall be in the range of 6.5 through 8.3 standard units.

Our May samples from the lake basin outflows and from just below the dam were slightly above the State's threshold for pH of 8.3 SU . The outflow from the middle basin was 8.33 SU , the north basin was 8.44 SU and the site downstream of the dam was 8.43 SU . The DEP report of their 1997 monitoring program cites a pH of 9.3 in July and 8.5 in Aug. for the site downstream of the dam. However, that report states that high pH values are likely to be found in a carbonate-based watershed and thus would not necessarily be a cause for concern.

Our May sample from upstream on Hoxie Brook was 8.31 SU, just above the State's threshold of 8.3. That was the only sample from the Adams/North Adams segment that exceeded the upper threshold and none were below the lower threshold of 6.5 SU . For the Williamstown segment, there was only one reading that was below the low threshold of 6.5 SU , at the upstream Christmas Brook site, which was 6.48 SU in October. Although much of the Hoosic watershed consists of carbonate materials, Stone Hill (from which Christmas Brook flows) is composed partially of glacial till. Thus, pH values might be less alkaline there than for most of the Hoosic River and its other tributaries.

Nitrate nitrogen Nitrates are compounds of nitrogen found in several different forms in terrestrial and aquatic ecosystems. Nitrates are essential plant nutrients, but in excess amounts they can cause significant water quality problems. Together with phosphorus, nitrates in excess amounts can accelerate eutrophication, causing dramatic increases in aquatic plant growth and changes in the types of plants and animals that live in the stream. This, in turn, affects dissolved oxygen, temperature, and other indicators. Excess nitrates can cause hypoxia (low levels of dissolved oxygen) and can become toxic to warm-blooded animals at concentrations of $10 \mathrm{mg} / \mathrm{L}$ or higher under certain conditions. Sources of nitrates include wastewater treatment plants, runoff from fertilized lawns and cropland, failing on-site septic systems, runoff from animal manure storage areas, and industrial discharges that contain corrosion inhibitors. According to the EPA's Volunteer Stream monitoring: a Methods Manual (1997), they are generally less than $1 \mathrm{mg} / \mathrm{l}$. Over $10 \mathrm{mg} / \mathrm{L}$
would be expected to have an impact on fresh water systems. We selected a threshold of $>1 \mathrm{mg} / \mathrm{L}$. as an alert value

During 2002, none of the five sites in the Cheshire area were close to the alert threshold of $1 \mathrm{mg} / \mathrm{L}$. Indeed, all were below $0.25 \mathrm{mg} / \mathrm{L}$ on all seven days sampled. DEP's samples from 1997 at the downstream dam site were likewise well below the threshold. In the Adams/North Adams segment, only our July samples at Heritage Park ( $1.44 \mathrm{mg} / \mathrm{L}$ ) and at the USGS gauge $(1.02 \mathrm{mg} / \mathrm{L})$ exceeded the alert threshold. And for the Williamstown segment, nitrate nitrogen levels never exceeded the alert level, although from late August through October they were relatively high at the downstream Christmas Brook site, possibly the result of activities on the Taconic Golf Course. At the upstream Christmas Brook site, they were consistently very low, possibly the result of biological activity in the pond.

Turbidity Turbidity is a measure of water clarity (i.e., how much the material suspended in water decreases the passage of light through the water). Suspended materials include soil particles (clay, silt, and sand), algae, plankton, microbes, and other substances. These materials are typically in the size range of 0.004 mm (clay) to 1.0 mm (sand). Higher turbidity reduces the amount of light penetrating the water, which reduces photosynthesis and the production of oxygen. Also, suspended materials can clog fish gills, reducing resistance to disease in fish, lowering growth rates, and affecting egg and larval development. As the particles settle, they can blanket the stream bottom, especially in slower waters, and smother fish eggs and benthic macroinvertebrates.

Sources of solids which cause turbidity include soil erosion, waste discharge and urban runoff. Turbidity often increases sharply during and after a rainfall. Natural or background turbidity varies from less than 1.0 NTU (nephelometric turbidity units) in mountain streams to more than 50 NTU in larger rivers after rainfall events. A change of 10 NTU's above background is considered a significant change. The Massachusetts stardards state that Class B waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this Class. The State's standard does not include specific NTU (nephelometric turbidity units) values. We selected >10 NTU as an alert threshold.

Turbidity levels appeared to be within a normal range for all samples from the Cheshire area in 2002. However, in the Adams/North Adams area, the turbidity level exceeded our alert level of 10 NTU at Phillips Creek (11.1 NTU) for the wet weather sample in late August. The designation of the August 30 sample as "wet weather" was based on rainfall of 1.4 inches at a location in the northern part of the watershed. However, it appeared that the southern part from Adams south received little or no rain during that period. All the North Adams sites exceeded the threshold for another wet weather sample in September. Phillips Creek was 33 NTU, Heritage Park 23 NTU, below the Eclipse Dam 29 NTU, at Marshall St. 25 NTU, and at the USGS gauge site 24 NTU. At this same time, the Adams sites were higher than normal ( $7 \mathrm{NTU}, 8.5 \mathrm{NTU}$ and 10 NTU ) but still below the threshold. As is true for total suspended solids, high levels of turbidity are likely following rain storms.

For the Williamstown segment, the turbidity results are similar to the total suspended solid results. The Christmas Brook upstream site had, with one exception, the highest readings, exceeding our alert threshold of 10 NTU in July (11.9 NTU), August (23.2 NTU), and September (15.8 NTU). The one exception was in June on Hemlock Brook, at which time the turbidity did not exceed the alert threshold, but at 7.6 NTU was 3 or more units higher than at any of the other sites. The downstream Christmas Brook site was above the alert threshold in August ( 10.58 NTU). Also of note was that the wet weather sampling on August 30 did not show high turbidity levels while the wet weather sample in May for total suspended solids did show high levels. A possible explanation is that the sampling on August 30 was about 18 hours after the rain, well
within the criteria for a wet weather sample but potentially sufficient time for flashy high gradient streams to return to normal clarity.

Water temperature The rates of biological and chemical processes depend on temperature. Aquatic organisms from microbes to fish are dependent on certain temperature ranges for their optimal health. Optimal temperatures for fish depend on the species: some survive best in colder water, whereas others prefer warmer water. Benthic macroinvertebrates are also sensitive to temperature and will move in the stream to find their optimal temperature. If temperatures are outside this optimal range for a prolonged period of time, organisms are stressed and can die.

For fish, there are two kinds of limiting temperatures, the maximum temperature for short exposures and a weekly average temperature that varies according to the time of year and the life cycle stage of the fish species. Reproductive stages (spawning and embryo development) are the most sensitive stages.
Temperature affects the oxygen content of the water (oxygen levels become lower as temperature increases); the rate of photosynthesis by aquatic plants; the metabolic rates of aquatic organisms; and the sensitivity of organisms to toxic wastes, parasites, and diseases.

Causes of temperature change include weather, removal of shading streambank vegetation, impoundments (a body of water confined by a barrier, such as a dam), discharge of cooling water, urban storm water (e.g., runoff from parking lots, driveways, roadways, and lawns) and groundwater inflows to the stream. The Massachusetts standard is that the water temperature shall not exceed $68^{\circ} \mathrm{F}\left(20^{\circ} \mathrm{C}\right)$ in cold water fisheries and shall not exceed $83^{\circ} \mathrm{F}\left(28^{\circ} \mathrm{C}\right)$ in warm water fisheries.

Water temperature readings in the Cheshire area taken at the times the water samples were collected showed higher than desirable temperatures (for a cold water fishery) from the lake basin outflows and the site immediately downstream of the dam during July and August, ranging from 20.1 degrees C to 23.6 degrees C. The temperatures farther downstream were cooler, indicating the effects of shading on the water temperature. Water temperatures taken midmorning may be several degrees lower than the actual daily maximum since temperatures will generally rise during the day, peaking in early afternoon. Thus, to fully assess the temperature regime in terms of fish habitat would require far more detailed monitoring.

In the Adams/ North Adams segment, water temperature readings made at the times the water samples were collected were below the appropriate thresholds with one exception. The temperature at the Marshall St. site was 20.1 degrees C, just above the threshold of 20 degrees C, in August. In the Williamstown segment, water temperature readings were higher than the threshold temperature for two sites in August, one on the Green River at GN01.15 (20.3 degrees C) and the second at the upper Christmas Brook site at GC01.42 (20.2 degrees C).

Dissolved oxygen The stream system both produces and consumes oxygen. It gains oxygen from the atmosphere and from plants as a result of photosynthesis. Running water, because of its churning, dissolves more oxygen than still water, such as that in a reservoir behind a dam. Respiration by aquatic animals, decomposition, and various chemical reactions consume oxygen. Wastewater from sewage treatment plants often contains organic materials that are decomposed by microorganisms, which use oxygen in the process. Other sources of oxygen-consuming waste include stormwater runoff from farmland, urban streets, feedlots, and failing septic systems. If more oxygen is consumed than is produced, dissolved oxygen levels decline and some sensitive animals may move away, weaken, or die.

DO levels fluctuate seasonally and over a 24 -hour period. They vary with water temperature and altitude. Cold water holds more oxygen than warm water and water holds less oxygen at higher altitudes. Thermal
discharges, such as water used to cool machinery in a manufacturing plant or a power plant, raise the temperature of water and lower its oxygen content. Aquatic animals are most vulnerable to lowered DO levels in the early morning on hot summer days when stream flows are low, water temperatures are high, and aquatic plants have not been producing oxygen since sunset. The Massachusetts standard states that the DO level shall not be less than $6.0 \mathrm{mg} / \mathrm{L}$ or $75 \%$ saturation in cold water fisheries nor less than $5.0 \mathrm{mg} / \mathrm{l}$ or $60 \%$ saturation in warm water fisheries.

Our readings for the Cheshire segment in 2002 showed only one that was below the state's threshold for DO ( $6.0 \mathrm{mg} / \mathrm{L}$ ), at the outflow from the north basin in July ( $4.85 \mathrm{mg} / \mathrm{L}$ ). However, the Cheshire Harbor site had readings below the threshold in terms of percent saturation of DO on four dates, the threshold being $75 \%$ while the readings were $71.4 \%, 70.8 \%, 66.2 \%$, and $65.2 \%$ from August through October. To fully assess this variable in terms of fish habitat, predawn measurements are required as dissolved oxygen is likely to be lowest at that time of day.

Within the Adams/North Adams segment, our readings in 2002 were well above the thresholds of $6.0 \mathrm{mg} / \mathrm{L}$ for a cold water fishery and $5.0 \mathrm{mg} / \mathrm{L}$ for a warm water fishery for all the sites. However, within the Williamstown segment, our readings showed levels that were below the state's threshold of $6 \mathrm{mg} / \mathrm{L}$, at the outflow from the pond at the upstream site on Christmas Brook in July ( $2.63 \mathrm{mg} / \mathrm{L}$ ), August ( $3.11 \mathrm{mg} / \mathrm{L}$ ), September ( $4.26 \mathrm{mg} / \mathrm{L}$ ) and October ( $5.32 \mathrm{mg} / \mathrm{L}$ ). This small tributary would not be fish habitat in any case, and the readings in the Green River downstream of Christmas Brook would indicate that the conditions in Christmas Brook are having no adverse effects on the Green River for fish habitat.

## Conclusions

It appears that the outflow from Cheshire Lake does not adversely affect the water quality of the Hoosic River for primary recreational uses. Additional monitoring sites within the Collins Brook watershed may be required to find the source of the higher-than-desirable levels of bacteria just downstream of the dam, found through this year's monitoring program and in previous years. The May results also found very high bacteria levels at the next site downstream suggesting that the Thunder Brook and Kitchen Brook watersheds might also need to be investigated further.

As might be expected, the temperature of the outflow from Cheshire Lake and the dissolved oxygen levels are at times higher and lower, respectively, than optimum for a cold water fishery. Neither the DO nor temperature readings were taken at optimal times for evaluating these indicators (DO too late in the day and temperature too early in the day). Therefore, although the sites downstream (HR36.19 and HR30.53) never had readings above or below the respective thresholds, they did approach the thresholds, especially for dissolved oxygen. More detailed monitoring is necessary before concluding that this segment of the river does not meet the criteria for a cold water fishery, but there may be some cause for concern.

The beneficial effects of the wetland ("the Jungle") are especially apparent for the set I parameters, all of which are below the thresholds on all sample dates at the Cheshire Harbor site but not in the town of Cheshire. The same is true for most set II parameters, although the dissolved oxygen levels at the Cheshire Harbor do approach the $\mathrm{mg} / \mathrm{L}$ threshold on the last two sample dates and tended to be lower than in Cheshire. Thus a more detailed assessment of that variable is warranted.

Overall, our monitoring in 2002 showed the lake outflows and this initial segment of the Hoosic River to be in generally good condition. As in the past, bacteria levels are still of concern downstream of Cheshire Lake. Locating the specific source, or sources, of bacteria will require additional efforts and should focus on the tributaries that join the Hoosic River north of Cheshire Lake.

The two tributaries in Adams appear to be in reasonably good condition. There was only the one elevated bacterial level in Pecks Brook during low flow. Hoxie was quite good, but with some apparent degradation between the upstream and downstream sites.

There were two bacteria samples from the tributary in North Adams, Phillips Creek, that exceeded the threshold for fecal coliform, once during moderate flow and once during low flow. There is some development in both the Phillips Creek and Tunnel Brook subwatersheds, with more proposed for Tunnel Brook. Additional monitoring at the confluence of the two may be warranted to determine whether just one or both are contributing to the problem.

The conditions at the Heritage Park site were overall the worst of these eight sites. The State's 2002 monitoring program included two sites upstream of ours, at Hodges Cross Rd. in North Adams and at Lime St. in Adams. When comparisons between the 3 sites are available, it should be possible to determine whether, and where, future monitoring should take place.

The levels of bacteria at the Marshall St. site exceeded the thresholds less in 2002 than in 2001. However, generally the water quality indicators were lower than at its comparison site upstream. Additional monitoring sites between the Eclipse Dam and Marshall St. might narrow the area of concern.

The final downstream site at the USGS gauge, which receives flow from the main stem of the Hoosic River and the North Branch, might be expected to reflect an average of the conditions from the two. In general, that would appear to be the case.

Overall, the condition of the river within the Adams/North Adams segment of the watershed appears to be slightly better in 2002 than it was in 2001. But there is still room for improvement.

Our monitoring in 2002 provides additional evidence of improved conditions within the Green River compared with those found in 2000 and earlier. Conditions in the area of the active farming operations appear to be similar to conditions in 2001, and thus improved from earlier years.

Although Christmas Brook continues to show levels of indicator bacteria higher than the thresholds for class B waters, they are well below the levels found prior to the extensive work on the sewer infrastructures on Gale Rd. and Spring St. Because Christmas Brook is a minor tributary to the Green River, its condition appears to have little effect on the overall condition of the Green.

Hemlock Brook appears to be in quite good condition at the location of our monitoring. Further monitoring downstream from Margaret Lindley Park would be needed to determine whether that situation holds along the entire length of the tributary.

## Action Plan

Conduct additional monitoring within the Collins Brook watershed, following a watershed survey of this subwatershed. Also, the Thunder Brook and Kitchen Brook watersheds should be investigated further. Finally, continued monitoring of this segment of the river is needed to provide a more complete and reliable understanding of the water quality.

A watershed survey of the Phillips Creek subwatershed should be conducted, followed by additional monitoring upstream of the 2002 site. Additional monitoring between the Eclipse Dam and the Marshall St.
sites on the North Branch would be useful to narrow in on the source(s) of the elevated bacteria levels at Marshall St. And continued monitoring of the main stem/south branch from Adams through North Adams is needed to follow up on the DEP and HooRWA 2002 programs within this area of the Hoosic watershed upstream of the Heritage Park site.

Additional temperature monitoring should be done to establish whether, and where, the Green River is meeting the conditions for a cold water fishery. Although a watershed survey of the Green River was made several years ago, recent land use changes would justify another survey to update the information. Continued monitoring of the Green River, to establish year-to-year variation, and more complete monitoring of Hemlock Brook, to establish baseline conditions, would be valuable.

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## References Cited

Hudson River Basin 1997 Water Quality Assessment Report. 2000. Report \# 11/12/13-AC-1. Prepared by: Laurie E. Kennedy and Mollie J. Weinstein. 98 pages.

Massachusetts Surface Water Quality Standards, 1995. 314 CMR 4.00. "Unofficial" version online at URL http://www.state.ma.us/brp/wm/files/314cmr4.pdf.

Schlesinger, Richard C. 2001a. Year 2000 results from bacteria monitoring in the Green River. Report on file with the Hoosic River Watershed Association.

Schlesinger, Dick. 2001b. Monitoring the Hoosic: North Branch and Main Stem in 2001. Report on file with the Hoosic River Watershed Association and available on their website - www.hoorwa.org.

Schlesinger, Dick. 2001c. How Clean the Green? Part II. Report on file with the Hoosic River Watershed Association and available on their website - www.hoorwa.org.

Testing the Waters Chemical and Physical Vital Signs of a River. 1997. By Sharon Behar. 211 pages.
Volunteer Stream monitoring: a Methods Manual. 1997. EPA 841-B-97-003. 211 pages. Office of Water.

## Appendix A. Data tables.

| Table 1. | Fecal coliform (colonies/100mL) |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | May | June | July | Aug | Sept | Oct. |
| Site ID | Location | 5/14 | 6/18 | 7/23 | 8/20 | 9/24 | 10/15 |
| CL02.48 | middle basin | 30 | $n s^{1 /}$ | 10 | ns | $\mathrm{mdl}^{2 /}$ | 10 |
| CL00.00 | north basin | mdl | mdl | mdl | ns | 10 | 20 |
| HR37.56 | below dam | 310 | 350 | $2100^{3 /}$ | ns | 610 | 370 |
| HR36.19 | in Cheshire | 1900 | 340 | 1250 | ns | 520 | 400 |
| HR30.53 | Cheshire Harbor | 240 | 210 | 160 | 150 | 210 | 210 |
| PK00.21 | Pecks Brook | 30 | 30 | 220 | 500 | 340 | 110 |
| HX00.91 | upper Hoxie Brook | 20 | 40 | 150 | 90 | 20 | 70 |
| HX00.33 | lower Hoxie Brook | 480 | 70 | 70 | 350 | 280 | 80 |
| PC00.29 | Phillips Creek | 70 | 910 | 150 | 930 | 170 | 10 |
| HR14.37 | Heritage Park | 2000 | 410 | 300 | ns | 390 | 300 |
| NB01.93 | Eclipse Dam | 180 | 70 | 180 | 760 | 200 | 40 |
| NB00.40 | Marshall St. | 140 | 190 | 570 | 3000 | 410 | 30 |
| HR08.96 | USGS Gauge | 720 | 530 | 480 | 380 | 510 | 320 |
| GW00.39 | Bloedel Park | 120 | 180 | 140 | 80 | 80 | 60 |
| GN10.62 | Southlawn Cemetery | 190 | 50 | mdl | mdl | 20 | 20 |
| GN09.16 | Deer Run | 280 | 240 | 490 | 300 | 140 | 180 |
| GC01.42 | upper Christmas Bk. | 1900 | 280 | 1100 | 80 | 90 | 50 |
| GC00.34 | lower Christmas Bk. | 560 | 880 | 270 | 70 | 160 | 110 |
| GN01.15 | Eastlawn Cemetery | 480 | 690 | 380 | 230 | 150 | 240 |
| HM06.10 | Hemlock Brook | 90 | 70 | 20 | 20 | 10 | 40 |

1/ no sample obtained.
$2 /$ level below the minimum detectable level.
$3 /$ values in bold italic exceed the State standard or our alert threshold.

| Table 2a. | E. coli (colonies/100mL) |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
|  | May | June | July | Aug | Sept | Oct. |
| Site ID | $5 / 14$ | $6 / 18$ | $7 / 23$ | $8 / 20$ | $9 / 24$ | $10 / 15$ |
|  |  |  |  |  |  |  |
| CL02.48 | 20 | ns | mdl | ns | mdl | mdl |
| CL00.00 | mdl | mdl | 10 | ns | mdl | mdl |
| HR37.56 | 250 | 300 | $\mathbf{1 6 6 0}$ | ns | $\mathbf{5 9 0}$ | 350 |
| HR36.19 | $\mathbf{2 4 0 0}$ | 310 | $\mathbf{1 3 0 0}$ | ns | $\mathbf{4 8 0}$ | 340 |
| HR30.53 | 240 | 200 | 150 | 120 | 220 | 140 |


| Table 2b. | E. coli (colonies/100ml) |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |
|  | May | June | July | Aug | Sept | Oct. |
| Site ID | $5 / 14$ | $6 / 18$ | $7 / 23$ | $8 / 20$ | $9 / 24$ | $10 / 15$ |
|  |  |  |  |  |  |  |
| PK00.21 | 20 | 20 | 280 | $\mathbf{4 9 0}$ | 330 | 70 |
| HX00.91 | 40 | 20 | 130 | 100 | 30 | 60 |
| HX00.33 | $\mathbf{6 0 0}$ | 80 | 60 | 320 | 280 | 80 |
| PC00.29 | 70 | $\mathbf{8 2 0}$ | 130 | $\mathbf{9 3 0}$ | 140 | mdl $^{1}$ |
| HR14.37 | $\mathbf{1 5 0 0}$ | $\mathbf{4 5 0}$ | 330 | ns | 370 | 280 |
| NB01.93 | 140 | 70 | 220 | $\mathbf{7 4 0}$ | 160 | 30 |
| NB00.40 | 190 | 170 | $\mathbf{6 8 0}$ | $\mathbf{2 2 0 0}$ | 250 | 20 |
| HR08.96 | $\mathbf{1 0 5 0}$ | $\mathbf{5 1 0}$ | $\mathbf{5 2 0}$ | 380 | $\mathbf{4 7 0}$ | 310 |
|  |  |  |  |  |  |  |
| GW00.39 | 140 | 190 | 180 | 70 | 30 | 40 |
| GN10.62 | $\mathbf{2 2 0}$ | 70 | mdl | mdl | 30 | 20 |
| GN09.16 | 250 | 220 | $\mathbf{4 8 0}$ | 280 | 90 | 130 |
| GC01.42 | $\mathbf{1 7 0 0}$ | 250 | $\mathbf{9 9 0}$ | 90 | 80 | 30 |
| GC00.34 | $\mathbf{8 7 0}$ | $\mathbf{7 7 0}$ | 250 | 50 | 140 | 70 |
| GN01.15 | $\mathbf{6 1 0}$ | $\mathbf{7 4 0}$ | 400 | 210 | 110 | 180 |
| HM06.10 | 60 | 60 | 20 | 20 | mdl | 20 |


| Table 3a. | Total phosphorous (as P) (mg/L) |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | May | June | July | Aug | Sept | Oct. |
| Site ID | 5/14 | 6/18 | 7/23 | 8/20 | 9/24 | 10/15 |
| CL02.48 | 0.02 | ns | 0.04 | ns | 0.02 | mdl |
| CL00.00 | 0.01 | mdl | 0.09 | ns | 0.05 | 0.02 |
| HR37.56 | 0.01 | 0.02 | 0.03 | ns | 0.06 | 0.02 |
| HR36.19 | 0.03 | 0.03 | 0.06 | ns | 0.04 | 0.07 |
| HR30.53 | 0.03 | 0.03 | 0.05 | 0.04 | 0.04 | 0.02 |
| PK00.21 | 0.02 | 0.01 | 0.04 | 0.02 | 0.01 | mdl |
| HX00.91 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | mdl |
| HX00.33 | 0.02 | 0.02 | mdl | 0.01 | 0.01 | mdl |
| PC00.29 | 0.03 | 0.02 | 0.05 | 0.06 | 0.03 | mdl |
| HR14.37 | 0.08 | 0.04 | 0.09 | ns | 0.04 | 0.02 |
| NB01.93 | 0.02 | 0.02 | 0.03 | 0.02 | 0.03 | mdl |
| NB00.40 | 0.01 | 0.02 | 0.02 | 0.03 | 0.03 | mdl |
| HR08.96 | 0.06 | 0.04 | 0.05 | 0.04 | 0.04 | 0.01 |


| Table 3b. | Total phosphorous (as P) (mg/L) |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
|  | May | June | July | Aug | Sept | Oct. |  |
| Site ID | $5 / 14$ | $6 / 18$ | $7 / 23$ | $8 / 20$ | $9 / 24$ | $10 / 15$ |  |
|  |  |  |  |  |  |  |  |
| GW00.39 | 0.02 | 0.04 | 0.01 | 0.01 | 0.01 | mdl |  |
| GN10.62 | 0.03 | 0.02 | mdl | mdl | mdl | mdl |  |
| GN09.16 | 0.03 | 0.05 | 0.02 | 0.01 | 0.01 | mdl |  |
| GC01.42 | 0.02 | $\mathbf{0 . 0 9}$ | $\mathbf{0 . 2 3}$ | $\mathbf{1 . 4 2}$ | $\mathbf{0 . 0 8}$ | 0.04 |  |
| GC00.34 | $\mathbf{0 . 1 0}$ | $\mathbf{0 . 1 1}$ | $\mathbf{0 . 0 7}$ | 0.04 | 0.04 | 0.02 |  |
| GN01.15 | 0.04 | 0.04 | 0.02 | 0.02 | 0.03 | mdl |  |
| HM06.10 | 0.01 | 0.04 | mdl | 0.03 | 0.02 | mdl |  |


| Table 4. | Total suspended solids (mg/L) |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | May | June | July | Aug | Sept | Oct. |
| Site ID | 5/14 | 6/18 | 7/23 | 8/20 | 9/24 | 10/15 |
| CL02.48 | 1 | ns | 1 | ns | 2 | 2 |
| CL00.00 | mdl | mdl | 10 | ns | 10 | 13 |
| HR37.56 | 1 | 1 | 7 | ns | 12 | 12 |
| HR36.19 | 9 | 1 | 6 | ns | 9 | 73 |
| HR30.53 | 3 | 3 | 6 | mdl | 9 | 8 |
| PK00.21 | 9 | mdl | mdl | mdl | 2 | 3 |
| HX00.91 | mdl | mdl | mdl | 7 | mdl | 1 |
| HX00.33 | 8 | 1 | mdl | 2 | mdl | mdl |
| PC00.29 | 10 | 1 | 12 | 4 | mdl | 3 |
| HR14.37 | 26 | 2 | 17 | ns | 8 | 5 |
| NB01.93 | 9 | 3 | mdl | mdl | 10 | 3 |
| NB00.40 | 14 | 1 | mdl | 2 | 9 | 2 |
| HR08.96 | 24 | 5 | 2 | 1 | 5 | 2 |
| GW00.39 | 10 | 5 | 1 | mdl | mdl | 1 |
| GN10.62 | 14 | 3 | mdl | 1 | mdl | mdl |
| GN09.16 | 12 | 4 | mdl | 1 | mdl | 1 |
| GC01.42 | mdl | 14 | 60 | 519 | 7 | 3 |
| GC00.34 | 19 | 26 | 14 | 2 | 4 | 7 |
| GN01.15 | 24 | 9 | mdl | mdl | 11 | mdl |
| HM06.10 | 6 | 3 | mdl | mdl | mdl | 3 |


| Table 5. |  | Conductivity | (microsiemens/cm) |  |  |  |  |
| :--- | ---: | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
|  |  |  |  |  |  |  |  |
|  | May | June | July | Aug. | Aug. | Sept. | Oct. |
| Site ID | $5 / 04$ | $6 / 8$ | $7 / 13$ | $8 / 10$ | $8 / 30$ | $9 / 14$ | $10 / 5$ |
|  |  |  |  |  |  |  |  |
| CL02.48 | 210 | 270 | 260 | 270 | 280 | 300 | 290 |
| CL00.00 | 240 | 320 | 300 | 280 | 280 | 320 | 290 |
| HR37.56 | 200 | 280 | 260 | 270 | 280 | 320 | 290 |
| HR36.19 | 150 | 250 | 270 | 270 | 270 | 290 | 280 |
| HR30.53 | 160 | 190 | 260 | 260 | 210 | 290 | 250 |
|  |  |  |  |  |  |  |  |
| PK00.21 | 140 | 210 | 180 | 250 | 230 | 160 | 220 |
| HX00.91 | 160 | 220 | 190 | 250 | 250 | 180 | 270 |
| HX00.33 | 160 | 220 | 180 | 280 | 260 | 180 | 290 |
| PC00.29 | 90 | 90 | 160 | 220 | 210 | 110 | 220 |
| HR14.37 | 200 | 270 | 410 | 430 | 330 | 190 | 450 |
| NB01.93 | 50 | 60 | 120 | 160 | 90 | 60 | 100 |
| NB00.40 | 70 | 90 | 190 | 170 | 140 | 70 | 140 |
| HR08.96 | 170 | 220 | 340 | 380 | 250 | 150 | 280 |
|  |  |  |  |  |  |  |  |
| GW00.39 | 120 | 180 | 140 | 170 | 190 | 210 | 260 |
| GN10.62 | 130 | 170 | 180 | 210 | 210 | 240 | 310 |
| GN09.16 | 120 | 190 | 190 | 190 | 190 | 230 | 300 |
| GC01.42 | 170 | 160 | 250 | 280 | 190 | 190 | 300 |
| GC00.34 | 320 | 400 | 390 | 330 | 340 | 320 | 490 |
| GN01.15 | 140 | 200 | 250 | 260 | 220 | 260 | 340 |
| HM06.10 | 120 | 160 | 150 | 170 | 180 | 160 | 170 |
|  |  |  |  |  |  |  |  |


| Table 6a. | pH (standard units) |  |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :---: |
|  | May | June | July | Aug. | Aug. | Sept. | Oct. <br> Site ID <br>  <br> $5 / 04$ |  |
|  | $6 / 8$ | $7 / 13$ | $8 / 10$ | $8 / 30$ | $9 / 14$ | $10 / 5$ |  |  |
| CL02.48 | $\mathbf{8 . 3 3}$ | 7.80 | 8.19 | 8.15 | 8.06 | 8.07 | 7.87 |  |
| CL00.00 | $\mathbf{8 . 4 4}$ | 8.20 | 7.79 | 7.99 | 8.15 | 7.94 | 8.08 |  |
| HR37.56 | $\mathbf{8 . 4 3}$ | 7.96 | 7.97 | 7.97 | 8.12 | 7.87 | 8.06 |  |
| HR36.19 | 8.28 | 8.04 | 7.47 | 7.51 | 7.69 | 7.55 | 7.65 |  |
| HR30.53 | 7.55 | 7.98 | 7.57 | 7.63 | 7.53 | 7.47 | 7.50 |  |


| Table 6b. | pH (standard units) |  |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :---: |
|  | May | June | July | Aug. | Aug. | Sept. | Oct. |  |
| Site ID | $5 / 06$ | $6 / 10$ | $7 / 15$ | $8 / 12$ | $8 / 30$ | $9 / 16$ | $10 / 7$ |  |
|  |  |  |  |  |  |  |  |  |
| PK00.21 | 8.24 | 8.23 | 7.88 | 7.52 | 8.10 | 7.85 | 7.78 |  |
| HX00.91 | 8.30 | 8.14 | 7.89 | 7.27 | 8.09 | 7.86 | 7.51 |  |
| HX00.33 | 8.31 | 8.20 | 8.02 | 7.72 | 8.16 | 7.94 | 8.05 |  |
| PC00.29 | 8.04 | 8.04 | 7.17 | 7.46 | 7.90 | 7.75 | 7.80 |  |
| HR14.37 | 7.61 | 7.80 | 7.89 | 7.76 | 7.83 | 7.80 | 7.77 |  |
| NB01.93 | 8.22 | 7.99 | 7.40 | 7.63 | 7.74 | 7.56 | 7.65 |  |
| NB00.40 | 7.95 | 7.93 | 8.02 | 8.00 | 7.70 | 7.54 | 7.61 |  |
| HR08.96 | 8.14 | 8.22 | 7.96 | 7.90 | 7.90 | 7.89 | 7.97 |  |
|  |  |  |  |  |  |  |  |  |
| GW00.39 | 7.95 | 7.28 | 7.36 | 7.59 | 7.66 | 7.43 | 7.47 |  |
| GN10.62 | 7.86 | 7.35 | 7.20 | 7.27 | 7.58 | 7.23 | 7.35 |  |
| GN09.16 | 7.98 | 7.47 | 7.56 | 7.76 | 7.76 | 7.47 | 7.69 |  |
| GC01.42 | 7.58 | 7.25 | 6.81 | 7.01 | 7.22 | 6.64 | 6.48 |  |
| GC00.34 | 7.71 | 7.25 | 7.44 | 7.38 | 7.64 | 7.37 | 7.30 |  |
| GN01.15 | 7.79 | 7.22 | 7.74 | 7.70 | 8.02 | 7.83 | 7.59 |  |
| HM06.10 | 7.89 | 6.91 | 7.16 | 7.50 | 7.14 | 7.46 | 7.13 |  |

1. The "before and after" check of the pH probe with the pH buffer solutions showed a drift in calibration of 0.2 SU. Thus the Green River July readings are somewhat suspect. The probe was replaced before the next sampling date.

| Table 7a. | Nitrate nitrogen (mg/L) |  |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :---: |
|  | May | June | July | Aug. | Aug. | Sept. | Oct. |  |
| Site ID | $5 / 04$ | $6 / 8$ | $7 / 13$ | $8 / 10$ | $8 / 30$ | $9 / 14$ | $10 / 5$ |  |
|  |  |  |  |  |  |  |  |  |
| CL02.48 | mdl | 0.02 | 0.06 | 0.04 | 0.09 | 0.05 | 0.06 |  |
| CL00.00 | mdl | 0.01 | 0.02 | 0.02 | 0.05 | 0.04 | 0.03 |  |
| HR37.56 | mdl | 0.03 | mdl | 0.01 | 0.05 | 0.03 | 0.05 |  |
| HR36.19 | 0.1 | 0.09 | 0.14 | 0.17 | 0.16 | 0.18 | 0.12 |  |
| HR30.53 | 0.09 | 0.09 | 0.2 | 0.25 | 0.22 | 0.18 | 0.22 |  |
|  |  |  |  |  |  |  |  |  |
| PK00.21 | 0.24 | 0.17 | 0.24 | 0.36 | 0.32 | 0.33 | 0.20 |  |
| HX00.91 | 0.22 | 0.26 | 0.36 | 0.49 | 0.42 | 0.28 | 0.37 |  |
| HX00.33 | 0.29 | 0.25 | 0.38 | 0.51 | 0.46 | 0.30 | 0.38 |  |
| PC00.29 | 0.08 | 0.17 | 0.45 | 0.66 | 0.44 | 0.20 | 0.47 |  |
| HR14.37 | 0.26 | 0.24 | 1.44 | 0.64 | 0.46 | 0.32 | 0.48 |  |
| NB01.93 | 0.13 | 0.07 | 0.14 | 0.15 | 0.19 | 0.13 | 0.10 |  |
| NB00.40 | 0.13 | 0.07 | 0.25 | 0.18 | 0.25 | 0.11 | 0.14 |  |
| HR08.96 | 0.20 | 0.17 | $\mathbf{1 . 0 2}$ | 0.51 | 0.34 | 0.24 | 0.22 |  |


| Table 7b. | Nitrate nitrogen (mg/L) |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
|  | May | June | July | Aug. | Aug. | Sept. | Oct. |
| Site ID | $5 / 07$ | $6 / 11$ | $7 / 16$ | $8 / 13$ | $8 / 30$ | $9 / 17$ | $10 / 8$ |
|  |  |  |  |  |  |  |  |
| GW00.39 | 0.31 | 0.38 | 0.38 | 0.28 | 0.23 | 0.31 | 0.29 |
| GN10.62 | 0.25 | 0.29 | 0.35 | 0.33 | 0.45 | 0.36 | 0.27 |
| GN09.16 | 0.33 | 0.39 | 0.39 | 0.31 | 0.34 | 0.37 | 0.35 |
| GC01.42 | 0.08 | 0.06 | 0.06 | 0.05 | 0.07 | 0.04 | 0.07 |
| GC00.34 | 0.43 | 0.46 | 0.29 | 0.36 | 0.74 | 0.89 | 0.73 |
| GN01.15 | 0.35 | 0.43 | 0.45 | 0.38 | 0.41 | 0.45 | 0.34 |
| HM06.10 | 0.12 | 0.13 | 0.17 | 0.24 | 0.36 | 0.50 | 0.15 |


| Table 8. |  | Turbidity (NTU) |  |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :---: | :---: |
|  |  |  |  |  |  |  |  |  |  |
|  | May | June | July | Aug. | Aug. | Sept. | Oct. <br> Site ID <br> $5 / 04$ |  |  |
|  |  | $6 / 8$ | $7 / 13$ | $8 / 10$ | $8 / 30$ | $9 / 14$ | $10 / 5$ |  |  |
| CL02.48 | 2.18 | 1.79 | 3.25 | 2.38 | 1.43 | 1.10 | 2.30 |  |  |
| CL00.00 | 1.40 | 1.78 | 4.37 | 4.67 | 2.95 | 4.90 | 4.80 |  |  |
| HR37.56 | 1.20 | 1.87 | 4.65 | 5.77 | 3.12 | 5.60 | 5.30 |  |  |
| HR36.19 | 1.80 | 1.74 | 3.10 | 5.19 | 3.06 | 3.00 | 4.20 |  |  |
| HR30.53 | 1.18 | 1.23 | 6.26 | 6.69 | 4.14 | 5.20 | 4.00 |  |  |
|  |  |  |  |  |  |  |  |  |  |
| PK00.21 | 0.70 | 0.29 | 0.16 | 0.04 | 0.28 | 7.0 | mdl |  |  |
| HX00.91 | 0.15 | 0.44 | mdl | 0.01 | mdl | 8.5 | mdl |  |  |
| HX00.33 | 0.44 | 0.47 | 0.14 | 0.15 | 0.02 | 10.0 | mdl |  |  |
| PC00.29 | 1.01 | 0.94 | 2.41 | 4.96 | $\mathbf{1 1 . 1}$ | $\mathbf{3 3 . 0}$ | 2.40 |  |  |
| HR14.37 | 1.57 | 2.06 | 2.16 | 2.47 | 4.89 | $\mathbf{2 3 . 0}$ | 2.10 |  |  |
| NB01.93 | 1.92 | 2.32 | 3.55 | 4.67 | 6.58 | $\mathbf{2 9 . 0}$ | 3.30 |  |  |
| NB00.40 | 2.25 | 2.67 | 3.62 | 4.12 | 6.44 | $\mathbf{2 5 . 0}$ | 3.40 |  |  |
| HR08.96 | 1.99 | 2.50 | 1.67 | 2.17 | 8.42 | $\mathbf{2 4 . 0}$ | 2.20 |  |  |
|  |  |  |  |  |  |  |  |  |  |
| GW00.39 | 1.23 | 2.43 | 0.58 | 0.82 | 1.89 | 1.20 | 0.35 |  |  |
| GN10.62 | 2.26 | 0.80 | 0.27 | 0.16 | 1.36 | 0.50 | mdl |  |  |
| GN09.16 | 1.81 | 1.33 | 0.44 | 0.33 | 1.49 | 0.85 | 0.20 |  |  |
| GC01.42 | 6.71 | 3.79 | $\mathbf{1 1 . 9}$ | $\mathbf{2 3 . 2}$ | $\mathbf{1 5 . 8}$ | 8.90 | 5.50 |  |  |
| GC00.34 | 2.96 | 3.92 | 5.26 | 3.68 | $\mathbf{1 0 . 5 8}$ | 8.20 | 2.70 |  |  |
| GN01.15 | 1.91 | 1.78 | 0.83 | 1.00 | 3.96 | 2.40 | 0.55 |  |  |
| HM06.10 | 0.64 | 7.60 | 0.48 | 0.45 | 0.53 | 0.40 | 0.25 |  |  |
|  |  |  |  |  |  |  |  |  |  |


| Table 9. | Water Temperature |  |  |  |  |  |  | (degrees C) |
| :--- | :---: | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
|  |  | May | June | July | Aug. | Aug. | Sept. | Oct. |
| Site ID | $5 / 04$ | $6 / 8$ | $7 / 13$ | $8 / 10$ | $8 / 30$ | $9 / 14$ | $10 / 5$ |  |
|  |  |  |  |  |  |  |  |  |
| CL02.48 | 9.2 | 19.5 | $\mathbf{2 3 . 6}$ | $\mathbf{2 3 . 1}$ | $\mathbf{2 0 . 5}$ | $\mathbf{2 0 . 1}$ | 18.0 |  |
| CL00.00 | 9.3 | 19.3 | $\mathbf{2 3 . 3}$ | $\mathbf{2 2 . 5}$ | $\mathbf{2 0 . 5}$ | 19.9 | 17.8 |  |
| HR37.56 | 9.2 | 18.4 | $\mathbf{2 3 . 3}$ | $\mathbf{2 2 . 6}$ | $\mathbf{2 0 . 1}$ | 19.6 | 17.8 |  |
| HR36.19 | 8.5 | 15.8 | 19.1 | 18.3 | 18.3 | 16.2 | 16.7 |  |
| HR30.53 | 6.5 | 13.2 | 16.3 | 17.8 | 15.1 | 15.3 | 15.0 |  |
|  |  |  |  |  |  |  |  |  |
| PK00.21 | 8.5 | 12.1 | 15.4 | 15.9 | 14.1 | 16.3 | 11.6 |  |
| HX00.91 | 9.6 | 12.6 | 16.1 | 16.2 | 14.6 | 16.8 | 12.2 |  |
| HX00.33 | 10.0 | 12.5 | 16.0 | 17.0 | 14.6 | 17.0 | 12.2 |  |
| PC00.29 | 7.3 | 11.6 | 13.7 | 13.9 | 13.4 | 16.6 | 11.2 |  |
| HR14.37 | 10.6 | 15.0 | 19.2 | 20.5 | 15.8 | 18.5 | 13.8 |  |
| NB01.93 | 7.5 | 12.8 | 18.8 | 19.8 | 14.6 | 16.9 | 12.0 |  |
| NB00.40 | 8.3 | 13.2 | 19.7 | $\mathbf{2 0 . 1}$ | 15.3 | 17.1 | 12.4 |  |
| HR08.96 | 9.8 | 14.9 | 19.8 | 20.1 | 15.5 | 18.1 | 13.1 |  |
|  |  |  |  |  |  |  |  |  |
| GW00.39 | 10.7 | 11.6 | 16.5 | 18.6 | 15.2 | 15.1 | 10.1 |  |
| GN10.62 | 10.4 | 11.8 | 15.7 | 18.2 | 14.9 | 15.2 | 10.6 |  |
| GN09.16 | 10.9 | 11.9 | 16.5 | 18.7 | 15.2 | 15.2 | 10.0 |  |
| GC01.42 | ns | 14.5 | 18.3 | $\mathbf{2 0 . 2}$ | 15.2 | 16.5 | 10.2 |  |
| GC00.34 | 12.9 | 15.8 | 17.7 | 17.4 | 16.4 | 16.6 | 11.6 |  |
| GN01.15 | 10.9 | 11.9 | 17.8 | $\mathbf{2 0 . 3}$ | 15.3 | 16.1 | 10.1 |  |
| HM06.10 | 10.1 | 11.1 | 15.2 | 17.0 | 14.4 | 14.4 | 9.3 |  |
|  |  |  |  |  |  |  |  |  |


| Table 10a. | Dissolved Oxygen (mg/L) |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
|  | May | June | July | Aug. | Aug. | Sept. | Oct. |
| Site ID | $5 / 04$ | $6 / 8$ | $7 / 13$ | $8 / 10$ | $8 / 30$ | $9 / 14$ | $10 / 5$ |
|  |  |  |  |  |  |  |  |
| CL02.48 | 10.53 | 7.16 | 7.51 | 7.32 | 6.51 | 7.54 | 6.54 |
| CL00.00 | 10.81 | 7.66 | 4.85 | 6.38 | 7.03 | 6.57 | 7.31 |
| HR37.56 | 10.94 | 8.53 | 7.07 | 6.61 | 7.68 | 7.00 | 8.00 |
| HR36.19 | 11.48 | 8.91 | 7.05 | 7.26 | 7.90 | 7.43 | 7.85 |
| HR30.53 | 10.48 | 8.28 | 7.48 | 6.83 | 7.05 | 6.64 | 6.60 |


| Table 10b. | Dissolved Oxygen (mg/L) |  |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  | May | June | July | Aug. | Aug. | Sept. | Oct. |
| Site ID | $5 / 06$ | $6 / 10$ | $7 / 15$ | $8 / 12$ | $8 / 30$ | $9 / 16$ | $10 / 7$ |
|  |  |  |  |  |  |  |  |
| PK00.21 | 12.30 | 10.60 | 9.51 | 9.28 | 10.40 | 9.48 | 10.26 |
| HX00.91 | 11.70 | 10.63 | 9.65 | 9.00 | 9.57 | 9.46 | 9.72 |
| HX00.33 | 11.19 | 10.21 | 9.18 | 8.86 | 9.37 | 9.21 | 10.05 |
| PC00.29 | 11.90 | 10.79 | 9.92 | 9.94 | 10.07 | 9.63 | 10.49 |
| HR14.37 | 10.90 | 9.53 | 8.80 | 7.58 | 9.05 | 7.95 | 8.80 |
| NB01.93 | 11.18 | 10.36 | 8.72 | 7.88 | 9.65 | 9.62 | 10.30 |
| NB00.40 | 11.50 | 10.39 | 9.16 | 8.90 | 9.82 | 9.28 | 10.11 |
| HR08.96 | 11.32 | 10.30 | 9.05 | 8.34 | 9.60 | 9.29 | 9.86 |
|  |  |  |  |  |  |  |  |
| GW00.39 | 11.48 | 10.51 | 8.89 | 8.51 | 9.07 | 9.03 | 9.98 |
| GN10.62 | 11.19 | 10.67 | 9.12 | 8.15 | 9.33 | 9.14 | 10.80 |
| GN09.16 | 11.21 | 10.34 | 9.65 | 9.50 | 9.50 | 9.67 | 10.73 |
| GC01.42 | 8.42 | 6.89 | 2.63 | 3.11 | 6.02 | 4.26 | 5.32 |
| GC00.34 | 8.23 | 8.45 | 7.10 | 6.56 | 8.12 | 7.91 | 8.64 |
| GN01.15 | 11.17 | 10.82 | 8.93 | 8.05 | 9.71 | 9.46 | 10.59 |
| HM06.10 | 11.60 | 10.66 | 9.58 | 8.64 | 9.40 | 9.31 | 10.25 |


| Table 11a. | Dissolved Oxygen (percent) |  |  |  |  |  |  |  |
| :--- | ---: | :--- | :--- | ---: | :--- | :--- | :--- | :--- |
|  | May | June | July | Aug. | Aug. | Sept. | Oct. |  |
| Site ID | $5 / 04$ | $6 / 8$ | $7 / 13$ | $8 / 10$ | $8 / 30$ | $9 / 14$ | $10 / 5$ |  |
|  |  |  |  |  |  |  |  |  |
| CL02.48 | 91.4 | 78.2 | 88.6 | 86.0 | $\mathbf{7 2 . 2}$ | 83.1 | $\mathbf{6 8 . 3}$ |  |
| CL00.00 | 93.8 | 83.3 | $\mathbf{5 6 . 7}$ | 73.7 | 77.8 | $\mathbf{7 2 . 2}$ | 77.3 |  |
| HR37.56 | 95.2 | 90.3 | 83.4 | 76.5 | 84.7 | 76.2 | 84.1 |  |
| HR36.19 | 98.1 | 90.4 | 76.0 | 76.9 | 84.0 | 75.5 | 80.5 |  |
| HR30.53 | 84.2 | 78.7 | 76.5 | 71.4 | $\mathbf{7 0 . 8}$ | $\mathbf{6 6 . 2}$ | $\mathbf{6 5 . 2}$ |  |
|  |  |  |  |  |  |  |  |  |
| PK00.21 | 105.0 | 98.5 | 95.1 | 93.7 | 99.3 | 96.7 | 94.6 |  |
| HX00.91 | 102.3 | 99.7 | 98.3 | 91.2 | 94.3 | 97.6 | 90.4 |  |
| HX00.33 | 99.4 | 95.6 | 92.7 | 91.6 | 92.3 | 95.3 | 93.7 |  |
| PC00.29 | 98.7 | 99.1 | 95.6 | 96.2 | 96.4 | 98.7 | 95.5 |  |
| HR14.37 | 98.0 | 94.7 | 95.4 | 85.4 | 91.4 | 85.0 | 85.1 |  |
| NB01.93 | 93.4 | 98.0 | 94.1 | 89.8 | 95.0 | 99.5 | 95.7 |  |
| NB00.40 | 99.0 | 98.8 | 100.0 | 97.7 | 98.1 | 96.2 | 95.8 |  |
| HR08.96 | 99.8 | 101.8 | 99.4 | 91.7 | 96.2 | 98.2 | 93.9 |  |
|  |  |  |  |  |  |  |  |  |


| Table 11b. | Dissolved Oxygen (percent) |  |  |  |  |  |  |
| :--- | ---: | ---: | :--- | ---: | :--- | :--- | :--- |
|  | May | June | July | Aug. | Aug. | Sept. | Oct. |
| Site ID | $5 / 07$ | $6 / 11$ | $7 / 16$ | $8 / 13$ | $8 / 30$ | $9 / 17$ | $10 / 8$ |
|  |  |  |  |  |  |  |  |
| GW00.39 | 102.2 | 96.5 | 90.9 | 90.8 | 90.3 | 89.7 | 88.7 |
| GN10.62 | 100.6 | 98.0 | 91.7 | 86.7 | 92.2 | 91.1 | 90.7 |
| GN09.16 | 101.5 | 96.6 | 98.8 | 101.5 | 94.3 | 96.4 | 95.1 |
| GC01.42 | 81.1 | $\mathbf{6 7 . 6}$ | 27.7 | $\mathbf{3 4 . 4}$ | $\mathbf{6 0 . 0}$ | $\mathbf{4 4 . 5}$ | $\mathbf{4 6 . 7}$ |
| GC00.34 | 80.2 | 85.2 | $\mathbf{7 4 . 4}$ | $\mathbf{6 8 . 0}$ | 82.7 | 81.1 | 79.6 |
| GN01.15 | 101.4 | 100.3 | 93.7 | 89.7 | 96.8 | 96.0 | 94.1 |
| HM06.10 | 102.7 | 96.8 | 95.4 | 89.6 | 92.2 | 90.8 | 89.5 |

## Appendix B Quality Control Results.

The quality control procedures for the monitoring program, as described in great detail in a Quality Assurance Program Plan dated April 20, 2002 and on file with HooRWA and DEP, included collecting replicate samples at $10 \%$ of the sites on each sampling occasion. The results for the indicator bacteria (Tables 1 and 2 below) show that the samples were well within acceptable limits.

| Table 1. | Fecal coliform (colonies/100mL) ( $\pm 30 \%$ acceptable) |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Replicate 1 |  |  | Replicate 2 |  |  |
| Date | S1 ${ }^{1}$ | S2 | RPD ${ }^{2}$ | S1 | S2 | RPD |
| 5/14/02 | 720 | 950 | -4.13\% | 240 | 190 | 4.36\% |
| 6/18/02 | 690 | 780 | -1.86\% | 910 | 1210 | -4.10\% |
| 7/23/02 | 150 | 120 | 4.55\% | 70 | 120 | -11.93\% |
| 8/20/02 | $0^{3}$ | $\mathrm{mdl}^{4}$ | no value ${ }^{5}$ | 1800 | 1700 | 0.77\% |
| 9/24/02 | no replicate samples collected |  |  |  |  |  |
| 10/15/02 | 50 | 70 | -8.25\% | 110 | 190 | -10.99\% |

1. S1 refers to the sample, S2 to the replicate.
2. Relative percent difference, calculated using log values for the bacteria counts and actual values for all other variables.
3. Replicate 1 was a sample of deionized water and thus should be 0 .
4. Below the minimum detectable limit for the test.
5. No value can be calculated if one or both are below the minimum detectable limit.

| Table 2. | E. coli (colonies/100mL) $( \pm 30 \%$ acceptable $)$ |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Replicate 1 |  |  |  | Replicate 2 |  |
| Date | S1 | S2 | RPD | S1 | S2 | RPD |
| 5/14/02 | 1050 | 1050 | 0.00\% | 240 | 200 | 3.38\% |
| 6/18/02 | 740 | 720 | 0.42\% | 820 | 1320 | -6.85\% |
| 7/23/02 | 130 | 120 | 1.66\% | 60 | 90 | -9.44\% |
| 8/20/02 | $0^{3}$ | mdl | no value | 1700 | 1400 | 2.64\% |
| 9/24/02 | no replicate samples collected |  |  |  |  |  |
| 10/15/02 | 30 | 70 | -22.15\% | 70 | 160 | -17.73\% |


| Table 3. | Total Suspended Solids (mg/L) ( $\pm 25 \%$ acceptable) |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Replicate 1 |  |  | Replicate 2 |  |  |
| Date | S1 | S2 | RPD | S1 | S2 | RPD |
| 5/14/02 | 24 | 30 | -22.22\% | 3 | 1 | 100.00\% |
| 6/18/02 | 9 | 7 | 25.00\% | 1 | mdl | no value |
| 7/23/02 | mdl | mdl | no value | mdl | mdl | no value |
| 8/20/02 | $0^{3}$ | 2 | -200.00\% | mdl | 3 | no value |
| 9/24/02 | no r | icate | mples colle |  |  |  |
| 10/15/02 | 3 | 3 | 0.00\% | 7 | 6 | 15.38\% |


| Table 4. | Total Phosphorous (mg/L) ( $\pm 10 \%$ acceptable or $\pm .01$ @ <0.05) |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Repli | ate 1 |  | Repl | ate 2 |
| Date | S1 | S2 | RPD | S1 | S2 | RPD |
| 5/14/02 | 0.06 | 0.05 | 18.18\% | 0.03 | 0.02 | 40.00\% |
| 6/18/02 | 0.04 | 0.04 | 0.00\% | 0.02 | 0.02 | 0.00\% |
| 7/23/02 | 0.01 | 0.02 | -66.67\% | mdl | 0.01 | no value |
| 8/20/02 | 0 | mdl | no value | 0.07 | 0.02 | 111.11\% |
| 9/24/02 | no replicate samples collected |  |  |  |  |  |
| 10/15/02 | 0.04 | 0.03 | 28.57\% | 0.02 | 0.02 | 0.00\% |

TSS and TP were not always within the acceptable limits (Tables 3 and 4). However, the 3 sample sets above the acceptable level (including replicate 2 on $8 / 20$ for which no value could be calculated but we assumed that if 3 vs. $1(5 / 14)$ was above the level, then 3 vs. less than 1 would be also) were all relatively low values for this variable. For TP, only the replicate 2 sample on $8 / 20$ was above the limit.

| Table 5. |  | Conductivity |  | $($ microsiemens/cm) ( $\pm 5 \%$ acceptable $)$ |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Replicate 1 |  | Replicate 2 |  |  | Replicate 3 |  |  |
| Date ${ }^{6}$ | S1 | S2 | RPD | S1 | S2 | RPD | S1 | S2 | RPD |
| 5/4,6,7 | 210 | 210 | 0.00\% | 90 | 90 | 0.00\% | 120 | 140 | -15.38\% |
| 6/8,10,11 |  |  |  |  |  |  |  |  |  |
| 7/13,15,16 |  |  |  |  |  |  | 390 | 390 | 0.00\% |
| 8/10,12,13 | 260 | 270 | -3.77\% | 430 | 460 | -6.74\% | 260 | 270 | -3.77\% |
| 9/14,16,17 | 290 | 300 | -3.39\% | 190 | 200 | -5.13\% |  |  |  |
| 10/5,7,8 | 290 | 290 | 0.00\% | 220 | 210 | 4.65\% |  |  |  |

6. The three dates are for the three sections of the river, which were sampled on different days. The replicate numbers refer to the same three segments. An attempt was may to collect replicates or run laboratory split samples on at least two of the three days. The laboratory split samples involved only nitrate nitrogen and turbidity,

For conductivity, three values appear to exceed the acceptable level. In addition to the replicate samples, the meter was calibrated against a standard solution of 447 microsiemens $/ \mathrm{cm}$ before being taken to the field, and rechecked upon return to the laboratory. Since the meter reads only to the nearest 10 microsiemens, we felt that a post-sampling reading of $45 \pm 1$ was sufficient for our equipment. The $5 / 7$ value could result from rounding, as could the $9 / 16$ value.

| Table 6. | pH (standard units) ( $\pm 5 \%$ acceptable) |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Replicate 1 |  |  | Replicate 2 |  |  | Replicate 3 |  |  |
| Date | S1 | S2 | RPD | S1 | S2 | RPD | S1 | S2 | RPD |
| 5/4,6,7 | 8.33 | 8.37 | -0.48\% | 8.04 | 8.04 | 0.00\% | 7.89 | 7.88 | 0.13\% |
| 6/8,10,11 |  |  |  |  |  |  |  |  |  |
| 7/13,15,16 |  |  |  |  |  |  | 7.44 | 7.44 | 0.00\% |
| 8/10,12,13 | 8.08 | 8.15 | -0.86\% | 7.76 | 7.88 | -1.53\% | 7.70 | 7.69 | 0.13\% |
| 9/14,16,17 | 7.47 | 7.56 | -1.20\% | 7.80 | 7.80 | 0.00\% |  |  |  |
| 10/5,7,8 | 8.08 | 8.07 | 0.12\% | 7.80 | 7.82 | -0.26\% |  |  |  |

None of the pH replicates exceeded the acceptable level. In addition to the replicate samples, we calibrated the meter against a 7.00 buffer and a 10.01 buffer before sampling, and checked against the 7.00 buffer after returning to the laboratory. The check following the $6 / 11$ sampling indicated excessive drift. The pH probe was replaced prior to the next sampling dates.

| Table 7. | Nitrate nitrogen (mg/L) ( $\pm 25 \%$ acceptable or $0.04 \mathrm{mg} / \mathrm{L}$ @ <0.1) |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Replicate 1 |  |  | Replicate 2 |  |  | Replicate 3 |  |  |
| Date | S1 | S2 | RPD | S1 | S2 | RPD | S1 | S2 | RPD |
| 5/4,6,7 | mdl | 0.01 | no value | 0.08 | 0.11 | -31.58\% | 0.12 | 0.08 | 40.00\% |
| 6/8,10,11 | 0.09 | 0.13 | -36.36\% |  |  |  | 0.06 | 0.02 | 100.00\% |
| 7/13,15,16 | 0.20 | 0.12 | 50.00\% | 1.02 | 0.94 | 8.16\% | 0.29 | 0.29 | 0.00\% |
| 8/10,12,13 | 0.05 | 0.04 | 22.22\% | 0.64 | 0.62 | 3.17\% | 0.38 | 0.26 | 37.50\% |
| 9/14,16,17 | 0.18 | 0.14 | 25.00\% | 0.32 | 0.42 | -27.03\% |  |  |  |
| 10/5,7,8 | 0.03 | 0.01 | 100.00\% | 0.47 | 0.48 | -2.11\% |  |  |  |

One third of the replicates and splits for nitrate nitrogen were unsatisfactory, a higher than expected result. Whether the method was not sufficiently precision or the analysis technique was poor has not yet been determined.

| Table 8. | Turbidity (NTU) ( $\pm 10 \%$ acceptable) |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Replicate 1 |  |  | Replicate 2 |  |  | Replicate 3 |  |  |
| Date | S1 | S2 | RPD | S1 | S2 | RPD | S1 | S2 | RPD |
| 5/4,6,7 | 2.18 | 2.00 | 8.61\% | 1.01 | 1.22 | -18.83\% | 0.64 | 0.62 | 3.17\% |
| 6/8,10,11 | 1.74 | 1.80 | -3.39\% |  |  |  | 3.79 | 3.85 | -1.57\% |
| 7/13,15,16 | 6.26 | 6.21 | 0.80\% | 1.67 | 1.66 | 0.60\% | 5.26 | 5.39 | -2.44\% |
| 8/10,12,13 | 2.49 | 2.38 | 4.52\% | 2.47 | 3.04 | -20.69\% | 1.00 | 0.97 | 3.05\% |
| 9/14,16,17 | 5.20 | 4.90 | 5.94\% | 23 | 26 | -12.24\% |  |  |  |
| 10/5,7,8 | 4.80 | 4.00 | 18.18\% | 2.40 | 3.00 | -22.22\% |  |  |  |

For turbidity also, one third of the replicates and splits for were unsatisfactory, a higher than expected result. Whether the method was not sufficiently precision or the analysis technique was poor has not yet been determined.

| Table 9. | Water temperature (degrees C) ( $\pm 5 \%$ acceptable) |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Replicate 1 |  |  | Replicate 2 |  |  | Replicate 3 |  |  |
| Date | S1 | S2 | RPD | S1 | S2 | RPD | S1 | S2 | RPD |
| 5/4,6,7 | 9.2 | 9.4 | -2.15\% | 7.3 | 7.2 | 1.38\% | 9.9 | 10.1 | -2.00\% |
| 6/8,10,11 |  |  |  |  |  |  |  |  |  |
| 7/13,15,16 |  |  |  |  |  |  | 17.7 | 17.7 | 0.00\% |
| 8/10,12,13 | 23.2 | 23.1 | 0.43\% | 20.5 | 20.7 | -0.97\% | 20.3 | 20.2 | 0.49\% |
| 9/14,16,17 | 15.3 | 15.2 | 0.66\% | 18.5 | 18.5 | 0.00\% |  |  |  |
| 10/5,7,8 | 17.8 | 17.8 | 0.00\% | 11.2 | 11.2 | 0.00\% |  |  |  |

All replicate temperature readings were within acceptable limits.

| Table 10. | Dissolved oxygen (mg/L) ( $\pm 5 \%$ acceptable) |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Replicate 1 |  |  | Replicate 2 |  |  | Replicate 3 |  |  |
| Date | S1 | S2 | RPD | S1 | S2 | RPD | S1 | S2 | RPD |
| 5/4,6,7 | 10.53 | 10.70 | -1.60\% | 11.90 | 11.94 | -0.34\% | 11.60 | 11.53 | 0.61\% |
| 6/8,10,11 |  |  |  |  |  |  |  |  |  |
| 7/13,15,16 |  |  |  |  |  |  | 7.10 | 7.08 | 0.28\% |
| 8/10,12,13 | 7.52 | 7.32 | 2.70\% | 7.58 | 7.87 | -3.75\% | 8.05 | 8.53 | -5.79\% |
| 9/14,16,17 | 6.64 | 6.60 | 0.60\% | 7.95 | 7.98 | -0.38\% |  |  |  |
| 10/5,7,8 | 7.31 | 7.18 | 1.79\% | 10.49 | 10.50 | -0.10\% |  |  |  |

For dissolved oxygen, only one replicate reading (in $\mathrm{mg} / \mathrm{L}$ ) was outside the acceptable limit, while none of the readings (in \%) exceeded the limit. The dissolved oxygen meter has a built in calibration chamber. It was calibrated prior to the first reading on a sample day, and whenever the site elevation changed by 100 feet or more.

| Table 11. | Dissolved oxygen (percent) ( $\pm 5 \%$ acceptable) |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Replicate 1 |  |  | Replicate 2 |  |  | Replicate 3 |  |  |
| Date | S1 | S2 | RPD | S1 | S2 | RPD | S1 | S2 | RPD |
| 5/4,6,7 | 91.4 | 93.3 | -2.06\% | 98.7 | 98.7 | 0.00\% | 102.7 | 101.6 | 1.08\% |
| 6/8,10,11 |  |  |  |  |  |  |  |  |  |
| 7/13,15,16 |  |  |  |  |  |  | 74.4 | 74.0 | 0.54\% |
| 8/10,12,13 | 88.1 | 86.0 | 2.41\% | 85.4 | 87.6 | -2.54\% | 89.7 | 93.5 | -4.15\% |
| 9/14,16,17 | 66.2 | 65.6 | 0.91\% | 85.0 | 85.4 | -0.47\% |  |  |  |
| 10/5,7,8 | 77.3 | 75.7 | 2.09\% | 95.5 | 95.4 | 0.10\% |  |  |  |

