Ossipee Watershed
Water Quality Monitoring Program
2004 Season

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Water Quality Monitoring Program

Executive Summary

In 2002, Green Mountain Conservation Group began testing the waters of the Ossipee Watershed by selecting ten sites in cooperation with the towns' conservation commissions. Impact of land use practices were heavily considered in selecting the site. All sections were further validated by natural resource experts from UNH. In 2002, fifteen volunteers were responsible for testing the ten sites.

2003 marked the second year of water quality monitoring for GMCG and a year of growth and expansion for the program. Five new sites were selected, and over twenty-five volunteers were recruited for testing. GMCG created and implemented an informal macroinvertebrate sampling event to further augment water quality testing in the Ossipee Watershed. In addition, GMCG and Ossipee Lake Alliance (OLA) launched the Ossipee Lake Protection Program (OLPP). As the first comprehensive program that encompassed all of Ossipee Lake, the OLPP served to examine three parts of the health of the lake and its surrounding area. The thirteen tributaries were tested four times throughout the summer. In partnership with NH Department of Environmental Services, the deepest spot of each of the lake's five water bodies (Ossipee Lake, Berry Bay, Broad Bay, Leavitt Bay, and Danforth Pond) were test once a month June through August. Finally, lake recreation was examined and quantified through the Lake Environmental Assessment Plan (LEAP).

This was largest and most comprehensive program ever initiated on Ossipee Lake. The major successes of this project were:

- Collected a baseline of data for both the tributaries and deep water locations.
- United the six children's camps in the area and engaged them in water quality monitoring.
- Discovered a variable milfoil infestation in Leavitt Bay.
- Counted 337 boats at Ossipee Lake Natural Area on July 4.

2004 was the third year of sampling for the RIVERS program. In cooperation with the town conservation commissions and UNH experts, some sites were added or removed and a total of 15 sites remain throughout the six towns. Also in 2004, GMCG and OLA split the duties of the OLPP program. While GMCG took on the tributary testing as part of their Water Quality Monitoring Program, OLA continued to test the deep water spots on the lake, monitor milfoil on the lake, and monitor recreation on the lake. The tributary testing was renamed the Ossipee Lake Tributaries (OLT) program.

A comprehensive assessment of the health of the water can only be achieved by observing water quality trends over a period of many years. As this was only the second year for this water quality monitoring program, and there is sparse historical data for the area, firm conclusions cannot yet be drawn. However, an important set of baseline data have been established. Continuing water quality monitoring efforts in the Ossipee Watershed over the long term will allow for observation of water quality trends over time and, in turn, the creation of strong conclusions of the state of the water. Thus, GMCG is working toward the long term sustainability of this program into the future.

1. Introduction

1.1 Green Mountain Conservation Group

The Green Mountain Conservation Group (GMCG) is a community-based, charitable organization dedicated to the protection and conservation of natural resources in the Ossipee Watershed in central Carroll County including the towns of Effingham, Freedom, Madison, Ossipee, Sandwich and Tamworth.

Founded in 1997, GMCG's mission is to coordinate and carry out environmental education, research, natural resource advocacy and voluntary land protection. GMCG is a networking and referral resource for area residents concerned about land use issues in their communities. It encourages individual and small group activism based on common sense and non-confrontational approaches to resolving problems. The guiding principle in its public education and activism is to present objective information in a neutral format with the belief that informed citizens will make good judgments about their area's natural resources.

During the summer of 2000 GMCG responded to growing concerns about Ossipee Lake by hosting a forum that featured a panel discussion by state experts and representatives of the New Hampshire Audubon Society and The Nature Conservancy. One of the conclusions drawn from the forum was that resolution of lake issues was being hampered by the lack of an organization representing the interests of a majority of the lake's stakeholders.

In 2000, GMCG worked with the University of New Hampshire Cooperative Extension and the Society for the Protection of the New Hampshire Forests to produce a series of Natural Resource Inventory (NRI) maps of each town in the Ossipee Watershed. The NRI maps include information on hydrology, soils, town conservation land, unfragmented land, public water supplies, known and potential contamination sites as well as co-occurrences of important resources. Copies of these maps were provided to each town in the watershed and are displayed at the town halls for public use.

A Water Quality Monitoring (WQM) program grew out of the NRI mapping project as a way to further study our natural resources and as a way to work with the broader community to plan for growth while protecting the environment. Since water does not recognize political boundaries, GMCG began working collaboratively on the WQM program with Saco River Corridor Commission (SRCC), an organization located in Maine.

Saco River Corridor Commission began its WQM program in 2001 and monitors 27 sites in twenty towns along the Saco River. GMCG modeled its Water Quality Program after SRCC. Beginning in 2002, GMCG monitored ten sites across the six towns in the Ossipee Waters, a subwatershed of the Saco Watershed. In 2003, GMCG increased the number of sites it tests from ten to fifteen. Together GMCG and SRCC monitor the quality of the water across two states, 26 towns and one watershed in the RIVERS (Regional Interstate Volunteers for the Ecosystems and Rivers of Saco) Program. These WQM programs enable the study the health of the entire watershed and track changes over time and educate the public.

Also in 2003, GMCG expanded is WQM program to include a biological monitoring component. With help from local Bug Experts, GMCG created and initiated a macroinvertebrate sampling event. Macroinvertebrates are tiny aquatic animals that lack a back bone but are visible to the naked eye. Often they can serve as unique water quality indicators.

1.2 Ossipee Watershed

The Ossipee Watershed (Figure 1) is part of the Saco River Basin, which is an area of about 379 square miles located in Carroll and Grafton Counties, New Hampshire. It contains 82 lakes and ponds that cover about 9,400 acres in thirteen towns. At its widest point the watershed extends approximately 29 miles east and west and twenty-three miles north and south. Water from the Ossipee Watershed flows into the Saco River and through Maine to the Atlantic Ocean. The watershed's drainage area is bound by the mountains of the Sandwich Range to the northwest, the Ossipee Mountains to the south and the sandy pine barren lands of the Ossipee-Freedom-Effingham plains to the east. Elevations range from 375 feet at the Maine-New Hampshire border in Effingham to 4,060 feet on Mount Passaconway in Waterville.

The Ossipee Watershed contains New Hampshire's largest stratified-drift aquifer. This type of aquifer is unique because it recharges more rapidly than any other. As a result of this quick recharge, stratified drift aquifers allow pollution and contamination to be carried more rapidly into the underground water supply. Therefore, conservation of the recharge lands is vital to the protection of drinking water supplies in New Hampshire and Maine.

The Ossipee Watershed is one of New Hampshire's most rural areas but is under developmental pressure. A study by the Office of State Planning, co-authored by The Society for the Protection of New Hampshire Forests and The Nature Conservancy, predicts that the population of Carroll County will increase 50% by 2020.

1.3 Ossipee Lake

Ossipee Lake is the center of the Ossipee Watershed. Comprised of over 4000 acres of water, the lake consists of a main body of water known as Ossipee Lake (or the Main Lake) and five large connecting bodies of water: Berry Bay, Broad Bay, Leavitt Bay, Danforth Pond and Huckins Pond (Figure 2).

As one of New Hampshire's largest lakes, it is a major economic contributor to the towns of Freedom and Ossipee. A primary destination for vacationers, boaters and wildlife enthusiasts, its appeal has placed it under developmental pressure and environmental stress. Particularly vulnerable are its unique ecological assets, including two globally rare pondshore communities, a pine barrens, a kettlehole quaking bog and the largest stratified drift aquifer in NH.

In 1995 the Environmental Protection Agency listed Ossipee Lake as one of the top five areas in New Hampshire to protect. However, there still has been no public education program on the importance of the lake and its environmental assets and the lake does not have a management or stewardship plan.

1.4 Water Quality Monitoring

Increased population, rapid residential and commercial development and expanded recreational use have put pressure and stress on Ossipee Lake and its rivers, making it necessary to implement a comprehensive Water Quality Monitoring (WQM) program. Routine water sampling and testing are essential for early detection of changes in water quality so that problems can be traced to their source before the lake becomes aversely affected.

Water quality data provides an understanding of how land use and underlying geological controls affect the water in our lakes, rives and streams. Because we do not have past data or long term background information to review, it is difficult to determine if current land use practices are negatively affecting water quality. Compiling water quality data will allow us to determine the effectiveness or harmfulness of specific land use practices in maintaining good water quality. These determinations can further guide us in making informed decisions to protect the watershed's natural resources. Minimally impaired, reference sites, might serve as a standard by which data from other sites are compared to determine the level of impairment.

Water quality data commonly reflect land-use variations but can also be associated with short-term climatic variations, such as temperature and precipitation. For example, during dry periods pollutants accumulate in the uplands and are ultimately flushed into the receiving waters during storm events. However, some short-term data (immediately after a storm event) can be quite revealing.

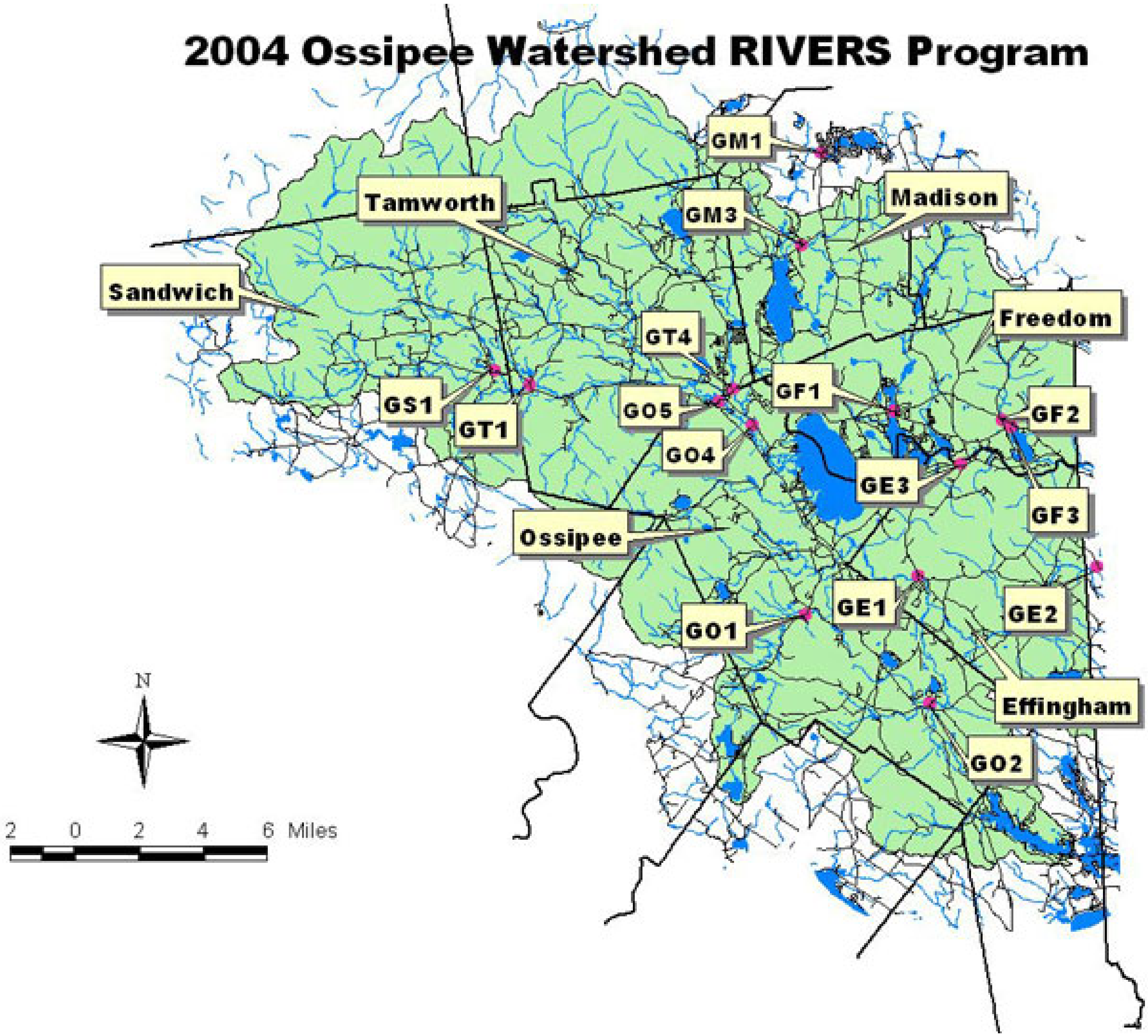

Figure 1. 2004 Ossipee Watershed Regional Interstate Volunteers for the Ecosystems and River of the Saco (RIVERS) Program test sites

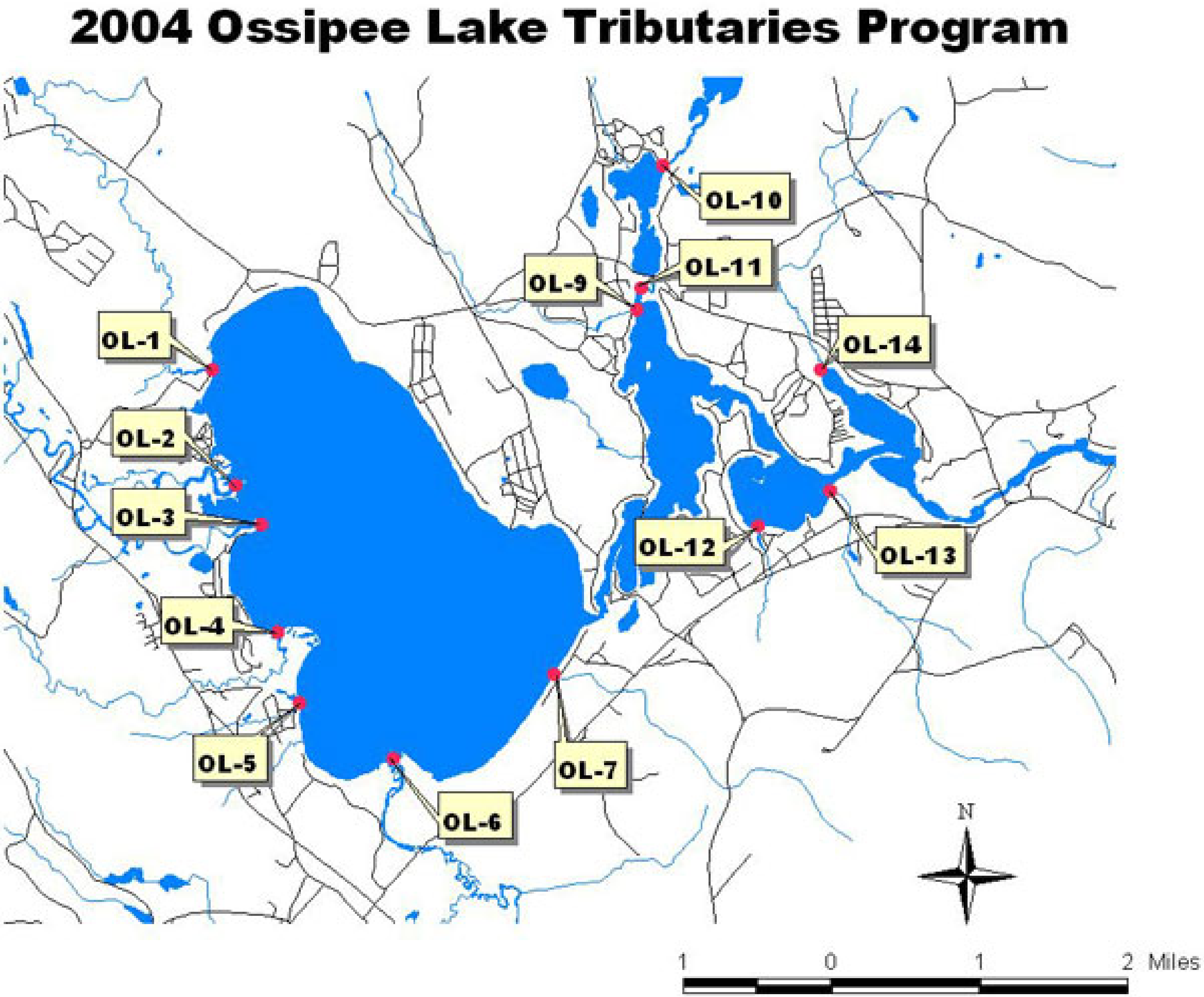

Figure 2. 2004 Ossipee Lake Tributaries (OLT) program test sites

2.0 Methods

2.1.1 RIVERS Site descriptions

Testing occurred at each of the fifteen sites through out the Ossipee Watershed (Figure 1). The following sites were sampled during the 2003 season (note that volunteers helped to write many of these descriptions).

GE-1 Pine River, Elm Street, Effingham

Pine River is a meandering river passing through glacial deposits. Bottom varies from sand to gravel to silt. At the test site the bottom appears to be mostly fine sand to silty mud. The water tends to be the color of strong tea most of the time, due to decaying vegetable matter. Long, streaming underwater grasses grow in the vicinity of the bridge, as well as water plants with small, oval leaves. Surrounding forest is mixed pine and hardwood, predominantly pine, with a lot of pitch pine and red pine as well as white. The terrain is quite flat along the river itself, though one end of the range that contains Green Mountain rises within an eighth of a mile of the river at the bridge. Fresh trash does not appear very frequently, but one can see old tires, a decaying television set, cans, bottles and scraps of packaging. The Pine River flows from the southern boundary of the Ossipee Watershed, through the Pine River State Forest, through several wetlands including Heath Pond Bog and into Ossipee Lake near Ossipee Lake Natural Area. GE-1 is located where the Pine River flows under Elm Street. The site is in the downstream shadow of a modern bridge with substantial concrete abutments. The river is about twenty feet wide. The current is steady enough to bend the subsurface weeds, but there are no surface ripples. Both up and downstream from the site, the river is open to the sky and mostly pines set back from both banks. This site was chosen because it is located downstream of two gravel pits as well as a designated drinking water zone. This site was also easily accessible.

GE-2 South River, Plantation Road, Parsonsfield, Maine

The South River flows from Province Lake and Lords Lake, through several wetlands and into Maine where it joins the Ossipee River. GE-2 is located just below the outlet of Lords Lake on Plantation Road. The testing site is immediately upstream from an aging concrete and steel bridge; the abutments are decaying and have clearly dropped cement into the river but some twenty feet below the actual test site. At the site, the river is about twenty feet wide, perhaps four to five feet deep toward the middle of the stream. The current is strong; there are several small rapids above and below the site. Much of the site gets direct sunlight, but the surrounding trees, mostly deciduous, overhang the river somewhat. There is some evidence of fishing activity. This site was chosen because it is located downstream of the town's transfer station and capped landfill. Potential road run-off is a concern as well. The site was also easily accessible.

GE-3 Ossipee River, Effingham Falls - New site in 2003

The Ossipee River drains Ossipee Lake. GE-3 is located just below the Ossipee Lake dam. The flow is rapid, and the water level is largely variable due to dam height and precipitation. Downstream the river turns to a slower moving meandering stream as the channel widens. The bottom is mostly gravel with sparse boulders and cobble. The stream is approximately 15-20 feet wide. Red maple, white pine, and bushes dominate the landscape around the site with a sandy top soil and a fine sand soil underneath. There are often fishermen here as this is a popular fishing site. People fish for rainbow trout just below the dam and rainbow trout at the site. Because this is such a popular fishing site there is also unfortunately a lot of trash here. The site is accessed via ? road where the tester parks at the Ossipee Lake Dam. The site is located at the end of the path downstream of the dam on the northern side of the stream. This site was chosen to determine the quality of water as it leaves Ossipee Lake.

GF-1 Danforth Brook, Ossipee Lake Road, Freedom
GF-1 is located where Danforth Brook flows under Ossipee Lake Road. It is a slow moving stream from Danforth Bay to Broad Bay. It is about 20 feet wide by 3-4 feet deep. Testing site is on the exit of Danforth about 150 feet. There is some outboard boat traffic entering Danforth from Broad Bay (1/day), but mostly canoe and kayak (2-3/day). Agitation exists in Danforth due to boat motors and water skiing. Site is surrounded by dense riparian vegetation. Some of this vegetation was cut early during the sampling season in 2003 and left exposed gravel. This test site was chosen to determine the impact of road run-off. Additional considerations were its accessibility and the fact that a previous study had been conducted.

GF-2 Cold River, Maple Street Bridge, Freedom
GF-2 is located in downtown Freedom Village where the Cold Brook flows under Maple Street. The sampling site is about 30 feet upstream from the dam that holds the Mill Pond. The pond is about 150 ft long, 20-25 feet across, with an average depth less than 6 feet. The actual sample site is located within 10 feet of a bridge that carries much of the auto and foot traffic within the village of Freedom. The pond is quite still during most of the summer as water does not flow over the top of the dam, just through a particular spillway. There is little human interaction with the water in the pond except when it is stocked for the kids fishing derby and the plastic duck race. This test site was chosen to determine the impact of road run-off and because the Brook runs through the village of Freedom and is easily accessible. An additional consideration was that the Freedom Conservation Commission has data on this site that had been gathered over a 20 year period.

GF-3 Cold River, Inlet to Loon Lake, Freedom - New Site in 2003
Cold Brook flows through Freedom Village and over a dam, just below GF-2, and into Loon Lake. GF-3 is several hundred yards upstream of the Cold Brook inlet to Loon Lake. The sampling site substrate consists mostly of gravel with minimal aquatic vegetation. A swiftly moving riffle is directly upstream, but the flow is slower at the site. The stream is approximately 5-6 feet wide. The site is surrounded by a mixed hardwood forest of ash, basswood, red maple, white oak, hemlock, and beech with a large amount of large white pines on the eastern side of the river. The herbaceous layer consists mostly of asters, golden rod, and ferns. There is a think top soil with plenty on leaf litter. The gravelly beach where sampling occurs is lined by grass. There are few obvious human influences at the site. There is a farm house upstream and a cemetery directly next to the site. Various wildlife inhabits the area including beaver and otter. The site is accessed via Maple Road where the tester parks at the cemetery. The site is just over the bank behind the cemetery. There is a path down the bank that goes to the right and the site is a little further to the right from this path at a gravelly beach on the stream situated between two white pines just off shore. This site was chosen because of concern over potential malfunctioning septic systems in Freedom Village.

GM-1 Banfield Brook, Route 113, Madison

While not in the Ossipee Watershed, this site is in the greater Saco Watershed. The brook comes down from Pea Porridge Pond in Madison and runs under Route 113. There are some houses along the brook's upper reaches in the Eidelweiss development. Banfield is rocky, with generally clear water. It stumbles down over a low concrete ledge ten feet before our testing site. In the summer there are water striders on the surface of the brook. This test site was chosen to determine the impact of road run-off, erosion and timber cutting to Pea Porridge Ponds. The stream also flows through the Eidelweiss development, located upstream of test site.

GM-2 Pequawket Brook, Route 113, Madison - New site in 2003

While not in the Ossipee Watershed, this site is in the greater Saco Watershed. GM-2 is off 113. It flows from a wetland at the edge of the watershed. There is a steep incline down to stream. The area surrounding the site is moderately wooded with deciduous trees. A large gravel operation near the stream is buffered only by twenty feet of forest. An abandon road leads up to stream embankment. Various wildlife such as beaver and river otter has been noted at the site occasionally. There is some erosion along banks and some dead fall of trees. Depth of stream varies with amount of rainfall. Stream has some aquatic growth and rocky/sandy in areas. This site was chosen because it's down stream of a large gravel operation. *This site was discontinued in 2004 because it did not appear that the gravel operation had any impact on the water and the site was outside of the Ossipee Watershed.*

GM-3 Forrest Brook, Silver Lake Hardware, Rt. 113, Madison - New Site in 2004

Forrest Brook, at the test site, has a smooth, slow-moving surface. The stream is about 12 feet wide, and the clear water carries very little amounts of floating matter: some bubbles/foam, leaves, bits of tree bark, and water striders. At the test site, the water has varied during the summer from 12 inches to less than 6 inches deep, depending on area rainfall. Both upstream and downstream are areas of shallower water where the stream burbles actively over rocks. The stream bottom consists of sand, gravel and cobble. Additionally, on the stream bottom lie pieces of tree detritus from overhanging trees and some leaves hinting of the nearness of autumn's arrival. The site is on the west side of the stream about twenty-five meters downstream from the culvert that carries Route 113 over the stream, and some eight feet down the road. (The culvert is the usual half-circle of corrugated, somewhat rusted, metal that highway departments install.) The site is reached by an undistinguished path from the parking lot of the Silver Lake Home Center down to the stream some ten meters downstream from the test site, and then along the stream, the detour necessitated by poison ivy just upslope from the test site. At the sample site, the stream flows south to north. To the west, the land rises about five feet up a gentle slope to its floodplain (on which Silver Lake Home Center is built); to the east, there is a steep bank some ten feet high up to rolling land where private residences are built (on lots of perhaps an acre each) along Forest Pines Road. The stream at this point gives no sign that it has descended on one branch down a mountainside through a scenic cascades area, and on another branch from a bog and past a cemetery. On the steep east shore, roots from two large pines and several smaller red maples grow over stream edge boulders and extend into the water which actively undercuts the stream bank trees. The mostly deciduous canopy of red maple, beech, and pines of several varieties shade the stream quite thoroughly at the test site. The understory trees include spruce, fir, hemlock, ash, witch hazel, and scrub oak. On the sandy banks grow mosses, ferns, asters and other wildflowers, poison ivy, Canada mayflowers, and other herbaceous plants. Only two pieces of litter were anywhere in sight at the time of writing this description. Eight meters downstream from the site, on the east side, a large water/sewer concrete construction rears up ten feet above the stream. Finally, in the late 1950s or early 1960s, when a late spring snowstorm melted rapidly, this section of Forrest Brook rose six feet above the road in this low, floodplain area. This site was chosen as it is located in the center of Madison within the Ossipee Watershed and is located near two drinking water protection zones.

GO-1 Beech River, Tuftonboro Road, Ossipee
The Beech River flows from Melvin Pond and Garland Pond in the southern Ossipee Mountains, along the Tuftonboro Road, and into the Pine River. The sampling location is where the river flows underneath the Tuftonboro Road. The stream is approximately 15 feet wide and 1-2 feet deep with a rocky substrate. The stream has a medium flow at the site and is clear with some foam/bubbles on top. There is a large beaver dam upstream of the bridge. Deciduous trees surround the site, including maple, oak, and ash with some hemlock and pine. Towards the end of the summer and into fall there is a thick shrub layer of golden rod, Queen Anne's lace, and aster. This site was chosen because of accessibility and because it is located upstream of a mill, dump and old tannery.

GO-2 Frenchman Brook, White Pond Road, Ossipee
This site is located about a ½ mile down White Pond Road just off Granite Road in the section of Ossipee known as Granite. White Pond Rd is a dirt road, maintained by the town. The site is approximately 40 feet upstream of where the stream crosses under White Pond Rd. There is a small pull-off below the brook and across the road is a barely discernible path that leads to a very small clearing on the bank where we do our testing. It is a quiet, apparently rarely visited site, except perhaps by deer and raccoon. At the site, the brook is narrow, about 5 feet across and curves both above and below the test area. The brook runs moderately fast with ripples in the center, and generally calm on the sides. The center of the brook is approximately 1 foot deep. There is a smaller brook that joins Frenchman's brook directly across from the test site. The bottom is silty with a deposit of dark colored pebbles in mid-stream. There are a couple of large dead branches in the brook downstream from the testing site. There is a moderate amount of organic debris (pine needles, leaves, ect.) near the edges of the brook; however, there are no aquatic plants. In general, the land from which we test is stable, although one week when we tested during a heavy rain event we noted a lot of disturbance when we stepped close to the edge of the brook. There is a large hemlock sheltering the test site. Other plants in the area include several types of fern (Royal, Sensitive, and Wood fern among them). The surrounding woods are mostly alder, mixed hardwood with a lot of maple samplings and pine. The topography surrounding the brook is mostly flat. Frenchman's Brook flows from Polly's Crossing, through a gravel pit, and into White Pond. This site also seems to be a common dumping station as a few bags of trash accumulated at the site and even a television and tool box in the middle of the stream. This site was chosen because Frenchman Brook runs under Route 16 just upstream of the test site, and there is the potential for road run-off impact. In addition, dumping has previously occurred upstream.

GO-3 Frenchman Brook, Polly's Crossing, Ossipee - New site in 2003
GO-3 is located in Polly's Crossing immediately downstream of a wetland. Sampling occurred where the stream flowed out of a culvert under a Class VI road. An upland forest surrounds the site. The stream is narrow and experiences intermittent flow during the drier months of the

summer. This site was chosen because of concern over high nutrient levels seen at GO-2 in 2002 that suggest a disturbance is occurring upstream. This site will help pinpoint the source of the disturbance. *This site was discontinued* because intermittent low flow of the site prevents regular sampling.

GO-4 Bearcamp River, UNH property, Newman Drew Rd, West Ossipee – New site in 2004
GO-4 is located on UNH property off of Newman Drew Rd. The site is accessed, however, from the Whit's End Campground land. Upstream from the site, the river makes a sharp right bend. The site is located on a small beach after this bend. There are often deer tracks along this beech, along with occasional moose and beaver tracks. The bottom is mostly sand with some gravel at the site with some large fallen trees in the water. The water is moderately fast moving, moving more swiftly than other Bearcamp River sites, and is about 0.5 – 2 feet deep, depending on rain fall and positioning in river due to an uneven and often changing bottom. Pine is the dominant tree here, along with some silver maples. This site was chosen to bracket development in the Ossipee area and because it was located on UNH property.

GO-5 Bearcamp River, Whittier Bridge, West Ossipee – New Site in 2004
GO-5 is located on the Bearcamp River in West Ossipee. The Bearcamp River flows from the Sandwich Range into Bearcamp Pond. Then it drains Bearcamp Pond and flows through along Rt. 25 in Tamworth until it flows into Ossipee Lake in Ossipee. The site is just below the Whittier Covered Bridge on Whittier Bridge Rd. GO-5 is approximately 2.5—3 river miles upstream from GO-4. Just downstream the river makes a horseshoe bend pointing north. The river is moderately fast moving here, but slow enough so that this is a popular swimming hole in the summer. The bottom is sandy and there is about a 100 foot wide beach on the north side of the stream where we test, another reason why this is such a popular swimming place. The river is about 30-35 feet wide and towards the middle the river is about 3-4 feet deep, depending on rainfall. There are no aquatic plants due to the sandy nature of the bottom. The surrounding forest is a mixed deciduous forest with some pine. This site was chosen to bracket development in the Ossipee area and because it is easily accessed.

GS-1 Cold River, Route 113, Sandwich.
GS-1 is located where the Cold River passes under Route 113 in Sandwich near the Tamworth/Sandwich town line. Cold River drains several streams that flow out of the White Mountain National Forest and the Sandwich Range Wilderness including Flat Mountain Pond. The river is about ten meters wide. GS-1 is downstream from a riffle and has a rocky substrate. The river stands up for its name as this site is usually the coldest in the WQM program. There is dense riparian vegetation on one side of the river and an upland deciduous forest on the other. This test site was chosen because of concerns about the gravel pit located upstream of the test site and because the river is situated upstream of Tamworth's drinking wellhead zone.

GT-1 Bearcamp River, Route 113, Tamworth
The site is located under the bridge where Rout 113 crosses the Bearcamp in South Tamworth near the Community School. The Bearcamp drains several streams that flow from Mount Israel in Sandwich. At the sampling site, the Bearcamp is a straight stretch of slow moving tea stained water. The river is 50-60 feet wide with a sandy bottom with scattered cobble and boulder sized rocks. It is about four feet deep at its deepest spot during summer median water level. There is no forest canopy directly at the sampling site and it receives full sunlight with the exception of

the portion under the bridge. There are red maples growing about 100 feet on either side of the bridge offering partial shade for much of the river. This site was chosen because of accessibility and because it provided a way for the students at The Community School to get involved with water testing. This site is located downstream of Tamworth's drinking water supply zone.

GT-2 Mill Brook, Earle Remick Natural Area, Tamworth

This sampling site is located within the Earle Remick Natural Area. The Mill Brook flows from the White Mountain National Forest and the Sandwich Range Wilderness and past the recently-capped Tamworth landfill. The site is set amongst a hemlock forest. The stream is about five meters wide and is swift moving with a rocky substrate. This test site was chosen because Tamworth's recently closed dump is located upstream and because established and well-maintained trails provide accessibility. *This site is no longer being sampled because the state has monitoring wells to keep track the capped dump.*

GT-3 Mill Brook, Durrell Road, Tamworth - New site in 2003

The site is located about one mile down Durrell Road on the North side of the road. The sampling site is on a straight stretch of stream with a steep slope leading down from the road and a relatively flat area on the opposite bank. Forest cover is dominated by eastern hemlock providing ample shade at the sampling site. The stream is straight, about 25-30 feet wide at the site and rather shallow: about 1-1.5 feet at its deepest point. It is about three to six inches deep where I sample. The bottom is dominated by sand and gravel with lost of cobble and bolder sized rocks scattered about. This site was chosen because of high nutrient levels seen at the downstream site (GT-2) in 2002 that suggests a disturbance has occurred up stream. Testing here will help pinpoint the source of this disturbance. *This site is no longer being sampled because the state has monitoring wells to keep track the capped dump.*

GT-4 Chocorua River, RT. 41, Tamworth - New site in 2004

From its source high on Mt. Chocorua, the Chocorua River drains the southeast side of the mountain. Just north of Lake Chocorua, the river's waters commingle with those of Stony Brook, Meadow Brook and their network of tributaries which drain the southern flanks of the mountain. Together, they enter the northern end of Lake Chocorua and eventually exit to the south under the landmark bridge and into adjacent Little Lake. From there they trace a long, slow, inverted "S" to Chocorua Village and pool before spilling over the dam, passing under Routes 113 and 16 and flowing south, contributing to the large marsh which runs along the east side of Route 16 from Chocorua to Moores Pond. From Moores Pond the river flows 2-1/2 miles through large stretches of marsh and finally emerges and passes under Route 41 at the Tamworth/West Ossipee line and just west of the Madison line. Monitoring Site GT#4 is at that bridge. A short distance from the site, the Chocorua River joins the Bearcamp River and flows into Ossipee Lake. The Chocorua River's course from source waters on the mountain to the Bearcamp River and Ossipee Lake points to the importance of this sampling site. It serves to monitor occurrences along a seven mile stretch of the busiest and most diversely utilized highway in our area, including locally cherished, pristine Lake Chocorua; and it feeds Ossipee Lake. The river is 8 to 12 feet wide in the area of the sampling site with a consistent, gentle flow with more ripples and surface effect at the site itself due to its location on the far side of the bend. About 3 to 5 feet deep in the center, the river appears to fluctuate 12 to 18 inches as indicated by the water lines on the walls. The water is clear and free from any odor. The bottom at the site is sand interspersed with stones and rocks and some scattered woody debris, with a tinge of rust presumably from the steel walls. About 6 feet downstream, beyond the bend and the current, there are patches of green algae on more stable sand covered with a thin layer of brown sediment. Due to the flow pattern, the east side differs significantly with green and brown algae and more grasses and accumulated woody debris in general on that side. About 40 feet upstream from the site, intermittent tree falls interrupt the flow and capture small amounts of debris, in one area creating a small waterfall. The site is bordered on the east by Route 41 and on the west by mixed young forest dominated by 3" to 10" diameter maples, some white oak and some small white pines. The dominant tree is a healthy, 24" diameter white oak. The lower story is dense with mixed grasses and ferns, mostly royal fern. In the immediate area of the sampling site where the substrate is coarse and uneven, obviously affected by the bridge construction, sweet fern, coarse grasses, a few birch saplings and goldenrod have taken hold.

2.1.2 OLT Site Descriptions

Table 1: Descriptions of tributary testing sites

Site #	Tributary Name	Description
OL-1	West Branch River	This river starts at the south end of Silver Lake and flows into Lily Pond adjacent to the International Paper mill on Route 41. From there it flows south and crosses Ossipee Lake Road, forming the boundary between Freedom and Ossipee. It enters Ossipee Lake between Babcock Road in Freedom and Nichols Road in Ossipee.
OL-2	Bearcamp River	This river originates in the town of Sandwich and follows Route 113 through the town of Tamworth, crossing under Route 16 south of West Ossipee. It passes the Gitchie Gumie Campground before entering the main body of Ossipee Lake north of Deer Cove.
OL-3	Patch Pond River	The tributary at Patch Pond Point begins as a pond behind the housing development at Deer Cove. The point at which the water flows into Ossipee Lake is on the north side of Deer Cove, south of Meadow Cove.
OL-4	Lovell River	This river originates at Connor Pond in the Ossipee Mountain Range and flows under Route 16 at the Indian Mound Golf Club. It enters the main body of Ossipee Lake south of Deer Cove at the site of the Bluffs, a housing development.
OL-5	Weetamoe Inlet	This brook flows into the Main Lake at the former location of Camp Weetamoe, now used for private rental cottages. The brook flows under Route 16, a major state highway, and through the Indian Mound Shopping Center and the Indian Mound Golf Course.
OL-6	Pine River	Pine River is one of the lake's major tributaries. It is the location of the only state boat ramp providing access to Ossipee Lake. From that location it flows under Route 25 and passes several clusters of homes before entering the main lake at its southern end adjacent to Ossipee Lake Natural Area.
OL-7	Red Brook	This brook enters the southeast end of the main body of Ossipee Lake between Long Sands and Ossipee Lake Natural Area. It flows past the Heath Pond Bog Natural Area, passing the commercial operations of South African Pulp and Paper Industries.
OL-9	Cold Brook	The headwaters of this brook are west of Trout Pond. It runs between Trout Pond and the Jackman Ridge along the Pequawket Trail and passes under the Ossipee Lake Road east of the Pequawket Trail. It subsequently enters the north side of Broad Bay between Camp Huckins and Ossipee Lake Marina.
OL-10	Danforth Pond Outlet	This brook flows into Danforth Pond from Huckins Pond, which is undeveloped. Although there is some use of this tributary by fishing boats with small engines and by personal watercraft.
OL-11	Danforth Brook	Danforth Brook flows from Danforth Pond, past Ossipee Lake Marina and into Broad Bay.
OL-12	Phillips Brook	This brook starts at Hanson Top and Davis Top. It crosses under Route 25 at Leavitt Road and enters Leavitt Bay, passing a housing development and campground near the point where it enters Leavitt Bay.

OL-13	**Leavitt Brook**	This brook starts at Hanson Top and Davis Top in the Green Mountain range. It crosses under Route 25 close to Camp Marist and enters the south end of Leavitt Bay between Leavitt Bay and the channel to Berry Bay on Camp Marist property.
OL-14	**Square Brook**	This brook passes through the Square Brook housing development on the northeast side of Ossipee Lake Road, passes under that road before entering the northwest end of Berry Bay.

2.1.3 RIVERS Testing Schedule

Sampling began on June 14 and ended on October 21. Sampling occurred ten times (every other week) throughout this period. Sampling occurred between 6:00 and 9:00 am because of two factors that influence dissolved oxygen in streams. First, dissolved oxygen levels can be affected as water temperatures rise throughout the day. Second, after a night of carbon dioxide-producing respiration, aquatic plants and algae begin producing oxygen through photosynthesis, thereby altering oxygen levels in the water. In order to maintain consistent dissolved oxygen measurements, it is important to test at the same time of day during each sampling period.

2.1.4 OLT Testing Schedule

Similar to the RIVERS program, sampling occurred between 6:00 and 9:00 am because of factors that influence dissolved oxygen in streams. OLT sites were sampled four times (biweekly) between July 5 and August 19.

Dates	WQM Staff	Sites	Volunteers	Access
Monday, July 5 & 19, August 2 & 16	Jennifer	OL13		Road
Tuesday, July 6 & 20, August 3 & 17	Jennifer	OL12	Robin Hood	Boat
	Claes	OL9 OL11	Camp Huckins	Boat
		OL1 OL2	Carolyn Buskirk & Cindy Sawyer	Boat
Wednesday, July 7 & 21, August 4 & 18	Jennifer	OL5 OL6	Camp Cody	Boat
	Claes	OL3 OL4	Camp Calumet	Boat
Thursday, July 8 & 22, August 5 & 19	Jennifer	OL7 OL10		Boat Road
		OL14	Susan Fine	Road

2.1.5 Parameters

Seventeen parameters were tested in the monitoring program. Four parameters were tested in the field by volunteers and GMCG staff (Table 1). These parameters were recorded on a data sheet (Appendix A) and replicated. For instructions on how to use field parameter equipment, refer to Appendix B.

Table 1: Field parameters tested.

Parameter	Units	Instrument Used	Range	Accuracy
pH	pH units	YSI 60	0 to 14	±0.1 unit within 10°C of calibration ±0.2 unit within 20°C
Dissolved Oxygen	mg/l, %	YSI 550A	0-50 mg/L 0-500% air saturation	0-200 % : ±2% air sat. or ±2% of reading, whichever is greater 200-500% : ±6% of reading 0-20 mg/L : ±0.3 mg/L or ±2% of reading, whichever is greater 20-50 mg/L : ±6% of reading
Turbidity	NTU	HACH Model 2100P Portable Turbidimeter	0-1000 NTU	+\- 2% of reading
Temperature	˚ C	HACH Non-mercury thermometer	-5 to 45˚C	+\- 0.3˚ C

Fourteen additional chemical parameters were tested (Table 2). Two water samples were collected in 250 ml bottles at each site. One sample was acidified with one milliliter of concentrated sulfuric acid then frozen. The other sample was filtered using a 47 mm diameter 0.45 micron mesh Whatman filter, stored in a 60 ml bottle and frozen.

Table 2: Lab parameters tested.

Parameter	Units	Instrument Used	Description	Sample Preservative
Total Phosphorus (TP)	ppb	Milton-Roy 1001^{+} Spectrophotometer	Std Methods Ascorbic Acid method. 10cm pathlenght cuvette	1 ml concentracted sulfuric acid and frozen
Dissolved Organic Carbon (DOC)	mg C/L	Shimadzu TOC 5000 with autosampler	High Temperature Catalytic Oxidation (HTCO)	Filtered and Frozen
Total Dissolved Nitrogen (TDN)	mg N/L	Shimadzu TOC 5000 coupled with an Antekk 720 N detector	HTCO with chemiluminescent N detection	
Nitrate (NO_3^-)	mg N/L	Lachat QuikChem AE	Automated Cd-Cu reduction	
Ammonium (NH_4^-)	mg N/L		Automated Phenate	
Dissolved Organic Nitrogen (DON)	mg N/L		DON= TDN-(NO_3^-+ $NH_4^{-)}$	
Phosphate (PO_4^{3-})	mg P/L	Lachat QuikChem AE	Automated Ascorbic Acid	
Silica (SiO_2)	mg SiO_2/L		Automated Molybdate Reactive Method	
Anions (Cl^-, SO_4^{2-})	mg/L	Ion Chromatograph	Anions via ion chromatography with suppressed conductivity	
Cations (Na^+, K^+, Ca^{2+}, Mg^{2+})	mg/L		Cations via ion chromatography and conductivity	

3. Summary and Discussion

3.1 Precipitation

Precipitation can have a significant impact on water quality. Periods of heavy rainfall, as well as the period of spring snowmelt, often coincide with the increased transport of pollutants and sediments into our surface waters that include lakes, streams and wetlands. Likewise, the water that infiltrates the soil and enters our surface waters as groundwater recharge can be laden with minerals that occur naturally, through the weathering of mineral formations, as well as, from human sources such as septic system effluent, leaching fertilizers and road salt applications. However, dry periods are often characterized by a reduction in the overland pollutant transport into our surface waters. During these dry periods, pollutants often accumulate in the watershed until the following heavy storm event or wet period provides a means of transporting debris, nutrients and other materials into our water bodies.

Precipitation during the first three months of 2004 was below the rainfall amounts for the previous three years of 2001-2003 (Figure 3). However, precipitation in April and May of 2004 was higher than the previous three years, while June of 2004 was relatively dry. The months of July-September 2004 harbored similar rainfall amounts that were similar to the four year average. October precipitation fell below the four year average, while November was slightly above.

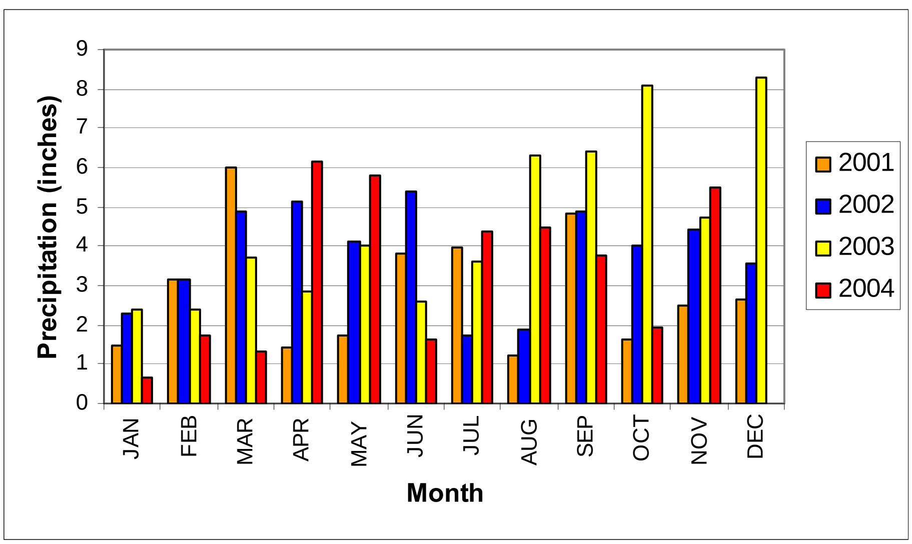

Figure 3: Tamworth precipitation, 2001-2004

3.2 Temperature

The temperature and range of temperatures that occur at the stream site will limit the type of stream organisms that can survive at their respective location. Processes, such as the removal of shoreside vegetation, that increase the water temperature; generally have a negative impact on the aquatic organisms. Raising temperatures will also reduce the water's capacity to hold oxygen and might further impact the suitability of these streams to harbor aquatic life including certain fish species. For example, temperatures in excess of 19˚C are often considered intolerable to trout.

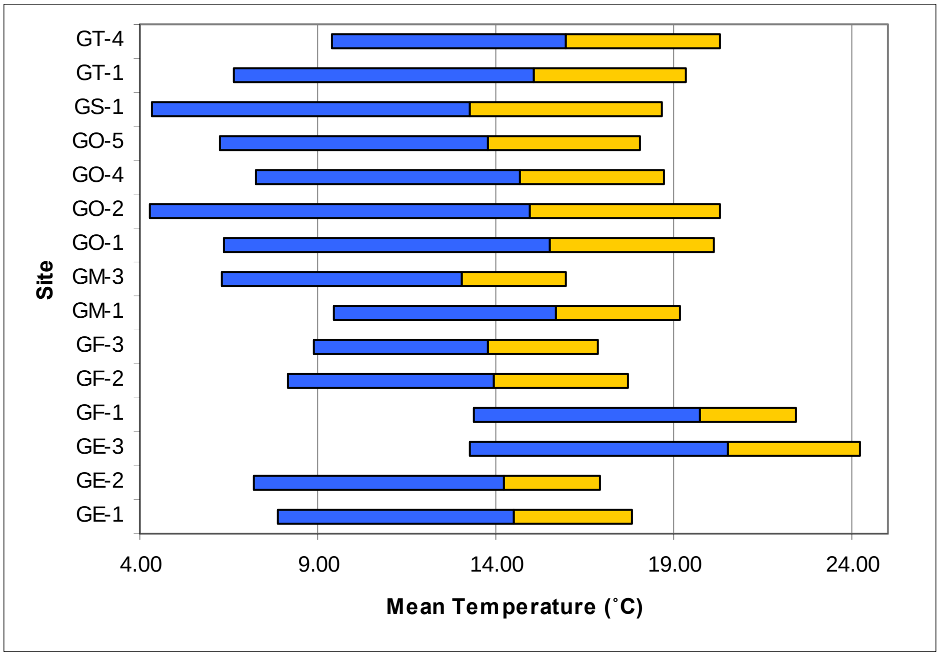

Figure 4: RIVERS inter site temperature comparison for 2004. Bars show range of temperatures. Darker bars show range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

Temperatures were variable across the RIVERS sites in 2004 (Figure 4). The highest average temperatures were observed at GF-1 (19.7 ˚C) and GE-3 (20.5 ˚C), both outlets to bodies of Ossipee Lake. The lowest mean temperature was seen at site GM-3 (13.0 ˚C) with GS-1 not much higher at 13.2 ˚C.

Mean temperatures at each site in 2004 were similar to 2003 and lower than 2002 (Figure 5). In 2004, the Ossipee Watershed experienced less rainfall than 2003; however the average temperatures were lower than 2003, which could attribute to similar temperature values for 2003 and 2004.

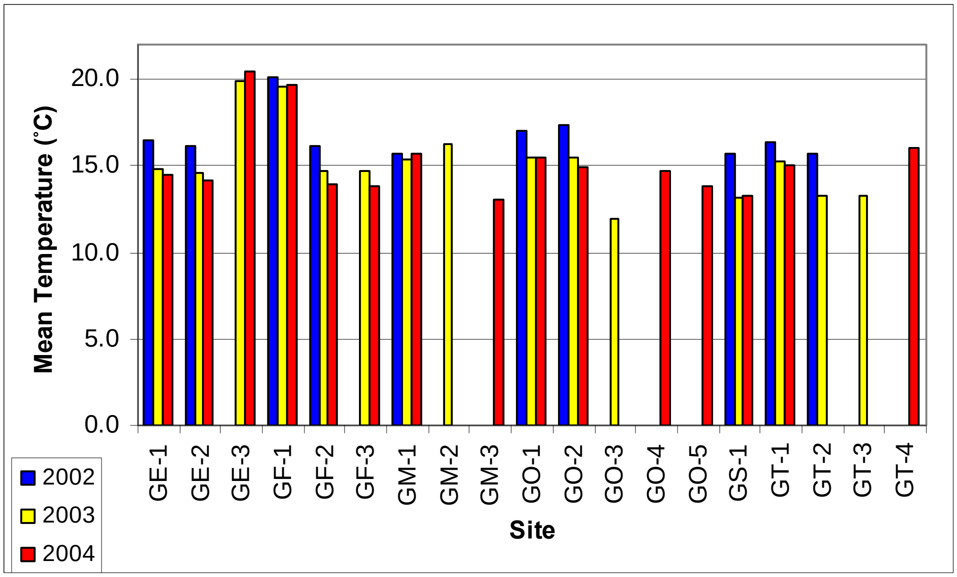

Figure 5: RIVERS site mean temperature comparison for 2002, 2003, and 2004.

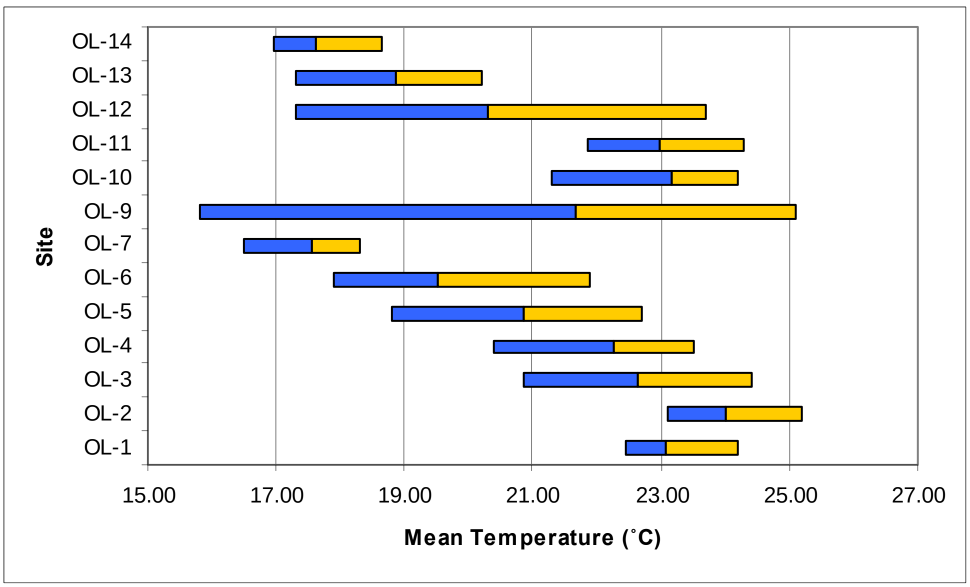

Figure 6: OLT inter site temperature comparison for 2004. Bars show range of temperatures. Darker bars show range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

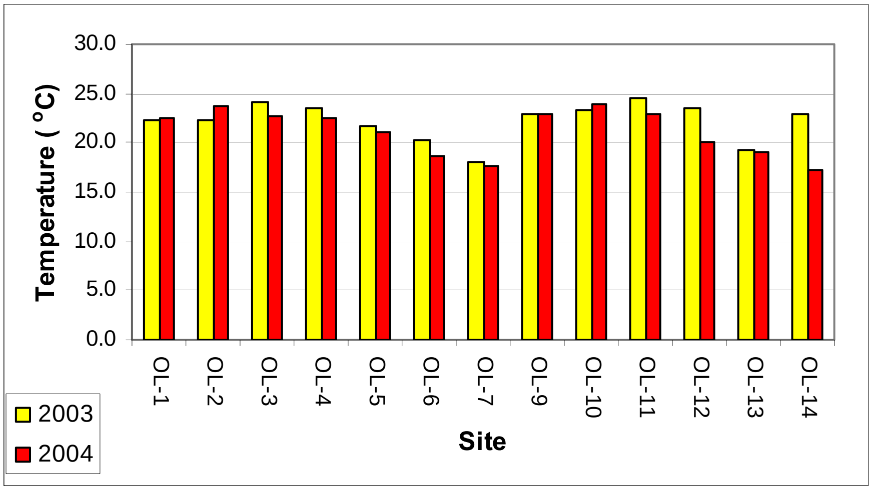

Figure 7: OLT site mean temperature comparison for 2003 and 2004.

3.3 Dissolved Oxygen

Oxygen is an essential component for the survival of aquatic life. Submergent plants and algae create oxygen through photosynthesis during the day. Respiration by both plants and animals consume oxygen continually. Respiration is associated with the natural bacteria, fungi and other decomposers in the stream that break down organic matter that enters the stream from upland sources, as well as, from the water originating from up-gradient lakes, wetlands and the stream itself. Oxygen can also be replenished in the streams through the turbulent mixing of the air and water, particularly in fast flowing and rocky stream reaches that facilitates the rapid diffusion of atmospheric oxygen into the stream water.

The capacity of the water to hold oxygen is temperature dependent; warmer water has a lower capacity to hold oxygen. Thus, you will generally measure less in-stream dissolved oxygen during the summer months than during the early spring and late fall months. To account for this interdependence of temperature and dissolved oxygen content, the dissolved oxygen data are oftentimes expressed as percent saturation which reflects the oxygen measured relative to the water's capacity to hold oxygen at a given temperature.

The dissolved oxygen concentrations in the Ossipee Watershed ranged from 7.10 mg/L at GF-1 and 7.13 mg/L at GO-1 to 13.96 mg/L at GO-2 and 12.60 mg/L at GS-1 (Figure 5). GS-1 was found to be the site with that provides the best example of good water quality in the Ossipee Watershed during the 2002 and 2003 RIVERS program. Percent saturations in the Ossipee Watershed ranged from 73.5% at GE-2 to 107.3% at GO-2 (Figure 6). As seen in Figure 7, most sites have a similar dissolved oxygen concentration in 2004 as in 2002 and 2003.

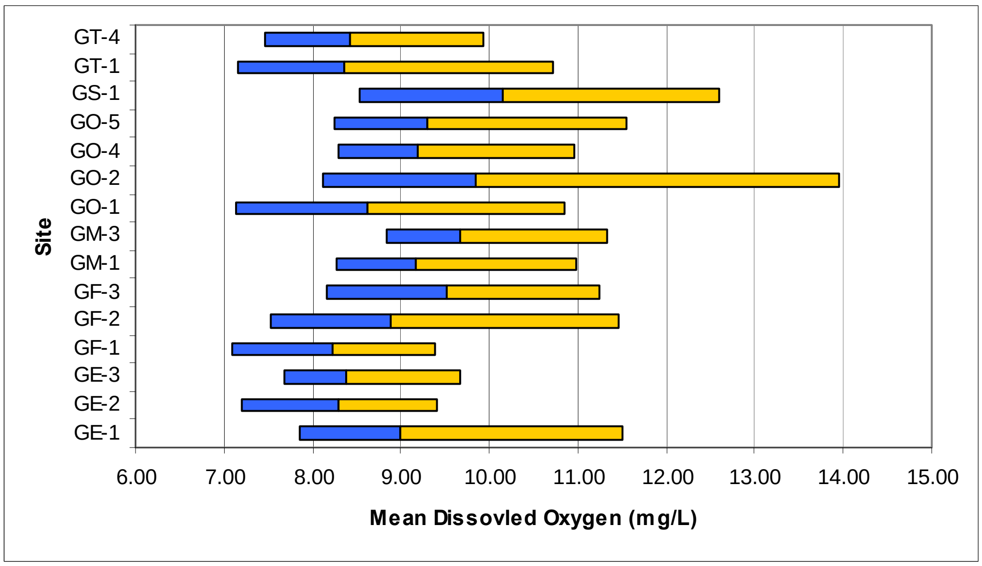

Figure 8: RIVERS dissolved oxygen concentration site comparison for 2004. Bars show range of dissolved oxygen concentrations. Darker bars show range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

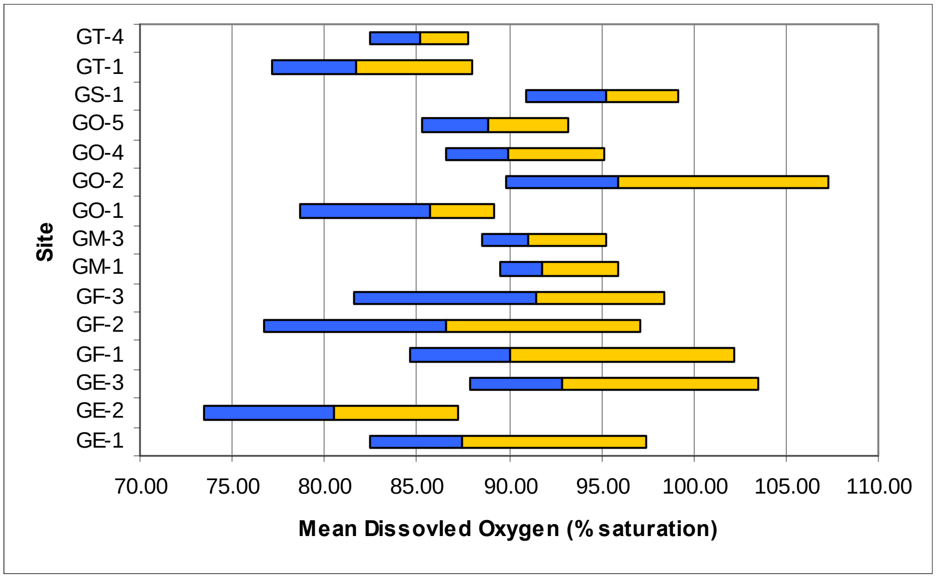

Figure 9: RIVERS dissolved oxygen percent saturation site comparison for 2004. Bars show range of dissolved oxygen concentrations. Darker bars show range less than the mean. Lighter bars show range greater than the mean.

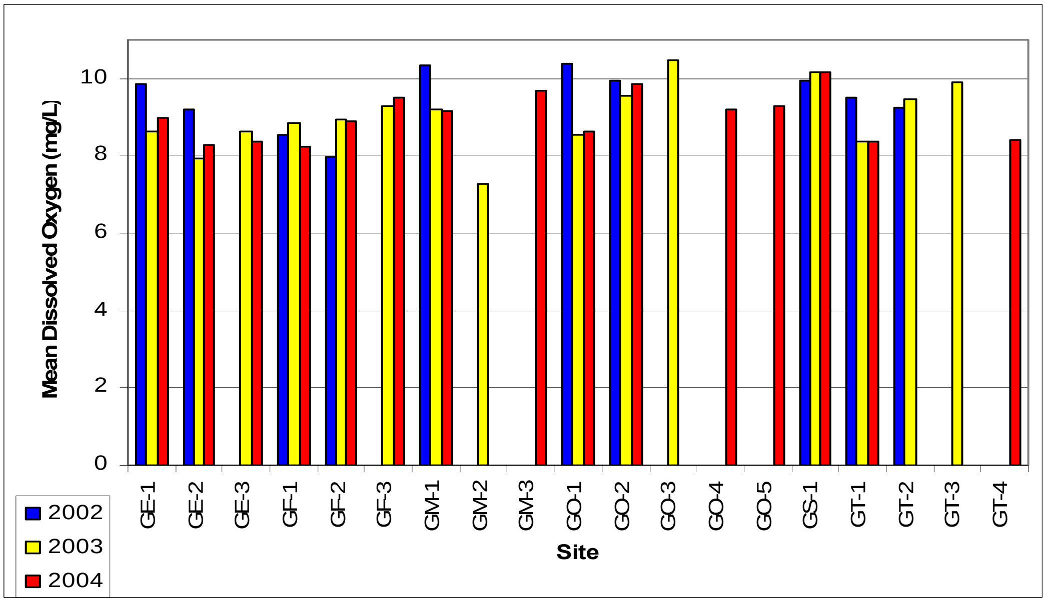

Figure 10: RIVERS site mean dissolved oxygen comparison for 2002, 2003, 2004.

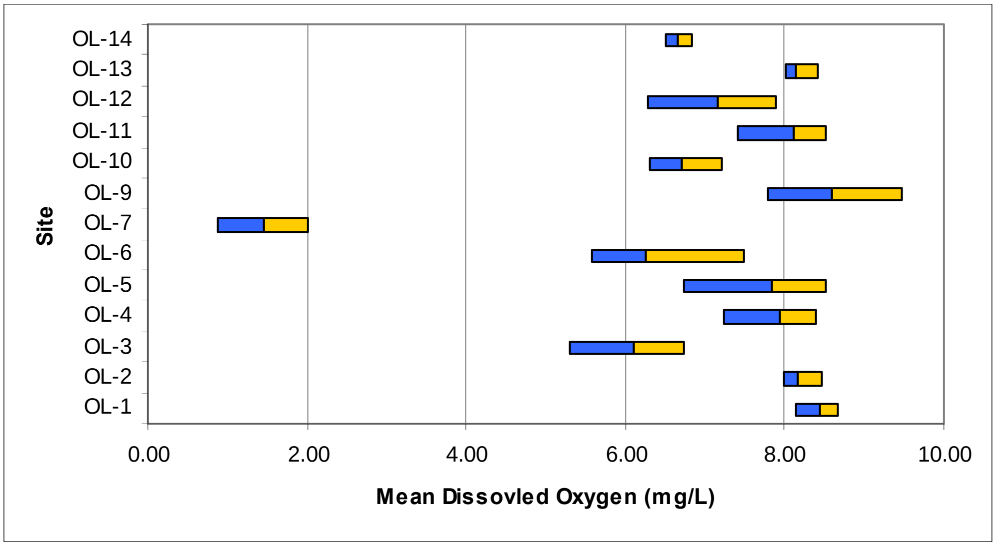

Figure 11: OLT dissolved oxygen concentration site comparison for 2004. Bars show range of dissolved oxygen concentrations. Darker bars show range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

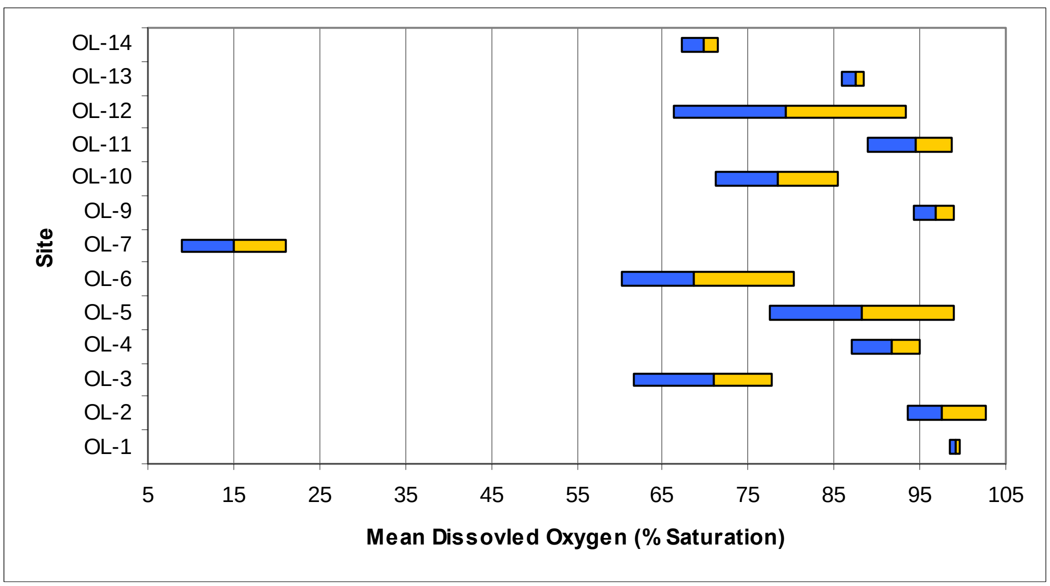

Figure 12: OLT dissolved oxygen percent saturation site comparison for 2004. Bars show range of dissolved oxygen concentrations. Darker bars show range less than the mean. Lighter bars show range greater than the mean.

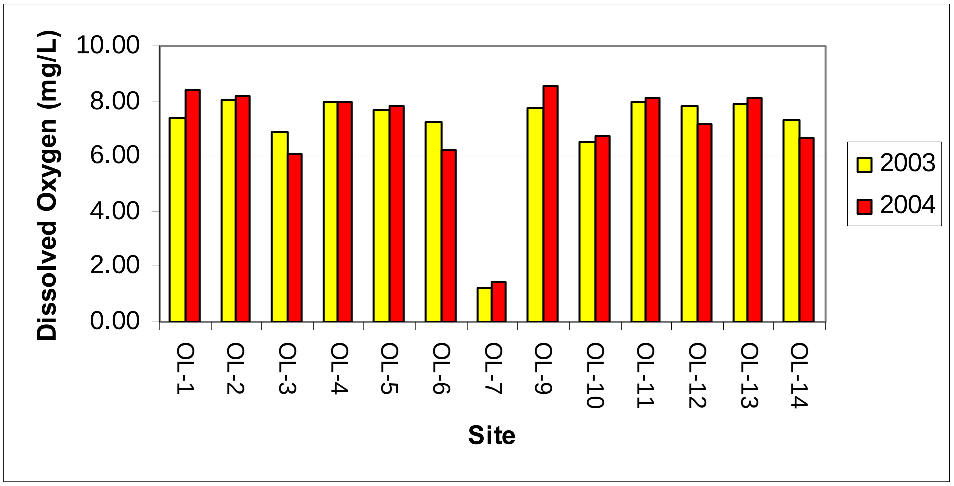

Figure 12: OLT site mean dissolved oxygen comparison for 2003 and 2004.

3.4 pH

The pH is a way of expressing the acidic level of stream water and is generally measured with an electrical probe sensitive to hydrogen ion activity. The pH scale has a range of one (very acidic) to fourteen (very "basic" or alkaline) and seven is neutral. The scale is neutral; changes in 1 pH unit reflect a ten times difference in hydrogen ion concentration. Most aquatic organisms tolerate a limited range of pH and most fish species require a pH of 5.5 or higher to grow and reproduce successfully. Wide pH fluctuations associated with industrial pollution and acid precipitation are generally considered the most sever acidic stressors to instream aquatic organisms. In New Hampshire, the spring runoff period is often considered the period during which the aquatic organisms are most susceptible to acid rain stress.

2004 pH in the Ossipee Watershed ranged from 5.92 at GE-2 to 7.63 at GE-3 (Figure 8). Mean pH in 2004 was slightly higher at all sites and dates than in 2003, but lower than 2002 data (except for GF-1) (Figure 9). GMCG began using new pH equipment in 2003. Volunteers frequently had trouble with the new pH meter and one was sent back twice for service. It is unknown if the meters are the reason behind the pH discrepancy from 2002 to 2003 and 2004. In addition, the higher volume of rain in 2003 could be reason for lower pH. However, sites along the Saco River, as measured by the volunteers of the Saco River Corridor Commission, did not exhibit a similar trend.

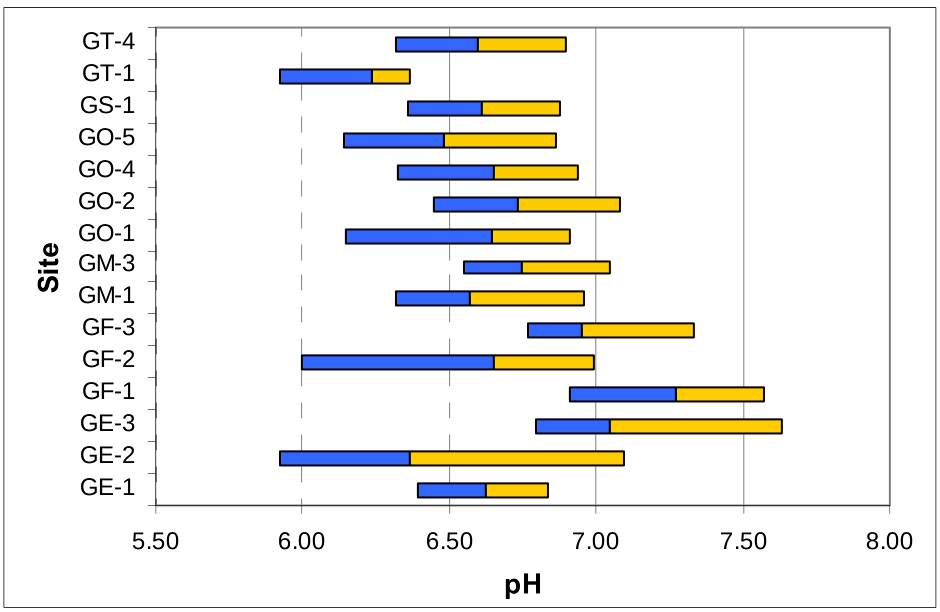

Figure 13: RIVERS site pH comparison for 2004. Bars show range of pH. Darker bars shows range less than the mean. Lighter bars show the range greater than the mean. Mean value is at point where dark and light bars meet.

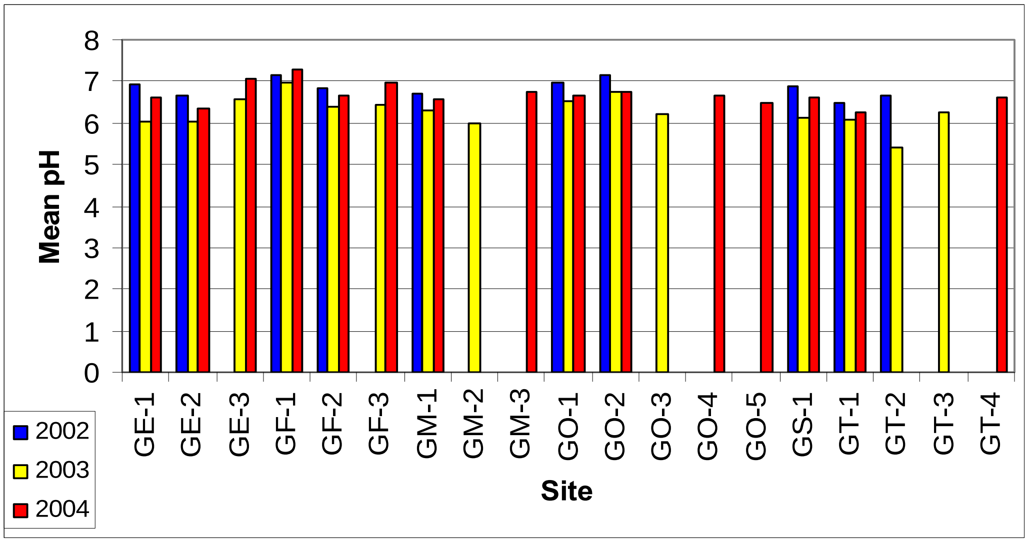

Figure 14: RIVERS site mean pH comparison for 2002, 2003, and 2004.

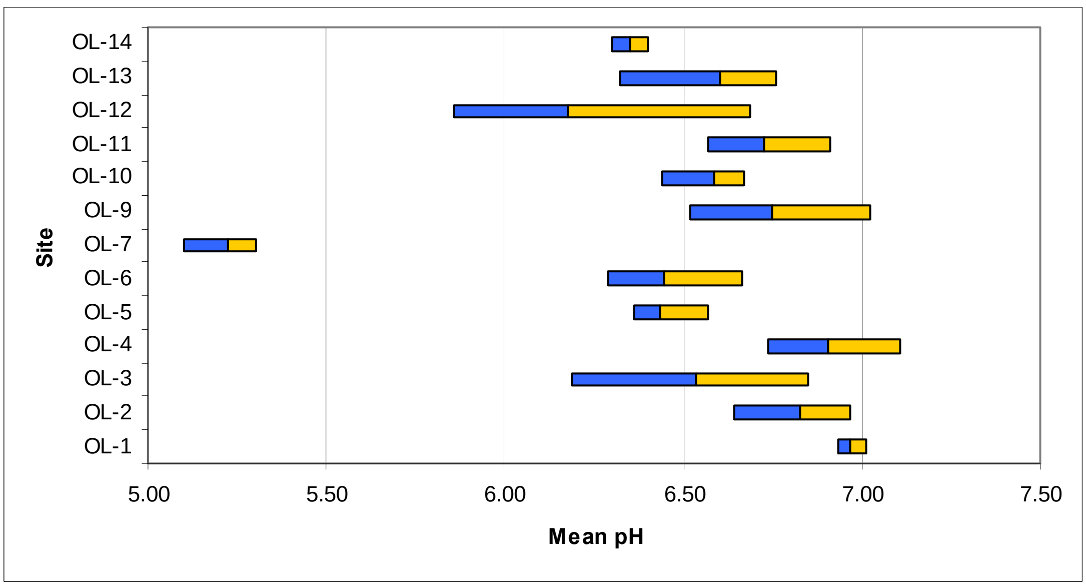

Figure 15: OLT site pH comparison for 2004. Bars show range of pH. Darker bars shows range less than the mean. Lighter bars show the range greater than the mean. Mean value is at point where dark and light bars meet.

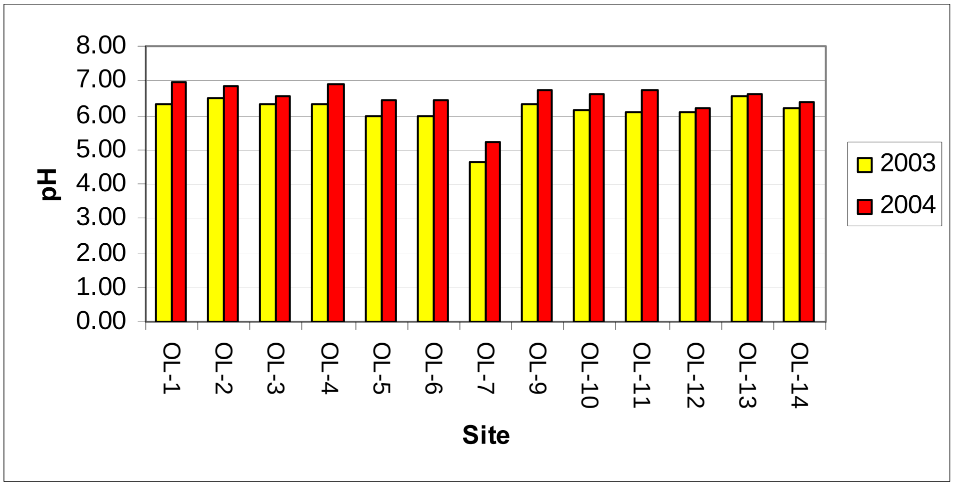

Figure 16: OLT site mean pH comparison for 2003 and 2004.

3.5 Turbidity

The amount of suspended material in the stream is referred to as the turbidity. Turbidity can be summarized by the amount of sediments, silt, algae, leaves, pollen and other solid debris that are suspended in the water column. The turbidity is measured with an electronic meter called a nephalometer and the turbidity is reported at nephalometric turbidity units (NTU). Many chemical pollutants and nutrients are commonly attached to silt particles and in some instances the turbidity might be used as a surrogate for other more expensive and involved analyses such as total phosphorus measurements (Figure 10). In previous years, it did not appear than total phosphorus in Ossipee Watershed sites was related to turbidity. However, in 2004 there was a closer relationship (R^2=0.6105). Besides the chemical pollutants and nutrients that are commonly attached to silt particles, the silt particles themselves can cause great in-stream changes. Silts can cover up nesting and prime habitat areas and can be highly abrasive to the gill structure of many aquatic organisms.

The mean turbidity in the Ossipee Watershed ranged from 0.19 NTU at GS-1 to 6.50 NTU at GO-2 (Figure 11). With considerably more rainfall in 2003 than 2002 and 2004, it is expected that some sites will exhibit higher turbidity (Figure 12). However, in 2004 GM-1, GO-1, and GO-2 experienced raised levels of turbidity in comparison to previous year's data.

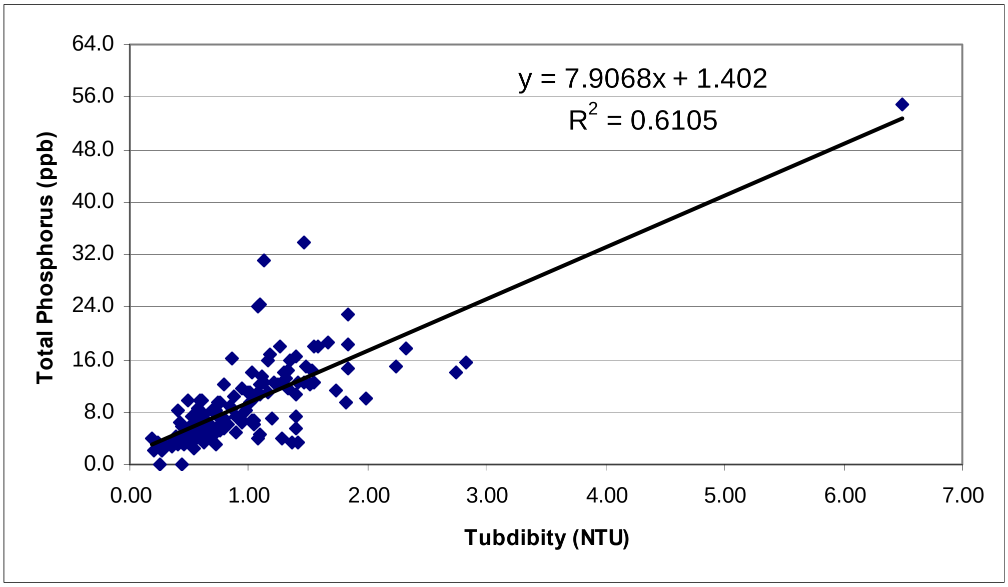

Figure 17: Total phosphorus vs. turbidity for RIVERS, 2004.

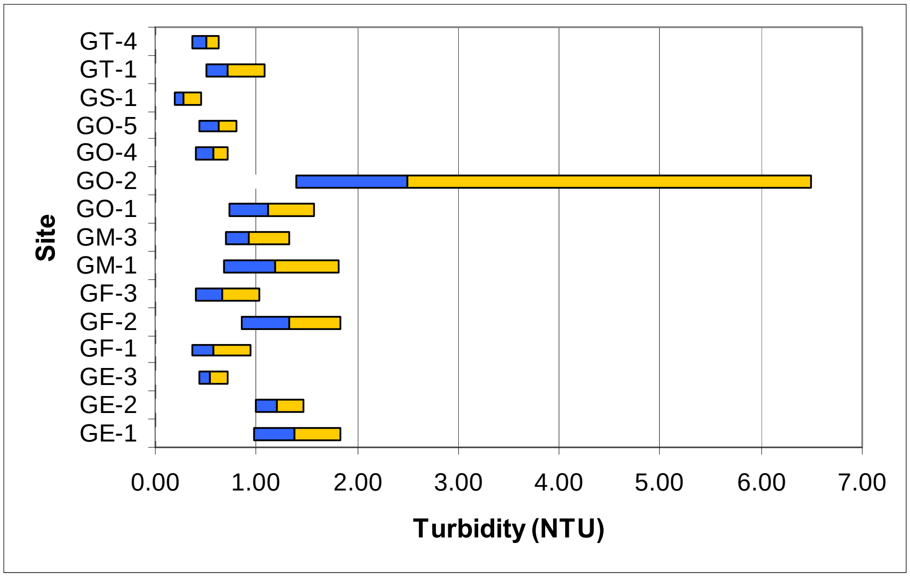

Figure 18: 2004 RIVERS inter site turbidity comparison. Bars show range of turbidity. Darker bars show range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

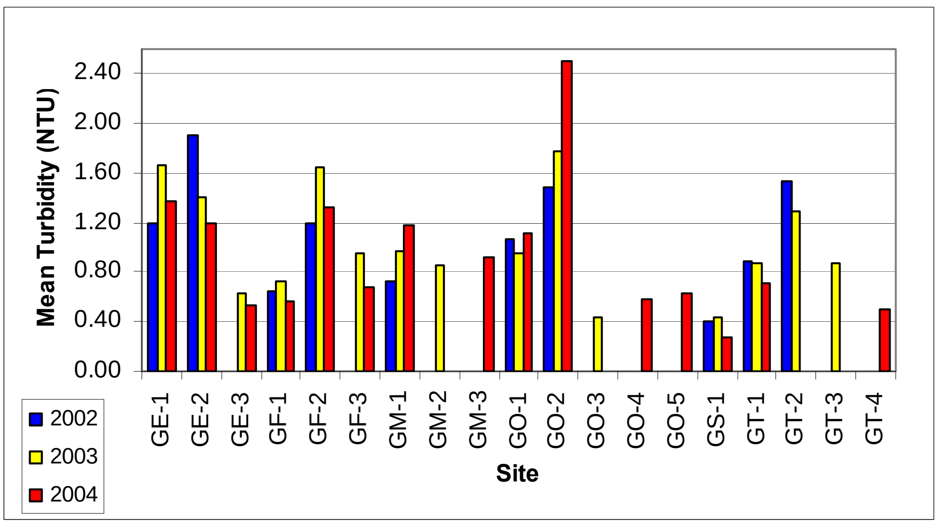

Figure 19: RIVERS site turbidity comparison for 2002, 2003, and 2004.

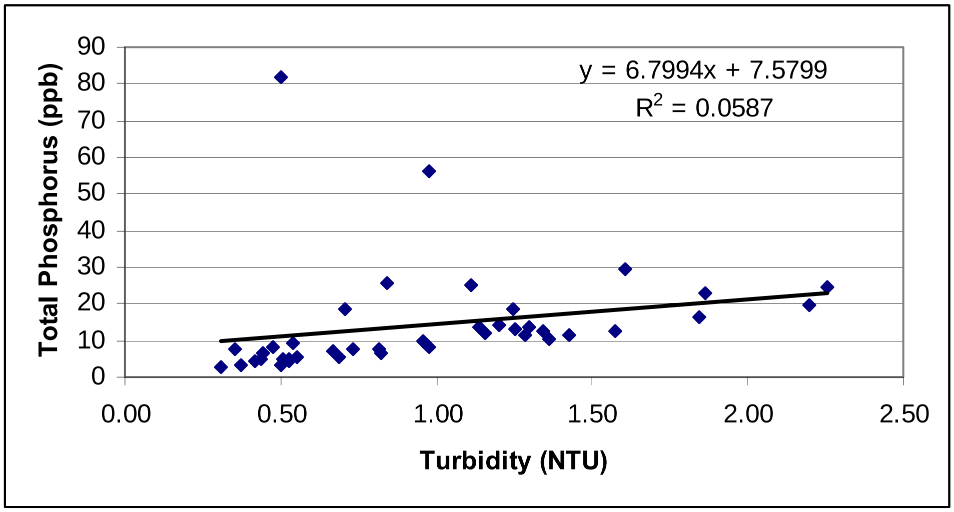

Figure 20: Total phosphorus vs. turbidity for OLT, 2004.

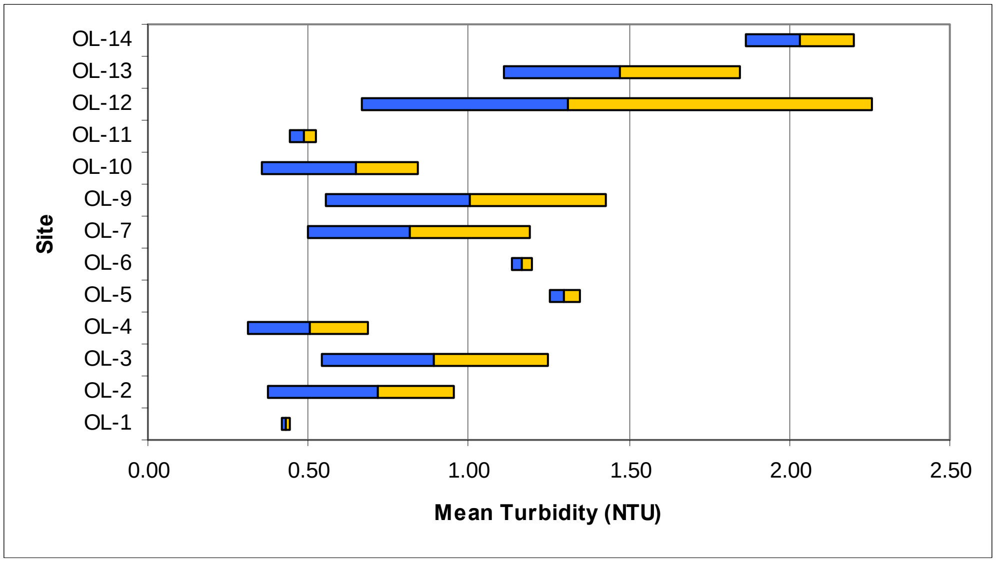

Figure 21: OLT inter site turbidity comparison. Bars show range of turbidity. Darker bars show range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

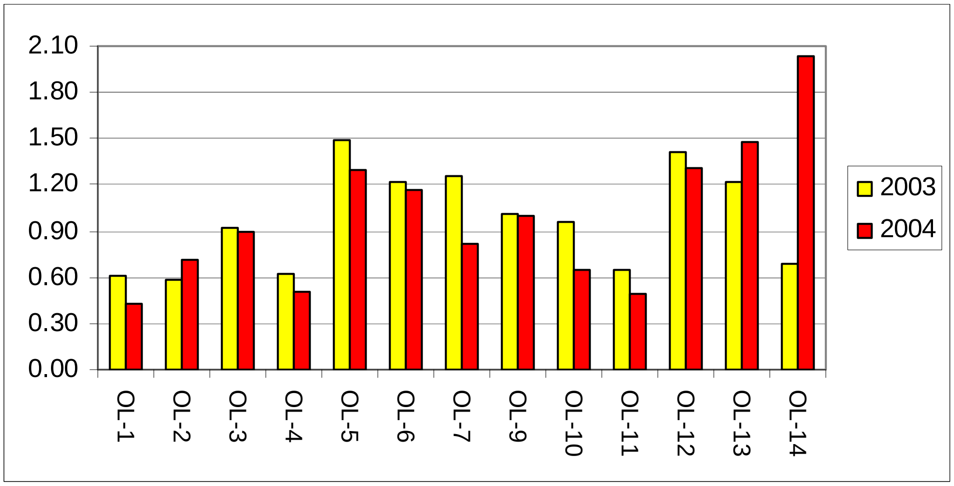

Figure 22: OLT site turbidity comparison for 2003, and 2004.

3.6 Total Phosphorus

Of the two nutrients most important to the growth of aquatic plants, nitrogen and phosphorus, it is generally observed that phosphorus is the more limiting to plant growth in freshwater systems. Phosphorus is primarily associated with human related activities within the watershed and is therefore important to monitor and control. The total phosphorus includes all dissolved phosphorus as well as the phosphorus contained in or adhered to suspended particles such as sediment and plankton. Total phosphorus will accumulate in the slow moving stream reaches and in impoundments where the particulate bound phosphorus settles out of the water column. These localized phosphorus rich regions can then serve as phosphorus sources that result in localized algal blooms and related water quality problems.

Total phosphorus in the Ossipee Watershed in 2004 ranged from 0.00 ppb at GS-1 to 54.90 ppb at GO-2 (Figure 13). The low total phosphorus level at GS-1 is comparable to the low levels observed in 2002 and 2003 (Figure 14).

Mean total phosphorus at most sites was lower in 2004 than 2003 and was similar to 2002 levels, except at GE-2, GF-2, and GO-2 which experienced higher levels (Figure 14). This could be due to the lower rainfall than 2003 and similar amount of rainfall to 2002. However, it should be expected that high total phosphorus due to rain is coupled with high turbidity. GO-2 did experience a raise in turbidity with the raise in total phosphorus; however, GE-2 and GF-2 did not. Other sites did experience a decrease in turbidity with a decrease in total phosphorus.

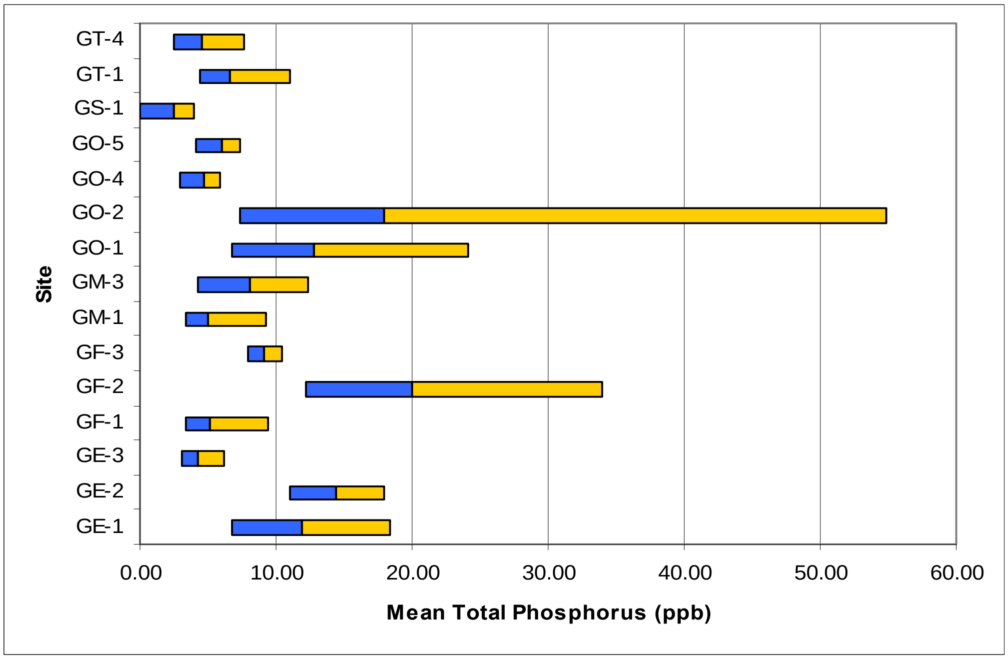

Figure 23: 2004 RIVERS total phosphorus site comparison. Darker bars shows range less than the mean. Lighter bars show the range greater than the mean. Mean value is at point where dark and light bars meet.

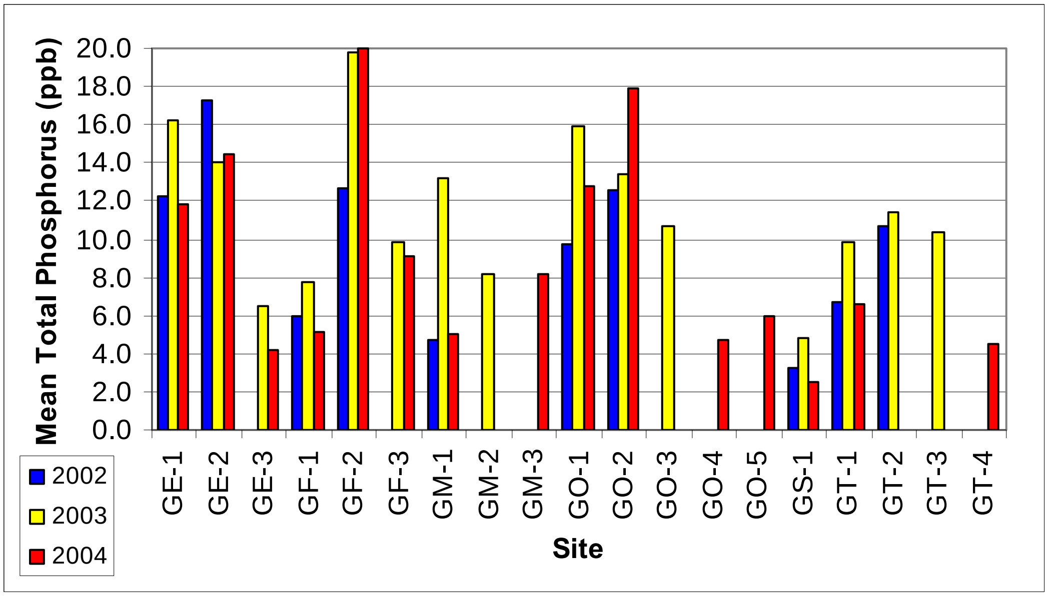

Figure 24: RIVERS site total phosphorus comparison for 2002, 2003, and 2004.

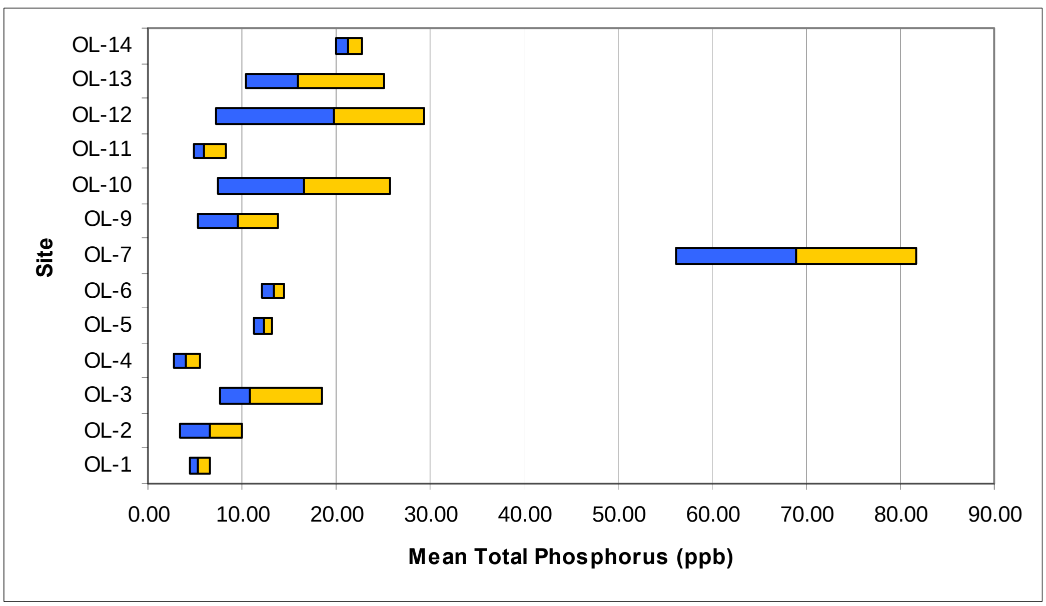

Figure 25: 2004 OLT total phosphorus site comparison. Darker bars shows range less than the mean. Lighter bars show the range greater than the mean. Mean value is at point where dark and light bars meet.

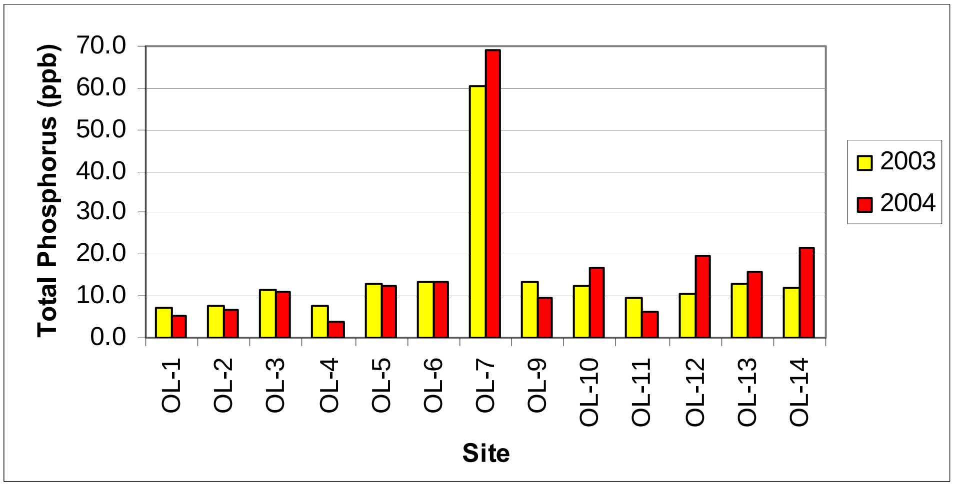

Figure 26: OLT site total phosphorus comparison for 2003 and 2004.

3.7 Phosphate

Phosphorus is often the limiting nutrient in streams and phosphate is the most biologically available form of phosphorus. Phosphate, a component of total phosphorus is typically very low in natural systems. Total phosphorus and phosphate are related. However, it is impossible for phosphate to exceed total phosphorus. By examining the total phosphorus and phosphate data, it is clear that there have been no lab errors, and total phosphorus exceeds phosphate levels (Figure 15). Sewage and agricultural inputs will increase PO_4^{3-} levels. High levels of phosphate can lead to problematic algal blooms and eutrophication. Sometimes low light levels limit production in a phosphate rich environment.

Phosphate ranged from zero at all sites to 17.72 µg P/L at GE-1 (Figure 16). Phosphate levels in 2003 were varied from 2002 (Figure 17). For some sites, this variation could be a result of higher precipitation amounts. Phosphate levels in 2004 were mostly lower than 2003, except for at GE-3, GO-2, and GT-1, most likely due to decrease rainfall.

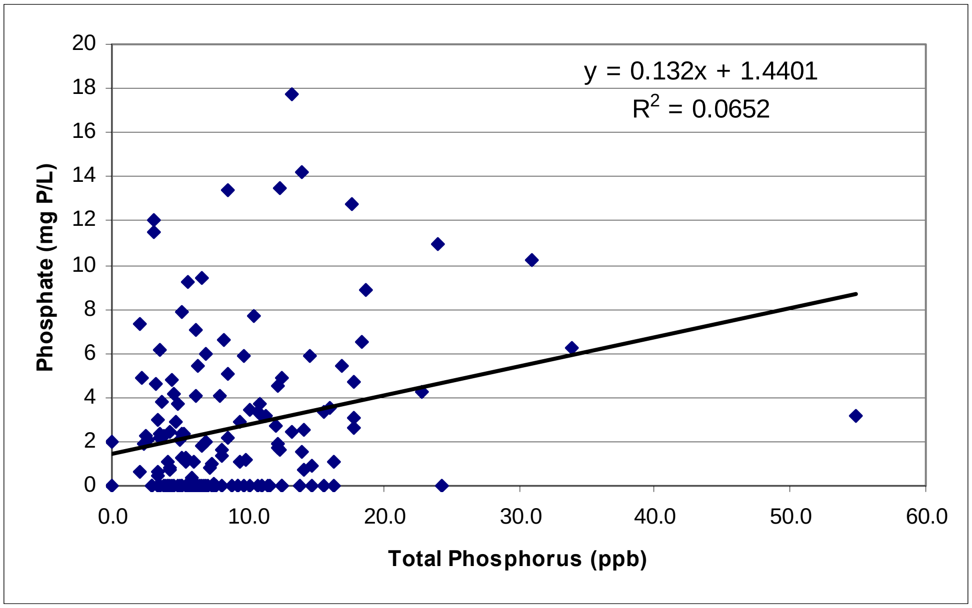

Figure 27: Comparison of phosphate and total phosphorus measurements for RIVERS test sites, 2004

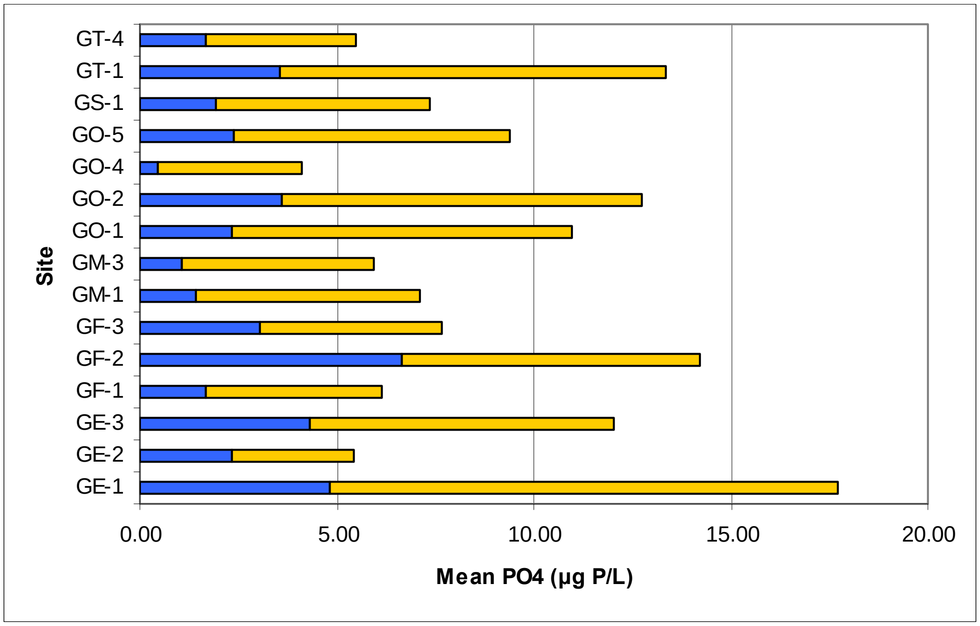

Figure 28: 2004 RIVERS site phosphate comparison. Bars show range of phosphate concentrations. Darker bars shows range less than the mean. Lighter bars shows range greater than the mean. Mean value is at point where dark and light bars meet.

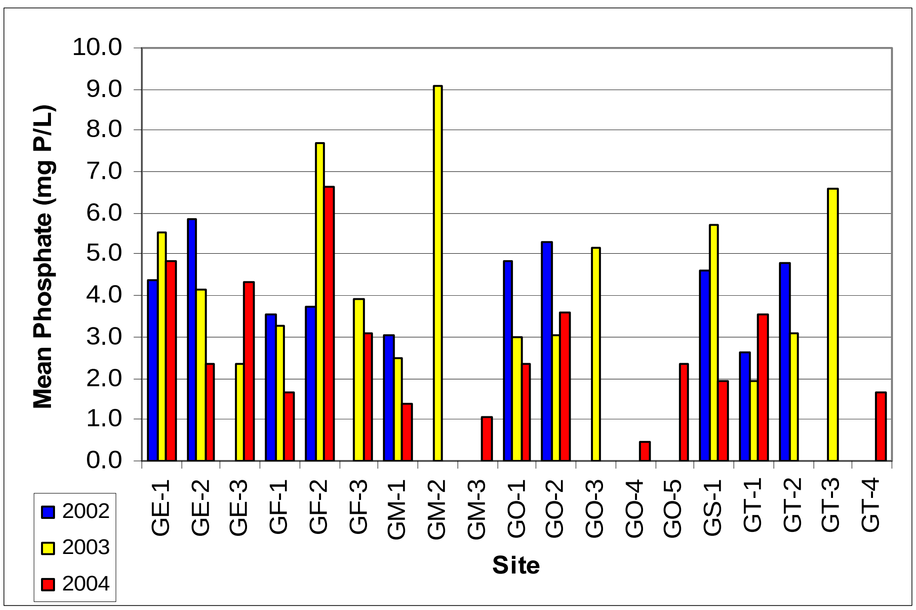

Figure 29: RIVERS site phosphate comparison for 2002, 2003, and 2004.

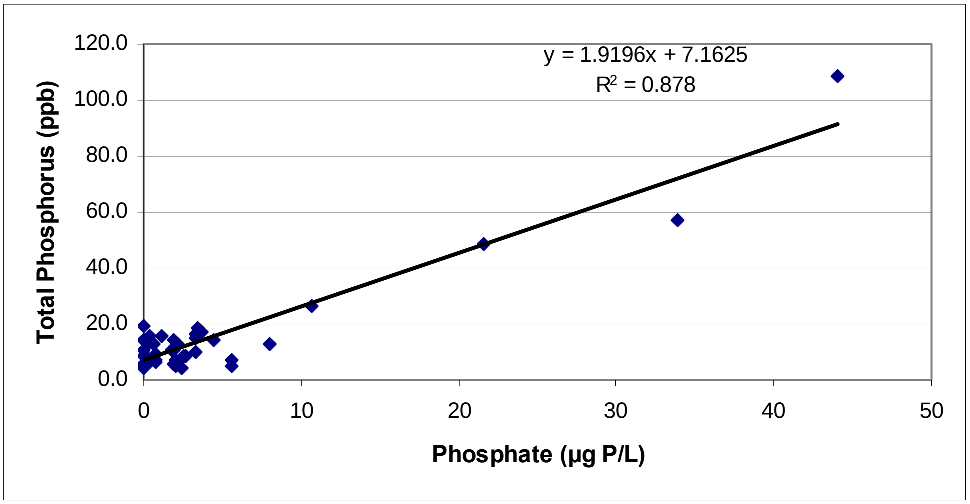

Figure 30: Comparison of phosphate and total phosphorus measurements for OLT test sites, 2004

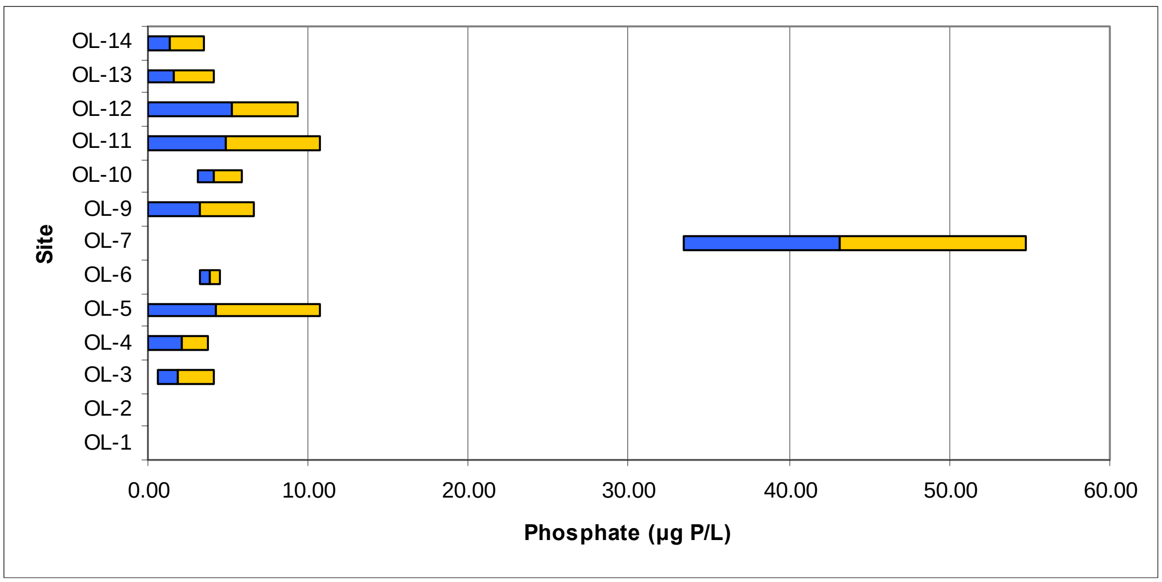

Figure 31: 2004 OLT site phosphate comparison. Bars show range of phosphate concentrations. Darker bars shows range less than the mean. Lighter bars shows range greater than the mean. Mean value is at point where dark and light bars meet.

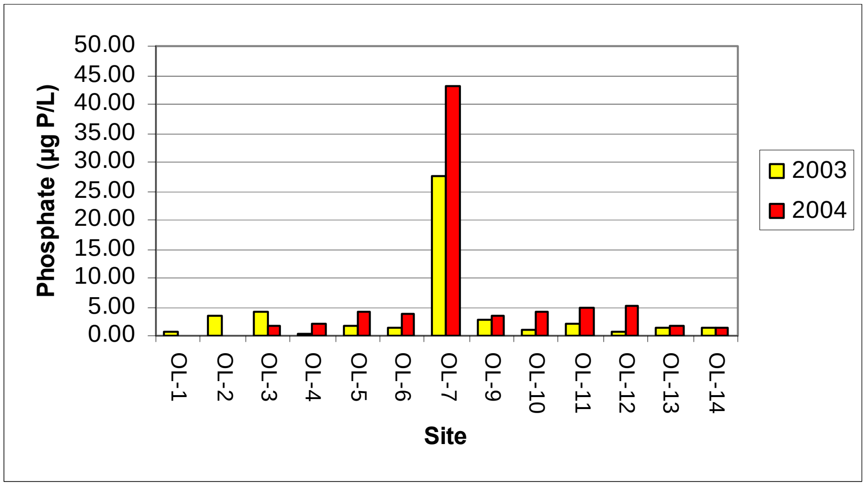

Figure 32: OLT site phosphate comparison for 2003 and 2004.

3. 8 Dissolved Organic Carbon

Dissolved organic carbon occurs naturally, through leaching and breakdown of organic material. The brown color of stream water is due to DOC (although color is not always an indicator of DOC concentration). DOC can be naturally occurring. Most DOC in streams is terrestrially derived (comes from outside the stream). Forest soils and wetland are a source of DOC. In addition to natural sources, DOC can also come from anthropomorphic inputs. Dissolved organic carbon affects the complexation, solubility and mobility of heavy metals. Generally, if metals are present, they can complex with DOC and make their way to surface water. Chlorination of high DOC water can cause the formation of trihalomethanes, which have been linked to cancer, reproductive problems and other health issues.

Mean DOC concentrations in the Ossipee Watershed ranged from 1.14 mg C/L at GM-1 to 12.03 mg C/L at site GE-2 (Figure 15). The high concentrations at both GE-1 and GE-2 are most likely due to wetlands upstream of the sampling sites. Mean DOC concentrations in 2004 were mostly lower at each site than in 2004 and higher than in 2002 (Figure 16). These fluctuations could be due to changes in precipitation.

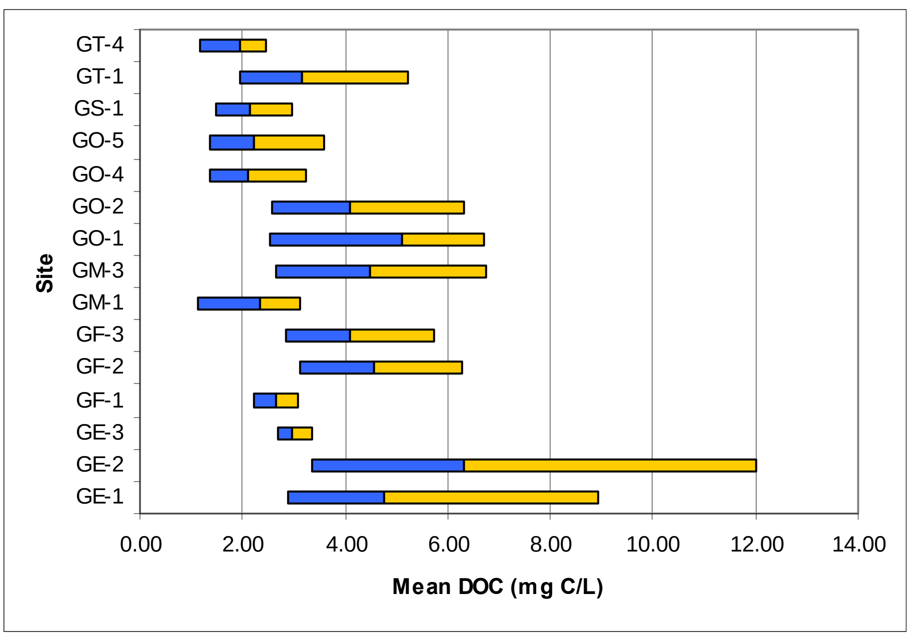

Figure 33: 2004 RIVERS site DOC comparison. Bars show range of DOC concentrations. Darker bars shows range less than the mean. Lighter bars shows range greater than the mean. Mean value is at point where dark and light bars meet.

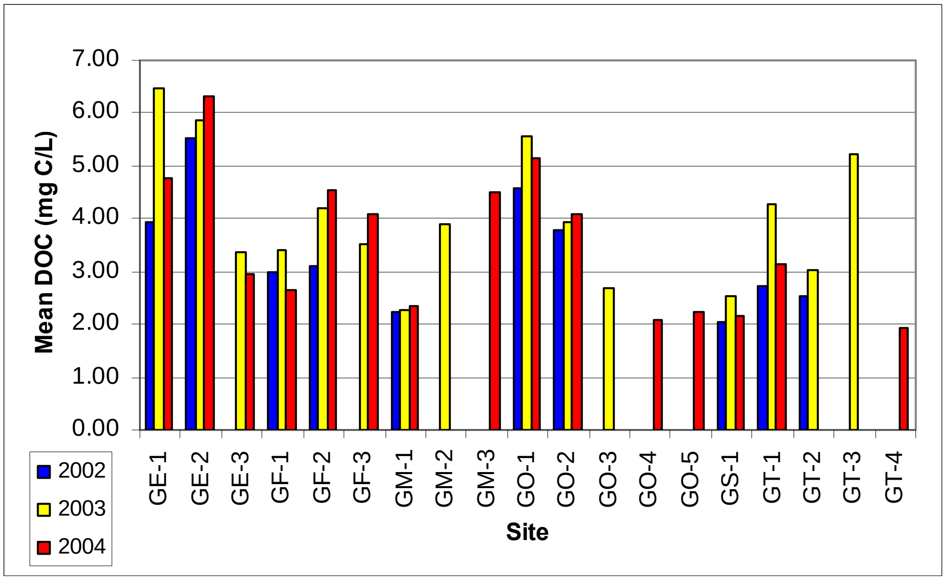

Figure 34: RIVERS site DOC comparison for 2002, 2003, and 2004.

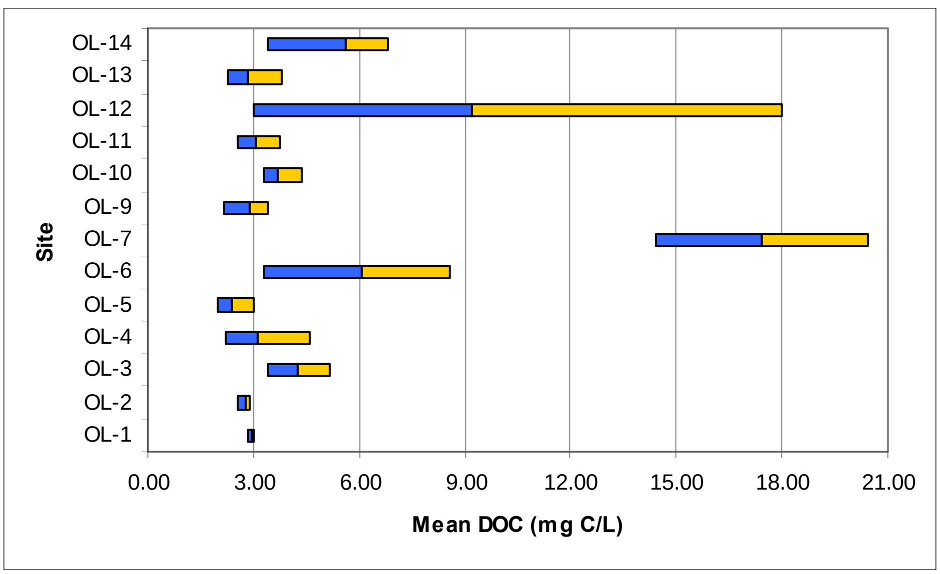

Figure 35: 2004 OLT site DOC comparison. Bars show range of DOC concentrations. Darker bars shows range less than the mean. Lighter bars shows range greater than the mean. Mean value is at point where dark and light bars meet.

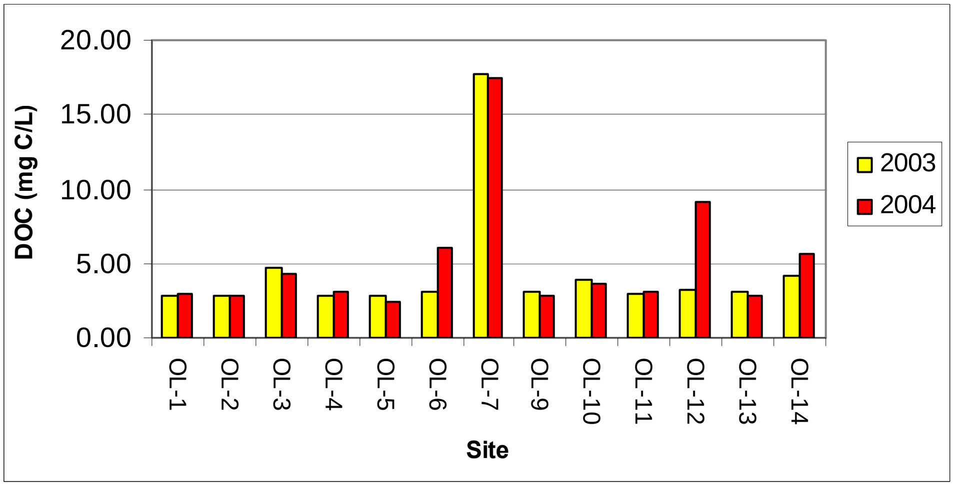

Figure 36: OLT site DOC comparison for 2003 and 2004.

3. 9 Nitrogen

Nitrogen is an important nutrient which is sometimes limiting in stream water, and unwanted algal blooms may result from excess nitrogen loading. Nitrogen is either organic or inorganic. Dissolved inorganic nitrogen (DIN) is the sum of the two forms of inorganic nitrogen, nitrate (NO_3^-) and ammonium (NH_4^+). Nitrate occurs naturally from nitrification of NH_4^+ to NO_3^-. Nitrification occurs in an oxic (oxygen rich) environment (such as stream water) where microbes convert NH_4^+ to nitrite (NO_2^-), and NO_2^- is quickly converted to NO_3^- for energy. The conversion of NO_2^- to NO_3^- is so fast that NO_2^- is usually undetectable in stream water, and NO_2^- is assumed to be zero. Elevated levels of nitrate indicate pollution from sewage, run off, agriculture or other anthropogenic activity. Nitrate contamination of drinking water can cause Methemoglobenemia, a serious illness in infants where respiration is inhibited. Ammonium is the preferred form of nitrogen for plant and microbial uptake since it is more energy efficient to use than nitrate. However, ammonium is typically very low in undisturbed streams. Ammonium is the product of organic breakdown and high levels of ammonium typically indicate some type of pollution (sewage, run off, agricultural). Dissolved organic nitrogen can be an important source of nitrogen for plants and microbes depending on the availability of DIN. In most undisturbed ecosystems, DON dominates TDN (DON is greater than DIN) and DIN tends to dominate TDN (DIN is greater than DON) in disturbed systems. Like DOC, DON complexes heavy metals and is generated largely in wetlands and forests soils.

Mean TDN concentrations among the Ossipee Watershed sites were relatively low (Table 3 and Figure 20) and ranged from 0.09 mg N/L at site GO-3 and GS-1 to 0.24 mg N/L at GO-2 and GT-2. Dissolved organic nitrogen ranged from 0.06 mg N/L at several sites including GO-3, GS-1 and GT-2 to 0.17 at GO-1. At all sites, mean nitrate concentrations were less than 0.09 mg N/L. Mean ammonium concentrations were less than 0.040 mg N/L at all sites except for GT-2, where the mean concentration was 0.095 mg N/L.

Table 3: Nitrogen concentrations for RIVERS test sites in 2002, 2003 and 2004. All concentrations are in mg/L.

site	2002				2003				2004			
	DON	Nitrate	NH_4	TDN	DON	Nitrate	NH_4	TDN	DON	Nitrate	NH_4	TDN
GE-1	0.13	0.05	0.02	0.20	0.16	0.05	0.012	0.23	0.15	0.08	0.012	0.24
GE-2	0.18	0.02	0.03	0.22	0.14	0.02	0.015	0.17	0.14	0.03	0.013	0.19
GE-3					0.09	0.02	0.01	0.12	0.10	0.02	0.011	0.15
GF-1	0.11	0.01	0.017	0.14	0.09	0.01	0.012	0.12	0.08	0.02	0.013	0.15
GF-2	0.11	0.04	0.021	0.17	0.19	0.02	0.019	0.23	0.22	0.04	0.020	0.27
GF-3					0.12	0.06	0.008	0.18	0.13	0.06	0.011	0.20
GM-1	0.10	0.04	0.027	0.17	0.08	0.03	0.016	0.12	0.08	0.03	0.020	0.14
GM-2					0.09	0.02	0.013	0.13				
GM-3									0.15	0.16	0.011	0.33
GO-1	0.13	0.03	0.015	0.17	0.17	0.02	0.015	0.20	0.13	0.03	0.017	0.18
GO-2	0.17	0.08	0.024	0.27	0.13	0.09	0.016	0.24	0.13	0.07	0.022	0.23
GO-3					0.06	0.02	0.01	0.09				
GO-4									0.08	0.08	0.008	0.17
GO-5									0.08	0.08	0.009	0.17
GS-1	0.05	0.05	0.014	0.14	0.06	0.03	0.006	0.09	0.08	0.03	0.008	0.12
GT-1	0.09	0.03	0.018	0.15	0.11	0.02	0.008	0.14	0.12	0.02	0.010	0.16
GT-2	0.05	0.09	0.097	0.23	0.08	0.09	0.0095	0.27				
GT-3					0.17	0.05	0.039	0.26				
GT-4									0.08	0.12	0.014	0.22

Table 4: Percentages of Nitrogen Concentrations of Total Dissolved Nitrogen in RIVERS test sites in 2002, 2003 and 2004.

site	2002				2003				2004			
	DON	Nitrate	NH_4	TDN	DON	Nitrate	NH_4	TDN	DON	Nitrate	NH_4	TDN
GE-1	64%	25%	10%	99%	70%	22%	5%	97%	63%	32%	5%	100%
GE-2	81%	9%	14%	104%	82%	12%	9%	103%	74%	19%	7%	100%
GE-3					75%	17%	8%	100%	69%	12%	8%	89%
GF-1	80%	7%	12%	99%	75%	8%	10%	93%	53%	15%	8%	76%
GF-2	64%	24%	12%	100%	83%	9%	8%	100%	82%	16%	8%	106%
GF-3					67%	33%	4%	104%	66%	29%	6%	100%
GM-1	60%	24%	16%	99%	67%	25%	13%	105%	60%	26%	15%	100%
GM-2					69%	15%	10%	95%				
GM-3									47%	49%	3%	100%
GO-1	74%	18%	9%	100%	85%	10%	8%	103%	72%	18%	10%	100%
GO-2	63%	30%	9%	101%	54%	38%	7%	98%	59%	31%	10%	100%
GO-3					67%	22%	11%	100%				
GO-4									49%	46%	5%	100%
GO-5									47%	47%	5%	100%
GS-1	38%	36%	10%	84%	67%	33%	7%	107%	65%	28%	7%	100%
GT-1	57%	20%	12%	89%	79%	14%	6%	99%	78%	16%	6%	100%
GT-2	21%	39%	42%	103%	30%	33%	4%	66%				
GT-3					65%	19%	15%	100%				
GT-4									38%	56%	6%	100%

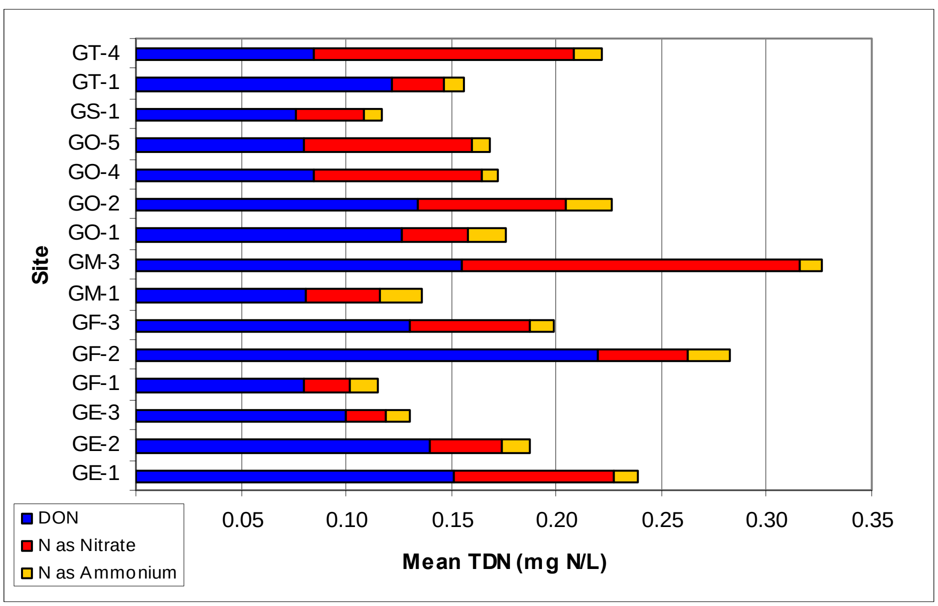

Figure 37: Mean TDM concentrations among the RIVERS test sites in 2004 with fractions of DON, nitrate and ammonium shown.

Mean DON comprised of more than 53% of the mean TDN at all sites except for GM-3, GO-4, GO-5, and GT-4 (all new sites this year), where DIN dominated TDN (Table 4, Figure 20). At site GM-3 and GO-5, mean DON was 47% of the mean TDN, while the mean DON at

GO-4 was 49% of the mean TDN. As organic nitrogen typically dominates in unimpaired systems, the low percentage of DON at site GT-4 (38%) could be indicative of an impairing input. Future testing at these sites will determine if there may be a constant source impairing these systems.

Table 5: Nitrogen concentrations for OLT test sites in 2003 and 2004. All concentrations are in mg/L.

site	2003				2004			
	DON	Nitrate	NH_4	TDN	DON	Nitrate	NH_4	TDN
OL-1	0.10	0.01	0.008	0.12	0.18	0.02	0.012	0.21
OL-2	0.11	0.03	0.083	0.14	0.13	0.02	0.013	0.16
OL-3	0.21	0.03	0.017	0.25	0.65	0.02	0.016	0.69
OL-4	0.10	0.01	0.010	0.12	0.22	0.03	0.014	0.26
OL-5	0.12	0.02	0.011	0.15	0.12	0.07	0.014	0.21
OL-6	0.11	0.04	0.020	0.17	0.28	0.05	0.008	0.34
OL-7	0.44	0.00	0.066	0.51	0.50	0.02	0.091	0.61
OL-9	0.09	0.01	0.013	0.11	0.14	0.01	0.022	0.21
OL-10	0.12	0.00	0.023	0.15	0.14	0.01	0.013	0.16
OL-11	0.11	0.01	0.007	0.13	0.14	0.02	0.008	0.17
OL-12	0.12	0.00	0.005	0.13	0.25	0.03	0.033	0.32
OL-13	0.07	0.01	0.026	0.10	0.44	0.03	0.029	0.50
OL-14	0.14	0.00	0.009	0.15	0.22	0.12	0.029	0.37

Table 6: Percentages of Nitrogen Concentrations of Total Dissolved Nitrogen in OLT test sites in 2003 and 2004.

site	2003				2004			
	DON	Nitrate	NH_4	TDN	DON	Nitrate	NH_4	TDN
OL-1	84%	9%	7%	100%	84%	11%	5%	100%
OL-2	77%	18%	60%	155%	80%	12%	8%	100%
OL-3	82%	11%	7%	100%	94%	3%	2%	100%
OL-4	82%	10%	8%	100%	83%	11%	6%	100%
OL-5	79%	13%	7%	100%	58%	35%	7%	100%
OL-6	66%	22%	12%	100%	83%	15%	2%	100%
OL-7	87%	0%	13%	100%	82%	3%	15%	100%
OL-9	81%	8%	11%	100%	67%	6%	10%	83%
OL-10	82%	2%	16%	100%	89%	3%	8%	100%
OL-11	90%	5%	5%	100%	84%	12%	5%	100%
OL-12	93%	3%	4%	100%	80%	10%	10%	100%
OL-13	67%	12%	25%	104%	89%	5%	6%	100%
OL-14	92%	2%	6%	100%	59%	33%	8%	100%

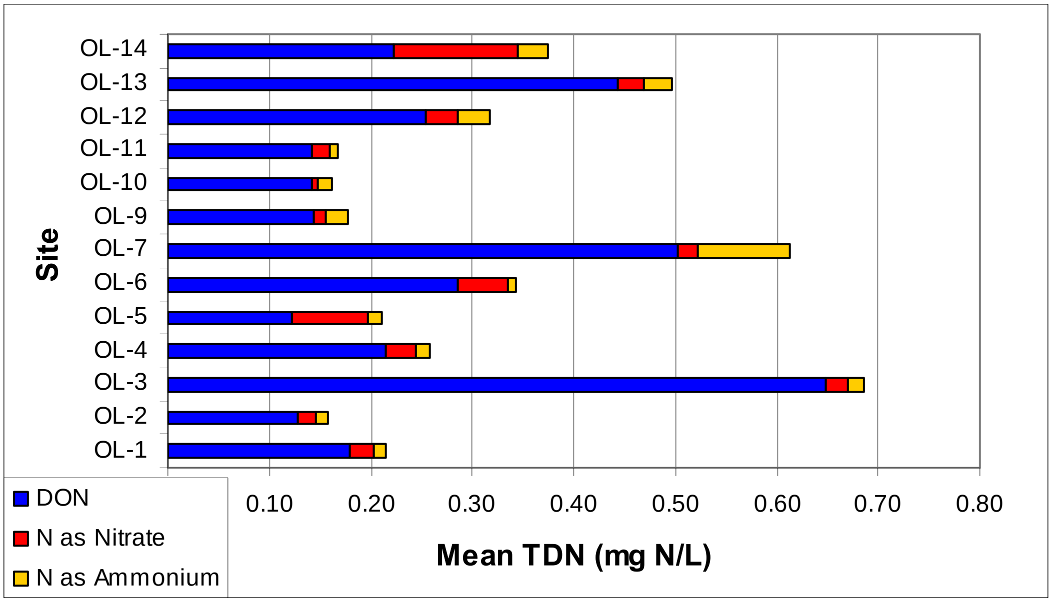

Figure 38: Mean TDM concentrations among the OLT test sites in 2004 with fractions of DON, nitrate and ammonium shown.

3. 10 Dissolved Organic Matter

Dissolved organic carbon and DON are both part of dissolved organic matter (DOM). An organic compound found naturally more than likely contains both carbon (C) and nitrogen (N). The quantity of C and N found in DOM is indicated by DOC and DON. Researchers often look at the DOC:DON (or C:N) ratios to determine the quality of the DOM (or how digestible it is). A lower C:N ratio generally indicates higher quality (more digestible) DOM. Dissolved organic carbon and DON are often positively related to each other as they are chemically bound together (when DOC increases so does DON), but this relationship may vary over space and time. Dissolved organic carbon and DON are not necessarily controlled by the same mechanisms. The regression line 1n Figure 21 does not seem to represent a strong linear relationship between DOC and DON. There is scatter around the line indicating that it may not be possible to accurately infer one from the other.

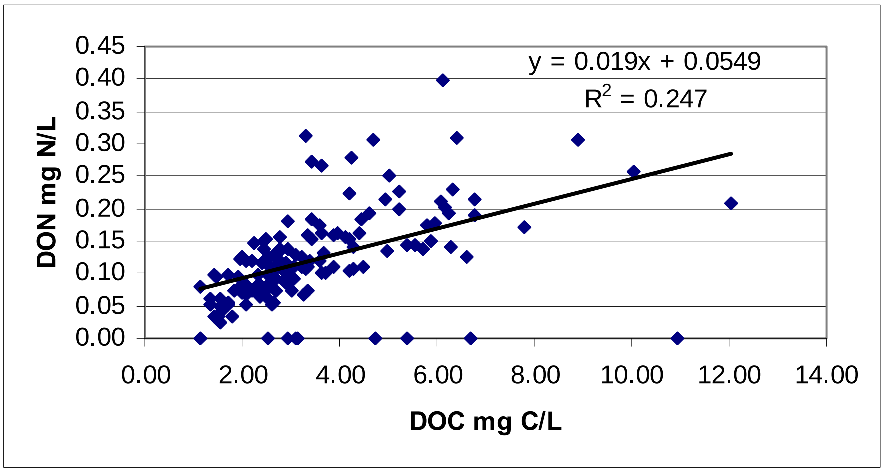

Figure 39: The relationship between dissolved organic nitrogen and dissolved organic carbon for RIVERS test sites during the 2004 sampling season.

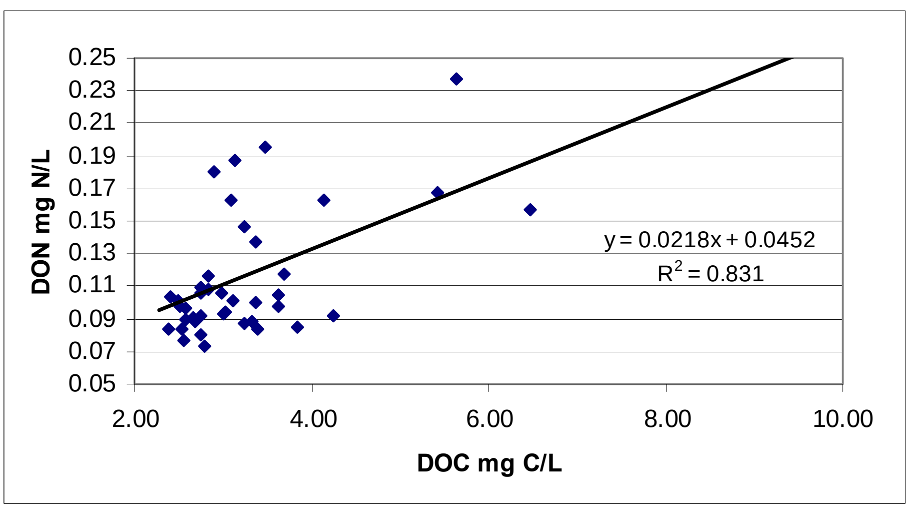

Figure 40: The relationship between dissolved organic nitrogen and dissolved organic carbon for OLT test sites during the 2004 sampling season.

3.11 Sodium and Chloride

Sodium and chloride are present in nature, but higher levels can be indicative of road salt application and elevated chloride may indicate domestic sewage contamination. Natural levels can vary depending on geology. For example, in the Seacoast Region of NH, sodium and chloride are quite high due to marine clays and sediments in the landscape. Sodium and chloride are typically related to each other. The linear regression line in Figure 22 appears to represent a strong linear relationship between sodium and chloride in the Ossipee Watershed.

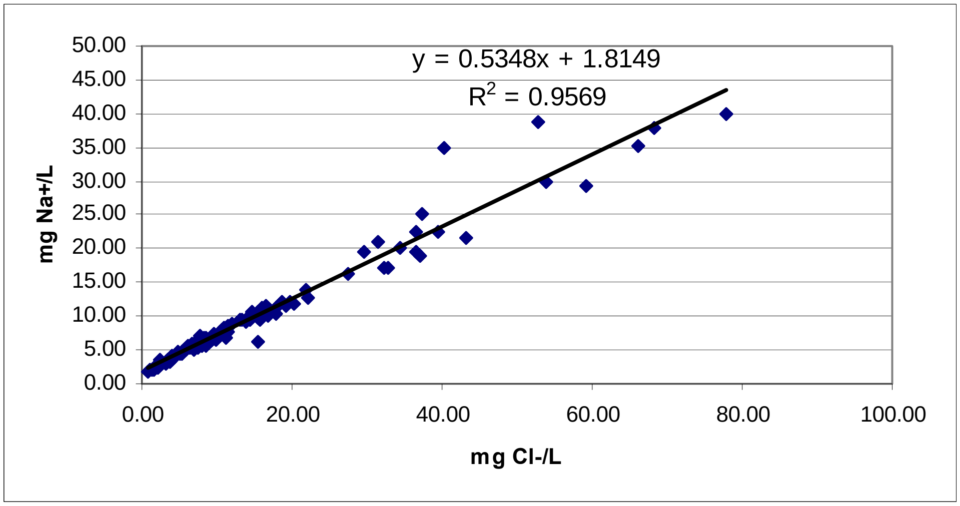

Figure 41: The relationship between sodium and chloride concentrations for RIVERS test sites, 2004.

Mean sodium concentration was below 12 mg/L at all sites except for GM-1 (18.80 mg/L) and GO-2 (29.25 mg/L) (Figure 23). Mean chloride concentrations were less than 20 mg/L at all sites except for GM-1 (34.16 mg/L) and GO-2 (47.90 mg/L) (Figure 24). Elevated sodium and chloride concentrations could indicate contamination from road salt application. Trends observed in 2002 and 2003 were similar (Figure 25 and 26).

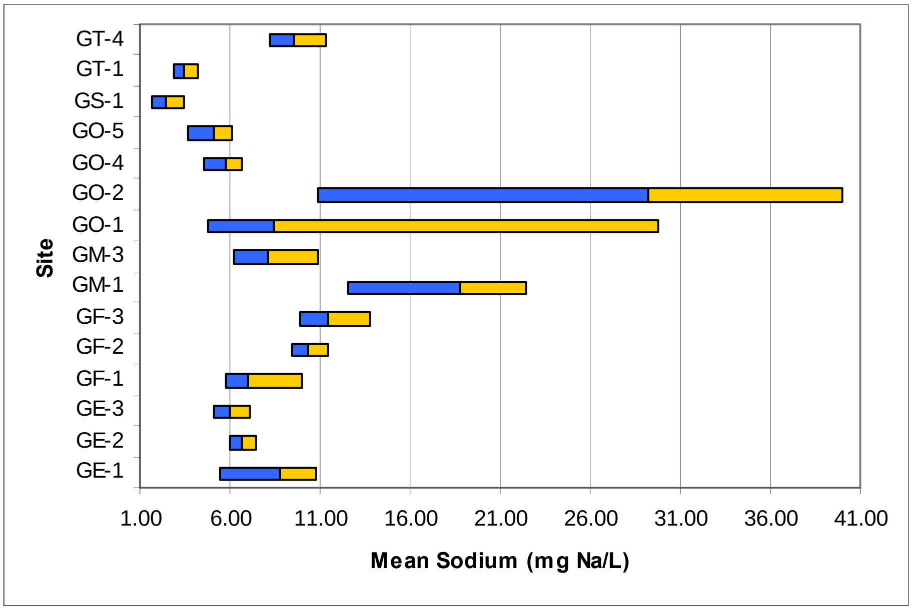

Figure 42: 2004 RIVERS site sodium comparison. Bars show range of sodium concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

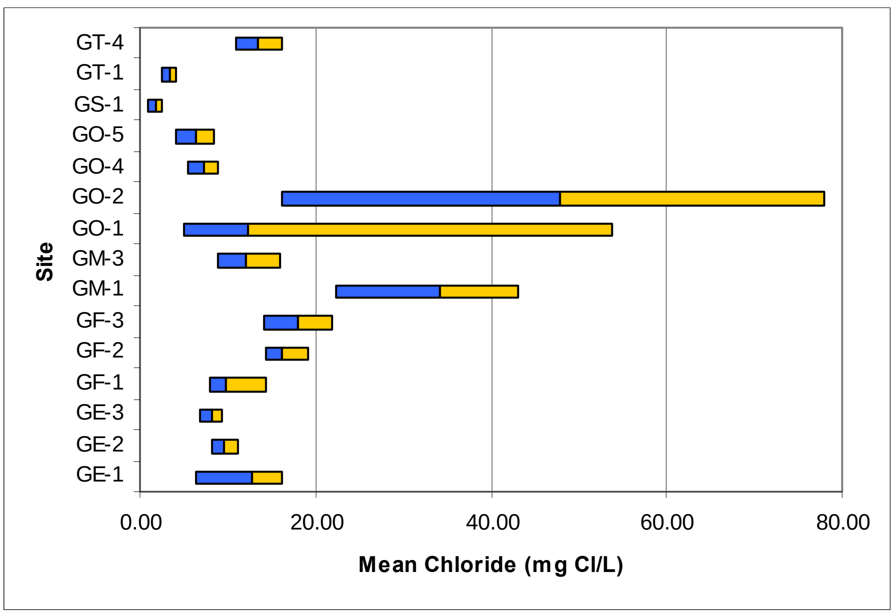

Figure 43: 2004 RIVERS site chloride comparison. Bars show range of chloride concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean.

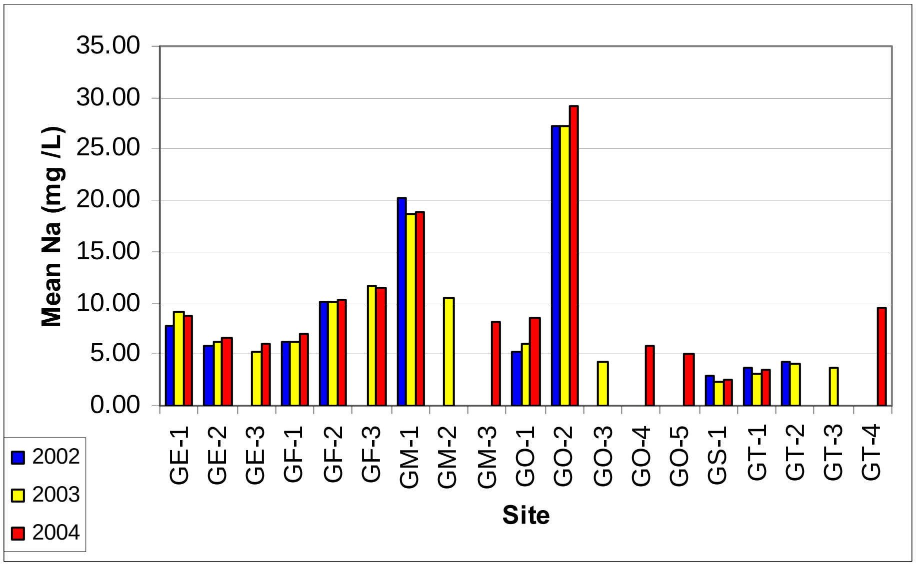

Figure 44: RIVERS site sodium comparison for 2002, 2003, and 2004. Bars show yearly mean chloride concentrations.

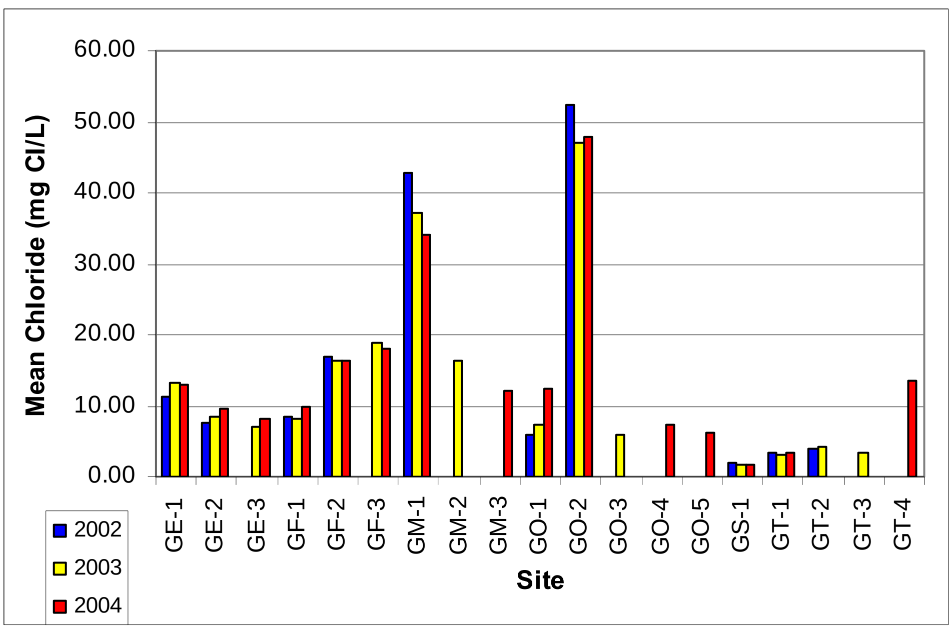

Figure 45: RIVERS site chloride comparison for 2002, 2003, and 2004. Bars show yearly mean chloride concentrations.

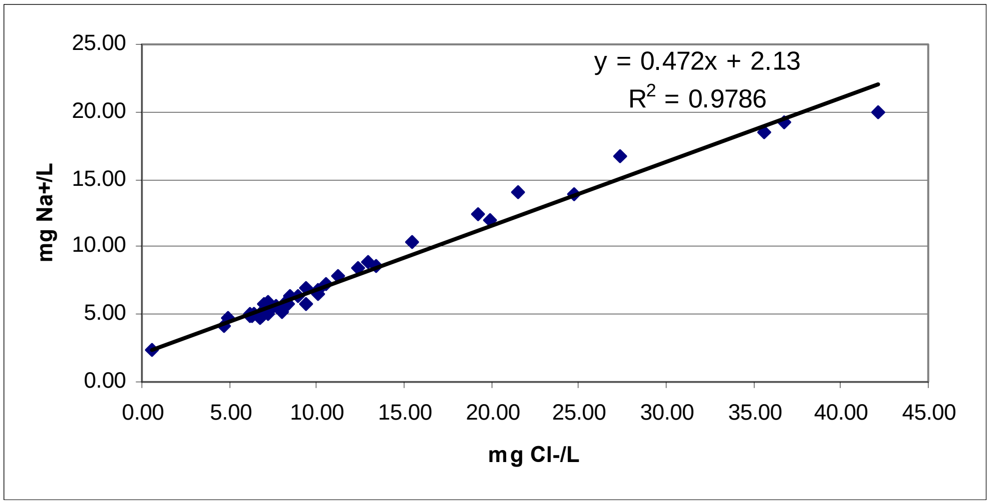

Figure 46: The relationship between sodium and chloride concentrations for OLT test sites, 2004.

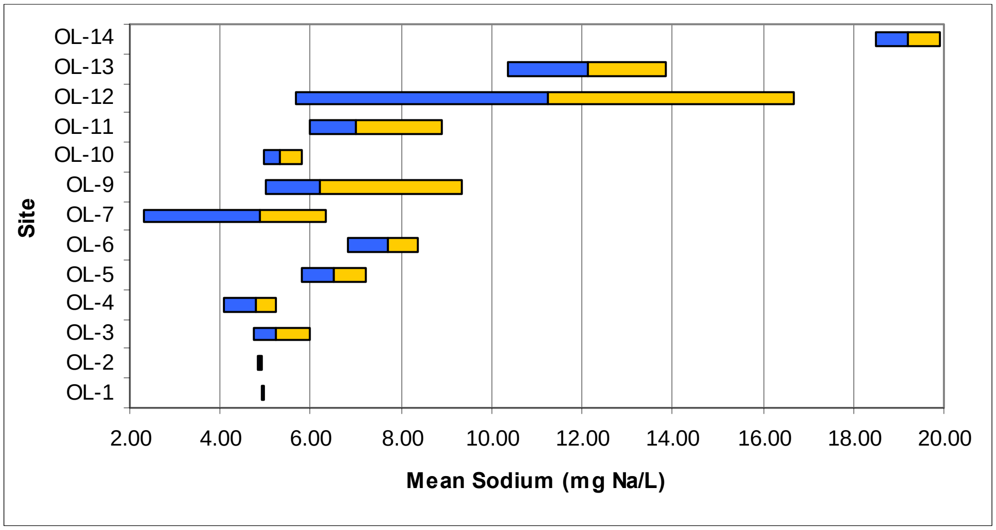

Figure 47: 2004 OLT site sodium comparison. Bars show range of sodium concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

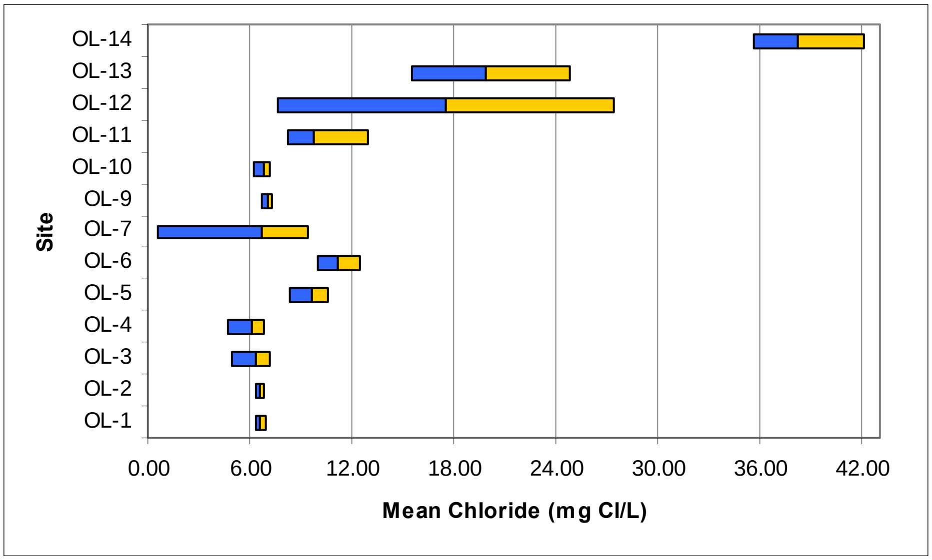

Figure 48: 2004 OLT site chloride comparison. Bars show range of chloride concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean.

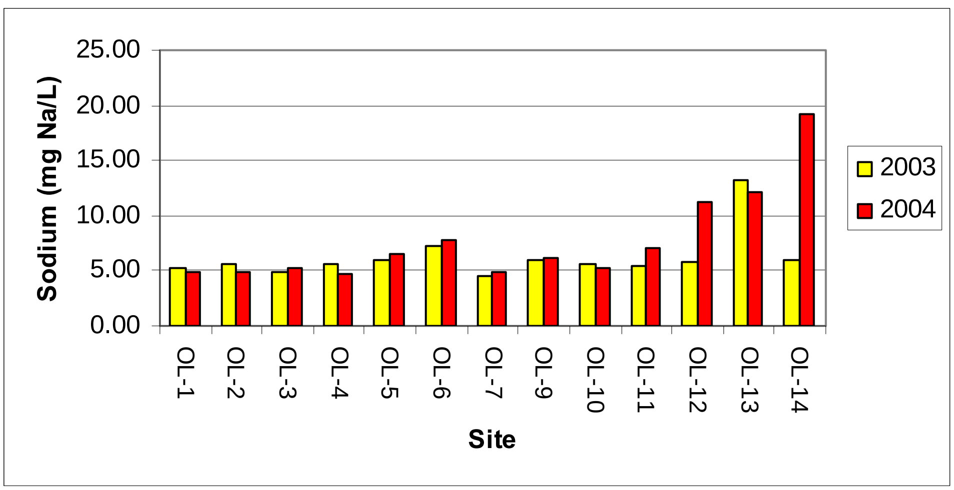

Figure 49: OLT site sodium comparison for 2003 and 2004. Bars show yearly mean chloride concentrations.

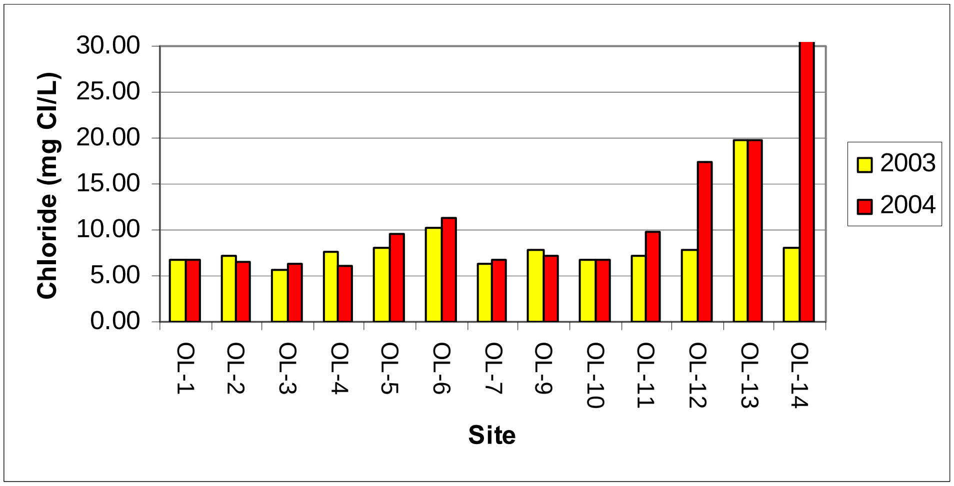

Figure 50: OLT site chloride comparison for 2003 and 2004. Bars show yearly mean chloride concentrations.

3.12 Sulfate

Sulfate occurs naturally from weathering. Historically, acid rain resulted in elevated sulfate levels, but acid rain is not as problematic today. Sulfate concentrations ranged from 0.41 mg S/L at GO-1 to 3.56 mg S/L at GO-5 (Figure 27). Sulfate concentrations were mostly higher in 2004 than in 2003 and lower than 2002 (Figure 28).

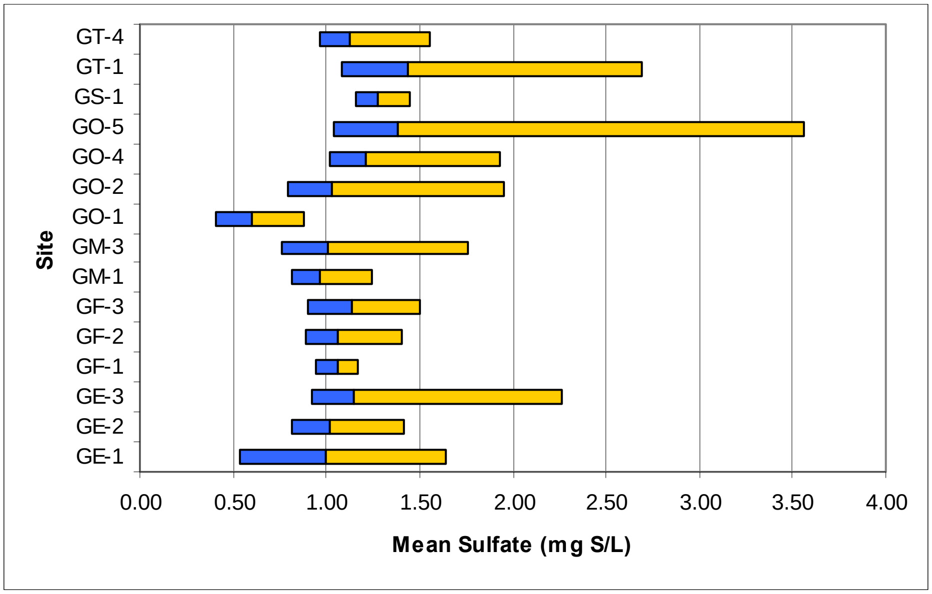

Figure 51: 2004 RIVERS site sulfate comparison. Bars show range of sulfate concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

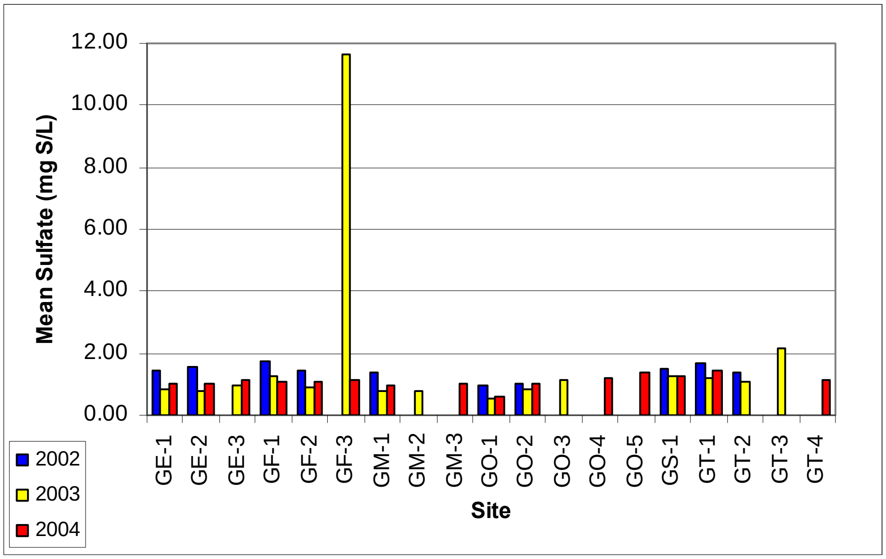

Figure 52: RIVERS site sulfate comparison for 2002, 2003, and 2004.

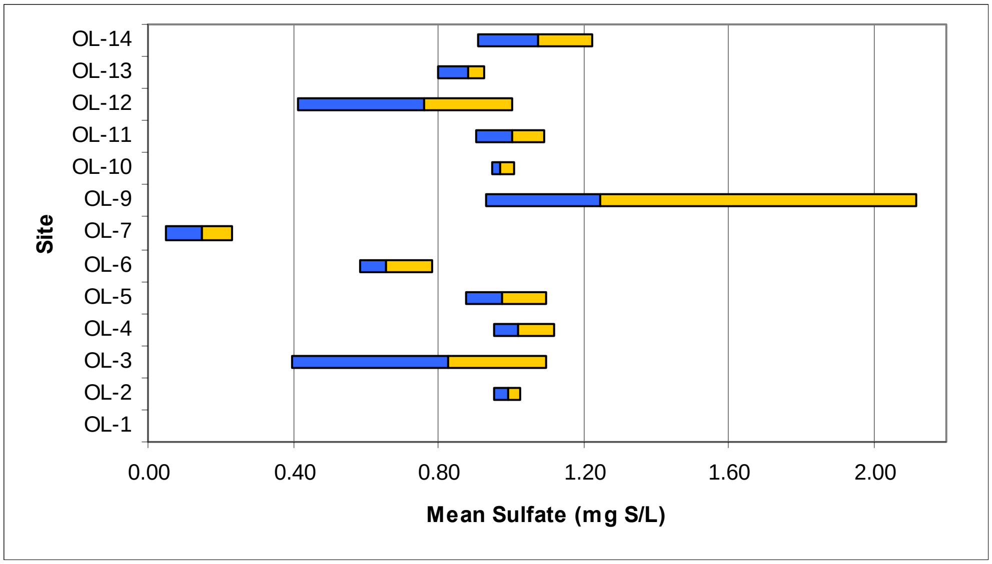

Figure 53: 2004 OLT site sulfate comparison. Bars show range of sulfate concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

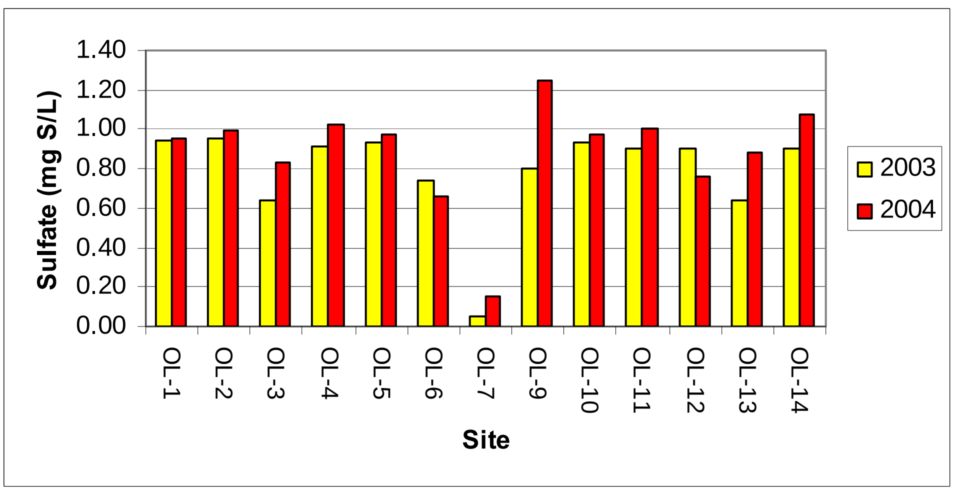

Figure 54: OLT site sulfate comparison for 2003 and 2004.

3.13 Silica

Silica is naturally produced during the weathering processes and is important for diatom growth and productivity. Silica can be used as a ground water tracer since groundwater has higher concentrations of SiO_2 than rain and run off. In the Ossipee Watershed sites, silica concentrations ranged from 0.00 at GE-1 to 11.57 mg/L at GF-3 (Figure 29).

Mean silica concentrations in 2004 were doubled at all sites in comparison to 2003 and were higher than 2004 levels (Figure 30). These sites most likely received more of their flow from groundwater during 2004. Though the maximum range in silica measurements was greater in 2003 than 2002, the mean silica concentration at all sites in 2003 was less than in 2002. Several sites experienced a large decrease in mean silica values between the two years.

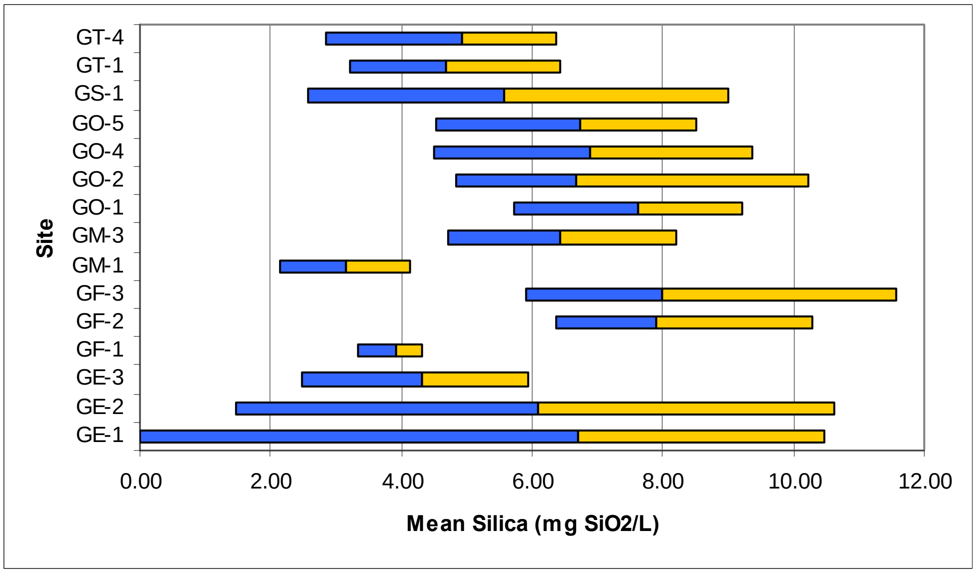

Figure 55: 2004 RIVERS site silica comparison. Bars show range of silica concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

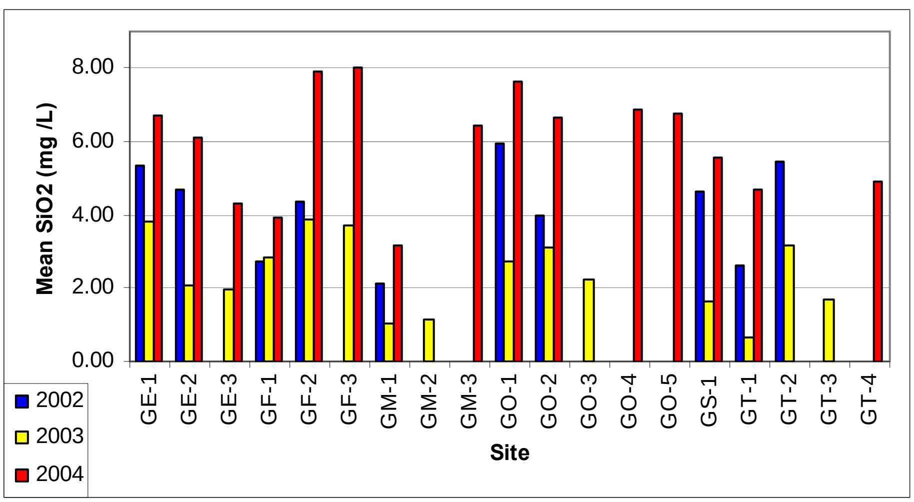

Figure 56: RIVERS site silica comparison for 2002, 2003, and 2004.

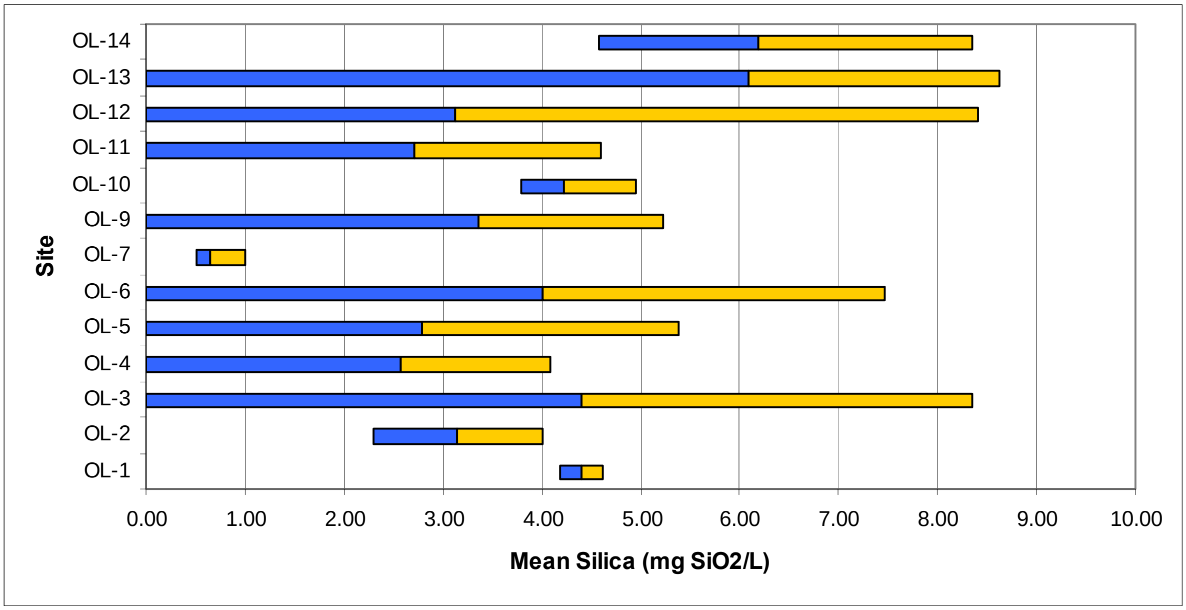

Figure 57: 2004 OLT site silica comparison. Bars show range of silica concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

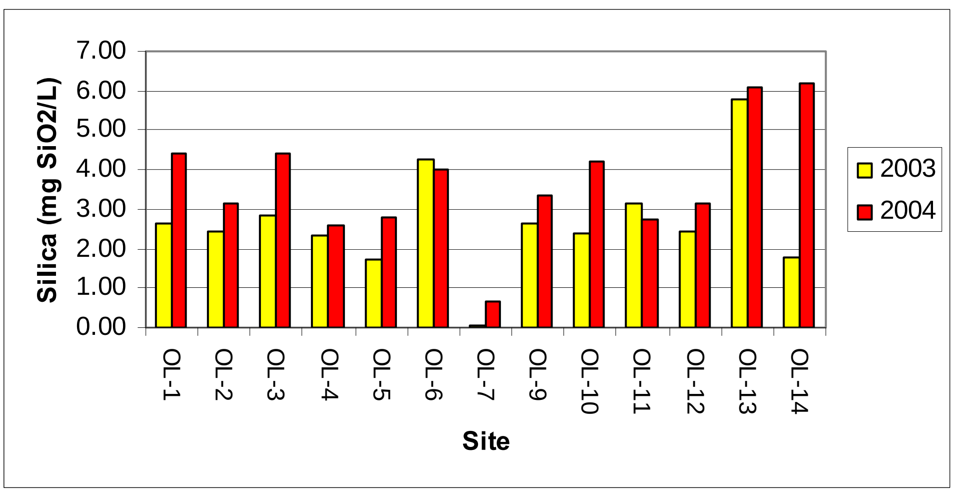

Figure 58: OLT site silica comparison for 2003 and 2004.

3.14 Potassium

Potassium occurs naturally from weathering and can be an important plant nutrient. Potassium concentrations ranged from 0.35 mg/L at GS-1 to 2.55 mg/L at GO-2 among sites in the Ossipee Watershed (Figure 31). Mean potassium concentrations in 2004 were similar to those in 2003 and 2002 (Figure 32).

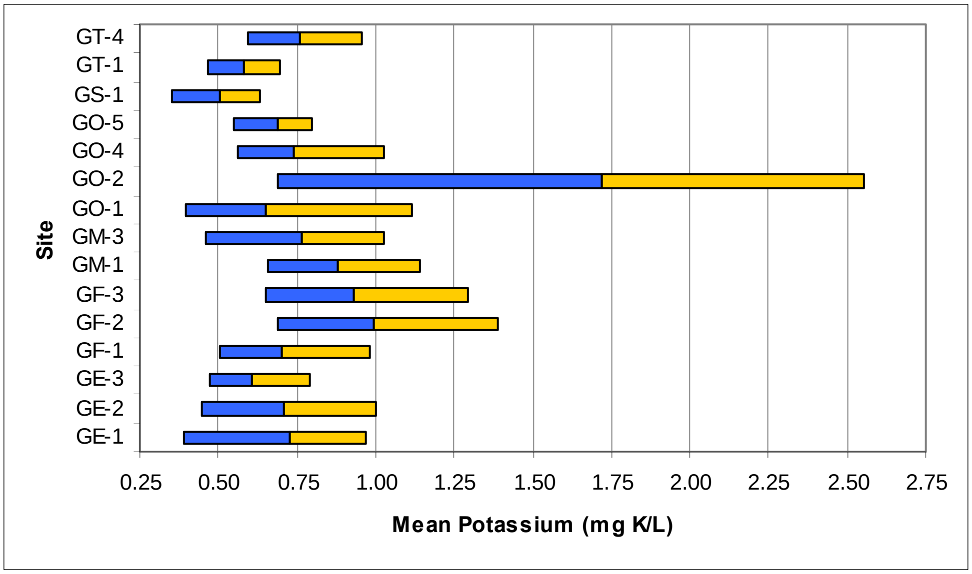

Figure 59: 2004 RIVERS site potassium comparison. Bars show range of potassium concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

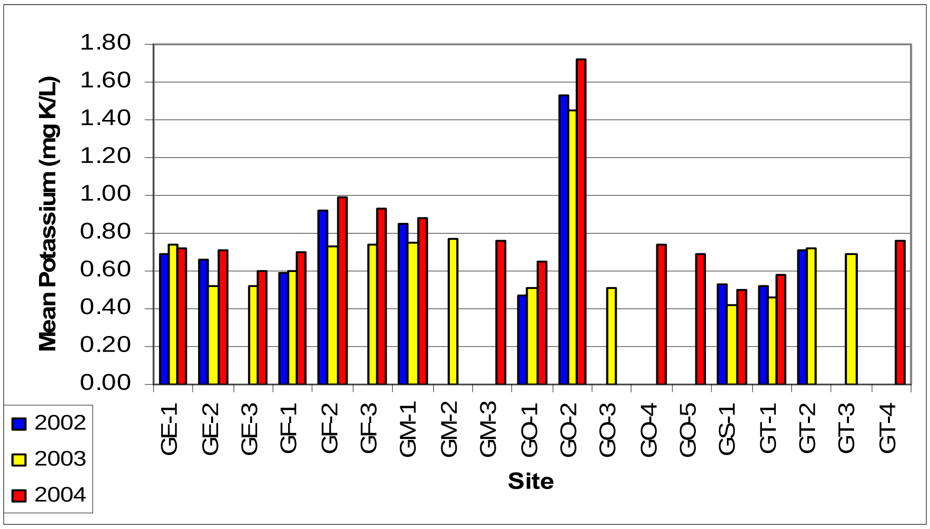

Figure 60: RIVERS site potassium comparison for 2002, 2003, and 2004.

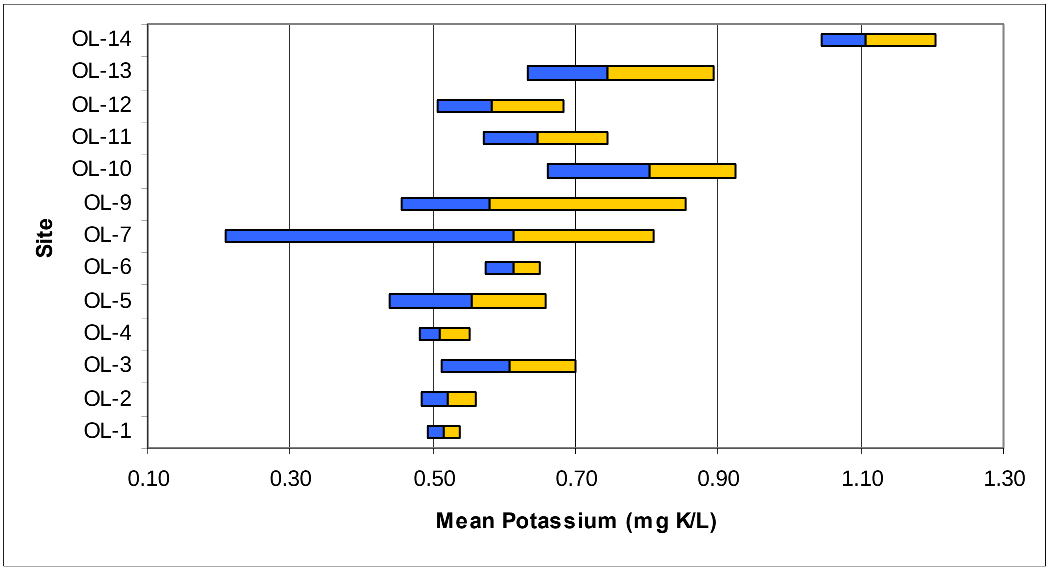

Figure 61: 2004 OLT site potassium comparison. Bars show range of potassium concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

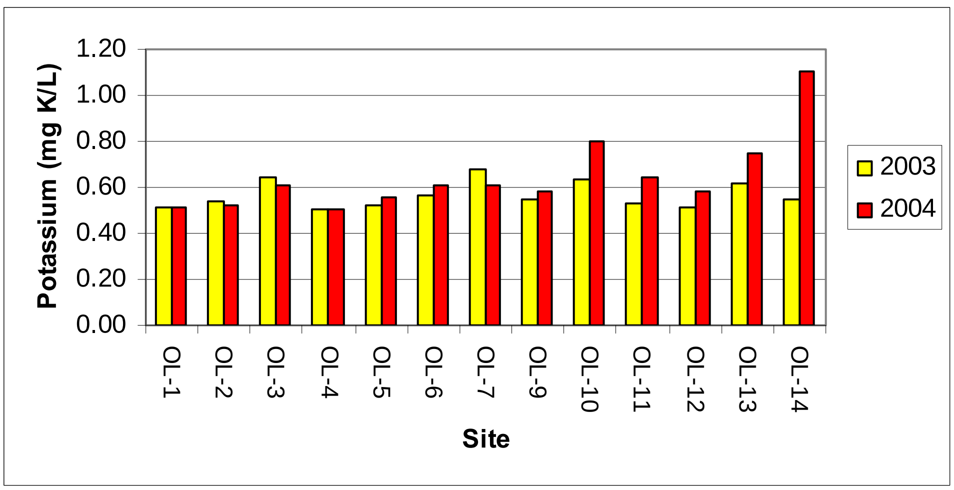

Figure 62: OLT site potassium comparison for 2003 and 2004.

3.15 Calcium and Magnesium

Calcium and magnesium result primarily from the weathering of rocks and are used to determine water “hardness”. In the Ossipee Watershed sites, calcium concentration ranged from 1.89 mg/L at GS-1 to 7.16 mg/L at GO-2 (Figure 33) and magnesium concentrations ranged from 0.35 mg/L at GT-4 to 1.31 mg/L at GF-3 (Figure 34). Both calcium and magnesium 2004 mean concentrations were similar to 2003 and 2002 concentrations (Figures 35 and 36).

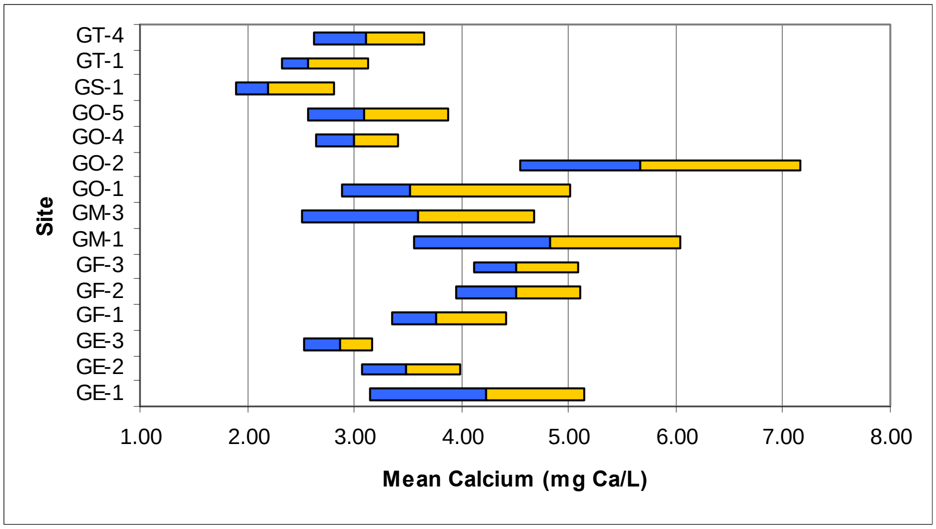

Figure 63: 2004 RIVERS site calcium comparison. Bars show range of calcium concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

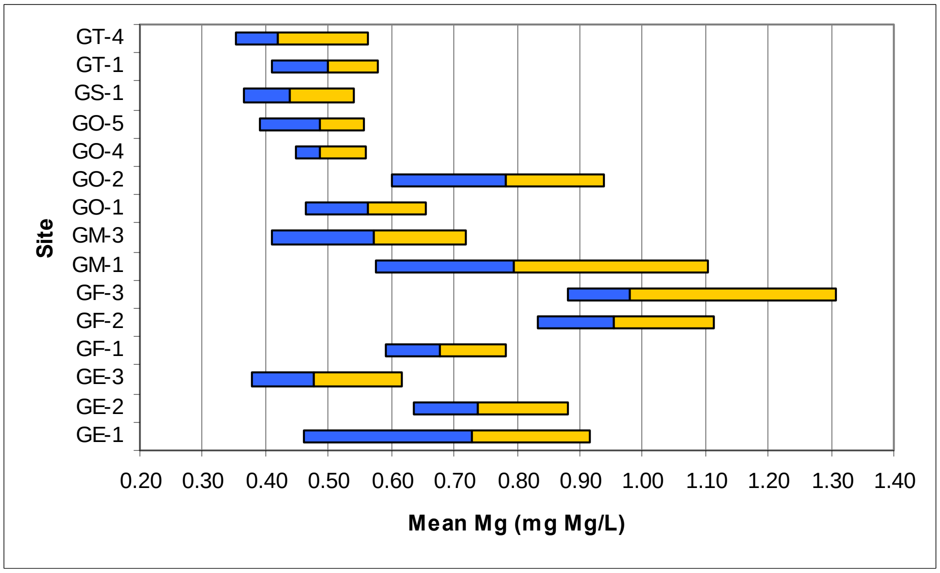

Figure 64: 2004 RIVERS site magnesium comparison. Bars show range of magnesium concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

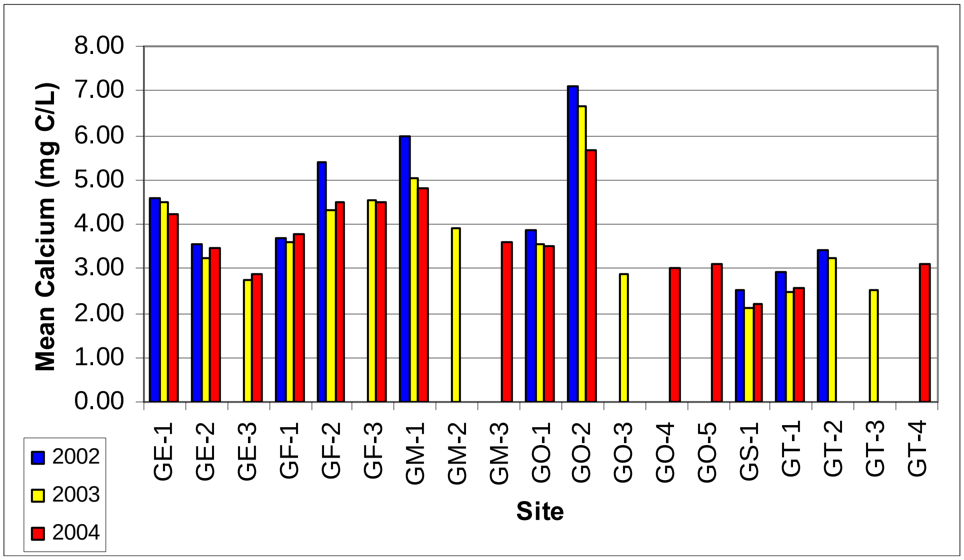

Figure 65: RIVERS site calcium comparison for 2002, 2003, and 2004.

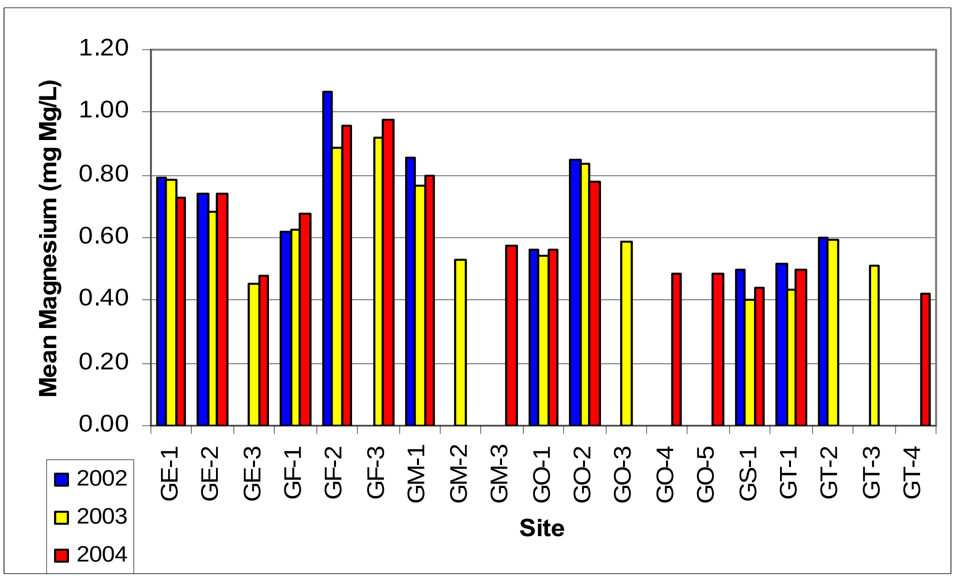

Figure 66: RIVERS site magnesium comparison for 2002, 2003, and 2004.

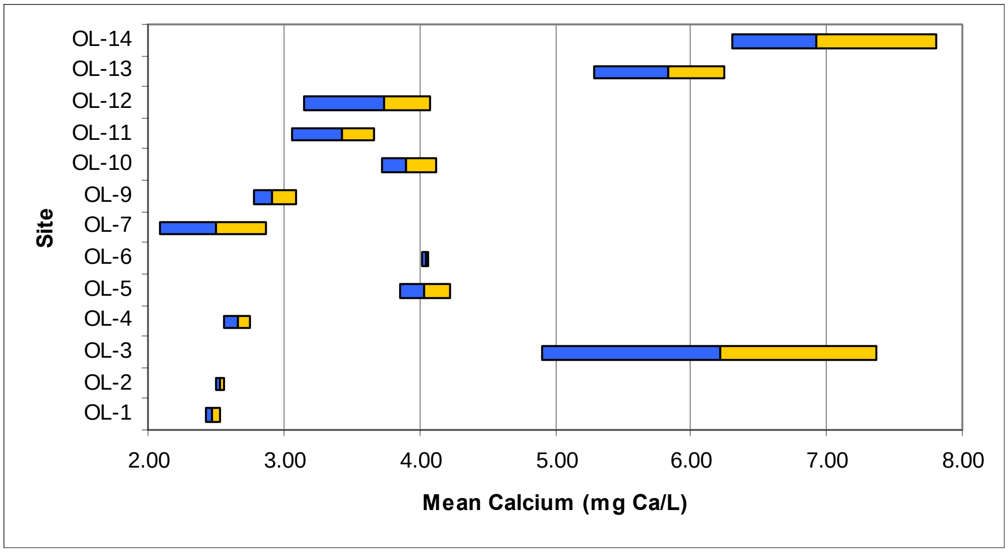

Figure 67: 2004 OLT site calcium comparison. Bars show range of calcium concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

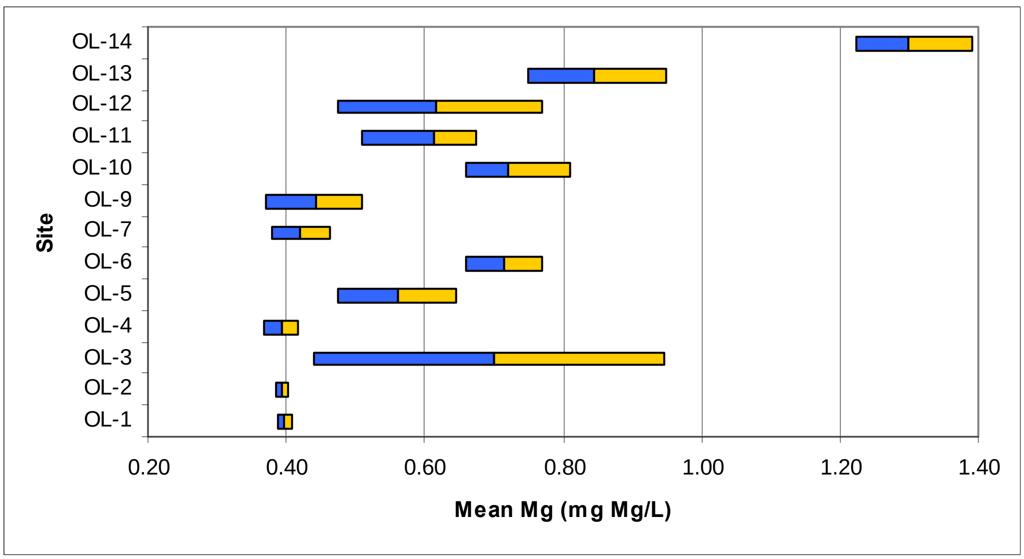

Figure 68: 2004 OLT site magnesium comparison. Bars show range of magnesium concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

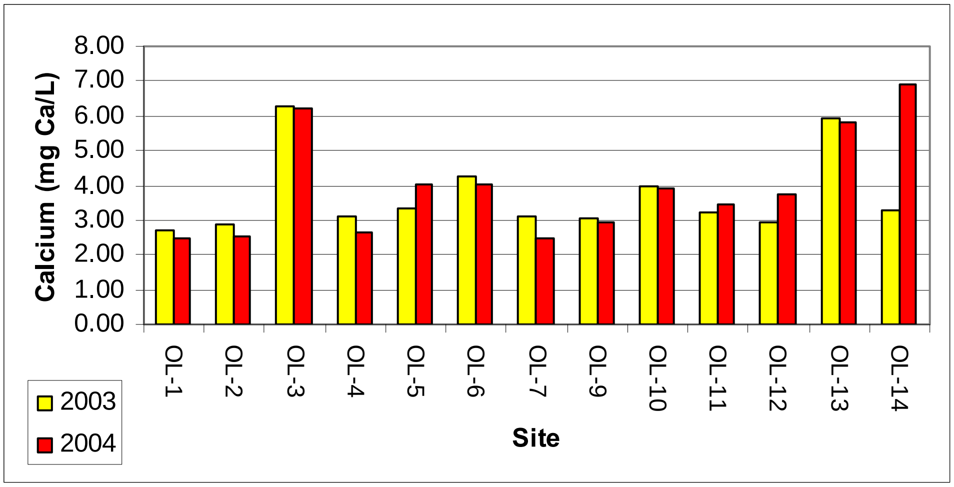

Figure 69: OLT site calcium comparison for 2003 and 2004.

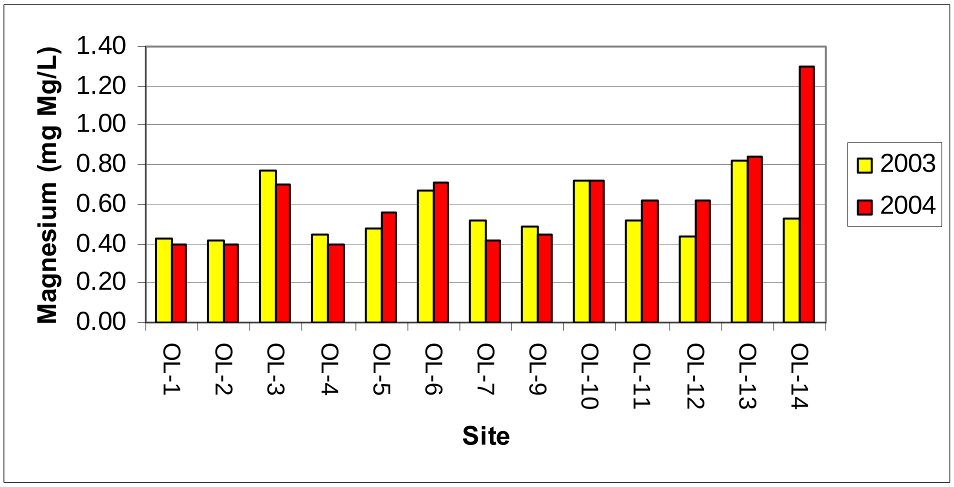

Figure 70: OLT site magnesium comparison for 2003 and 2004.

3.16 Relative RIVERS Site Summaries

GE-1 Pine River, Elm Street, Effingham

GE-1 exhibited high levels of silica. In 2004, silica levels were higher than 2002 and 2003 across the watershed due to less precipitation than both years which increased ground water input. 2004 silica levels at GE-1 were one of the highest of all the test sites. This may indicate that the Pine River receives a lot of input from groundwater flow. Indeed, the aquifer is at its closest point to the surface near this site. In addition, dissolved organic carbon levels were again relatively high at GE-1 indicating there is more decomposition at this site and possibly wetland input. However, dissolved organic nitrogen levels were not high in the 2004 season as was noted in 2003.

GE-2 South River, Plantation Road, Parsonsfield, ME

GE-2 also exhibited elevated levels of silica indicating more groundwater input with reduced precipitation in 2004. Dissolved organic carbon concentrations remained elevated as well.

GE-3 Ossipee River, Effingham Falls

Similar results were found in 2004 as in 2003 at GE-3. Just below the Ossipee Lake impoundment the Ossipee River has low turbidity and higher temperatures. These are most likely due to the lake water that flows through this site. The top layer of the lake is predominantly the layer that flows over the dam and into the Ossipee River. This layer typically has warmer temperature and lower turbidity.

GF-1 Danforth Brook, Ossipee Lake Road, Freedom

Similarly to 2003, Danforth Brook in 2004 was characterized by some of the highest temperatures in the watershed. This could be explained by the high temperatures in Danforth Pond. Danforth Pond had the highest temperatures of all the Ossipee Lake water bodies sampled in the Ossipee Lake Protection Program. Danforth Brook also showed high pH which was consistent with the high pH found in Danforth Pond.

GF-2 Cold Brook, Maple Street, Freedom

GF-2 exhibited the highest silica levels in the watershed in 2004 indicating groundwater input. Upstream of the sampling site, large, minimally moving wetland flows into Mill Pond that could have a large groundwater input. This could also explain the high dissolved organic nitrogen levels found in 2004 as well. In addition, total phosphorus levels were elevated in 2004.

GF-3 Cold Brook, Loon Lake inlet, Freedom

In 2003, GF-3 exhibited some of the highest sulfate levels in the watershed. However, this was not the case in 2004. This site also experienced a large increase in silica levels with the reduced precipitation in 2004.

GM-1 Banfield Brook, Route 113, Madison

As was seen in 2003, sodium and chloride levels were high at this site, potentially indicating road salt influence. Total phosphorus surges were not seen in 2004 as in 2003.

GM-3 Forrest Brook, Rt. 113, Madison
This site is very well shaded by the upper canopy and had the lowest mean temperature of all of the RIVERS sites. It also had high levels of silica indicating groundwater input. However, as with all of the new sites in 2004, the dissolved inorganic nitrogen dominated the total dissolved nitrogen, indicating impairment.

GO-1 Beech River, Tuftonboro Road, Ossipee
GO-1 silica levels were tripled in 2004 in comparison to 2003 levels most likely due to increased groundwater inflow due to a decrease in precipitation. Mean silica levels at GO-1 in 2003 were less than half of the values in 2002. It could be assumed that GO-1 was receiving a higher amount of groundwater inflow in 2002 than 2003. This could be due to increased precipitation levels in 2003.

GO-2 Frenchman Brook, White Pond Road, Ossipee
In 2002 and 2003, this site was identified as impaired due to several factors. First, dissolved inorganic nitrogen was high relative to the total dissolved nitrogen. Calcium, magnesium, sodium and chloride levels were also high. In 2004, calcium, magnesium, sodium, and chloride were again found to be elevated. In addition, the dissolved inorganic nitrogen was high relative to total dissolved nitrogen. This may indicate that this apparent impairment was not just single year event. Site GO-3 was added upstream in Frenchman Brook in an attempt to pinpoint the disturbance; however this site was discontinued due to its intermittent flow. More work should be done to locate a better upstream site.

GO-4 Bearcamp River, UNH property, Newman Drew Rd., Ossipee
High silica levels at this site indicated a significant amount of groundwater input. There is some indication of impairment at this site as dissolved inorganic nitrogen dominated the total dissolved nitrogen. This was a new site in 2004. Future testing will help determine if this is a common theme for this site.

GO-5 Bearcamp River, Whittier Bridge, Ossipee
Similarly to GO-4, this site as experience high levels of silica and the dissolved inorganic nitrogen dominated the total dissolved nitrogen. This also was a new site in 2004 and continued testing will help develop a baseline for this site.

GS-1 Cold River, Route 113, Sandwich
With its low nutrient concentration, temperature, and turbidity and high dissolved oxygen concentration, all of which were seen in 2002 and 2003, GS-1 can still serve as a minimally impacted reference site for the rest of the Ossipee Watershed.

GT-1 Bearcamp River, Route 113, Tamworth
Similar to 2002 and 2003, though the water is quite tea-stained at this site, GT-1 had a relatively low DOC level. However dissolved oxygen levels were also low. This could be a factor of the several wetlands that the Bearcamp winds through before passing by GT-1.

GT-4 Chocorua River, RT. 41, Tamworth
This new site's dissolved inorganic nitrogen also dominated the total dissolved nitrogen indicating impairment. Continued testing will determine if this is a common occurrence.

3.17 Relative OLT Site Summaries

OL-1 West Branch River
With low turbidity and nutrients and high dissolved oxygen and pH, this site exhibits good water quality.

OL-2 Bearcamp River
DIN dominated TDN, indicating that this site may be impaired. DIN does not dominate at site GT-2 (upstream in the Bearcamp River) in the RIVERS program, suggesting the disturbance may be between these two sites.

OL-3 Patch Pond Point River
OL-3 experiences high levels of magnesium, calcium, potassium and silica. High silica levels suggest that this site may be ground water fed.

OL-4 Lovell River
With low turbidity and nutrients and high dissolved oxygen and pH, this site exhibits good water quality.

OL-5 Weetamoe Brook
With low turbidity and nutrients and high dissolved oxygen and pH, this site exhibits good water quality.

OL-6 Pine River
While this site has low turbidity levels and high dissolved oxygen concentrations, sodium and chloride are high, indicating a potential disturbance. This, along with the higher levels of Ca and Mg were not seen at the RIVERS program site GE-1, upstream on the Pine River. However, both Pine River sites experienced high silica levels indicating the stream is ground water fed. Indeed, the Pine River is located over a part of the aquifer that is very close to the surface.

OL-7 Red Brook
OL-7 exhibits many traits of a wetland system: low dissolved oxygen and high nitrogen and phosphorus. Indeed, this site drains a large shrub-dominated wetland. The low temperatures in Red Brook could suggest ground water inflow.

OL-9 Cold Brook
This site exhibited high levels of both total phosphorus and phosphate.

OL-10 Huckins Pond Outflow
With the elevated levels of phosphorus and DOC, it appears that this stream flows through a wetland. The high levels of phosphorus, calcium and magnesium could explain why Danforth Pond has high chlorophyll and ANC levels.

OL-11 Danforth Brook
With low turbidity and nutrients and high dissolved oxygen and pH, this site exhibits good water quality.

OL-12 Phillips Brook
The higher temperatures seen at this site could be due to the minimal shade and flow. A new infestation of variable milfoil was found at this site in 2003.

OL-13 Leavitt Brook
OL-13 exhibited high levels of magnesium, calcium, potassium, and silica. A high pH was also observed. The high pH could be due to the high levels of base cations such as Mg, Ca and K. High silica could indicate that this stream is ground water fed.

OL-14 Square Brook
With low turbidity and nutrients and high dissolved oxygen and pH, this site exhibits good water quality.

4. Recommendations

In 2004, Green Mountain Conservation Group held its second Water Quality Monitoring Program Steering Committee meeting with stakeholders including: New Hampshire Department of Environmental Service, Maine Department of Environmental Protection, Saco River Corridor Commission, Environmental Protection Agency, Chocorua Lakes Association, Maine Chapter of The Nature Conservancy, University of New Hampshire Water Resources Department, University of New Hampshire Cooperative Extension, The Community School, the Eaton Conservation Commission, and the Water Quality Monitoring volunteers in both Maine and New Hampshire. Some of the recommendations from this meeting included:

- Continue monitoring in the Ossipee Watershed to expand upon three years of data to create a long term database
- Select 6 RIVERS sites to test throughout the winter on a monthly bases (weather permitting)
- Place staff and rain gages at each site to better monitor precipitation and water level
- Conduct more storm event sampling
- Purchase conductivity meter as a multi-parameter meter with a 66 foot cable to add a parameter to the RIVERS program and also to use in deep water sampling in Ossipee Lake
- Add deep water sampling to the WQM program with Camps on the lake with GMCG's own multi-parameter meter, kemmerer bottle, and sechi disk.
- Sample all OLT sites from the road closest to the lake, except for Bearcamp and Pine River, to get more river data rather than lake data
- Work with towns to secure another year of funding and access if towns are committed to long range funding
- Work with other lake associations in the watershed to add their data to the GMCG website database
- Work with The Community School and Rose de Mars (WQM volunteer and hydrogeologist) to create GIS maps of several of the sites and their smaller watersheds
- Start the regular WQM season earlier (April)
- Work with Maine Department of Environmental Protection, New Hampshire Department of Environmental Services, Saco River Corridor Commission, and Ned Hatfield (WQM volunteer) to consider guiding volunteers in streamside assessment to gather qualitative data
- In the future consider adding macroinvertebrate and ground water sampling to the program
- Work with towns to create watershed wide water/aquifer protection program from the White Mountains to the Atlantic Ocean

5. Work Cited

Green Mountain Conservation Group and Saco River Corridor Commission. 2003 *Saco Watershed Water Quality Monitoring Program QAPP.*

New Hampshire Office of State Planning, Society for the Protection of New Hampshire Forests and The Nature Conservancy. *New Hampshire's Changing Landscape.*

Field Data Sheet

PART I – SITE AND SAMPLER IDENTIFICATION

Site Code Number_______________________________ Sample Collection Date______________________________

Site Location__________________________________ Sample Collection Time Begin/Finish_________________________

Field Samplers Names____

Signature of Sampler____

PART II – WEATHER CONDITIONS

Current Weather: □ Clear □ Partly Cloudy □ Mostly Cloudy □ Fog □ Haze □ Sunny □ Drizzle □ Steady Rain □ Downpour □ Snow (*check all that apply*)

Rainfall in previous 24 hours: □ None □ Light □ Heavy _______inches

Source of rainfall information: __________________________________ (*i.e. rain gauge, regional weather report, etc.*)

PART III – SITE OBSERVATIONS (*check all that apply*)

Water Appearance: □ Clear □ Milky □ Turbid □ Foamy □ Oily □ Light/Dark Brown □ Greenish □ Other (*explain*)_________________________

Water Odor: □ None □ Fishy □ Chlorine □ Rotten Eggs □ Other(*explain*)____

Wildlife Observations:____

Floatable Observations (*i.e. leaves, foam, or debris*):____

Bottom Observations (*i.e. color, bottom type, silt, rocky, algae, sand etc.*)____

Local Observations (erosion, flooding, road work, littering or other disturbances)____

PART IV – EQUIPMENT INFORMATION

pH Meter Used____________ Calibration Completed yes / no Time Completed_______ a.m. Volunteer Initials________

DO Meter Used____________ Calibration Completed yes / no Time Completed_______ a.m. Volunteer Initials________

Turbidity Meter Used___________ Calibration completed by water quality staff once every 3 months

PART V – FIELD MEASUREMENTS

Depth that measurements were taken________________________ inches *(Indicate the depth of the **probe** in the water when taking the measurement).*

	Temperature	Turbidity	pH	Dissolved Oxygen	
Reading #1	° C	NTU		mg/l	% sat.
Reading #2	° C	NTU		mg/l	% sat.
	HACH Thermometer Reading ° C				

Averages (to be computed by staff)	° C	NTU		mg/l	% sat.

PART VI – SAMPLE COLLECTIONS

Time Silica, DOC,TDN, NH4, PO4, cations, anions sample collected	a.m.	Time Total Phosphorus sample collected	a.m.

REPLICATE SAMPLE COLLECTED? YES NO

Time Silica, DOC,TDN, NH4, PO4, cations, anions **replicate sample** collected	a.m.	Time Total Phosphorus **replicate sample** collected	a.m.

Test Sites Codes / Locations

GM-1	Banfield Brook, Rt. 113, Eidelweiss, Madison	GT-4	Chocorua River, Rt. 41 Bridge, Tamworth
GM-3	Forrest Brook, Rt. 113, Silver Lake Hardware, Tamworth	GE-1	Pine River, Elm St., Effingham
GF-1	Danforth Pond outlet, Ossipee Lake Rd., Freedom	GE-2	South River, Plantation Rd., Parsonsfield
GF-2	Cold Brook, Maple St., Freedom	GE-3	Ossipee River, Rt. 153, Effingham Falls
GF-3	Cold Brook, inlet to Loon Lake, Cemetery Rd., Freedom	GO-1	Beech River, Tuftonboro Rd., Ossipee
GS-1	Cold River, Rt. 113, Sandwich	GO-2	Frenchman Brook, White Pond Rd., Ossipee
GT-1	Bear Camp River, Rt. 113, Tamworth	GO-4	Bearcamp River, UNH property accessed via Witt's End Camp Ground, West Ossipee
		GO-5	Bearcamp River, Whittier Bridge, West Ossipee

Additional Comments (*i.e. problems with sampling procedures, etc*.)

YSI 550A Dissolved Oxygen Meter Calibration

Step 1:
Turn on the DO meter ½ hour before you begin calibrating.

Step 2:
Press and release both the ↑ and ↓ keys to enter into calibration mode. The screen will display *CAL* and **%**.

Step 3:
Press the *ENTER* (↵) key.

Step 4:
The screen will prompt you to enter the altitude. The number **5** should be displayed. If necessary, you the ↑ and ↓ keys to select the number **5**. Then press the *ENTER* (↵) key.

Step 5:
A percent saturation value will appear on the screen. Wait for the reading to stabilize. It has stabilized when the number to the nearest tenth has stopped fluctuating. Press the *ENTER* (↵) key.

Step 6:
The screen will prompt you to enter a salinity value and should display ***0.0***. If the value displayed is not ***0.0*** use the ↑ and ↓ keys to select the number ***0.0***. Press the *ENTER* (↵) key. The meter will return to normal operation and is ready for use.

Step 7:
If you are not taking a measurement right away, return the probe to its storage chamber.

YSI 60 pH Meter Calibration

Step 1:
Turn the pH meter on ½ hour before you calibrate.

Step 2:
Rinse the probe with distilled water.

Step 3:
Pour 30 ml of pH 4 (YELLOW) buffer solution in the graduated cylinder.

Step 4:
Immerse probe in the cylinder.

Step 5:
Press and release both the ↑ and ↓ keys at the same time. The meter will display *CAL* and stand will flash on the bottom of the screen. The main display will read **7.00** (sometimes it may read **4.00**).

Step 6:
Press and release the *ENTER* key. STAND will stop flashing and the decimal point in the pH value will start flashing.

Step 7:
Watch the decimal point. When the decimal point has stopped flashing, the reading is stable.

Step 8:
Press and hold the *ENTER* key until the display reads *SAVE*.

Step 9:
The screen will now prompt you to use a new pH buffer solution. The display will ready either **4.01** or **10.01** (+/- 0.01). You will see *CAL* and *SLOPE* flashing at the bottom of the screen.

Step 10:
Remove probe from solution and rinse well with distilled water. Pour the pH meter back into its container and rinse the cylinder well with distilled water.

Step 11:
Pour 30 ml of pH 7 (RED) buffer solution in graduated cylinder.

Step 12:
Immerse probe in the cylinder.

Step 13:
Press and release the *ENTER* key. *SLOPE* will stop flashing and a second decimal point in the pH value will start flashing.

Step 14:
Watch the decimal point. When the decimal point has stopped flashing, the reading is stable.

Step 15:
Press and hold the *ENTER* key until the display reads *SAVE*.

Step 16:
If you are a Tuesday through Friday volunteer, skip to Step 17.If you are a Monday volunteer, repeat Steps 9-15 with the pH 10 (BLUE) buffer solution for a 3 point calibration. When you have completed the 3 point calibration, the meter will return to normal operation.

Step 17:
STOP. You have completed the calibration. Press and release the *MODE* key to return to normal operation.

HACH Thermometer Measurement

Step 1:
Place HACH Thermometer in the water when you arrive at your test site.

Step 2:
After finishing with the pH meter, remove the HACH thermometer from the water.

Step 3:
Being careful not to touch the bottom of the thermometer, read the temperature on the thermometer. Record the temperature value on the data sheet.

Step 4:
Return thermometer to the cooler.

YSI 60 pH Meter Measurement

Step 1:
Gently place the probe in the water. Be sure that both the pH (glass bulb at bottom of probe) and the temperature (black nub at top of probe) sensors are completely immersed. The pH meter does not need to be stirred.

Step 2:
Allow the reading to stabilize. It has stabilized with the number to the nearest tenth has stopped fluctuating. However, if the reading is changing in one continual direction (example: pH value is slowly increasing 0.01 every few seconds) wait until the value is fluctuating back and forth between several values (example: pH value changes from 6.56 to 6.57 and then back to 6.56 again).

Step 3:
Record the pH value and the temperature.

Step 4:
Remove the probe from the water.

Step 5:
Repeat Steps 1-4 for a second reading.

Step 6:
If there is more than a 0.20 pH unit difference between the two readings, please take a third reading by repeating Steps 1-4 again.

Step 7:
Return the probe to the storage chamber.

Water Sample Collection

Step 1:

Label each bottle as follows:

Site Number	
Date	
Time	*Initials*

Note: The time written on each bottle should be the same.

Step 2:

Remove caps from both bottles and rinse with stream water. Make sure you pour the rinse water out downstream of where you are gathering the sample.

Step 3:

With the mouth of the bottle facing upstream, fill each bottle SIMULTANEOUSLY to the shoulder (where the bottle starts getting narrower at the top) and cap. Return samples to the cooler.

HACH 2100P Turbidimeter Turbidity Meter Measurement

Step 1:
Turn the turbidity meter on by pressing the *POWER* key. The display should read 0.00 NTU and say *AUTO RNG* and *SIG AVG* at the bottom. If *AUTO RNG* and *SIG AVG* do not appear, press the *MODE* until they both appear.

Step 2:
Take two glass vials out of the box and rinse with stream water. Make sure you pour the rinse water out downstream of where you are gathering the sample.

Step 3:
With the mouth of the vial facing upstream, fill each vial to the top and cap.

Step 4:
Set one vial aside.

Step 5:
Thoroughly dry the vial with the paper towel provided. Do not handle the glass after this point. Hold the vial by the cap.

Step 6:
Place one drop of silicon oil on the vial. Use the black cloth to rub the oil over the vial and polish the glass.

Step 7:
Open the lid of the turbidity meter. Place the vial inside so the white diamond (sometimes a triangle) lines up with the marker on the meter.

Step 8:
Close the lid and press the *READ* button. *NTU, AUTO RNG* and *SIG AVG* will flash while the meter is establishing an average of the readings.

Step 9:
When *NTU* has stopped flashing, the reading has stabilized. Record this value.

Step 10:
Repeat Steps 5-9 with the second vial.

Step 11:
If the two readings differ by more than 0.20 NTU, please take a third reading by repeating Steps 2-9.

Step 12:
Pour the water out. Return the vials to the box. Turn the off meter of by pressing the *POWER* button.

YSI 550A Dissolved Oxygen Meter Measurement

Step 1:
Place the probe in the water and stir continuously with an even, steady rhythm.

Step 2:
Press the ***MODE*** key to change the measurement to **mg/l**.

Step 3:
Wait for the reading to stabilize. It has stabilized with the number to the nearest tenth has stopped fluctuating. However, if the reading is changing in one continual direction (example: value is slowly increasing 0.01 mg/l every few seconds) wait until the value is fluctuating back and forth between several values (example: pH value changes from 7.89 to 7.90 mg/l and then back to 7.89 mg/l again).

Step 4:
Record this value, but DO NOT REMOVE THE PROBE FROM THE WATER YET!!!

Step 5:
Press the ***MODE*** twice to change the measurement unit to % saturation. Record this value.

Step 6:
Remove the probe from the water.

Step 7:
Repeat Steps 1-6.

Step 8:
If there is more than a 0.20 mg/l difference between the two mg/l readings, please take a third reading by repeating Steps 1-6 again.

Step 9:
Return the probe to its storage chamber.

Sample Processing Sheet

Step 1:
Pull samples out of coolers as soon as they arrive to let them dry off.

Step 2:
When all bottles have arrived in the office, check labels. Add GMCG codes to sample number.
Acidified samples: *Site #, Week#, A*
Example: GO-2 3A
Filtered samples: *Site #, Week#, A*
Example: GO-2 3B

Step 3:
To clear up some of the bottles, grab all "A" bottles (to be acidified). Put in the blue dish pan with the acid. Put dish gloves on. Bring dish pan to sink.

Step 4:
Remove all the caps from all the bottles. Make sure bottle are filled only to shoulder. If water level is higher, dump excess in sink.

Step 5:
Add 1 mL of acid (just below the bulb on the pipette) to each bottle. Recap bottles.

Step 6:
Put bottles on lower shelf in freezer. Return acid to storage.

Step 7:
Fill out chain of custody form. For examples of this form, look in total phosphorus file.

Step 8:
Label 60 mL bottles (one for each "B" sample) with tape and complete labels (Step 2).

Step 9:
Gather filtering equipment and bring to sink.

Step 10:
Begin running about 6 cups of water through coffee maker.

Step 11:
Place one filter using the forceps (no fingers!) on the part of the filter with the black ring. Reassemble the filter.

Step 12:
Add syringe to set up.

Step 13:
Add 20 mL (approximate) of sample to syringe and filter through.

Step 14:
Shake and empty water from bottle. Separate syringe.

Step 15:
Repeat Steps 13-14 two more times.

Step 16:
Add syringe and filter 60 mL of sample.

Step 17:
Make sure filtered sample water level is at the shoulder of the bottle.

Step 18:
Undo filter set up. Remove and dispose of filter. Dump out remaining sample in 250 mL bottle.

Step 19:
Repeat Steps 11-18 for each "B" sample.

Step 20:
When filtering is complete, rinse all components of filtering system including syringe and forceps, with hot water from coffee pot. Leave filtering system to dry on paper towels on microwave.

Step 21:
250 mL bottles (now empty) get saved for UNH to wash. 60 mL bottles get placed in upper level of freezer.