

Lake Tahoe and Truckee River Watershed Third Annual Snapshot Day



Introduction

The third annual Snapshot Day 2003 was held on May 10, 2003 in the Lake Tahoe and Truckee River watersheds. More than 250 committed citizen-volunteers, working closely with many water quality management agencies, participated in gathering water quality information in the form of visual assessments, photos, and water quality data at 125 locations (compared to 100 volunteers at 44 locations in 2001 and 313 volunteers at 112 locations in 2002).

2003 Snapshot Day	Volunteers	Locations
North Shore Lake Tahoe	59	40
South Shore Lake Tahoe	85	37
Lake Tahoe (lake sites)	16	6
Marina Sites	6	2
Middle Truckee River	55	26
Lower Truckee River	29	14
<i>Totals for 2003</i>	<i>250</i>	<i>125</i>

This collaborative effort was planned and coordinated by the Citizen Monitoring Working Group of the Lake Tahoe Environmental Education Coalition (LTEEC). The Citizen Monitoring Working Group includes private citizens as well as representatives from non-profit organizations, agencies, and the academic community. Organizations involved in planning and operating this event included:

- California State Water Resources Control Board (SWRCB)
- Citizens at Fallen Leaf Lake
- Incline Village General Improvement District (IVGID)
- Lahontan Regional Water Quality Control Board (Lahontan)
- Lake Tahoe Community College (LTCC)
- Lake Tahoe Environmental Education Coalition (LTEEC)
- League to Save Lake Tahoe
- Marine Research and Education
- Nevada Division of Environmental Protection (NDEP)
- Sierra Nevada College (SNC)
- Tahoe Regional Planning Agency (TRPA)
- Tahoe Resource Conservation District (TRCD)
- Truckee River Aquatic Monitors (TRAM)
- Truckee River Watershed Council (TRWC)
- U.S. Forest Service (USFS)
- UC Davis Tahoe Research Group (UCD TRG)
- University of California Cooperative Extension (UCCE)
- University of Nevada Cooperative Extension (UNCE)
- University of Nevada Reno (UNR) Electrical Engineering Department, and
- Washoe-Storey Conservation District (WSCD)

The citizen-monitoring program of the California State and Regional Boards is the *Clean Water Team*, and the participating volunteers in the Lake Tahoe and Truckee River watersheds adopted that moniker as well. Volunteers from Lake Tahoe, Fallen Leaf Lake, Truckee and Reno joined together to make the Third Annual Snapshot Day event a watershed-wide effort.

What is Snapshot Day?

Snapshot Day is a one-day, volunteer-based event designed to collect watershed information during one moment in time. Volunteer “team leaders” are trained, and these leaders accompany teams of volunteers to various pre-determined sites to collect information relative to the health of our watersheds. The purpose of this effort is two-fold: 1) to promote environmental education and stewardship, and 2) to collect valuable water quality information. While there is a great deal of high quality agency and university-sponsored monitoring taking place in the region, there is still insufficient information to adequately assess the status of all of the aquatic resources in the Truckee River and Lake Tahoe Basin watersheds. With proper training and quality assurance, community volunteers can help fill this void by providing valuable information for watershed management and pollution prevention.

For example, this year volunteers in the Lake Tahoe watershed collected water samples from the mouth of the tributaries entering Lake Tahoe for particle size analysis by the University of California (see Particle Size Analysis for Snapshot Day – Lake Tahoe Basin, Rabidoux & Schladow, 2003). This effort will aid in the development and testing of the UC Davis Lake Tahoe Clarity Model, a critical component of the Lake Tahoe Total Maximum Daily Load (TMDL) Project that will serve as a plan for the effective and efficient restoration of clarity to the Lake. (For more information regarding this project, see Lahontan’s website at http://www.swrcb.ca.gov/rwqcb6/TMDL/Tahoe/Tahoe_Index.htm or contact the agency directly.)

Citizen Monitoring: The Clean Water Team

The mission of the Clean Water Team citizen monitors is to produce environmental information that is needed to protect the chemical, physical and biological integrity of aquatic resources within the Truckee River and Lake Tahoe Basin watersheds. The Citizen Monitoring Working Group of the Lake Tahoe Environmental Education Coalition and its partners realize that hands-on training will inform and engage the community in effective watershed stewardship. This team is one of the nine working groups of LTEEC whose goal is to support coordinated public outreach education efforts throughout the Tahoe Basin.

The goals of the Citizen Monitoring Working Group are to:

- Build awareness of water quality issues, aquatic resources and pollution prevention
- Screen for water quality problems, including the identification of sources of pollution and detection of illegal activities (i.e., chemical spills, filling of wetlands, diversions, illicit discharges, destruction of stream environment zones (SEZs), non-compliance with ordinances or regulations in place to protect natural resources, etc.)
- Assess the status and trend of valued biologic and ecologic resources within the watershed

- Provide water quality data that may be: 1) compared to TRPA's Environmental Thresholds and/or water quality standards set by the States of California and Nevada; or 2) used in trend analyses
- Provide baseline water quality data for un-monitored waters to determine how they compare to the water quality standards
- Provide data for evaluating the effectiveness of restoration activities (also called best management practices, or BMPs) and various other pollution control strategies

It is important to note that citizen monitoring is designed to supplement existing agency monitoring efforts; all information is provided to the regulatory and resource management agencies, whose responsibility it is to protect water quality.

Methods

Citizen monitoring "team leaders" were provided training during the month prior to Snapshot Day (May 10, 2003). Team leader trainings covered descriptions and protocols for visual observations, photo-documentation, water quality field measurements (temperature, pH, conductivity, dissolved oxygen), and water sampling (grab samples sent into the laboratory for subsequent analysis of nutrient and sediment concentrations and turbidity). Each monitoring team leader was required to attend at least one session. Training for the Lake Tahoe watershed team leaders was taught by Heather Segale, Lake Tahoe Environmental Education Coalition (LTEEC); Holly Sheradin, California State Water Resources Control Board (SWRCB); and Rita Whitney, Tahoe Regional Planning Agency. Three training sessions were held at Lake Tahoe: one in South Lake Tahoe at the Lake Tahoe Community College (LTCC) and two in Incline Village at Sierra Nevada College (SNC). Training for the Middle Truckee River was led by Beth Christman of the Truckee River Watershed Council, Holly Sheradin, and Jill Wilson of the Lahontan Regional Water Quality Control Board. The Lower Truckee River watershed team leader training was taught by Jason Kuchnicki and Mary Kay Riedl of the Nevada Division of Environmental Protection.

Visual observations and photo-documentation were performed according to the procedures provided by the SWRCB Clean Water Team. The standardized observation form, the *California Stream and Shore Walk Visual Assessment Form*, was slightly revised to better meet our needs. At least three photos were taken at each sampling site (bed conditions, view across stream and view upstream from the starting point). All stream-walks were initiated from a downstream position, traveling upstream.

A variety of instruments and kits were used on Snapshot Day by the volunteers. The majority of the monitoring teams were assigned armored Enviro-safe thermometers (alcohol filled, 0.5° C resolution) or hand-held digital thermometers (0.1° C resolution), non-bleeding Whatman pH indicator strips (0.5 pH unit resolution), hand-held Oakton TDS Tester Conductivity meters (10 µS/cm resolution), and Chemet dissolved oxygen kits (colorimetric, indigo carmine dye reaction, 1 mg/L resolution below 6 mg/L and 2 mg/L resolution above 6 mg/L). Most of these instruments/kits were provided via funding from University of Nevada Reno (UNR) Electrical Engineering Department or through a Proposition 13 grant from the California SWRCB, with some other instruments/kits loaned from the California SWRCB, US Environmental Protection Agency (US EPA), LTCC, and others. Some of the monitoring teams were equipped with higher resolution instruments provided by California SWRCB,

Carson Valley Subconservancy District, SNC, TRPA, TRAM, USFS, US Geological Survey (USGS), UCD TRG, and NDEP. Turbidity meters, to be used at three centralized drop off points, were supplied by the California SWRCB, USEPA and the USFS. All of the instruments and kits were calibrated and tested/standardized at a quality control session held one day prior to the event.

All observations, photos, field measurements and samples were taken between 9:00 a.m. and 12:00 noon on May 10, 2003. All samples were kept chilled with ice or blue ice in coolers from the point of collection until analyzed. Coliform samples were collected in sterile Whirl-paks and nutrient and turbidity samples were collected in clean (acid rinsed) Nalgene® plastic bottles. Samples were brought to four centralized locations: LTCC, SNC, Truckee Regional Park, and the WSCD office. Coliform samples were then transported from these drop off points and delivered to the Lahontan laboratory (Lake Tahoe samples), U.S. Geologic Survey (Middle Truckee River samples), and Truckee Meadows Water Reclamation Facility (Lower Truckee River samples) laboratories within 4 hours of collection. The analysis procedure for fecal coliform was initiated within 6 hours of sample collection. (Note: Those samples not received within the permitted time period were excluded from analysis.)

Turbidity samples were run on the afternoon of Snapshot Day along with replicate testing of field measurements such as pH and conductivity. Nutrient samples were kept refrigerated and then analyzed by High Sierra Lab (Lake Tahoe and Middle Truckee River samples) and TMWRF (for the Lower Truckee River samples) within the allotted holding times for the various constituents.

This year, in the Lake Tahoe watershed, additional samples were collected for particle size distribution analysis. Samples from Lake Tahoe tributary streams were collected at their mouths in Nalgene® sampling bottles provided by UC Davis. These samples were brought to SNC for collection by Dr. Geoffrey Schladow, research professor from UC Davis. The samples were transported to UC Davis and stored at 36°C until the laboratory tests were performed (between 4 and 10 days). Water samples were run through two instruments, a LiQuilaz S05-HF sensor and a Coulter LS-230. The LiQuilaz and Coulter produce particle size distributions using laser scattering and diffraction, respectively. Particles detectable by laser scattering are typically made up of clays and fine silts. These particles are the most likely to scatter light, and are also too small to quickly settle out of the water column. Thus, it is these particles that have the greatest impact on Lake Tahoe clarity (Rabidoux A. & Schladow G. 2003).

The turbidity of the water near the lake surface was also measured as part of Snapshot Day by researcher Kendrick Taylor of the Desert Research Institute (DRI). A boat was configured with a bow mounted water pump/sampling probe. Water was continuously pumped from a depth of 0.5 m to analytical instruments on the boat. Two turbidity sensors and a global positioning system allowed the turbidity of the water to be recorded about every 10 m of horizontal distance while the boat was moving. Survey transects were made as close to the shore as possible, which was typically along the 1.5 m depth contour or 20 m offshore, whichever was further from shore. Additional offshore transects, spaced about 200 m apart, were measured until the turbidity was below 0.15 NTU. (This is the general background turbidity for deeper portions of the lake.) Some measurements were made in the middle of the lake to confirm that deep lake turbidity was less than 0.15 NTUs (Taylor K, 2003).

Site Locations

Volunteers gathered data at 125 locations, including multiple reaches within some streams, in the Lake Tahoe and Truckee River watersheds (see maps in appendix) as follows:

Lake Tahoe (On Lake):

- North Shore Lake Tahoe, Dollar Point
- North Shore Lake Tahoe, Sunnyside
- North Shore Lake Tahoe, Tahoe City #65
- North Shore Lake Tahoe, Watson Creek
- North Shore Lake Tahoe, Memorial Point
- South Shore Lake Tahoe, Ski Run Marina
- South Shore Lake Tahoe, Outside Marina at Ski Run

Lake Tahoe Tributaries, South Shore:

- Angora, at Lake Tahoe Blvd., (project)
- Angora at Washoe, above Golf Course
- Angora Creek at Upper Truckee
- Bijou Creek at mouth
- Bijou Creek at Fairway
- Bijou Creek at Pioneer
- Bijou Park Drainage, Culvert into Ski Run Marina
- Bijou Park Drainage, Culvert under Werner Salas Road
- Burke Creek at USGS staff
- Cascade Creek
- Cold Creek above project
- Cold Creek at project
- Tahoe Keys Marina Cove East
- Eagle Falls Creek
- Echo Creek at Upper Truckee
- Edgewood Creek at mouth
- Fallen Leaf Lake
- Glen Alpine Creek (Fallen Leaf Lake)
- Heavenly Ski Area
- Tahoe Keys, Marina and Lagoon
- Lonely Gulch Creek at mouth
- Lincoln Creek at mouth
- McFaul Creek at mouth
- Upper Truckee River, Moshier (main)
- North Zephyr Creek
- Rubicon Creek at mouth, Bliss St Park
- Saxon Creek at Trout Creek
- Upper Truckee River at Hwy 50, side channel
- South Zephyr Creek at mouth
- Tallac Creek at mouth
- Taylor Creek at mouth
- Trout Creek, Behind LTCC1
- Trout Creek, Behind LTCC2

- Upper Truckee River at mouth
- Trout Creek at mouth
- Upper Truckee River, Xmas/Grass Valley

Lake Tahoe Tributaries, North Shore:

- Barton Creek above Hwy 28
- Burnt Cedar Creek at Lakeshore
- Bliss Creek
- Blackwood Creek at mouth
- Bonpland Creek
- Brockway (Baldy) Creek at Coon Beach
- Burton Creek at Star Harbor
- Carnelian Canyon at Hwy 28
- Carnelian Bay Creek above Hwy 28
- Deer Creek above Incline
- Dollar Creek at mouth
- First Creek at mouth
- Glenbrook Creek at Old Hwy 50
- General Creek at mouth
- General Creek at Highway 89
- Griff Creek at mouth
- Homewood Creek at mouth
- Incline Creek at mouth
- Logan House Creek
- Lake Forest Creek at mouth
- Madden Creek at mouth
- Marlette Creek
- Meeks Creek
- McKinney Creek at mouth
- North Logan House Creek
- Quail Lake Creek at mouth
- Rosewood Creek above Third
- Secret Harbor Creek at mouth
- Second Creek at Lakeshore
- Slaughter House at the Lake
- Tahoe Vista/Snow Creek at mouth
- Hatchery Creek at Star Harbor
- Tahoe City State Park
- Tahoe City Urban Ditch at lake
- Third Creek at mouth
- Tunnel Creek at mouth
- Ward Creek at mouth
- Ward Creek at Highway 89
- Watson Creek at mouth
- Wood Creek at Lakeshore
- Wood Creek at Tanager (Crystal Bay Marina)

Truckee River Watershed – Middle Truckee River:

- Alder Creek
- Bear Creek
- Boca Dam
- Boyington Mill
- Worn Mill
- Cabin Creek
- Coldstream Canyon
- Deep Creek
- Davies Merrill Creek
- Donner Creek
- Union Valley Creek
- Gray Creek
- Independence Creek
- Martis Creek
- Pole Creek
- Prosser Creek
- Sagehen Creek
- Silver Creek
- Squaw Creek
- Truckee River at three different locations:
 - o Big Chief Corridor
 - o Regional Park
 - o Floriston
- Trout Creek (Lower)
- Trout Creek (Upper)

Truckee River Watershed – Lower Truckee River:

- Alum Creek
- Bull Ranch Creek
- Chalk Creek
- Dog Creek
- Dry Creek
- Jumbo Creek
- Lewer's Creek
- Muskgrove Creek
- Roberts Creek
- Sunrise Creek
- Thomas Creek
- Unnamed Creek
- White's Creek

Beneficial Uses of the State's Waters

Water quality standards are established to protect beneficial uses of each State's waters. The most common beneficial uses include drinking water, recreation and fisheries. When a water quality standard is established, the first step is to identify the beneficial uses sensitive to the parameter. Then criteria are established based on the levels needed to protect the sensitive uses.

In many Sierra streams, propagation of cold-water fish (i.e. trout or salmon) is a designated beneficial use of the water. In such streams, numerical and narrative water quality standards generally are set at levels that will "support the beneficial use" of a cold water fishery. Such streams generally require cooler temperatures (ranges adequate for Rainbow trout survival shown below) and higher dissolved oxygen content than water in streams and lakes that do not have cold-water fishery as a designated beneficial use. Cold-water fish also require habitat characteristics that promote spawning (clear gravel beds, riffles), rearing habitat (glides and pools) and adequate food sources such as macroinvertebrates (mayfly, nymphs, stonefly nymphs, and caddisfly larvae). Such characteristics can be monitored, but they do not usually have numeric standards.

(Note that dissolved oxygen, temperature, total suspended solids (TSS) and turbidity are parameters directly related to habitat for which most waters generally have standards. Because macroinvertebrates are believed to be a primary indicator of stream health as related to fisheries, both Lahontan and NDEP are in the process of developing an Index of Biologic Integrity (IBI). These are basically standards for benthic macroinvertebrates.)

General EPA Temperature Ranges for Rainbow Trout

Species	Growth	Maxima	Spawning*	Embryo Survival**
Rainbow Trout	19°C (66 °F)	24°C (75 °F)	9°C (48 °F)	13°C (55 °F)
* The optimum or mean of the range of spawning temperatures reported for the species. ** The upper temperature for successful incubation and hatching reported for the species. Adapted from EPA's Draft Volunteer Stream Monitoring: A Methods Manual .				

Results

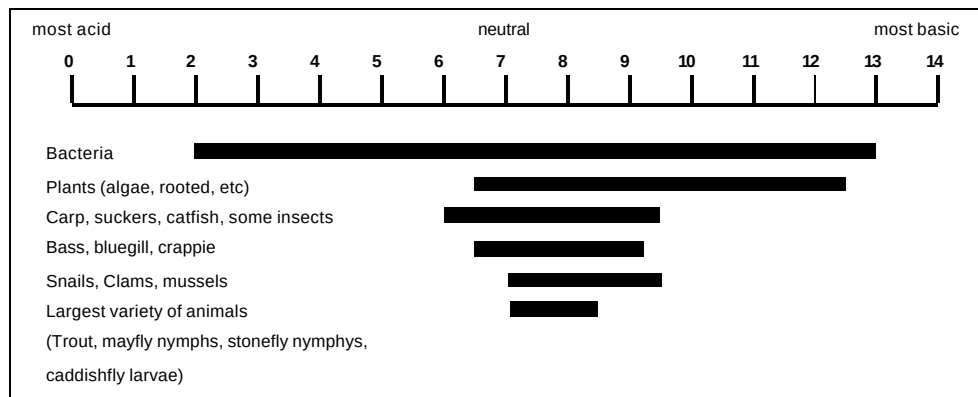
Water temperature ranged from 1.4 to 13.0 °C (116 valid responses). The highest measured temperatures were at Musgrove Creek (13 °C), Tallac Creek at the mouth (10.5 °C), North Shore Lake Tahoe at Memorial Point (10.5 °C), Independence Creek (10.2 °C), and Bull Ranch Creek (10° C). In past measurements, the majority of the higher temperature readings were located at much lower elevations than the Lake Tahoe Basin. Most of these readings were taken within tributaries to the lower Truckee River, a high desert environment where one would expect slightly higher temperatures. However, this year the higher temperatures were seen throughout the range of elevations. Generally, cooler water temperatures are

considered better habitat for aquatic life in mountain streams and lakes (see also Beneficial Uses of the State's Waters, above). Cold water holds more oxygen, an essential ingredient for fish and invertebrates. Higher temperatures promote nutrient solubility and can occur as a result of low flow (shallow) conditions, and/or a lack of canopy (tree) cover along stream banks, which acts to shade and thus prevent solar heating of the water.

A majority of sites with measured **pH values** were within the range of 6.5 to 8.5, which is typical of fresh water streams or lakes in the Sierras. In fresh water, pH in the range of 6.5 to 8.5 should protect most organisms. Nevertheless, there were 41 out of 115 valid responses with a pH less than 6.5. This is a much higher incidence of low pH values compared to previous Snapshot Day events.

One possible reason for these lower pH values may be the snowfall that occurred over much of the Basin the morning of Snapshot Day. Natural rainwater/snow has a slightly acidic pH of about 5.5. This is caused by sulphur and/or nitrous oxide reactions in the atmosphere. Our watershed is located downwind from two major metros, San Francisco and Sacramento. These areas produce a lot of nitrous oxides from vehicle emissions. Literally, these lower pH values could stem from acid rain! The range of pH tolerated by organisms varies can be seen in this chart from the *SWRCB Clean Water Team pH Fact Sheet*. An analysis of aquatic life (bio-assessment) might provide better information for determining if the pH is acceptable within these streams.

pH Ranges that Support Aquatic Life



pH ranges that support aquatic life.

Dissolved oxygen measurements ranged between 2.5 and 12 mg/L. Cold, clean water usually has levels of dissolved oxygen averaging above 6.0 mg/L, and single-measurement levels below 5 mg/L are considered dangerous for (cold water) aquatic life. While water quality objectives for dissolved oxygen will vary from region to region, waters that support coldwater fishes usually require that dissolved oxygen concentration shall not fall below 6 to 8 mg/L (while for waters that support warm water fishes, the objective requires that the dissolved oxygen concentration shall not fall below 5 to 6 mg/L). Five sites had dissolved oxygen levels below 6.0 mg/L. These were at Tahoe City State Park (2.5 mg/L), Trout Creek near Lake Tahoe Community College (5 mg/L), Madden Creek (5 mg/L), Union Valley (5 mg/L), and Boca Dam (5.5 mg/L).

Conductivity measurements ranged from 10-2575 $\mu\text{S}/\text{cm}$ (micro Siemens per centimeter, the units used for conductivity measurements in fresh water). Conductivity is used as an indicator of dissolved solids (e.g., minerals or salts), with higher levels associated with degraded water quality. The numeric value of **total dissolved solids** (TDS) is roughly 65% of the numeric value of conductivity measurements however the direct relation is site specific. TDS is measured in milligrams per liter (mg/L) which are equivalent to parts per million (ppm). Conductivity will vary with water source. Conductivity may be affected by the local/regional geology, thus indicating inputs from natural sources such as groundwater seepage, springs and/or geothermal activity. Anthropogenic sources that may affect conductivity include drainage from agricultural fields, wastewater discharge, or inputs stemming from accelerated erosional processes.

Six sites out of 116 valid responses had measurements $\geq$ (greater than or equal to) 300 $\mu\text{S}/\text{cm}$. The sites with elevated conductivity measurements, along with the corresponding TDS measurements, are Chalk Creek (2575 $\mu\text{S}/\text{cm}$, 1670 mg/L), Lincoln Creek (710 $\mu\text{S}/\text{cm}$, 460 mg/L), Heavenly Ski Area Creek (520 $\mu\text{S}/\text{cm}$, 340 mg/L), Bull Ranch Creek (450 $\mu\text{S}/\text{cm}$, 290 mg/L), Jumbo Creek (430 $\mu\text{S}/\text{cm}$, 280 mg/L) and Burnt Cedar Creek at Lakeshore Drive (340 $\mu\text{S}/\text{cm}$, 220 mg/L). In the two previous years, the higher conductivity measurements were generally from the Lower Truckee River watershed. This year, the higher values were located in various locations throughout the entire watershed. The very high conductivity of Chalk Creek in the lower Truckee River area means this water would not pass for potable or irrigation water. State of Nevada water quality standards set for this water is a single value of less than or equal to 95.0 mg/l. Assuming the numeric value of TDS is roughly 65% of the conductivity, then the TDS far exceeds the standard. The high reading at Chalk Creek will be followed up with further sampling by the Nevada Division of Environmental Protection.

Acceptable Ranges for Water Conductivity

Water Type	Conductivity $\mu\text{S}/\text{cm}$ (micro Siemens per centimeter)
Distilled Water	0.5 - 3.0
Melted snow	2 - 42
Potable water in U.S.	30 - 1500
Irrigation Supply Water	< 750

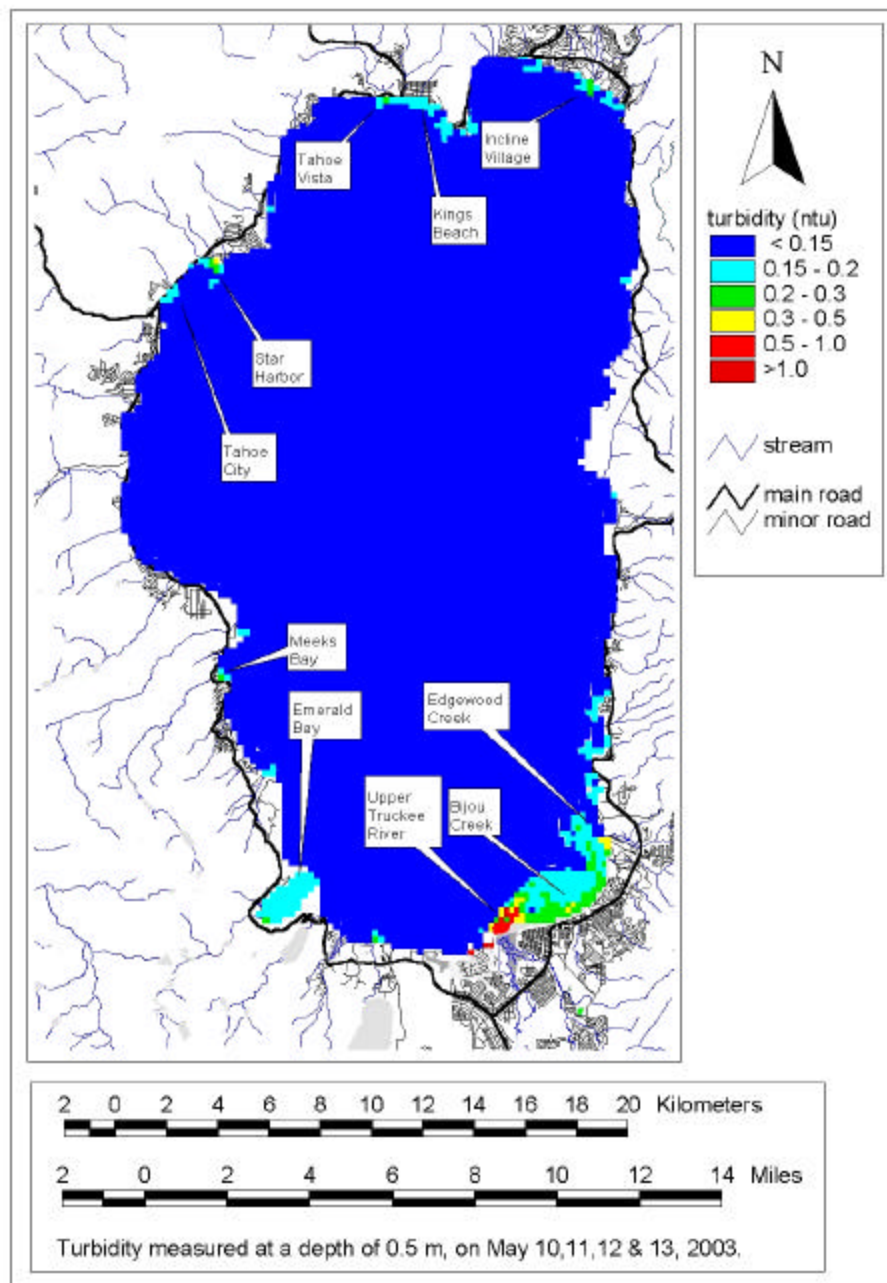
Turbidity is a measure of the amount of suspended particles in the water. Algae, suspended sediment, organic matter and some pollutants, can cloud the water making it more turbid. Suspended particles diffuse sunlight and absorb heat, which can increase temperature and reduce light available for algal photosynthesis. If the turbidity is caused by suspended sediment, it can be an indicator of erosion, either natural or man-made. High sediment loads can clog the gills of fish, foul gravel beds and smother fish eggs and benthic insects. The sediment can also carry pathogens, pollutants and nutrients.

The US EPA's recommended criteria for turbidity in streams in Eco-Region II (forested mountains in the western U.S.), is 1.3 NTU (Nephelometric Turbidity Units) or less (*US EPA Ambient Water Quality Criteria Recommendations*). Higher NTU levels indicate poorer water clarity. Valid turbidity data was determined for 112 sites, 67 of which had levels $\geq$ 1.3 NTU.

The four most turbid sites were Burnt Cedar Creek at Lakeshore (18.9 NTU), Dry Creek (15 NTU), Lincoln Creek (13.7 NTU) and Bijou Creek (11.9 NTU).

Within Lake Tahoe, undeveloped portions of the lakeshore (Figure 1) had a low turbidity similar to deep portions of the lake. Most developed areas had at least a slightly elevated turbidity. The Upper Truckee River, which was flowing with spring run off, had the largest effect on lake turbidity both in terms of the value of the turbidity and the size of the area that had elevated turbidity readings (Taylor K, 2003).

FIGURE 1: Near Shore Turbidity Measurements



Another way of measuring **water clarity**, primarily in lakes, bays and harbors, is by determining the transparency of the water using a Secchi disk. Some Secchi disk measurements were taken on Snapshot Day, while additional measurements were made as part of the North American Secchi Dip-In, during July of 2003. In some cases, in shallow water, the Secchi disc could be seen all the way to the bottom and those results are not presented here. In locations where there was deep water or turbid conditions, the Secchi disk results are given below:

Secchi Depth Measurements

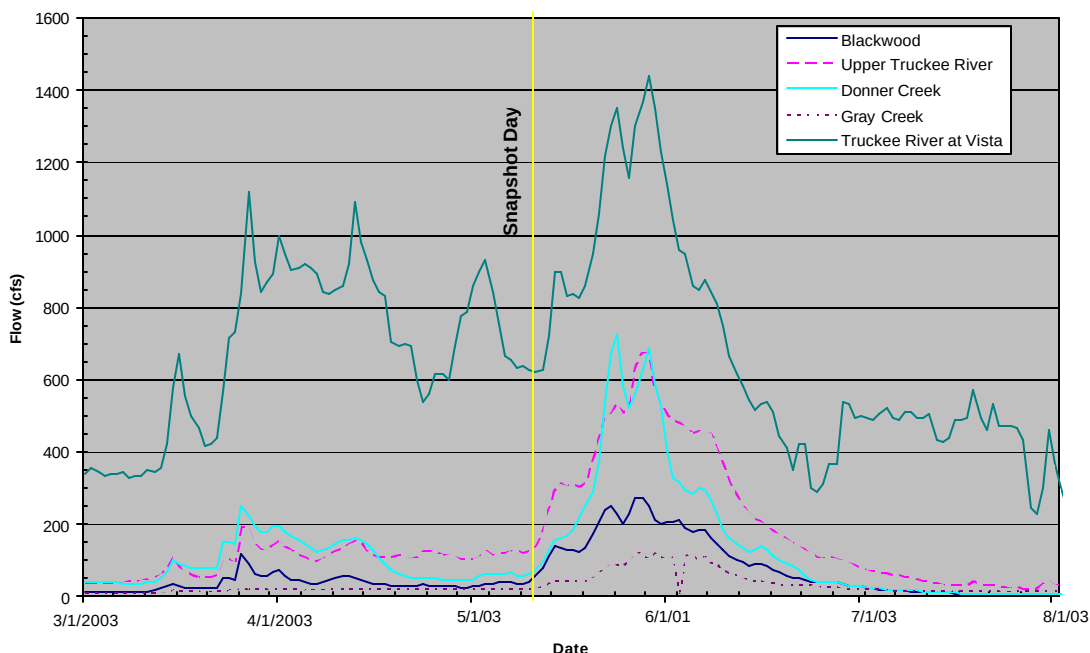
Location	Secchi depth in meters
North Lake Tahoe (near Dollar Point)	23.5
Cove East, Tahoe Keys	3.0
Lake Tahoe outside Ski Run Marina	2.9
Ski Run Marina	1.5

The Secchi depth readings from Snapshot Day were comparable to past years on the North Shore but far worse at the South Shore sites. The lake level has been steadily dropping for the last few years. This can contribute to lower readings, especially in marinas where circulation is limited. For example, Secchi readings at Cove East in the Tahoe Keys measured 3.0 meters, and the bottom measured 3.25 meters deep. The readings both in and outside of Ski Run Marina (the point at which the disk was no longer visible) were only 1.5 and 2.9 meters below the surface. These measurements do not meet the EPA's recommended minimum criteria for Secchi depths in lakes in Eco-Region II, which is 4.5 meters. However, the good news is that lakewide at the TRG midlake stations, the Secchi readings were the best in 6 years. These were comparable to readings before the flood of 1997.

The phytoplankton primary productivity readings (basically a measurement of the amount of algae in the lake) have been high for the last several years. There was a large increase after the flood, and for the first time since then, the numbers were 16 % lower than last year's all time high. Many watershed resource managers are suggesting that the Environmental Improvement Program projects are starting to show some positive effects in Lake Tahoe's clarity.

Stream flow data (volume of water) was obtained from USGS gauging stations, which corresponded with many of the Snapshot Day monitoring sites. The Snapshot Day event was held one month earlier in 2002 and 2003 than in 2001 to better capture spring runoff. However, based on the 2002-2003 stream flow data (hydrographs) for various streams located throughout the Tahoe-Truckee watershed, it appears that the spring melt had not reached its peak (Figure 2). Because of a late cold weather pattern, it seems that peak runoff occurred around the end of the month.

Figure 2: Streamflow for Selected Streams



Average snow pack as of the *May 2003 NRCS Water Supply Outlook Report* for the Lake Tahoe Basin was 108 percent, with the Truckee River at 123 percent, and the Carson River at 114 percent. Reported **precipitation** was 97 percent of average in the Lake Tahoe Basin, 92 percent of average for the Truckee River and 86 percent of average for the Carson River. Reported **stream flow** forecasts was 81 percent of average in the Lake Tahoe Basin, 81 percent of average for the Truckee River and 75 percent of average for the Carson River. Low flow conditions can have an impact on several water quality parameters such as dissolved oxygen, conductivity, temperature, and algae growth.

Visual observations at most of the study locations were indicative of generally good water quality conditions. There were, however, a few locations that did exhibit indications of some water quality degradation. Three out of 125 valid responses observed oil. Tahoe Keys Marina/Lagoon, Tahoe Keys Marina Cove East, and Bijou Creek had oil reported. In two locations, Bijou Creek and Ski Run Marina, water clarity was reported as “murky” (can’t see bottom in 4 inches or less). Litter was reported at 17 out of 125 sites with valid responses. Many locations (62 out of 125 sites) were reported with visible algae.

Valid coliform bacteria data was developed for 25 sites. Fecal coliform bacteria are a group of bacteria that are mostly found in the feces of warm-blooded animals, including humans, pets, livestock, beaver, and birds. E. Coli is a common type of fecal coliform bacteria. Of these 25 sites, none had fecal coliform levels in excess of 40 CFU/100 ml (CFU/ 100 ml are colony forming units, roughly equivalent to the number of bacteria cells, in 100 ml of sample water).

Sixty-three samples were analyzed for various **nutrient concentrations**, including ammonia (NH_3 and NH_4^+), nitrate (NO_3^-), phosphate (PO_4^{3-}) and total phosphorus (TP). We measured these because nitrogen and phosphorus determine the maximum amount of algae that can grow in

virtually every water body. Excess nutrients lead to excess algae, odors, discolored waters, loss of clarity, and nighttime oxygen depletion, which in turn can cause fish kills in extreme cases.

Nitrogen is required by all organisms for the basic processes of life to make proteins, to grow, and to reproduce. Nitrogen is very common and found in many forms in the environment. Inorganic forms include nitrate, nitrite, ammonia, and nitrogen gas. Organic nitrogen is found in the cells of all living things and is a component of proteins, peptides, and amino acids. Nitrogen is a nutrient that stimulates the growth of algae in streams and lakes. Algae include benthic forms, attached to the rocks and sediment of the streambeds (as observed by the monitors), as well as phytoplankton. Phytoplankton are microscopic single cell algae that drift in the water and that can cause the water to have a green color. Benthic algae and phytoplankton are essential components to the ecosystem, but in relatively large concentrations these organisms are known to reduce water clarity, or reduce oxygen levels during the evening (they consume oxygen at night). One cause for decreasing clarity in Lake Tahoe is an increase in phytoplankton populations as a result of increasing nutrient concentrations.

Ammonia is a reduced, toxic form of nitrogen and is usually associated with the decomposition of organic matter and wastes. Total ammonia consists of the un-ionized (NH_3) plus the ionized (NH_4^+) forms. Ionized ammonia is relatively nontoxic while un-ionized ammonia is toxic to fishes and aquatic invertebrates, even in low concentrations. Only three out of 51 Lake Tahoe and Middle Truckee River samples had ammonia nitrogen (measured as NH_4^+) concentrations greater than 10 $\mu\text{g/L}$ (micrograms per liter, equivalent to parts per billion). These samples were from Bijou Creek at the mouth (42 $\mu\text{g/L}$), Bijou Creek upstream (20 $\mu\text{g/L}$), and Incline Creek at the mouth (20 $\mu\text{g/L}$). The Truckee River Water Reclamation Facility laboratory measured ammonia as NH_3 and all samples measured approximately 20 or 30 $\mu\text{g/L}$.

Nitrate (NO_3^-) is highly soluble (dissolves easily) in water and is stable over a wide range of environmental conditions. It is easily transported in streams and groundwater. Nitrates feed plankton (microscopic plants and animals that live in water), aquatic plants, and algae, which are then eaten by invertebrates and fish. Nitrite (NO_2^-) is relatively short-lived in water because it is quickly converted to nitrate by bacteria. Nitrate concentrations were measured at 63 locations, and 12 of them had concentrations greater than 25 $\mu\text{g/L}$. These included Tahoe City State Park drainage (1556 $\mu\text{g/L}$), Chalk Creek (724 $\mu\text{g/L}$), Dry Creek (245 $\mu\text{g/L}$), Thomas Creek (164 $\mu\text{g/L}$), Tahoe City Urban Ditch (150 $\mu\text{g/L}$), North Logan House Creek (60 $\mu\text{g/L}$), Squaw Creek (54 $\mu\text{g/L}$), McKinney Creek (52 $\mu\text{g/L}$), Quail Lake Creek (49 $\mu\text{g/L}$), Bonpland Creek (45 $\mu\text{g/L}$), Secret Harbor Creek (45 $\mu\text{g/L}$) and Bijou Creek at the mouth (28 $\mu\text{g/L}$).

In terms of total **dissolved inorganic nitrogen** (ammonia + nitrite + nitrate nitrogen), the EPA's recommended criterion for streams in Eco-Region II is 100 $\mu\text{g/L}$. TRPA has a more stringent standard of no more than 25 $\mu\text{g/L}$ for most tributaries to Lake Tahoe (Nevada side of Lake Tahoe). Five locations had dissolved inorganic nitrogen concentrations greater than 100 $\mu\text{g/L}$: Tahoe City State Park, Chalk Creek, Dry Creek, Thomas Creek and Tahoe City Urban Ditch. An additional 15 locations had concentrations greater than 25 $\mu\text{g/L}$, including Bijou Creek at the mouth, North Logan House Creek, Squaw Creek, McKinney Creek, Quail Lake Creek, Musgrove Creek, Bonpland Creek, Secret Harbor Creek, Alum Creek, Dog Creek, Jumbo Creek, Roberts/Tower Creek, White's Creek and Union Valley.

Laboratory tests for organic nitrogen are expensive and were not included as part of this project. Therefore, we cannot calculate total nitrogen (TN).

Phosphorous is another nutrient that stimulates algal growth. Six of the samples (out of 58) were above the 50- $\mu\text{g/L}$ standard for total phosphorous (based on State of Nevada annual average total phosphorous standard for tributaries to Lake Tahoe: NAC 445A.1915). Eleven of the samples were above the more stringent California state standard of 30- $\mu\text{g/L}$ total phosphorous for tributaries to Lake Tahoe. These Lake Tahoe standards will certainly be more stringent than those in lower elevation watersheds; however, they provide a cutoff point to make a comparison. The sites with total phosphorous values greater than 30 $\mu\text{g/L}$ included Bijou Creek at mouth (86 $\mu\text{g/L}$), Bijou Creek at Fairway (80 $\mu\text{g/L}$), Barton Creek (71 $\mu\text{g/L}$), Hatchery Creek at Star Harbor (64 $\mu\text{g/L}$), Burnt Cedar Creek at Lakeshore (45 $\mu\text{g/L}$), Carnelian Canyon Creek (45 $\mu\text{g/L}$), Tahoe City State Park (42 $\mu\text{g/L}$), Second Creek (34 $\mu\text{g/L}$), Lake Forest Creek (31 $\mu\text{g/L}$), and Bonpland Creek (30 $\mu\text{g/L}$).

Phosphorus pollution has been identified as a serious problem contributing to the degradation of water quality in Lake Tahoe. Furthermore, the Truckee River below Reno has been listed on the *State of Nevada's 2002 303(d) List* for total phosphorus so a TMDL will need to be developed for that reach of the river. Sediment entering streams and the lake from human caused erosion of soil along roads, or from residential or commercial properties, is a common source of phosphorous. This is why it is important to implement BMPs on your property; source control is the most effective means to control erosion and runoff.

When phosphorous is in the form of orthophosphate molecules it is considered “**soluble reactive phosphorous**,” the form of phosphorous that is readily bio-available for the stimulation of algae growth. Twenty-two of the samples (out of 63) were above the US EPA's recommended criteria for streams in Eco-Region II, which is 8.75 $\mu\text{g/L}$ for soluble reactive phosphorous. These sites were Hatchery Creek at Star Harbor (57 $\mu\text{g/L}$), Bijou Creek at mouth (28 $\mu\text{g/L}$), Second Creek (20 $\mu\text{g/L}$), Bijou Creek at Fairway (20 $\mu\text{g/L}$), Lake Forest Creek (19 $\mu\text{g/L}$), Tahoe City State Park (18 $\mu\text{g/L}$), Burnt Cedar Creek at Lakeshore (18 $\mu\text{g/L}$), Homewood Creek (16 $\mu\text{g/L}$), Martis Creek (15 $\mu\text{g/L}$), Bonpland (14 $\mu\text{g/L}$), Carnelian Canyon Creek (14 $\mu\text{g/L}$), Truckee River at Regional Park (11 $\mu\text{g/L}$), First Creek (11 $\mu\text{g/L}$), Trout Creek Upper in Truckee (11 $\mu\text{g/L}$), Rosewood Creek (11 $\mu\text{g/L}$), Dollar Creek (11 $\mu\text{g/L}$), Carnelian Bay Creek (10 $\mu\text{g/L}$), Snow Creek (10 $\mu\text{g/L}$), Truckee River at Big Chief Corridor (9 $\mu\text{g/L}$), Truckee River at Floriston (9 $\mu\text{g/L}$), and Wood Creek (9 $\mu\text{g/L}$).

The Lake Tahoe Environmental Education Coalition, Tahoe Regional Planning Agency, Truckee River Watershed Council and Washoe-Storey Conservation District store all of the data and photos electronically. As soon as the California SWRCB database is available for use, all visual assessment data, water quality data, and site photographs will be made available for viewing on the internet. A summary of the field and laboratory data is available in the Appendix to this report. A separate *Snapshot Day 2003 Data Appendix* is also available upon request.

Discussion

It is important to remember that the measurements made on Snapshot Day were designed to represent a single point in time and do not necessarily represent average conditions. Still, it is interesting to compare the results with some applicable standards. As mentioned in the results, the US EPA has recommended criteria for nutrients, Secchi depth, and turbidity. These and other US EPA recommended water quality criteria are considered by the states when developing their own water quality standards. State standards related to Lake Tahoe are

generally the most stringent of the Tahoe-Truckee region. When general US EPA criteria are not available, these Tahoe standards were used as a point of reference.

In California, the Lahontan RWQCB water quality standards are composed of the beneficial uses and objectives described in the Basin Plan. The Lahontan Basin Plan is approved by the USEPA, and includes many watershed specific standards. The Basin Plan takes into account the natural background levels of certain constituents. For example, concentrations of dissolved solids and nutrients are relative to natural geologic conditions; in other words, some water bodies have naturally higher levels of these substances. Likewise, the State of Nevada's Division of Environmental Protection has set water quality standards throughout Nevada that are specific to waters and their beneficial uses.

Some of the standards require complex calculations. For example, one must consider the temperature and pH of a water sample when determining the allowable concentrations of ammonia. While a full discussion of all of the standards is not within the scope of this report, the following table provides some relatively simple examples, mostly paraphrased, for a few of the standards:

Examples of Lake Tahoe Water Quality Standards

Parameter	Standard
Temperature	Shall not exceed 15° C, surface waters of Fallen Leaf Lake (CA)
pH	7.0 - 8.4 in Lake Tahoe (CA and NV)
TDS	Shall not exceed 60 mg/L average in Lake Tahoe (CA and NV)
Dissolved Oxygen	Mean no less than 6.5 and minimum of 4.0 mg/L for Lahontan waters designated as "cold freshwater habitat" (CA)
Turbidity	Shallow water shall not exceed 3 NTU near tributaries and 1 NTU not directly influenced by streams (TRPA)
Secchi Depth	December-March average of not less than 33.4 meters for Lake Tahoe (TRPA), and a mean of 18.5 meters for Fallen Leaf Lake (Lahontan Region, CA)
Algae	Lahontan RWQCB waters shall not contain biostimulatory substances (nutrients) that cause algae to become a nuisance or to affect the water's beneficial uses (CA)
Total Nitrogen	Mean of no more than 190 µg/L (CA)
Inorganic Nitrogen	Mean of no more than 25 µg/L for most tributaries to Lake Tahoe, Nevada side of Lake Tahoe (TRPA)
Total Phosphorous	Annual average of no more than 50 µg/L for most tributaries, Nevada side of Lake Tahoe (NV) and no more than 30 µg/L for most tributaries, California side of Lake Tahoe (CA)
Soluble Reactive Phosphorous	Mean of no more than 7 µg/L for Lake Tahoe, Nevada side (TRPA)
Fecal Coliform	Log mean of 20 CFU (30 day period) and maximum of 40 CFU, (Lahontan Region, CA)

Water quality standards are the foundation of the water quality-based control program mandated by the Clean Water Act. Water Quality Standards define the goals for a water body by designating its uses, setting criteria to protect those uses, and establishing provisions to protect water quality from pollutants. A water quality standard consists of four basic elements:

- (1) designated uses of the water body (e.g., recreation, water supply, aquatic life, agriculture),
- (2) water quality criteria to protect designated uses (numeric pollutant concentrations and narrative requirements),
- (3) an antidegradation policy to maintain and protect existing uses and high quality waters, and
- (4) general policies addressing implementation issues (e.g., low flows, variances, mixing zones).

For full and more detailed information on water quality objectives in California refer to the Lahontan Regional Water Quality Control Board *Basin Plan* at the following website: <http://www.swrcb.ca.gov/rwqcb6/> and select “Available Documents.” For water quality standards in Nevada see the following website: <http://ndep.state.nv.us/nac/445a119.pdf> or visit the NDEP Bureau of Water Quality Planning website at: <http://ndep.state.nv.us/bwqp/stdsw.htm>. For the Tahoe Regional Planning Agency (TRPA) water quality standards, see the following website: <http://www.trpa.org/Documents.htm> and select “Environmental Threshold Carrying Capacities.”

The results and data gathered from the 2003 Snapshot Day were once again interesting, and in many cases different from the 2001 and 2002 data. One way in which our 2003 monitoring results were similar to those of 2001 and 2002 was that at the majority of all Lake Tahoe and Truckee River sites, the observed quality of the water was good to excellent. We can be thankful for that.

Snapshot Day took place in May in order to try to capture the spring snowmelt or “runoff.” During this time period, streams generally experience higher than average flows. By holding the event in May, it was anticipated that certain constituents (e.g. fecal coliform) might be less concentrated because of increased runoff. However, there was the possibility of capturing other constituents (e.g. phosphorous) at more concentrated levels due to an increased loading of sediment to the streams. Higher flows can contribute to increased erosion, higher loading of sediment into the streams, and ultimately increased levels of phosphorous. Unfortunately, we overshot the mark and held the event just before the spring melt began to occur.

The majority of sites had nitrate and phosphorous within the TRPA surface discharge standards (total nitrogen of no more than 500 µg/L and total phosphorous of no more than 100 µg/L for surface water runoff which directly enters Lake Tahoe). However, there were a few notable outliers.

The following sampling sites were noteworthy for having poor readings in one or more water quality parameters:

- **Tahoe City State Park** had high nitrate concentrations (1556 µg/L) and low dissolved oxygen (2.5 mg/L). The high nitrate readings for Tahoe State Park this year were probably due to very low flow and almost stagnant water at the sample point. This location is a park in a very urban setting. This can result in significant contributions from urban runoff, and high readings have been observed here in the past.

- The **Chalk Creek** sample in the Lower Truckee River watershed has also raised concern due to the high conductivity (2575 $\mu\text{S}/\text{cm}$), nitrate (724 $\mu\text{g}/\text{L}$), soluble reactive phosphorus (150 $\mu\text{g}/\text{L}$), and total phosphorus (170 $\mu\text{g}/\text{L}$) results. Although unresolved, it is hypothesized that urbanization of the watershed is turning this ephemeral creek into more of a perennial system. In the process, runoff from lawn sprinkling, golf courses and storm water are transporting nutrients to the creek. This area will continue to be monitored by NDEP.
- **Lincoln Creek** was the site a major gasoline spill and cleanup several years ago, and NDEP performed an aggressive remedial program which resulted in effective protection of surface waters. The site is now monitored on a quarterly basis. From correspondence with NDEP, it appears the lower portions of Lincoln Creek flow year round from groundwater seepage, which is most likely the source of the high iron that can be seen in the creek. The high conductivity (710 $\mu\text{S}/\text{cm}$) and turbidity (13.7 NTU) is still suspect and will be looked at in follow-up samples throughout the year by TRPA
- **Wood Creek**, one of several streams in the Incline area, flows through the most commercial and industrial area. This area has a high percentage of impervious coverage (impermeable surfaces that will not allow water to infiltrate into the ground). The Best Management Program (BMP) program for residential properties has been very effective in the Incline area; however, there is much work to be done in the commercial properties. TRPA has had complaints of grease and oil runoff from parking lots from homeowners in the Tanager Street area, so a sampling site was added. The water quality results showed nothing unusual although the volunteers did make note of obvious oil spills on the ground near the stream. A subsequent field visit by TRPA did show evidence of a discharge point for parking lot runoff from a local business. TRPA discussed the problem with the property owner, and they were sent information on how to install BMPs in commercial properties.
- **Ski Run Marina** and **Tahoe Keys Marina Cove East** did not meet the EPA's recommended minimum criteria for Secchi depths in lakes in Eco-Region II with measurements of 1.5 meters and 3.0 meters, respectively. The low lake level this year certainly contributed to these readings, especially in the Ski Run Marina. Ski Run has not been dredged in several years, and has been going through a change of ownership recently. The TRPA Project Review Department has requested the Snapshot Day data for discussion and inclusion in a permit application for the marina.
- None of the sites tested on May 10, 2003 had elevated fecal coliform levels. In 2001, higher than expected coliform bacteria results for three sites resulted in follow-up sampling activities, and eventually a violation was issued from TRPA and Lahontan RWQCB for one of these instances. In 2003 and 2002, the bacteria counts taken during the Snapshot Day event were all within acceptable ranges, however there were a few sites with slightly elevated levels compared to all the others. Given the very cold and snowy day, any activity for coliform is suspicious. The sites that exhibited detectable fecal Coliform levels were Lake Forest, Bijou Creek, and South Zephyr below the horse stables. There should be an effort later in the summer to assess

selected beaches and marinas for coliform levels, especially where swimming is popular

Due in part to Snapshot Day efforts, several areas are now on the “radar screen” for agencies and local jurisdictions to implement water quality improvements. Consultants who are responsible for stream restoration and project implementation are using this data for background information on water quality as well as habitat restoration. Further volunteer monitoring of these sites will be helpful in the large task of finding ways to reduce further pollution of Lake Tahoe.

Conclusion

Snapshot Day was not only successful in engaging the public in active watershed stewardship, but it also provided much valuable data to the responsible agencies. The third annual event again included the entire Tahoe-Truckee watershed. We hope to continue to build on this collaborative effort by encouraging continued monitoring throughout the year, during runoff events, and on Snapshot Day 2004!

It is our hope that this annual event will stimulate interest and excitement for water quality monitoring throughout the region. The Snapshot Day event provides a focal point for the Clean Water Team’s efforts. As momentum continues to grow for water quality monitoring in the region, the Clean Water Team will be seeking volunteers willing to make an annual commitment to monitor a specific field site on a monthly basis, to focus on certain hotspots identified by other studies and research, or to sample water quality at the peaks of storm events. Monthly data will be analyzed to reveal and document impacts on the watershed. They can also be used by agencies, local landowners, and other stakeholders to collaborate, problem-solve, and ultimately protect the watershed we live in.

For more information about how to get involved with water quality monitoring activities contact the following agencies:

- *Lake Tahoe Basin* – Contact Heather Segale, Lake Tahoe Environmental Education Coalition, (775) 832-4138 or Rita Whitney, Tahoe Regional Planning Agency, (775) 588-4547, ext. 258
- *Fallen Leaf Lake* – Grant Adams, Fallen Leaf Lake Research, (530) 541-8535
- *Incline Village* – Contact Sarah Tone, Incline Village GID Waste Not/Incline Village Clean Water Team, (775) 831-8603
- *Middle Truckee River (Tahoe City to Nevada State Line)* – Contact Beth Christman, Truckee River Watershed Council, (530) 550-8760
- *Lower Truckee River (Nevada Stateline to Pyramid Lake)* – Contact Mary Kay Riedl, Nevada Division of Environmental Protection, (775) 687-9454

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Waste Not, Incline Village General Improvement District

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Appendices

Lake Tahoe Priority Watershed Map

Middle Truckee River Sub-Basin Map

Lower Truckee River Watershed Map

2003 Summary of Field and Lab Data

Watershed Key

Maps Contrasting 2001, 2002 and 2003 Data

Water Temperature: 2001, 2002 and 2003

pH: 2001, 2002 and 2003

Conductivity: 2001, 2002 and 2003

Turbidity: 2001, 2002 and 2003

Dissolved Oxygen: 2001, 2002 and 2003

Ammonia: 2001, 2002 and 2003

Nitrate: 2001, 2002 and 2003

Soluble Reactive Phosphorus: 2001, 2002 and 2003

Total Phosphorus: 2001, 2002 and 2003

Bacteria: 2001, 2002 and 2003

Note: Data collected as part of the Snapshot activities is available electronically. Contact Heather Segale, Lake Tahoe Environmental Education Coalition, University of Nevada Cooperative Extension, (775) 832-4138 or segaleh@unce.unr.edu or visit <http://www.lteec.org>.

TABLE A: Snapshot Day 2003 Summary Field and Lab Data

Station Name	Station ID	Water Temperature (°C)	pH	DO (ppb)	Conductivity (us)	Turbidity (NTU) (1)	Ammonia NH3-N (ppb) (2,3)	Nitrate NO3-N (ppb) (2,3)	Dissolved Inorganic Nitrogen DIN-N (ppb) (2,3)	Soluble Reactive Phos. SRP-P (ppb) (2,3)	Total Phosphorus TP-P (ppb) (2,3)	No. of Colonies per 100 mL (4)	Secchi Depth (m)
Lake Tahoe "On Lake" Sites													
North Shore Lake Tahoe, Dollar Point	TAH-NLAKE1	6.2	7.2	7.5	82.2	0.2	-	-	-	-	-	-	23.5
North Shore Lake Tahoe, Sunnyside	TAH-NLAKE2	6.2	7.3	7	80.5	0.2	-	-	-	-	-	-	-
North Shore Lake Tahoe, Tahoe City #65	TAH-NLAKE3	5.9	7.5	6	82	0.2	1	7	8	2	6	0	-
North Shore Lake Tahoe, Watson Creek	TAH-NLAKE4	6.5	7	7.5	82.5	0.2	-	-	-	-	-	-	-
North Shore Lake Tahoe, Memorial Point	TAH-NLAKE5	10.5	7	-	70	-	3	3	6	1	8	-	-
South Shore Lake Tahoe, Ski Run Marina	TAH-SLAKE2	7	5.5	8	240	-	-	-	-	-	-	2	1.5
South Shore Lake Tahoe, Outside Marina at Ski Run	TAH-SLAKE3	7	5.5	-	90	-	-	-	-	-	-	-	2.9
South Lake Tahoe Sites													
Angora, at Lake Tahoe Blvd., (project)	SLT-ANG1	3.2	5.4	8	70	0.13	-	-	-	-	-	-	-
Angora at Washoe, abv Golf Course	SLT-ANG2	5.5	5.5	8	10	-	-	-	-	-	-	-	-
Angora Creek at Upper Truckee	SLT-ANG3	5.7	5.75	9	30	0.87	-	-	-	-	-	0	-
Bijou Creek at mouth	SLT-BJCR-00	6.9	5	-	40	11.9	42	28	70	28	86	34	-
Bijou Creek at Fairway	SLT-BJCR-01	5.6	5	-	230	6.04	20	19	39	20	80	29	-
Bijou Creek at Pioneer	SLT-BJCR-02	5.1	5.5	-	160	3.38	-	-	-	-	-	-	-
Bijou Park Drainage, Culvert into Ski Run Marina	SLT-BPDR-00	7	6	-	100	2.3	-	-	-	-	-	4	-
Bijou Park Drainage, Culvert under Werner Salas Road	SLT-BPDR-01	9	6	-	-	0.22	-	-	-	-	-	-	-
Burke Creek at USGS staff	SLT-BURK	7.2	6	9	-	0.89	-	-	-	-	-	19	-
Cascade Creek	SLT-CASC	6.8	5.5	9	187	0.12	-	-	-	-	-	0	-
Cold Creek abv project	SLT-COLD1	3	5.5	8	10	1.91	-	-	-	-	-	-	-
Cold Creek at project	SLT-COLD2	4.7	-	10	50	1.46	-	-	-	-	-	-	-
Tahoe Keys Marina Cove East	SLT-COVE	9.7	8.1	9.22	60	1.35	-	-	-	-	-	0	3
Eagle Falls Creek	SLT-EAGL	4.2	5.25	11	155	0.04	-	-	-	-	-	-	-
Echo Creek at Upper Truckee	SLT-ECHO	1.4	5.5	6	10	0.08	-	-	-	-	-	-	-
Edgewood Creek at mouth	SLT-EDGE-00	7.3	7.5	7	18	2.89	-	-	-	-	-	0	-
Fallen Leaf Lake	SLT-FLLF	-	-	-	150	-	-	-	-	-	-	-	-
Glen Alpine Creek (Fallen Leaf Lake)	SLT-GLNA	3.4	7.01	10.16	22	0.16	-	-	-	-	-	-	-
Heavenly Ski Area	SLT-HEAV2	5.3	5.75	-	520	8.05	-	-	-	-	-	1	-
Tahoe Keys, Marina and Lagoon	SLT-KEYS	9.9	8.1	10.42	138	2.31	-	-	-	-	-	0	-
Lonely Gulch Creek at mouth	SLT-LGCR-00	-	5.25	-	30	0.25	-	-	-	-	-	-	-
Lincoln Creek at mouth	SLT-LINC	4	7	-	710	13.7	-	-	-	-	-	-	-
McFaul Creek at mouth	SLT-MCFA-00	8.5	7	8	126	1.63	-	-	-	-	-	2	-
Upper Truckee River, Moshier (main)	SLT-MOSH	4.1	5.5	10	70	0.78	-	-	-	-	-	3	-
North Zephyr Creek	SLT-NZHR	4.5	7	-	110	5.13	-	-	-	-	-	-	-
Rubicon Creek at mouth, Bliss St Pk.	SLT-RBCN	3	5.5	-	50	3.13	-	-	-	-	-	-	-
Saxon Creek at Trout Creek	SLT-SAXN	2	5	8	50	1.36	-	-	-	-	-	-	-
Upper Truckee River at Hwy 50, side channel	SLT-SIDE-01	5	5.5	10	59	0.80	-	-	-	-	-	0	-
South Zephyr Creek at mouth	SLT-SZHR-00	4.5	7	-	110	0.55	-	-	-	-	-	16	-
Tallac Creek at mouth	SLT-TALL-00	10.5	5	8	50	0.79	-	-	-	-	-	-	-
Taylor Creek at mouth	SLT-TALR-00	7.5	5	8	20	0.26	-	-	-	-	-	-	-
Trout Creek, Behind LTCC1	SLT-TCCC1	3.1	5	7	50	2.16	-	-	-	-	-	-	-
Trout Creek, Behind LTCC2	SLT-TCCC2	5.3	5	5	40	2.17	-	-	-	-	-	-	-
Upper Truckee River at mouth	SLT-TRMO	-	-	-	58	0.98	-	-	-	-	-	-	-
Trout Creek at mouth	SLT-TROU-00	7.3	5.5	7	50	2.39	-	-	-	-	-	-	-
Upper Truckee River, Xmas/Grass Valley	SLT-XMAS	2.1	5.5	10	50	0.3	3	7	10	6	15	0	-

TABLE A: Snapshot Day 2003 Summary Field and Lab Data

Station Name	Station ID	Water Temperature (°C)	pH	DO (ppb)	Conductivity (us)	Turbidity (NTU) (1)	Ammonia NH3-N (ppb) (2,3)	Nitrate NO3-N (ppb) (2,3)	Dissolved Inorganic Nitrogen DIN-N (ppb) (2,3)	Soluble Reactive Phos. SRP-P (ppb) (2,3)	Total Phosphorus TP-P (ppb) (2,3)	No. of Colonies per 100 mL (4)	Secchi Depth (m)
North Lake Tahoe Sites													
Barton Creek abv Hwy 28	NLT-BART-01	5	8	-	-	2.2	1	9	10	6	71	-	-
Burnt Cedar Creek at Lakeshore	NLT-BCDC	5.5	7	-	92	18.9	3	2	5	18	45	-	-
Bliss Creek	NLT-BLIS-00	5	6.5	7	340	1	2	5	7	7	18	-	-
Blackwood Creek at mouth	NLT-BLKW-00	4.6	6.5	8	100	0.3	3	8	11	5	10	-	-
Bonpland Creek	NLT-BONP-00	2	6.5	-	62	4.4	4	45	49	14	30	-	-
Brockway(Baldy) Creek at Coon Beach	NLT-BROC-00	-	-	-	80	-	-	-	-	-	-	-	-
Burton Creek at Star Harbor	NLT-BRTN-01	7	7	-	-	1.4	2	3	5	8	19	1	-
Carnelian Canyon at Hwy 28	NLT-CACN-03	6	7	-	57	5.2	3	6	9	14	45	-	-
Carnelian Bay Creek abv Hwy 28	NLT-CBCR-01	-	6.5	-	110	1.9	2	1	3	10	15	-	-
Deer Creek abv Incline	NLT-DEER	5.5	7	7	40	4.7	-	-	-	-	-	-	-
Dollar Creek at mouth	NLT-DLRH-00	4.1	6.5	9	230	3.4	3	4	7	11	23	-	-
First Creek at mouth	NLT-FRST-00	3	6.75	-	61.9	2.2	3	4	7	11	19	-	-
Glenbrook Creek at Old Hwy 50	NLT-GLENO50-02	-	-	-	80	-	-	-	-	-	-	-	-
General Creek at mouth	NLT-GNRL-00	3.9	6.5	10	-	0.8	1	5	6	4	9	-	-
General Creek at Highway 89	NLT-GNRL-01	4.4	6.5	10	25	0.6	3	5	8	8	12	-	-
Griff Creek at mouth	NLT-GRIF-00	3.2	7	10	25	2	3	4	7	5	11	-	-
Homewood Creek at mouth	NLT-HMWD-00	5	6.5	9	78	0.4	3	8	11	16	19	-	-
Incline Creek at mouth	NLT-INCL-00	3	6	12	77.5	2	20	5	25	7	20	-	-
Logan House Creek	NLT-LHCR-00	1.72	7.78	11.95	110	1.1	4	15	19	5	17	-	-
Lake Forest Creek at mouth	NLT-LKFC-00	5.3	6.5	8	127	1.2	2	11	13	19	31	20	-
Madden Creek at mouth	NLT-MADC-00	3.2	6.5	5	116	0.3	4	14	18	3	7	-	-
Marlette Creek	NLT-MARL-00	2	-	9	57	1.3	1	9	10	4	15	-	-
Meeks Creek	NLT-MEEK-00	4.3	5.5	8	60	0.6	2	4	6	3	8	1	-
McKinney Creek at mouth	NLT-MKNY-00	1.9	6.5	11	20	0.3	3	52	55	2	7	-	-
North Logan House Creek	NLT-NLHC-00	1.9	8.04	11.43	30	3.5	4	60	64	7	20	-	-
Quail Lake Creek at mouth	NLT-QULC-00	2.8	6.5	8	90	0.5	2	49	51	3	9	-	-
Rosewood Creek abv Third	NLT-RSWD-01	5	6.5	-	44.5	3.2	1	20	21	11	27	-	-
Secret Harbor Creek at mouth	NLT-SCRT-00	4	6.5	7	260	1.8	3	45	48	7	23	-	-
Second Creek at Lakeshore	NLT-SECD-01	4.11	7.83	10.7	90	2.7	2	3	5	20	34	-	-
Slaughter House at the Lake	NLT-SLHO-00	9	7	7	160	-	-	-	-	-	-	0	-
Tahoe Vista/Snow Creek at mouth	NLT-SNOW-00	6	6.5	-	-	4.9	-	-	-	-	-	0	-
Hatchery Creek at Star Harbor	NLT-STAR-01	5	-	-	160	3	3	3	6	57	64	2	-
Tahoe City State Park	NLT-TCSP-00	8.1	6.2	2.5	70	3.3	1	1556	1557	18	42	0	-
Tahoe City Urban Ditch at lake	NLT-TCUB-00	5.5	6	7	27	4.9	1	150	151	8	25	2	-
Third Creek at mouth	NLT-THRD-00	4	7	6	13	2.4	1	3	4	5	18	-	-
Tunnel Creek at mouth	NLT-TUNN-00	3	6.5	-	110	0.2	3	2	5	7	11	-	-
Ward Creek at mouth	NLT-WARD-00	9	6.5	7	60	0.3	1	2	3	7	13	-	-
Ward Creek at Highway 89	NLT-WARD-01	7	6.5	7	40	0.3	-	-	-	-	18	-	-
Watson Creek at mouth	NLT-WATS-00	4	6.5	8	40	1.8	2	5	7	4	18	-	-
Wood Creek at Lakeshore	NLT-WOOD-00	2	6.5	-	50	1.8	2	3	5	9	23	-	-
Wood Creek at Tanager (Crystal Bay Marina)	NLT-WOOD-02	3	6.5	-	70	-	-	-	-	-	-	-	-

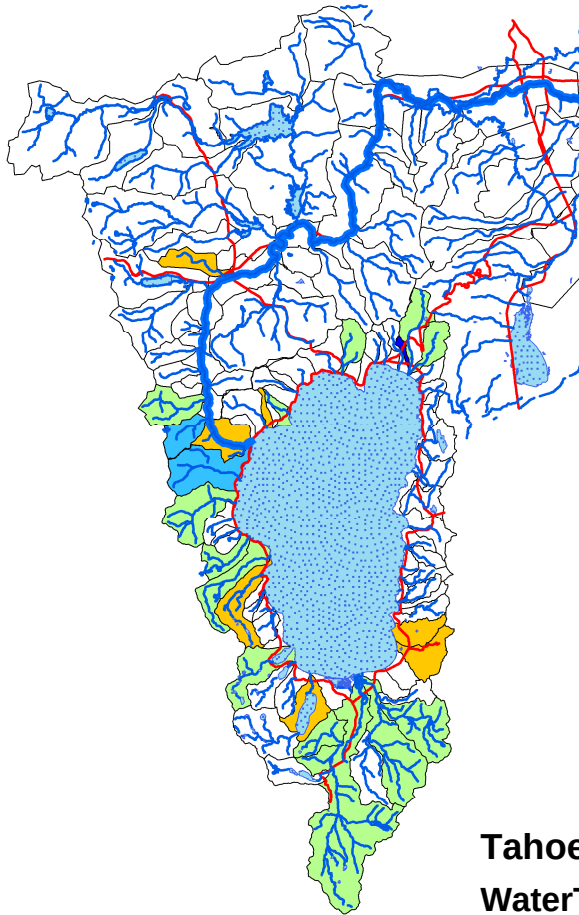
TABLE A: Snapshot Day 2003 Summary Field and Lab Data

Station Name	Station ID	Water Temperature (°C)	pH	DO (ppb)	Conductivity (us)	Turbidity (NTU) (1)	Ammonia NH3-N (ppb) (2,3)	Nitrate NO3-N (ppb) (2,3)	Dissolved Inorganic Nitrogen DIN-N (ppb) (2,3)	Soluble Reactive Phos. SRP-P (ppb) (2,3)	Total Phosphorus TP-P (ppb) (2,3)	No. of Colonies per 100 mL (4)	Secchi Depth (m)
Middle Truckee River Sites													
Alder	MTR-ALDR	5	6.5	10	10	2.35	3	13	16	8	17	-	-
Bear Creek	MTR-BEAR	5	6.5	8	80	0.78	3	7	10	4	9	-	-
Big Chief Corridor	MTR-BIGC	6	6.5	8	90	1.02	4	8	12	9	19	-	-
Boca Dam	MTR-BOCA -00	8.7	7.3	5.5	74	2.1	3	3	6	3	18	-	-
Boyington Mill	MTR-BOCA-01	8.5	7	7	72	1.21	-	-	-	-	-	-	-
Worn Mill	MTR-BOCA-02	5.1	7	-	120	1.61	-	-	-	-	-	-	-
Cabin Creek	MTR-CABN	4	6.5	9	60	1.2	-	-	-	-	-	-	-
Coldstream canyon	MTR-COLD	5	7	9	50	0.59	-	-	-	-	-	-	-
Deep Creek	MTR-DEEP	6	6	7	50	1.34	-	-	-	-	-	-	-
Davies Merrill	MTR-DMCB	7.9	7	-	100	2.53	-	-	-	-	-	-	-
Donner	MTR-DONN	8	6.5	9	80	0.96	3	15	18	8	16	-	-
Union Valley	MTR-GLEN	7	7	5	120	1.83	4	23	27	8	19	-	-
Gray	MTR-GRAY	3	6.8	9	220	1.3	-	-	-	-	-	-	-
Floriston	MTR-I80C	7	7	7	90	1.94	3	12	15	9	18	-	-
Independence	MTR-INDE	10.2	6.75	6	60	1.83	-	-	-	-	-	-	-
Martis Creek	MTR-MART	5	6.8	9	110	2.74	4	3	7	15	28	-	-
Pole Creek	MTR-POLE	3.5	6.5	10	80	1.36	-	-	-	-	-	-	-
Prosser	MTR-PROS	4	6.5	9	60	1.33	-	-	-	-	-	-	-
Sagehen	MTR-SAG10	3.7	6.75	-	80	2.4	-	-	-	-	-	-	-
Silver Creek	MTR-SLVR	4.1	6.7	9	-	1.92	-	-	-	-	-	-	-
Squaw Creek	MTR-SQCR	6.5	6.5	6	140	0.94	2	54	56	2	8	-	-
Regional Park	MTR-TOWN	5.5	6.5	6.9	110	1.09	5	16	21	11	15	-	-
Truckee River 1	MTR-TRO1	5.5	6.5	9.5	100	1.01	-	-	-	-	-	-	-
Trout Creek Lower	MTR-TROU-00	6	6.5	9	100	1.82	4	3	7	7	16	-	-
Trout Creek Upper	MTR-TROU-01	5.7	7	11.45	140	1.49	4	3	7	11	21	-	-
Upper Little Truckee	MTR-ULTB	-	-	-	120	-	-	-	-	-	-	-	-
Lower Truckee River Sites													
Alum Creek	LTR-ALUM	9	6.5	8	120	9.9	30	5	35	20	-	-	-
Bull Ranch Creek	LTR-BUL	10	7	-	450	1.6	20	5	25	10	10	-	-
Chalk Creek	LTR-CHA	8	7	-	2,575	1.0	30	724	754	150	170	-	-
Dog Creek	LTR-DOG	7	5	-	160	1.5	30	5	35	20	0	-	-
Dry Creek	LTR-DRY	9	5	-	230	15.0	20	245	265	80	-	-	-
Jumbo Creek	LTR-JUM	7.8	5	-	430	4.5	30	5	35	30	20	-	-
Lewer's Creek	LTR-LEW	9	5	-	160	3.2	20	5	25	60	80	-	-
Musgrove Creek	LTR-MUS	13	4	-	280	4.5	30	21	51	30	-	-	-
Roberts / Tower Creek	LTR-ROB	9	5	8	160	7.7	20	15	35	40	40	-	-
Sunrise Creek	LTR-SUN	8	5	-	160	1.5	-	-	-	-	-	-	-
Thomas Creek	LTR-THOM	9	7.5	-	150	-	20	164	184	50	-	-	-
Unnamed Creek	LTR-UNN	7.5	6	-	110	2.3	20	5	25	10	0	-	-
White's Creek	LTR-WHI-01	9	5.2	-	120	8.0	20	13	33	10	-	-	-
Minimum Value	-	1.4	4.0	2.5	10	0.0	1	1.0	3.0	1.0	0.0	0.0	1.5
Maximum Value	-	13.0	8.1	12.0	2,575	18.9	42	1556.0	1557.0	150.0	170.0	34.0	23.5
Count (# of valid responses)	123	116	115	78	116	112	63	63	63	63	58	25	4
Notes: Note 1: Turbidity (NTU) lab analysis conducted at the four collection sites (Sierra Nevada College, Lake Tahoe Community College, Truckee and Washoe-Storey Conservation District). Note 2: Lake Tahoe and Middle Truckee River Watershed nutrient analysis conducted by High Sierra Water Lab. Concentrations in Parts Per Billion (PPB). Note 3: Lower Truckee River Watershed nutrient analysis conducted by Truckee Meadows Water Reclamation Facility. Concentrations in Parts Per Billion (PPB). Note 4: Fecal Coliform analysis conducted at Lahontan Regional Water Quality Control Board. Value represents number of colonies per 100 mL. Coliform value of zero is equal to "Non-Detect" less than one.													

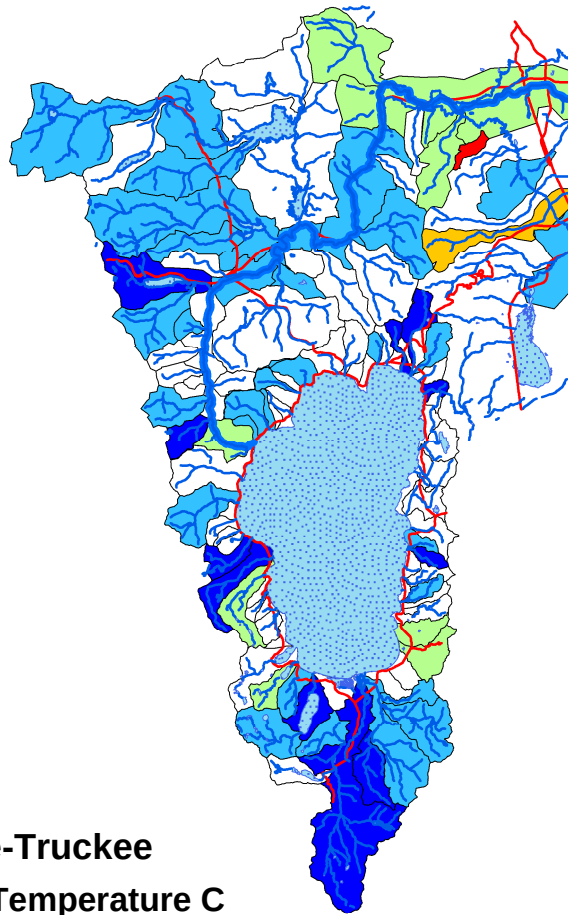
 14-Nov-2003
 Prepared by H. Segale

Temperature (C)

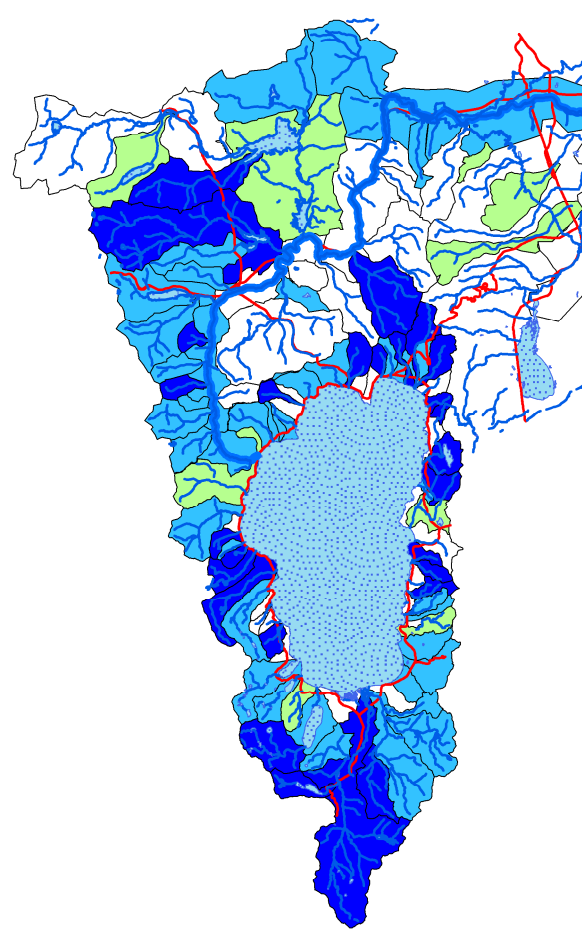
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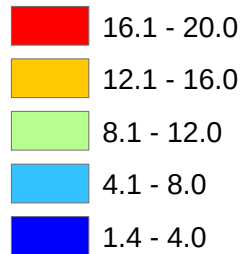
2002



2003



Tahoe-Truckee WaterTemperature C

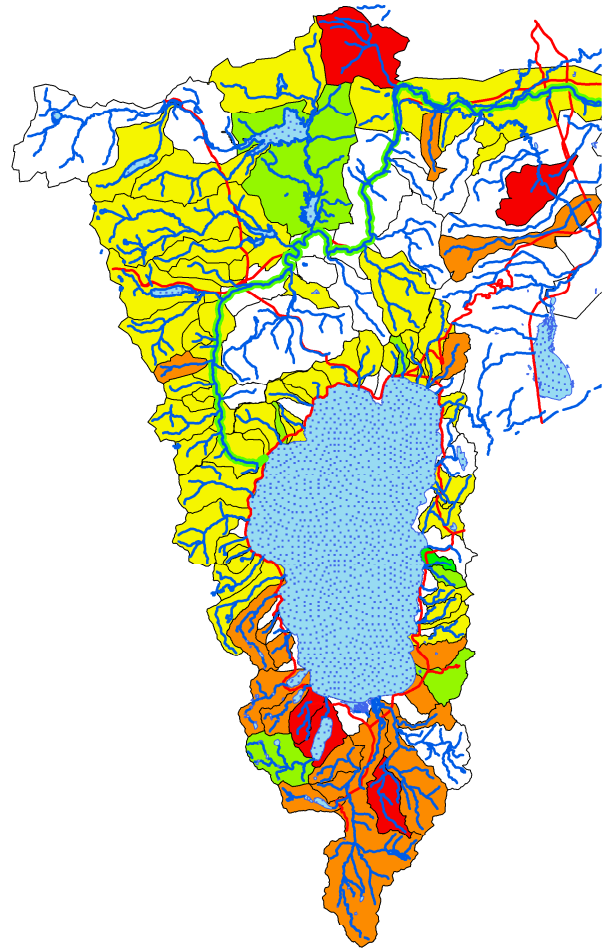
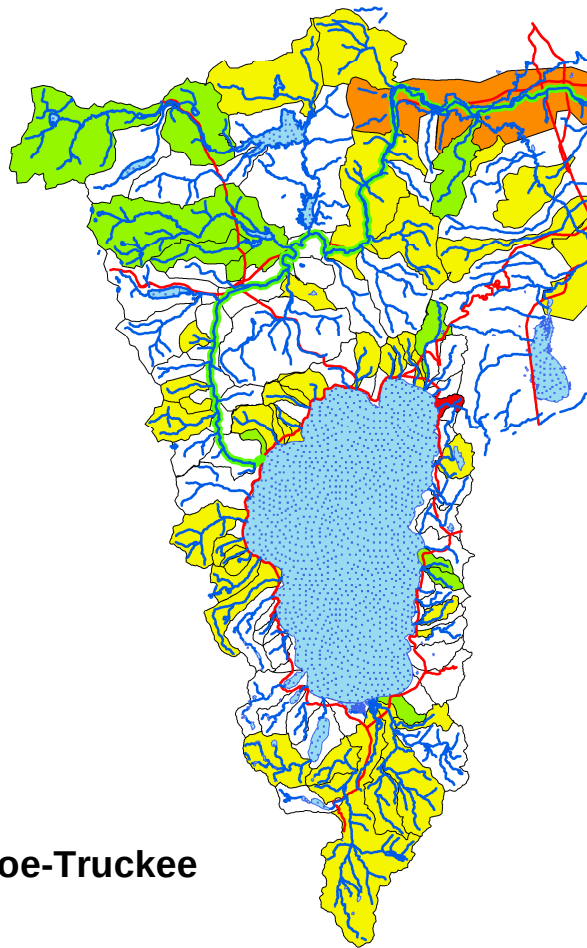
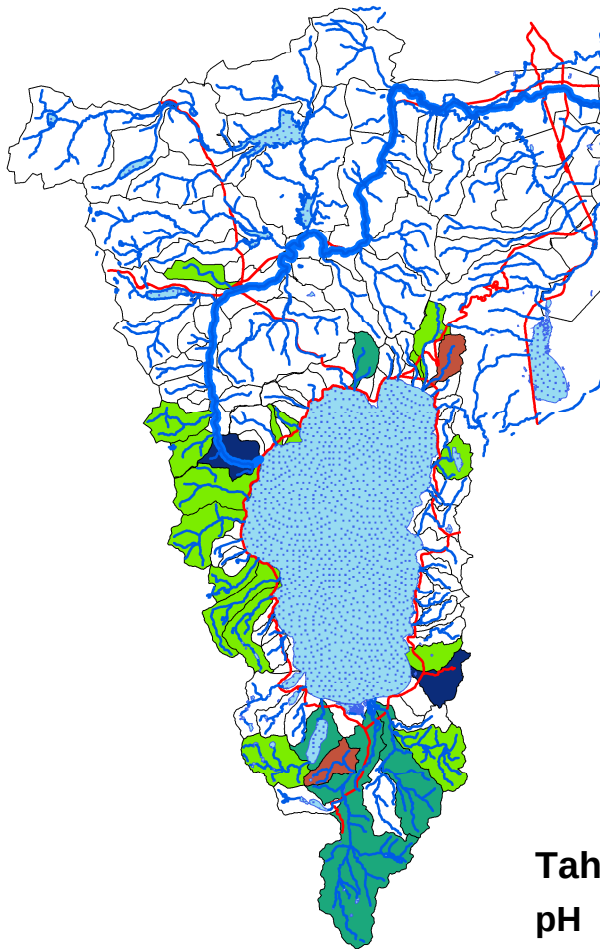


pH

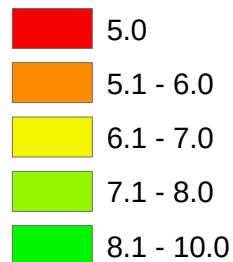
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**Tahoe-Truckee
pH**

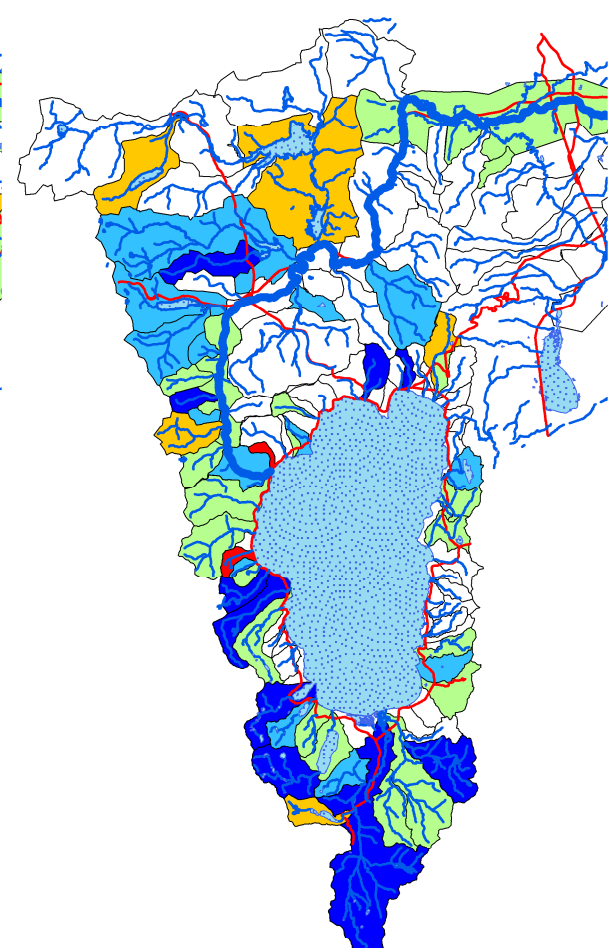
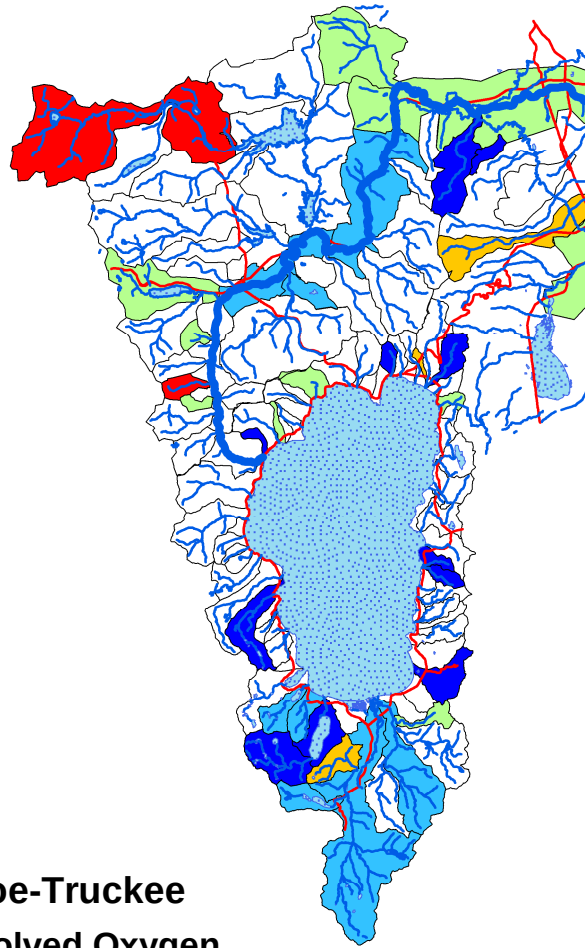
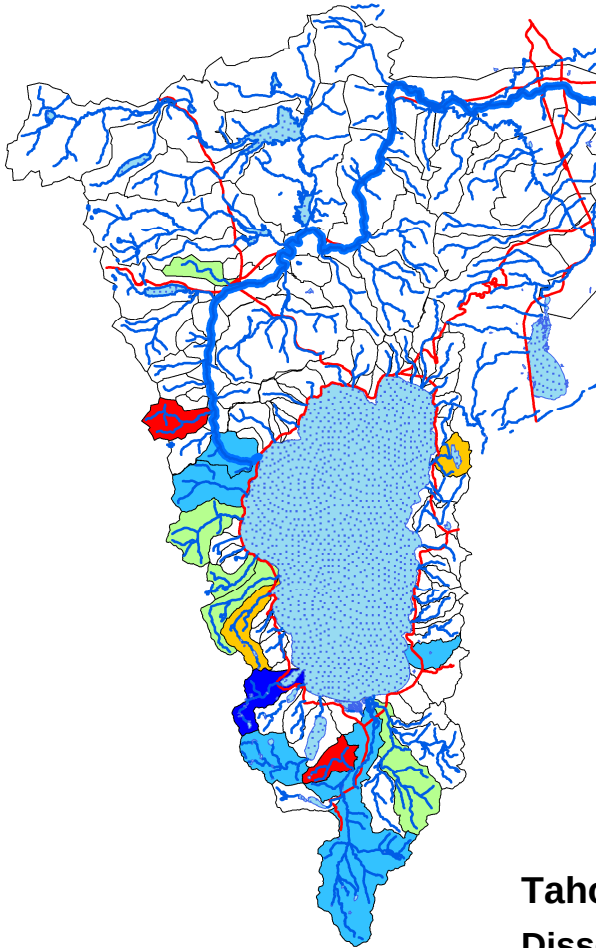


Dissolved Oxygen (DO)

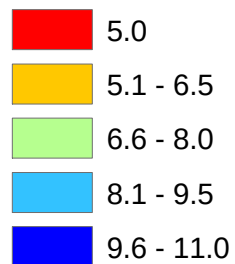
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Tahoe-Truckee Dissolved Oxygen

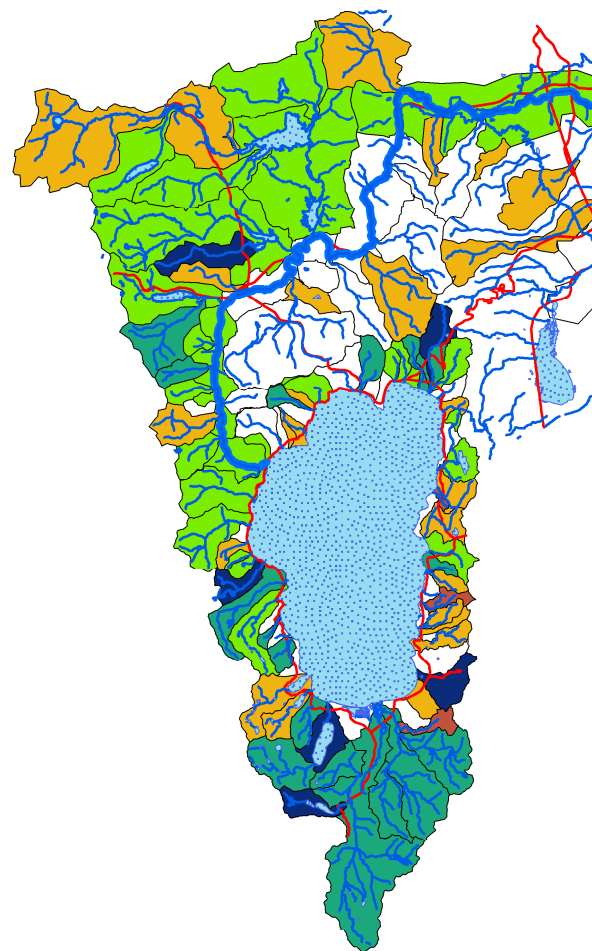
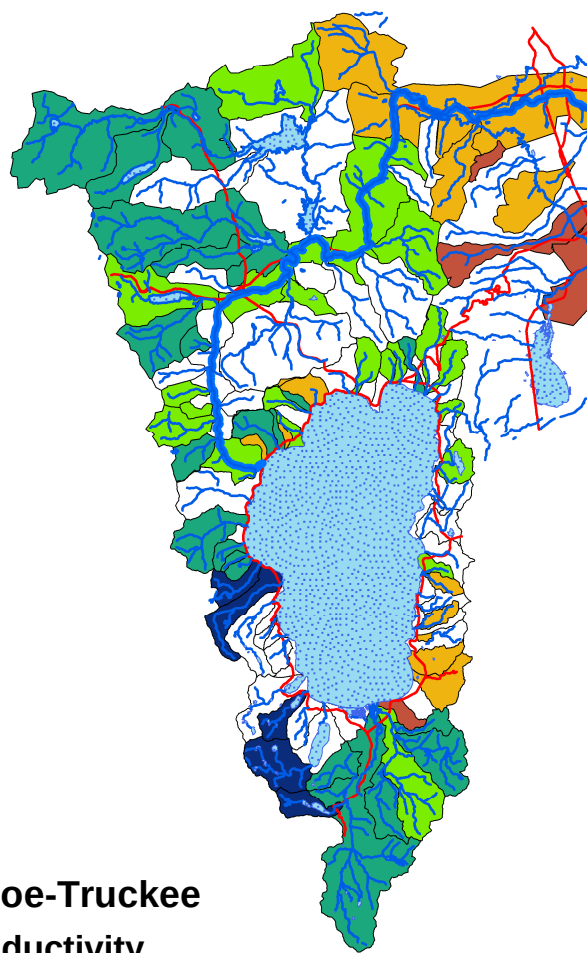
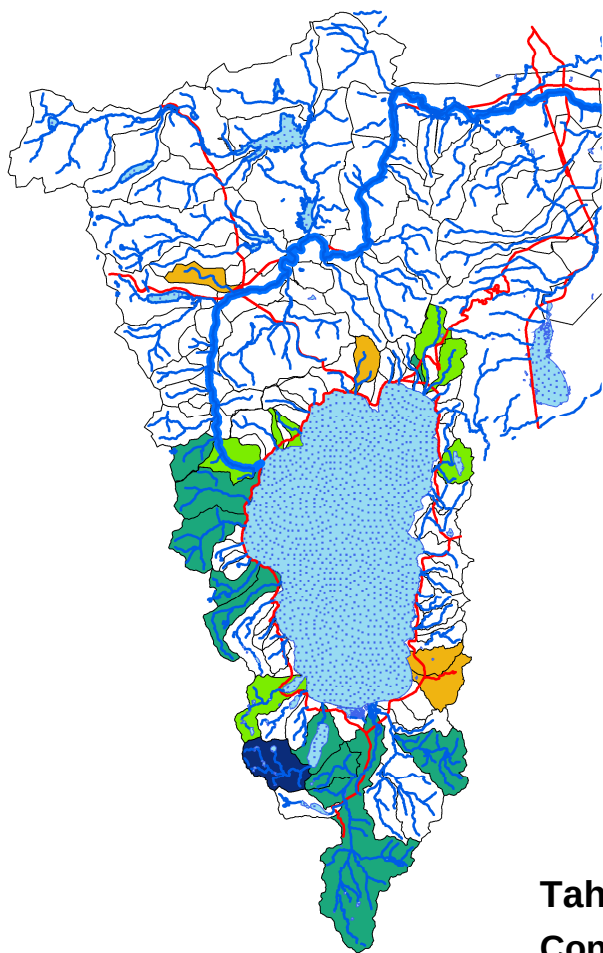


Conductivity-uS

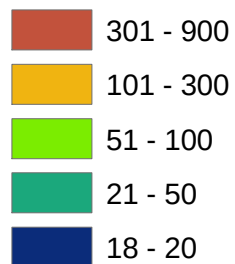
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Tahoe-Truckee Conductivity

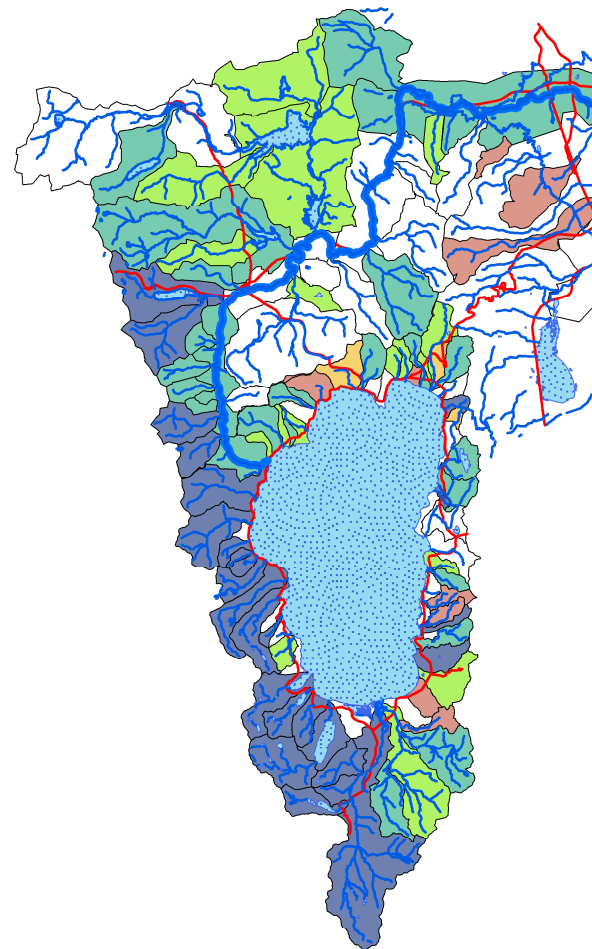
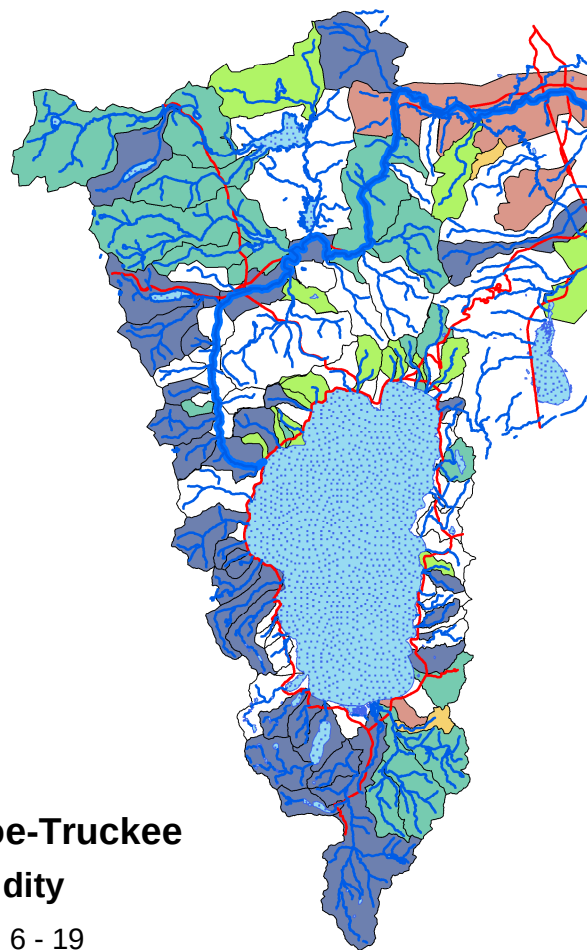
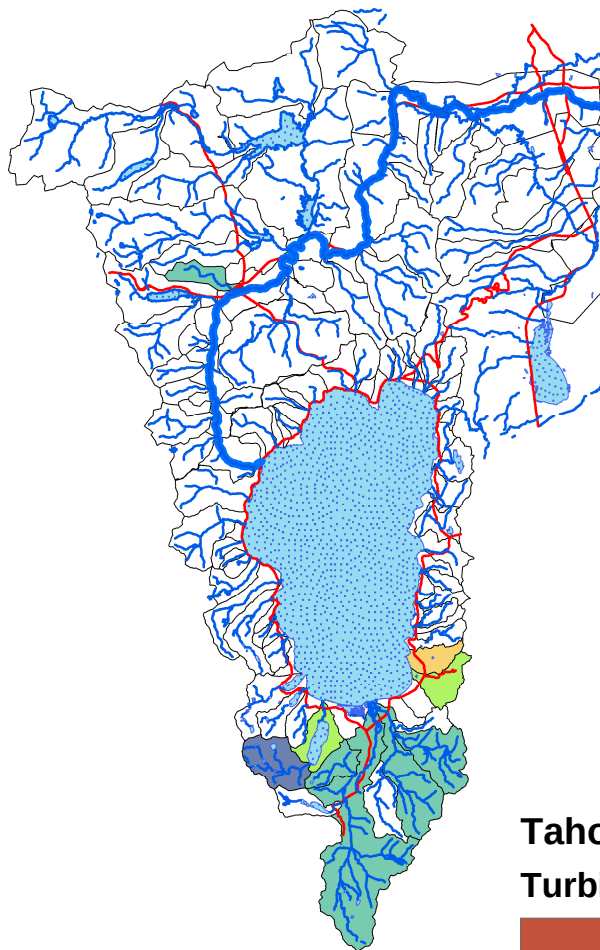


Turbidity (NTU)

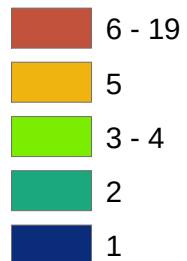
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Tahoe-Truckee Turbidity

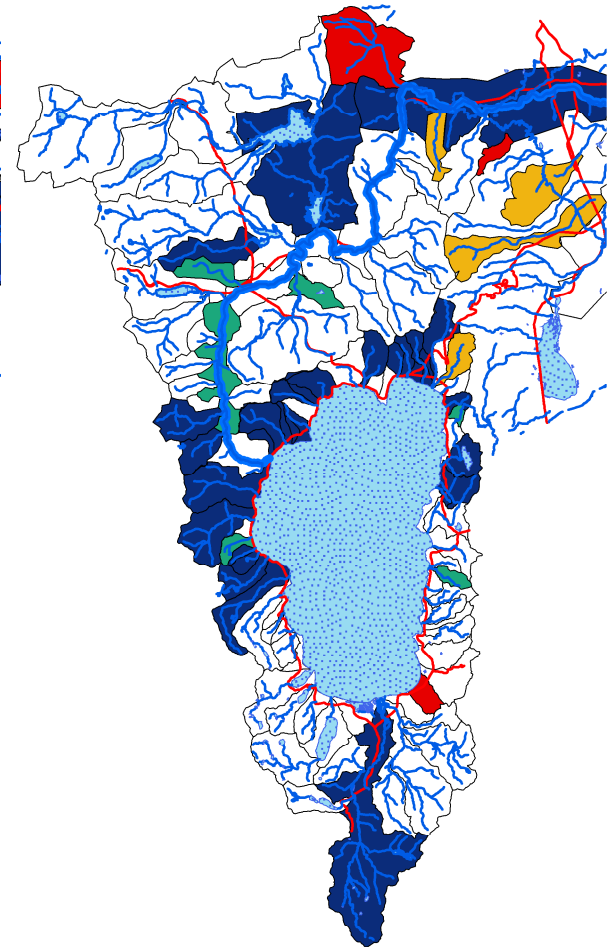
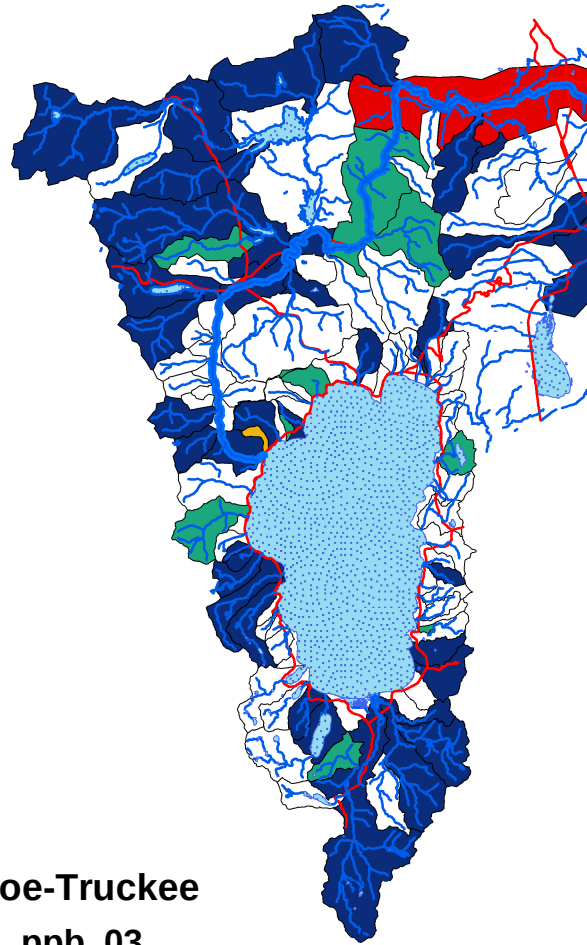
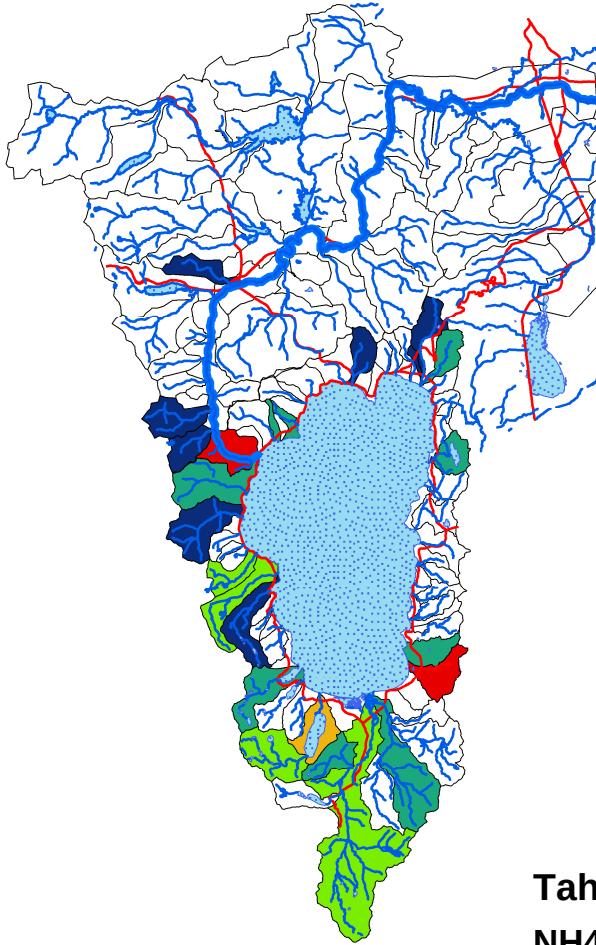


Ammonia (NH3) ppb

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Tahoe-Truckee NH4_ppb_03

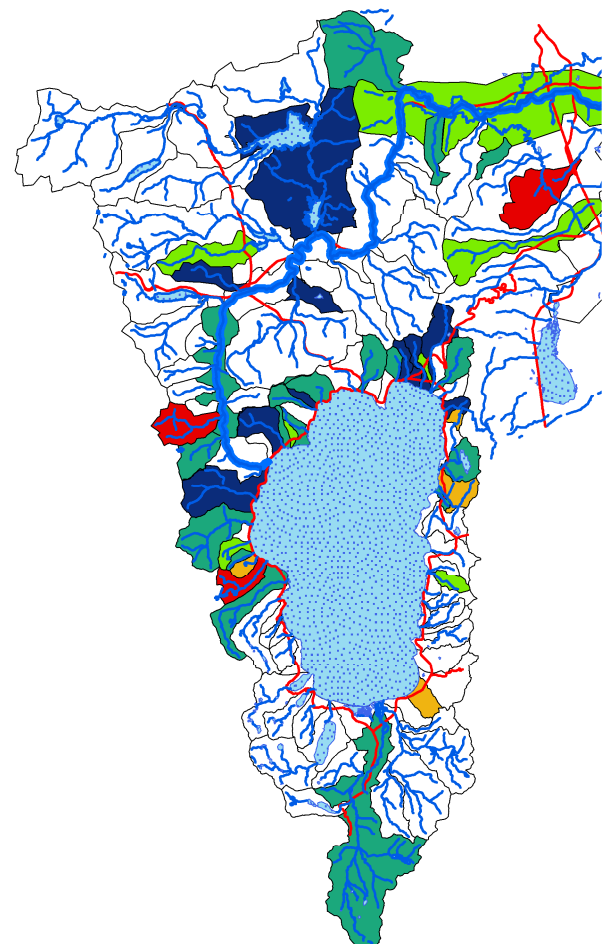
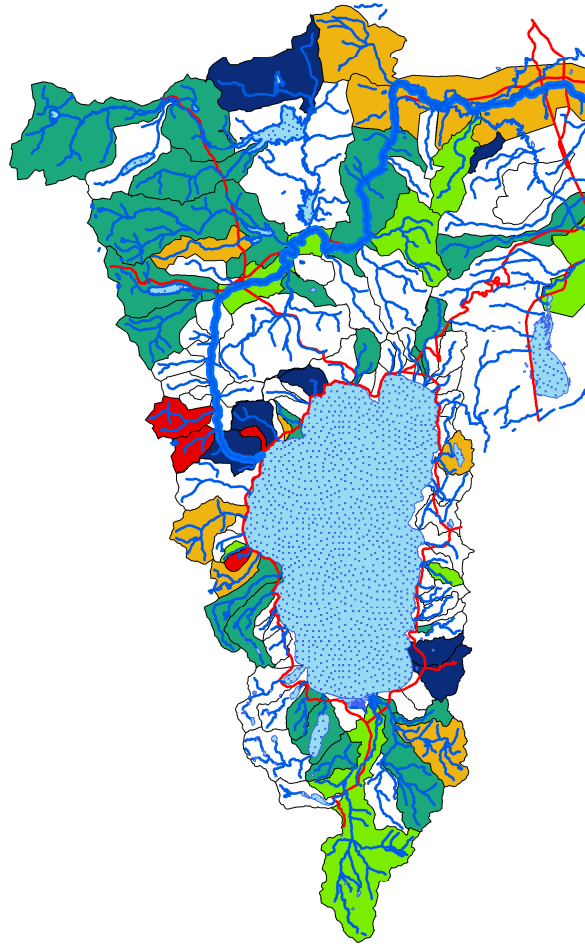
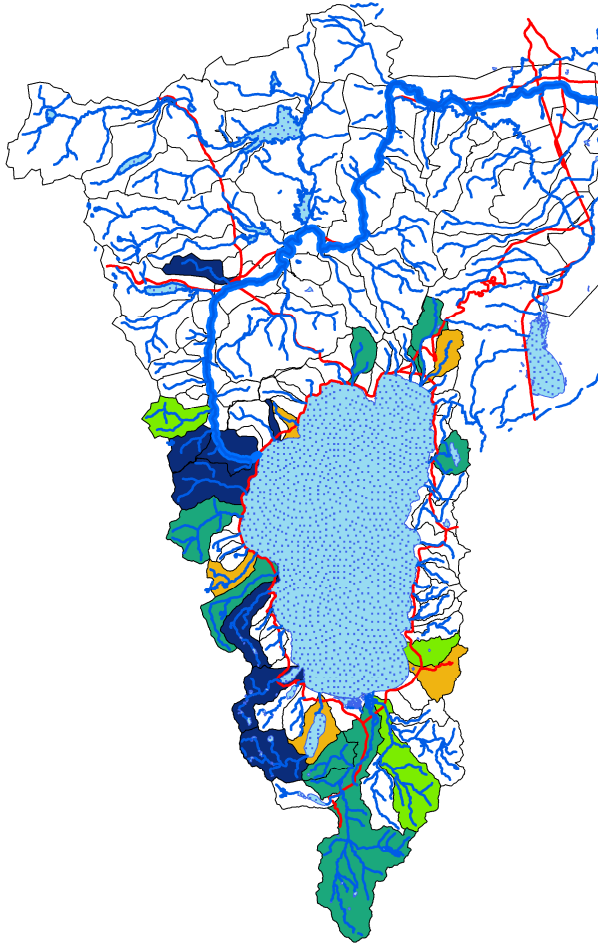


Nitrate (NO3)- ppb

2001

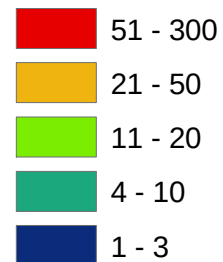
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Tahoe-Truckee

NO3_ppb_03

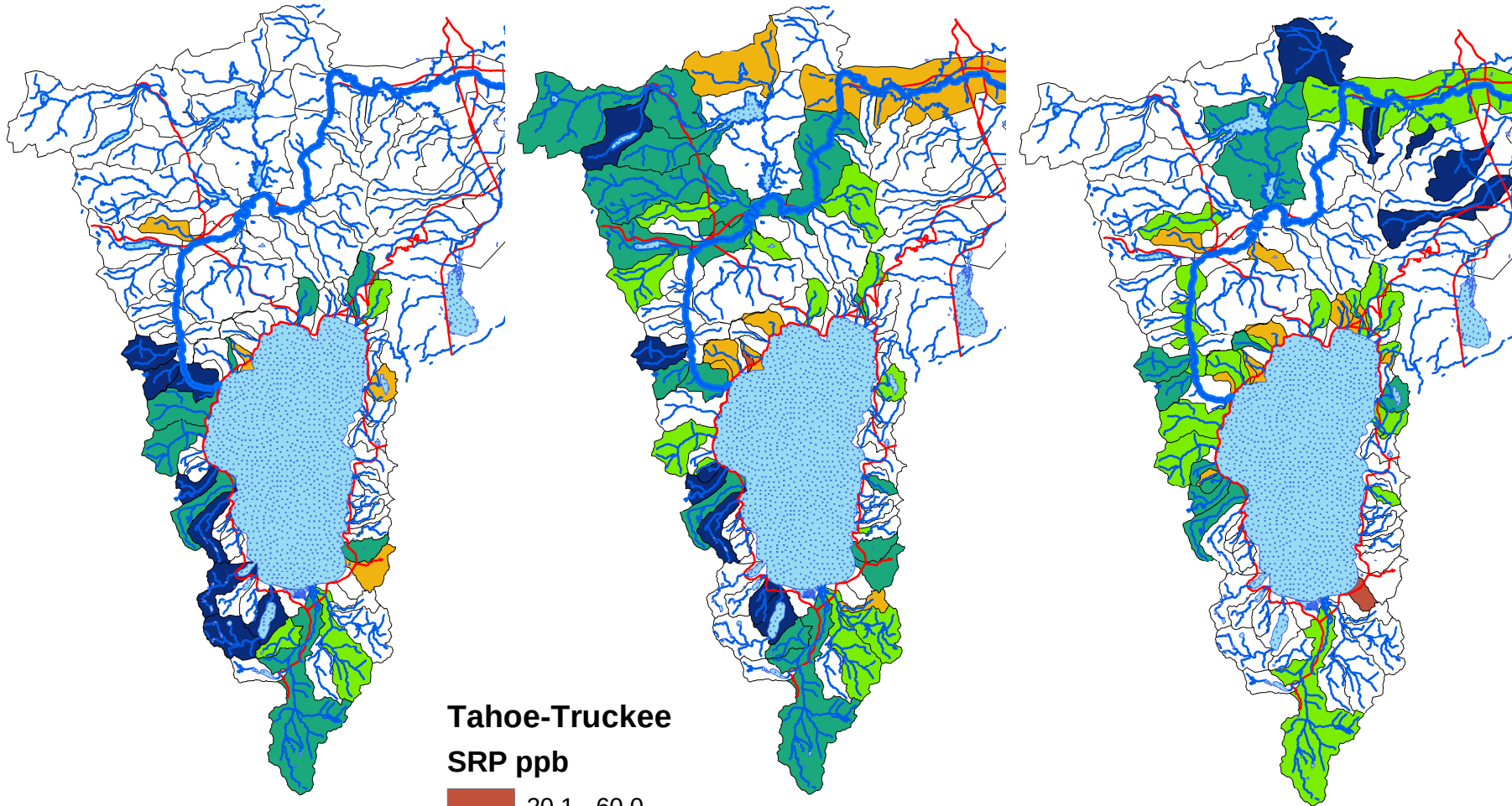


Soluble Reactive Phosphorus (PO₄) ppb

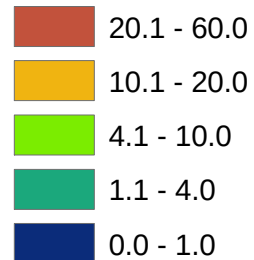
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Tahoe-Truckee SRP ppb

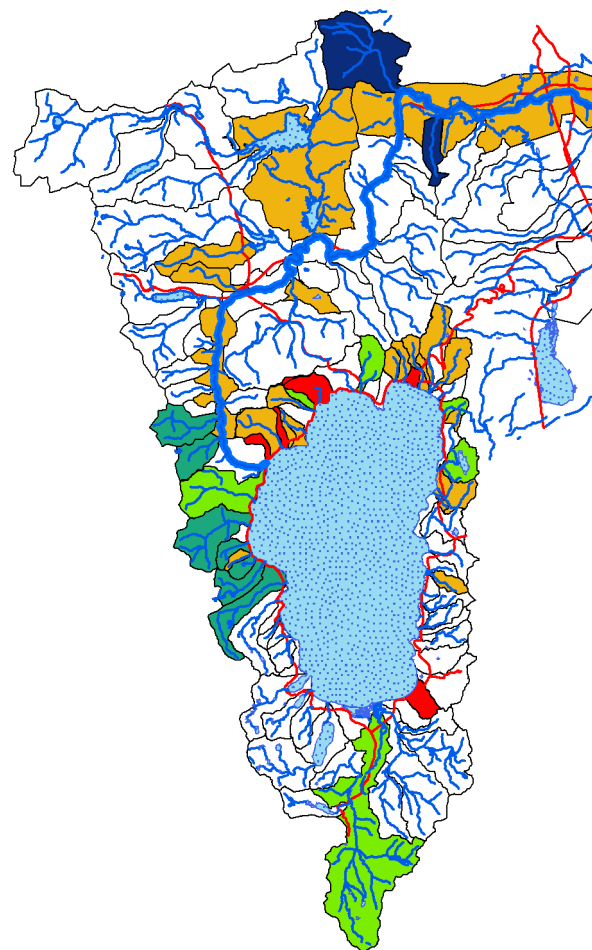
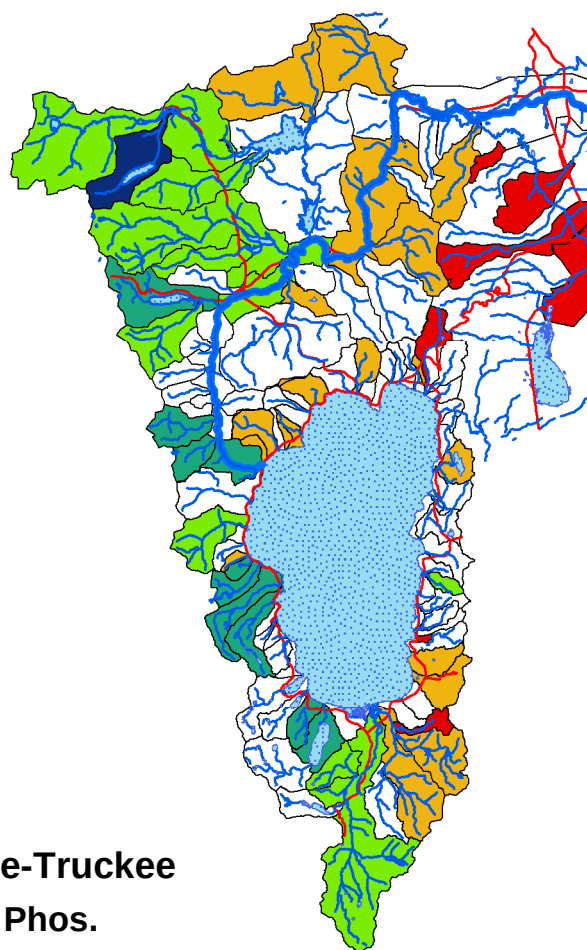
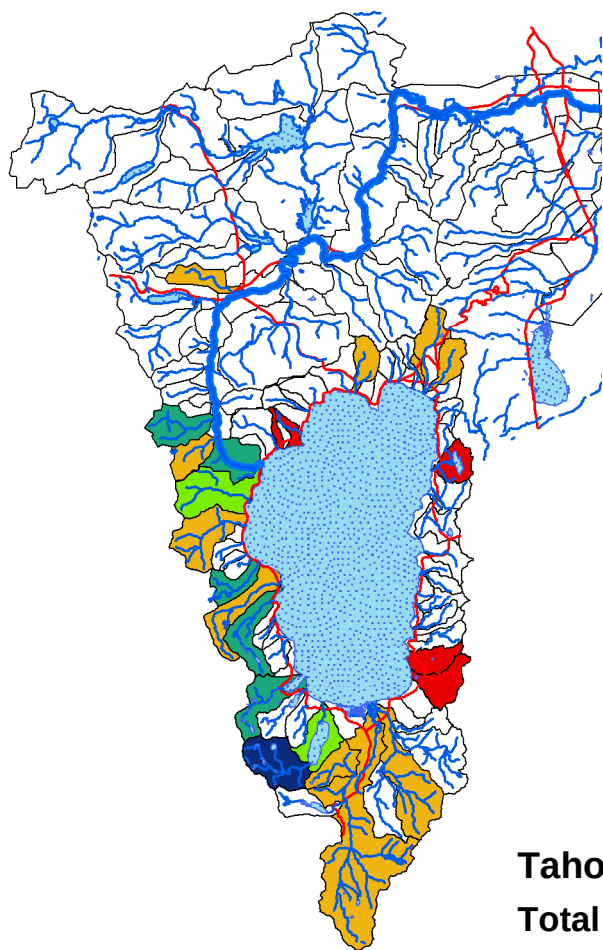


Total Phosphorus (TP)

2001

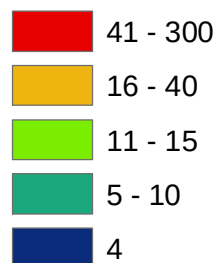
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Tahoe-Truckee

Total Phos.



Fecal Coliform (colony/100 ml)

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2003

