EXECUTIVE SUMMARY

Thank you for your continued hard work sampling **Pawtuckaway Lake, Nottingham** this year! Your monitoring group sampled the deep spot **five** times this year and has done so for many years. As you know, conducting multiple sampling events each year enables DES to more accurately detect water quality changes. Keep up the great work!

The New Hampshire Department of Environmental Services (DES), in conjunction with the U.S. Environmental Protection Agency (EPA) and the environmental consulting firm AECOM, conducted a Total Maximum Daily Load (TMDL) for total phosphorus for your lake. The TMDL refers to the pollutant reductions a waterbody needs to meet New Hampshire's water quality standards. Pawtuckaway Lake was listed on the 2008 impaired waters [303(d)] list because elevated algal growth impaired the primary contact recreation (swimming) use. Phosphorus is the nutrient responsible for algal growth and is the pollutant to be reduced to control algal growth. DES is required by the Federal Clean Water Act (CWA), Section 303(d), to report every two years to the EPA on all waters not meeting state water quality standards.

The TMDL conducted at your lake identified an in-lake target phosphorus value that, when met, should result in no additional primary contact recreation impairments due to algal growth. A phosphorus budget was constructed, phosphorus sources identified and phosphorus reductions allocated to each of the sources to meet the target value. An implementation plan provides recommendations on watershed remediation activities to reduce phosphorus inputs to the lake.

The draft TMDL will be provided to your lake association, town, and watershed stakeholders for review and will also be available on the DES website at www.des.nh.gov/organization/divisions/water/wmb/tmdl/index.htm. There will be a period for public review and comment, anticipated for Summer 2009, where DES and/or AECOM will present it's findings to interested stakeholders. We anticipate a TMDL informational session in conjunction with the annual VLAP Workshop scheduled for May 16, 2009. We encourage your lake association and/or residents to attend the workshop to learn more about TMDLs in general and the TMDL for your lake. Phosphorus load reductions can only occur with the knowledge, participation and action of watershed residents, businesses and stakeholders. If you are interested in participating in an informational session at the VLAP Workshop please contact the VLAP Coordinator at sara.steiner@des.nh.gov or 603-271-2658. If you are interested in learning more about the TMDL Program, or attending additional informational sessions, please contact Peg Foss, TMDL Coordinator, at Margaret.foss@des.nh.gov or 603-271-5448.

Prior to receiving the TMDL recommendations and development of an implementation plan, the Pawtuckaway Advisory Committee, Pawtuckaway

Lake Improvement Association and the Town of Nottingham have taken proactive steps in addressing watershed phosphorus loading.

As a result of phosphorus loading from tributaries and watershed runoff, algal blooms and more specifically Cyanobacteria blooms have become increasingly more frequent in recent years. Cyanobacteria blooms have led to Pawtuckaway Lake as being impaired and not meeting state water quality standards.

To reduce algal blooms and eliminate Cyanobacteria blooms, phosphorus loading as a result of watershed runoff must be prioritized and addressed. In 2006, the Town of Nottingham, with support of the Pawtuckaway Advisory Committee and Pawtuckaway Lake Improvement Association received a DES local watershed initiative grant to assist with this process. Pollutant load allocation will occur through the development of a watershed based plan. In addition, several shoreline properties will be selected for landscape best management practice (BMP) design and implementation targeted at reducing stormwater runoff rates and volumes through storage and infiltration. GeoSyntec, Inc. was selected by DES to assist with development of the watershed based plan and BMP design. The Town of Nottingham has offered time and materials assistance to construct the BMPs.

Landscape BMPs will likely include native vegetation buffer plantings, stream bank stabilization, vegetated swales along lake roads, and stormwater detention/infiltration areas within the watershed. A byproduct of this will be sediment load and therefore phosphorus load reductions.

In addition to the watershed based plan and BMP design and implementation, the Town will lead an educational outreach campaign targeting landowners within the watershed about their individual impact on the watershed, stormwater runoff and the lake. Education will be accomplished through development and distribution of a Waterfront and Watershed property owner's brochure.

BMP recommendations for 12 sites were provided. A combination of Best Management Practices (BMPs) including stormwater diversion, velocity reduction, and infiltration, along with stabilizing road ditches with stone or erosion control matting were considered.

In 2008, PLAC, GeoSyntec, Inc. and the Town of Nottingham finalized site selection for stormwater improvements. Two sites, Barderry Lane and Tuckaway Shores were selected for final design and construction. Improvements include road shoulder and ditchline stabilization, bioretention, and level spreaders for stormwater energy dissipation. Construction is anticipated for October, 2008.

A Weed Watcher training was conducted at Pawtuckaway Lake during **2008**. Volunteers were trained to survey the lake once a month from **May** through **September**. To survey, volunteers slowly boat, or even snorkel, around the perimeter of the lake and any islands it may contain. Using the materials provided in the Weed Watcher kit, volunteers look for any species that are suspicious. After a trip or two around the lake, volunteers will have a good knowledge of its plant community and will immediately notice even the most subtle changes. If a suspicious plant is found, the volunteers immediately send a specimen to DES for identification. If the plant specimen is an exotic species, a biologist will visit the site to determine the extent of the problem and to formulate a management plan to control the nuisance infestation. Remember that early detection is the key to controlling the spread of exotic plants.

Volunteers from your lake also participated in the Lake Host™ Program this year. The Lake Host™ Program is funded through DES and Federal grants. The program was developed in 2002 by NH LAKES and NHDES to educate and prevent boaters from spreading exotic aquatic plants to lakes and ponds in New Hampshire. Since then, the number of participating lakes and ponds and volunteers has doubled, the number of boats inspected has tripled, and the number of "saves" (exotic plants discovered) has increased from four in 2002 to a total of 224 in 2008. The program is invaluable in educating boaters and protecting NH's waterbodies from exotic aquatic plant infestations, thereby preventing recreational hazards, property value decline, aquatic ecosystem decline, aesthetic issues, and saving costly remediation efforts. Lake Host™ staff made **two** "saves" at your lake and discovered the following aquatic vegetation entering or leaving your lake in 2008:

Native milfoil (native)
Variable milfoil (exotic)
Bladderwort (native)
Grassy spike rush (native)
Aquatic moss (native)
Water Chestnut (exotic)

Great work! We encourage volunteers to continue participating in the Lake Host™ Program to protect the future of your lake.

OBSERVATIONS & RECOMMENDATIONS

DEEP SPOT

➢ Chlorophyll-a

Chlorophyll-a, a pigment found in plants, is an indicator of algal or cyanobacteria abundance. Algae are typically microscopic plants that are naturally found in the lake ecosystem. The measurement of chlorophyll-a in the water gives biologists an estimation of the algal concentration or lake productivity. Table 14 in Appendix A lists the current year chlorophyll-a data.

Figure 1 depicts the historical and current year chlorophyll-a concentration in the water column.

The median summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 4.58 mg/m^3.

NORTH STATION
The current year data (the top graph) show that the chlorophyll-a concentration ***increased*** from **May** to **August**, and then ***decreased*** from **August** to **September**.

The historical data (the bottom graph) show that the **2008** chlorophyll-a mean is ***slightly greater than*** the state and similar lake medians. For more information on the similar lake median, refer to Appendix D.

Overall, visual inspection of the historical data trend line (the bottom graph) shows an ***increasing*** in-lake chlorophyll-a trend since monitoring began. Specifically the mean chlorophyll concentration has ***worsened*** since **1988**.

SOUTH STATION
The current year data (the top graph) show that the chlorophyll-a concentration ***increased*** from **May** to **August**, and then ***decreased*** from **August** to **September**. Chlorophyll-a concentrations were ***elevated*** in **August (11.6 mg/m^3)**. Typically, chlorophyll-a concentrations above **15 mg/m^3** are indicative of an algal bloom.

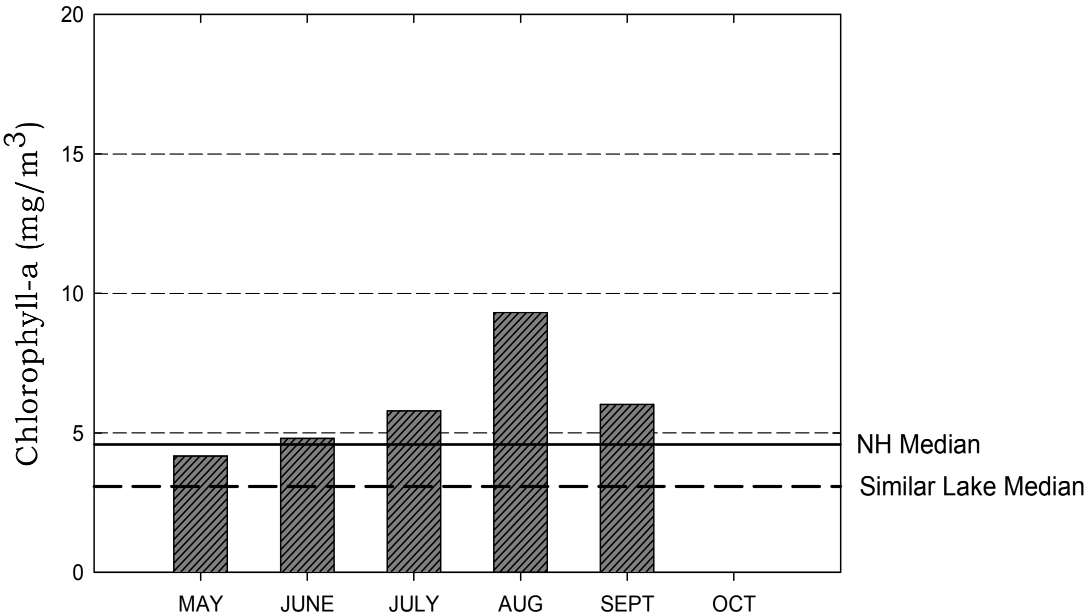
The historical data (the bottom graph) show that the **2008** chlorophyll-a mean is ***slightly greater than*** the state and similar lake medians. For more information on the similar lake median, refer to Appendix D.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a ***variable*** in-lake chlorophyll-a trend since monitoring began. Specifically the mean chlorophyll concentration has ***fluctuated between approximately 3.01 and 10.63 mg/m^3*** since **1992**.

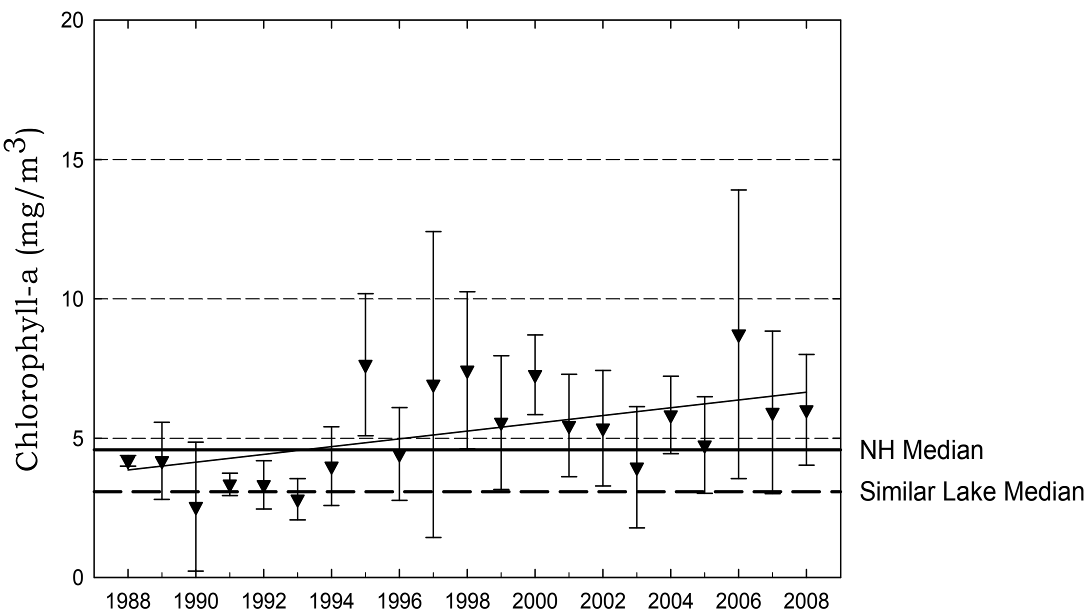
While algae are naturally present in all waterbodies, an excessive or increasing amount of any type is not welcomed. Phosphorus is the nutrient that algae typically depend upon for growth in New Hampshire lakes and ponds. Algal concentrations increase as nonpoint sources of phosphorus from the watershed increase, or as in-lake phosphorus sources increase. Increased Chlorophyll-a concentrations can also affect water clarity, causing Secchi-disk transparency to decrease (worsen) and turbidity to increase (worsen).
Therefore, it is extremely important for volunteer monitors to continually educate all watershed residents about management practices that can be implemented to minimize phosphorus loading to surface waters.

Pawtuckaway Lake, North Stn., Nottingham

Figure 1. Monthly and Historical Chlorophyll-a Results



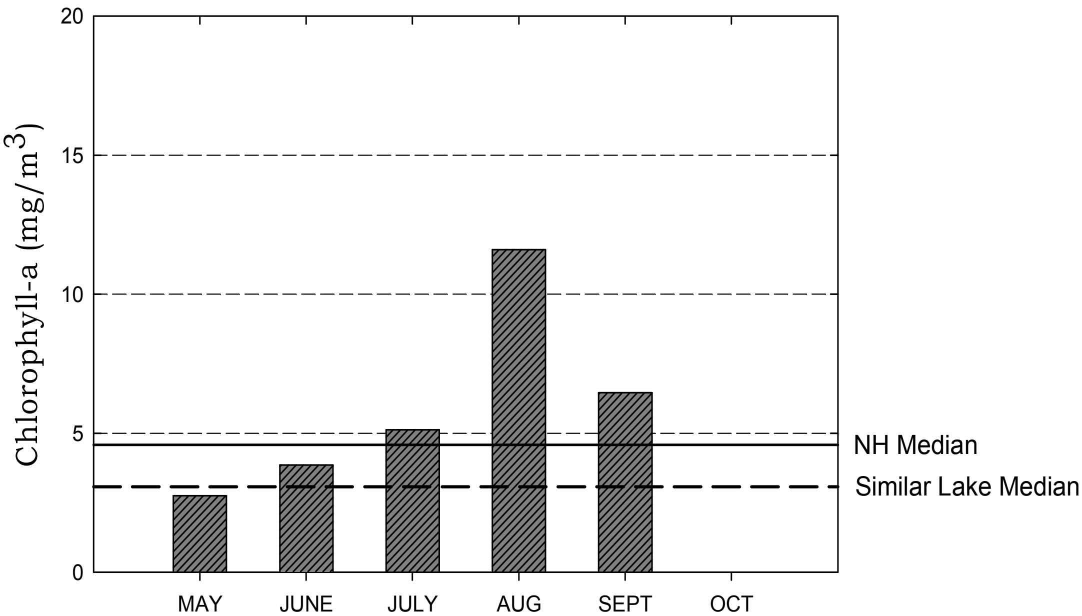
2008 Chlorophyll-a Results



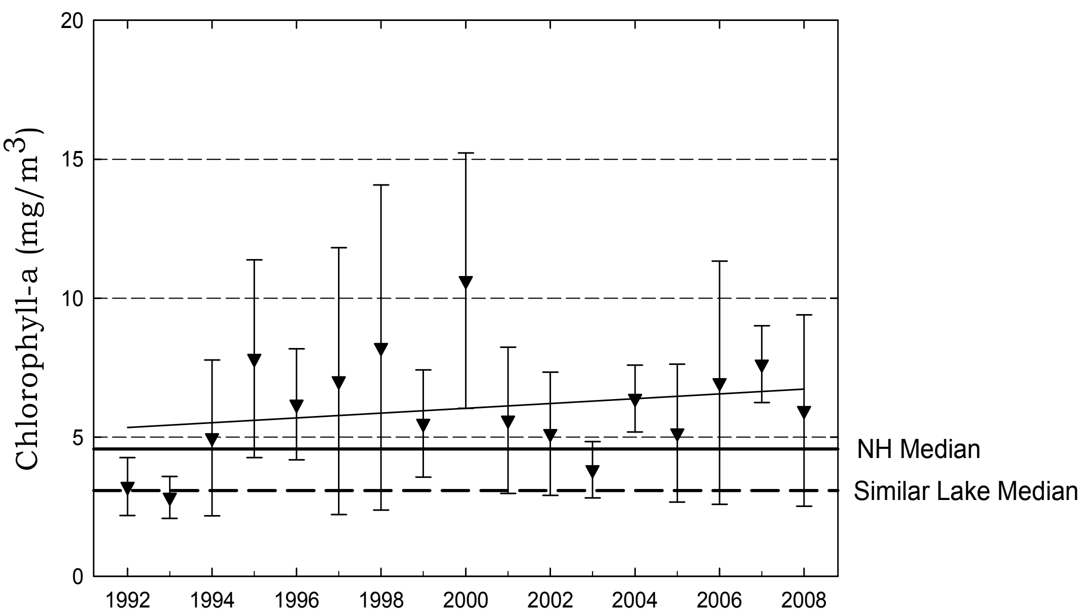
Historical Chlorophyll-a Results

Pawtuckaway Lake, South Stn., Nottingham

Figure 1. Monthly and Historical Chlorophyll-a Results



2008 Chlorophyll-a Results



Historical Chlorophyll-a Results

➢ Phytoplankton and Cyanobacteria

Table 1 lists the phytoplankton (algae) and/or cyanobacteria observed in the pond in **2008**. Specifically, this table lists the three most dominant phytoplankton and/or cyanobacteria observed and their relative dominance in the sample.

Table 1. Dominant Phytoplankton/Cyanobacteria (July 2008)

Station	Division	Genus	% Dominance
North	Pyrrophyta	Ceratium	30.7
North	Cyanophyta	Anabaena	23.4
North	Chrysophyta	Dinobryon	14.5
South	Chrysophyta	Dinobryon	25.3
South	Chlorophyta	Staurastrum	21.7
South	Pyrrophyta	Ceratium	13.7

Phytoplankton populations undergo a natural succession during the growing season. Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession. Diatoms and golden-brown algae populations are typical in New Hampshire's less productive lakes and ponds.

A moderate amount of the cyanobacterium ***Anabaena*** was observed in the **July** plankton sample at the **North Station**. ***This cyanobactieria, if present in large amounts, can be toxic to livestock, wildlife, pets, and humans.*** Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding cyanobacteria.

Cyanobacteria can reach nuisance levels when phosphorus loading from the watershed to surface waters is increased and favorable environmental conditions occur, such as a period of sunny, warm weather.

The presence of cyanobacteria serves as a reminder of the pond's delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading to the pond by eliminating fertilizer use on lawns, keeping the pond shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

In addition, residents should also observe the pond in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to "pile" cyanobacteria into scums that accumulate in one section of the pond. If a fall bloom occurs, please collect a sample in any clean jar or bottle and contact the VLAP Coordinator.

➢ Secchi Disk Transparency

Volunteer monitors use the Secchi disk, a 20 cm disk with alternating black and white quadrants, to measure how far a person can see into the water. Transparency, a measure of water clarity, can be affected by the amount of algae and sediment in the water, as well as the natural color of the water. Table 14 in Appendix A lists the current year transparency data. **The median summer transparency for New Hampshire's lakes and ponds is 3.2 meters.**

Figure 2 depicts the historical and current year transparency ***with and without*** the use of a viewscope.

NORTH STATION
The current year ***non-viewscope*** in-lake transparency ***increased*** from **May** to **June**, and then ***decreased gradually*** from **June** to **September**.

The current year ***viewscope*** in-lake transparency ***decreased gradually*** from **June** to **September**.

The transparency measured with the viewscope was generally ***greater than*** the transparency measured without the viewscope this summer. As discussed previously, a comparison of the transparency readings taken with and without the use of a viewscope shows that the viewscope typically increases the depth to which the Secchi disk can be seen into the lake, particularly on sunny and windy days. We recommend that your group measure Secchi disk transparency with and without the viewscope on each sampling event.

It is important to note that viewscope transparency data are not compared to a New Hampshire median or similar lake median. This is because lake transparency with the use of a viewscope has not been historically measured by DES. In the future, the New Hampshire and similar lake medians for viewscope transparency will be calculated and added to the appropriate graphs.

The historical data (the bottom graph) show that the **2008** mean non-viewscope transparency is ***approximately equal to*** the state median and is ***much less than*** the similar lake median. Please refer to Appendix D for more information about the similar lake median.

Visual inspection of the historical data trend line (the bottom graph) shows a ***decreasing*** trend, meaning that the transparency has ***worsened*** since monitoring began in **1988**.

SOUTH STATION
The current year ***non-viewscope*** in-lake transparency ***increased slightly*** from **May** to **July**, and then ***decreased gradually*** from **July** to **September**.

The current year ***viewscope*** in-lake transparency ***decreased gradually*** from **June** to **September**.

The transparency measured with the viewscope was generally ***greater than*** the transparency measured without the viewscope this summer. As discussed previously, a comparison of the transparency readings taken with and without the use of a viewscope shows that the viewscope typically increases the depth to which the Secchi disk can be seen into the lake, particularly on sunny and windy days. We recommend that your group measure Secchi disk transparency with and without the viewscope on each sampling event.

It is important to note that viewscope transparency data are not compared to a New Hampshire median or similar lake median. This is because lake transparency with the use of a viewscope has not been historically measured by DES. In the future, the New Hampshire and similar lake medians for viewscope transparency will be calculated and added to the appropriate graphs.

The historical data (the bottom graph) show that the **2008** mean non-viewscope transparency is ***slightly greater than*** the state median and is ***much less than*** the similar lake median. Please refer to Appendix D for more information about the similar lake median.

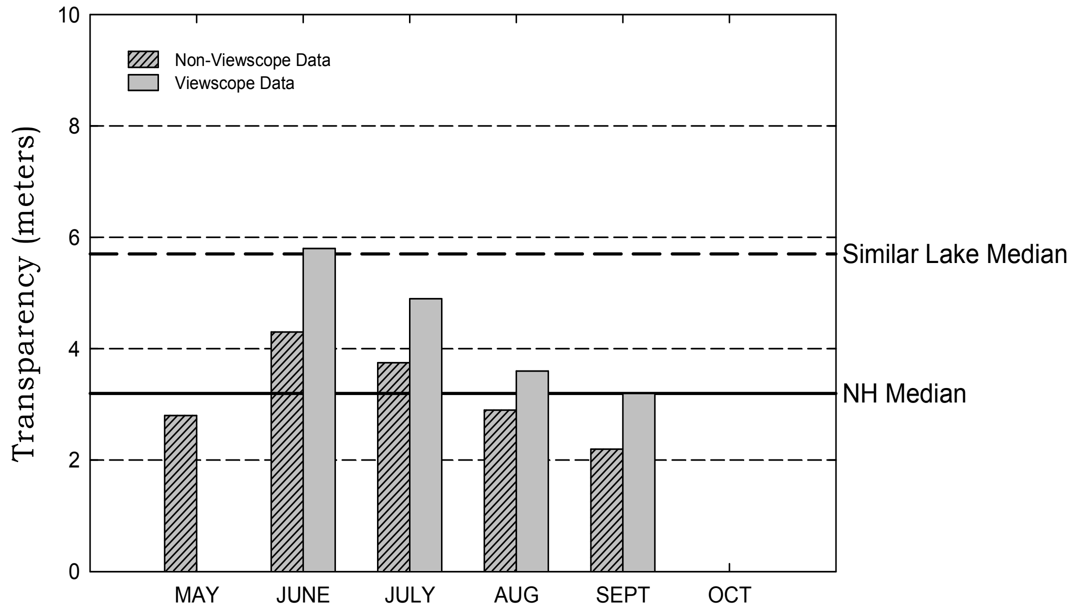
Visual inspection of the historical data trend line (the bottom graph) shows a ***relatively stable*** trend. Specifically, the mean transparency has remained ***relatively stable, ranging between 2.72 and 4.14 meters*** since **1992**.

Typically, high intensity rainfall causes sediment-laden stormwater runoff to flow into surface waters, thus increasing turbidity and decreasing clarity. Efforts should continually be made to stabilize stream banks, pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the pond. Guides to best management practices that can be implemented to reduce, and possibly even eliminate, nonpoint source pollutants, are available from DES upon request.

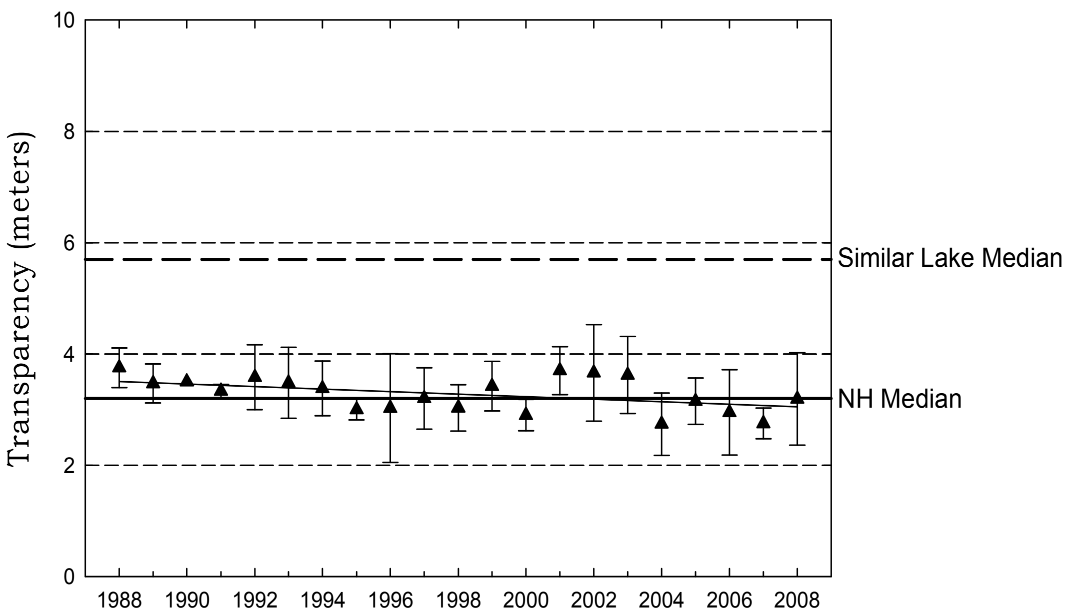
We recommend that your group continue to measure the transparency with and without the use of the viewscope on each sampling event. Ultimately, we would like all monitoring groups to use a viewscope to take Secchi disk readings as the use of the viewscope results in less variability in transparency readings between monitors and sampling events. At some point in the future, when we have sufficient data to determine a statistical relationship between transparency readings collected with and without the use of a viewscope, it may only be necessary to collect transparency readings with the use of a viewscope.

Pawtuckaway Lake, North Stn., Nottingham

Figure 2. Monthly and Historical Transparency Results



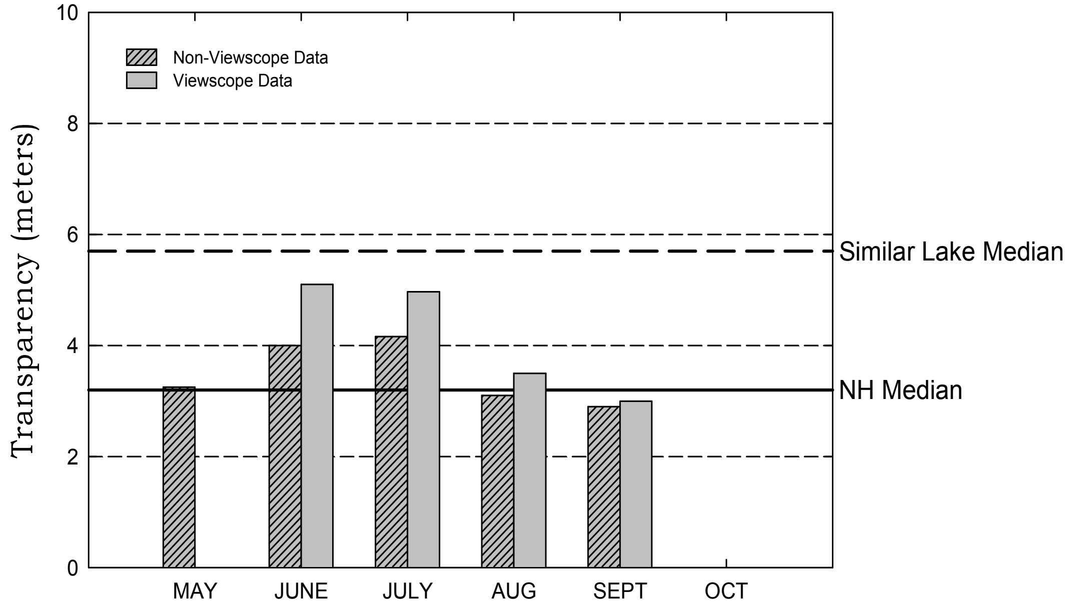
2008 Transparency Viewscope and Non-Viewscope Results



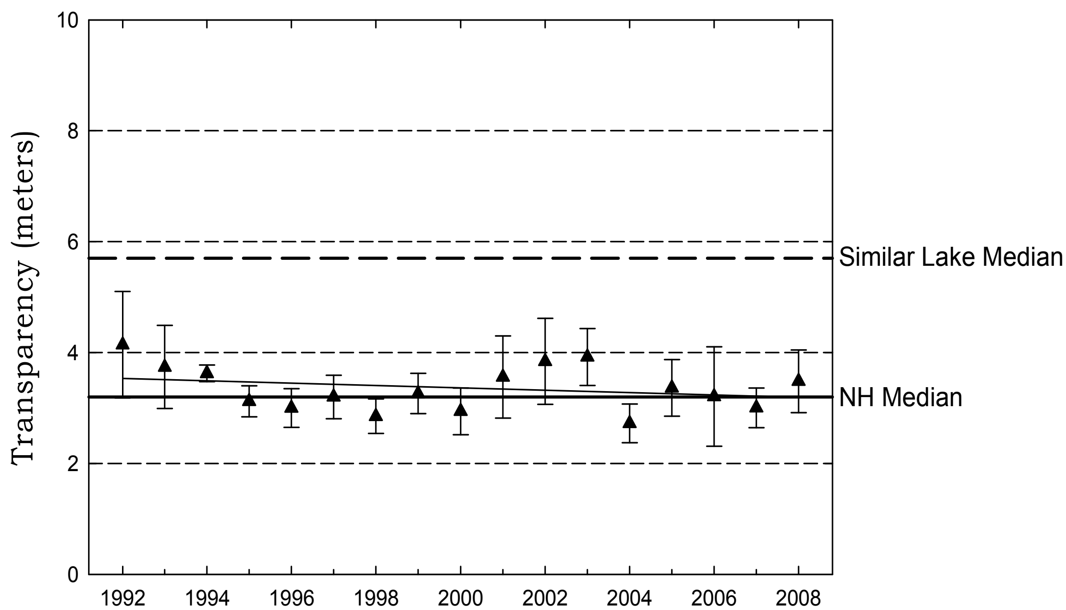
Historical Transparency Non-Viewscope Results

Pawtuckaway Lake, South Stn., Nottingham

Figure 2. Monthly and Historical Transparency Results



2008 Transparency Viewscope and Non-Viewscope Results



Historical Transparency Non-Viewscope Results

➢ Total Phosphorus

Phosphorus is typically the limiting nutrient for vascular plant and algae growth in New Hampshire's lakes and ponds. Excessive phosphorus in a pond can lead to increased plant and algal growth over time. Table 14 in Appendix A lists the current year total phosphorus data for in-lake and tributary stations. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 12 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

The graphs in Figure 3 depict the historical amount of epilimnetic (upper layer) and hypolimnetic (lower layer) total phosphorus concentrations; the inset graphs depict current year total phosphorus data.

NORTH STATION
The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***decreased*** from **May** to **June**, ***increased*** from **June** to **August**, and then ***decreased*** from **August** to **September**.

The historical data show that the **2008** mean epilimnetic phosphorus concentration is ***slightly less than*** the state median and is ***slightly greater than*** the similar lake median. Refer to Appendix D for more information about the similar lake median.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***increased greatly*** from **May** to **September**.

The hypolimnetic (lower layer) turbidity samples were ***elevated*** on the **July, August and September** sampling events (**8.26, 10.9 and 8.62 NTUs**). This suggests that the lake bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling and/or that the ***lake bottom is covered by an easily disturbed thick organic layer of sediment***. When the lake bottom is disturbed, phosphorus rich sediment is released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

The historical data show that the **2008** mean hypolimnetic phosphorus concentration is ***much greater than*** the state and similar lake medians. Please refer to Appendix D for more information about the similar lake median.

Overall, visual inspection of the historical data trend line for the epilimnion and hypolimnion shows an ***increasing*** phosphorus trend since monitoring began. Specifically the mean annual epilimnetic and hypolimnetic phosphorus concentration has ***worsened*** since monitoring began in **1989**.

SOUTH STATION
The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***decreased*** from **May** to **June**, and then ***increased gradually*** from **June** to **September**.

The historical data show that the **2008** mean epilimnetic phosphorus concentration is ***slightly less than*** the state median and is ***slightly greater than*** the similar lake median. Refer to Appendix D for more information about the similar lake median.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***remained stable*** from **May** to **June**, ***decreased slightly*** from **June** to **July**, ***increased*** from **July** to **August**, and then ***decreased*** from **August** to **September**.

The hypolimnetic (lower layer) turbidity sample was ***slightly elevated*** on the **August** sampling event (**3.02 NTUs**). This suggests that the lake bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling and/or that the lake bottom is covered by an easily disturbed thick organic layer of sediment. When the lake bottom is disturbed, phosphorus rich sediment is released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

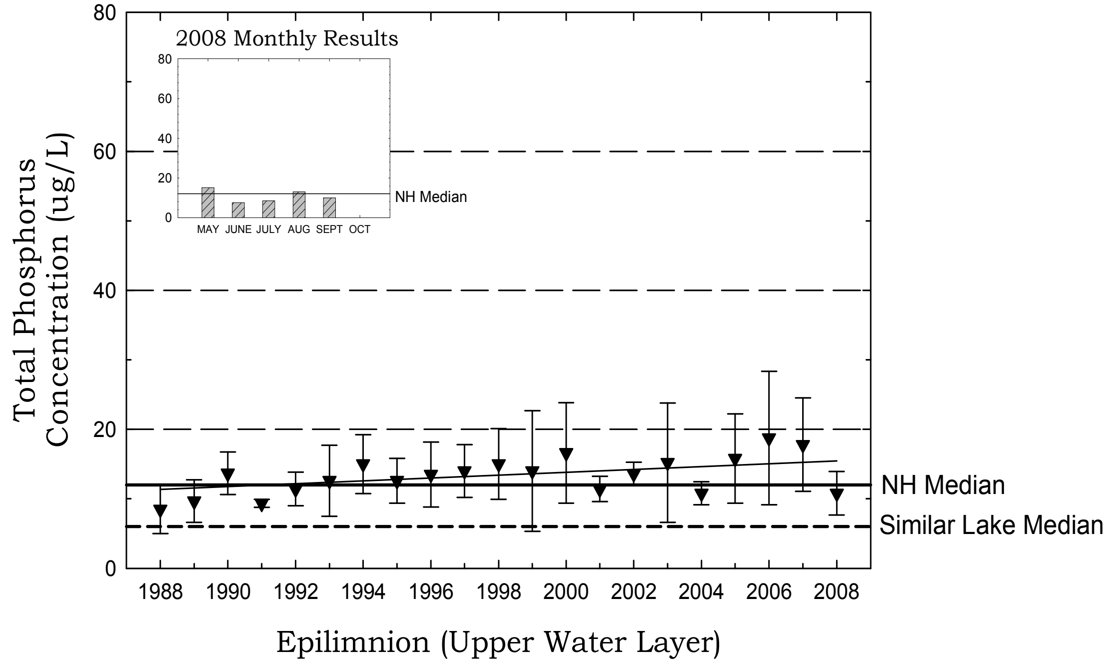
The historical data show that the **2008** mean hypolimnetic phosphorus concentration is ***approximately equal to*** the state median, and ***slightly greater than*** the similar lake median. Please refer to Appendix D for more information about the similar lake median.

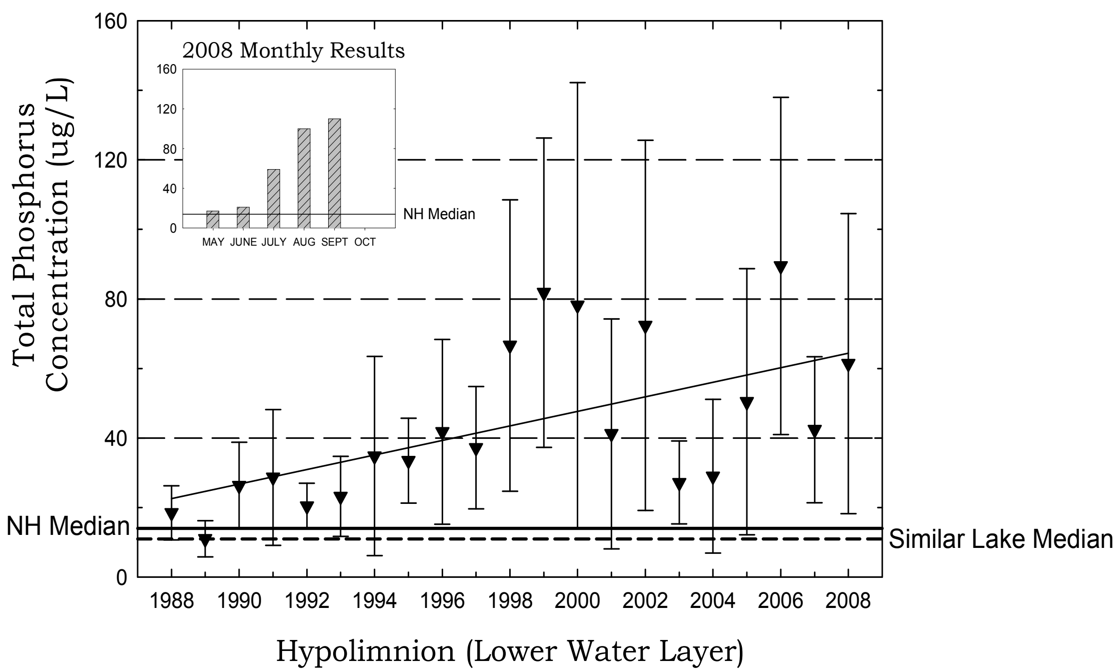
Overall, visual inspection of the historical data trend line for the epilimnion and hypolimnion shows a ***variable*** phosphorus trend since monitoring began. Specifically the mean annual epilimnetic phosphorus concentration has ***fluctuated between approximately 7.6 and 28.8 ug/L***, and the mean annual hypolimnetic phosphorus concentration has ***fluctuated between approximately 10.8 and 60.6 ug/L,*** since monitoring began in **1992**.

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about the watershed sources of phosphorus and how excessive phosphorus loading can negatively affect the ecology and the recreational, economical, and ecological value of lakes and ponds.

Pawtuckaway Lake, North Stn., Nottingham

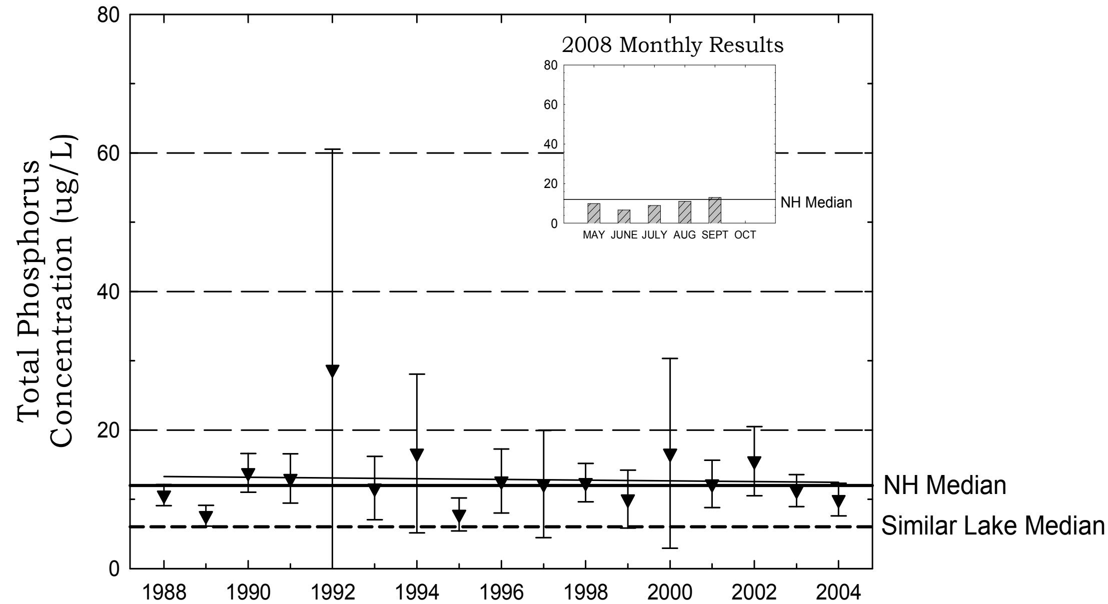
Figure 3. Monthly and Historical Total Phosphorus Data



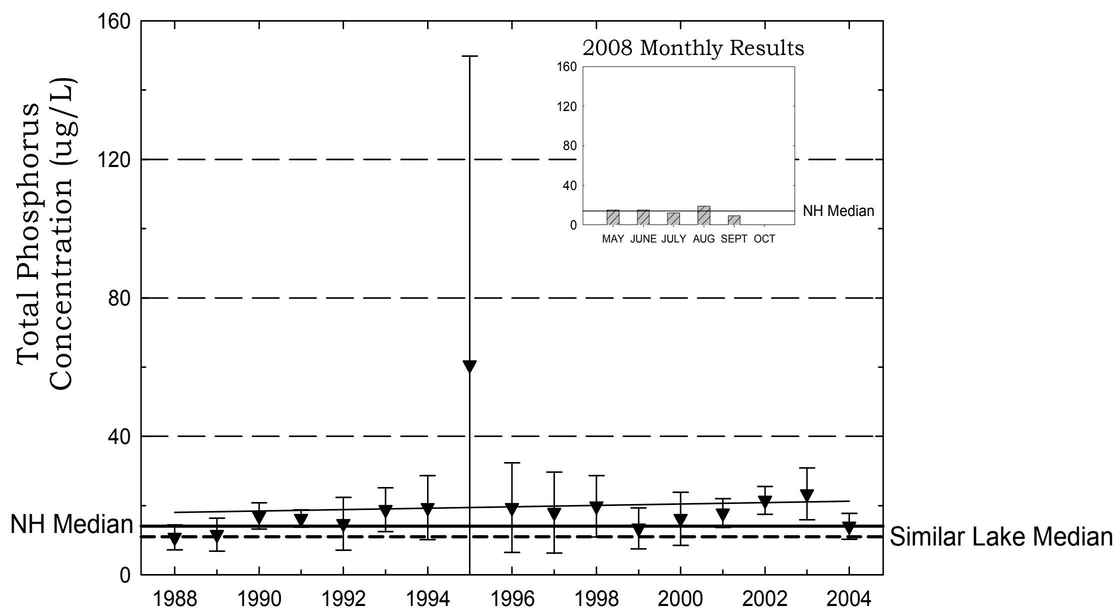


Pawtuckaway Lake, South Stn., Nottingham

Figure 3. Monthly and Historical Total Phosphorus Data



Epilimnion (Upper Water Layer)



Hypolimnion (Lower Water Layer)

➢ pH

Table 14 in Appendix A presents the current year pH data for the in-lake stations.

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 6.0 typically limits the growth and reproduction of fish. A pH between 6.0 and 7.0 is ideal for fish. The median pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.6**, which indicates that the state surface waters are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

The pH at the **North Station** deep spot this year ranged from **6.33 to 6.50** in the epilimnion and from **5.71 to 6.04** in the hypolimnion, which means that the water is ***slightly acidic***.

The pH at the **South Station** deep spot this year ranged from **6.21 to 6.89** in the epilimnion and from **5.68 to 6.26** in the hypolimnion, which means that the water is ***slightly acidic***.

It is important to point out that the hypolimnetic (lower layer) pH was ***lower (more acidic)*** than in the epilimnion (upper layer). This increase in acidity near the bottom is likely due to the decomposition of organic matter and the release of acidic by-products into the water column.

Due to the state's abundance of granite bedrock and acid deposition received from snowmelt, rainfall, and atmospheric particulates, there is little that can be feasibly done to effectively increase pond pH. The pH at the deep spot, however, is sufficient to support aquatic life.

➢ Acid Neutralizing Capacity (ANC)

Table 14 in Appendix A presents the current year epilimnetic ANC for the deep spot.

Buffering capacity (ANC) describes the ability of a solution to resist changes in pH by neutralizing the acidic input. The median ANC value for New Hampshire's lakes and ponds is **4.9 mg/L**, which indicates that many lakes and ponds in the state are at least "moderately vulnerable" to acidic inputs. For a more detailed explanation about ANC, please refer to the "Chemical Monitoring Parameters" section of this report.

The acid neutralizing capacity (ANC) of the **North Station** epilimnion (upper layer) ranged from **2.6 to 4.1 mg/L**, and the ANC of the **South Station** epilimnion ranged from **2.9 to 4.6 mg/L**. This indicates that the lake is ***moderately vulnerable*** to acidic inputs.

➢ Conductivity

Table 14 in Appendix A presents the current conductivity data for in-lake stations.

Conductivity is the numerical expression of the ability of water to carry an electric current, which is determined by the number of negatively charged ions from metals, salts, and minerals in the water column. The median conductivity value for New Hampshire's lakes and ponds is **40.0 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The conductivity in the lake is relatively ***stable***. Typically conductivity levels greater than 100 uMhos/cm indicate the influence of pollutant sources associated with human activities. These sources include septic system leachate, agricultural runoff, and road runoff which contains road salt during the spring snow-melt. We hope this trend continues!

It is possible that de-icing materials applied to nearby roadways during the winter months may be influencing the conductivity in the lake. In New Hampshire, the most commonly used de-icing material is salt (sodium chloride).

Therefore, we recommend that the **epilimnion** (upper layer) be sampled for chloride next year. This additional sampling may help us identify what areas of the watershed are contributing to the increasing in-lake conductivity.

Please note that the DES Limnology Center in Concord is able to conduct chloride analyses, free of charge. As a reminder, it is best to conduct chloride sampling in the spring as the snow is melting and during rain events.

➢ Dissolved Oxygen and Temperature

Table 9 in Appendix A depicts the dissolved oxygen/temperature profile(s) collected during **2008**.

The presence of sufficient amounts of dissolved oxygen in the water column is vital to fish and amphibians and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

NORTH STATION
As previously mentioned, the turbidity and total phosphorus concentration in the hypolimnion (lower layer) sample was ***elevated*** on each of the sampling events this year. Historically, the hypolimnetic dissolved oxygen concentration has been ***low*** on most sampling events. This suggests that the lake bottom is

composed of a thick layer of organic material that is easily disturbed. The presence of a thick organic layer on the lake bottom, which is likely comprised of decomposed plants and algae, would explain the lower dissolved oxygen concentration near the lake bottom.

SOUTH STATION
The dissolved oxygen concentration was ***much lower in the hypolimnion (lower layer) than in the epilimnion (upper layer)*** at the deep spot on the **Month** sampling event. As stratified lakes age, and as the summer progresses, oxygen typically becomes ***depleted*** in the hypolimnion by the process of decomposition. Specifically, the reduction of hypolimnetic oxygen is primarily a result of biological organisms using oxygen to break down organic matter, both in the water column and particularly at the bottom of the lake where the water meets the sediment. When hypolimnetic oxygen concentration is depleted to less than 1 mg/L, **as it was on the annual biologist visit this year and on many previous annual visits,** the phosphorus that is normally bound up in the sediment may be re-released into the water column, a process referred to as ***internal phosphorus loading***.

The ***low*** hypolimnetic oxygen level is a sign of the **pond's *aging*** health. This year the DES biologist collected the dissolved oxygen profile in **July**. We recommend that the annual biologist visit for the **2009** sampling year be scheduled during **June** so that we can determine if oxygen is depleted in the hypolimnion ***earlier*** in the sampling year.

➢ Turbidity

Table 14 in Appendix A presents the current year data for in-lake turbidity.

Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

The turbidity of the epilimnion (upper layer) samples was ***slightly elevated*** (**1.99 and 1.92 NTUs**) on the **May** sampling event. The abnormally wet conditions this summer likely led to increased stormwater runoff entering the lake. Stormwater runoff can carry particulate matter and deposits it in the lake causing turbid conditions. Or, an algal bloom had occurred in the lake.

As discussed previously, the **North Station** hypolimnetic (lower layer) turbidity was ***elevated*** (**8.26, 10.9 and 8.62 NTUs**) on the **July, August and September** sampling events. In addition, the hypolimnetic turbidity has been elevated on many sampling events during previous sampling years. This suggests that the lake bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling and/or that the lake bottom is covered by an easily disturbed thick organic layer of sediment. When the lake bottom is disturbed, phosphorus rich sediment is released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

TRIBUTARY SAMPLING

➢ Total Phosphorus

Table 14 in Appendix A presents the current year total phosphorus data for tributary stations. Please refer to the "Chemical Monitoring Parameters" section of the report for a detailed explanation of total phosphorus.

The phosphorus concentration ranged from **340 to 2,100 ug/L** in **Fernalds A**, and from **220 to 2,400 ug/L** in **Fernalds B** this year. This tributary has had a history of ***elevated*** and ***fluctuating*** phosphorus concentrations.

The phosphorus concentration in the **Mountain Brook** sample on the **June and July** sampling events was ***elevated*** **(42 and 52 ug/L)**. It had rained approximately **1.0 inch** during the **24 hours** prior to the **June** sampling event. It is likely that watershed wetland systems were releasing phosphorus-enriched water into the lake from tributaries that drain the wetland area. Also, rain events typically carry phosphorus laden watershed runoff to tributaries. Phosphorus sources in the watershed can include agricultural runoff, failing or marginal septic systems, stormwater runoff, road runoff, and watershed development.

The phosphorus concentration in the **White Grove Brook** sample on the **August** sampling event was ***elevated*** **(61 ug/L),** and the turbidity was also ***slightly elevated*** **(4.49 NTUs)**. It had rained approximately **1.0 inch** during the **24 hours** prior to the **August** sampling event, and was raining while sampling. Rain events typically carry sediment and phosphorus laden watershed runoff to tributaries. Phosphorus sources in the watershed can include agricultural runoff, failing or marginal septic systems, stormwater runoff, road runoff, and watershed development.

We recommend that your monitoring group conduct stream surveys and rain event sampling along these tributaries so we can better determine the source(s) of the elevated phosphorus concentrations.

For a detailed explanation on how to conduct rain event sampling and stream surveys, please refer to the 2002 VLAP Annual Report special topic article, which is posted on the VLAP website at www.des.nh.gov/organizations/divisions/water/wmb/vlap/categories/publications.htm.

➢ pH

Table 14 in Appendix A presents the current year pH data for the tributary stations. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation of pH.

The pH of **Fernalds A, Fernalds B, Back Creek B, Mountain Brook, Round Pond Brook,** ranged from **5.86 to 6.97 (> 6)** and is sufficient to support aquatic life.

The pH of **Fundy Brook** appears to be slightly acidic. This can be caused by the presence of humic, tannic and fulvic acids. Humic, tannic and fulvic acids naturally occur as a result of decomposing organic matter such as leaves. These acids may also cause the water to be tea colored. In New Hampshire the presence of granite bedrock and acid deposition also naturally lowers the pH of freshwaters.

➢ Conductivity

Table 14 in Appendix A presents the current conductivity data for the tributary stations. Please refer to the "Chemical Monitoring Parameters" section of the report for a more detailed explanation of conductivity.

The conductivity has ***remained relatively stable*** in **Fundy Brook, Mountain Brook, Back Creek B, and Round Pond Brook** since monitoring began. We hope to see this continue

Fernalds Brook and **White Grove Brook** have experienced elevated conductivity levels since monitoring began. We recommend that your monitoring group conduct a conductivity survey of tributaries with ***elevated*** conductivity and along the shoreline of the pond to help identify the sources of conductivity. As previously mentioned increasing conductivity typically indicates the influence of pollutant sources associated with human activities.

We recommend that your monitoring group conduct stream surveys and rain event sampling along the tributaries with ***elevated*** conductivity so that we can determine potential sources to the lake.

For a detailed explanation on how to conduct rain event sampling and stream surveys, please refer to the 2002 VLAP Annual Report special topic article, which is posted on the VLAP website at ***http://www.des.nh.gov/organization/divisions/water/wmb/vlap/categories/publications.htm****, or contact the VLAP Coordinator.*

➢ Turbidity

Table 14 in Appendix A presents the current year turbidity data for the tributary stations. Please refer to the "Other Monitoring Parameters" section of the report for a more detailed explanation of turbidity.

Overall, tributary turbidity levels ***increased slightly*** during the **2008** sampling season. The turbid conditions were likely the result of stormwater runoff from significant rain events throughout the season. Rainfall creates runoff that washes sediment and organic materials into tributaries causing turbid water conditions. Eventually, the suspended solids settle out once the flow is reduced or the tributary flow enters the lake.

- **Bacteria (*E. coli*)**

Table 14 in Appendix A lists the current year data for bacteria *(E.coli)* testing. *E. coli* is a normal bacterium found in the large intestine of humans and other warm-blooded animals. *E.coli* is used as an indicator organism because it is easily cultured and its presence in the water, in defined amounts, indicates that sewage **may** be present. If sewage is present in the water, potentially harmful disease-causing organisms **may** also be present. Please refer to the "Other Monitoring Parameters" section of the report for a more detailed explanation.

Bacteria sampling was not conducted this year. If residents are concerned about sources of bacteria such as failing septic systems, animal waste, or waterfowl waste, it is best to conduct *E. coli* testing when the water table is high, when beach use is heavy, or immediately after rain events.

- **Chlorides**

Table 14 in Appendix A lists the current year data for chloride sampling. The chloride ion (Cl^-) is found naturally in some surface waters and groundwaters and in high concentrations in seawater. Research has shown that elevated chloride levels can be toxic to freshwater aquatic life. In order to protect freshwater aquatic life in New Hampshire, the state has adopted **acute and chronic** chloride criteria of **860 and 230 mg/L** respectively. The chloride content in New Hampshire lakes is naturally low, generally less than 2 mg/L in surface waters located in remote areas away from habitation. Higher values are generally associated with salted highways and, to a lesser extent, with septic inputs. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

Chloride sampling was **not** conducted during **2008**.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:
During the annual visit to your pond, the biologist conducted a sampling procedures assessment audit for your monitoring group. Specifically, the biologist observed the performance of your monitoring group while sampling and filled-out an assessment audit sheet to document the volunteer monitors' ability to follow the proper field sampling procedures, as outlined in the VLAP Monitor's Field Manual. This assessment is used to identify any aspects of sample collection in which volunteer monitors failed to follow proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the samples

volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group did an ***excellent*** job collecting samples on the annual biologist visit this year! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the biologist to provide additional training. Keep up the good work!

Sample Receipt Checklist

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if your group followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did a ***very good*** job when collecting samples this year! Specifically, the members of your monitoring group followed the majority of the proper field sampling procedures when collecting and submitting samples to the laboratory. However, the laboratory did identify a few aspects of sample collection that your group could improve upon, as follows:

- **Sample labeling:** Please label your samples with a waterproof pen preferably by using a black permanent before sampling. ***Please label your sample bottles with the Lake name, station name, station depth, date and time samples were collected.*** Check to make sure that the ink does not wash off the bottle when exposed to water. If your association has made its own sample bottle labels, please fold over one corner of each label before placing it on a sample bottle so that the label will not become permanently attached to the bottle. In addition, please make sure that the labels will stick to the bottles when they are wet.

- **Sample bottle volume:** Please fill each sample bottle up to the neck of the bottle where the bottle curves in. This will ensure that the laboratory staff will have enough sample water to conduct all of the necessary tests.

  Please be careful to not overflow the small brown bottle used for phosphorus sampling since this bottle contains acid. If you do accidentally overflow the small brown bottle, please rinse your hands and the outside of the sample bottle and make a note of this on your field sampling sheet. The laboratory staff will put additional acid in the bottle in the laboratory to preserve the sample.

USEFUL RESOURCES

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, DES Booklet WD-03-42, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-03-42.pdf.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, DES fact sheet WMB-10, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-10.pdf.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, DES fact sheet WD-SP-1, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-1.pdf.

Impacts of Development Upon Stormwater Runoff, DES fact sheet WD-WQE-7, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/aot/documents/wqe-7.pdf.

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, DES fact sheet WD-BB-9, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/bb/documents/bb-9.pdf.

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, DES fact sheet WD-SP-2, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-2.pdf.

Road Salt and Water Quality, DES fact sheet WD-WMB-4, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-4.pdf.

Sand Dumping - Beach Construction, DES fact sheet WD-BB-15, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/bb/documents/bb-15.pdf.

Shorelands Under the Jurisdiction of the Comprehensive Shoreland Protection Act, DES fact sheet SP-4, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-4.pdf.

Watershed Districts and Ordinances, DES fact sheet WD-WMB-16, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-16.pdf.