

## EXECUTIVE SUMMARY

Thank you for your continued hard work sampling **Halfmoon Lake** this year! We congratulate your group for sampling your lake **twice** this summer. However, we strongly encourage your monitoring group to sample **additional** times each summer. Typically, we recommend that monitoring groups sample **three times** per summer (once in **June, July, and August**). We understand that the number of sampling events you decide to conduct per summer will depend upon volunteer availability, and your monitoring group's goals and funding availability. However, with a limited amount of data it is difficult to determine accurate and representative water quality trends. Since weather patterns and activity in the watershed can change throughout the summer, from year to year, and even from hour to hour during a rain event, it is a good idea to sample the lake at least once per month during the summer.

If you are having difficulty finding volunteers to help sample or to travel to one of the laboratories, please call the VLAP Coordinator and DES will help you work out an arrangement.

Finally, please remember that one of your most important responsibilities as a volunteer monitor is to educate your association, community, and town officials about the quality of your lake and what can be done to protect it! DES biologists may be able to assist you in educating your association members by attending your annual lake association meeting.



# 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<sup>3</sup>.**

The current year data (the top graph) show that the chlorophyll-a concentration **decreased** from **July** to **August**.

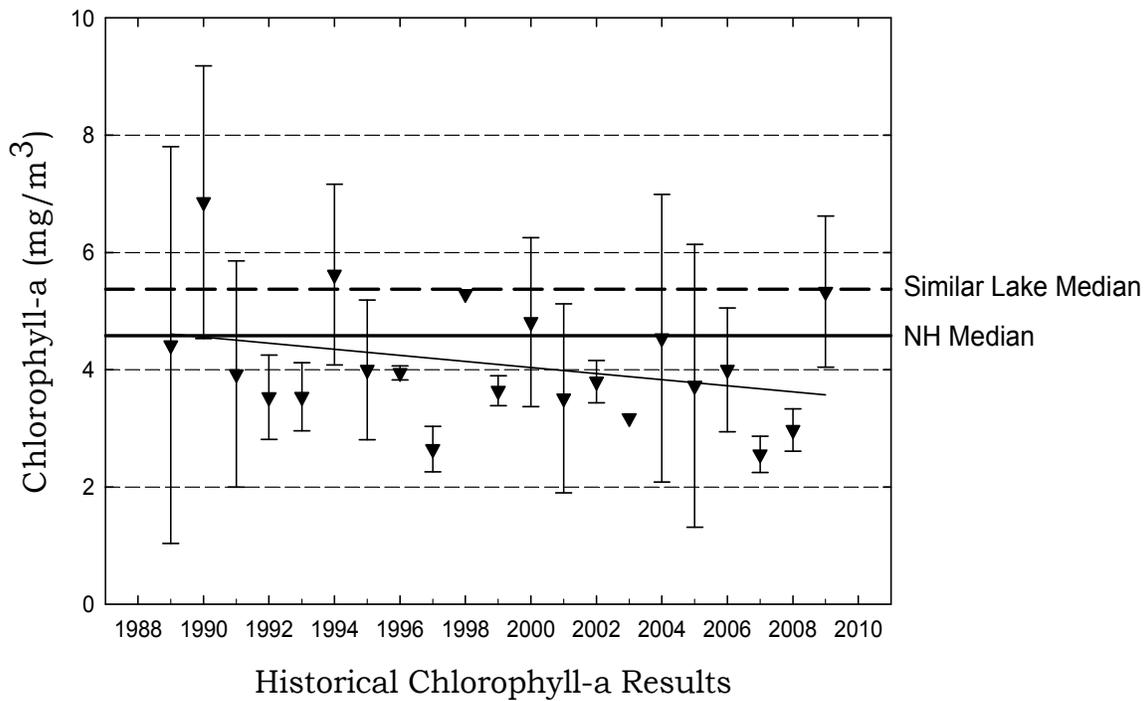
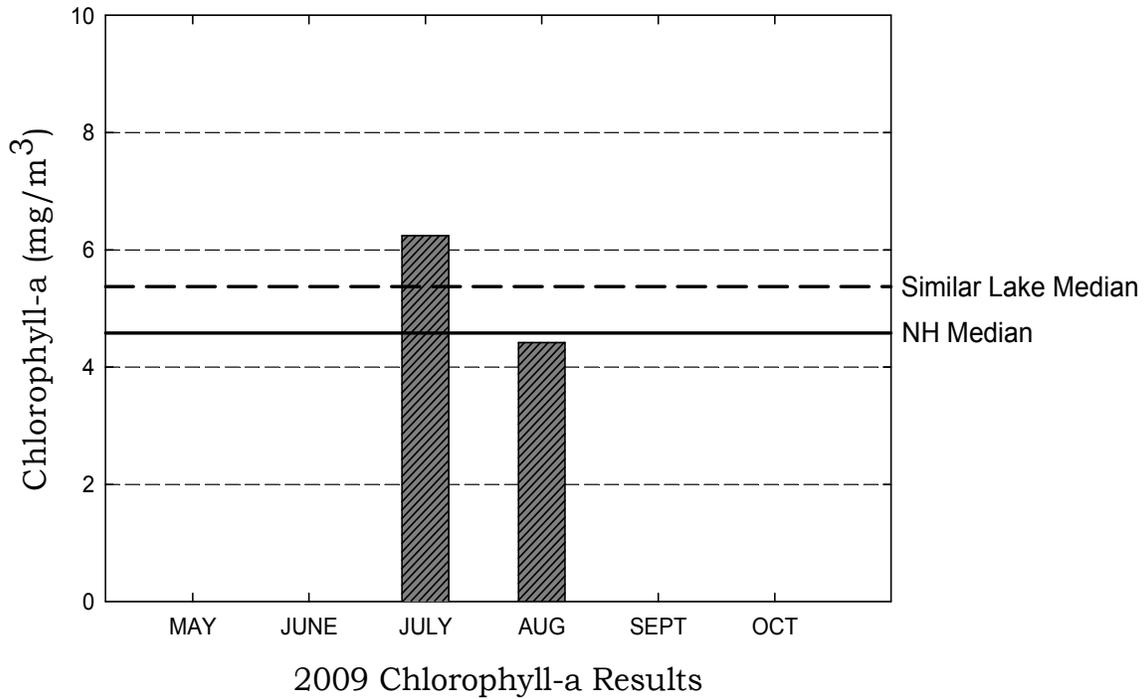
The historical data (the bottom graph) show that the **2009** chlorophyll-a mean is **slightly greater than** the state median and is **approximately equal to** the similar lake median. For more information on the similar lake median, refer to Appendix D.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a **decreasing** in-lake chlorophyll-a trend since monitoring began. Specifically the mean chlorophyll concentration has **improved** since **1989**.

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.

# Halfmoon Lake, Barnstead

**Figure 1.** Monthly and Historical Chlorophyll-a Results



### ➤ **Phytoplankton and Cyanobacteria**

Table 1 lists the phytoplankton (algae) and/or cyanobacteria observed in the pond in **2009**. 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 2009)**

<b>Division</b>	<b>Genus</b>	<b>% Dominance</b>
Bacillariophyta	Rhizosolenia	44.2
Chrysophyta	Chrysosphaerella	31.0
Bacillariophyta	Asterionella	21.1

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.

### ➤ **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.

The current year *non-viewscope* in-lake transparency *decreased slightly* from **July** to **August**.

The current year *viewscope* in-lake transparency *increased slightly* from **July** to **August**.

The transparency measured with the viewscope was generally *greater than* the transparency measured without the viewscope this summer. 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 **2009** mean non-viewscope transparency is **approximately equal to** the state median and is **slightly greater than** the similar lake median. Please refer to Appendix D for more information about the similar lake median.

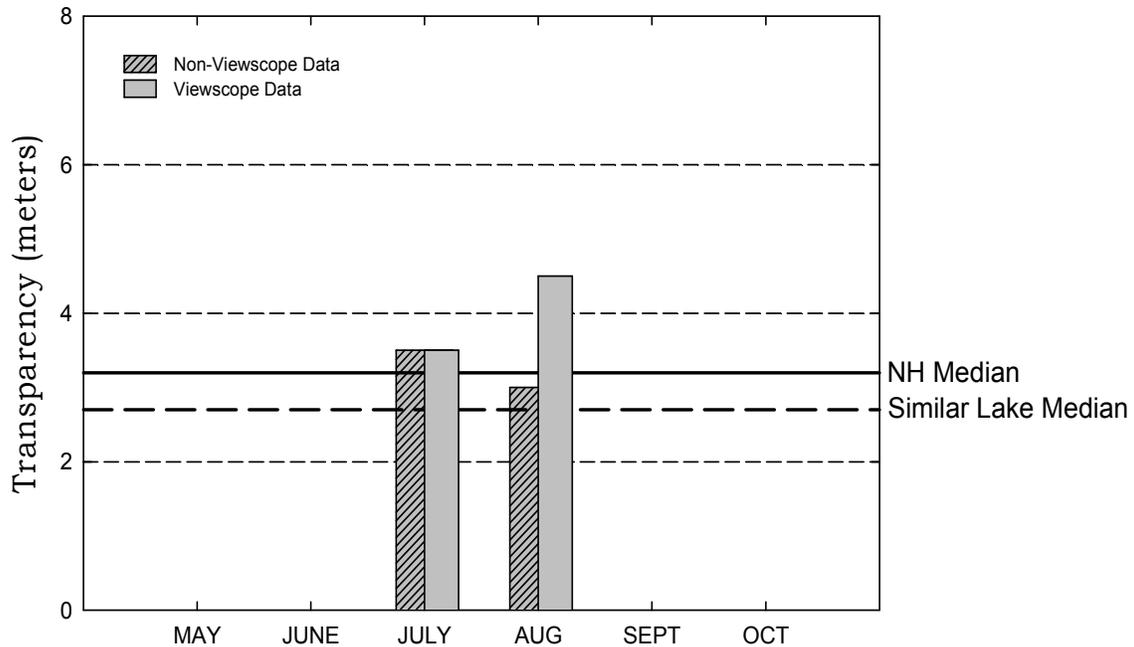
Visual inspection of the historical data trend line (the bottom graph) shows a **stable** trend. Specifically, the transparency has **remained relatively stable ranging between 2.50 and 4.80 meters** since monitoring began in **1989**.

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.

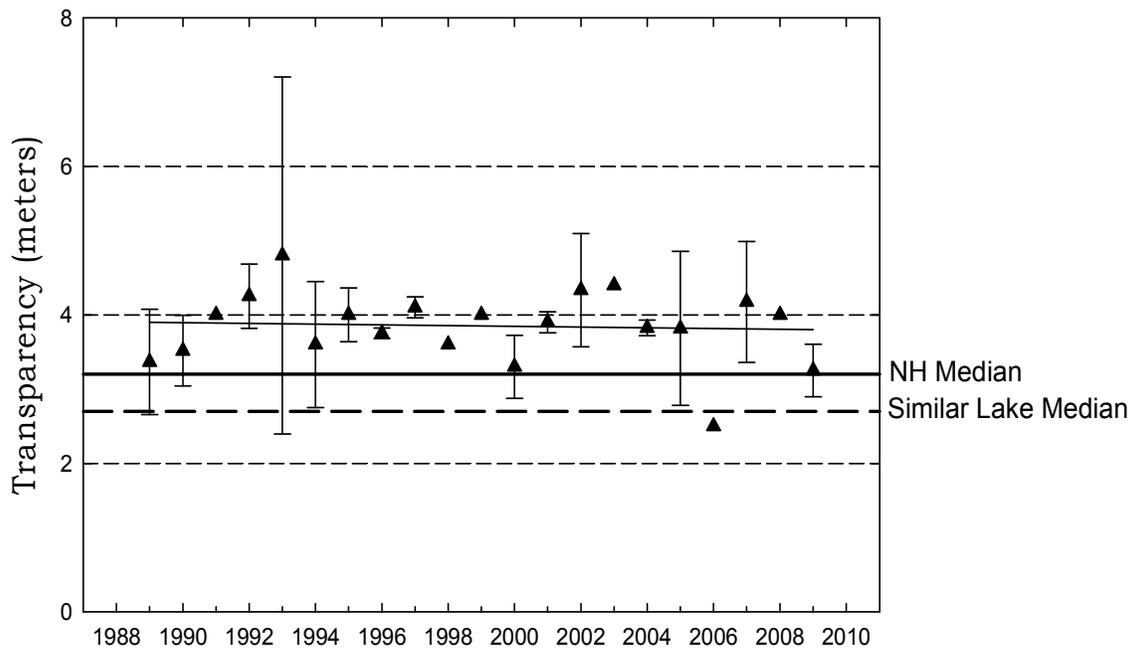
We recommend that your group continue to measure the transparency with and without the use of the viewscope on each sampling event. Ultimately, we would like all monitoring groups to use a viewscope to take Secchi disk readings as the use of the viewscope results in less variability in transparency readings 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.

# Halfmoon Lake, Barnstead

**Figure 2.** Monthly and Historical Transparency Results



2009 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.

The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration **increased slightly** from **July** to **August**.

The historical data show that the **2009** mean epilimnetic phosphorus concentration is **slightly less than** the state and similar lake medians. 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 slightly** from **July** to **August**.

The historical data show that the **2009** mean hypolimnetic phosphorus concentration is **approximately equal to** the state median and is **slightly less than** the similar lake median. Please refer to Appendix D for more information about the similar lake median.

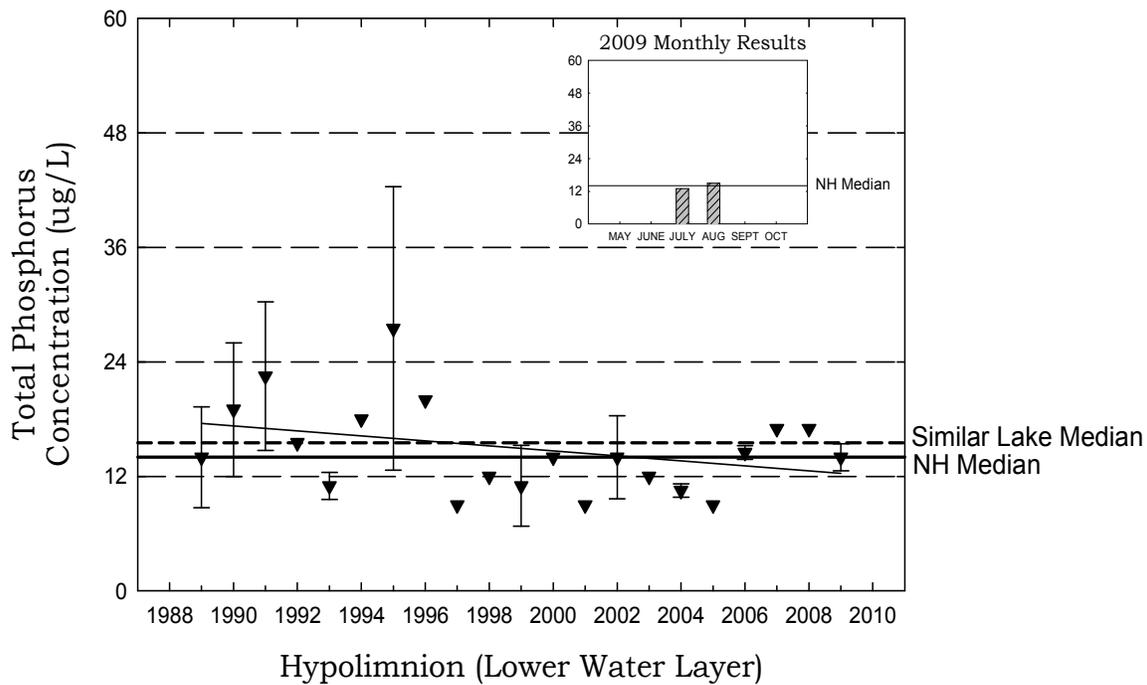
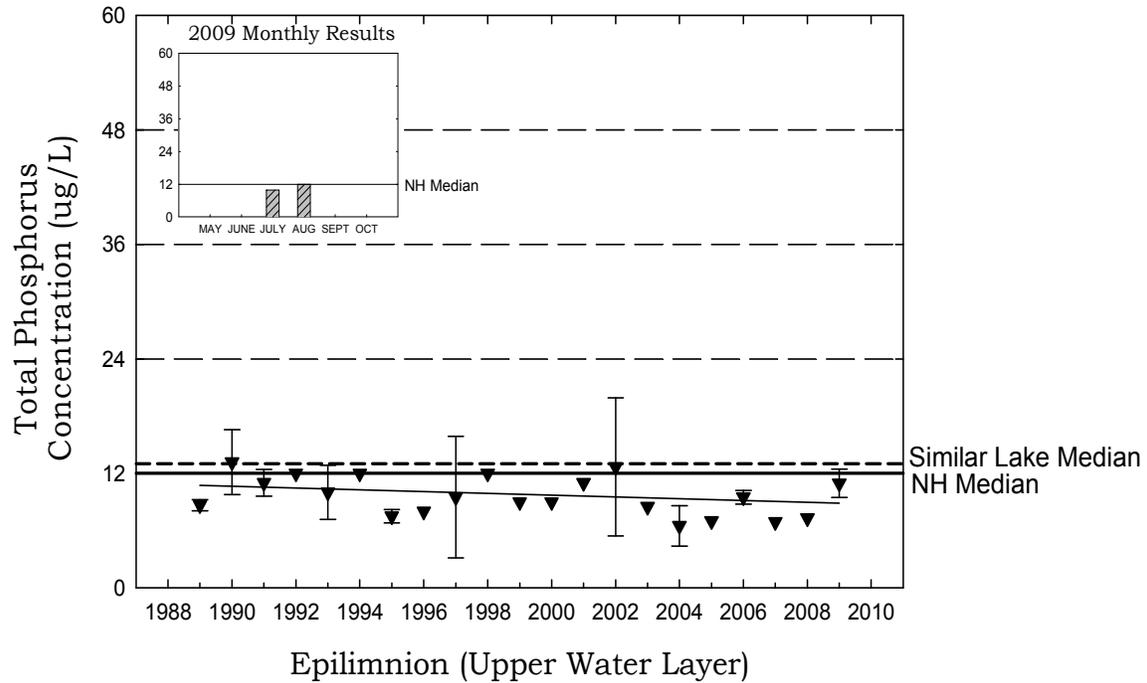
Overall, visual inspection of the epilimnetic historical data trend line shows a **slightly decreasing** phosphorus trend. Specifically, the mean annual epilimnetic phosphorus concentration has **improved** since monitoring began in **1997**.

Overall, visual inspection of the hypolimnetic historical data trend line shows a **variable** phosphorus trend since monitoring began. Specifically the mean annual concentration has **fluctuated between approximately 9 and 27 ug/L** since monitoring began in **1997**.

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.

# Halfmoon Lake, Barnstead

**Figure 3.** Monthly and Historical Total Phosphorus Data



## ➤ 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 deep spot this year ranged from **6.64 to 6.82** in the epilimnion to **6.44** in the hypolimnion, which means that the water is *slightly acidic*.

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 epilimnion (upper layer) ranged from **2.3 mg/L to 4.1 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 has **gradually increased** in the lake since monitoring began. In addition, the in-lake conductivity is **slightly greater than** the state median. Typically, increasing conductivity indicates the influence of pollutant sources associated with human activities. These sources include failed or marginally functioning septic systems, agricultural runoff, and road runoff which contains road salt during the spring snow-melt. New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could also contribute to increasing conductivity. In addition, natural sources, such as iron and manganese deposits in bedrock, can influence conductivity.

It is likely 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 **2009**.

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.

The dissolved oxygen concentration was **much lower in the hypolimnion (lower layer) immediately off the bottom, than in the epilimnion (upper layer)** at the deep spot on the **July** 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 lake’s **aging** health. This

year the DES biologist collected the dissolved oxygen profile in **July**. We recommend that the annual biologist visit for the **2010** 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 deep spot turbidity was **relatively low** this year, which is good news.

However, we recommend that your group sample the pond and any surface water runoff areas during significant rain events to determine if stormwater runoff contributes turbidity and phosphorus to the lake.

*For a detailed explanation on how to conduct rain event sampling, 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.*

## 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 in the **Fern Hill Inlet** sample on the **July and August** sampling events was **elevated (20 and 35 ug/L)**, however, the turbidity was **not elevated (0.87 and 1.17 NTUs)**.

It had rained approximately **1.0 inch** during the **24-72 hours** prior to the **August** sampling event. It is possible 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 **Horse Farm Inlet** sample on the **July and August** sampling events was **elevated (23 and 37 ug/L)**, and the turbidity was also **elevated (2.59 and 5.56 NTUs)**.

The phosphorus concentration in the **Rt. 28 Inlet** sample on the **July and August** sampling events was **elevated (54 and 46 ug/L)**, and the turbidity was also **elevated (3.27 and 3.44 NTUs)**.

The phosphorus concentration in the **Dugans Inlet** sample on the **July and August** sampling events was **elevated (24 and 36 ug/L)**, and the turbidity was also **slightly elevated (2.28 and 2.86 NTUs)**.

Record summer rainfall likely increased stormwater runoff and nutrient loading to the tributary. As impervious surface cover increases in the watershed, stormwater runoff volumes increase. This transports phosphorus-laden stormwater into tributaries and eventually the lake/pond. Efforts should be made in the watershed to reduce impervious surfaces and limit phosphorus sources such as fertilizer use, septic influences, agricultural impacts, and sediment/erosion control.

### ➤ **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 the tributary stations ranged from **6.01 to 6.74 (> 6)** and is sufficient

to support aquatic life.

### ➤ **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.

Overall, the conductivity has **remained stable** in the tributaries since monitoring began.

However, the **Rt. 28 Inlet** experienced elevated conductivity levels this season, and has experienced elevated or fluctuating conductivity 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.

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

Therefore, we recommend that the **tributaries** 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.*

### ➤ **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** during the **2009** sampling season.

The **Dugans Inlet, Horse Farm Inlet and Rt. 28 Inlet** experienced turbid conditions in **August**, likely the result of stormwater runoff from significant rain events prior to sampling. 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.

The *E. coli* concentration was **very low** at each station sampled on the **August** sampling event. Specifically, each result was **14 counts or less**, which is **much less than** the state standard of 406 counts per 100 mL for recreational surface waters that are not designated public beaches and 88 counts per 100 mL for surface waters that are designated public beaches.

### ➤ **Chlorides**

Table 14 in Appendix A lists the current year data for chloride sampling. The chloride ion (Cl<sup>-</sup>) 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 **2009**.

## **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 sample bottles with the lake name, town name, station name, 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.

**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](http://www.des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-03-42.pdf).

*Erosion Control for Construction in the Protected Shoreland Buffer Zone*, DES fact sheet WD-SP-1, (603) 271-2975 or <http://des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-1.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](http://www.des.nh.gov/organization/commissioner/pip/factsheets/bb/documents/bb-9.pdf).

*NH Stormwater Management Manual Volume 1: Stormwater and Antidegradation*, DES fact sheet WD-08-20A, (603) 271-2975 or <http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20a.pdf>

*NH Stormwater Management Manual Volume 2: Post-Construction Best Management Practices Selection and Design*, DES fact sheet WD-08-20B, (603) 271-2975 or <http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20b.pdf>

*NH Stormwater Management Manual Volume 3: Erosion and Sediment Controls During Construction*, DES fact sheet WD-08-20C, (603) 271-2975 or <http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20c.pdf>

*Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act*, DES fact sheet WD-SP-2, (603) 271-2975 or <http://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](http://www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-4.pdf).

*Vegetation Maintenance Within the Protected Shoreland*, DES fact sheet WD-SP-5, (603) 271-2975 or <http://des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-5.pdf>