EXECUTIVE SUMMARY

Thank you for your continued hard work sampling **Mirror Lake** this year! Your monitoring group sampled the tributaries **ten** times this year and has done so since 2007. As you know, conducting multiple sampling events each year enables DES to more accurately detect water quality changes. Keep up the great work!

If your monitoring group's sampling events this year were limited due to not having enough time to pick-up or drop-off samples at the Limnology Center in Concord, please remember the Plymouth State University Center for the Environment Satellite Laboratory is open in Plymouth. This laboratory was established to serve the large number of lakes/ponds in the greater North region of the state. This laboratory is inspected by DES and operates under a DES approved quality assurance plan. We encourage your monitoring group to utilize this laboratory next summer for all sampling events, except for the annual DES biologist visit. To find out more about the Center for the Environment Satellite Laboratory, and/or to schedule dates to pick up bottles and equipment, please call Aaron Johnson, laboratory manager, at (603) 535-3269.

Non-Point Source Program Update
In 2009, the Mirror Lake Protective Association (MLPA) applied to DES for an EPA Section 319 watershed restoration grant. A grant will be awarded in the amount of $65,000 to the MLPA in 2010. The restoration grant will help provide funding to develop a watershed management plan for Mirror Lake. DES Biologists have documents potentially toxic cyanobacteria at several locations around the lake in past years. A goal of the management plan is to reduce phosphorus inputs to the lake resulting in decreased cyanobacteria concentrations.

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.

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

Chlorophyll-a data are not available for 2009. Deep spot sampling is not conducted as part of the routine VLAP sampling for Mirror Lake.

➢ 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.

Phytoplankton monitoring was not conducted by VLAP in 2009. Mirror Lake has experienced cyanobacteria blooms, resulting in DES issued lake warnings in years past. Mirror Lake experienced a late seasonal cyanobacteria bloom in 2009. Because the bloom occurred post swim season, and the bloom duration was limited, a lake warning was not issued.

The historical presence of cyanobacteria serves as a reminder of the lake's delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading to the lake 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 lake in September and October during 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 in large concentrations. Wind and currents tend to congregate 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.**

Transparency data are not available for 2009. Deep spot sampling is not conducted as part of the routine VLAP sampling for Mirror Lake.

➢ 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.**

Total phosphorus data are not available for 2009. Deep spot sampling is not conducted as part of the routine VLAP sampling for Mirror Lake.

➢ 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.

pH data are not available for 2009. Deep spot sampling is not conducted as part of the routine VLAP sampling for Mirror Lake.

➢ 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.

ANC data are note available for 2009. Deep spot sampling is not conducted as part of the routine VLAP sampling for Mirror Lake.

➢ 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.

Conductivity data are not available for 2009. Deep spot sampling is not conducted as part of the routine VLAP sampling for Mirror Lake.

➢ Total Kjeldahl Nitrogen and Nitrite+Nitrate Nitrogen (only those lakes with current year Lake Survey data)

Table 7a in Appendix A presents the current year and historical Total Kjeldahl Nitrogen and Table 7b presents the current year and historical nitrite and nitrate nitrogen. Nitrogen is another nutrient that is essential for the growth of plants and algae. Nitrogen is typically the limiting nutrient in estuaries and coastal ecosystems. However, in freshwater, nitrogen is not typically the limiting nutrient. Therefore, nitrogen is not typically sampled through VLAP. However, if phosphorus concentrations in freshwater are elevated, then nitrogen loading may stimulate additional plant and algal growth. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

Nitrogen data are not available for 2009. Deep spot sampling is not conducted as part of the routine VLAP sampling for Mirror Lake.

➢ 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.

Dissolved oxygen and temperature data are not available for 2009. Deep spot sampling is not conducted as part of the routine VLAP sampling for Mirror Lake.

➢ 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.

Turbidity data are not available for 2009. Deep spot sampling is not conducted as part of the routine VLAP sampling for Mirror Lake.

TRIBUTARY SAMPLING

➢ Total Phosphorus

Figure 1 and 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 **Abenaki Lagoon** ranged from **12 ug/L** to **58 ug/L** in 2009. Phosphorus concentrations were elevated in February, ***decreased*** in March, ***increased*** from March through June, and then ***decreased*** from June through November. Phosphorus concentrations spiked in **June (58 ug/L)** after 0.5 inches of rainfall in the previous 24-72 hours. It is likely that the rain event and already elevated water levels flushed excess nutrients from Abenaki Lagoon. Overall, phosphorus concentrations continue to be ***slightly elevated*** in the lagoon but are relatively stable throughout the year.

The phosphorus concentration in **Waumbeck Rd** ranged from **15 ug/L** to **42 ug/L** in 2009. Phosphorus concentrations ***decreased*** from February to March, ***increased*** from March to June, ***decreased slightly*** from June to July, ***increased*** from July to August, and then ***decreased*** from August to November. Phosphorus concentrations were slightly elevated in **June (31 ug/L)**, likely the result of 0.5 inches of rainfall in the previous 24-72 hours. Phosphorus concentrations spiked in **August (42 ug/L)**, and turbidity levels were also elevated **(4.33 NTUs)**. Elevated turbidity levels are most often a result of sediment and/or organic material present in the sample. These materials typically contain attached phosphorus and when present in elevated amounts contribute to elevated tributary phosphorus levels. Overall, phosphorus concentrations continue to be ***slightly elevated*** but remain relatively stable throughout the year.

The phosphorus concentration in **West Inlet A** ranged from **13 ug/L** to **51 ug/L**, and phosphorus concentrations in **West Inlet B** ranged from **12 ug/L** to **48 ug/L** in 2009. Phosphorus concentrations at both stations ***decreased*** from February to April, ***increased*** from April to August, and then ***decreased*** from August to November. The increased phosphorus concentrations from April to August were likely due to elevated stormwater levels received this summer. These tributaries drain watershed wetland systems. Wetland systems typically release phosphorus-enriched water following significant rain events. 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. Overall, phosphorus concentrations continue to be ***slightly elevated*** and fluctuate throughout the year.

The phosphorus concentration in **East Inlet** ranged from **15 ug/L** to **100 ug/L** in 2009. Phosphorus concentrations ***decreased*** from February to April, ***increased*** from April to July, and then ***decreased*** from July to November. Phosphorus concentrations were elevated in February **(76 ug/L)** and sediment was noted in the sample. The sample was not analyzed for turbidity due to an equipment error, however we suspect that sediment contamination led to the elevated phosphorus levels. Phosphorus concentrations were elevated in July **(100 ug/L)** and the turbidity was also elevated **(7.16 ug/L)**. Elevated turbidity levels are most often a result of sediment and/or organic material present in the sample. These materials typically contain attached phosphorus and when present in elevated amounts contribute to elevated tributary phosphorus levels. Phosphorus concentrations were elevated from May through September and were likely due to elevated stormwater levels received this summer. This tributary drains watershed wetland systems. Wetland systems typically release phosphorus-enriched water following significant rain events. Also, rain events may 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. Overall, phosphorus concentrations continue to be ***elevated*** and fluctuate throughout the year.

➢ pH

Figure 2 and 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 **5.68 to 7.10** and is sufficient to support aquatic life.

The pH tended to be more acidic in the winter months. This is likely due to any snowmelt reaching the tributaries. Winter precipitation (typically in the form of snow) generally has a pH between **4.0** and **5.0**. As this melts, it can temporarily decrease pH levels in tributaries and lakes.

➢ Conductivity

Figure 3 and 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 ***gradually decreased*** in the tributaries since monitoring began.

However, the tributary system continued to experienced elevated conductivity levels this season, and has experienced elevated or fluctuating conductivity since monitoring began. The conductivity levels at each station ***increased*** from **March** to **September**, and spiked in September. This conductivity spike corresponds with a September spike in chloride levels. Typically, elevated 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 important to note that conductivity levels in the **East Inlet** are much lower than those measured at other stations. The East Inlet drains a separate sub-watershed area and is not influenced by headwaters originating at Abenaki Lagoon.

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** continue to 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

Figure 4 and 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, **2009** tributary turbidity levels were ***similar*** to historical tributary turbidity levels.

Abenaki Lagoon experienced turbid conditions in **May (3.33 NTUs)**. Weather records indicate no precipitation 5 days prior to sampling, suggesting that an algal bloom may have occurred in the lagoon.

Waumbeck Rd experienced turbid conditions in **August (4.33 NTUs)**. Sediment was noted in the sample. Please be careful to observe tributary flow conditions and only sample when sufficient flow is present.

East Inlet experienced turbid conditions in **July, August and September (7.16, 2.92, and 2.35)**. Sediment and/or organic material were noted in the samples. Please be careful to observe tributary flow conditions and only sample when sufficient flow is present.

➢ 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

Figure 5 and 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.

Abenaki Lagoon was sampled for chloride on each sampling event. The results ranged from **14 mg/L to 29 mg/L**, which is ***much less than*** the state acute and chronic chloride criteria. However, this is greater than what we would expect to measure in undisturbed New Hampshire surface waters.

Waumbeck Rd was sampled for chloride on each sampling event. The results ranged from **5.1 mg/L to 24 mg/L**, which is ***much less than*** the state acute and chronic chloride criteria. However, this is greater than what we would expect to measure in undisturbed New Hampshire surface waters.

West Inlet A was sampled for chloride on each sampling event. The results ranged from **12 mg/L to 25 mg/L**, which is ***much less than*** the state acute and chronic chloride criteria. However, this is greater than what we would expect to measure in undisturbed New Hampshire surface waters.

West Inlet B was sampled for chloride on each sampling event. The results ranged from **13 mg/L to 25 mg/L**, which is ***much less than*** the state acute and chronic chloride criteria. However, this is greater than what we would expect to measure in undisturbed New Hampshire surface waters.

East Inlet was sampled for chloride on each sampling event. The results ranged from **< 5.0 mg/L to 23 mg/L**, which is ***much less than*** the state acute and chronic chloride criteria. However, this is greater than what we would expect to measure in undisturbed New Hampshire surface waters.

Overall, chloride concentrations in Abenaki Lagoon, Waumbeck Rd, West Inlet A and West Inlet B ***decreased*** from February to June, ***increased*** from June to September, where they spiked, and then ***decreased*** from September to November. East Inlet did not seem to follow a similar pattern, and chloride concentrations were much lower, however spiked in September following a rain event. The chloride concentrations also tended to correlate with the conductivity levels measured throughout the season.

We recommend that your monitoring group continue to conduct chloride sampling particularly in the spring during snow-melt and rain events during the summer. This will establish a baseline of data that will assist your monitoring group and DES to determine lake quality trends in the future.

Please note that chloride analyses can be run free of charge at the DES Limnology Center. Please contact the VLAP Coordinator if you are interested in chloride monitoring.

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:

- **Tributary sampling:** Sediment and or organic debris were observed in the white sample bottle for several stations during several sampling events. Please do not sample tributaries that are too shallow to collect a "clean" sample free from organic debris and sediment and do not sample the stream if the stream bottom has been disturbed. You may need to move upstream or downstream to collect a "clean" sample. If you disturb the stream bottom while sampling, please rinse out the bottle and move to an upstream location and sample in an undisturbed area.

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.

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.

*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

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.

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.