EXECUTIVE SUMMARY

LAKE SUNAPEE DEEP SPOT STATIONS
Current Year Chlorophyll-a, Secchi-disk Transparency, and Phosphorus:
Overall, the water quality at the Lake Sunapee deep spot stations (Stations 200, 210, 220, and 230) continued to be very good during the 2007 sampling season. Specifically, the chlorophyll-a concentration continued to be very low, and much less than the state median, but slightly greater than the similar lake median. **The Secchi disk transparency continued to be much greater than the state median, but was slightly less than the similar lake median.** The epilimnetic phosphorus concentration was much less than the state median, but slightly greater than the similar lake median, while the hypolimnetic phosphorus concentration was much less than the state median, and slightly less than the similar lake median.

Historical Chlorophyll-a, Secchi-disk Transparency, and Phosphorus Trends:
For the fifth consecutive season, DES used linear regression statistics to analyze the annual mean historical data for the three major in-lake sampling parameters (chlorophyll-a concentration, Secchi-disk transparency, and total phosphorus concentration). This type of analysis is a non-subjective method that can be used to determine if there has been an overall increase or decrease in the annual mean for each parameter since sampling began.

Overall, the statistical analysis of the historical data shows that the mean annual chlorophyll-a concentration at Stations 200, 210, 220 and 230 has not significantly changed (either continually increased or decreased) since monitoring began.

The statistical analysis of the historical data shows that the mean annual transparency at each of the deep spot stations has not significantly changed (either continually increased or decreased) since monitoring began.

The statistical analysis of the historical data shows that the mean annual epilimnetic phosphorus concentration at each of the deep spot stations has not significantly changed (either continually increased or decreased) since monitoring began. Statistical analysis shows that the mean annual hypolimnetic phosphorus concentration at Stations 210, 220 and 230 has not significantly changed since monitoring began. Statistical analysis shows that the mean annual hypolimnetic phosphorus concentration at **Station 200** has ***significantly increased*** (meaning ***worsened***) on average at a rate of **2.103 percent** per year during the sampling period **1986** to **2007**.

Cyanobacteria:
The cyanobacteria, *Merismopedia* and *Gleocapsa,* were present in small amounts in the July 16 and/or August 14 samples at Stations 200, 210, 220 and 230. These cyanobacteria do not produce toxins and are not harmful to humans, pets or livestock. In addition, small amounts of the cyanobacteria *Anabaena* were present intermittently throughout the summer at each station. If present in large amounts, *Anabaena* may be toxic to livestock, wildlife, pets, and humans. Cyanobacteria can reach nuisance levels when excessive nutrients and favorable environmental conditions occur.

Watershed residents should continue to act proactively to reduce nutrient loading into the lake by eliminating fertilizer use on lawns, keeping the lake shoreline natural, re-vegetating cleared areas within the watershed, treating stormwater runoff before it discharges into surface waters, and properly maintaining septic systems and roads.

pH:
Overall, the pH at the deep spot stations was satisfactory to support aquatic life. It is important to note that the hypolimnetic (lower layer) pH decreases as the summer progresses at each station. 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.

Acid Neutralizing Capacity (ANC):
The Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) at each deep spot station ranged from 2.4 to 4.8 mg/L, and continued to remain less than the state mean. Specifically, the epilimnetic layer at each deep spot station continued to be "moderately vulnerable" to acidic inputs (such as acid precipitation). Since the surface waters in New Hampshire are naturally low in ANC, primarily due to the presence of granite bedrock, there is little that can be feasibly done to reverse this problem.

Conductivity:
The 2007 mean epilimnetic (upper layer) and hypolimnetic (lower layer) conductivity was lower than has been measured since 1999. It is likely that the lack of rainfall during the **2007** sampling season reduced watershed runoff to the lake. Typically, rain events and snow melt cause potentially pollutant laden watershed runoff to reach tributaries and ultimately the lake leading to elevated conductivity levels.

Overall, the conductivity has steadily increased (worsened) at each of the deep spot stations since monitoring began and remains greater than the state median of 40 uMhos/cm. The conductivity was particularly high from 2003 to 2005 at each deep spot station. The rate at which the conductivity level in the lake has been increasing since monitoring began is concerning. Typically, sources of increasing conductivity are due to human activity. These sources include effluent from septic systems which eventually leaches into the groundwater (and ultimately into the tributaries and the lake), effluent from waste water treatment plants, agricultural runoff, and road runoff (which typically contains road salt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron deposits in

bedrock, can influence conductivity. As always, any new development should be monitored for the implementation and effectiveness of Best Management Practices (BMPs) to reduce the amount and improve the quality of surface runoff from the site.

Dissolved Oxygen:
As stratified lakes age over time, oxygen becomes depleted in the hypolimnion (the lower layer) by the process of decomposition. In addition, depleted oxygen concentrations in the hypolimnion of thermally stratified lakes typically occur as the summer progresses. Overall, the hypolimnetic dissolved oxygen concentration remained relatively stable at Station 200, fluctuated at Station 210, decreased as the summer progressed at Station 220, and remained relatively stable at Station 230.

Specifically, the Station 210 dissolved oxygen profile conducted in June revealed dissolved oxygen levels greater than 100 percent saturation from 1.0 to 29.0 meters. Typically, layers of algae located in the epilimnion and metalimnion can increase the amount of dissolved oxygen in the water column, since oxygen is a by-product of photosynthesis. However these layers generally occur at the depths which sunlight penetrates the water column, and where nutrients are readily available, and are not typical in the hypolimnion of lakes. Since the percent saturation was greater than 100 percent throughout the water column, this indicates that there may have been a technical problem with the dissolved oxygen meter. Also, it is important to note the sharp decrease in dissolved oxygen on the July sampling event. Dissolved oxygen concentrations ranged between 2.0 and 2.5 mg/L between 4.0 and 30 meters indicating a potential technical problem with the dissolved oxygen meter. Please remember to thoroughly inspect meter probes for air bubbles and membrane solution prior to each sampling event and record any technical difficulties on field data sheets.

Chloride:
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. The median epilimnetic chloride value for New Hampshire lakes and ponds in **5 mg/L**. 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.

Based on historical chloride data, we recommend that your monitoring group continue to conduct chloride sampling in the epilimnion at the deep spot for long-term trend analysis. In addition, we recommend that your monitoring group conduct conductivity and chloride sampling in the inlet tributaries located near salted roadways, particularly in the winter and spring during snow melt and rain events, and periodically during summer rain events.

Furthermore, if your monitoring group has conducted any independent conductivity and/or chloride sampling investigations, we request that you submit this data to the VLAP coordinator. Sharing of this data will allow DES to not only assist your group in determining the extent and severity of chloride pollution in the Lake Sunapee watershed, but also to assess the extent and severity of chloride pollution throughout the state.

NEARSHORE STATIONS

Chlorophyll-a, Secchi-disk Transparency, and Phosphorus:

Statistical analysis shows that the mean annual chlorophyll concentration has not significantly increased or decreased at any of the nearshore stations since monitoring began. Visual observation suggests the mean annual chlorophyll-a concentration has been increasing (worsening) at Stations 030, 070, 100.1, and 110, and decreasing (improving) at Stations 020, 060, 080, and 090 since monitoring began.

The viewscope transparency at the nearshore stations continued to be very good during 2007. However, it is important to point out that statistical analysis of the data show that the mean annual viewscope transparency at Station 060 has decreased (worsened) by approximately 9.9 percent per year since monitoring began. It appears that since 2004, Station 060 has been sampled in a shallower location than where it was sampled at during 1989 through 2003, which could account for the decreasing overall viewscope transparency trend at this station since monitoring began.

Statistical analysis of transparency data from Station 010, 030 and 110 shows that the transparency has not significantly increased or decreased since monitoring began. Visual observations suggests the mean annual transparency has been increasing (improving) at Stations 030 and 070, and decreasing (worsening) at stations 010, 020, 100.1 and 110 since monitoring began.

Statistical analysis of the data shows that the mean annual phosphorus concentration at Stations 030, 070, 080 and 110 has increased (worsened) by approximately 9.7 percent, 8.2 percent, 9.8 percent, and 3.6 percent respectively, per year since 1986. (Please note that the significant worsening trend for Station 030 is exacerbated by the elevated 2005 and 2006 annual mean at this station.)

Statistical analysis of the data also shows that the mean annual phosphorus concentration at Station 060 has decreased (meaning improved) by approximately 9.9 percent per year since 1989. However, it is important to note that this improving trend is exacerbated by the elevated phosphorus concentrations measured during 1989 and 1990 at this station. Since 1991, statistical analysis of the data shows a stable phosphorus concentration at this station.

Visual observations suggest the mean annual phosphorus concentration has been increasing (worsening) at stations 020 and 090 since monitoring began.

pH:

Overall, the pH at the nearshore stations was satisfactory to support aquatic life.

Conductivity:

The 2007 mean epilimnetic conductivity of the nearshore stations ranged between approximately 83.60 uMhos/cm and 87.88 uMhos/cm, which is much greater than the state median for conductivity in epilimnetic waters. The mean annual conductivity

for 2007 is lower than has been measured during the past few years. It is likely that the lack of rainfall during the 2007 sampling season reduced watershed runoff to the lake. Typically, rain events and snow melt cause potentially pollutant laden watershed runoff to reach tributaries and ultimately the lake leading to elevated conductivity levels. Overall, the mean annual conductivity in the epilimnion at each nearshore station has steadily increased (worsened) since monitoring began.

Turbidity:
The mean turbidity reading at the nearshore stations ranged from approximately 0.81 to 13.13 NTUs. Turbidity levels were elevated at Station 080 on the August and September sampling events. Station 080 is particularly shallow, suggesting bottom sediment contamination of the sample. Please remember to inspect the Kemmerer bottle for sediment and re-sample if necessary. Bottom sediment can cause elevated turbidity levels and total phosphorus concentrations.

TRIBUTARY STATIONS

There are numerous tributary systems located throughout the Lake Sunapee watershed that the LSPA continued to monitor on a monthly basis during the 2007 sampling season.

As observed at the in-lake and nearshore stations, the conductivity level in the majority of the tributary sampling locations has gradually increased (worsened) since monitoring began. DES recommends that LSPA continue to monitor the tributary stations on a monthly basis during the sampling season and that rain event sampling be conducted in many locations. In addition, DES recommends that further chloride and sodium sampling be conducted at seven stations (Stations 515.1, 830, 830.15, 830.2, and 835), which have shown excessively high conductivity levels. Ideally, it would be best if all stations with conductivity levels greater than 100 uMhos/cm were sampled for chloride and sodium so that DES can better understand what might be causing the overall increase in conductivity at the tributary, nearshore, and deep spot stations. It is best to conduct tributary chloride and sodium sampling in the spring during snowmelt and during rain events.

There are numerous tributary sampling stations in the Lake Sunapee watershed where the levels of conductivity, phosphorus, and/or turbidity are of concern. Ideally, it would be best if each of these sampling locations could be thoroughly investigated by conducting stream surveys, bracket sampling, and rain event sampling to identify specific sources of pollutant loading. With a limited staff and trained volunteers and a limited budget, we realize that LSPA will need to prioritize additional sampling needs. DES suggests that the tributary systems which contribute the largest amount of stream flow to the lake be investigated first, which include Otter Brook (Station 505), Chandler Brook (Stations 670 and 670.5), Johnson Brook (Station 675), Blodgett Brook (Stations 790, 790.2, and 790.4), Pike Brook (Station 800, 800.5, and 800.8), King Hill Brook (Station 805), and Herrick Cove (Stations 830, 830.15, and 830.2).

For a detailed explanation regarding what specific parameters are of concern and what additional sampling activities are recommended at each of these particular stations, please refer to Appendix D.

***E. coli*:**

The LSPA has discontinued sampling for *E.coli* as a routine parameter for tributary stations due to the relatively low *E.coli* levels that have been found in the tributary samples and the nearshore station samples in the past. The LPSA has decided to collect *E.coli* samples on a case-by-case basis when there is a reason to suspect that there is a problem. DES agrees that *E.coli* and optical brighteners testing should be conducted when there is a suspected problem (such as failing septic systems, animal waste, or waterfowl waste).

However, DES recommends that *E.coli* samples be collected whenever rain event samples are taken since bacteria from fecal matter may be washed into tributaries during rain events.

Sampling Procedures Annual Assessment Audit:
The VLAP Coordinator conducted a sampling assessment of the Lake Sunapee Protective Association deep spot sampling team during 2005. The team followed the proper field sampling procedures and there was no need for the biologist to provide additional training. Therefore, the VLAP Coordinator did not conduct an annual assessment audit during 2006. It is recommended that DES conduct an annual assessment audit of the LSPA every three years. Please call the VLAP Coordinator to schedule your annual biologist visit in 2008.

Field Duplicate Sample Collection
During the 2007 sampling season, the LSPA monitors collected duplicate samples on at least a 10 percent basis when collecting field samples from deep spot, nearshore, and tributary stations. The majority of the duplicate results met the appropriate QA/QC criteria. DES commends the LSPA on implementing this additional form of QA/QC and recommends that the LSPA continues to do so in the future.

Field Data Sheets and Sample Receipt Checklist:
The 2007 sample receipt checklists showed that the majority of the LSPA volunteer monitors continued to follow the proper sampling techniques when collecting deep spot, nearshore, and tributary stations. Volunteers were promptly notified by laboratory staff when corrections in sampling procedures were necessary.

RECOMMENDATION FEASIBILITY AND IMPLEMENTATION
DES acknowledges that it is not unusual for volunteer monitoring groups to have limited access, time, funding, volunteer ability, and training to conduct multiple stream surveys at the same time. Therefore, DES recommends that volunteer monitoring groups prioritize increased sampling needs and then implement a plan to address these needs over time. DES recommends that the tributary systems which contribute the highest percentages of the total streamflow to the lake, new development projects, and roadway improvement projects rank high on the priority list for more in-depth sampling investigations. If the association would like guidance on how to prioritize increased sampling activity needs, or how to conduct nonpoint source studies, please contact the VLAP coordinator.

Despite the need for the implementation of additional sampling and stream surveys, DES commends the LSPA staff and volunteer monitors for continuing to do an excellent job of identifying nonpoint source pollution problems in the watershed and working to correct these problems.

Keep up the good work and please feel free to contact the VLAP Coordinator with any questions or additional needs for guidance and assistance!