OBSERVATIONS &

RECOMMENDATIONS

After reviewing data collected from **NUTTS POND, MANCHESTER,** the program coordinators have made the following observations and recommendations:

Thank you for your continued hard work sampling the pond this season! Your monitoring group sampled **four** times this season. As you know, multiple sampling events each season enable DES to more accurately detect water quality changes. Keep up the good work!

FIGURE INTERPRETATION

➤ **Figure 1 and Table 1:** Figure 1 (Appendix A) shows the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the pond has been monitored through VLAP.

Chlorophyll-a, a pigment found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives an estimation of the algal concentration or lake productivity. **The median summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 4.58 mg/m^3.**

The current year data (the top graph) show that the chlorophyll-a concentration *decreased gradually* from **April** to **June** and then *increased slightly* from **June** to **September**. (Please note that the pond was not sampled during July or August this season.) The elevated chlorophyll concentration on the **April** and **May** sampling events suggest that an algal bloom had occurred in the pond.

The historical data (the bottom graph) show that the 2005 chlorophyll-a mean is *much greater than* the state median and the similar lake median (for more information on the similar lake median, refer to Appendix F).

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 concentration has *fluctuated between approximately 10.8 and 24.8 mg/m³* since **2000**. After 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean chlorophyll-a concentration since monitoring began.

While algae are naturally present in all ponds, an excessive or increasing amount of any type is not welcomed. In freshwater ponds, phosphorus is the nutrient that algae depend upon for growth. Algal concentrations may increase as nonpoint sources of phosphorus from the watershed increase, or as in-lake phosphorus sources increase (such as sediment phosphorus releases, known as internal loading). Therefore, it is extremely important for volunteer monitors to continually educate all watershed residents about activities within the watershed that affect phosphorus loading and pond quality.

➤ **Figure 2 and Table 3:** Figure 2 (Appendix A) shows the historical and current year data for pond transparency. Table 3 (Appendix B) lists the maximum, minimum and mean transparency data for each sampling season that the pond has been monitored through VLAP.

Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (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 from erosion, as well as the natural colors of the water. **The median summer transparency for New Hampshire's lakes and ponds is 3.2 meters.**

The current year data (the top graph) show that the in-lake transparency *increased gradually* from **April** to **September**. (Please note that the pond was not sampled for transparency in July or August.)

The historical data (the bottom graph) show that the 2005 mean transparency is *slightly less than* the state median and was *slightly greater than* the similar lake median (refer to Appendix F for more information about the similar lake median).

Overall, visual inspection of the historical data trend line (the bottom graph) shows a *variable* trend for in-lake transparency. Specifically, the transparency has *fluctuated between approximately 1.76 and 3.10 meters* since monitoring began in **2000**. As previously

discussed, after 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean transparency since monitoring began.

Typically, high intensity rainfall causes sediment erosion to flow into ponds and streams, 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 designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from DES upon request.

➤ **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amount of epilimnetic (upper layer) phosphorus and hypolimnetic (lower layer) phosphorus; the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the pond has joined VLAP.

Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Excessive phosphorus in a pond can lead to increased plant and algal growth over time. **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 current year data for the epilimnion (the top inset graph) show that the phosphorus concentration *decreased slightly* from **April to May,** *decreased* from **May** to **June,** and then *increased slightly* from **June** to **September.** (Again, please keep in mind that the pond was not sampled during **July** or **August.**)

The historical data show that the 2005 mean epilimnetic phosphorus concentration is *greater than* the state median and the similar lake median (refer to Appendix F 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 **April** to **May,** and *increased steadily* from **May** to **September.** (Again, please keep in mind that the pond was not sampled during July or August.)

In addition, the turbidity of the hypolimnion (lower layer) sample was *elevated* on each sampling event this season (ranging from **26.2** to **83.2 NTUs**). This suggests that the lake bottom is covered by a thick organic layer of sediment which is easily disturbed. The orange color of the hypolimnetic water also suggests the iron is present in the bottom layer.

The historical data show that the 2005 mean hypolimnetic phosphorus concentration is *much greater than* the state median and the similar lake median (refer to Appendix F for more information about the similar lake median).

Overall, visual inspection of the historical data trend line for the epilimnion shows an *increasing, meaning worsening,* phosphorus trend since monitoring began in **2000.**

Overall, visual inspection of the historical data trend line for the hypolimnion shows a *decreasing, meaning improving,* phosphorus trend since monitoring began in 2000.

As discussed previously, after 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean phosphorus concentration since monitoring began.

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and the recreational, economical, and ecological value of lakes and ponds. Phosphorus sources within pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands.

TABLE INTERPRETATION

➤ **Table 2: Phytoplankton**
Table 2 (Appendix B) lists the current and historical phytoplankton species observed in the pond. Specifically, this table lists the most dominant phytoplankton species observed in the sample and their relative abundance in the sample.

The dominant phytoplankton species observed in the **June** sample were *Ceratium* **(dinoflagellate),** *Asterionella* **(diatom),** and *Dinobryon* **(golden-brown).**

The dominant phytoplankton species observed in the **September** sample were *Mallomonas* (golden-brown), *Oscillatoria* (cyanobacteria), *Sphaerocystis* (green), and *Ceratium* (dinoflagellate).

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 are typical in New Hampshire's less productive lakes and ponds.

➢ **Table 2: Cyanobacteria**
In addition to the cyanobacteria *Oscillatoria* being one of the most dominant species in the **September** phytoplankton sample, a **small amount** of *Oscillatoria* was observed in the **June** plankton sample this season. *This species, 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 (this is often caused by rain events) 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 (any clean jar or bottle will be suitable) and contact the VLAP Coordinator.

➢ **Table 4: pH**
Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

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 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 surface waters in the state are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean pH at the deep spot this season ranged from **6.42** in the hypolimnion to **6.85** in the epilimnion, which means that the water is *slightly acidic.*

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

Due to the presence of granite bedrock in the state and acid deposition (from snowmelt, rainfall, and atmospheric particulates) in New Hampshire, there is not much that can be done to effectively increase pond pH.

➢ **Table 5: Acid Neutralizing Capacity**
Table 5 (Appendix B) presents the current year and historical epilimnetic ANC for each year the pond has been monitored through VLAP.

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, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) was **16.6 mg/L** this season, which is *greater than* the state median. In addition, this indicates that the pond *has a low vulnerability* to acidic inputs (such as acid precipitation).

> **Table 6: Conductivity**
> Table 6 (Appendix B) presents the current and historical conductivity values for tributaries and in-lake data. 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 mean annual conductivity in the epilimnion at the deep spot this season was **877 uMhos/cm**, which is *much greater than* the state median.
>
> The conductivity continued to remain *much greater than* the state mean in the pond and inlets this season. Typically, sources of increased conductivity are due to human activity. These activities include septic systems that fail and leak leachate into the groundwater (and eventually into the tributaries and the pond), 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 contribute to increasing conductivity. In addition, natural sources, such as iron and manganese deposits in bedrock, can influence conductivity. *In particular, we suspect that untreated urban runoff contributes to the elevated level of conductivity in Nutts Pond.*
>
> We recommend that the City of Manchester implement best management practices to treat stormwater runoff before it flows into the pond.
>
> It is possible that de-icing materials applied to nearby roadways during the winter months may be influencing the conductivity in the pond. In New Hampshire, the most commonly used de-icing material is salt (sodium chloride).
>
> *Chloride sampling was conducted at the deep spot on each sampling event this season. Please refer to the discussion of Table 13 for information regarding chloride results.*

> **Table 8: Total Phosphorus**
> Table 8 (Appendix B) presents the current year and historical total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The total phosphorus concentration was *slightly elevated* (**29 ug/L**) in the **Inlet** on the **April** sampling event this season. The turbidity was also slightly elevated at this station on the **April** sampling event 3.14 NTUs). This suggests that soil erosion may be occurring in this area of the watershed.

If you suspect that erosion is occurring in this area of the watershed, we recommend that your monitoring group conduct a stream survey and storm event sampling along this inlet. This additional sampling may allow us to determine what is causing the *elevated* levels of turbidity and phosphorus.

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" or contact the VLAP Coordinator.

➤ **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**
Table 9 (Appendix B) shows the dissolved oxygen/temperature profile(s) for the 2005 sampling season. Table 10 (Appendix B) shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column 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 *lower in the hypolimnion (lower layer) than in the epilimnion (upper layer)* at the deep spot of the pond on the **April, May,** and **September** sampling event. In addition, it is important to point out that the hypolimnetic dissolved oxygen became *increasingly depleted* as the summer progressed.

As stratified ponds age, and as the summer progresses, oxygen typically becomes *depleted* in the hypolimnion by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake/pond where the water meets the sediment. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion, 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*).

➢ **Table 11: Turbidity**

Table 11 (Appendix B) lists the current year and historical data for in-lake and tributary 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.

As discussed previously, the hypolimnetic turbidity was *elevated* on each sampling event this season, and has been *elevated* on most previous sampling seasons. This suggests that the lake bottom is covered by a thick organic layer of sediment which is easily disturbed. The orange color of the hypolimnetic water also suggests the iron is present in the bottom layer.

➢ **Table 12: Bacteria (*E.coli*)**

Table 12 lists only the historical data for bacteria *(E.coli)* testing. (Please note that Table 12 now lists the maximum and minimum results for all past sampling seasons.) *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.

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.

➢ **Table 13: Chloride**

The chloride ion (Cl-) is found naturally in some surfacewaters 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.

The deep spot was sampled for chloride on each sampling event this season. The results ranged from **157 to 290 mg/L** in the **epilimnion, 290 to 520 mg/L** in the **metalimnion**, and **440 to 765 mg/L** in the **hypolimnion**.

Results *greater than* 230 mg/L exceeded the state chronic chloride criteria and *all results* were *much greater than* what is typically observed in New Hampshire's lakes and ponds. It is also important to point out that the 2005 chloride results at the deep spot were *greater than* the 2004 results.

These data suggest that a **chemocline** is present in **Nutts Pond.**

We recommend that your monitoring group continue to conduct chloride sampling at the deep spot, particularly in the spring soon after snow-melt and after 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 there will be an additional cost for each of the chloride samples and that these samples must be analyzed at the DES laboratory in Concord. In addition, it is best to conduct chloride sampling in the spring as the snow is melting and during rain events.

➢ **Table 14: Current Year Biological and Chemical Raw Data**
This table lists the most current sampling season results. Since the maximum, minimum, and annual mean values for each parameter are not shown on this table, this table displays the current year "raw" (meaning unprocessed) data. The results are sorted by station, depth zone (epilimnion, metalimnion, and hypolimnion) and parameter.

➢ **Table 15: Station Table**
As of the Spring of 2004, all historical and current year VLAP data are included in the DES Environmental Monitoring Database (EMD). To facilitate the transfer of VLAP data into the EMD, a new station identification system had to be developed. While volunteer monitoring groups can still use the sampling station names that they have used in the past (and are most familiar with), an EMD station name also exists for each VLAP sampling location. For each station sampled at your pond, Table 15 identifies what EMD station name corresponds to the station names you have used in the past and will continue to use in the future.

DATA QUALITY ASSURANCE AND CONTROL

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 the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did an *excellent* job when collecting samples and submitting them to the laboratory this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the laboratory staff to contact your group with questions, and no samples were rejected for analysis.

USEFUL RESOURCES

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, NHDES Booklet WD-03-42, (603) 271-2975.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet WMB-10, (603) 271-2975 or www.des.state.nh.us/factsheets/wmb/wmb-10.htm.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, NHDES Fact Sheet WD-SP-1, (603) 271-2975 or www.des.state.nh.us/factsheets/sp/sp-1.htm.

Impacts of Development Upon Stormwater Runoff, NHDES Fact Sheet WD-WQE-7, (603) 271-2975 or www.des.state.nh.us/factsheets/wqe/wqe-7.htm.

Iron Bacteria in Surface Water, NHDES Fact Sheet WD-BB-18, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-18.htm.

Low Impact Development Hydrologic Analysis. Manual prepared by Prince George's County, Maryland, Department of Environmental Resources. July 1999. To access this document, visit www.epa.gov/owow/nps/lid_hydr.pdf or call the EPA Water Resource Center at (202) 566-1736.
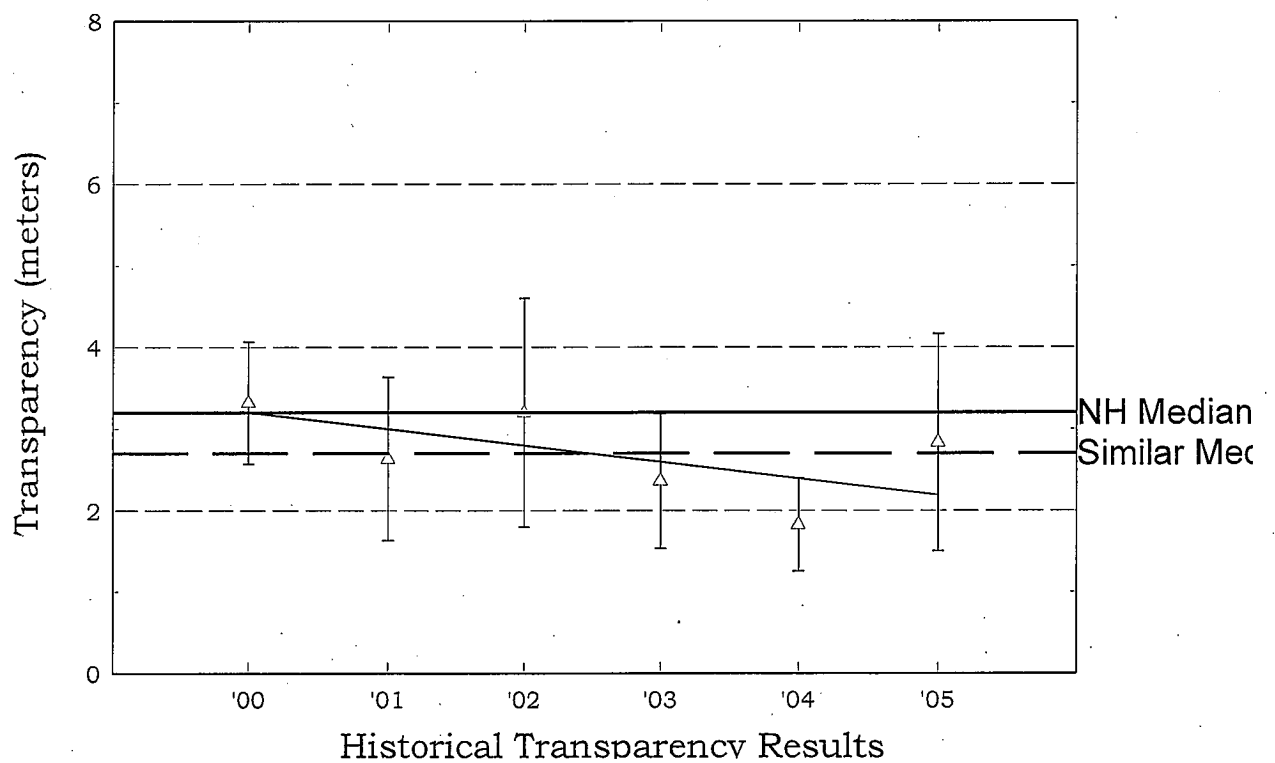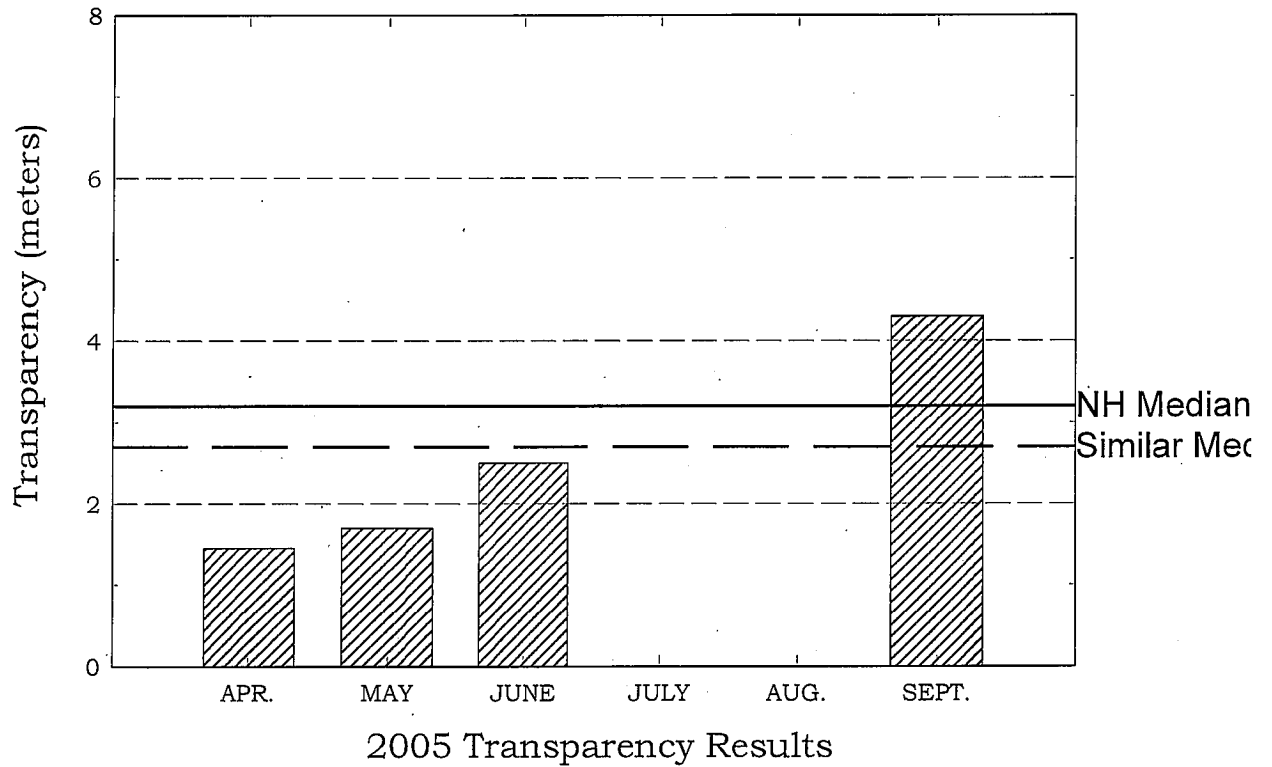
Nutts Pond, Manchester

Figure 1. Monthly and Historical Chlorophyll-a Results
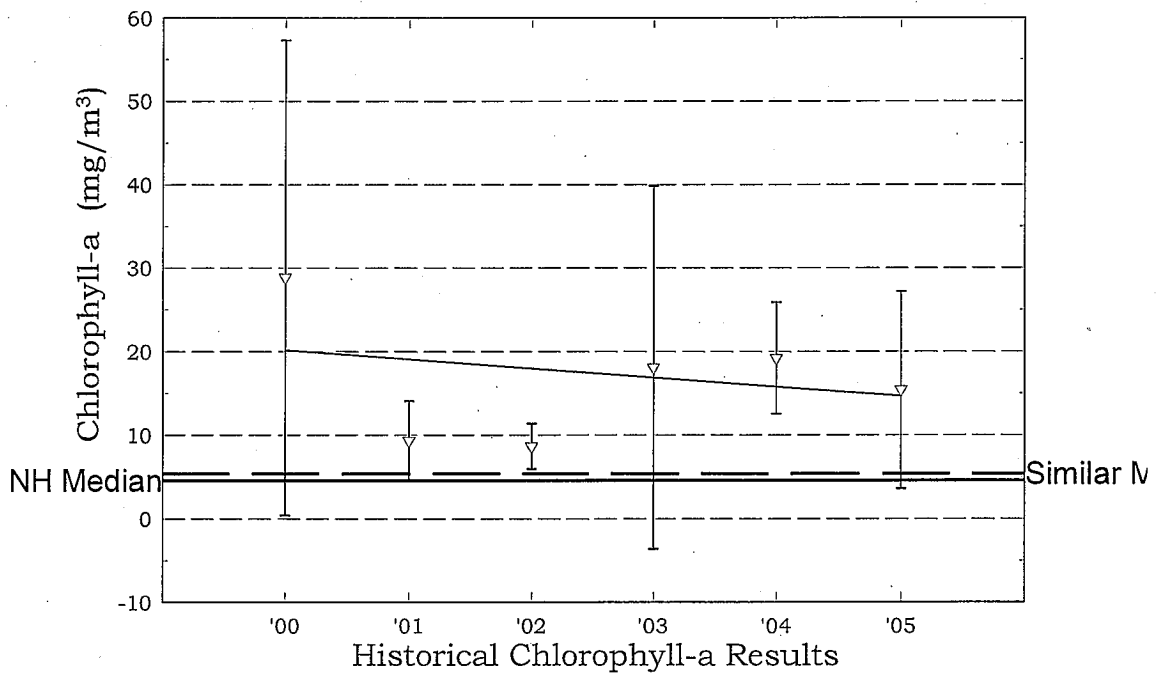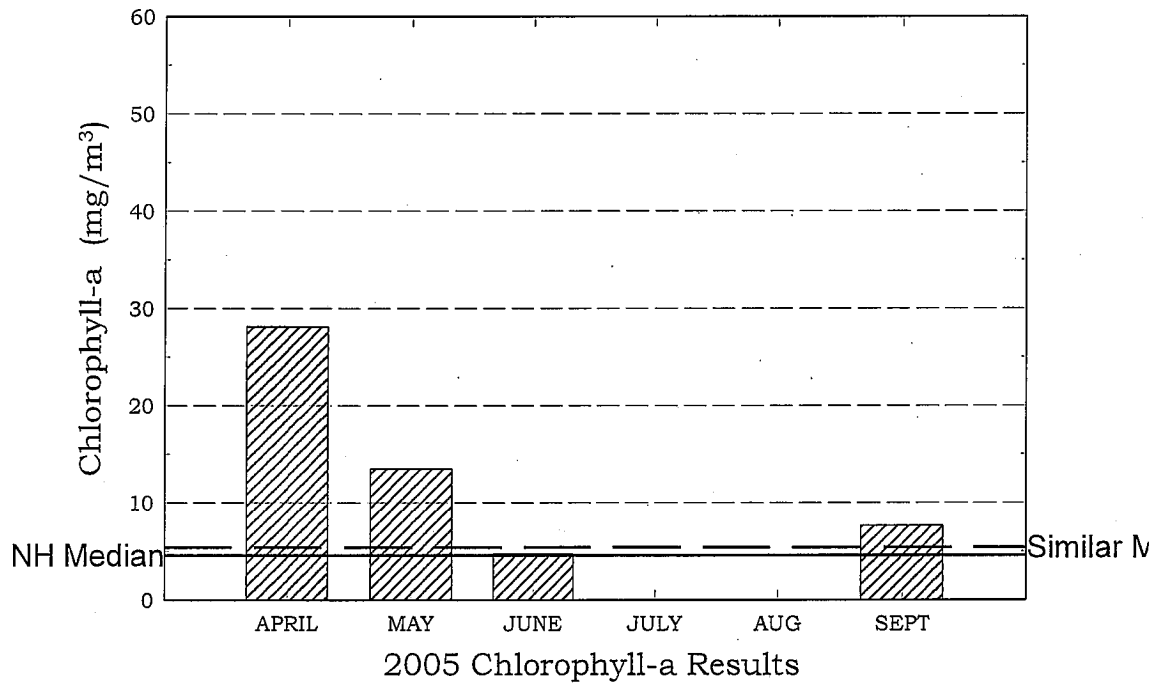
Nutts Pond, Manchester

Figure 2. Monthly and Historical Transparency Results

2005 Transparency Results

Historical Transparency Results

Nutts Pond, Manchester

Figure 3. Monthly and Historical Total Phosphorus Data.

Epilimnion (Upper Water Layer)

Hypolimnion (Lower Water Layer)