New Hampshire Volunteer Lake Assessment Program

Clough Pond
Loudon
2009 Interim Report

NHDES
Water Division
Watershed Management Bureau
29 Hazen Drive
Concord, NH 03301

NEW HAMPSHIRE DEPARTMENT OF
Environmental Services

Acknowledgements

The New Hampshire Department of Environmental Services Volunteer Lake Assessment Program (VLAP) is a collaborative effort that depends on the cooperation of many people. The continued help and support of these individuals and groups has contributed to the increased popularity of VLAP during its 25-year history.

The VLAP Coordinator and Limnology Center Director extend their greatest thanks to each of the devoted volunteer monitors for spending countless hours sampling, and identifying potential watershed pollution. The wealth of water quality information collected by volunteers is overwhelming and the data is instrumental to the Environmental Protection Agency and the NHDES to commit resources to the production of Total Maximum Daily Loads (TMDLs) and watershed management planning that help protect our beautiful lakes. We also thank the volunteers for their continued support and enthusiasm for the program.

The VLAP Coordinator and Limnology Center Director also extend a well deserved thank you to the following DES staff:

- Biology Section Interns Anna Sullivan, Alicia Pickett-Hale and Deidra Sargent for conducting annual biologist visits, analyzing samples in the laboratory, and managing data.
- Kathryn Rosengren for her tireless efforts to manage the Plymouth State University (PSU) Satellite Laboratory to ensure its operation for VLAP and Volunteer River Assessment Program (VRAP) groups.
- Jen Drociak, DES Volunteer River Assessment Program Coordinator, for assisting in VLAP plankton sample analysis.
- Teresa Ptak, DES Clean Vessel Act Program Coordinator, and Megan Kerivan, Biology Section Intern, for chlorophyll-a analysis.
- Scott Ashley, DES Biology Section Quality Assurance and Control Officer, for data management and PSU Satellite Laboratory oversight.
- Andrew Cornwell, DES Watershed Management Bureau Data Specialist, for data management and GIS support.
- DES Laboratory Services staff who handled a constant influx of total phosphorus and *E.coli* samples from VLAP, yet continued to deliver results quickly to volunteers.

The VLAP Coordinator and Limnology Center Director also recognize the staff and interns of the Lake Sunapee Protective Association (LSPA), Colby-Sawyer College (CSC), and the Sunapee Satellite Laboratory in New London for supporting VLAP monitoring efforts in the Lake Sunapee region. The CSC-LSPA Satellite Laboratory, under the management of Bonnie Lewis, continued to distribute equipment to volunteer monitors and process samples in an extremely professional and timely manner.

We would again like to thank Kathryn Rosengren, DES Intern, for managing the PSU Satellite Laboratory in the interim between hiring a new Laboratory Manager. The PSU

Satellite Laboratory provided equipment and processed samples for a number of lakes and rivers in Northern New Hampshire this season. A new PSU Satellite Laboratory Manager, Aaron Johnson, is now on board. We encourage area lake monitors to utilize the PSU Satellite Laboratory for samples analyses and technical assistance.

VLAP Lakes and Volunteer Monitors 2009 Sampling Season

Angle Pond, Sandown	Brant Sayre, Fred Black, Norm Baxter
Armington Lake, Piermont	Mike Poole, Grita Taylor, Robert Pode
Ashuelot Pond, Washington	Don Damm, Erin Zanni
Ayers Pond, Barrington	Ron St. Jean, Diane St. Jean, Michael Cavanaugh
Baptist Pond, Springfield	Perry Hodges, Bob Ruel, B. Harriett
Baxter Lake, Farmington	Rene Turgeon
Bearcamp Pond, Sandwich	Gail Colozzi, Bob Greene
Beaver Lake, Derry	Bob Madden, Tim Pellegrino, Tristan Smith
Berry Bay, Ossipee	Tara Schroeder, Susan Marks, Molly Newton
Blaisdell Lake, Sutton	Leon C. Malan
Broad Bay, Ossipee	Tara Schroeder, Molly Newton, Susan Marks
Burns Pond, Whitefield	Ed Betz
Canaan Street Lake, Canaan	John Bergeron, Tim Jennings, Dan Fleetham Sr., Pierce Rigrod, Dudley Smith, Rob Schaffer
Canobie Lake, Windham	Dick Hannon, Bob Schroeder, Alexia Hannon
Captain's Pond, Salem	Charlie Hudson
Center Pond, Stoddard	Glenn Webber
Chalk Pond, Newbury	Dennis Varley
Chapman Pond, Sullivan	Richard Smith, Nicki Barth
Chase Pond, Wilmot	Wayne Hayes
Chestnut Pond, Epsom	Martha Chase, Barry Arseneau
Clement Pond, Hopkinton	Marianne and Rich Sharpe, Amy Sharpe, Jason Gilligan
Clough Pond, Loudon	Curt Darling, Tom Edwards
Cobbetts Pond, Windham	Tom Leclair, John Pallaria, Derek Monson
Cole Pond, Andover	Ann Schultz
Conner Pond, Ossipee	Lynne Hart, Anita Fahy
Contention Pond, Hillsboro	Bob Taraskiewicz, Bill Munsey
Contoocook Lake, Jaffrey	Ted Covert, Leon Noel, Carolyn West
Crescent Lake, Acworth	Tim Perry, Stan Rastalis, Bob Kroupa, Jerry Bushway, Sue Paton, Mike Heidorn, Bill Paxton
Crystal Lake, Gilmanton	Jean Martin
Crystal Lake, Manchester	Todd Connors, Jeff Marcoux, Jen Drociak
Danforth Pond, Lower, Freedom	Tara Schroeder, Molly Newton
Deering Lake, Deering	Bob Compton, Connor Compton, Dick and Barbara Boudrot
Dodge Pond, Lyman	Patti Slavtcheff, Donna Trudell
Dorrs Pond, Manchester	Jeff Marcoux, Jen Drociak
Dublin Lake, Dublin	Karen Bunch, Felicity Pool, Hannah Atmer, Margot Sprague, Louisa Birch
Duck Pond, Freedom	Bill Clark
Dutchman Pond, Springfield	Jen Fletcher
Eastman Pond, Grantham	Jackie Underhill, Bill Underhill, Bev Woodhouse, Mary O'Rourke, Ron Carr, Jan Evans, Dick Hocker, Bob Parker, Charlie McCarthy, Gale Schmidt, Shelia Shulman, Jane Ralph, Maynard Wheeler
Emerson Pond, Rindge	Jim and Martha Grant
Forest Lake, Dalton/Whitefield	Neil Lupton, Clare Lupton, Rick Wright

Forest Lake, Winchester	Dave Johnson, Doug Sears
French Pond, Henniker	Mike French
Frost Pond, Jaffrey	Leslie Whone
Garland Pond, Moultonborough	Tim Sullivan
Gilmore Pond, Jaffrey	Mike Lichter
Goose Pond, Canaan	Dave Barney, Wayne Casey, Mike Riesf
Governor's Lake, Raymond	Ken Pothier
Granite Lake, Nelson/Stoddard	Tom Newcombe, Ian Newcombe
Great Pond, Kingston	Dave Ingalls, Skip Clark, Ted Holcombe, William Bixby
Gregg Lake, Antrim	Bob Southall
Halfmoon Lake, Barnstead	Mike Fedorchak, Larry Holt, Bill Dugan, Frank Bramante
Halfmoon Pond, Washington	Carol Andrews, Richard Fairweather
Harantis Lake (Houston Pond), Chester	Jo Columbus
Harrisville Pond, Harrisville	Suzanne Coble, Tucker Cutler
Harvey Lake, Northwood	Karen Smith, Nick Charest
Hermit Lake, Sanbornton	Marie Westcott
Highland Lake, Andover	Len Davis, Robert Welch, Frank Baker, Joe Smith, Jim Cooley
Highland Lake, Stoddard/Washington	Jeff Berry, William Bearce, Mike Jubert
Hills Pond, Alton	Carol Marcin, Andrea Knight, Gary Murphy
Horseshoe Pond, Concord	Thomas Roy
Hunkins Pond, Sanbornton	Lisa Rixen, Lisa Morin
Island Pond, Stoddard	Don Flemming, Geof Molina
Island Pond, Washington	Jean and Mike Kluk, Lawrence Allen, John Butcher, Robin and Tucker Schuldt
Island Pond, Big, Derry/Hampstead	Herb Lippold, Drennan Lowell, Len Snell, Dick Jones
Jenness Pond, Northwood	Hal Kreider, Earl Klaubert, Ron Covey
Katherine, Lake, Piermont	George and Joyce Tompkins, Helga Mueller
Kezar Lake, North Sutton	Ken Sutton, Keith Brooks, Charlie Ash
Kilton Pond, Grafton	John and Jan Bidwell
Kimball Pond, Canterbury	Bob Fife
Knowles Pond, Northfield	Alan and Cindy Leach
Kolelemook Lake, Springfield	Gerald Cooper, B. Cooper
Laurel Lake, Fitzwilliam	Barbara Green, Phyllis Lurvey, Perry and Roberta Nadeau, Daniel Shrives, Kathy Olson, Fred Krompegal, Linda Anderson
Leavitt Bay, Ossipee	Tara Schroeder, Molly Newton, Susan Marks
Ledge Pond, Sunapee	Bruce and Shirley Thompson, Bob and Ellen Kanerva
Lees Pond, Moultonboro	Karin Nelson, Bev Nelson, Jim Nelson
Locke Lake, Barnstead	Cindy and Jim Covalucci, Janice Rice, Chris Joly, Judy Strachan, Bev Lussier
Long Pond, Lempster	Al Grotheer, Nola Gerrits
Long Pond, Pelham	Flo and Dave Parece
Loon Lake, Plymouth/Rumney	Rich Stewart, Dean Moss, Jim Flynn, Darryl Howes
Loon Pond, Gilmanton	Richard Hillsgrove
Lower Beech Pond, Tuftonboro	Jim Minieri, Richard Crawford, David Fielding, Marsha and Jim Murphy, Marty Martel, Eedee Dopp, Rex Hawley, Tom Kennedy, Sandy Newman
Lyford Pond, Canterbury	Frank and Claire Babineau

Martin Meadow Pond, Lancaster	Bruce Ferguson, John Ogel, Jim Whithand, John Gale
Mascoma Lake, Enfield	Roger Barnes, Austin Flint, Jim Martel, Lee Hammon, Erland Schulson, Andy Tobins, Ray Buskey, Jack Foster, Bill Martel, Lee Hammond, Roger Hammond, Jim Magnell
Lake Massasecum, Bradford	Dave Currier, Chase Hand, Robert Toppi
May Pond, Washington	Mike and Sherry Morrison
Messer Pond, New London	Nancy and Bruce Stetson, Terri Bingham, John Harris, Harvey P.
Mill Pond, East Washington	Jed and Nan Schwartz
Millen Pond, Washington	Dennis O'Malley, Tyler Libby
Mirror Lake, Tuftonboro	Beth and Larry Urda, Pam Urda
Lake Monomonac, Rindge	Lorraine Gauthier, Andy and Skip McCusker, Drew Graham, Kevin McCusker
Moores Pond, Tamworth	Donald Pepin
Mountain Lake, North, Haverhill	Don Drew
Mountain Lake, South, Haverhill	Don Drew
Mountainview Lake, Sunapee	Eleanor Thompson, James Segalini
New Pond, Canterbury	Mike Ryan, Ginny Dow
Northwood Lake, Northwood	Andrea Tomlinson, Ray Grandmaison, Babette Morrill
Norway Pond, Hancock	Dick and Josephine Warner
Nubanusit Lake, Nelson	Dave Birchenough, Maurice Lagace, Ed MacDonald
Nutts Pond, Manchester	Jen Drociak, Jeff Marcoux
Onway Lake, Raymond	Jonathan Wood, Francis McManus
Lake Ossipee, Ossipee	Tara Schroeder, Molly Newton, Bob Reynolds
Otter Pond, New London/Sunapee	Gerry, Betsy, and Chris Shelby
Otternick Pond, Hudson	Mike Cunningham, Nancy Branco
Partridge Lake, Littleton	Dayton Goudie, Mark Meau
Pawtuckaway Lake, Nottingham	Jim Kelly, Steve Donahue, Will Urban, Rick Morrissey, Jack Caldon
Pea Porridge Pond, Big, Madison	Bob Borchers, Ralph Lutjen, Rich Sholtanis, Paul Mattatall, Joe Lee, P. McKenna, Bob Ingram
Pea Porridge Pond, Mid, Madison	Bob Borchers, Ralph Lutjen, Rich Sholtanis, Paul Mattatall, Joe Lee, P. McKenna, Bob Ingram
Pearly Pond, Rindge	Phil Folsom, Mark Evans
Pemigewasset Lake, Meredith	Paul Flaherty, Bob Peach
Perkins Pond, Sunapee	Gary Szalucka, Robin Saunders
Phillips Pond, Sandown	Barbara Cameron, Ed Smith, Frank and Sherry King, Al and Marion Lake
Pillsbury Lake, Webster	M.J. Turcott, Pat Adams
Pine Island Pond, Manchester	Merrill Lewis, S. Donahue
Pine River Pond, Wakefield	Carl True, Dave Lee, Barry Fryer, Jim Fitzpatrick, Jeff Bintz
Pleasant Lake, Deerfield	Chuck Reese, Jim Creighton
Pleasant Lake, New London	Dick Kellom, Terry Dancy, Kittie Wilson, John Wilson, Pete Dunning, Hod Moses
Pleasant Pond, Francestown	Anne Clark, Thomas and Jaclyn Clark, Harry Woodbury
Pleasant Pond, Henniker	Ruth and John Heespelink
Pool Pond, Rindge	Missy and Eric Eckstein, Barbara Maffett

Post Pond, Lyme	Lou-Anne Conroy, Tom Morrissey
Powwow Pond, East Kingston	Scott Urwick, Laurel Urwick, Adrienne Urwick
Pratt Pond, New Ipswich	Ralph Barker
Province Lake, Effingham	Steve and Mary Craig
Rand Pond, Goshen	Bernie Cutter, Rich Locke
Reservoir Pond, Lyme	Lee Larson
Robinson Pond, Hudson	Pete Heller, Mitch Albanese, Jane Bowles
Rock Pond, Windham	Sue and Frank Burgess
Rockwood Pond, Fitzwilliam	Frank Bateman, Bruce Bender
Rockybound Pond, Croydon	Catherine Stroomer, Don Hanlon, Barry Wade, Liz Lee
Round Pond, Little, Wakefield	Dave Guinta
Round Pond, Lyman	Patti Slavtcheff, Donna Trudell
Russell Reservoir, Harrisville	Bob Sturgis
Rust Pond, Wolfeboro	Ed Webb, Keith Simpson, Christie Parker
Sand Pond, Marlow	Jaye and Ted Aldrich, Mark and Pat Allen
Sawyer Lake, Gilmanton	Jess Day, Paula Adams
Scobie Pond, Francestown	Chuck Rolph
Sebbins Pond, Bedford	Louis Pinard, Mackenzie Turgeon
Shellcamp Pond, Gilmanton	Mike and Leona Jean
Showell Pond, Sandown	Fred Riley, Tina Buckley
Silver Lake, Harrisville	Roger and Sandy Williams, Panos Pitsas, Chet Hurd
Skatutakee Lake, Harrisville	B. J. Adams, Gordon Page, George Lowery
Snake River, New Hampton	Janan Hays
Sondogardy Pond, Northfield	Mark and Donna St. Cyr
Spectacle Pond, Enfield	Kathy Gips, Liz Bankert
Spofford Lake, Chesterfield	Bayard Tracy, David Wood, Pam Walton, Elliot Rowsey, Fred Szmit
Stevens Pond, Manchester	Jeff Marcoux, Jen Drociak
Stinson Lake, Rumney	Les Gilbert, Ken Soper, Jack McInnis
Stocker Pond, Grantham	Pat Woolson
Stone Pond, Marlborough	Marge Shepordson, Ira Garvin
Sunapee Lake, Sunapee	Dave Beardsley, Kristen Wills, Chase, and Cortland Begor, Chris and Tom McKee, Deb Benjamin, George and Jill Montgomery, Joe Goodnough, June and Peter Fichter, Kara Obey, S. Godin, Malory Newcombe, Kayla Reed, C. Lewin, D. Mikita, Midge Eliassen, Sue and Gene Venable, Robert Wood, Clare Bensley, Bruce Byrne, Dick Katz, John Robb, Sue Eaton, Bill Hall, Bob and Glenda Cottrill, Shelby Blunt, Jack Sheehan, Jack Hambley, Bonnie Lewis, Robert Kenerson, Brianna, Danielle
Sunapee Lake, Little, New London	Jack Sheehan, Robert Scott, Sarah Snyderman
Suncook Pond, Upper, Barnstead	Randy Roberts
Suncook Pond, Lower, Barnstead	Randy Roberts
Sunset Lake, Alton	Carol Marcin, Andrea Knight, Tony Lampsana, Bill Marson
Swanzey Lake, Swanzey	Ronnie and Ann Bedaw
Tarleton Lake, Piermont	Helga Mueller, George and Joyce Tompkins
Thorndike Pond, Jaffrey	Jim Banghart
Todd Lake, Newbury	Norman Lehouiller, Bob Doherty, John Warren
Tolman Pond, Nelson	Barry Tolman

Tom Pond, Warner	John Hamilton
Tucker Pond, Salisbury	Tom Duffy, Brennen Vargas
Turee Pond, Bow	Kally Abrams, Quinn Abrams
Walker Pond, Boscawen	Steve Landry, Bruce and Kate Johnson, Maxwell and Betsy Millard, Susan Roman, Michele Tremblay
Warren Lake, Alstead	Kate Tarlow Morgan, Mike Heirdorn, Dave Lawlor, Rosemary Dowling, Zev Kazati-Morgan
Waukeena Lake, Danbury	Don and Kenneth Hartford, Judith and Tom Brewer
Lake Waukewan, Meredith	Boo Gershun, Don Thompson, Duncan McNeish, Neil Akiyama
Webster Lake, Franklin	Shelley Pellegrini, Brian Campbell
White Oak Pond, Holderness	Galen Beach, Nancy Voorhis
Wicwas Lake, Meredith	David and Marjorie Thorpe, John Ramsay
Wilson Pond, Swanzey	Tom Bouffard, Dave Norris, Rebecca Madrigal, Jim Glimenakis, Abbott Fletcher
Lake Winnepocket, Webster	George Embley, Dennis Card, Maureen McCanty
Lake Winnisquam, Laconia/Belmont	Dave and Charlene Reinauer, Dave McLaughlin, C. McLaughlin, E. McLaughlin, Dave Burns, Emily Burns
Lake Winona, New Hampton	Lee Gardinier, Penny Burke, Arthur Dunscombe

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Introduction

The 2009 VLAP Sampling Season

The Volunteer Lake Assessment Program (VLAP) set a new participation record for the third straight season. A total of 178 lakes were sampled, 2 new lakes joined the program, and approximately 500 volunteer monitors participated in the VLAP!

We extend a special welcome to the volunteer monitoring groups that joined VLAP for the first time this year. These volunteers represent the following waterbodies: Kimball Pond, Canterbury; and Walker Pond, Boscawen.

And, we welcome back our friends and new monitors at Sawyer Lake, Gilmanton; and Wilson Pond, Swanzey who rejoined VLAP during the 2009 season.

2009 Weather Conditions in New Hampshire

The 2009 sampling season was marked by cool temperatures and above average wetfall. According to the National Weather Service climate data, May was colder and wetter (3.96 inches of rain in Concord, NH) than normal; June was colder and much wetter (10th wettest June on record and double the normal rainfall for Concord, NH); July set records for cold and wet weather (9th coldest and 6th wettest July on record for Concord, NH); August was slightly warmer but wetter (over four inches of rain and nearly one inch above normal in Concord, NH); and September was colder and much drier (13th driest September on record for Concord, NH). Overall, 23 inches of rain fell from May through September, making it the 4th wettest summer on record (past 140 years) for Concord, NH. Also note that 2008 was the 8th wettest summer and 2006 was the 7th wettest summer on record. Is this a lasting phenomenon?

The rainy 2009 season increased nutrient loading to many lakes and ponds. The wet conditions likely led to increased plant, algal and bacterial growth. However the decreased sunlight and cooler water temperatures may have kept overly abundant plant and algal growth at bay. The increased stormwater runoff volumes likely elevated turbidity, decreased water clarity, and increased phosphorus.

Stormwater runoff also provided the nutrients required for accelerated cyanobacteria growth. Fourteen VLAP lakes experienced cyanobacteria bloom conditions that resulted in public beach advisories or health warnings to lake residents.

2009 Program Updates

Plymouth State University's (PSU) VLAP Satellite Laboratory lost it's Lab Managers and operated at a diminished capacity this season. However a new Lab Manager, Aaron Johnson, has been hired and we anticipate the lab to be fully operational next season. We welcome Aaron into this challenging role and look forward to working with him in the future. Feel free to stop by and say hello to Aaron this winter and spring.

VLAP will continue work on a grant from the National Oceanic and Atmospheric Administration (NOAA). The grant is targeted for the North Country to increase program participation and volunteer monitoring for VLAP, VRAP and Weed Watchers (VLAP's sister programs). Volunteer monitoring groups located in the North Country can expect easy access to monitoring equipment and sample bottles. Also, please look for upcoming educational and outreach initiatives targeted at the North Country.

2009 Report Updates

Appendix B (Data Tables) in the Biennial Reports has undergone a minor change. The first page of a data table will include the Table Number, Lake Name, Town, and Table Description in the header. Subsequent pages will not include this information, however the footer will indicate the table number and page number. For example: 1-1, 1-2, 1-3 corresponds to table 1 page 1, table 1 page 2, and table 1 page 3.

Concluding Remarks

Carerfully read the "Observations and Recommendations" and "Data Quality Assessment and Quality Control" sections of your report, and *pay special attention to our recommendations* to improve lake quality and the current sampling program. These suggestions provide a mechanism to identify watershed pollution sources and develop management plans to reduce pollutant loads and improve water quality. Please take advantage of these important recommendations. Also, if a stream survey was recommended, please contact the VLAP Coordinator in the spring to schedule a survey before the busy summer sampling season.

This year's Special Topic Article **"Lake Drawdown: Friend or Foe"** is found in Appendix C of the Interim Report and Appendix D of the Biennial Report. This will provide you with a useful tool to evaluate the pros and cons to lake drawdowns along with the DES Fact Sheets *Lake Drawdowns for Weed Control* and *Why Lake Drawdowns are Conducted*. Please share the information with your neighbors and town officials.

We realize that a vast amount of important information is presented in the following report. If you have any questions regarding your 2009 report, please feel free to contact us. And finally, please contact the VLAP Coordinator this spring to schedule the annual biologist visit, stream survey or site walk, or to schedule a summer lake association meeting speaker.

Sincerely,

Sara Steiner
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Data Interpretation: Reading Your Report

Upon receiving your annual report, please read the "Observations and Recommendations" section carefully. Current and historical water quality trends for your lake and its tributaries are described in detail. You may find it helpful to refer back to the "Monitoring Parameters" section of your report to better understand the information provided in the "Observations and Recommendations" section.

Interim Report

Figures 1 through 3 in the "Observations and Recommendations" section graphically display deep spot sampling data. The data tables in Appendix A summarize current year deep spot and tributary data.

In the "Observations and Recommendations" section, the deep spot data for most parameters sampled is compared to the respective New Hampshire median to provide an understanding of how the quality of your lake deep spot compares to other New Hampshire lake deep spots.

Biological: Living plants or organisms.

Chemical: Parameters related to the chemistry of water.

Physical: Parameters that can be perceived using the senses, such as Secchi Disk transparency.

Epilimnetic: Of the upper thermal layer of the lake.

Biennial Report

The graphs in Appendix A display deep spot sampling data. The data tables in Appendix B summarize the current year and historic deep spot and tributary data by providing the annual mean and maximum and minimum values for each parameter sampled by your monitoring group.

In the "Observations and Recommendations" section, the deep spot data for most parameters sampled is compared to the respective New Hampshire median to provide an understanding of how the quality of your lake deep spot compares to other New Hampshire lake deep spots. The following table summarizes key **biological, chemical, and physical** parameters for all the state's lakes surveyed since 1976.

Summer Epilimnetic Values of New Hampshire Lakes

Parameter	#*	Min	Max	Mean	Median
pH (units)	780	4.3	9.3	6.5**	6.6
Alkalinity (mg/L)	781	-3	85.9	6.6	4.9
Total Phosphorus (ug/L)	772	<1	121	-	12
Conductivity (uMhos/cm)	768	13.1	696	59.4	40.0
Chloride (mg/L)	742	<2	198	-	4
Chlorophyll-a (mg/m3)	776	0.19	143.8	7.16	4.58
Secchi Disk (m)***	663	0.40	13	3.7	3.2

** = the number of lake stations sampled*

*** = average pH reading; not average of hydrogen ion concentration*

**** = does not include "visible on bottom" readings*

Recommendations discussed in the "Observations and Recommendations" section may include adding additional sampling locations and increasing the number of sampling events your monitoring group conducts. Expanding your sampling program will provide additional data that will help DES determine more accurate and representative trends and will also help identify pollution sources. Recommendations may also include encouraging your monitoring group to work with your lake association, watershed residents, and local officials to implement management practices to protect and improve lake quality.

After reviewing your annual report, discuss the recommendations with your monitoring group and lake association. Prioritize the recommendations according to your association's goals. Then, contact the VLAP coordinator to discuss how to effectively implement an action plan.

Data Interpretation: Graphs and Tables

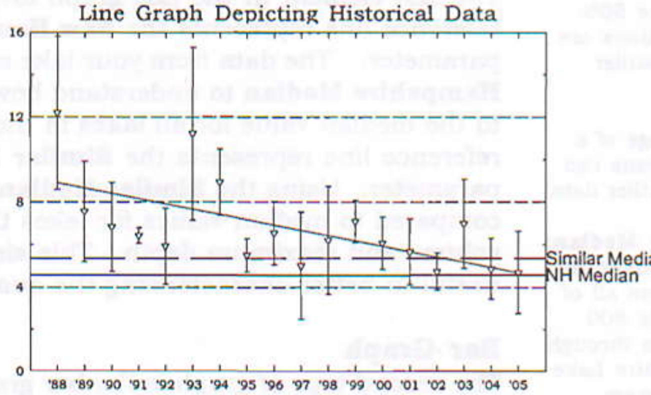
There are two types of graphs in the Biennial Report (Appendix A) and the Interim Report (Figures 1 through 3), a line graph and bar graph, which present deep spot chlorophyll-a, transparency, and phosphorus data. Each graph conveys much more information to the reader than a table or verbal description could, so it is important that the reader is able to interpret these graphs.

Line Graph

Mean: Average. To calculate the mean, the reading or concentration for a particular parameter on each sampling event is added together, which results in a total for the season. The season total is then divided by the number of sampling events during the season, which results in an average concentration or reading per sample event.

The line graph summarizes sampling results for the years your group has collected data, as shown in the example below. The graph shows the **mean** for a given year as an up-turned or down-turned triangle. The triangle points in the direction of more desirable values. For example, chlorophyll-a and total phosphorus have downward triangles, indicating lower values are better, while transparency has upward triangles, signifying higher values are more desirable.

Line Graph Depicting Historical Data



Standard deviation: A statistic measuring the spread of the data around the mean.

Range: Difference between the high and low values.

Variation: the extent to which or range in which data varies.

A measure of the spread of the data around the mean, or **standard deviation,** is shown as the vertical lines extending up and down from the mean. Standard deviation is similar to **range** except standard deviation is a more exact measure of variation. In this case, the lines indicating standard deviation on your graphs illustrate the amount of **variation** in the results for a particular test for all the times you sampled in that year. For example, if all the chlorophyll results were similar each time you sampled this year, then the amount of deviation from the average would be small. If there was a wide range of chlorophyll concentrations in the lake, then the deviation would be large.

Regression Line: A statistical tool used to predict trends in data.

Annual trends data can be discerned by looking at the **regression line** and noting its direction and degree of slant. If the line is slanted downward (like this "\"), it indicates an improving trend in chlorophyll-a and total phosphorus, but a worsening trend in transparency. If the line is slanted upward (like this "/"), it depicts a worsening trend in chlorophyll-a and phosphorus, but an improving trend in transparency. The steeper the slope of the regression line, the stronger the trend. A horizontal regression line indicates the parameter is stable, neither improving nor worsening over time.

Linear Regresion: The process of finding a straight line that best approximates a set of points on a graph

Outlier: A value far from most others in a set of data.

Skew:A measurment of consistency, or more precisely, the lack of consistency.

Median: A value in an ordered set of values below and above which there is an equal number of values (i.e.; the 50% percentile). Medians are not affected by outlier data.

Mean: The average of a set of values. Means can be affected by outlier data.

New Hampshire Median: A descriptive statistic for data collected from all of the approximately 800 lakes in the state through the New Hampshire Lake Assessment Program.

New Hampshire Mean: A descriptive statistic for data collected from all of the approximately 800 lakes in the state for the New Hampshire Lake Assessment Program.

Similar Median: Using New Hampshire Lake Assessment Program data, New Hampshire lakes have been classified into ten categories based on lake maximum depth and lake volume. Median values for particular parameters have been determined for each of the ten groups.

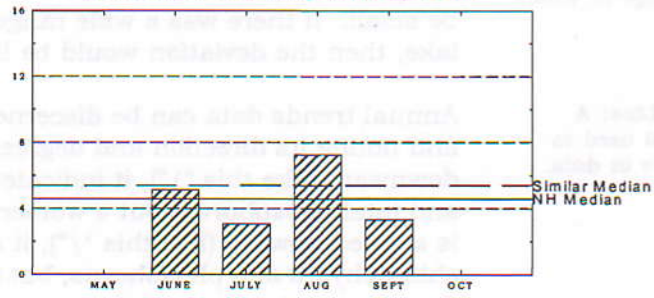
Do not draw absolute conclusions from annual data if the lake was only sampled once a year as it is difficult to determine representative trends with such a limited amount of data. Also, if the line graph shows a parameter worsening, review the data provided in Appendix A (Interim Report) or Appendix B (Biennial Report). Look for sampling events with one extremely high or low sampling result which could be considered an **outlier**. Outliers can **skew** the trend line. You need many years of data before trends become apparent, and ten years before they are considered statistically significant. After your lake has been monitored through VLAP for at least 10 consecutive years, we will analyze the deep spot data using **linear regression** analysis to determine if there has been an increase or decrease of the annual mean for chlorophyll-a, transparency, and total phosphorus since monitoring began.

The last element in the line graph are two reference lines. One reference line represents the **New Hampshire Median** for that particular parameter. The data from your lake can be compared to the **New Hampshire Median** to understand how the quality of your lake compares to the median value for all lakes in the state as a whole. The second reference line represents the **Similar Median** for that particular parameter. Using the **Similar Median**, the data for your lake can be compared to median values for lakes that are similar, based on lake volume and maximum depth. This simple classification scheme can be useful in better characterizing the quality of your lake.

Bar Graph

The second type of graph is the bar graph. It represents the current year's monthly data for a given parameter. When more than one sampling event occurred in a month, the plotted value will represent an average result for that month. Consult Table 14 for individual sampling event results. The bar graph emphasizes individual values for comparison rather than overall trends and allows for easy data comparisons within one sampling season.

Bar Graph Depicting Monthly Data



Tables

Tables in Appenix A in the Interim Report summarize data collected during the 2009 sampling season. Tables in Appendix B in the Biennial Report summarize data collected during 2009 and previous years. The Biennial Report provides the maximum, minimum, and mean values for each station by sampling year for most tests, where applicable.

Lake Maps

Bathymetric Map: A map that shows the topography of the lake's bottom; contours depict the lake depths.

A **bathymetric map** in Appendix B (Interim Report) and Appendix C (Biennial Report) depicts the depth contours of your lake. A station map in Appendix B (Interim Report) and Appendix C (Biennial Report) depicts the name and location of the tributary and deep spot samples collected from your lake. If stations are missing, please make corrections and send the map to the VLAP Coordinator.

Data Interpretation: Monitoring Parameters

Biological Parameters

Algal Abundance

Algae, also referred to as **phytoplankton**, are photosynthetic plants that contain chlorophyll but do not have true roots, stems, or leaves. They do, however, grow in many forms such as aggregates of cells (colonies), in strands (filaments), or as microscopic single cells. They may also be found growing on objects, such as rocks or vascular plants, on the lake bottom or free-floating in the water column.

Phytoplankton: Microscopic algae drifting through the water column.

Regardless of their form, these primitive plants carry out **photosynthesis** and accomplish two very important roles in the process. First, they convert non-living compounds into organic, meaning living, matter. These tiny plants form the base of a lake **food chain**. Microscopic animals, formally referred to as **zooplankton**, graze upon algae like cows graze on grass in a field. Fish also feed on algae. Second, the water is **oxygenated**, aiding the chemical balance and biological health of the lake system.

Photosynthesis: Producing carbohydrates for food with the aid of sunlight.

Food chain: Arrangement of organisms in a community according to the order of predation.

Zooplankton: Microscopic animals drifting through the water column.

Oxygenated: Holding oxygen in solution.

Algae require light, nutrients, and certain temperatures to thrive. All of these factors are constantly changing in a lake on a daily, seasonal, and yearly basis. Therefore, algae populations and the abundance of individual algal species naturally change in composition and distribution with changes in weather or lake quality.

VLAP uses the measure of **chlorophyll-a** as an indicator of the algal abundance. Because algae are plants and contain the green pigment chlorophyll, the concentration of chlorophyll measured in the water gives an estimation of the algal concentration. If the chlorophyll-a concentration increases, this indicates an increase in the algal population. Generally, a chlorophyll-a concentration of less than 5 mg/m^3 typically indicates water quality conditions that are representative of **oligotrophic** lakes, while a chlorophyll-a concentration greater than 15 mg/m^3 indicates **eutrophic** lakes. A chlorophyll concentration greater than 10 mg/m^3 generally indicates an undesirable reproduction of algae, is occuring.

Chlorophyll-a: A green pigment found in algae.

Oligotrophic: Low biological production.

Eutrophic: High biological production; nutrient rich.

The **median** chlorophyll concentration for New Hampshire lakes is **4.58 mg/m^3** and the **mean** is **7.16 mg/m^3**. The Interim Report provides current year chlorophyll data in Figure 1 and Table 14 in Appendix A. The Biennial Report provides current year and historical chlorophyll data in Figure 1 in Appendix A; and the minimum, maximum and mean values for the lake/pond in Table 1 in Appendix B.

Median: A value in an ordered set of values below and above which there is an equal number of values (i.e.; the 50th percentile). Medians are not affected by outlier data.

Mean: The average of a set of values. Means can be affected by outlier data.

Category	Chlorophyll-a (mg/m3)
Good	0 - 5
More than desirable	5.1-15
Nuisance amounts	>15

Phytoplankton and Cyanobacteria

The type of phytoplankton (algae) and/or cyanobacteria present in a lake can be used as an indicator of general lake quality. The most direct way to obtain this information is to collect a plankton sample at the deep spot using a **plankton net**, count the quantity of phytoplankton and cyanobacteria contained in the sample, and identify the genera present in the sample using a microscope. An abundance of **cyanobacteria** (blue-green algae), such as *Anabaena, Aphanizomenon, Oscillatoria,* or *Microcystis* may indicate an excessive phosphorus concentration or that the lake ecology is out of balance. On the other hand, diatoms such as *Asterionella, Synedra,* and *Tabellaria* or golden-brown algae such as *Dinobryon* or *Chrysosphaerella,* are typical phytoplankton found in New Hampshire's less productive lakes. In shallow warm waters with minimal wave action such as a cove, filamentous green algae may grow and form what looks like a mass of green cotton candy.

Plankton net: Fine mesh net used to collect microscopic plants and animals.

Cyanobacteria:Bacterial microorganisms that photosynthesize and may produce chemicals toxic to other organisms, including humans.

Succession: The decline of dominant species of algae over a period of time as another species increases and becomes dominant.

Phytoplankton populations undergo a natural **succession** during the growing season. Many factors influence this succession: amount of sunlight, availability of nutrients, temperature of the water, and the amount of zooplankton grazing. As shown in the diagram on the next page, it is natural for diatoms to be the dominant phytoplankton in the spring and then green algae in the early summer, while cyanobacteria may dominate in mid to late summer. The phytoplankton samples collected will show different dominant species, depending on when the samples were collected. Phytoplankton are identified in the Observations and Recommendations section of the Interim Report and Table 2 in Appendix B of the Biennial Report. Phytoplankton groups and species are listed below.

Phytoplankton Groups and Genera Common to New Hampshire Lakes and Ponds

Greens (Chlorophyta)

Actinastrum	*Eudorina*	*Pandorina*	*Spirogyra*
Arthrodesmus	*Kirchneriella*	*Pediastrum*	*Staurastrum*
Dictyosphaerium	*Micractinium*	*Scenedesmus*	*Stigeoclonium*
Elakotothrix	*Mougeotia*	*Sphaerocystis*	*Ulothrix*

Diatoms (Bacillariophyta)

Asterionella	*Melosira*	*Rhizosolenia*	*Synedra*
Cyclotella	*Fragilaria*	*Surirella*	*Tabellaria*

Dinoflagellates (Pyrrophyta)

Ceratium	*Peridinium*	*Gymnodinium*

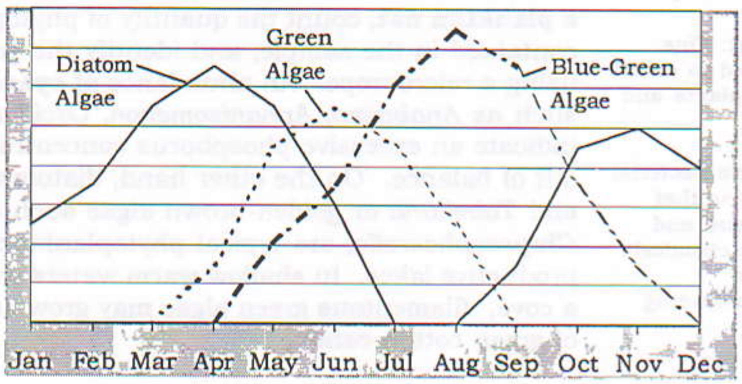
Cyanobacteria (Cyanophyta)

Anabaena	*Chroococcus*	*Gloeotrichia*	*Microcystis*
Aphanizomenon	*Coelosphaerium*	*Lyngbya*	*Oscillatoria*

Golden-Browns (Chrysophyta)

Chrysosphaerella	*Mallomonas*	*Synura*	*Uroglenopsis*
Dinobryon			

A Typical Seasonal Succession of Lake Algae



Cyanobacteria

Cyanobacteria: Bacterial microorganisms that photosynthesize and may produce chemicals toxic to other organisms, including humans.

Cyanobacteria are bacterial microorganisms that photosynthesize. Cyanobacteria may accumulate to form surface water scums. They produce a blue-green pigment but may impart a green, blue, or pink color to the water. Cyanobacteria are some of the earliest inhabitants of our waters, and they are naturally occurring in New Hampshire lakes. They are part of the aquatic food web and can be eaten by various grazers in the lake ecosystem, such as zooplankton and mussels. Research indicates that cell abundance increases as the in-lake phosphorus levels increase.

Akinete: A resting stage cell produced by cyanobacteria to withstand harsh conditions, such as winter.

Although they are most often seen when floating near the lake surface, many cyanobacteria spend a portion of their life cycle on the lake bottom during the winter months as **akinetes**. As spring provides more light and warmer temperatures, cyanobacteria move up the water column and eventually rise toward the surface where they can form dense scums, often seen in mid to late summer and, weather permitting, sometimes well into the fall.

Some cyanobacteria produce toxins that adversely affect livestock, domestic animals, and humans. According to the World Health Organization (WHO), toxic cyanobacteria are found worldwide in both inland and coastal waters. The first reports of toxic cyanobacteria in New Hampshire occurred in the 1960s and 1970s. During the summer of 1999, several dogs died after ingesting toxic cyanobacteria from Lake Champlain in Vermont. The WHO has documented acute impacts to humans from cyanobacteria from the U.S. and around the world as far back as 1931. While most human health impacts have resulted from ingestion of contaminated drinking water, cases of illnesses have also been attributed to swimming in waters infested with cyanobacteria.

The possible effects of cyanobacteria on the "health" of New Hampshire lakes and their natural inhabitants, such as fish and other aquatic life, are under study at this time. The Center for Freshwater Biology (CFB) at the University of New Hampshire (UNH) is currently examining the potential impacts of these toxins upon the lake food web. The potential human health hazards via exposure through drinking water and/or during recreational water activities are also a concern to toxicologists throughout the world.

Cyanobacteria occur in all lakes, everywhere. There are many types of cyanobacteria in New Hampshire lakes. Most cyanobacteria do not have the ability to produce toxins. In New Hampshire, there are several common cyanobacteria that include: *Gleotrichia, Merismopedia, Anabaena, Oscillatoria, Coelospharium, Lyngba* and *Microcystis*. *Anabaena* and *Aphanizomenon* produce **neurotoxins** that interfere with the nerve function and have almost immediate effects when ingested. *Microcystis* and *Oscillatoria* are best known for producing **hepatotoxins** known as microcystins. *Oscillatoria* and *Lyngbya* produce **dermatotoxins** which cause skin rashes.

Neurotoxin: Nerve toxins.

Hepotoxins: Liver toxins.

Dermatoxins: Toxins that cause skin irritations.

Both DES and UNH have extensive lake monitoring programs. Generally, the water quality of New Hampshire's lakes is very good. However, DES strongly advises against using lake water for consumption, since neither in-home water treatment systems nor boiling the water will eliminate cyanobacteria toxins if they are present.

If you observe a well-established potential cyanobacteria bloom or scum in the water, please adhere to the following:

- Do not wade or swim in the water!
- Do not drink the water or let children drink the water!
- Do not let pets or livestock into the water!

Exposure to toxic cyanobacteria scums may cause various symptoms, including nausea, vomiting, diarrhea, mild fever, skin rashes, eye and nose irritations, and general malaise. If anyone comes in contact with a cyanobacteria scum, they should rinse off with fresh water as soon as possible.

If you observe a Cyanobacteria scum, please call the cyanobacteria hotline at 419-9229. DES will sample the scum and determine if it contains cyanobacteria that are associated with toxic production. An advisory will be posted on the immediate shoreline indicating that the area may not be suitable for swimming. DES will issue a press release and will notify the town health officer, beach manager, and/or property owner, and the New Hampshire Department of Health and Human Services. DES will continue to monitor the water and will notify the appropriate parties regarding the results of the testing. When monitoring indicates that cyanobacteria are no longer present at levels that could harm humans or animals, the advisory will be removed.

Secchi Disk Transparency

The Secchi Disk is a 20 centimeter disk with alternating black and white quadrants. It has been used since the mid-1800s to measure the transparency of water. The Secchi Disk is named after the Italian professor P.A. Secchi whose early studies established the experimental procedures for using the disk. Transparency, a measure of the water clarity, is affected by the amount of algae, color, and particulate matter within a lake. In addition, the transparency reading may be affected by wave action, sunlight, and the eyesight of the volunteer monitor. Therefore, it is recommend that two or three monitors take a Secchi Disk reading, and then average all the measurements.

DES recommends that all volunteer groups collect transparency readings with and without the use of a **viewscope**. A comparison of the transparency readings taken with and without the use of a viewscope indicates that the use of a viewscope typically increases the depth to which the Secchi Disk can been seen, particularly on sunny and windy days. The use of the viewscope results in less variability in transparency readings between monitors and between sampling events.

Viewscope: A white plastic PVC pipe with a clear plexiglas end.

In general, a transparency greater than 4.5 meters indicates oligotrophic conditions, while a transparency of less than 2 meters is indicative of eutrophic conditions.

The **median** transparency for New Hampshire lakes is **3.2 meters** and the **mean** transparency is **3.7 meters**. Figure 2 in the Interim Report Observations and Recommendations section and in Appendix A of the Biennial Report presents current year and historical transparency values with and without the use of the viewscope. Table 14 in Appendix A of the Interim Report presents current year transparency data. Table 3a and 3b in Appendix B of the Biennial Report shows the minimum, maximum, and mean transparency values without and with the use of a viewscope, respectively, for all years of participation.

Median: A value in an ordered set of values below and above which there is an equal number of values (i.e.; the 50th percentile). Medians are not affected by outlier data.

Mean: The average of a set of values. Means can be affected by outlier data.

Water Clarity (Transparency) Ranges for Lakes and Ponds

Category	Water Clarity (m)
Poor	<2
Good	2-4.5
Exceptional	>4.5

Correlations between transparency and chlorophyll-a are an important indicator of lake quality. If the deep spot chlorophyll-a increased and the Secchi Disk transparency decreased, increased algae populations are likely affecting the water clarity. If the chlorophyll-a has not increased, but the transparency has decreased, the reduced transparency could be attributed to increased **turbidity** caused by stream inputs, motorboat activity, shoreline construction, or disturbances of bottom sediments.

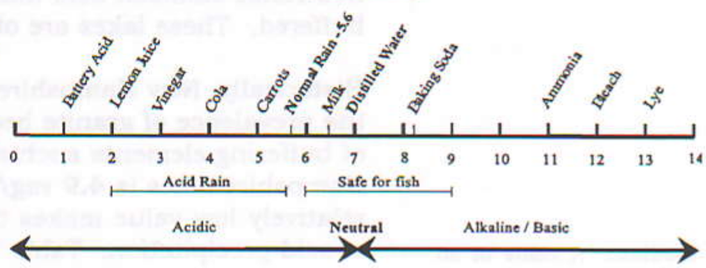
Turbidity: The amount of suspended particles in water, such as clay, silt, and algae that cause light to be scattered and absorbed, not transmitted in straight lines through the water.

Chemical Parameters

pH

pH is measured on a logarithmic scale of 0 to 14. The lower the pH the more acidic the solution, due to higher concentrations of hydrogen ions. Acid rain typically has a pH of 3.5 to 5.5 due to pollutants added from the air. In contrast, the **median** pH for New Hampshire lakes is **6.6.**

pH Scale



Median: A value in an ordered set of values below and above which there is an equal number of values (i.e.; the 50th percentile). Medians are not affected by outlier data.

Lake pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.0 severely limits the growth and reproduction of fish. A pH between 6.0 and 7.0 is ideal.

Thermally stratified: Water layered by temperature differences. During the summer, cooler, more dense water is typically found closer to the lake bottom, while warmer, less dense water is found closer to the lake surface.

Many lakes exhibit lower pH values in the deeper waters than nearer the surface. This effect is greatest in the bottom waters of a **thermally stratified** lake. Decomposition carried out by **bacteria** in the lake bottom causes the pH to drop, while photosynthesis by phytoplankton in the upper layers causes the pH to increase. Tannic and humic acids released into the water by decaying plants can create more acidic waters particularly in areas influenced by wetlands. After the spring-time snow melt or a significant rain event, surface waters may have a lower pH than deeper waters and may take several weeks to recover, since snowmelt and rainfall typcially have pH values of 5 or lower.

Bacteria: Tiny organisms that break down dead matter.

Table 14 in Appendix A of the Interim Report provides current year pH data for the in-lake and tributary stations. Table 4 in Appendix B of the Biennial Report presents the in-lake and tributary true mean pH data for each year the lake has been sampled.

pH Ranges for New Hampshire Lakes and Ponds

Category	pH (units)
Critical (toxic to most fish)	<5
Endangered (toxic to some aquatic organisms)	5-6
Satisfactory	>6

Acid Neutralizing Capacity

Buffering capacity or acid neutralizing capacity (ANC) describes the ability of the lake to resist changes in pH by neutralizing the acidic input to the lake. The higher the ANC the greater the ability of water to neutralize acids. This concept can be compared to a person taking an antacid to neutralize stomach acid indigestion. Low ANC lakes are not well-buffered. These lakes are often adversely affected by acidic inputs.

Historically, New Hampshire has had naturally low ANC waters because of the prevalence of granite bedrock. Granite contains only a small amount of buffering elements such as calcium. The **median** ANC for New Hampshire lakes is **4.9 mg/L** while the **mean** ANC is **6.6 mg/L**. This relatively low value makes these surface waters vulnerable to the effects of acid precipitation. Table 14 in Appendix A of the Interim Report presents the current year epilimnetic ANC data. Table 5 in Appendix B of the Biennial Report presents the mean epilimnetic ANC for each year the lake has been sampled.

Median: A value in an ordered set of values below and above which there is an equal number of values (i.e.; the 50th percentile). Medians are not affected by outlier data.

Mean: The average of a set of values. Means can be affected by outlier data.

Acid Neutralizing Capacity Ranges for New Hampshire Lakes and Ponds

Category	ANC (mg/L)
Acidified	<0
Extremely Vulnerable	0-2
Moderately Vulnerable	2.1-10
Low Vulnerability	10.1-25
Not Vulnerable	>25

Conductivity

Conductivity is the numerical expression of the ability of water to carry an electrical current. It is determined primarily by the number of **ionic particles** present. The soft waters of New Hampshire have traditionally had low conductivity values, generally less than 50 uMhos/cm. However, specific categories of good and bad levels cannot be constructed for conductivity because variations in watershed geology can result in natural fluctuations in conductivity. Generally, values in New Hampshire lakes exceeding 100 uMhos/cm indicate cultural, meaning human, disturbances. An increasing conductivity trend typically indicates **point source** and/or **non-point sources** of pollution are occuring within the watershed.

Ionic particle(s): An atom or group of atoms carrying an electrical charge. Typically, salts, minerals, and metal atoms.

Non-point source pollution: Pollution originating from a diffuse area (not a single point) in the watershed, often entering the water body via surface runoff or groundwater.

Point source pollution: Pollution often resulting from discharges into water from identifiable sources (points), such as industrial waste or municipal sewers.

The **median** conductivity for New Hampshire lakes is **40.0 uMhos/cm** while the **mean** conductivity is **59.4 uMhos/cm**. Table 14 in Appendix A of the Interim Report presents the current year in-lake and tributary conductivity data. Table 6 in Appendix B of the Biennial Report presents mean conductivity values for in-lake and tributary data for each year the lake has been sampled.

Lake aging: Nautral process by which a lake fills-in over time.

Watershed: The land that drains to a particular body of water.

Eutrophication: Lake aging accelerated by the increased nutrient input exceeding the natural supply.

Cultural eutrophication: When increased nutrient input and debris into a lake is caused by human activity.

Phosphorus: The most important parameter measured in NH lakes becuase it is typically the nutrient that determines the rate of lake aging.

Limiting nutrient: Nutrient that, in small increase, can cause larger changes in biological production.

Biological Production: Total amount or weight of living organisms.

Oligotrophic: Low biological production and nutrients; highest lake quality classification.

Eutrophic: High biological production, nutrient rich; lowest lake quality classification.

Epilimnion: The upper, well-circulated, warm layer of a thermally stratified lake.

Hypolimnion: The deep, cold, relatively undisturbed bottom waters of a thermally stratified lake.

Phosphorus

Like all of us, lakes age over time. **Lake aging** is the natural process by which a lake fills-in over thousands of years. Lakes fill-in with erosional materials carried in by tributary streams, with materials deposited directly through the air, and with materials produced in the lake itself. From the time a lake is created, the aging process begins. Although many New Hampshire lakes have the same chronological age, they fill-in at different rates due to differences in lake depth and size and individual **watershed** characteristics. **Eutrophication** is the term used to describe lake aging that is accelerated by the process of increased nutrient input to a lake.

Lakes can age more quickly than they would naturally due to human impacts, a process called **cultural eutrophication**. This accelerated aging results from watershed activities that increase nutrient loading and/or the deposition of other debris, such as fertilizing lawns, converting forest or pasture to cropland, and creating new impervious areas such as rooftops, parking lots, and driveways. Studies in New Hampshire have shown that phosphorus exports from agricultural lands is at least five times greater than from forested lands, and in urban areas may be more than 10 times greater than from forested lands.

The key nutrient in the eutrophication process is **phosphorus.** Phosphorus is the **limiting nutrient** in New Hampshire lakes; the greater the phosphorus concentration in a lake, the greater the **biological production**. Phosphorus sources within a lake's watershed include septic system effluent, animal waste, lawn fertilizer, eroding roadways and construction sites, natural wetlands, and atmospheric deposition. Reducing the amount of phosphorus in a lake will typically result in reduced algal concentrations.

A deep spot epilimnetic (upper layer) phosphorus concentration of less than 10 ug/L typically indicates **oligotrophic** conditions, while an epilimnetic concentration greater than 20 ug/L is indicative of **eutrophic** conditions. The **median** phosphorus concentration in the **epilimnion** layer of New Hampshire lakes is **12 ug/L**. The **median** phosphorus concentration in the **hypolimnion** is **14 ug/L**. Figure 3 in the Interim Report Observations and Recommendations section and Figure 3 in Appendix A of the Biennial Report depicts the epilimnetic and hypolimnetic total phosphorus values for all sampling years. Table 14 in Appendix A of the Interim Report presents current year in-lake and tributary total phosphorus data. Table 8 in Appendix B of the Biennial Report presents mean total phosphorus data for in-lake and tributary stations for each year the lake has been sampled.

Epilimnetic Total Phosphorus Ranges for New Hampshire Lakes

Category	TP (ug/L)
Ideal	<10
Average	11-20
More than desirable	21-40
Excessive	>40

Nitrogen

Total Kjeldahal Nitrogen (TKN): A measures the total concentration of nitrogen in a sample present as ammonia (a form of nitrogen found in organic materials, sewage, and many fertilizers) or bound in organic (living) compounds.

Nitrite (NO_2) + Nitrate (NO_3): A measure of the major inorganic species of nitrogen found in lake waters, and often used as a nitrogen source by algae. In New Hampshire lakes, nitrite nitrogen is extremely low so that NO_2 + NO_3 is essentially the same as NO_3.

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 and is seldom the limiting nutrient in New Hampshire freshwaters. 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. Various forms of organic and inorganic nitrogen can be sampled, inlcuding **Total Kjeldahal Nitrogen, nitrite** and **nitrate.** Total nitrogen is the sum of nitrite, nitrate and total Kjeldahl nitrogen forms. The ratio of total nitrogen to total phosphorus (TN:TP) is used to determine which nutrient determines the amount of algae growth, meaning which nutrient is limiting, when other factors such as light and temperature are sufficient for growth. A value less than 15 indicates nitrogen is limiting while a value greater than 15 suggests phosphorus is limiting. Table 14A in Appendix A (Interim Report) lists current year nitrogen data. Table 7a and 7b in Appendix B (Biennial Report) lists the nitrogen sampling data if your lake has been sampled for this parameter.

Dissolved Oxygen and Temperature

The presence of dissolved oxygen is vital to bottom-dwelling organisms as well as fish and amphibians. If the concentration of dissolved oxygen is low, typically less than 5 mg/L, species intolerant, meaning sensitive, to this situation, such as trout, will be forced to move up closer to the surface where there is more dissolved oxygen but the water column is generally warmer, and the species may not survive.

Temperature is also a factor in the dissolved oxygen concentration. Water can hold more oxygen at colder temperatures than at warmer temperatures. Therefore, a lake will typically have a higher concentration of dissolved oxygen during the winter, spring, and fall than during the summer.

Thermal stratification: Water layering by temperature.

ppm: Parts per million; equal to mg/L.

Internal phosphorus loading: Addition of phosphorus to the hypolimnion from the lake sediments due to a chemical change initiated by low oxygen conditions.

At least once during each summer, a DES biologist measures the dissolved oxygen and temperature at set intervals from the bottom of the lake to the surface. These measurements allow us to determine the extent of **thermal stratification** as well as the lake oxygen content. Many of the more productive lakes experience a decrease in dissolved oxygen in the deeper waters as summer progresses. Bacteria in the lake sediments decompose the dead organic matter that settles out of the water column. Decomposition results in oxygen depleted bottom waters. More productive lakes tend to have organic-rich sediments leading to greater decomposition and potentially creating a severe dissolved oxygen deficit of less than 1 ppm. Low oxygen conditions can then trigger phosphorus that is normally bound to the sediment to be released back into the water column, a process called **internal phosphorus loading.** Once lake mixing occurs, bottom water phosphorus can enter the upper waters and stimulate additional algal growth.

Thermocline: Barrier between warm surface layer (epilimnion) and cold deep layer (hypolimnion) where a rapid decrease in water temperature occurs with increasing depth.

The dissolved oxygen percent saturation shows the percentage of oxygen that is dissolved in the water at a particular temperature and depth. Typically, during the summer, the deeper the reading, the lower the percent saturation due to decomposition occuring at the lake bottom. A high reading at or slightly above the **thermocline** may be due to a layer of algae, producing oxygen during photosynthesis. Colder waters are also able to hold more dissolved oxygen than warmer waters, and, generally, the deeper the water, the colder the temperature. As a result, a reading of 9 mg/L of oxygen at the warm lake surface will yield a higher percent saturation than a reading of 9 mg/L of oxygen at 25 meters where the water is much cooler. **Table 9 in Appendix A (Interim Report) and Appendix B (Biennial Report) shows the dissolved oxygen/temperture profile data for the current sampling year, and Table 10 (Biennial Report) shows historical hypolimnetic dissolved oxygen readings.**

Chloride

The chloride ion (Cl^-) is found naturally in some surface waters and groundwaters and in high concentrations in seawater. Higher-than-normal chloride concentrations in fresh water, typically sodium chloride, that is used on foods and present in body wastes, can indicate sewage pollution. The use of highway deicing salts can also introduce chlorides to surface water or groundwater.

Ionic: Existing as or characterized by ions.

Although chloride can originate from natural sources, most of the chloride that enters the environment in New Hampshire is associated with the storage and application of road salt. Road salt, which is most often sodium chloride, readily dissolves and enters aquatic environments in **ionic** forms. As such, chloride-containing compounds commonly enter surface water, soil, and ground water during late-spring snowmelt since the ground is frozen during much of the late winter and early spring.

Chloride ions are conservative, which means that they are not degraded in the environment and tend to remain in solution, once dissolved. Chloride ions that enter ground water can ultimately be expected to reach surface water and, therefore, influence aquatic environments and humans.

Acute toxicity: An adverse effect such as mortality or debilitation caused by an exposure of 96 hours or less to a toxic substance (i.e; short period of time).

Chronic toxicity: An adverse effect such as reduced reproductive success or growth, or poor survival of sensitive life stages, which occurs as a result of prolonged exposure to a toxic substance (i.e; long period of time).

Research has shown that elevated chloride levels can be toxic to freshwater aquatic life. Among the species tested, freshwater aquatic plants and invertebrates tend to be the most sensitive to chloride. In order to protect freshwater aquatic life in New Hampshire, the state has adopted **acute** and **chronic** chloride water quality standards of 860 and 230 mg/L, respectively, for surface waters.

The chloride content in New Hampshire lakes is naturally low **(median = 4 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. **Table 13 in Appendix A (Interim Report) and Appendix B (Biennial Report)** lists the chloride data if your lake has been sampled for this parameter.

Other Parameters

Turbidity

Turbidity in water is caused by suspended matter, such as clay, silt, and algae that cause light to be scattered and absorbed, not transmittted in straight lines through the water. Secchi Disk transparency, and therefore water clarity, is strongly influenced by turbidity. High turbidity readings are often found in water adjacent to construction sites; during rain events unstable soil erodes and causes turbid water downstream. Also, improper sampling techniques, such as hitting the bottom of the lake with the Kemmerer bottle or stirring up the stream bottom when collecting tributary samples, may also cause high turbidity readings. The New Hampshire **median** for lake turbidity is **1.0 NTU**. Table 14 in Appendix A (Interim Report) presents current year turbidity data. Table 11 in Appendix B (Biennial Report) lists turbidity data for all sampling years.

Statistical Summary of Turbidity Values for New Hampshire Lakes and Ponds

Category	Value (NTU)
Minimum	<0.1
Maximum	22.0
Median	1.0

Bacteria

Surface waters contain a variety of microorganisms including bacteria, fungi, protozoa, and algae. Most of these occur naturally and have little or no impact on human health. Health risks associated with water contact occur generally when there is contamination from human sources or other warm blooded animals. Contamination arises most commonly from sources of fecal waste such as failing or poorly designed septic systems, leaky sewage pipes, nonpoint source runoff from wildlife habitat areas, or inputs from wastewater treatment plant outflows within a watershed. Swim beaches with heavy use, shallow swim areas, and/or poor water circulation also have commonly reported bacteria problems. Therefore, water used for swimming should be monitored for indicators of possible fecal contamination. Contamination is typically short-lived since most bacteria cannot survive long in surface waters as their natural environment is the gut of warm blooded animals. A recent study has shown that *E. coli* can live fairly long periods of time in the sediments.

Pathogens: Disease-causing organisms.

Specific types of bacteria, called indicator organisms, are the basis of bacteriological monitoring, because their presence indicates that sources of fecal contamination exist. Indicators estimate the presence and quantity of things that cannot be meaured easily by themselves. We measure these sewage or fecal indicators rather than the **pathogens** themselves to estimate sewage or fecal contamination and, therefore, the possible risk of disease associated with using the water.

New Hampshire closely follows the bacteria standards recommended by the U.S. Environmental Protection Agency (EPA). Following a 1988 EPA report recommending the use of *Escherichia coli (E.coli)* as a standard for public water supplies and human contact, DES followed suit by adopting *E.coli* as the indicator organism. The standards for Class B waters specify that no more than 406 *E. coli* counts/100 mL, or a geometric mean based on at least three samples obtained over a 60 day period, be greater than 126 *E. coli* counts/100 mL. Designated public beach areas and other Class A waters, have more stringent standards: 88 *E. coli* counts/100 mL in any one sample, or a geometric mean of three samples over 60 days of 47 *E. coli* counts/100 mL. Table 14 in Appendix A (Interim Report) presents current year *E. coli* data. Table 12 in Appendix B (Biennial Report) presents current year and historical *E. coli* results for each station sampled.

EXECUTIVE SUMMARY

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

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 pond 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.

We encourage your monitoring group to formally participate in the DES Weed Watchers program, a volunteer program dedicated to monitoring lakes and ponds for the presence of exotic aquatic plants. This program only involves a small amount of time during the summer months. Volunteers survey their waterbody once a month from **May** through **September**. To survey, volunteers slowly boat, or even snorkel, around the perimeter of the waterbody and any islands it may contain. Using the materials provided in the Weed Watcher kit, volunteers look for any species that are suspicious. After a trip or two around the waterbody, volunteers will have a good knowledge of its plant community and will immediately notice even the most subtle changes. If a suspicious plant is found, the volunteers immediately send a specimen to DES for identification. If the plant specimen is an exotic species, a biologist will visit the site to determine the extent of the problem and to formulate a management plan to control the nuisance infestation. Early detection is the key to controlling the spread of exotic plants.

If you would like to help protect your lake or pond from exotic plant infestations, contact Amy Smagula, Exotic Species Program Coordinator, at 271-2248 or visit the Weed Watchers website at www.des.nh.gov/organization/divisions/water/wmb/exoticspecies/weed_watcher.htm.

OBSERVATIONS & RECOMMENDATIONS

DEEP SPOT

➢ Chlorophyll-a

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

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

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

The current year data (the top graph) show that the chlorophyll-a concentration ***increased*** from **June** to **August**. The August chlorophyll concentration was **12.81 mg/m^3**. Typically, chlorophyll concentrations above 15.00 mg/m^3 are indicative of an algal bloom.

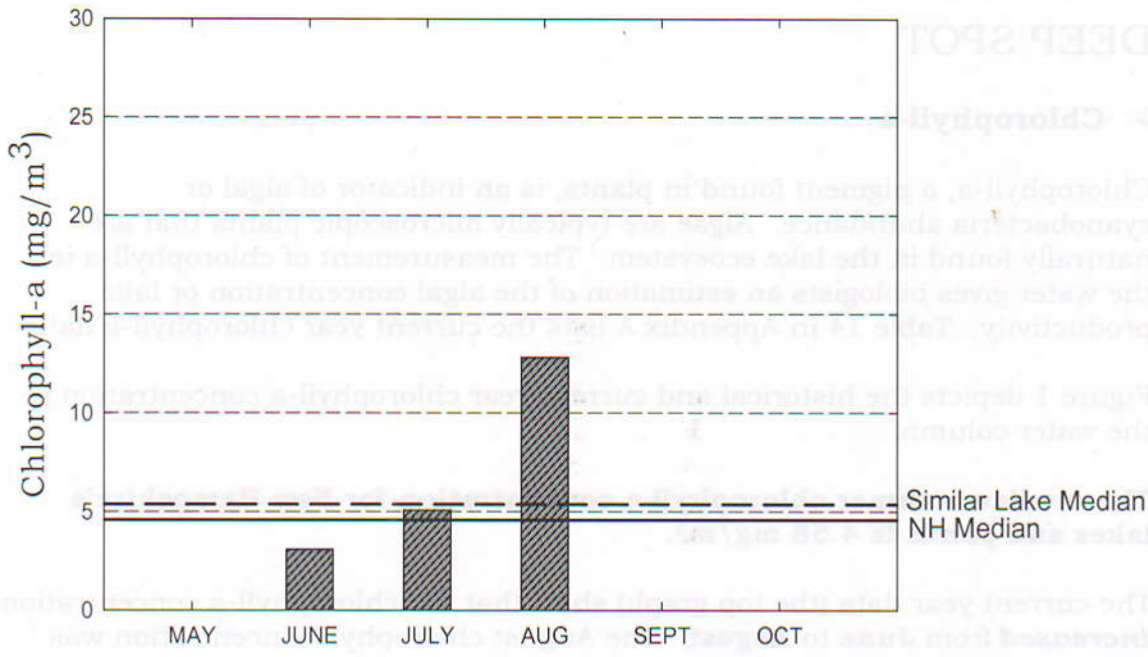
The historical data (the bottom graph) show that the **2009** chlorophyll-a mean is ***greater than*** the state and similar lake medians. For more information on the similar lake median, refer to Appendix D.

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

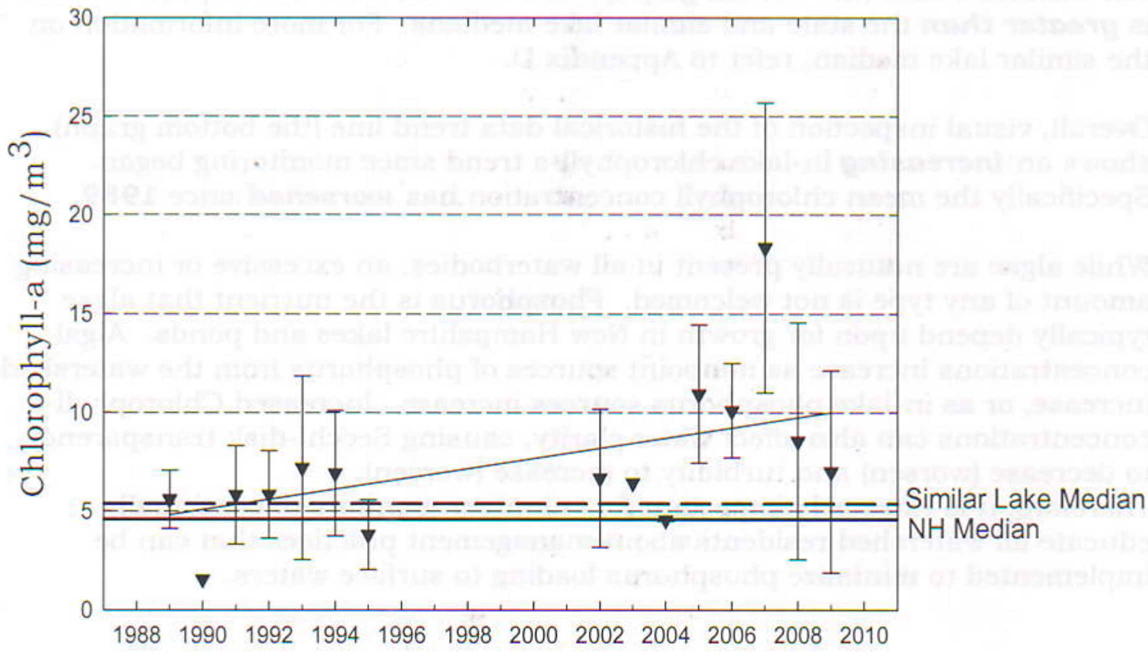
While algae are naturally present in all waterbodies, an excessive or increasing amount of any type is not welcomed. Phosphorus is the nutrient that algae typically depend upon for growth in New Hampshire lakes and ponds. Algal concentrations increase as nonpoint sources of phosphorus from the watershed 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.

Clough Pond, Loudon

Figure 1. Monthly and Historical Chlorophyll-a Results



2009 Chlorophyll-a Results



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)

Division	Genus	% Dominance
Chrysophyta	Dinobryon	27.4
Pyrrophyta	Ceratium	22.1
Chrysophyta	Mallomonas	13.3

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

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

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

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

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

➢ Secchi Disk Transparency

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

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

The current year ***non-viewscope*** in-lake transparency ***increased slightly*** from **June** to **July**, and then ***decreased slightly*** from **July** to **August**.

The viewscope in-lake transparency was ***slightly greater than*** the non-viewscope transparency on the **July** sampling event. The transparency was ***not*** measured with the viewscope on the **June** or **August** sampling events. A comparison of 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.

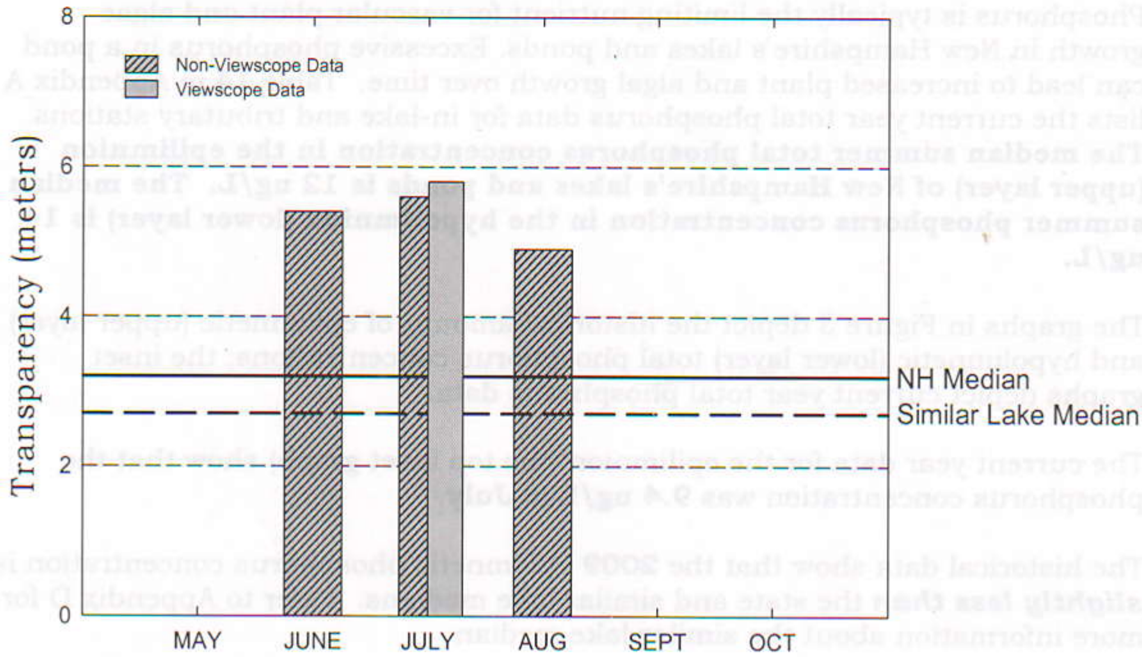
The historical data (the bottom graph) show that the **2009** mean non-viewscope transparency is ***much greater than*** the state and similar lake medians, and is the second highest mean transparency measured since monitoring began. Please refer to Appendix D for more information about the similar lake 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 4.0 and 5.5 meters*** since monitoring began in **1989**.

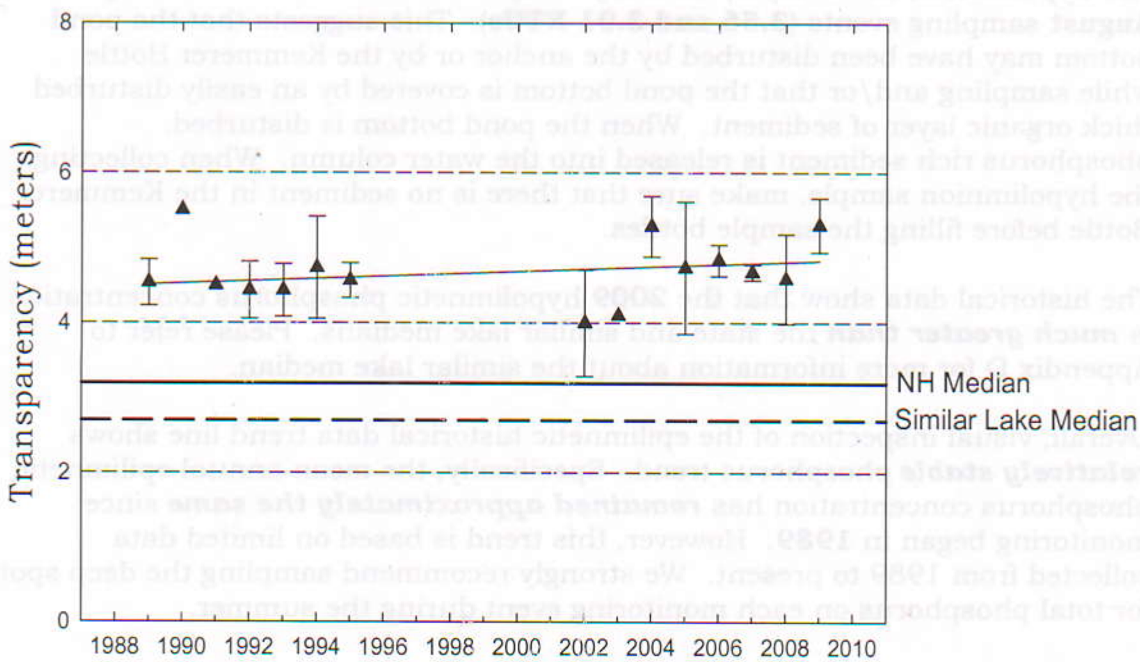
Typically, high intensity rainfall causes sediment-laden stormwater runoff to flow into surface waters, thus increasing turbidity and decreasing clarity. Efforts should continually be made to stabilize stream banks, pond shorelines, disturbed soils within the watershed, and especially dirt roads located 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.

Clough Pond, Loudon

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 was **9.4 ug/L** in **July**.

The historical data show that the **2009** 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 was **26 ug/L** in **July**.

The hypolimnetic (lower layer) turbidity sample was ***elevated*** on the **July and August** sampling events (**3.56 and 3.91 NTUs**). This suggests that the pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling and/or that the pond bottom is covered by an easily disturbed thick organic layer of sediment. When the pond bottom is disturbed, phosphorus rich sediment is released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

The historical data show that the **2009** hypolimnetic phosphorus concentration is ***much greater than*** the state and similar lake medians. Please refer to Appendix D for more information about the similar lake median.

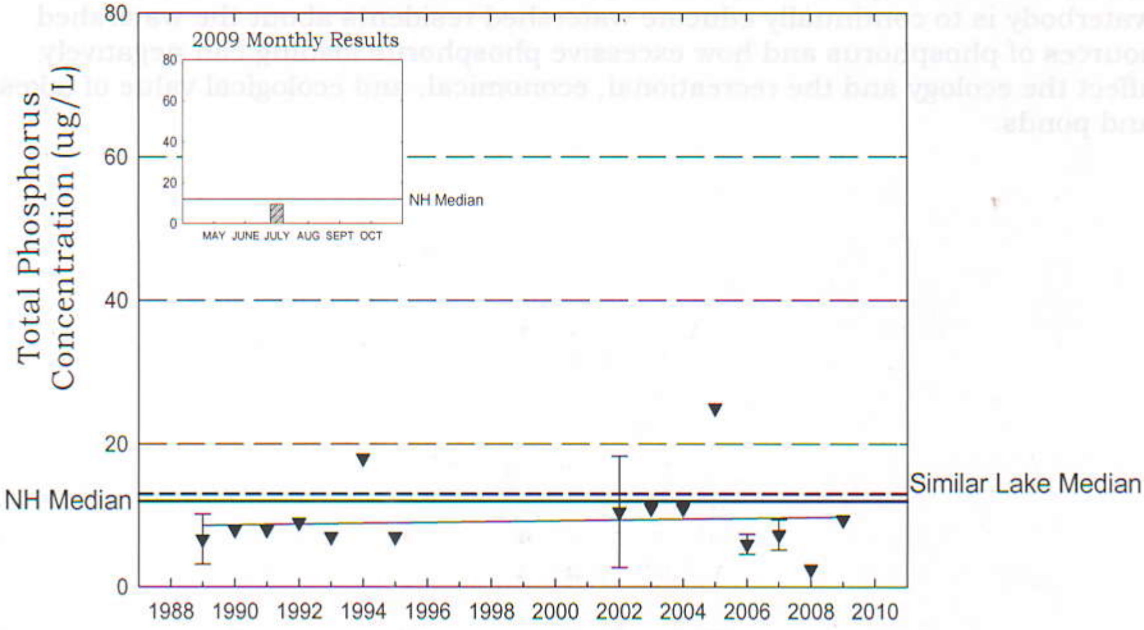
Overall, visual inspection of the epilimnetic historical data trend line shows ***relatively stable*** phosphorus trend. Specifically, the mean annual epilimnetic phosphorus concentration has ***remained approximately the same*** since monitoring began in **1989**. However, this trend is based on limited data collected from 1989 to present. We strongly recommend sampling the deep spot for total phosphorus on each monitoring event during the summer.

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 5 and 39 ug/L*** since monitoring began in **1989**. However, this trend is based on limited data collected from 1989 to present. We strongly recommend sampling the deep spot for total phosphorus on each monitoring event during the summer.

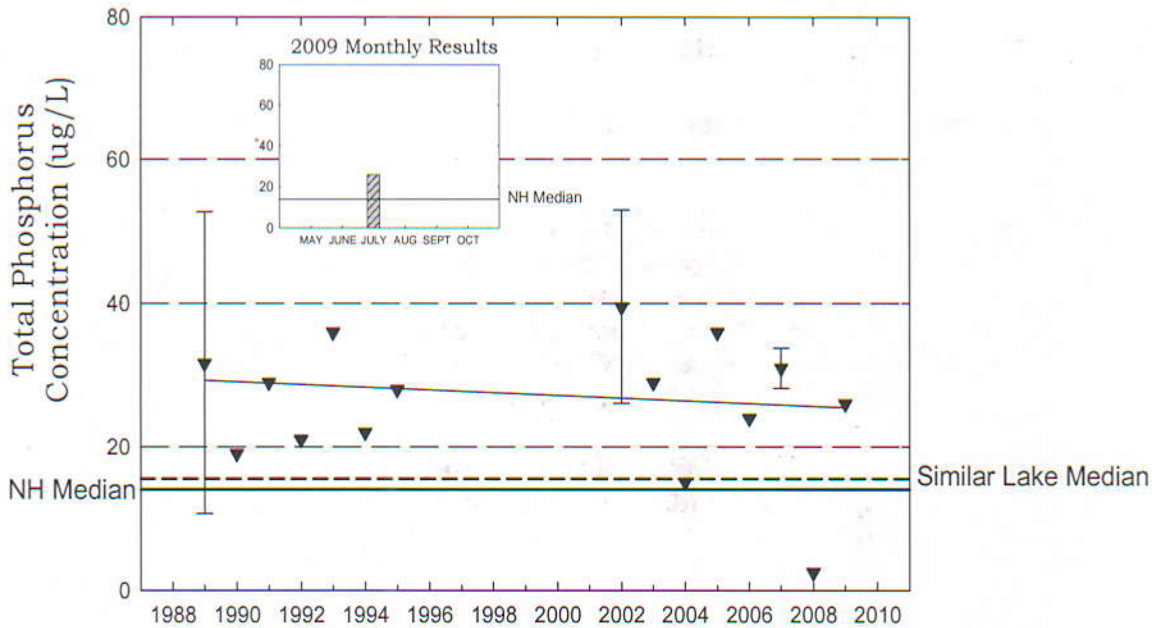
One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about the watershed sources of phosphorus and how excessive phosphorus loading can negatively affect the ecology and the recreational, economical, and ecological value of lakes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

Clough Pond, Loudon

Figure 3. Monthly and Historical Total Phosphorus Data



Epilimnion (Upper Water Layer)



Hypolimnion (Lower Water Layer)

➢ pH

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

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

The pH at the deep spot this year ranged from **6.62 to 6.87** in the epilimnion and from **6.07 to 6.21** in the hypolimnion, which means that the water is ***slightly acidic***.

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

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

➢ Acid Neutralizing Capacity (ANC)

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

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

The acid neutralizing capacity (ANC) of the epilimnion (upper layer) ranged from **5.1 mg/L to 6.6 mg/L**. This indicates that the pond 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 ***increased*** in the pond since monitoring began. In addition, the in-lake conductivity is ***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.

We recommend that your monitoring group conduct a shoreline conductivity survey of the pond to help identify the sources of conductivity.

To learn how to conduct a shoreline or tributary conductivity survey, please refer to the 2004 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.*

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).

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 greater than **100 percent** saturation between **five** and **seven** meters at the deep spot on the **July** sampling event. Wave action from wind can also dissolve atmospheric oxygen into the upper layers of the water column. Layers of algae can also increase the dissolved oxygen in the water column, since oxygen is a by-product of photosynthesis. Considering that the depth to which sunlight could penetrate into the water column was approximately **5.6** meters on this sampling event, as shown by the Secchi disk transparency depth, and that the metalimnion, the layer of rapid decrease in water temperature and increase in water density where algae typically congregate, was located between approximately **four** and **seven** meters, we suspect that an abundance of algae in the metalimnion caused the oxygen super-saturation.

The dissolved oxygen concentration was ***much lower in the hypolimnion (lower layer) than in the epilimnion (upper layer)*** at the deep spot on the **July** sampling event. As stratified ponds 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 pond where the water meets the sediment. When hypolimnetic oxygen concentration is depleted to less than 1 mg/L, **as it was on the annual biologist visit this year and on many previous annual visits**, the phosphorus that is normally bound up in the sediment may be re-released into the water column, a process referred to as ***internal phosphorus loading***.

The ***low*** hypolimnetic oxygen level is a sign of the pond's ***aging*** and ***declining*** 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 turbidity of the metalimnion (middle layer) sample was ***elevated*** (**1.53, 1.79, 2.57 NTUs**) on the **June, July and August** sampling events. This suggests that a layer of algae may have been present at this location. Algae are often found in the metalimnion of ponds due to the differences in density between the epilimnion and the hypolimnion and the resulting abundance of food in that layer.

As discussed previously, the hypolimnetic (lower layer) turbidity was ***elevated*** (**3.56 and 3.91 NTUs**) on the **July and August** sampling events. In addition, the hypolimnetic turbidity has been elevated on many sampling events during previous sampling years. This suggests that the pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling and/or that the lake bottom is covered by an easily disturbed thick organic layer of sediment. When the pond bottom is disturbed, phosphorus rich sediment is released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

TRIBUTARY SAMPLING

➢ Total Phosphorus

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

The total phosphorus concentrations were **relatively low** in **2009**. However, phosphorus samples were collected during only one sampling event. We strongly recommend collecting total phosphorus during each sampling event so we can determine how concentrations fluctuate during the summer months.

In general, record summer rainfall likely increased stormwater runoff and nutrient loading to the tributaries. As impervious surface cover increases in the watershed, stormwater runoff volumes increase. This transports phosphorus-laden stormwater into tributaries and eventually the 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 **6.56 to 6.84 (> 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.

The **Inlet** and **Outlet** experienced ***elevated*** conductivity levels this season, and have experienced ***increasing*** 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.

To learn how to conduct a shoreline or tributary conductivity survey, please refer to the 2004 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.*

It is possible 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, **2009** tributary turbidity levels were ***similar*** to historical tributary turbidity levels.

The **Outlet** experienced slightly turbid conditions throughout the season. Particulate matter in the water column, most likely sediment, pollen and algae, are typically blown toward the Outlet in Clough Pond. These materials can congregate in a thin layer on the surface. When sampling the Outlet, please try to collect the sample in an area free of surface debris, or try to remove the debris prior to collecting the sample.

➢ Bacteria (*E. coli*)

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

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

➢ Chlorides

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

Chloride sampling was **not** conducted during **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 an ***excellent*** job when collecting samples and submitting them to the laboratory this year! 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, DES Booklet WD-03-42, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-03-42.pdf.

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

Erosion Control for Construction in the Protected Shoreland Buffer Zone, DES fact sheet WD-SP-1, (603) 271-2975 or 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.

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.

Low Impact Development: Taking Steps to Protect New Hampshire's Surface Waters, DES fact sheet WD-WMB-17, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-17.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.

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

Weed Watchers: An Association to Halt the Spread of Exotic Aquatic Plants, DES fact sheet WD-BB-4, (603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/factsheets/bb/documents/bb-4.pdf.

Appendix A: Tables

Table 9
CLOUGH POND
LOUDON
Current year dissolved oxygen and temperature data.

Station ID	Station Name	Date	Depth	DO (mg/L)	DO Sat (%)	Temp (Deg C)
CLOLOUD	CLOUGH POND-DEEP SPOT	07/29/2009	0.10	8.1	98.3	25.2
			1.00	8.0	97.3	25.0
			2.00	8.2	98.4	24.5
			3.00	8.3	98.3	23.7
			4.00	8.4	97.2	22.5
			5.00	12.0	102.0	18.0
			6.00	13.6		14.3
			7.00	12.5	112.2	10.7
			8.00	4.3	36.7	8.2
			9.00	3.8	31.5	7.4
			10.00	2.3	18.7	6.7
			11.00	0.2	1.8	6.3
			12.00	0.2	1.7	6.1
			13.00	0.2	1.8	6.0
			14.00	0.2	1.8	5.9
			15.00	0.2	1.8	5.9
			16.00	0.3	2.1	5.9
			17.00	0.3	2.3	5.9

Table 14
Current Year Chemical and Biological Raw Data
Annual Report
CLOUGH POND
LOUDON

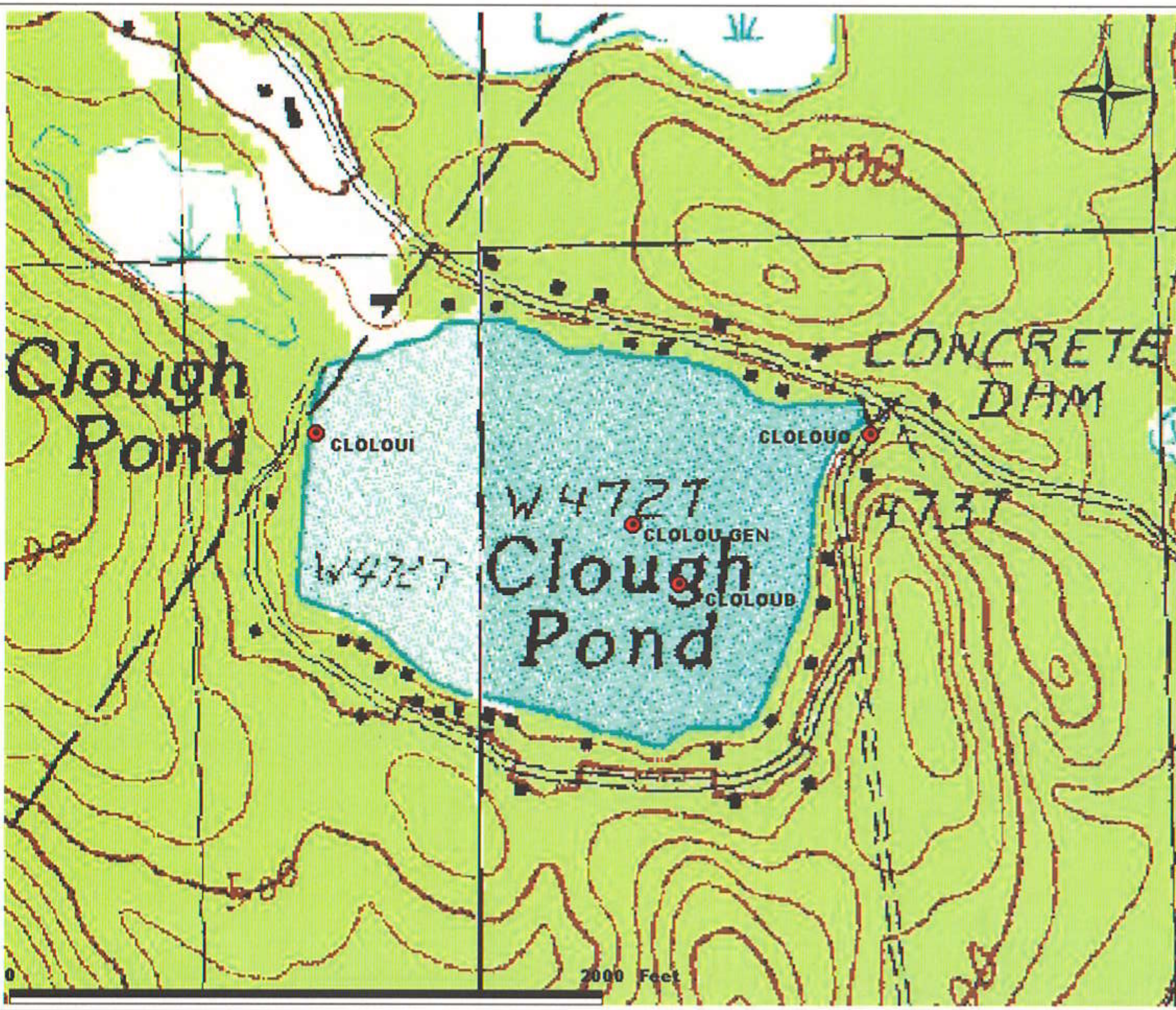
Station Name	Depth Zone	Date	ANC	Chl-A	COND	pH	TP	Transparency		Turbidity
								VS	NVS	
CLOUGH POND-DEEP SPOT	COMP	06/24/2009		3.1						
		07/29/2009		=5.0888						
		08/26/2009		=12.8084						
	EPI	06/24/2009	5.1		=80.03	6.62			=5.4	=0.51
		07/29/2009	6.3		=77.2	6.69	0.0094	=5.8	=5.6	=0.64
		08/26/2009	6.6		=74.77	6.87			=4.9	=1.1
	HYP	06/24/2009			=80.82	6.07				=0.79
		07/29/2009			=87.09	6.19	0.026			=3.56
		08/26/2009			=90.16	6.21				=3.91
	MET	06/24/2009			=77.44	6.91				=1.53
		07/29/2009			=76.47	6.91	0.013			=1.79
		08/26/2009			=75.85	6.4				=2.57
CLOUGH POND-INLET		06/24/2009			=80.05	6.81				=0.48
		07/29/2009			=77.09	6.56	0.0065			=0.82
		08/26/2009			=74.66	6.81				=0.95
CLOUGH POND-OUTLET		06/24/2009			=79.83	6.71				=2.59
		07/29/2009			=79.45	6.79	0.012			=1.93
		08/26/2009			=76.75	6.84				=1.25

Please Note: pH (units), TP (mg/L) (TP ND = less than 0.005 mg/L), Cond (UMHOS/cm), Transparency (M)(VS=Viewscope; NVS = Non Viewscope), E.coli (cts/100mL), Turbidity (NTU), ANC (mg/L), CL (mg/L), Chl-A (mg/M3), CaC03 (mg/L)

Table 15
SAMPLING STATONS
CLOUGH POND
LOUDON

Station ID	Station Name	Depth Zone
CLOLOUD	CLOUGH POND-DEEP SPOT	COMPOSITE
	CLOUGH POND-DEEP SPOT	EPILIMNION
	CLOUGH POND-DEEP SPOT	HYPOLIMNION
	CLOUGH POND-DEEP SPOT	METALIMNION
	CLOUGH POND-DEEP SPOT	
CLOLOUI	CLOUGH POND-INLET	
CLOLOUO	CLOUGH POND-OUTLET	
CLOLOUTB	CLOUGH POND-TOWN BEACH	

Appendix B: Maps

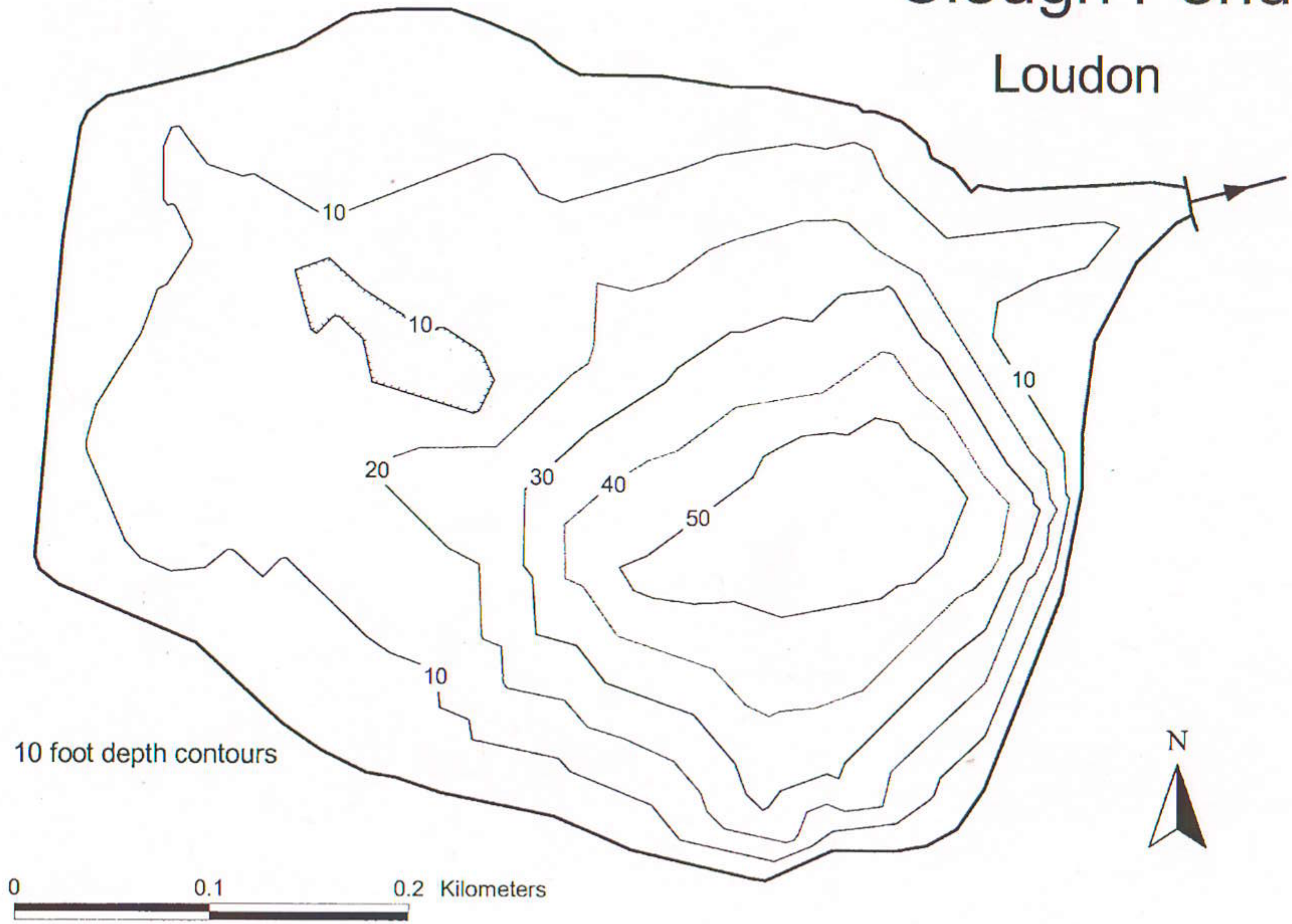


CLOUGH POND
TOWNS OF LOUDON AND CANTERBURY

STATION ID	STATION NAME
CLOBELD	DEEP SPOT
CLOLOU-GEN	GENERIC
CLOLOUD	DEEP SPOT
CLOLOUI	INLET
CLOLOUO	OUTLET

Clough Pond

Loudon

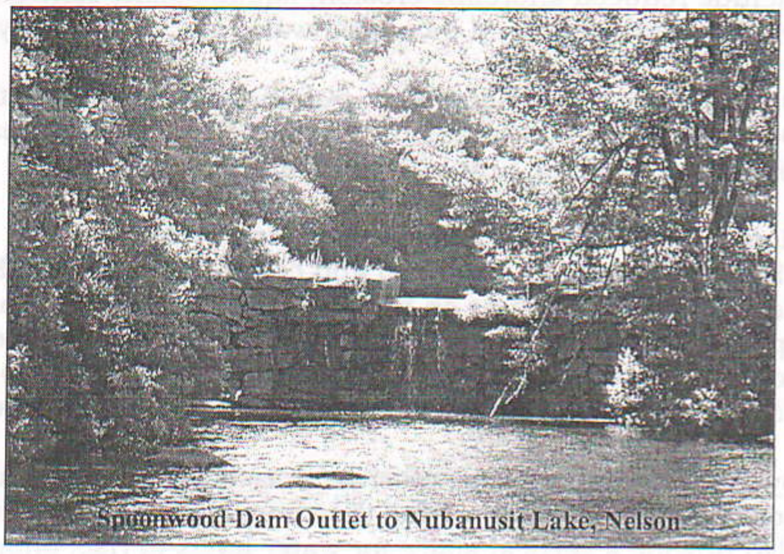


Appendix C: Special Topic

Lake Drawdowns: Friend or Foe?

A Brief History of New Hampshire's Dams

New Hampshire has over 4,800 dams statewide, many of which were constructed over a century ago. Dams were integral to economic growth in New Hampshire. Over time the purpose and function of these dams has changed, however they are an essential part of our landscape.



Spoonwood Dam Outlet to Nubanusit Lake, Nelson

In the eighteenth century, settlers constructed the first dams to power grist and lumber mills downstream. During the winter months settlers needed a method to store and access water; dams provided the solution. As time passed, dams were used by a growing number of manufacturers to advance the industrial revolution. When logging was at its peak, dams were constructed between forests and downriver sawmills to offer temporary storage. These early dams are among the oldest and largest engineering schemes still in operation in New Hampshire.

After the devastating flood of 1927, many dams were constructed to provide flood control. Overtime, the flow of water from dammed areas was harnessed for other purposes, such as hydroelectric power, water supply, further flood control, and recreational purposes. Dams also created habitats for many fish and wildlife species, and a water supply source to communities.

The most common dam structure found throughout New Hampshire is the earthen embankment dam. The earthen embankment dam is constructed using earth or rock fill, and is dependent upon some form of concrete, stone, or timber spillway section. The dam relies on its own weight and the characteristics of built materials to maintain a steady seepage for its stability.

Other commonly used dam structures in New Hampshire are gravity dams constructed of concrete or masonry, such as stone or brick, which typically have a spillway. Buttress dams characteristically consist of a wall or arch supported by several buttresses spaced across the downstream side of the dam.

What is Lake Drawdown?

Lake drawdown is the seasonal (typically fall in New Hampshire) lowering of a body of water and is normally achieved by removing stop logs to increasing water flow from the dams. The technique originated when settlers wanted to control the amount of water released downstream to power mills. The practice also helped to maintain water flow during seasonal changes in precipitation and water level.

Lake drawdowns are often conducted for the same reasons today, and benefits often include reduced shoreline erosion, aquatic plant control, reduced adverse effects of winter ice damage, and increased water storage capacity to reduce spring flooding.

Drawdowns of New Hampshire public waters are regulated by the New Hampshire Department of Environmental Services (DES) Dam Bureau to ensure that the drawdown is in the best interest of all parties affected.

How does drawdown reduce shoreline erosion?
Shoreline erosion is a natural and continuous process. High water conditions can have irreparable effects on the shoreline if water levels are above normal. The force applied by lake water and soil saturation will gradually erode the shoreline. Wave action caused by high winds or boating activity can also erode the shoreline above the normal water line. However, there are ways to mitigate and slow the erosive process.

By lowering water levels, erosive forces of waves are reduced and only occur below the normal water level protecting the shoreline from high waters and erosion. Drawdowns also provide a vertical space for water levels to rise; often as a result of spring runoff and precipitation, allowing water levels to return to normal heights.

How can drawdown help control aquatic plant growth?
Aquatic plants are commonly found along the water's edge and are beneficial to the aquatic ecosystem. The vegetation provides habitat and food for a variety of wildlife (including fish), filters out pollutants and nutrients from surface runoff, and stabilizes banks to prevent shoreline erosion. High abundances of native and exotic aquatic plants can often be considered a nuisance by property owners, swimmers and boaters.

Drawdowns are used as a low cost and toxic free mechanism of potentially reducing exotic and native plant infestations. The objective is sediment exposure resulting in desiccation of root systems during late fall ground freezes. The freezing is intended to damage or kill root systems and seeds to reduce or eliminate some plant species. Some aquatic vegetation is not easily controlled by the drawdowns. There are several annual aquatic species that produce seeds, and free-floating plants that are not effectively managed by drawdown.

Aquatic plant management success is related to the frost depth and sediment dewatering. Rooted vegetation may be exposed to freezing temperatures; however an adequate frost depth may not be achieved, thus not successfully impacting seed bases and root systems.

How do drawdowns reduce adverse impacts to lake structures?
Once a lake or pond has frozen, the thickness of the ice can reach a depth of two or more feet. Eventually, the ice can exert a hefty force upon the shoreline or associated structures, moving or damaging objects in its path. Lake drawdown can combat the effects of these forces by re-directing where the pressure is exerted. This allows the natural shoreline and nearby structures to remain unaltered or disturbed.

The exposure of the shoreline during the fall months also allows property owners to carry out required minimum impact maintenance or repairs to their property. Some maintenance requires a Wetlands Permit so be sure to consult with the DES Wetlands Bureau before taking on large projects.

How do drawdowns reduce flooding?
Spring snowmelt and precipitation, depending upon the rate at which both occur, can ultimately raise lake and pond water levels. In recent years, the state has experienced severe storm events that have caused extensive flooding. The ability of lakes and ponds to store this excess water is crucial.

Fall drawdowns provide extra storage capacity for lakes and ponds during spring run-off events. This in turn can help reduce shoreline erosion and property damage due to flooding, and can reduce potential downstream flooding.

If the spring is arid and lakes and ponds do not return to normal water levels, multiple problems can result. The key is to maintain meticulous control over the water outflow of the pond, a responsibility of dam management.

How do drawdowns affect aquatic species populations?
Lake drawdowns may cause sudden changes in aquatic ecosystems and shoreline habitats. Fish and waterfowl populations may experience shortages in food sources. Amphibians and benthic invertebrates may exhibit changes in species abundance or composition. Species, such as snails and mussels that are unable to travel quickly, may not move fast enough to keep up with the receding waters resulting in mortality through desiccation or competition as a food source. Most drawdowns are controlled and occur slowly, but no drawdown can be free of species and habitat destruction.

How do drawdowns impact suspended sediments and nutrients?
Water volumes increase downstream during drawdowns. Even though the flows are temporary, if water is released too quickly it can cause concern both downstream and in upstream wetlands. The same environmental impacts that occur in the lake also occur in any upstream wetland. These wetland areas contain complicated food webs and a series of different inhabitants that must struggle with each drawdown. Although drawdowns are closely monitored to prevent major disturbances to the waterbody, little attention is provided for the many upland wetlands.

Drawdowns increase nutrient and sediment loading downstream. At the conclusion of fall lake turnover, nutrients typically confined to the hypolimnetic waters are mixed into one isothermal water layer. The potential for short-term algal or cyanobacteria blooms increase both in the lake and downstream waterbodies. High algal cell populations may also lead to dissolved oxygen depletion in downstream waterbodies. If drawdown occurs too quickly, the increased water flow and energy enhances the probability of bank erosion. The suspended sediments will increase turbidity and smother the benthic environments that support aquatic biota.

A Case Study at Ashuelot Pond, Washington
Ashuelot Pond in Washington, N.H., has a history of lake drawdown. Since the mid-1980s Ashuelot has been drawn down in an attempt to control aquatic vegetation, specifically native plant populations. In 1991, DES regulated annual drawdowns to 3.5

feet for flood control, and deep drawdowns to take place every fifth year. The DES Biology Section researched the physical, chemical, biological and ecological impacts of drawdowns to Ashuelot Pond. The study focused on impacts of drawdowns on aquatic plant percent cover, aquatic biota, and overall water quality. The results are as follows.

Throughout Ashuelot Pond the general aquatic plant percent cover did not illustrate a statistically significant change. When the results were more closely examined, only a few aquatic plant populations showed weakly significant changes. Only one species, Pondweed, had a definitive statistical decrease in the water body. In 2005, the Ashuelot River downstream of the dam, presented a small but statistically significant increase in overall aquatic plant cover compared to the data sets from 2002, 2003 and 2004.

Deep drawdowns and shallower drawdowns were compared to determine effects on macroinvertebrates (small bugs lacking a backbone that are a food source for fish). The overall number of macroinvertebrates did not significantly increase or decrease after the drawdowns. The deep drawdown did not impact species population however there was an impact on species diversity. The dominant macroinvertebrate species shifted from Dipterans (example: black fly, mayfly, or stonefly) to Amphipods (a species of shrimp-like crustaceans) after the deep drawdown.

One interesting observation by biologists is that no freshwater mussels were observed on the lake bottom or on the shoreline during the study period. It is not know if this is a natural condition of the lake of if continuous drawdowns may eliminate freshwater mussels from the lake biota.

The frog population was not adversely affected by the deep drawdowns. Statistical analysis of the data concluded the frog populations were rather stable in the pond. It is evident that adult frogs continued reproducing and egg masses were observed throughout the study.

Fish populations are measured by the Proportional Stock Density (PSD), which is a value used to describe the structural balance of a fish population. The PSD of largemouth bass in Ashuelot Pond has been variable over time. The weights of large mouth bass were found to have no significant difference among years, which suggests the drawdown had no direct impact on the largemouth bass population.

The study of Ashuelot Pond provided a thorough assessment of New Hampshire lake drawdown affects on the aquatic ecosystem. Drawdowns do not yield dramatic declines in aquatic plant abundance or diversity suggesting that drawdowns are not successful tools in reducing the overall aquatic plant percent cover in a pond. Drawdowns do, however, exert some negative pressures on aquatic organisms. The conclusion for Ashuelot Pond is to protect the integrity of the aquatic ecosystem; deep water drawdowns are not the best method to control aquatic plant growth.

Who to Contact

For more information relative to the design, construction, maintenance and operation of dams, please contact the DES Water Division Dam Bureau at (603) 271-3406 or email mdamsafety@des.state.nh.us. General information is available at www.des.nh.gov/Dam/. You may also visit our office at 29 Hazen Drive in Concord, New Hampshire.

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Types of Dams Common to New Hampshire, WD-DB-2, DES Fact Sheet, (603)271-3503 or http://des.nh.gov/organization/commissioner/pip/factsheets/db/documents/db-2.pdf

Why Lake Drawdowns Are Conducted, WD-DB-16, DES Fact Sheet, (603) 271-3406 or http://des.nh.gov/organization/commissioner/pip/factsheets/db/documents/db-16.pdf

Appendix D: New Hampshire Similar Lake Groupings and Data

2009 VLAP LAKES: SIMILAR GROUPINGS BASED ON LAKE VOLUME AND MAXIMUM DEPTH

Maximum Depth Category Breakpoints = 0-10 m; 10-25 m; >= 25 meters
Volume Category Breakpoints = 1-100,000 m3; 100,000 - 5,000,000 m3; 5,000,000-50,000,000 m3; >50,000,000 m3

GROUP 1
Volume = 1 - < 100,000 m3
Maximum Depth = 0 - <10 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
DORRS POND	MANCHESTER	2.9	1.3	92000	7.12	596	31.2
HORSESHOE POND	CANTERBURY						
HOUSTON (HARANTIS) POND	CHESTER	2.6	1.2	94000	8.13	588	32.5
KIMBALL POND	CANTERBURY	1.2	0.4	16500	4.17	49	14.2
LOCKE LAKE	BARNSTEAD	2.5					
MILL POND	EAST WASHINGTON						
PRATT POND	NEW IPSWICH	8.9		71000	15.58	113.2	9.1
ROUND POND	LYMAN	4.6	1.1	81000	7.53	819.3	46.1
SEAVEY POND	WINDHAM	2.5	0.8	34500	4.37	1482.9	202.5

GROUP 2
Volume = 100,000 - < 5,000,000 m3
Maximum Depth = 0 - <10 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
ARMINGTON LAKE	PIERMONT	9.7	3.7	2125500	57.55	553.6	1.7
ASHUELOT POND	WASHINGTON	7.8	1.8	2229500	121.2	6475	16.2
AYERS POND	BARRINGTON	9.1	4.4	4030500	92.11	804.1	1
BAPTIST POND	SPRINGFIELD	7.5	2.4	972500	40.02	673.4	3.7
BACK LAKE	PITTSBURG	4.6	2	2965500	145.12	310.8	0.6
BAXTER LAKE	FARMINGTON	4.6	2.1	2452500	119.34	987.1	1.9
BEARCAMP POND	SANDWICH	9.2	2.7	1769500	67.58	3108	8.5
BOLSTER POND	SULLIVAN	4.3	7.8	250000	13.52	251.2	5.6
BURNS POND	WHITEFIELD	6.1	2.9	1390500	47.55	1243.2	4.1
CANAAN STREET LAKE	CANAAN	6.7	3.4	4146500	122.62	635.6	0.7
CAPTAIN POND	SALEM	8.6	2.5	874000	36.54	388.5	2.1
CENTER POND	STODDARD	8.5	3.9	1354500	34.4	466.2	2.1
CHALK POND	NEWBURY	3.6	2	166500	8.5	137.3	4.6
CHAPMAN POND	SULLIVAN	5.2	2.2	177500	7.93	284.9	8.9
CHASE POND	WILMOT	3.4	1.9	296000	15.78	3643.1	62.5
CHESTNUT POND	EPSOM	7	3.4	420000	12.26	62.2	0.8
CLOUGH POND	BELMONT	6.4	3.7	165500	4.49	27.4	0.7
COLD (COLE) POND	ANDOVER	5.5	2.4	141500	5.99	298.5	10.7
CONTENTION POND	HILLSBOROUGH	9.9	5.7	2168500	38.28	802.9	2.2
CONTOOCOOK LAKE	JAFFREY	6.4	2.2	1944000	153.78	2382.8	6.8
COUNTRY POND	KINGSTON	9.4	2.6	3268000	103.19	4221.7	6.2
CRESCENT LAKE	ACWORTH	7.3	3.2	1526500	47.02	1183.6	3.7
CRYSTAL LAKE	MANCHESTER	6.4	2.9	217000	7.53	81	1.8
DINSMORE POND	SANDWICH	6.4	2.3	348000	15.01	259	3.8
DODGE POND	LYMAN	3	1.8	167500	9.39	1100.9	28.3
DUCK POND	FREEDOM	4.3	2.4	359000	15.01	117.9	1.9
DUTCHMAN POND	SPRINGFIELD	3	1.9	210000	11.29	46.3	1.4
EASTMAN POND	GRANTHAM	9.2	3	4066500	135.57	1985.8	2.1
EMERSON POND	RINDGE	5.2	1.3	509000	45.81	213.7	2.4
FOREST LAKE	WINCHESTER	9.8	4.7	1653000	35.21	1813	5
FOREST LAKE	WHITEFIELD	6.4	3	2318000	77.58	505.9	1
FROST POND	JAFFREY	3.7	2.1	889500	41.8	126.9	0.8
GARLAND POND	MOULTONBORO	4.9	1.3	533000	32.54	5672.1	51.4
GOVERNORS LAKE	RAYMOND	3	1.9	394000	21.12	275.1	3.4
HALFMOON LAKE	ALTON	8.2	4.4	4545000	102.38	1761.2	2
HALFMOON POND	WASHINGTON	5.8	2.6	856000	33.39	2002	16.6
HARVEY LAKE	NORTHWOOD	6.1	3.1	1320500	42.49	628.4	2.7
HAUNTED (SCOBIE) LAKE	FRANCESTOWN	5.2	2.4	1361500	69.08	1528.1	5.4
HORSESHOE POND	CONCORD	4.2	1.3	236000	18.17	280.3	4.8
HUNKINS POND	SANBORNTON	7	4.2	253500	5.99	101	1.9
ISLAND POND	STODDARD	5.5	2.4	1529500	63.94	8852.1	353
IVANHOE, LAKE (ROUND POND)	WAKEFIELD	6.1	3.6	1809000	27.52	160.6	0.5
JENNESS POND	NORTHWOOD	8.5	2.7	2535500	94.09	743.3	1.6
KATHERINE, LAKE	PIERMONT	6.4	3.5	528000	15.01	212.4	2

GROUP 2 (CONTINUED)
Volume = 100,000 - < 5,000,000 m3
Maximum Depth = 0 - <10 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
KEZAR LAKE	SUTTON	8.2	2.7	1975500	73.49	2771.3	8.2
KILTON POND	GRAFTON	3.1	1.2	318500	27.52	1813	34.7
KOLELEMOOK LAKE	SPRINGFIELD	6.7	4.1	1623000	40.02	246.9	0.9
LEDGE POND	SUNAPEE	5.2	2.8	1233000	44.56	338	1.3
LITTLE DIAMOND POND	STEWARTSTOWN	4.6	1.9	407000	21.53	170.9	3.6
LOON LAKE	PLYMOUTH	8.8	3.9	1784500	45.28	906.5	2.6
LONG POND	PELHAM	7.6	3.2	1559000	48.8	462	1.5
LYFORD POND	CANTERBURY	2.7	1.4	144000	10.52	141.9	4.3
MARTIN MEADOW POND	LANCASTER	9.1	4.1	1954000	47.75	388.5	0.9
MAY POND	WASHINGTON	7.6	2.4	1467700	60.3	1528	6.9
MELENDY POND	BROOKLINE	6.8	2.7	180000	6.76	82.9	2.2
MESSER POND	NEW LONDON	7.6	2.6	704000	26.99	569.8	4.7
MIRROR LAKE	WHITEFIELD	7	2.3	399000	17.16	215	2.6
MOUNTAIN LAKE, LOWER	HAVERHILL	7.7	3.8	917000	24.28	938.2	4.1
MOUNTAIN LAKE, UPPER	HAVERHILL	5.4	2.5	232500	12.14	872	17.1
MOUNTAINVIEW LAKE	SUNAPEE	6.7	4.1	1758000	42.41	336.7	1
NEW POND	CANTERBURY	3	1.4	167000	11.7	40.9	1.1
NORWAY POND	HANCOCK	5.5	2.5	509000	20.03	1839.9	19.2
NUTT POND	MANCHESTER	9.2	4	260500	6.52	168	3.1
ONWAY LAKE	RAYMOND	8.9	3.2	2509000	77.7	2374.3	4.6
OTTER POND	SUNAPEE	7.6	4	3000500	74.87	4491.2	7.6
OTTERNICK POND	HUDSON	3.7	1.9	261500	13.76	1113.7	20.5
PEARLY LAKE	RINDGE	5.4	2	1156000	57.55	1036	5.2
PECKER POND	RINDGE	4.5	1.8	178000	9.71	78.6	2.6
PEMIGEWASSET LAKE	MEREDITH	8.8	2.4	2329500	97.61	1346.8	2.8
PERKINS POND	SUNAPEE	3	1.4	877000	63.54	284.9	1.3
PHILLIPS POND	SANDOWN	5.8	3.1	1058500	34.52	811.8	3.7
PILLSBURY LAKE	WEBSTER	3	1.4	263500	18.21	2247.8	36.8
PINE ISLAND POND	MANCHESTER	3	1.5	265000	17.16	17889.2	326
PLEASANT POND	FRANCESTOWN	6.4	3.2	2394000	75.68	425.8	0.9
PLEASANT POND	HENNIKER	9.2	4.5	1543000	37.29	362.6	1.2
POOL POND	RINDGE	4.1	2.4	1175500	48.16	1113.7	5.5
POTANIPO POND	BROOKLINE	7.6	4.1	2823000	68.8	6267.8	10.7
POWWOW POND	KINGSTON	3.2	1.3	1296000	99.76	8158.5	30.3
RAND POND	GOSHEN	8.2	3.4	534000	15.66	132.1	1.4
ROBINSON POND	HUDSON	9	3.3	1189000	35.61	336.7	1.3
ROCK POND	WINDHAM	8.2	3	418500	14	172	2.5
ROCKWOOD POND	FITZWILLIAM	6.7	3.2	989500	30.76	336.7	1.8
ROCKYBOUND POND	CROYDON	9.1	4.5	1166500	26.14	214.2	0.7
RUSSELL RESERVOIR	HARRISVILLE	4.7	1.6	170000	10.52	2845.4	93.5
SAWYER LAKE	GILMANTON	4.5	3	953500	31.77	378.2	1.9
SEBBINS POND	BEDFORD	7	3.4	273500	8.01	90.6	1.6
SHELLCAMP POND	GILMANTON	4.9	1.6	950000	60.22	830.3	4.7
SHOWELL POND	SANDOWN	7.2	3.1	235500	8.09	62.2	1.2
SKATUTAKEE, LAKE	HARRISVILLE	6.2	2.9	3044500	105.58	4532.5	8.3
SONDOGARDY POND	NORTHFIELD	4.9	2.7	443000	16.51	1139.6	11.1
SPECTACLE POND	ENFIELD	5.5	3	1313500	43.54	327.1	1.4
STEVENS POND	MANCHESTER	5.2	2.8	176000	6.27	180	4.9
STOCKER POND	GRANTHAM	5.8	2.7	697000	25.7	507.1	3.5
SUNCOOK POND, LOWER	BARNSTEAD	4.9	2.9	2916500	99.27	14193.1	22.2
SUNRISE LAKE	MIDDLETON	4.1	1.9	1966000	103.96	854.7	2
THORNDIKE POND	JAFFREY	7	3.4	3513500	107.24	1036	1.7
TODD LAKE	NEWBURY	6.1	2.2	1466500	68.07	155.4	0.5
TOLMAN POND	NELSON	3.9	2.4	364000	15.5	120.6	1.9
TOM POND	WARNER	4.1	2.5	314000	12.75	243.3	3.5
TUCKER POND	SALISBURY	6.7	2	449500	22.9	196.8	2.1
TUREE POND	BOW	3	1.9	357000	19.02	790.2	9.5
WALKER POND	BOSCAWEN	12.8	4.5	3205500	70.46	2382.8	3.2
WARREN LAKE	ALSTEAD	4.2	2.2	1671000	75.07	1309.9	3.8
WAUKEENA LAKE	DANBURY	6.1	1.2	276500	21.29	114	2.5

GROUP 3
Volume = 5,000,000 < 50,000,000 m3
Maximum Depth = 0 - <10 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
FRENCH POND	HAVERHILL	7.8	3.5	43191500	12.54	310.8	2.9
HIGHLAND LAKE	STODDARD	9.6	2.4	6971500	288.14	7692.3	7
MONOMONAC, LAKE	RINDGE	7.8	2.8	8093500	287.78	5037.7	3.6
NORTHWOOD LAKE	NORTHWOOD	6.3	3.1	8488000	277.99	6225.9	3.9
PROVINCE LAKE	EFFINGHAM	4.9	2.8	11268500	410.37	1890.7	1

GROUP 4
Volume = 1 - < 100,000 m3
Maximum Depth = 10 - <25 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)

GROUP 5
Volume= 100,000 - < 5,000,000 m3
Maximum Depth = 10 - < 25 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
ANGLE POND	SANDOWN	11.6	3	1924500	60.7	611.4	1.5
BEAVER LAKE	DERRY	14	5	2707500	54.07	2331	4.1
BEECH POND, LOWER	TUFTONBORO	15.2	6.8	4250500	62.73	647.5	0.8
BERRY BAY	FREEDOM	11.6	3.7	2147000	58.85	93211.8	254
BLAISDELL LAKE	SUTTON	13.1	5.4	3479500	64.06	181.3	0.3
CLEMENT POND	HOPKINTON	15.5	6.6	3153500	48.04	619	0.9
CONNER POND	OSSIPEE	19.2	9.8	3368000	35.01	220.5	0.3
DANFORTH POND, LOWER	FREEDOM	16.8	7.1	918500	12.91	4765.6	31.6
DEERING RESERVOIR	DEERING	11.3	3.5	4442500	127.64	1139.6	1.3
FRENCH POND	HENNIKER	11.8	4.3	727500	16.79	196.7	1.2
GILMORE POND	JAFFREY	13.1	3.7	1736500	46.54	120.9	0.4
GLEN LAKE	GOFFSTOWN	15.8	5.9	2826500	48.08	52400	80
GOULD POND	HILLSBOROUGH	11.1	5.7	1113000	19.5	2590	11.8
GREAT POND	KINGSTON	16.2	4.5	3700500	82.56	2175.6	2.6
GREGG LAKE	ANTRIM	11	5.3	4199000	78.95	1191.4	1.6
HARRISVILLE POND	HARRISVILLE	12.5	4.7	2264500	48.56	3263.4	8.4
HERMIT LAKE	SANBORNTON	15.2	2.5	1756000	71.26	1504.6	4.2
HIGHLAND LAKE	ANDOVER	13.4	5	4278500	85.39	1320.9	1.5
HILLS POND	ALTON	12.8	5.5	3054000	55.68	595.7	1
ISLAND POND	WASHINGTON	16.8	5.6	4574000	81.83	647.5	1
ISLAND POND, LITTLE	PELHAM	15.2	5.2	3248500	62.73	284.9	0.4
KNOWLES POND	NORTHFIELD	17	5.8	1396500	24.28	147.6	0.6
LAUREL LAKE	FITZWILLIAM	13.4	6.1	3826000	62.73	310.8	0.4
LEAVITT BAY	OSSIPEE	12.8	3.4	2429000	71.31	92010	221.3
LEES POND	MOULTONBORO	11.3	3.7	2675000	72.56	7148.4	12.9
LONG POND	LEMPSTER	20.3	6	2955500	48.56	466.9	0.9
LOON POND	GILMANTON	13.6	7	3436000	49.05	440.3	0.6
MILLEN POND	WASHINGTON	12.6	5	3185500	63.13	336.7	0.7
MOORES POND	TAMWORTH	11.3	4.4	886000	20.23	4949.9	34
PARTRIDGE LAKE	LITTLETON	15.2	5.8	2434000	42.05	362.6	0.6
PEA PORRIDGE POND, BIG	MADISON	13.7	4	2295500	57.54	579.2	1.5
PEA PORRIDGE POND, MIDDLE	MADISON	13.4	4.7	831500	17.52	751.1	5.3
PEQUAWKET POND	CONWAY	16.5	3.9	2236500	57.79	7096.6	18.5
POST POND	LYME	11.6	7	3132500	45.04	3367	4.4
RESERVOIR POND	DORCHESTER	13.7	3.8	1728000	44.92	117	0.4
SAND POND	MARLOW	21.6	6.2	3977500	64.38	334.7	0.5
STONE POND	MARLBOROUGH	14.6	6	1570500	26.26	284.9	1
SUNSET LAKE	ALTON	23.7	5.6	4651000	82.96	1456	1.7
SWANZEY LAKE	SWANZEY	16.2	6.9	3271500	47.35	414.4	0.6
WHITE OAK POND	HOLDERNESS	10.7	4	4697500	117.76	1217.3	1.3
WINONA, LAKE	NEW HAMPTON	14.6	6.6	4149000	62.45	1346.8	1.6

GROUP 6
Volume = 5,000,000 - < 50,000,000 m3
Maximum Depth = 10 - <25 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
BROAD BAY	OSSIPEE	22.3	8.3	15573500	187.7	90826.3	34.1
CANOBIE LAKE	WINDHAM	15.2	5.5	8379000	151.11	569.8	0.3
COBBETTS POND	WINDHAM	19.2	5.2	7208000	139.5	828.8	0.4
CRYSTAL LAKE	GILMANTON	16.2	5	8998500	178.42	7133.6	3.8
GOOSE POND	CANAAN	10.1	5.2	11769000	224.2	4118.1	1.6
ISLAND POND	DERRY	24.3	5.4	11558000	201.49	4403	1.8
MASCOMA LAKE	ENFIELD	20.1	8.7	39458000	451.18	39627	4.6
MASSASECUM, LAKE	BRADFORD	15.2	3.9	6420000	162.56	2446	1.9
MIRROR LAKE	TUFTONBORO	13.1	4	6185000	152.77	725.2	0.5
PAWTUCKAWAY LAKE	NOTTINGHAM	15.2	2.9	10740000	364.22	5361.3	2.3
PINE RIVER POND	WAKEFIELD	16.8	3.7	9000000	240.38	3367	2.1
PLEASANT LAKE	DEERFIELD	19.8	7	13995000	199.71	906.5	0.4
RUST POND	WOLFEBORO	12.2	7.4	6310500	84.98	668.2	0.6
SPOFFORD LAKE	CHESTERFIELD	19.5	9.1	26020500	286.03	1165.5	0.2
STINSON LAKE	RUMNEY	23.5	10.7	14827500	141.64	1921.1	0.9
SUNAPEE LAKE, LITTLE	NEW LONDON	13.1	4.4	8449500	191.01	1605.8	1.1
SUNCOOK POND, UPPER	BARNSTEAD	13.1	5.6	7895000	140.26	12975.8	7.5
TARLETON, LAKE	PIERMONT	20	8.5	10881500	127.64	1945.5	1.1
WAUKEWAN, LAKE	MEREDITH	21.4	6.7	24809000	369.36	3056	0.6
WEBSTER LAKE	FRANKLIN	11.8	5.5	13586500	247.75	4506.6	1.5
WICWAS LAKE	MEREDITH	10.9	3.9	5110500	132.62	2149.7	2
WINNEPOCKET, LAKE	WEBSTER	20.4	5.8	5315500	91.82	699.3	0.6

GROUP 7
Volume = >= 50,000,000 m3
Maximum Depth = 10 - <25 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
OSSIPEE LAKE	OSSIPEE	18.5	8.5	108,421,500	1251.25	84822.1	4.6

GROUP 8
Volume = 100,000 - < 5,000,000 m3
Maximum Depth > = 25 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)

GROUP 9
Volume = 5,000,000 - < 50,000,000 m3
Maximum Depth > = 25 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
DUBLIN LAKE	DUBLIN	31.1	10.1	9798500	96.6	303.7	0.2
GRANITE LAKE	STODDARD	28.9	9.8	9027000	92.19	984.2	0.7
NUBANUSIT LAKE	NELSON	30.2	11.5	30024500	289.35	2097.9	0.4
PLEASANT LAKE	NEW LONDON	28.6	10.5	25761000	245.2	3030.3	0.7
SILVER LAKE	HARRISVILLE	26.2	10.4	13878500	134.64	569.8	0.2

GROUP 10
Volume = > 50,000,000 m3
Maximum Depth > = 25 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
CONNECTICUT LAKE, FIRST	PITTSBURG	49.7	17	193502000	1136.07	21445.1	0.8
FRANCIS, LAKE	CLARKSVILLE	25	12.2	102676000	842.55	44030	2.6
SUNAPEE LAKE	SUNAPEE	31.9	11.4	188150000	1655.22	11680.8	0.3
WINNISQUAM, LAKE	LACONIA	53	15.2	262306500	1725.7	118028.7	2.2

DES LAKE ASSESSMENT PROGRAM SUMMER EPILIMNION AND UPPER LAYER BIOLOGICAL AND CHEMICAL CHARACTERISTICS (page 1 of 2)

Volume and Maximum Depth Category	Statistical Parameter	Maximum Depth (m)	Volume (m3)	Secchi (m)	Chl-a (mg/m3)	Total Phos. (ug/L)	pH (units)	Alkalinity (mg/L)	Conductivity (uMhos/cm)
GROUP 1	MIN	0.50	3000.00	0.40	0.55	1.000	4.50	-1.90	13.80
Volume = 1 - < 100,000 m3	MAX	9.80	99000.00	9.80	58.57	78.000	9.20	85.90	818.00
Maximum Depth = 0 - <10 m	MEAN	3.11	52683.54	2.16	8.23	18.888	6.36	8.35	67.57
	MEDIAN	2.50	53000.00	1.80	5.41	16.000	6.40	4.40	33.90
	COUNT	161.00	161.00	159.00	157.00	160.000	161.00	161.00	159.00
GROUP 2	MIN	1.20	100000.00	0.40	0.36	0.500	4.30	-3.00	14.80
Volume = 100,000 - < 5,000,000 m3	MAX	9.70	4696000.00	8.10	143.80	121.000	9.30	62.30	696.00
Maximum Depth = 0 - <10 m	MEAN	4.77	678122.80	2.93	8.23	15.000	6.53	6.43	67.58
	MEDIAN	4.45	341500.00	2.70	5.37	13.000	6.60	4.50	42.15
	COUNT	274.00	421.00	418.00	418.00	418.000	418.00	418.00	410.00
GROUP 3	MIN	4.9	5042000.0	2.7	1.8	7.000	6.1	1.5	27.3
Volume = 5,000,000 < 50,000,000 m3	MAX	9.7	43191500.0	8.0	6.0	18.000	6.9	15.6	77.7
Maximum Depth = 0 - <10 m	MEAN	8.0	11997600.0	3.7	4.3	11.250	6.6	5.3	47.6
	MEDIAN	7.8	8290750.0	3.3	4.5	10.000	6.8	5.0	43.3
	COUNT	10.0	10.0	10.0	10.0	8.000	10.0	10.0	10.0
GROUP 4	MIN	10.30	86000.00	5.0	5.81	10.000	5.90	0.50	18.00
Volume = 1 - < 100,000 m3	MAX	10.30	86000.00	5.0	5.81	10.000	5.90	0.50	18.00
Maximum Depth = 10 - <25 m	MEAN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	MEDIAN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	COUNT	1.00	1.00	1.00	1.00	1.000	1.00	1.00	1.00
GROUP 5	MIN	10.00	123000.00	0.80	0.36	0.500	5.10	-0.20	14.42
Volume= 100,000 - < 5,000,000 m3	MAX	24.40	4951000.00	11.40	63.68	49.000	7.90	23.80	229.00
Maximum Depth = 10 - < 25 m	MEAN	14.34	1913529.91	4.91	5.14	8.409	6.63	5.03	50.36
	MEDIAN	13.60	1586500.00	4.50	4.17	7.000	6.70	3.80	34.05
	COUNT	117.00	117.00	116.00	113.00	116.000	117.00	117.00	116.00

DES LAKE ASSESSMENT PROGRAM SUMMER EPILIMNION AND UPPER LAYER BIOLOGICAL AND CHEMICAL CHARACTERISTICS (page 2 of 2)

Volume and Maximum Depth Category	Statistical Parameter	Maximum Depth (m)	Volume (m3)	Secchi (m)	Chl-a (mg/m3)	Total Phos. (ug/L)	pH (units)	Alkalinity (mg/L)	Conductivity (uMhos/cm)
GROUP 6	MIN	10.10	5029000.00	2.10	1.28	2.500	5.70	0.90	19.33
Volume = 5,000,000 - < 50,000,000 m3	MAX	24.40	45548000.00	10.20	7.86	23.000	7.40	22.90	337.00
Maximum Depth = 10 - <25 m	MEAN	17.21	13544487.50	5.39	3.27	7.313	6.79	6.65	67.34
	MEDIAN	16.65	9288000.00	5.75	3.08	6.000	6.90	5.65	48.85
	COUNT	40.00	40.00	38.00	40.00	40.000	40.00	40.00	38.00
GROUP 7	MIN	14.60	54285000.00	3.40	1.99	2.000	6.30	4.50	28.77
Volume = >= 50,000,000 m3	MAX	18.50	120736500.00	4.00	3.73	10.000	6.70	5.50	134.40
Maximum Depth = 10 - <25 m	MEAN	16.17	94481000.00	3.67	3.06	6.330	6.53	5.03	69.50
	MEDIAN	15.40	108421500.00	3.60	3.46	7.000	6.60	5.10	45.34
	COUNT	3.00	3.00	3.00	3.00	3.000	3.00	3.00	3.00
GROUP 8	MIN	29.60	2313500.00	9.3	0.57	5.000	6.80	3.10	22.00
Volume = 100,000 - < 5,000,000 m3	MAX	29.60	2313500.00	9.3	0.57	5.000	6.80	3.10	22.00
Maximum Depth > = 25 m	MEAN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	MEDIAN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	COUNT	1.00	1.00	1.00	1.00	1.000	1.00	1.00	1.00
GROUP 9	MIN	26.20	6662000.00	3.90	0.19	0.500	5.70	-0.10	21.20
Volume = 5,000,000 - < 50,000,000 m3	MAX	40.00	30024500.00	11.60	2.56	7.000	7.10	12.90	64.60
Maximum Depth > = 25 m	MEAN	30.88	15838800.00	7.77	1.45	3.800	6.43	4.21	34.24
	MEDIAN	30.35	12814250.00	7.50	1.27	4.000	6.40	2.90	30.20
	COUNT	10.00	10.00	9.00	10.00	10.000	9.00	9.00	8.00
GROUP 10	MIN	25.00	57503000.00	3.20	1.42	2.000	6.30	3.20	30.40
Volume = > 50,000,000 m3	MAX	55.50	2375841000.00	10.30	3.95	8.000	7.40	16.80	78.90
Maximum Depth > = 25 m	MEAN	41.04	348659833.33	7.34	2.39	4.958	6.94	7.09	50.19
	MEDIAN	43.00	187598500.00	8.50	2.02	4.500	6.90	6.40	45.50
	COUNT	12.00	12.00	12.00	12.00	12.000	11.00	11.00	11.00

DES LAKE ASSESSMENT PROGRAM SUMMER HYPOLIMNION CHEMICAL CHARACTERISTICS (page 1 of 2)

Volume and Maximum Depth Category	Statistical Parameter	Maximum Depth (m)	Volume (m3)	Total Phos. (ug/L)	pH (units)	Alkalinity (mg/L)	Conductivity (uMhos/cm)
GROUP 1	MIN	1.70	11000.00	0.5000	4.70	-0.80	15.20
Volume = 1 - < 100,000 m3	MAX	9.80	99000.00	98.0000	8.80	85.00	458.00
Maximum Depth = 0 - <10 m	MEAN	4.29	65192.07	20.8110	6.18	8.06	56.87
	MEDIAN	3.95	67000.00	17.0000	6.20	4.70	31.40
	COUNT	82.00	82.00	82.0000	82.00	82.00	82.00
GROUP 2	MIN	2.20	100000.00	0.5000	4.30	-3.40	14.60
Volume = 100,000 - < 5,000,000 m3	MAX	9.90	4696000.00	217.0000	8.10	116.60	1419.00
Maximum Depth = 0 - <10 m	MEAN	5.73	731873.56	21.5754	6.28	7.67	75.35
	MEDIAN	5.80	374000.00	15.5000	6.30	5.30	41.78
	COUNT	382.00	382.00	378.0000	377.00	372.00	371.00
GROUP 3	MIN	4.90	5042000.00	0.5000	5.60	1.50	35.00
Volume = 5,000,000 < 50,000,000 m3	MAX	9.70	43191500.00	72.0000	6.90	30.10	96.70
Maximum Depth = 0 - <10 m	MEAN	7.97	11997600.00	29.2500	6.28	8.46	52.68
	MEDIAN	7.80	8290750.00	17.5000	6.30	4.80	42.03
	COUNT	10.00	10.00	10.0000	10.00	10.00	10.00
GROUP 4	MIN	10.30	86000.00	27.0000	5.90	7.90	30.00
Volume = 1 - < 100,000 m3	MAX	10.30	86000.00	27.0000	5.90	7.90	30.00
Maximum Depth = 10 - <25 m	MEAN	N/A	N/A	N/A	N/A	N/A	N/A
	MEDIAN	N/A	N/A	N/A	N/A	N/A	N/A
	COUNT	1.00	1.00	1	1.00	1.00	1.00
GROUP 5	MIN	10.00	123000.00	0.5000	5.20	0.20	16.12
Volume= 100,000 - < 5,000,000 m3	MAX	24.40	4951000.00	247.0000	7.00	39.30	286.00
Maximum Depth = 10 - < 25 m	MEAN	14.37	1925306.03	20.0776	6.10	7.63	56.77
	MEDIAN	13.60	1606750.00	13.0000	6.10	5.70	39.30
	COUNT	116.00	116.00	116.0000	114.00	113.00	115.00

DES LAKE ASSESSMENT PROGRAM SUMMER HYPOLIMNION CHEMICAL CHARACTERISTICS (page 2 of 2)

Volume and Maximum Depth Category	Statistical Parameter	Maximum Depth (m)	Volume (m3)	Total Phos. (ug/L)	pH (units)	Alkalinity (mg/L)	Conductivity (uMhos/cm)
GROUP 6	MIN	10.10	5029000.00	2.5000	5.30	0.80	20.43
Volume = 5,000,000 - < 50,000,000 m3	MAX	24.40	45548000.00	79.0000	7.10	36.30	339.00
Maximum Depth = 10 - <25 m	MEAN	17.21	13544487.50	14.8125	6.19	7.86	70.05
	MEDIAN	16.65	9288000.00	11.0000	6.20	6.50	50.10
	COUNT	40.00	40.00	40.0000	40.00	40.00	37.00
GROUP 7	MIN	14.60	54285000.00	2.0000	6.00	3.50	29.17
Volume = >= 50,000,000 m3	MAX	18.50	120736500.00	8.0000	6.50	5.50	133.30
Maximum Depth = 10 - <25 m	MEAN	16.17	94481000.00	5.6667	6.27	4.37	68.31
	MEDIAN	15.40	108421500.00	7.0000	6.30	4.10	42.47
	COUNT	3.00	3.00	3.0000	3.00	3.00	3.00
GROUP 8	MIN	29.6	2313500	6.000	6.20	6.20	29.10
Volume = 100,000 - < 5,000,000 m3	MAX	29.6	2313500	6.000	6.20	6.20	29.10
Maximum Depth > = 25 m	MEAN	N/A	N/A	N/A	N/A	N/A	N/A
	MEDIAN	N/A	N/A	N/A	N/A	N/A	N/A
	COUNT	1.00	1.00	1	1.00	1.00	1.00
GROUP 9	MIN	26.20	6662000.00	0.5000	5.40	0.90	20.50
Volume = 5,000,000 - < 50,000,000 m3	MAX	40.00	30024500.00	25.0000	6.60	11.80	91.00
Maximum Depth > = 25 m	MEAN	30.88	15838800.00	6.6500	6.08	4.20	41.46
	MEDIAN	30.35	12814250.00	5.5000	6.10	3.60	35.70
	COUNT	10.00	10.00	10.0000	10.00	10.00	9.00
GROUP 10	MIN	25.00	57503000.00	1.0000	5.80	3.30	31.60
Volume = > 50,000,000 m3	MAX	55.50	2375841000.00	27.0000	7.00	9.70	77.90
Maximum Depth > = 25 m	MEAN	41.04	348659833.33	8.9167	6.36	6.37	48.26
	MEDIAN	43.00	187598500.00	7.0000	6.40	6.30	42.40
	COUNT	12.00	12.00	12.0000	12.00	12.00	12.00