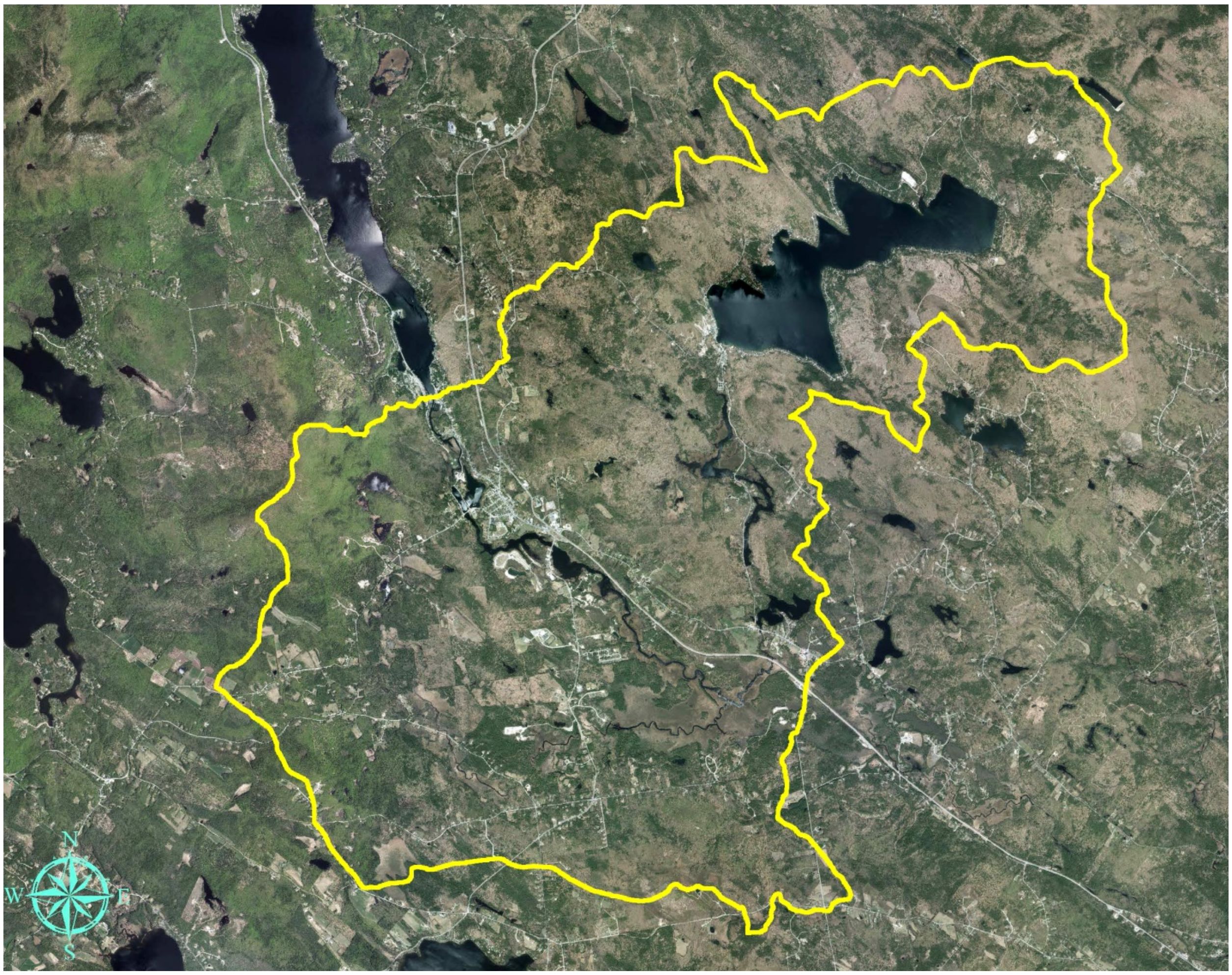
RFQ/B

Request for Qualifications and Bids

Development of a Watershed Management Plan for the Merrymeeting River Watershed Including Merrymeeting Lake



March 26, 2018

Cyanobacteria Mitigation Steering Committee of New Durham / Alton

Attention: Fred Quimby
P.O. Box 243
New Durham, New Hampshire 03855

Development of a Watershed Management Plan (WMP) for the Merrymeeting River Watershed Area

Project background and geographic area

The New Durham/Alton Cyanobacteria Mitigation Steering Committee (CMSC) with support from the Merrymeeting Lake Association and the New Hampshire Fish and Game Department (NH F&G)and other partners is seeking statements of qualifications from qualified firms to work with stakeholders to develop a watershed management and restoration plan for the Merrymeeting River and Merrymeeting Lake Watershed. The watershed includes the towns of New Durham and Alton and drains into Lake Winnipesaukee. In addition to the NH F&G and the towns of New Durham and Alton, and other sponsors and stakeholders involved with the evaluation and restoration of the watershed include community and civic groups and five community working groups reporting to the CMSC. Working groups dealing with the Powder Mill State Fish Hatchery (PMSFH) best management practices, Merrymeeting River Water Quality, Watershed Management Plan, Financing and Public Relations bring together over 20 individuals from the two communities.

The New Durham segment of the Merrymeeting River contains one natural pond (Marsh Pond) and two impoundments, Jones and Downing Ponds, which are on the NHDES 2016 303(d) list of impaired for Aquatic Life Use and Primary Contact Recreation due to high levels of cyanobacteria and cyanotoxins, likely due to nutrient enrichment with phosphorus. Studies by Merrymeeting River Water Quality working group (MRWQWG) conducted in 2016 and 2017 complement NH DES trophic studies of the same areas in 1986 and 2003 and show elevated levels of phosphorus in the entire Merrymeeting River but particularly in Marsh, Jones and Downing Ponds, at the headwaters of the river, where the current levels phosphorus exceed the phosphorus assimilative capacity threshold in Marsh and Jones Ponds (see letter from the Town of New Durham to the United States Environmental Protection Agency (USEPA) dated February 20,2018-Appendix 1). While a point source of phosphorus has been identified in the PMSFH and a conceptual plan is in place to reduce phosphorus discharge there, non-point sources identified in tributaries unassociated with the PMSFH also have high phosphorus levels (see Appendix 2).

Merrymeeting Lake sits at 646 feet above sea level and is surrounded by 7 mountains. The mountains are carved from the Merrymeeting ring-dike complex of the White Mountain magma series, characteristic of previous ancient volcanic activity*. The Lake has a watershed of 10.5 square miles (6848 acres) and is surrounded by woodlands with 380 permanent and seasonal houses limited to 250 feet of the shoreline. All shoreline homes have septic systems. Despite this, annual Water Quality Reports dating back to 1980 consistently show this waterbody to be pristine with phosphorus levels below 7ug/L (ppb) and chlorophyll-a levels below 1.1 ug/ L (ppb) characteristic of its oligotrophic classification. Recent logging activity involving 1900 acres in this watershed, threaten this waterbody. The New Durham Water Quality Committee (NDWQC) has been monitoring three streams draining the logging area. Other factors which may have an impact on the lake water quality include failing septic systems, the use of lawn fertilizers, stormwater runoff over private lands, and shoreline erosion.

The watershed for the New Durham segment of the Merrymeeting River covers 6.5 Square miles (4160 acres) and is primarily low density housing, mostly within 250 feet of the shoreline (76 houses with 11 seasonal), and extensive woodland with a single farm. Some recent logging activity has occurred in this watershed as well. While the MMRWQWG has collected extensive year-round water quality measurements, including measurements throughout the water column in deep water settings, and calculated the assimilative capacities for this area, work needs to be continued to calculate the maximum annual phosphorus loads to this area. Remediation of the point source of phosphorus by the PMSFH is NOT part of this Watershed Management Plan (WMP); it is being addressed jointly by the Hatchery Best Management Practices Working Group (HBMP WG), the Environmental Protection Agency (EPA), the New Hampshire Fish and Game Department (NH F&G) and engineering consultants. However, the phosphorus load arising from the PMSFH must be considered in loading models of this section of the watershed. Phosphorus loads are measured quarterly by the PMSFH and recorded in the EPA-ECHO data base. In 2017 the USEPA requested the PMSFH take samples for phosphorus and total suspended solids biweekly; based on these reports the New Durham Water Quality Committee calculated the PMSFH discharged 815 pounds of phosphorus into the river in that year.

The watershed in the Alton segment of the Merrymeeting River is 19.3 square miles (12,352 acres) and includes woodland, a number of farms, as well as commercial and residential areas. While phosphorus levels remain high throughout the Merrymeeting River System (see Appendix 2), none of the water in the Alton segment has been listed by the NH DES as impaired. However, the presence of extensive impervious land in Alton coupled with agricultural, commercial and residential land uses make nutrient contributions to the Merrymeeting River due to stormwater runoff likely; this should be addressed as part of land use modeling.

I.DESIRED QUALIFICATIONS

Respondents should demonstrate their capabilities for relevant services in the Northeastern US with a focus on New England lake, river and stream systems. The CMSC along with their project partners seek vendors that have a strong understanding of the underlying principles of watershed and restoration management and planning and at least three years of experience demonstrating these capabilities. Specific desired qualifications include:

1. Experience completing planning, design, and feasibility for river and watershed restoration;
2. An understanding of river, stream and watershed processes and applications of fluvial geomorphology and restoration principles;
3. An understanding of river and stream engineering in the context of fluvial geomorphology and ecology and the application of engineering services to river and stream restoration;
4. An understanding of lake, river, stream and watershed ecology and ecosystem-based habitat restoration for multiple species and life stages;
5. Demonstrated experience in using nutrient loading models and specifically in the development of lake and pond nutrient budgets;
6. Experience developing conceptual designs for lake and river watershed management and restoration projects (e.g. culvert design, stormwater runoff abatement, shoreline protection, streambank stabilization);
7. Experience in Watershed Plan development and implementation;
8. Demonstrated experience in successful community and stakeholder outreach and planning processes;
9. Experience providing effective presentation of complex and controversial issues to the public including shoreline residential communities and farming communities where fertilizer and animal waste runoff may be an issue;
10. A demonstrated ability to meet project goals within the projected timeline.

II. SOLICITATION OF BIDS

Respondents should review carefully the scope of work contained in this announcement and provide a technical proposal describing the general project approach and a detailed description of your approach to each of the tasks outlined, along with a proposed completion date for each task and an estimated cost for the completion of each task (see Section III. below for more details).

III. REQUIRED SUBMISSIONS

Qualification and bid solicitation packages shall include the following components:

1. A cover letter indicating a primary contact for the qualification and bid solicitation package and that person's title, address, phone number, and email address. The cover letter should note that the consultant is able to render services in New Hampshire and include the relevant certificates (professional engineer, certified wetland scientist, certified floodplain manager, etc.).
2. A description of the respondent's general approach to lake, river and watershed management and restoration skills and specialties for which the respondent is qualified, and a summary of directly relevant work experience of the respondent. The respondent must address how the respondent meets the desired qualifications outlined above (Section I). Please consult the section VIII-SELECTION CRITERIA (below) for additional guidance.
3. List of references including the names, titles, and contact information for clients for whom similar work has been conducted in the past 5 years.
4. The project team, including the project team organization, team member qualifications and the anticipated level of involvement of key team members in each phase of the project as described in the project approach and scope of work.
5. Project reference pages including a summary of the project, the specific role of the respondent in the project, and representative photographs.
6. A technical proposal that describes the teams approach and scope of work.
7. A proposed project schedule.
8. A task table that includes the following elements:
    a. Description of each task
    b. Description of the key team members completing each task.
    c. Proposed completion date for each task
    d. Deliverables for each task or group of tasks
    e. Estimated costs for completion of each task
9. A bid to complete the all the tasks of all required documents

A complete and timely submission of all required documents is required for the Request for Qualifications and Bidding (RFQ/B) package to be considered (see Time line below).

Each respondent will submit one portable document format (pdf) file to: fwq1@cornell.edu and one hard copy printed double sided, detailing the qualification/bid package by the close of the business day (5PM) on April 27, 2018 to the New Durham/Alton Cyanobacteria Mitigation Steering Committee in care of Fred Quimby, P.O. Box 243, New Durham, NH 03855.

After quality based and bid ranking is complete (see the VIII. Selection Criteria below) the CMSC will announce their first choice by May 30,2018.

IV. PROJECT TEAM AND LEVEL OF PARTICIPATION

The qualification package will identify the individuals responsible for managing the project and conducting the specific project tasks. The expected level of participation in each project task and the overall project should also be included. An organization chart showing anticipated lines of communication and decision-making hierarchy will be included.

V. PROJECT APPROACH AND SCOPE OF WORK

The qualifications/bidding package must contain all the elements found in the Scope of Work Guidance Document. It must be clear how all these elements will be addressed and also how public participation and interaction with various stakeholders will occur.

VI. PROJECT SCHEDULE

The respondent will provide a schedule to conduct and complete the project. The schedule will include specific tasks as outlined in the Scope of Work Guidance Document. Project tasks will be laid out in a flow chart identifying the anticipated days to complete each task and the interrelationship of conducting and completing each task by June 30,2019.

VII. BID DOCUMENTS

The respondent will provide an estimate for completing each task and a final bid for completing the project. This can be included as part of the Project Schedule (as seen above).

VIII. SELECTION CRITERIA

Selection will be based on the qualification/bidding package. Respondents will be assessed based on the following criteria:

1. Specialized experience of the project team (25%)
    a. Specialized experience relating to the development of river and lake watershed management and restoration plans.
    b. Demonstrated ability to complete the work within the required schedule and budget.
    c. Ability to effectively solicit, assess, and use comments and suggestions from stakeholders during project development.
    d. Successful cooperation with non-profits, local, state, and federal agencies and private partners.
    e. Experience providing effective presentation to the public of controversial information.
2. Project Personnel (25%)

The respondent will be rated on the principal team members' role and participation level, projects management effectiveness, and the qualifications and experience of key personnel, their communication abilities, and availability during the project.

3. Project Approach (20%)
   The respondent will be rated on the approach to the project scope outlined in the Work Scope Guidance Document, the understanding of the project scope and schedule of work and the interfacing tasks.

4. Project Bid (30%)
   The respondent will be rated on the final bid for the entire project.

IX. REQUEST FROM QUALIFICATIONS AND BID QUESTIONS

The New Durham/Alton Cyanobacteria Mitigation Steering Committee and their project partners will not respond to telephone questions about the RFQ/B. Questions regarding the RFQ/B must be submitted via email to the chair of the CMSC, Fred Quimby at fwq1@cornell.edu. Questions must be submitted by 5:00PM on April 9,2018. Any information obtained by speaking one-on-one with a project partner is not considered an official response for the purposes of this process. A digest version of all questions and answers will be emailed to everybody submitting a question. Additional persons wishing to receive the digest version should request a copy via email from Fred Quimby. The targeted distribution date for the digest version is April 13, 2018.

X. TIME LINE

March 26,2018	Request for qualifications/Bids (RFQ/B) release
April 9, 2018	Deadline for submittal of questions on the RFQ/B
April 13, 2018	Questions and answers digest distributed
April 27, 2018	Deadline for receipt of RFQ/B packages (at 5:00PM)
May 30, 2018	Anticipated final selection of a contractor and notification of all firms

The CMSC reserves the right to conduct interviews with selected teams. The decision to conduct interviews may affect the specified time line.

XI. DISCLAIMER

This request for qualifications and bids (RFQ/B) does not commit the Cyanobacteria Mitigation Steering Committee to award a contract or pay any costs incurred during the preparation of the RFQ/B package. The CMSC reserves the right to reject any or all of the proposals for completing this work. Also, the CMSC reserves the right to eliminate the need for the selected firm to complete one or more of the tasks and to negotiate the final bid based on the tasks being completed.

SCOPE OF WORK GUIDANCE DOCUMENT

Development of the Watershed Management Plan for the Merrymeeting River and Merrymeeting Lake

BACKGROUND:

The New Durham Segment of the Merrymeeting River Watershed Area

The Merrymeeting River and Lake watershed area is 36.5 square miles (23,360 acres) and the river runs from the northwest corner of New Durham to Lake Winnipesaukee in Alton Bay, NH (see Appendix 3) a total of 10miles (16.1 km). The drainage for the Merrymeeting Lake/River system is the Winnipesaukee River and the Hydrologic Unit Code is 1070002.The lake is designated by the NH DES as Assessment Unit NHLAK700020102-03.

Merrymeeting Lake and its tributaries comprise the headwaters for the Merrymeeting River (see Appendix 4). The Lake, which has a surface area of 1229.8740 acres, sits 646 feet above sea level and is surrounded by a ring-dike complex typical of ancient volcanic activity. From the Merrymeeting Lake outlet the river flows down a gradient north and west to Lake Winnipesaukee, which sits at 504 feet above sea level. Merrymeeting Lake has been the object of many Trophic Lake Surveys conducted since 1981 by the Lay Lakes Monitoring Program (LLMP) (UNH cooperative extension) and is classified as oligiotrophic by the NH DES (see Appendix 5). The Lake is managed by the NH F&G department as a Salmon/Lake Trout Fishery and receives rainbow trout and salmon annually from the Powder Mill State Fish Hatchery (PMSFH). Lake trout are self-replicating as are small mouth bass, yellow perch, bluegill, sunfish, black bullhead, eastern chain pickerel, burbot(cusk), white suckers and rainbow smelt. Several of the Lake tributaries are classified by the NH DES wetlands department as ideal for cold water fish reproduction including streams with wild brook trout and rainbow smelt. Merrymeeting Lake has also been studied for lake water cyanobacteria microcystin levels and found to have the 9.17 ng/L microcystin, the lowest level of 12 NH lakes tested. The Lake also has an active invasive species monitoring program and remains free of all reportable invasive species. The LLMP and Invasive species monitoring programs are sponsored by the Merrymeeting Lake Association. The lake is listed on the NH DES 2016 305(b)/303(d) report as impaired for Aquatic Life and Fish consumption due to the presence of mercury and low water pH (both air-borne contaminants). In 2017 the voters of New Durham approved the establishment of the Merrrymeeting Lake overlay district to reduce future residential home construction within the watershed area of the lake. Despite this action, the Lake currently has over 380 households, many permanent, and all with septic systems. Many residents use lawn fertilizers containing phosphorus despite constant reminders not to do so from the Merrymeeting Lake Association (MMLA). The Lake has one commercial marina which has a tightly regulated EPA discharge permit, In addition, the lake supports three water skiing schools where wake boarding is practiced. This sport creates large wakes which often flow over the residential shoreline walls bringing soil into the lake. The lake has two roads circling it within 100 feet of the shoreline and many instances of roadside ditch soil erosion can be found. Also, there are numerous instances where stormwater runoff over private residential property runs into the lake which could be corrected by building barriers such as water gardens. In addition, two culverts have been recognized as defective and are currently scheduled for replacement. Beginning in 2016 the Town of New Durham began a new winter road maintenance program which shifted from a de-icing treatment of primary sand/salt usage to a treated salt usage. The primary treated salt solution has led to a 45-50% reduction in salt used and a 75% reduction in sand used; and a great reduction in sediment in stormwater runoff from entering the rivers and lakes. Finally, in 2017 a major effort was made to harvest logs within the watershed. While selected streams draining the harvest area are being monitored nearing 1900 acres of land draining into Merrymeeting Lake have been exposed by this logging operation.

The Merrymeeting River runs from the State Dam, in the southwest corner of Merrymeeting Lake, to Alton Bay on Lake Winnipesaukee. Since 1947 the NH F&G Department (NHF&G) has operated a fish hatchery, 100 feet below the dam, where it raises brook trout, rainbow trout, and brown trout for dissemination throughout the state. It is also the State's only production facility for Land Locked Salmon. The hatchery uses approximately 6.5 million gallons of water a day which is taken from two locations within Merrymeeting Lake. During the summer this flow, through the hatchery, is the only headwater for the river. In the Spring, Fall and Winter additional water is released from the Lake via the dam's spillway. The Powder Mill State Fish Hatchery comprises approximately 25 acres out of a total of 102 acres purchased in 1977 from George Marks and this area is known as the Marks Wildlife Management Area and includes much of Marsh Pond. Within 1000 feet of the hatchery is the first of three impoundments in the New Durham segment of the Merrymeeting River. In their order of appearance below the hatchery are Marsh, Jones and Downing Ponds. Each has been the subject of trophic and biological surveys dating back to 1938. Historically the Merrymeeting River had been used to transport logs from the area around the lake to saw mills located on Marsh Pond and the southern end of Downing Pond in the late 1700s and 1800s. Water quality testing was conducted by the CMSC Merrymeeting River Water Quality Working Group throughout the year 2017; the sampling sites are shown on Appendix 6.

Marsh Pond, NH DES Assessment Unit #NHIMP700020102, sits 590 feet above sea level and currently has a surface area of 15 acres. While there was no dam on Marsh Pond in 1950, a boulder dike at the mouth of the Merrymeeting Road Bridge was built in the 1980s to allow repairs on Jones Pond dam. NH DES trophic surveys conducted in 1986 and 1987 had dissolved oxygen at the deepest point of 0.2ppm, transparency of 3.4m, phosphorus was 33 ppb at the surface and 112 ppb at 4m, chlorophyll-a of 30.31 ug/L and the deep-water temperature was 54F; it was classified as eutrophic**. This report recognized that the pond receives a large load of phosphorus due to the hatchery. This pond has been the object of extensive water quality surveys by the New Durham Water Quality Committee in 2016 and 2017. The same deep-water site used in the previous NH DES surveys was the target site for water quality assessments throughout the water column in 2017, which can be used to calculate the phosphorus turnover in this pond(provided on request). The NH DES 303(d) list shows Marsh pond impaired for fish consumption due to mercury. Extensive studies conducted by the UNH cooperative extension service in 2017 demonstrates a rich community of cyanobacteria in this pond close to the bottom of the pond where oxygen depletion also occurs (data available on request). No blooms have been reported perhaps due to the cold water released into the pond from the hatchery (average year-round hatchery temperature is 55F). Spring 2017 runoff into tributaries of Marsh, Jones and Downing Ponds can be found in Appendix 1. None of the tributaries to Marsh Pond contained significant levels of phosphorus. However, photographs taken around Marsh Pond after heavy rains in 2017 show areas with extensive shoreline erosion and stormwater runoff (photos available on request). There are only seven residences which border (within 100 feet) Marsh Pond, all with septic systems. According to the NH F&G, the Marks WMA contains white tailed deer, moose, black bear, beaver, snowshoe hare, ruffed grouse, several species of migrating songbirds and muskrat. In Marsh Pond you find migratory waterfowl including black ducks, mallards, wood ducks, hooded mergansers, Canada geese, and blue winged and green winged teal. Other birds include great blue heron, eastern kingbirds, tree and rough winged swallow, and marsh wrens. Endangered species also live in this habitat and will be described later.

Jones Pond (also called stump pond and unnamed pond #3, and Jones Dam Pond), NH DES Assessment unit# NHIMP700020102-01, sits 545 feet above sea level, has a surface area of 59 acres, and is an impoundment located just south of Marsh Pond. Jones Pond was the subject of a biological survey in 1938 by the NH F&G in an effort to identify areas in which to establish cold water fisheries. Deep water testing at 8 feet showed oxygen concentrations of 6.1 ppm and water temperatures of 75F***. This pond was stocked with brook trout in 1942. NH DES Trophic surveys conducted in 1986 and 1987 showed a transparency of 3.4 M, phosphorus between 30 and 40ppb, chlorophyll-a of 7.24 ug/L, bottom dissolved oxygen varied between 9.2 (winter) and 0.2 (summer) ppm. The pond was classified as mesotrophic**. No invasive plants were identified in this report. This waterbody was the subject of investigation since 2008 by the New Durham Water Quality Committee(NDWQC) and the Merrymeeting River Water Quality Working Group(MRWQWG). The NDWQC identified variable milfoil in Jones Pond in 2008 and proposed a mitigation plan to the NH DES (variable milfoil was first documented by the NH DES in 2003). For the past three years variable milfoil has been removed by hand pulling only. Comments by our contract Diver Assisted Suction Harvesting(DASH) operator in 2017 about the high nutrient content of the water and the rich layer of sediment on the bottom make harvesting the variable milfoil almost impossible. In 2016 the NH DES placed Jones Pond on the 303(d) list of impaired surface waters for Aquatic Life (milfoil), Fish consumption (mercury) and Primary contact recreation (cyanobacteria hepatotoxic microcystins). The culprit organism in the latter case was found to be Oscillatoria. At its peak the cell count for Oscillatoria was 2,300,000 cells /ml on August 12,2016. Extensive water quality surveys have been conducted in Jones Pond since 2016 (see Appendix 2). Phosphorus levels varied over the year from 16.4 (Spring) to 30.7 ppb (Summer) at the surface. Deep water phosphorus levels were above 60 ppb and deep-water chlorophyll-a levels were greater than 30 ug/L. Compared to the 1987 survey this Pond has degraded significantly. Spring 2017 surveys of erosion and culverts around Jones Pond documented one broken culvert responsible for roadside sediment washing into Jones Pond and one shoreline with extensive erosion around the Merrymeeting Road Bridge (photos available on request). There are some 17 residences bordering (within 100 feet) Jones Pond, all with septic systems.

Downing Pond, NH DES Assessment unit# NHLAK700020102-02, is the last impoundment in New Durham, it has a surface area of 63 acres and sits at 538 feet above sea level. It's inlet is approximately 1000 feet from the Jones Pond dam. The last NH DES Trophic survey was conducted in 2003 (summer) and 2004 (winter) and had a transparency of 3.0M, bottom dissolved oxygen varied from 7.4-14.5 ppm, chlorophyll-a of 6.3ug/L, phosphorus varied from 42 (surface) to 41ug/L (bottom), heavy plant cover was restricted to about 10% of the surface and no exotic plants were seen. It was classified as eutrophic at that time based mainly on the high quantity of vascular plants in the waterbody. The report noted that the elevated phosphorus levels were likely due to the upstream fish hatchery**. The MRWQWG surveys of 2016 showed chlorophyll-a of 8.1 ug/L, phosphorus of 35.9 ug/L, and transparency of 1.8M. The 2017 survey showed chlorophyll-a levels varying from 5.0-6.9 ug/L, phosphorus varied from 17-29 ppb, dissolved oxygen from 7-13 mg/L with heavy vascular plant growth now extended to 30% of the surface water. A large portion of the differences between these two years is due to the heavy rainfall seen in 2017 which diluted the concentrations of everything measured (see Appendix 1). Beginning in 2015 the NH DES placed advisories on Downing Pond due to cyanobacteria blooms. Again, advisories were posted in 2016 and the same organism, Anabaena sp., was documented in both blooms. Cell counts during the 2015 bloom reached 4,100,000 cells /ml and in 2016 170,000 cells/ml. Also, in 2016 the NH DES listed Downing Pond on the 303(d) report as impaired for Fish Consumption and Primary Contact Recreation due to mercury and cyanobacteria-hepatotoxic microcystins. Despite not being mentioned as an impairment, variable milfoil has been observed and treated in Downing Pond since 2011. Dermal rashes on kayakers and a dead domestic cat last seen alive drinking from the pond during the bloom were reported. Tributaries to Downing Pond were tested in 2017 and several were found with phosphorus levels of 13.4 and 17.7 ug/L, one of these traversed agriculture fields. There are some 20 residences bordering (within 100 feet) Downing Pond, all with septic systems. The specific conductivity in all three ponds were consistent and close to the conductivity seen in Merrymeeting Lake which is 50-60 uS/cm suggesting that human activities (like failed septic systems) are probably not operating to cause the degradation seen in the ponds.

To summarize the trophic status of the New Durham waterbodies according to the NH DES Aquatic Life Nutrient Criteria and their interpretation by the Lay Lakes Monitoring Program (LLMP); water clarity (in meters) can be >4(excellent),2.5-4.0 (fair) and <2.5 (poor);chlorophyll-a (ug/L) can be <3.3 (excellent),3.3-5.0(fair), and >5.0(poor);phosphorus can be <8.0(excellent),8.0-12.o(fair),and >12.0(poor).

2016/2017 average levels

	Clarity		chlorophyll-a		Phosphorus	
MML	11.6	excellent	1.0	excellent	3.6	excellent
Marsh	3.3	fair	7.3	poor	30.28	poor
Jones	3.3	fair	6.1	poor	25.34	poor
Downing	3.0	fair	3.8	poor	21.56	poor

The New Hampshire Wildlife Action Plan of 2015 indicates the land and water in the Merrymeeting River Watershed in New Durham has the highest ranked wildlife habitat by Ecological Condition in the State of New Hampshire. The New Durham segment of the Merrymeeting River watershed is home for a variety of threatened and endangered species including: reproducing populations of both Bald Eagles and Common Loons, as well as the Ebony Boghaunter, Blanding turtle, Spotted turtle, Wood turtle and the plants Flatstem Pondweed and Hollow Joe-pye Weed.****

The Alton Segment of the Merrymeeting River Watershed

The Alton segment of the Merrymeeting River has NH DES Assessment Unit 3RIV700060401 and is approximately 6 miles long before discharging into Lake Winnipesaukee. When leaving New Durham the river immediately forms the State Merrymeeting Marsh Wildlife Management Area (MMWMA)(see Appendix 7). The original land for this WMA was acquired by NH F&G in 1950 with additional parcels acquired over the years. The NH F&G today manages 531 acres and has flowage rights on a total of 722 acres. Approximately 75% of the WMA is located in Alton and the other 25% in New Durham. In addition, there is the Cate Conservation Easement on the Alton side of the WMA and the conserved Town forest on the New Durham side. The wetlands of MMWMA include emergent and deep water, scrub-shrub, forested wetlands and bogs. Uplands surrounding the Marsh are vegetated mainly by oak and white pine with blueberry bush understory. The common wildlife here are similar to that described above for the Marks WMA. There exist a parking lot and boat launch off Rt.11 and flowage is maintained by the Alton Dam on the northerly side of Rt.140. Each of these sites are also water quality sampling sites (Appendix 6).

As previously mentioned, the NH DES Advisory posted in 2016 for cyanobacteria included the boat launch area of the WMA. Water quality in this area was very similar to that found in Downing Pond (Appendix 2). A second major source of water in the WMA is Coffin Brook which enters MMWMA from the southwest. Coffin Brook is a primary river of interest to the NHDES and NHF&G as a wild brook trout habitat and one of the few remaining habitats of reproducing Brindle Shiners. Water quality testing in 2017 showed that Coffin Brook is also a major source of phosphorus in the river system, despite draining land with little impervious cover and very low-density housing. However, there are several farms in this watershed which may be a contributing factor; this is reinforced by the observation that the levels of total phosphorus (TP) in Coffin Brook are highest in the Spring in contrast to the New Durham segment of the Merrymeeting River where the TP concentrations become higher as the Summer progresses. The median value for total phosphorus (TP) just above the brook's entrance into the MMWMA was 25 ug/L (see Rt.28 Coffin Brook) and sampling upstream from this point the brook had a median value of 30 ug/L (similar to the median value of Marsh Pond below the hatchery). Exploring the source of this phosphorus is the goal of our 2018 water quality survey. As the river flows north toward Lake Winnipesaukee the TP concentrations decreased to a low median concentration of 17 ug/L as the river enters Alton Bay (this is best visualized by looking at the boxwisker figure found in Appendix 2).It is worth noting that the total volume of water entering Alton Bay is much greater than that seen in the New Durham segment of the river and thus despite a median concentration of 17 ug/L TP, the total phosphorus load entering the Lake is very high. Also, along this stretch of the river, through the commercial district of Alton, the concentration of chloride increases, especially in the early Spring, possibly due to road salt runoff. Chloride concentrations vary between 8-15 mg/L throughout the New Durham segment of the river but increase to 22 mg/L as the river enters Alton Bay. It is interesting that the TP concentrations fall in the river as it passes through Alton's commercial district where the percentage of impervious land cover goes up dramatically. The only 303(d) list impairment of the Alton segment of the Merrymeeting River is for Aquatic Life, low pH; although the last quarter mile of the river before entering Alton Bay has been treated annually for variable milfoil.

Alton Bay, a subwatershed of Lake Winnipesaukee, is monitored by the LLMP. Samples of their testing can be found in Appendix 8. The average and (range) of concentrations for various analytes in Alton Bay during 2015 sampling are: Total phosphorus 6.9ug/L (5.5-9.8), chlorophyll-a 1.0 ug/L (0.7-1.3), clarity 9.9M (8.5-11.3) making this waterbody oligotrophic.

There are 5 subwatershed management plans for Lake Winnipesaukee currently published on the winnipesaukeegateway website maintained by the Lake Winnipesaukee Association.

In our 2018 water quality surveys we intend to collect total flow and phosphorus loads at the following locations: above the Powder Mill Fish Hatchery (which when combined with the hatchery supply will provide the total flow of headwater into the river), at the Merrymeeting Road Bridge(inlet into Jones

Pond), Main Street Bridge (flow leaving Downing Pond and heading into Alton), and Rt.140 in Alton (flow just above the inlet to Lake Winnipesaukee). One of the tasks in this RFQ/B document will be to document areas through the Alton segment of the Merrymeeting River where pollutants are introduced and to develop mitigation plans to rectify them. All of our 2018 water survey results will be provided to the consultants as soon as they are available. Additionally, the Merrymeeting River Water Quality Working Group will interact with the consultants during 2018 and try to integrate into their work any additional testing requested by the consultants. All of the working group's 2016 and 2017 data has been introduced into the NH DES Environmental Monitoring Database.

In order to address the watershed impairments described above, the Cyanobacteria Mitigation Steering Committee (CMSC) raised funds from the two impacted towns as well as the Merrymeeting Lake Association and the NH Department of Fish and Game to develop a watershed management plan for the Merrymeeting River Watershed. The watershed planning effort for the river and Merrymeeting Lake will provide scientific understanding of nutrient, total suspended solids and sediment loads, identify pollutant hot spot areas, and provide recommendations for specific restoration actions to improve water quality with the goal of eventually reducing the incidence of harmful cyanobacteria blooms. The plan will incorporate the EPA's Nine Elements of Watershed Planning.

OVERALL PROJECT DESCRIPTION

The Cyanobacteria Mitigation Steering Committee's Watershed Management Plan working group (WMP WG) will act as the Project Manager and Coordinate directly with the hired consultant to ensure that project objectives and tasks are completed as written in the contract between the CMSC and the consultant.

The project consists of developing a watershed management plan as described in the following project description. The watershed management plan is a tool for managing existing and future conditions including land use planning and potential impacts on surface water quality. Plans identify existing watershed pollution contributions and sources, help establish water quality goals, estimate the reductions or limits of pollutants needed to meet water quality goals, and identify the actions needed to achieve pollutant reductions. The plan shall prioritize recommended actions based on cost/benefit analysis, and set implementation timelines. They also identify potential sources of funding to carry out components of the plan. The plan will incorporate the EPA's nine elements of watershed planning. The selected consultant will convene and facilitate public and project partner meetings and contribute to semiannual and final reports to project partners. There are 33 tasks associated with this plan and each must be fully addressed by the consultant. Excluded from these tasks/plans is the detailed description of how phosphorus, nitrogen and total suspended solids arise from the Powder Mill State Fish Hatchery (PMSFH) and find their way into the hatchery's discharge into the Merrymeeting River. Also, there is no need to address a mitigation of this problem. These activities will be addressed using other consultant engineers. However, this plan should recognize the PMSFH as a point source for phosphorus pollution of the river and the phosphorus loads associated with this point source must be taken into consideration when determining assimilative capacity and maximum annual phosphorus loads into the river system.

I. Develop a Site-Specific Project Plan (SSPP)

The SSPP should document the following using the template in Appendix A: for Developing Watershed Management Plans in NH, Revision 3, April 14,2010, pp11-14.

1. The type and source of data being used to determine existing water quality.
2. The process used to verify that the quality of the data is acceptable for use in determining existing water quality.
3. The process used to determine the water quality goals.
4. A description of the model used to:
    a. Estimate the current and future pollution sources and loadings
    b. Estimate the pollutant reductions needed to meet the water quality goals.

At a minimum the description should include: the name, date, revision number, and name of the organization or individual who developed the model/method.

5. Identification of the person(s) responsible for running the loading models and their qualifications.

Task Deliverable 1: Completed Site Specific Project Plan documenting each feature described above in I:1,2,3,4, and 5.

II. Attend the project kickoff meeting

The consultant will participate in a kickoff meeting to introduce the project to the public.

Task Deliverable 2: Coordinate with the project team to define the consultant's role in the meeting and attend the meeting.

III. Collect and evaluate existing water quality data (EPA key elements a and b)

The consultant shall review all the relevant water quality data collected by the NH DES (Trophic Surveys) and the Cyanobacteria Mitigation Steering Committee which was collected using the Lay Lake Monitoring Program and is available for the years 2016 and 2017 (for the Merrymeeting River) and since 1981 (for Merrymeeting Lake and Lake Winnipesaukee-Alton Bay-Pavilion) in the NH DES Environmental Monitoring Database. The consultant will coordinate with the federal, state and local organizations as well as the public, for the purposes of initial data gathering, historical accounts, and other pertinent information. The quality of data used to determine existing water quality must be verified according to the process documented in the Site Specific Project Plan (SSPP) as identified in Section 5 of the NH DES document: Guidance for Developing Watershed Management Plans in New Hampshire for Section 319 Nonpoint Source Grant Project (issued August 22, 2008 and revised April 14,2010).

The subwatersheds of interest include: Merrymeeting Lake, Marsh Pond, Jones Pond, Downing Pond, and Lake Winnipesaukee-Alton Bay-Pavilion. The consultant will review the available information to confer and provide guidance in selecting the parameters of concern for each waterbody.

Once the quality of data has been verified, it is used to calculate the current median water quality for the parameters of concern. Calculation of current median water quality should be conducted in accordance with the: Standard Operating Procedure of Assimilative Capacity Analysis for New Hampshire Waters, NH DES August 22, 2008.

Task Deliverable 3 : Documentation of data quality assessment process, parameters of concern selection, and calculation of the current existing median water quality for the identified parameters of concern (total phosphorus and chlorophyll-a as a minimum)for each subject waterbody.

IV. Conduct Assimilative Capacity Analysis (EPA Key element b).

An analysis of a waterbody's assimilative capacity is used to determine the total assimilative capacity, the reserve assimilative capacity, and the remaining assimilative capacity (high quality waters) or negative assimilative capacity (impaired waters) for phosphorus and chlorophyll-a. This information is then used to determine water quality goals and actions necessary to achieve those goals.

The assimilative capacity analysis should be conducted in accordance with the: Standard Procedure for Assimilative Capacity Analysis for New Hampshire Waters (2008).

Assimilative Capacity for phosphorus (PAC) has been conducted by the New Durham Water Quality Committee (NDWQC) in 2018 and can be found in Appendix 1. This PAC was calculated for Marsh, Jones and Downing Ponds based on data collected in 2016 and 2017. The consultant should revise these PACs with new 2018 data collected by the CMSC and add the PAC for Merrymeeting Lake as well as Alton Bay Lake Winnipesaukee).

Task Deliverable 4-8: Documentation of Assimilative Capacity Analysis including total assimilative capacity, remaining assimilative capacity, or negative assimilative capacity for phosphorus and chlorophyll-a for:

a. Task Deliverable 4: Merrymeeting Lake, and
b. Task Deliverable 5: Marsh Pond, and
c. Task Deliverable 6: Jones Pond, and
d. Task Deliverable 7: Downing Pond, and
e. Task Deliverable 8: Alton Bay-Pavilion.

V. Establish Water Quality Goals (EPA Key element h)

After the assimilative capacity analysis is conducted, the water quality goals are established. The goals of this WMP are to limit any further phosphorus loads into the Merrymeeting River to those which will not lead to further degradation of any of the following waters: Merrymeeting Lake, Marsh Pond, Jones Pond, Downing Pond, Lake Winnipesaukee-Alton Bay. The Merrymeeting River Water Quality Working Group (MRWQ WG) will serve as an advisory Committee with David Neils representing the NH DES. The committee will develop a process to be used to determine the water quality goals. They will carry out the process for determining the water quality goals, and make a recommendation for formal goals. Once agreed upon, the water quality goals will be formally established and used to guide the development of the Watershed Management Plan.

Task Deliverable 9: Formal establishment of the water quality goals for phosphorus and documentation of the process used to formally arrive at the water quality goals.

VI. Identify Current and Potential Future Pollution Sources (EPA key element a)

Identification of current and potential future pollution sources should be completed through the use of a pollutant loading analysis model, such as the Spreadsheet Tool for Estimating Pollutant Loads (STEPL), which determines the annual pollution source loads for each subwatershed including: Merrymeeting Lake, Marsh Pond, Jones Pond, Downing Pond, Coffin Brook, Wentworth Pond, and Alton Bay, Lake Winnipesaukee. The CMSC recognizes that this is a complex watershed to model and although we encourage the use of either the STEPL Model or the Lakes Loading Response Model (LLRM Model); additional models may be considered for specific applications within the watershed. Any of these additional models would need to be approved, in advance, with the CMSC.

Task Deliverables 10-16: A documented identification of the current and future pollution source loads by land use type and source group for phosphorus for the following subwatersheds:

a. Task Deliverable 10,Merrymeeting Lake, and
b. Task Deliverable 11, Marsh Pond, and
c. Task Deliverable 12, Jones Pond, and
d. Task Deliverable 13, Downing Pond, and
e. Task Deliverable 14, Coffin Brook, and
f. Task Deliverable 15, Wentworth Pond, and
g. Task Deliverable 16, Alton Bay-Lake Winnipesaukee.

VII. Estimate Pollution Limits or Reductions Needed (EPA Key element b)

After pollution sources have been identified, the total load limits or reductions needed to maintain the water quality goals for future watershed conditions are estimated through modeling. High quality waters (Merrymeeting Lake and Lake Winnipesaukee) may need to limit future pollutant loading to meet their desired water quality goal. Impaired waters (Marsh Pond, Jones Pond, Downing Pond) will need to reduce existing loading to meet water quality criteria and restore use. For this analysis the PMSFH phosphorus discharge must be considered. In 2017 there were two estimates of annual load for phosphorus from the PMSFH; the NDWQC made one estimate based on monthly water flow through the two outfalls and the EPA mandated biweekly testing for phosphorus at each outfall. The second estimate is reported in the EPA ECHO database, by Hatchery personnel, based on quarterly flow and quarterly phosphorus measurements at each outfall.

For example, for phosphorus, the Dillon-Rigler and Vollenweider models are used to estimate in-lake phosphorus concentration based on existing and future phosphorus loading from the watershed. The model outputs are analyzed to determine the phosphorus reductions or limitations needed to achieve the in-lake phosphorus water quality goals. Other models may be more appropriate for making these estimates in rivers and streams.

Task Deliverable 17: Determine the current annual phosphorus source loads estimates. Identify appropriate scale and model for load estimates and run the model to determine current load estimates for the following subwatersheds: Merrymeeting Lake, Marsh pond, Jones Pond, Downing Pond and Alton Bay-Lake Winnipesaukee. Although Wentworth Pond (Alton) has never been submitted to a Lake Trophic Survey, we have extensively sampled (in 2017) water from the Merrymeeting River at Rt. 140 just above Wentworth Pond. This data may be used to help calibrate any Merrymeeting River modeling that would be useful in understanding the potential water quality impacts on Wentworth Pond. This analysis shall be submitted to the CMSC and MRWQ WGs for review.

Task Deliverable 18: Estimate future loading for phosphorus. Select the appropriate model and determine the data needs for buildout analysis. Also run the buildout analysis to predict future loads based on projected population and land use change with the results presented to the CMSC and MRWQWGs.

Task Deliverable 19: Document modeling output for use in the watershed management plan. Develop modeling technical report to describe the process and outputs including identification of pollutant loading causes and sources to the extent at which they are present in the watershed.

Task Deliverable 20: Coordinate with the CMSC and the NH DES to develop a method to assess septic system condition, age, geographic extent to obtain sufficiently detailed information to calibrate watershed loading models.

Task Deliverable 21: Coordinate with the CMSC and local transportation officials to identify and document local stormwater Best Management Practices (BMPs) with high potential for sediment and phosphorus load reductions.

Task Deliverable 22: Attend a meeting of the CMSC and its working groups to review tasks 18-21 above.

VIII. Develop the Watershed Management Plan (EPA Key elements c, d, f, g, h & i)

Development of the Merrymeeting River Watershed Management Plan consists of two primary components; Actions to limit and reduce phosphorus and a Verification System.

1. Determine actions to limit or reduce phosphorus pollution.
   Determining the actions or management measures that should be implemented to meet the established water quality goals is accomplished by estimating the pollutant removal efficiency expected for each management measures (e.g.

implementation of best management practices (BMP)and determining which measure, or combination of measures, are needed to achieve the necessary load limits or reductions estimated under Task Deliverable 18 and 19. Available pollutant removal efficiency values of various BMPs can be obtained from NH DES upon request.
This process also takes into consideration estimates of the amount of technical and financial assistance that is needed, associated costs, and the sources and authorities that will be relied upon to implement the management measures, as well as a schedule for implementation. Infiltration sites, erosion of stream banks and culvert upgrades should be accompanied by photos of the existing problem areas. Consideration should also be given to waterfowl populations and their impact on phosphorus loading.

2. Develop a Plan Verification System.

   To verify that the recommended control actions are being implemented, interim measurable milestones are identified and success indicators are established to determine whether loading reductions are being achieved and progress is being made toward attaining the water quality goals.

   A system of verification is developed and documented that is to be used once the watershed management plan is implemented. The intention of the verification system is to determine if the management measures identified in the watershed management plan are working towards achieving the water quality goals. The verification system consists of the following:

   a. Interim measurable milestones for determining whether Nonpoint Source (NPS) measures or other control actions are being implemented.
   b. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against criteria established below.
   c. A set of criteria which can be used to determine whether the desired pollutant loading is being achieved over time and if substantial progress is being made towards attaining water quality standards, and, if not, the criteria for determining whether the watershed-based plans needs to be revised.

Task Deliverable 23: Documented descriptions of the actions/management measures needed to achieve the necessary load reduction estimates under Task 18 and 19.

Task Deliverable 24: Further design and provide preliminary design for up to four BMPs. Selections for BMPs should be made based on estimated load reduction, cost, feasibility and opportunity.

Task Deliverable 25: Documented method to measure the effectiveness of the actions/management measures that will achieve the necessary load reductions.

IX. Outreach and Education (EPA element e)

The outreach and education component of Watershed Management Planning is twofold. The first is project-specific and is developed to enhance the public's understanding of the WMP and development. Outreach should focus on the purpose of watershed planning, and, key issues in the selected watershed, and should encourage public participation in selecting, designing, and implementing the actions/management measures for the plan.

The second component is plan-specific and is a separate chapter or section contained within the WMP document. The CMSC already has selected an Outreach and Public Education working group which will develop recommendations for public outreach and education activities to be performed during plan implementation. These activities will be coordinated with those of the Lake Winnipesaukee Association and be published on the Winnipesaukee Gateway website.

Task Deliverables 26: A project-specific outreach and education plan.

Task Deliverable 27: Plan-specific outreach and education plan.

Task Deliverable 28: A meeting with the combined public of New Durham and Alton to review the WMP.

Task Deliverable 29: A Public meeting, designed cooperatively between the consultant and the CMSC and perhaps the Lake Winnipesaukee Association (LWA), in which the CMSC will introduce activities in which the public can participate as the WMP is implemented. The role of the consultant will be to back up the CMSC and answer questions which arise from the public and aid the CMSC in the appropriate answer.

X. Draft and Final Watershed Management Plan

Publish a Watershed Management Plan for the Merrymeeting River Watershed including Merrymeeting Lake and the subwatersheds of Marsh, Jones and Downing Ponds and Coffin Brook through integration with the existing Winnipesaukee Gateway website.

Task Deliverable 30: Submit a draft of the WMP to NH DES and CMSC for initial review and comment.

Task Deliverable 31: Coordinate with the CMSC, project managers, and stakeholders to review the draft WMP and provide comments

Task Deliverable 32: Submit the revised draft WMP to the CMSC for comment, amend the draft as necessary and re-submit to the CMSC for final approval.

Task Deliverable 33: Integrate the Final WMP into the Winnipesaukee Gateway website and provide the NH DES with electronic copies of the model(s) used to develop the plan along with an electronic copy of the Merrymeeting River Watershed Management Plan components uploaded to the Gateway website.

*= Roadside Geology of Vermont and New Hampshire, Braford B. Van Diver (1987), p185

**=Staff Report 156, New Hampshire Lakes and Ponds Inventory, vol. 4, April 1988 by Estabrook, Martin and Henderson. Summarized by the NH DES Survey Lake Data Summary 2018.

***=Biological Survey of Lakes and Ponds in Sullivan, Merrimack, Belknap and Strafford Counties. Report 86. NH F&G.

****= Long Term Variable Milfoil Management Plan for Jones and Downing Ponds (2016) , by NH DES, Amy Smagula.

Acknowledgements: The data presented in this report was only made possible through the generous volunteer time of Dr. Robert Craycraft, with assistance from LLMP technicians Mike Gelinas and Bill Malay and graduate student Sabina Perkins. We thank David Swenson who assisted in the preparation of this RFQ/B document. The CMSC is also most grateful to Director Glen Normandeau (NH F&G), Jason Smith and Edward Malone (NH F&G) and David Neils (NH DES) for their assistance and encouragement. And Pat Tarpey, Director of the Lake Winnipesaukee Association and Hilary Snook (US EPA) for donating their time for the public education of Alton and New Durham residents. Finally, we wish to acknowledge the role of Jeffrey Marcoux in review of the final draft RFQ/B and making helpful recommendations.

Appendices.

1. Letter from the Town of New Durham to Danielle Gaito, Water Permits Branch, US EPA , Region 1, Boston, MA dated February 20,2018. Cover letter and four tables.
2. Two figures and 1 table of water quality values throughout the Merrymeeting River watershed sampled in 2017.
3. Figure of the Merrymeeting River Watershed Area entitled: Water Quality Monitoring.
4. Merrymeeting Lake topographical map.
5. Merrymeeting Lake Water Quality Summary by LLMP for 2016. Entitled: Merrymeeting Lake 2016 Sampling Highlights New Durham, NH.
6. Merrymeeting River LLMP Sampling Sites 2017
7. Map of the Merrymeeting Marsh Wildlife Management Areas entitled: NH Fish and Game Department Wildlife Management Areas.
8. Table of Water Quality Results for Alton Bay, entitled: Alton Bay 2015 Sampling Highlights Alton, NH

Other documents which may assist the consultant are available by mail upon request and include:

1. NH DES Wetlands Division, Aquatics Restoration Mapper showing: Merrymeeting Lake and Tributaries .
2. Marsh, Jones and Downing Ponds deep water sampling throughout the year 2017
3. Figure showing the temperature, redox potential, conductivity, pH, dissolved oxygen, phycocyanin and chlorophyll-a throughout the water column in Marsh Pond deep water site in 2017. These tests were run monthly in 2017.

4. Figure showing roadside runoff and soil erosion dumping into Upper Merrymeeting River at the State Boat Landing.
5. River bank erosion in Upper Merrymeeting River-Marsh Pond.
6. Distribution of Variable Milfoil in New Durham, Jones and Downing Ponds.
7. Figure of broken culvert by Jones Pond.
8. Figure of shoreline erosion at the Merrymeeting Road Bridge at Jones Pond.
9. Figure illustrating a paved section off the side of the Main Street Bridge directing stormwater into the river.

ADDITIONAL RESOURCES:

1. Guidance for Developing Watershed Management Plans for New Hampshire for Section 319 Nonpoint Source Grant Program Project, NH DES, Revised April 14, 2010.
2. Watershed Plan examples: http://des.nh.gov/organization/divisions/water/wmb/was/watershed based plans.htm and http://www.winnipesaukeegateway.org/management-plans/introduction/
3. NHDES Watershed Assistance Section website http://des.nh.gov/organization/divisions/water/wmb/was/index.htm
4. UNH Lay Lakes Monitoring Program: http://cfb.unh.edu/programs/LLMP/nhllmp.htm

APPENDIX 1

SCOTT KINMOND
TOWN ADMINISTRATOR

skinmond@newdurhamnh.us
www.newdurhamnh.us

TOWN HALL
4 MAIN STREET
NEW DURHAM, NH 03855

TEL: (603) 859-2091
FAX: (603) 859-6644

TOWN OF NEW DURHAM, NEW HAMPSHIRE
OFFICE *of the* BOARD OF SELECTMEN

February 20, 2018

Danielle Gaito
Water Permits Branch
Environmental Protection Agency, Region 1
5 Post Office square, Suite 100 (OEP06-4)
Boston, MA 02109-3912

Re: NH Fish & Game- Powder Mill Fish Hatchery- EPA Permit

Hello Ms. Gaito,

I am writing to provide a synopsis of our water quality testing for 2017.Sample collection was conducted by LLMP trained technicians working for the New Durham/Alton Cyanobacteria Mitigation Steering Committee and its working groups. Sample analysis was conducted by the Laboratory for Freshwater Biology, under the supervision of Dr. Robert Craycraft. All our data has been introduced into the NH DES EMD database for closer scrutiny.

In Table 1 we provide the phosphorus assimilative capacity (based on our recorded data) for Marsh, Jones and Downing Ponds in New Durham, NH. We compared lake nutrient thresholds based on the historical trophic ratings determined during lake surveys conducted by the NH DES in 1985/6 and 2003 with data we collected at the same locations in the past two years. While all three ponds recorded phosphorus assimilative capacity values over the water quality threshold in the years 1985/6, 2003, and 2016, some reserve capacity was calculated for Downing Pond in 2017 and for Marsh Pond, if the median phosphorus value rather than the mean value was used. When the 2016 and 2017 data were combined any phosphorus reserve in Marsh Pond disappears.

During the year 2016 total precipitation was below the normal of 40.4 inches (Table 2), whereas in 2017 the total precipitation was above normal. In addition, the snow melt was diminished in 2016. We believe the dramatic increase in Spring runoff in 2017 resulted in lower phosphorus concentrations due to dilution whereas the drought in 2016 may have contributed to increased concentrations. For this reason, we combined the data from these years.

We also calculated water flow and phosphorus loads at the Main Street Bridge throughout the year (Table 3) and compared those loads to the nearest (in time) published discharged load from the Powder Mill State Fish Hatchery (PMSFH). As you can see the Spring thaw for 2017 diluted the phosphorus concentrations and non-point sources contributed 85-88% of the total load in the Spring compared to the PMSFH contributing 70-81% of the total load in the Summer and Fall.

1

APPENDIX 1 (Cont'd)

Phosphorus measured in tributaries to the Merrymeeting River showed relatively low concentrations except in a single intermittent brook on Jones Pond (Table 4). A Merrymeeting River Watershed Management Plan will be developed in the Spring of 2018 to address all non-point sources of phosphorus pollution.

Finally, using figures supplied by the PMSFH from their biweekly survey of outfall discharges, we calculated the total phosphorus discharged by the PMSFH into the Merrymeeting River in 2017 was 815 lbs. The EPA ECHO database reports a figure of 983 lbs. of phosphorus discharged into the Merrymeeting River in 2017 using quarterly figures.

Our conclusion is that the PMSFH is a significant point source of phosphorus pollution in the Merrymeeting River. The Powder Mill PMSFH discharges into Marsh Pond which has no phosphorus assimilative capacity remaining. To prevent further degradation of Marsh Pond, and the entire Merrymeeting River system, we strongly urge the US EPA to limit the discharge of phosphorus from the PMSFH into the Merrymeeting River to a concentration not to exceed the assimilation capacity nutrient threshold for each pond based on its trophic class minus 10%, i.e. 25.2ug/L for Marsh Pond (see the top of TABLE 1).

If you should have any questions please feel free to contact me at any time.

Respectfully,

Fred Quimby, PhD
Chairman
New Durham Water Quality Committee

cc. David Webster, Chief Water Permits Branch
cc. Stergio Spanos, NH DES

Appendix 1 (Cont'd)

TABLE 1

Assimilative Capacity Analysis (Phosphorus) in

Marsh, Jones, and Downing Ponds (New Durham, NH)

Background on the three ponds:

Waterbody	Best Trophic Status	Year	Total Phosphorus Threshold(ug/L)
Marsh Pond	Eutrophic	1986	<=28 (10%,25.2)
Jones Pond	Mesotrophic	1986	<=12 (10%,10.8)
Downing Pond	Eutrophic	2003	<=28 (10%,25.2)

Marsh Pond	**Jones Pond**	**Downing Pond**
1985/86	**1986**	**2003**
20.8 ug/L in excess of Assimilative capacity	22.2 ug/L in excess*	16.8 ug/L in excess*
2016	**2016**	**2016**
Gelinas and Malay	Gelinas and Malay	Gelinas and Malay**
n=2	n=2	n=1
Mean/median41.7	Mean and Median31.2	35.9
16.5 ug/L in excess*	9.1 ug/L in excess*	10.7 ug/L in excess*
2017	**2017**	**2017**
Craycraft n=7	Craycraft n=3	Crayfcraft n=7
Med=22.70 Mean=27.02	Med=19.8 Mean=21.43	Med=19.50 Mean=19.51
Med=2.5 ug/L reserve	Med=9.0 ug/L in excess*	Med=5.7 ug/L reserve
Mean=1.82 ug/L in excess*	Mean=10.63 ug/L in excess*	Mean=5.69 ug/L reserve

Combined 2016/2017 Data

N=9	5	8
Median=26.9 ug/L	25.8 ug/L	19.7 ug/L
Mean=30.28	25.34 ug/L	21.56 ug/L
ACP(Med)=1.7 ug/L in excess*	15.0 ug/L in excess*	5.5 ug/L remaining
ACP(Mean)=5.08ug/L in excess*	14.45 ug/L in excess*	3.64ug/L remaining(reserve)

*In excess of the assimilative capacity

** LLMP trained by Craycraft

Appendix 1 (Cont'd)

TABLE 2

Precipitation and Snow Fall Data (Annual) for 2015-2017*

Concord, NH	Precipitation (in)	Above/Below Annual Average	Snow Fall	Above/Below Annual Average
2015	38.31	-3.3	80.0	+18.6
2016	33.07	-7.54	49.2	-12.2
2017	44.19	+3.58	83.1	+21.7

* = taken from the National Weather Service website

Appendix 1 (Cont'd)

TABLE 3

COMPARING TOTAL PHOSPHORUS LOADS

RELEASED FROM THE HATCHERY WITH

LOADS MEASURED AT THE NEW DURHAM MAIN STREET BRIDGE IN 2017

Month	**Hatchery TP**		**Date**	**Bridge TP**		**Date**	**% Bridge Load Due To**
	Conc.(1)	**Load(2)**		**Conc.(1)**	**Load(2)**		**Hatchery**
May	30/50	0.996	5/18	19.0	5.570	5/16	17.80%
June	40/50	1.017	6/15	26.4	5.596	6/20	18.17
August	30/90	0.937	8/11	23.3	1.332	8/18	70.41
Nov.	40/70	1.755	11/09	19.9	2.149	11/12	81.68

FLOW MEASURED AT THE MAIN STREET BRIDGE (MGD)

Month	date	Flow	Condition
May	5/16	73.3	Spring thaw and spillway
June	6/20	53.0	Spring rains
August	8/18	14.3	Summer Dry period
November	11/12	27.0	Fall Draw down and rain

MGD = Million gallons per day
(1) Hatchery and Bridge phosphorus concentration in ug/L; hatchery has 2 outfalls,001/002.
(2) Hatchery and Bridge phosphorus daily loads in kilograms per day

Appendix 1 (Cont'd)

TABLE 4

Phosphorus Concentrations in Tributaries to the Merrymeeting River

(Downing Pond Watershed)

Marsh Pond Tributaries

Name	Location	Date	Phosphorus (ug/L)
Bear Pond Brook	north of Marsh	11/25/16	6.3(1)
Un-named Bk	north of Marsh	12/11/17	11.7 (active logging)(1)
Un-named Beaver Bk	west of Marsh	5/7/17	8.6(2)
Un-named Beaver Bk	west of Marsh	6/4/17	7.9(2)
Un-named Beaver Bk	west of Marsh	8/1/17	7.7(2)
Bracket Rd culvert#3	east of Marsh	5/7/17	2.0(1)

Jones Pond Tributaries

Culvert at 66 MMRd	above Jones Dam	7/14/17	29.0(1)

Downing Pond Tributaries

Foxy Johnny B culvert	near Downing Dam	5/7/17	13.4(2)
Woodlot BW1	north Downing Pond	5/7/17	6.0(1)
Woodlot BW2	east of Downing Pond	5/7/17	17.7(1)

(1)=intermittent flow

(2) continuous flow throughout the year

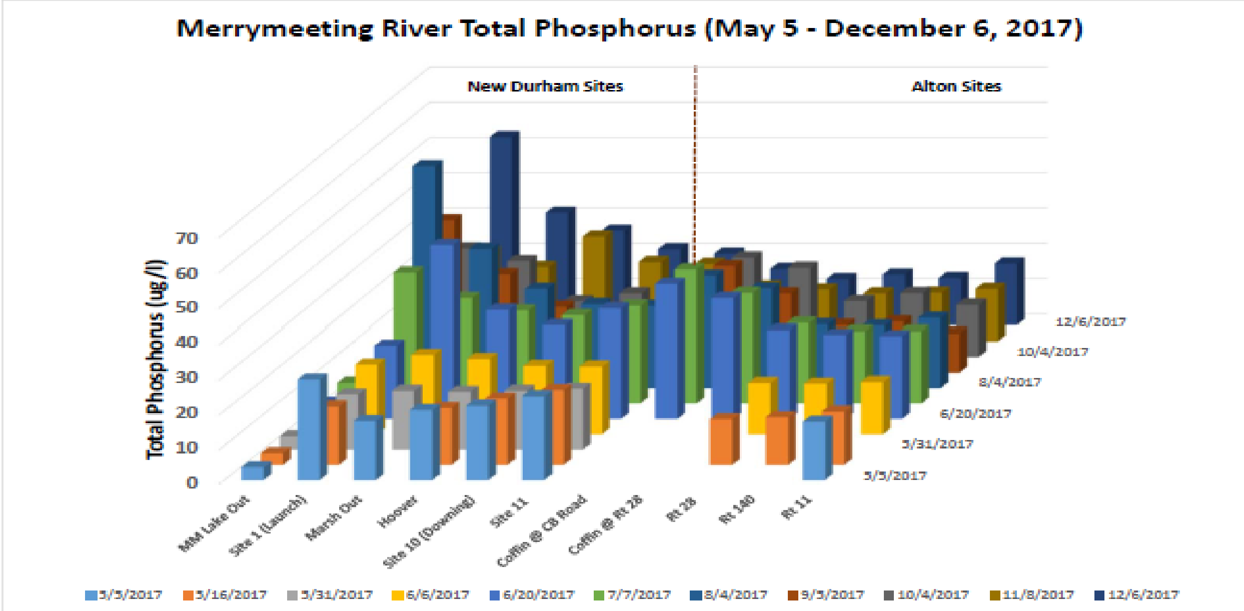
Appendix 2
Merrymeeting River Data Listing (May 5, 2017 - February 21, 2018)

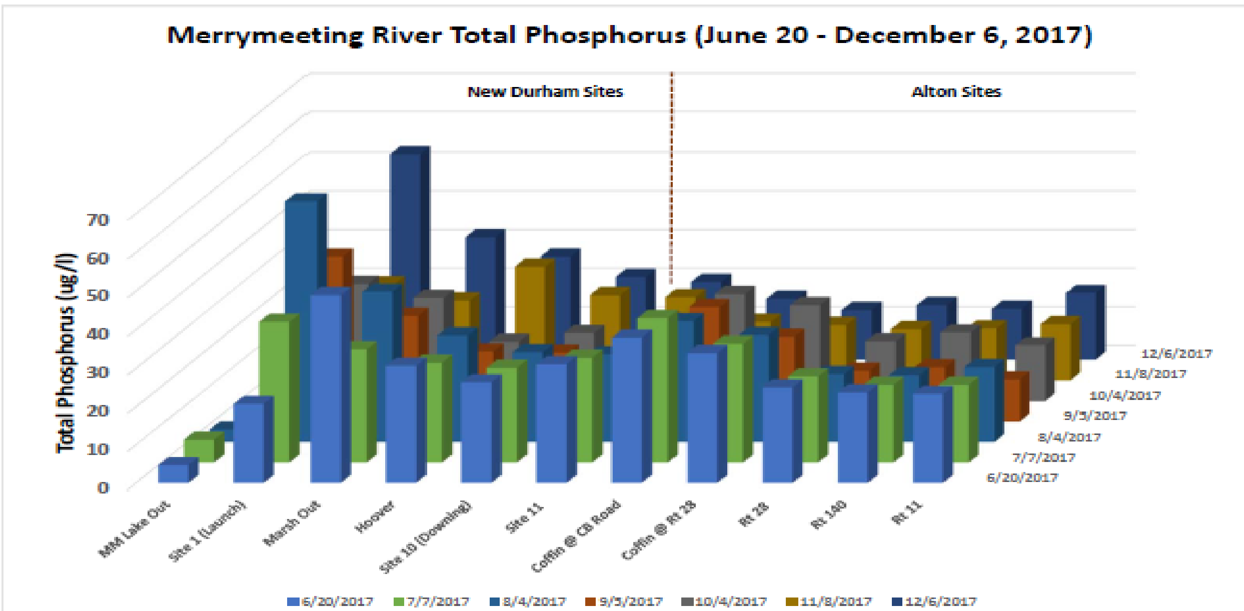
Lake	Site	Date	Depth (meters)	Time (24:00)	Temperature (oC)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (% saturation)	Total Phosphorus (υg/l)	Turbidity (NTU)	Specific Conductivity (υS/cm)	Chloride (mg/l)	pH (standard units)	Alkalinity @ pH 5.1 (mg/l)
Merrymeeting River	MM Lake Outflow (Merrymeeting Road)	5/5/2017	0.1	9:48	8.9	11.7	101.1	3.7	0.4	54.5	10.1	7.0	8.3
Merrymeeting River	MM Lake Outflow (Merrymeeting Road)	5/16/2017	0.1	9:23	10.5	11.3	101.0	3.3	0.3	55.7	12.0	6.7	8.1
Merrymeeting River	MM Lake Outflow (Merrymeeting Road)	5/31/2017	0.1	6:48	14.7	10.0	98.0	3.8	0.4	57.5	9.3	6.8	8.0
Merrymeeting River	MM Lake Outflow (Merrymeeting Road)	6/6/2017	0.1	11:40	14.4	9.8	96.1	4.6	0.6	57.3	9.8	6.9	7.7
Merrymeeting River	MM Lake Outflow (Merrymeeting Road)	6/20/2017	0.1	9:50	20.8	8.7	97.1	4.7	0.4	57.3	8.2	7.2	8.2
Merrymeeting River	MM Lake Outflow (Merrymeeting Road)	7/7/2017	0.1	9:55	22.4	7.9	91.4	6.0	0.3	65.3	------	6.9	8.4
Merrymeeting River	MM Lake Outflow (Merrymeeting Road)	8/4/2017	0.1	8:27	22.3	7.2	82.9	3.3	0.4	68.0	11.5	6.9	8.8
Merrymeeting River	MM Lake Outflow (Merrymeeting Road)	9/5/2017	0.1	10:47	20.0	8.2	89.8	4.0	0.3	79.7	------	7.0	10.2
Merrymeeting River	MM Lake Outflow (Merrymeeting Road)	10/4/2017	0.1	8:04	18.2	8.3	87.6	3.0	0.4	59.7	------	7.4	8.1
Merrymeeting River	MM Lake Outflow (Merrymeeting Road)	11/8/2017	0.1	9:54	12.1	9.8	91.3	3.5	0.5	57.4	------	7.3	7.9
Merrymeeting River	MM Lake Outflow (Merrymeeting Road)	12/6/2017	0.1	9:57	6.0	10.8	86.9	5.6	0.5	109.1	------	6.8	10.9
Merrymeeting River	MM Lake Outflow (Merrymeeting Road)	2/21/2018	0.1	9:39	2.0	13.8	99.4	4.1	0.4	58.8	------	7.0	8.2
Merrymeeting River	Site 1 (Boat Access)	5/5/2017	0.1	10:25	7.6	11.2	93.6	28.9	0.5	68.8	15.7	7.0	7.1
Merrymeeting River	Site 1 (Boat Access)	5/16/2017	0.1	9:37	10.0	11.5	102.0	16.8	0.4	56.8	12.7	6.8	6.8
Merrymeeting River	Site 1 (Boat Access)	5/31/2017	0.1	7:06	12.9	9.1	86.7	15.8	0.5	60.2	9.5	6.7	7.8
Merrymeeting River	Site 1 (Boat Access)	6/6/2017	0.1	11:30	12.3	10.0	93.8	19.9	0.6	60.1	10.1	6.7	7.6
Merrymeeting River	Site 1 (Boat Access)	6/20/2017	0.1	9:40	18.0	9.0	94.9	20.8	0.7	56.9	8.2	7.0	7.8

Lake	Site	Date	Depth (meters)	Time (24:00)	Temperature (₀C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (% saturation)	Total Phosphorus (υg/l)	Turbidity (NTU)	Specific Conductivity (υS/cm)	Chloride (mg/l)	pH (standard units)	Alkalinity @ pH 5.1 (mg/l)
Merrymeeting River	Site 1 (Boat Access)	7/7/2017	0.5	10:25	12.4	11.6	108.5	36.7	0.8	53.6	10.5	7.0	8.5
Merrymeeting River	Site 1 (Boat Access)	8/4/2017	0.1	8:33	15.5	8.2	81.7	62.5	2.2		9.4	------	9.0
Merrymeeting River	Site 1 (Boat Access)	9/5/2017	0.1	11:01	15.3	10.1	101.0	42.8	0.9	59.3	------	6.9	11.2
Merrymeeting River	Site 1 (Boat Access)	10/4/2017	0.1	8:20	14.3	7.5	73.5	30.4	0.8	61.4	------	6.8	8.1
Merrymeeting River	Site 1 (Boat Access)	11/8/2017	0.1	9:42	10.1	9.5	84.5	24.9	0.7	57.8	------	6.9	7.5
Merrymeeting River	Site 1 (Boat Access)	12/6/2017	0.1	9:44	6.0	10.5	84.2	53.2	3.9	56.1	------	6.7	7.6
Merrymeeting River	Site 1 (Boat Access)	2/21/2018	0.1	9:59	3.0	13.1	97.3	24.0	0.6	59.5	------	6.8	7.3
Merrymeeting River	Marsh Outflow (Bridge)	5/16/2017	0.1	9:06	10.3	11.1	99.2	17.0	0.5	48.2	10.5	6.8	6.3
Merrymeeting River	Marsh Outflow (Bridge)	5/31/2017	0.1	7:21	13.8	9.2	88.6	16.9	0.5	55.7	9.4	6.7	8.2
Merrymeeting River	Marsh Outflow (Bridge)	6/6/2017	0.1	11:10	13.3	8.4	80.4	22.6	0.8	55.0	8.9	6.7	7.2
Merrymeeting River	Marsh Outflow (Bridge)	6/20/2017	0.1	9:27	21.7	7.2	82.0	49.0	1.3	49.6	6.3	6.7	8.2
Merrymeeting River	Marsh Outflow (Bridge)	7/7/2017	0.1	12:55	21.9	8.0	91.0	29.6	0.5	50.3	9.4	6.9	7.6
Merrymeeting River	Marsh Outflow (Bridge)	8/4/2017	0.1	8:43	24.2	7.1	84.4	39.1	0.8	57.9	9.4	6.6	7.6
Merrymeeting River	Marsh Outflow (Bridge)	9/5/2017	0.1	10:36	18.0	8.8	93.0	27.5	0.5	54.7	------	6.8	7.3
Merrymeeting River	Marsh Outflow (Bridge)	10/4/2017	0.1	8:34	14.5	7.5	73.5	26.8	0.9	60.0	------	6.7	7.8
Merrymeeting River	Marsh Outflow (Bridge)	11/8/2017	0.1	9:33	8.9	8.5	73.6	20.7	0.6	46.9	------	6.6	6.2
Merrymeeting River	Marsh Outflow (Bridge)	12/6/2017	0.1	9:32	3.9	11.9	90.6	31.7	0.6	53.3	------	6.8	7.7
Merrymeeting River	Marsh Outflow (Bridge)	2/21/2018	0.1	9:28	1.8	12.5	89.8	18.5	0.3	44.6	------	6.6	6.2
Merrymeeting River	Hoover Bridge	5/5/2017	0.1	10:50	12.4	9.8	91.8	20.1	0.6	52.2	10.8	7.0	5.8

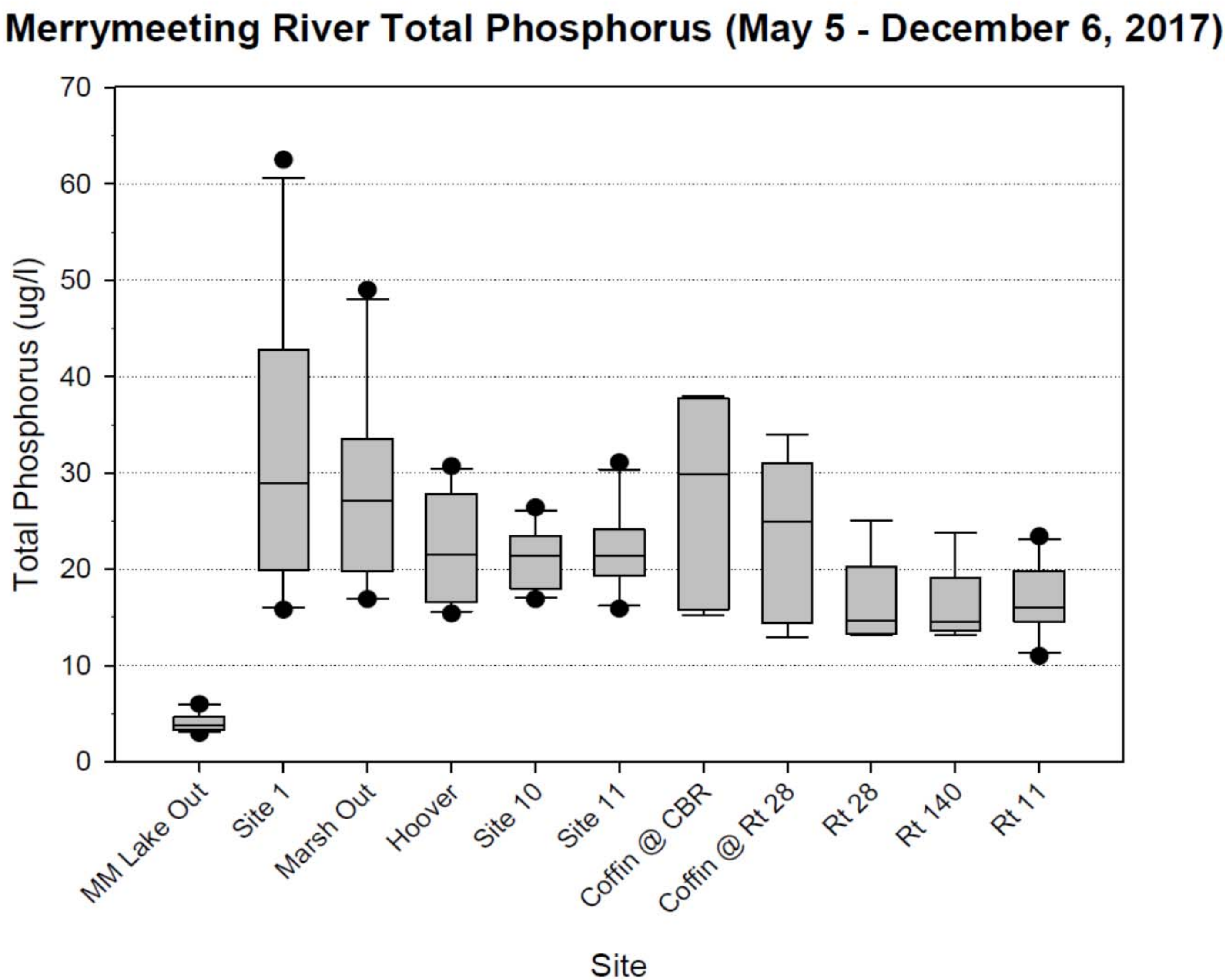
Lake	Site	Date	Depth (meters)	Time (24:00)	Temperature (oC)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (% saturation)	Total Phosphorus (υg/l)	Turbidity (NTU)	Specific Conductivity (υS/cm)	Chloride (mg/l)	pH (standard units)	Alkalinity @ pH 5.1 (mg/l)
Merrymeeting River	Hoover Bridge	5/16/2017	0.1	8:57	10.2	10.5	93.8	16.4	0.4	46.8	10.3	6.8	6.0
Merrymeeting River	Hoover Bridge	5/31/2017	0.1	7:43	13.8	8.4	81.4	16.6	0.5	54.7	8.4	6.7	7.4
Merrymeeting River	Hoover Bridge	6/6/2017	0.5	11:00	13.5	8.1	77.8	21.5	0.7	57.2	9.4	6.7	7.4
Merrymeeting River	Hoover Bridge	6/20/2017	0.1	9:09	22.0	5.9	67.2	30.7	0.7	55.1	8.1	6.6	7.8
Merrymeeting River	Hoover Bridge	7/7/2017	0.5	13:40	23.1	8.0	93.1	26.1	0.4	51.2	9.1	6.7	7.5
Merrymeeting River	Hoover Bridge	8/4/2017	0.1	9:00	24.7	5.6	67.5	27.8	0.5	59.1	10.1	6.5	7.4

Appendix 2 (Cont'd)



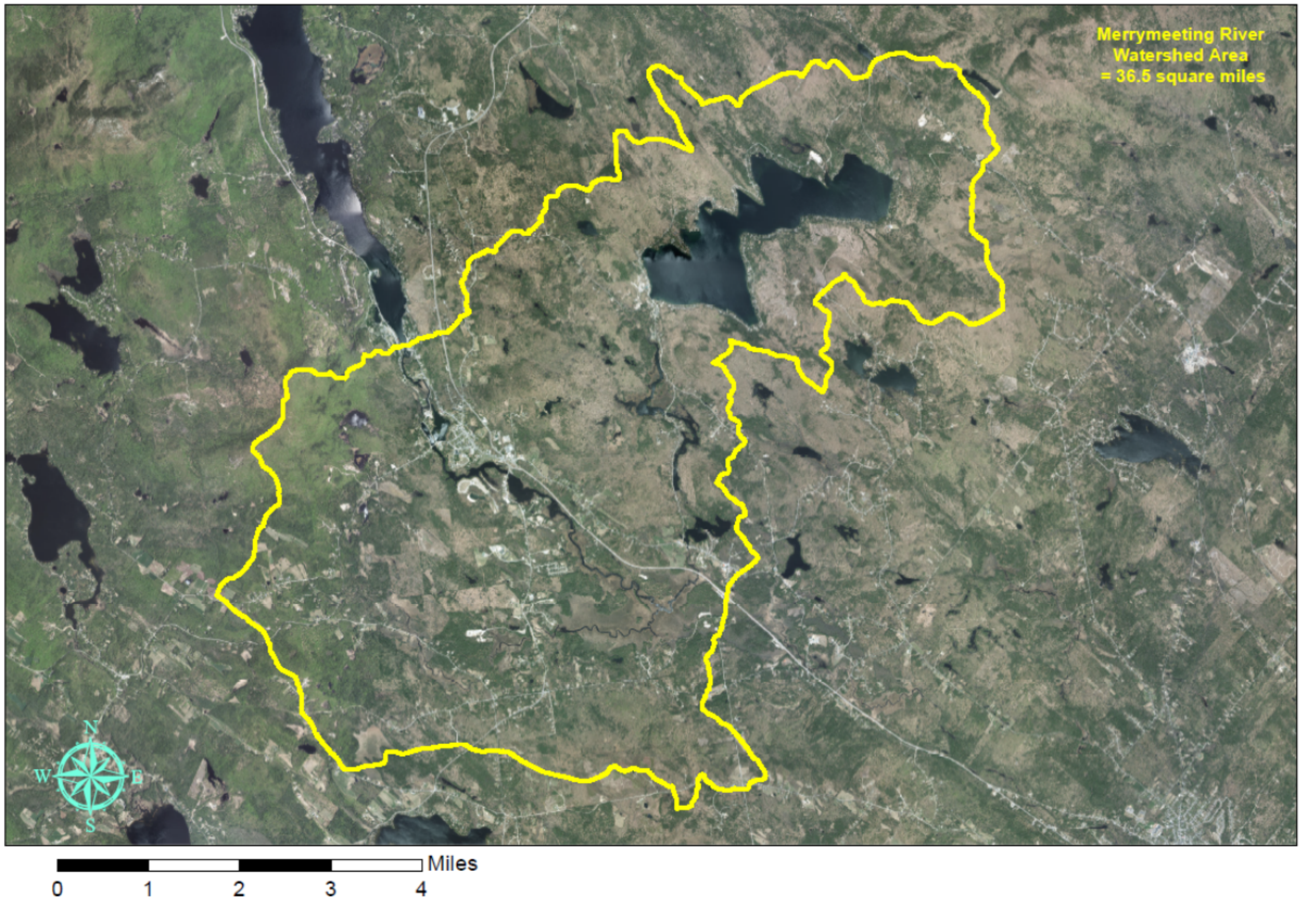


Appendix 2 (Cont'd)



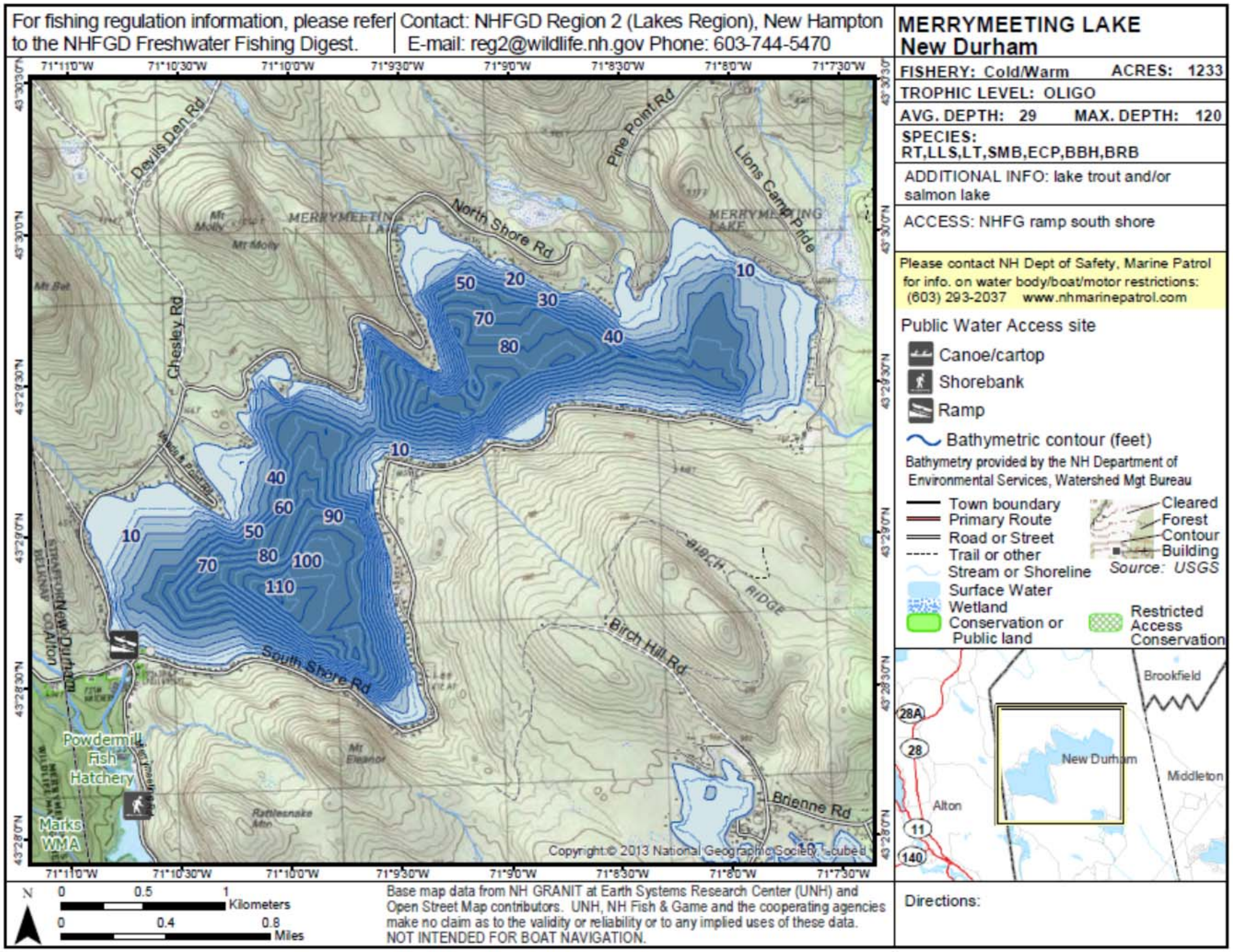
Appendix 3

Merrymeeting River Watershed
Alton and New Durham, NH



The Merrymeeting River watershed was deliniated using the United States Geological Survey Streamstats web application, https://water.usgs.gov/osw/streamstats/
The Watershed boundary extends upstream of the Merrymeeting River as it intersects Route 11 (latitude 43.47021 longitude -71.23391).
Aerial Orthophoto: 2015 Statewide High Resolution Aerial Photography, Source: NH GRANIT, http://www.granit.unh.edu/

Appendix 4


For fishing regulation information, please refer to the NHFGD Freshwater Fishing Digest.
Contact: NHFGD Region 2 (Lakes Region), New Hampton E-mail: reg2@wildlife.nh.gov Phone: 603-744-5470
MERRYMEETING LAKE
New Durham
FISHERY: Cold/Warm
ACRES: 1233
TROPHIC LEVEL: OLIGO
AVG. DEPTH: 29
MAX. DEPTH: 120
SPECIES: RT,LLS,LT,SMB,ECP,BBH,BRB
ADDITIONAL INFO: lake trout and/or salmon lake
ACCESS: NHFG ramp south shore
Please contact NH Dept of Safety, Marine Patrol for info. on water body/boat/motor restrictions: (603) 293-2037 www.nhmarinepatrol.com
Public Water Access site
Canoe/cartop
Shorebank
Ramp
Bathymetric contour (feet)
Bathymetry provided by the NH Department of Environmental Services, Watershed Mgt Bureau
Town boundary
Primary Route
Road or Street
Trail or other
Stream or Shoreline
Surface Water
Wetland
Conservation or Public land
Restricted Access Conservation
Cleared
Forest
Contour
Building
Source: USGS
Devils Den Rd
Pine Point Rd
Lions Camp Pride
North Shore Rd
Chesley Rd
South Shore Rd
Birch Hill Rd
Brienne Rd
Powdermill Fish Hatchery
Marks WMA
New Durham
Alton
Brookfield
Middleton
Copyright © 2013 National Geographic Society, i-cubed
Kilometers
Miles
Base map data from NH GRANIT at Earth Systems Research Center (UNH) and Open Street Map contributors. UNH, NH Fish & Game and the cooperating agencies make no claim as to the validity or reliability or to any implied uses of these data.
NOT INTENDED FOR BOAT NAVIGATION.
Directions:

Appendix 5

Merrymeeting Lake

2016 SAMPLING HIGHLIGHTS

Station – 1 Broad Cove

New Durham, NH

Extension

Station 1 Broad Cove (Figure 7) was used as a reference point to represent the overall Merrymeeting Lake water quality. Water quality data displayed in Tables 1 and 2 are surface water measurements with the exception of the dissolved oxygen data that were collected near the lake bottom.

Blue = Excellent = Oligotrophic

Yellow = Fair = Mesotrophic

Red = Poor = Eutrophic

Gray = No Data

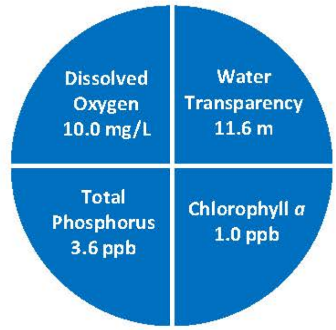


Figure 1. Merrymeeting Lake Water Quality (2016)

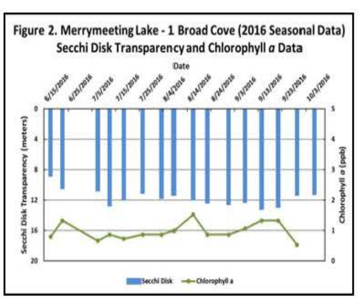
Table 1. 2016 Merrymeeting Lake Seasonal Averages and NH DES Aquatic Life Nutrient Criteria

Parameter	Oligotrophic "Excellent"	Mesotrophic "Fair"	Eutrophic "Poor"	Merrymeeting Lake Site 1 Broad Cove Average (range)	Merrymeeting Lake Site 1 Broad Cove Classification
Water Clarity (meters)	> 4.0	2.5 - 4.0	< 2.5	11.6 meters (8.8 – 13.2)	Oligotrophic
Chlorophyll *a* (ppb)	< 3.3	> 3.3 – 5.0	> 5.0 – 11.0	1.0 ppb (0.5 – 1.5)	Oligotrophic
Total Phosphorus (ppb)	< 8.0	> 8.0 – 12.0	> 12.0 – 28.0	3.6 ppb (< 2.0 – 6.4)	Oligotrophic
Dissolved Oxygen (mg/L)	> 5.0	2.0 – 5.0	<2.0	10.0 mg/L (7.5 – 13.3)	Oligotrophic

* Dissolved oxygen concentrations were measured on September 14, 2016 between 16.0 and 29.5 meters, in the bottom waters.

Table 2. 2016 Merrymeeting Lake Seasonal Average Accessory Water Quality Measurements

Parameter	Assessment Criteria					Merrymeeting Lake Site 1 Broad Cove Average (range)	Merrymeeting Lake Site 1 Broad Cove Classification
Color (color units)	< 10 uncolored	10 – 20 slightly colored	20 – 40 lightly tea colored	40 – 80 tea colored	> 80 highly colored	3.5 color units (range: 2.0 – 6.2)	Uncolored
Alkalinity (mg/L)	< 0.0 acidified	0.1 – 2.0 extremely vulnerable	2.1 – 10 moderately vulnerable	10.1 – 25.0 low vulnerability	> 25.0 not vulnerable	7.7 mg/L (range: 7.5 – 7.8)	Moderately vulnerable
pH (std units)	< 5.5 suboptimal for successful growth and reproduction		6.5 – 9.0 optimal range for fish growth and reproduction			7.1 standard units (range: 6.5 – 7.3)	Optimal range for fish growth and reproduction
Specific Conductivity (uS/cm)	< 50 uS/cm Characteristic of minimally impacted NH lakes		50-100 uS/cm Lakes with some human influence	> 100 uS/cm Characteristic of lakes experiencing human disturbances		56.1 uS/cm (range: 55.2- 56.5)	Lakes with some human influence



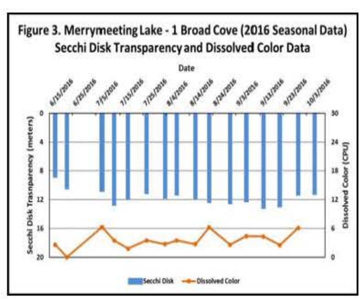


Figure 2 and 3. Seasonal Secchi Disk transparency, chlorophyll *a* concentrations and dissolved color concentrations. Figures 2 and 3 illustrate the interplay among Secchi Disk transparency, chlorophyll *a* and dissolved color. Shallower water transparency measurements oftentimes correspond to increases in chlorophyll *a* and/or color concentrations.

Appendix 5 (Cont'd)

LONG-TERM TRENDS

WATER CLARITY: The Merrymeeting Lake water clarity measurements, measured as Secchi Disk transparency, display a trend of increasing water clarity over thirty-three years of water quality monitoring conducted between 1981 and 2016 (Figure 4).

CHLOROPHYLL: The Merrymeeting Lake chlorophyll *a* concentrations, a measure of microscopic plant life within the lake, display a trend of decreasing concentrations over thirty-three years of water quality monitoring conducted between 1981 and 2016 (Figure 4).

TOTAL PHOSPHORUS: Phosphorus is the nutrient most responsible for microscopic plant growth. The Merrymeeting Lake total phosphorus concentrations display a trend of increasing concentrations over thirty years of water quality monitoring conducted between 1981 and 2016 (Figure 5).

COLOR: The Merrymeeting Lake color data, the result of naturally occurring "tea" color substances from the breakdown of soils and plant materials, display a trend of decreasing concentrations over twenty-nine years of water quality monitoring conducted between 1987 and 2016 (Figure 5).

Figure 4. Merrymeeting Lake - Site 1 Broad Cove (1981-2016)
Long-term Secchi Disk Transparency and Chlorophyll *a* Data

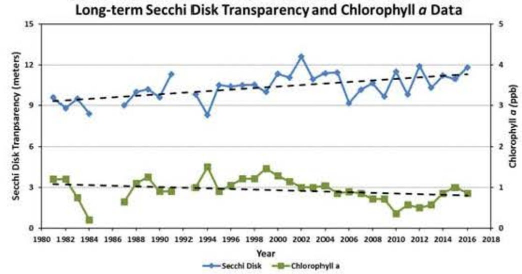


Figure 5. Merrymeeting Lake - Site 1 Broad Cove (1981-2016)
Long-term Total Phosphorus and Dissolved Color Data

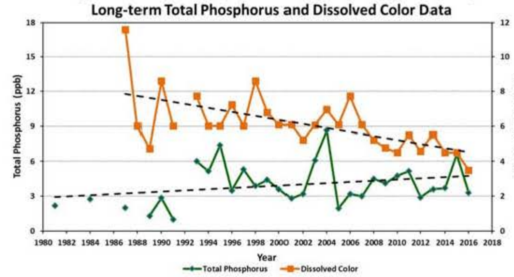


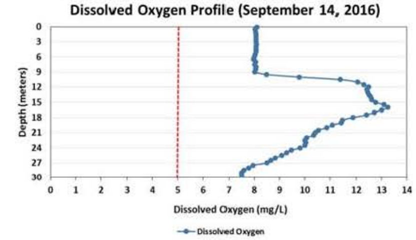
Table 3. Merrymeeting Lake Seasonal Average Water Quality Inter-Site Comparison (2016)

Sampling Station	Average (range) Secchi Disk (meters)	Average (range) Total Phosphorus (ppb)	Average (range) Chlorophyll *a* (ppb)	Average (range) Dissolved Oxygen (mg/L)
1 Broad Cove	**11.6** m (range: 8.8 – 13.1)	**3.6** ppb (1.7 – 6.4)	**1.0** ppb (range: 0.5 – 1.5)	**10.0** mg/L (range: 7.5 – 13.3)
2 Owls Head	**11.3** m (range: 8.7 – 13.0)	**3.1** ppb (range: 1.9 – 4.4)	**0.9** ppb (range: 0.6 – 1.3)	**6.6** mg/L (range: 5.7 – 9.0)
3 East End	**10.7** m (range: 8.8 – 12.8)	**3.5** ppb (range: 1.0 – 6.1)	**0.9** ppb (range: 0.7 – 1.5)	**Not Assessed.** No bottom layer

Figures 4 and 5. Changes in the Merrymeeting Lake water clarity (Secchi Disk depth), chlorophyll *a*, dissolved color and total phosphorus concentrations measured between 1981 and 2016. **These data illustrate the relationship among plant growth, water color and water clarity. Total phosphorus data are also displayed and are oftentimes correlated with the amount of plant growth.**

Figure 6. Merrymeeting Lake dissolved oxygen profile collected on September 14, 2016. The vertical red line indicates the dissolved oxygen concentration commonly considered the threshold for successful growth and reproduction of cold water fish such as trout and salmon. *Notice the high dissolved oxygen concentrations near the lake bottom.*

Figure 6. Merrymeeting Lake - Site 1 Broad Cove
Dissolved Oxygen Profile (September 14, 2016)



Reccomendations

Implement Best Management Practices within the Merrymeeting Lake watershed to minimize the adverse impacts of polluted runoff and erosion on Merrymeeting Lake. Refer to "Landscaping at the Water's Edge: An Ecological Approach" and "New Hampshire Homeowner's Guide to Stormwater Management: Do-It-Yourself Stormwater Solutions for Your Home" for more information on how to reduce nutrient loading caused by overland run-off.

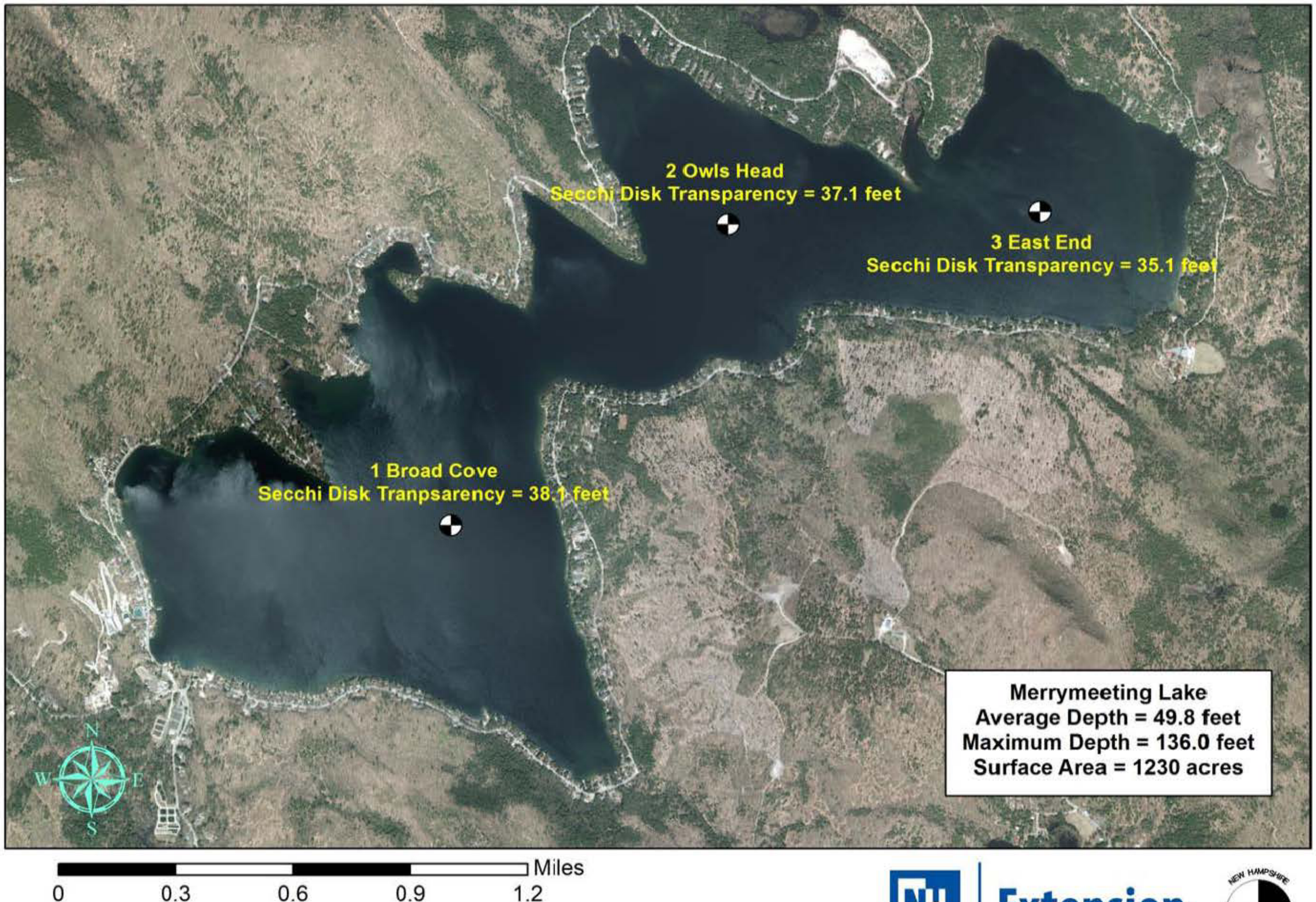
- http://extension.unh.edu/resources/files/Resource004159_Rep5940.pdf
- http://soaknh.org/wp-content/uploads/2016/04/NH-Homeowner-Guide-2016.pdf

Appendix 5 (Cont'd)

Figure 7. Merrymeeting Lake

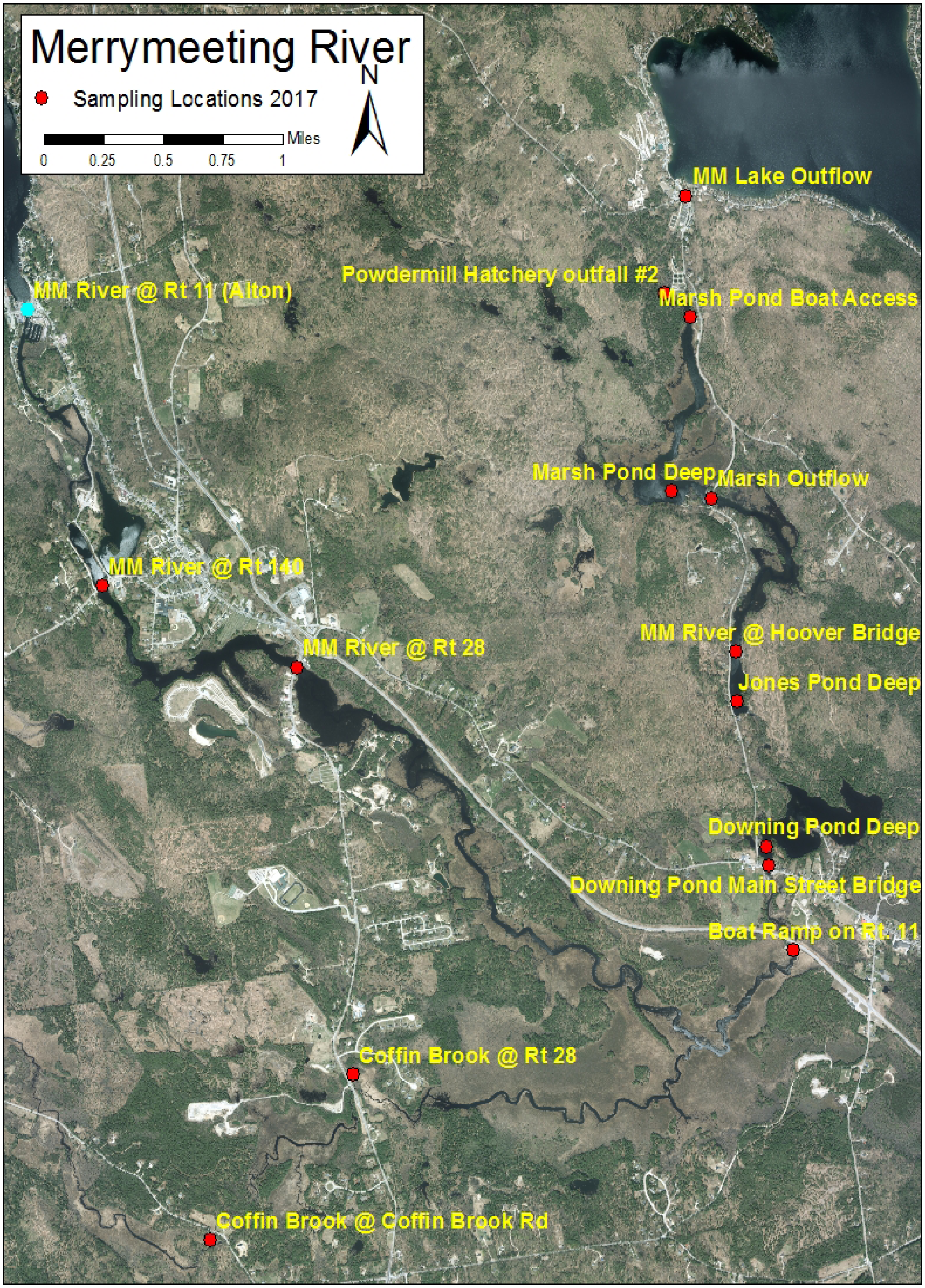
New Durham, NH

2016 Deep water sampling site locations with seasonal average water clarity

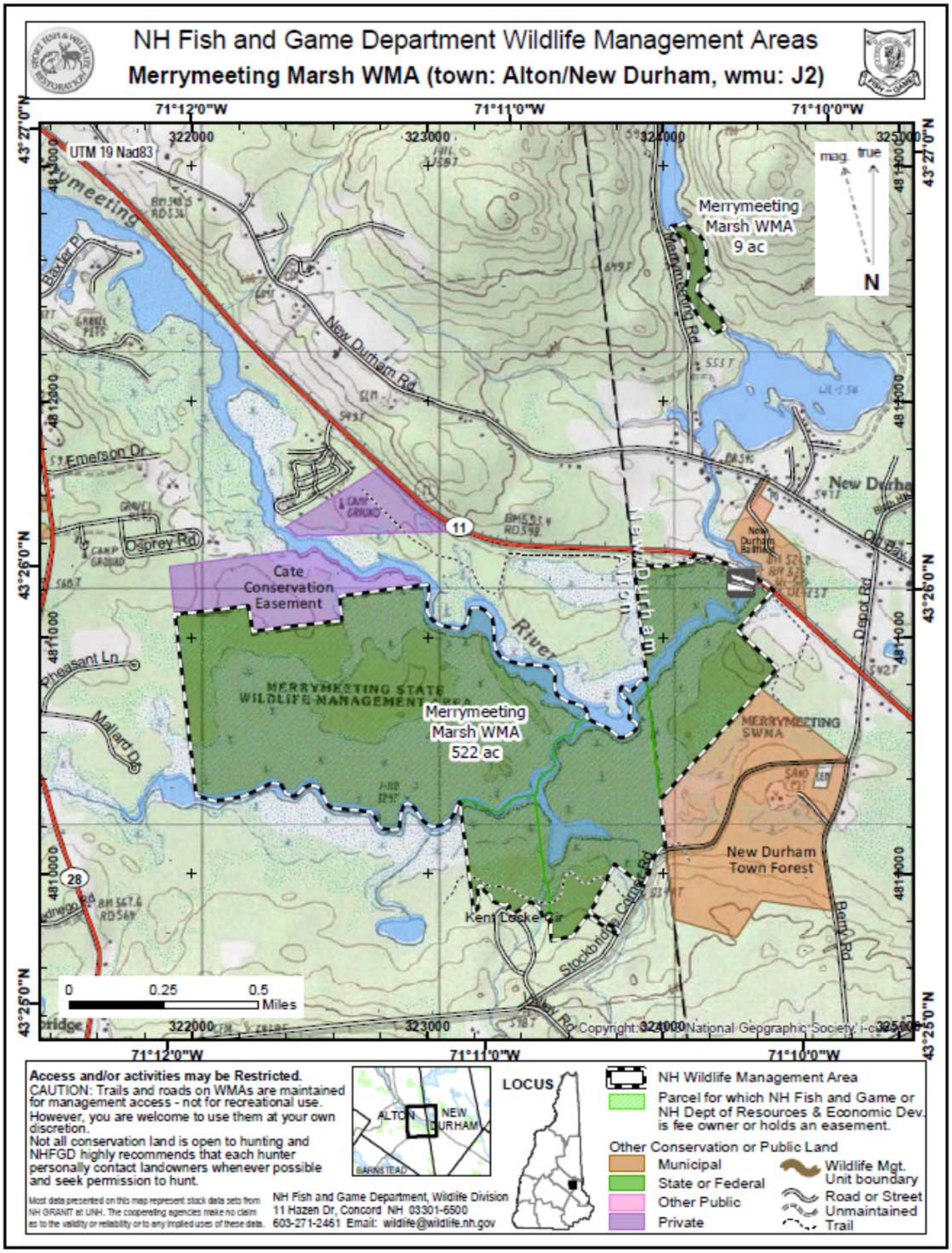


Site location GPS coordinates were collected by the UNH Center for Freshwater Biology
Aerial Orthophoto Source: 2015 Statewide High Resolution Aerial Photography, NH GRANIT

Appendix 6


Merrymeeting River
Sampling Locations 2017
Miles
0 0.25 0.5 0.75 1
N
MM Lake Outflow
Powdermill Hatchery outfall #2
Marsh Pond Boat Access
MM River @ Rt 11 (Alton)
Marsh Pond Deep
Marsh Outflow
MM River @ Rt 140
MM River @ Rt 28
MM River @ Hoover Bridge
Jones Pond Deep
Downing Pond Deep
Downing Pond Main Street Bridge
Boat Ramp on Rt. 11
Coffin Brook @ Rt 28
Coffin Brook @ Coffin Brook Rd

Appendix 7


NH Fish and Game Department Wildlife Management Areas
Merrymeeting Marsh WMA (town: Alton/New Durham, wmu: J2)
UTM 19 Nad83
Merrymeeting Marsh WMA 9 ac
Merrymeeting Marsh WMA 522 ac
Cate Conservation Easement
New Durham Rd
Emerson Dr
Osprey Rd
Pheasant Ln
Mallard Dr
River
Alton
New Durham
Depot Rd
Berry Rd
Stockbridge Corner Rd
Kent Locke Cir
New Durham Town Forest
MERRYMEETING STATE WILDLIFE MANAGEMENT AREA
11
28
mag. true
N
0 0.25 0.5 Miles
71°12'0"W
71°11'0"W
71°10'0"W
43°27'0"N
43°26'0"N
43°25'0"N
322000
323000
324000
325000
4812000
4811000
4810000
Copyright: National Geographic Society
Access and/or activities may be Restricted.
CAUTION: Trails and roads on WMAs are maintained for management access - not for recreational use. However, you are welcome to use them at your own discretion.
Not all conservation land is open to hunting and NHFGD highly recommends that each hunter personally contact landowners whenever possible and seek permission to hunt.
Most data presented on this map represent stock data sets from NH GRANIT at UNH. The cooperating agencies make no claim as to the validity or reliability or to any implied uses of these data.
NH Fish and Game Department, Wildlife Division
11 Hazen Dr, Concord NH 03301-6500
603-271-2461 Email: wildlife@wildlife.nh.gov
ALTON
NEW DURHAM
BARNSTEAD
LOCUS
NH Wildlife Management Area
Parcel for which NH Fish and Game or NH Dept of Resources & Economic Dev. is fee owner or holds an easement.
Other Conservation or Public Land
Municipal
State or Federal
Other Public
Private
Wildlife Mgt. Unit boundary
Road or Street
Unmaintained
Trail

Appendix 8

Alton Bay

2015 SAMPLING HIGHLIGHTS

Station 25 Alton

Alton, NH

University of New Hampshire
Cooperative Extension

Station 25 Alton (Figure 7) was used as a reference point to represent the overall condition of Alton Bay. Water quality data displayed in Tables 1 and 2 are surface water measurements with the exception of the dissolved oxygen data that are collected near the lake bottom.

Blue = Excellent = Oligotrophic

Yellow = Fair = Mesotrophic

Red = Poor = Eutrophic

Gray = No Data

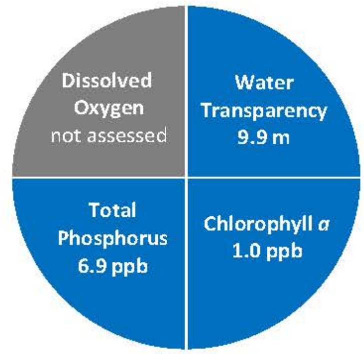


Figure 1. Alton Bay Water Quality (2015)

Table 1. 2015 Alton Bay Seasonal Averages and NH DES Aquatic Life Nutrient Criteria

Parameter	Oligotrophic "Excellent"	Mesotrophic "Fair"	Eutrophic "Poor"	Alton Bay Average (range)	Alton Bay Classification
Water Clarity (meters)	4.0 – 7.0	2.5 - 4.0	< 2.5	9.9 meters (8.5 – 11.3)	Oligotrophic
Chlorophyll *a* (ppb)	< 3.3	> 3.3 – 5.0	> 5.0 – 11.0	1.0 ppb (0.7 – 1.3)	Oligotrophic
Total Phosphorus (ppb)	< 8.0	> 8.0 – 12.0	> 12.0 – 28.0	6.9 ppb (5.5 – 9.8)	Oligotrophic
Dissolved Oxygen (mg/L)	5.0 – 7.0	2.0 – 5.0	<2.0	Not measured *	Not Assessed *

* Site 25 did not develop a deep water layer that is the basis for the dissolved oxygen classification criteria.

Table 2. 2015 Alton Bay Seasonal Average Accessory Water Quality Measurements

Parameter	Assessment Criteria					Alton Bay Average (range)	Alton Bay Classification
Color (color units)	< 10 uncolored	10 – 20 slightly colored	20 – 40 lightly tea colored	40 – 80 tea colored	> 80 highly colored	6.9 color units (5.5 – 9.3)	Uncolored
Alkalinity (mg/L)	< 0.0 acidified	0.1 – 2.0 extremely vulnerable	2.1 – 10 moderately vulnerable	10.1 – 25.0 low vulnerability	> 25.0 not vulnerable	7.8 mg/L (7.0 – 8.7)	Moderately vulnerable
pH (standard units)	< 5.5 suboptimal for successful growth and reproduction		6.5 – 9.0 optimal range for fish growth and reproduction			7.3 standard units (7.3 – 7.3)	Optimal range for fish growth and reproduction
Specific Conductivity (*u*S/cm)	< 50 *u*S/cm Characteristic of minimally impacted NH lakes		50-100 *u*S/cm Lakes with some human influence	> 100 *u*S/cm Characteristic of lakes experiencing human disturbances		70.9 uS/cm (70.7 – 71.0)	Lakes with some human influence

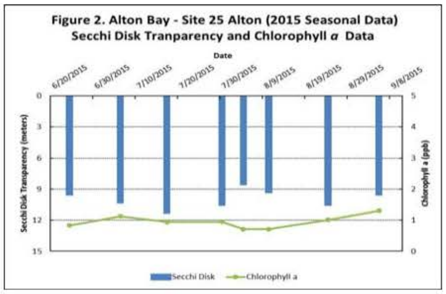


Figure 2. Alton Bay - Site 25 Alton (2015 Seasonal Data) Secchi Disk Tranparency and Chlorophyll *a* Data

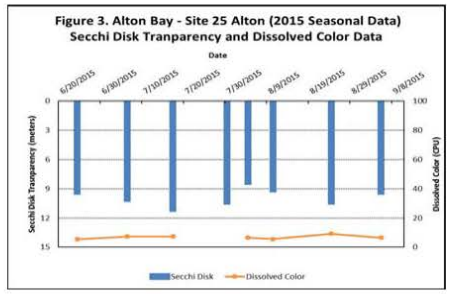


Figure 3. Alton Bay - Site 25 Alton (2015 Seasonal Data) Secchi Disk Tranparency and Dissolved Color Data

Figure 2 and 3. Seasonal Secchi disk transparency, chlorophyll *a* concentrations and dissolved color concentrations. Figures 2 and 3 illustrate the interplay among Secchi Disk transparency, chlorophyll *a* and dissolved color. Shallower water transparency measurements oftentimes correspond to increases in chlorophyll *a* and/or color concentrations.

LONG-TERM TRENDS

WATER CLARITY: The Alton Bay (Site 25 Alton) water clarity measurements, measured as Secchi Disk transparency, display a trend of increasing water clarity over the thirty-two years of water quality monitoring conducted between 1983 and 2015 (Figure 4).

CHLOROPHYLL: The Alton Bay (Site 25 Alton) chlorophyll *a* concentrations, a measure of microscopic plant life within the lake, have oscillated among years but have been relatively stable over the thirty-two years of water quality monitoring conducted between 1983 and 2015 (Figure 4).

TOTAL PHOSPHORUS: Phosphorus is the nutrient most responsible for microscopic plant growth. The Alton Bay (Site 25 Alton) total phosphorus measurements display a trend of increasing total phosphorus concentrations between 2001 and 2015 (Figure 5).

COLOR: The Alton Bay (Site 25 Alton) color data, the result of naturally occurring "tea" colored substances from the breakdown of soils and plant materials, display a trend of increasing color concentrations between 1985 and 2015 (Figure 5).

Figure 4. Alton Bay- Site 25 Alton (1983-2015)
Long-term Secchi Disk Transparency and Chlorophyll *a* Data

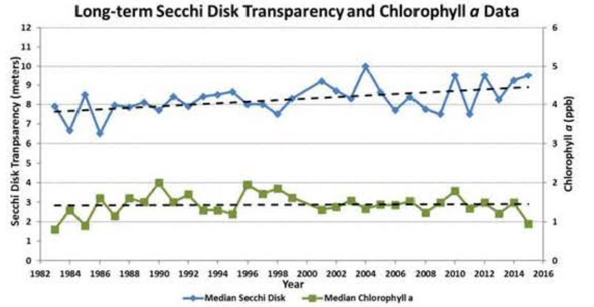


Figure 5. Alton Bay - Site 25 Alton (1985-2015)
Long-term Total Phosphorus and Dissolved Color Data

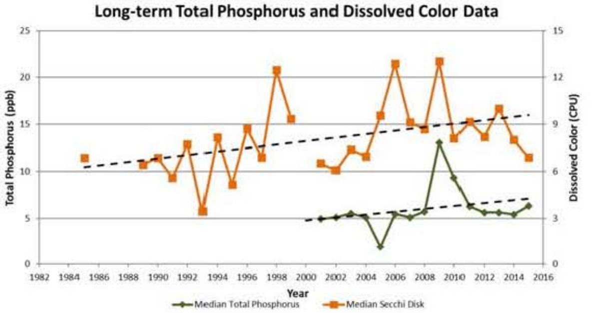


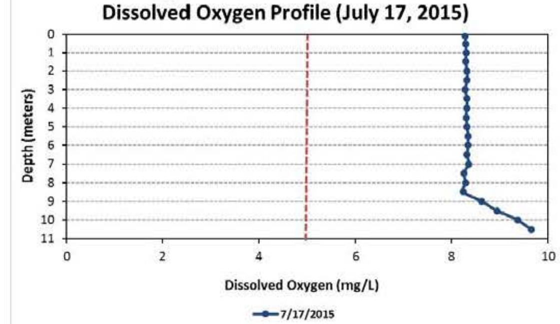
Table 3. Alton Bay Seasonal Average Water Quality Inter-site Comparison (2015)

Site	Average (range) Secchi Disk Transparency (meters)	Average (range) Chlorophyll *a* (ppb)	Average (range) Total Phosphorus (ppb)
25 Alton	8.5 (range: 0.2 – 10.5)	1.0 (range: 0.7 – 1.3)	6.9 (range: 5.5 – 9.8)
Pavillion	6.4 (Single Value)	1.5 (Single Value)	7.4 (Single Value)

Figures 4 and 5. Changes in the Alton Bay water clarity (Secchi Disk depth), chlorophyll *a*, dissolved color and total phosphorus concentrations measured between 1997 and 2015. **These data illustrate the relationship among plant growth, water color and water clarity. Total phosphorus data are also displayed and are oftentimes correlated with the amount of plant growth.**

Figure 6. July 17, 2015 Alton Bay (Site 25 Alton) dissolved oxygen profile. The vertical red line indicates the oxygen concentration commonly considered the threshold for successful growth and reproduction of cold water fish.

Figure 6. Alton Bay - 25 Alton
Dissolved Oxygen Profile (July 17, 2015)



Recommendations

Implement Best Management Practices within the Lake Winnipesaukee watershed to minimize the adverse impacts of polluted runoff and erosion into Lake Winnipesaukee (Alton Bay). Refer to "Landscaping at the Water's Edge: An Ecological Approach" and "New Hampshire Homeowner's Guide to Stormwater Management: Do-It-Yourself Stormwater Solutions for Your Home" for information on how to reduce nutrient loading caused by overland run-off.

- http://extension.unh.edu/resources/files/Resource004159_Rep5940.pdf
- http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-11-11.pdf

Appendix 8 (Cont'd)

Figure 7. Lake Winnipesaukee - Alton Bay
Alton, NH
2015 and historical sampling sites and seasonal average water clarity

Aerial Orthophoto Source: NH GRANIT
Site location GPS coordinates collected by the UNH Center for Freshwater Biology

THE END