A Watershed Management Plan for Lake Winnipesaukee
Plan 1: Meredith, Paugus, and Saunders Bays

Executive Summary

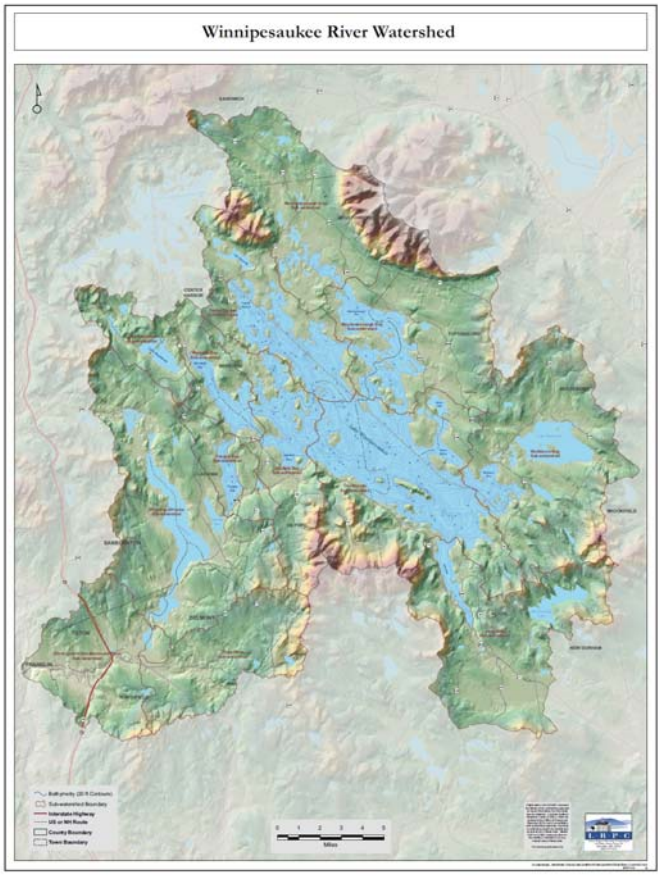
Project Overview

Preparing a watershed management plan for Lake Winnipesaukee has challenged planners and decision makers for some time.

In addition to being the state's largest water body and a significant economic force, its morphology is more a system of interconnected bays rather than a single cohesive body of water.

Each embayment has differing characteristics and land-based influences and in-lake responses to nutrient inputs. Thus, management should be done for each embayment, accounting for these characteristics.

The Lake Winnipesaukee Watershed Management Plan website represents the combined efforts of many partners to forge a unique, subwatershed approach to create an effective, sustainable planning and implementation process using state-of-the-art information systems.



Rather than a hard copy to sit on a shelf, the web-based plan will conveniently store and retrieve information, maps, photos, on-going projects, water quality and site-restoration plans on a continuing basis, creating opportunities for students, professionals, and the general public to learn more about the watershed as the information is developed and released from credible sources.

In addition, the site will provide information on resource issues, recreational opportunities, fish & wildlife, land use and zoning, and more.

The initial plan presented here by the project partners is the **"Plan 1: Meredith, Paugus, and Saunders Bays Subwatershed Management Plan".** As future subwatershed plans are developed for each embayment, they will be added to the website.

The final outcome will be a comprehensive Lake Winnipesaukee Watershed Management Plan, the implementation of which will result in achieving the goal of improving and sustaining the long term health of the watershed and the high quality water of Lake Winnipesaukee.

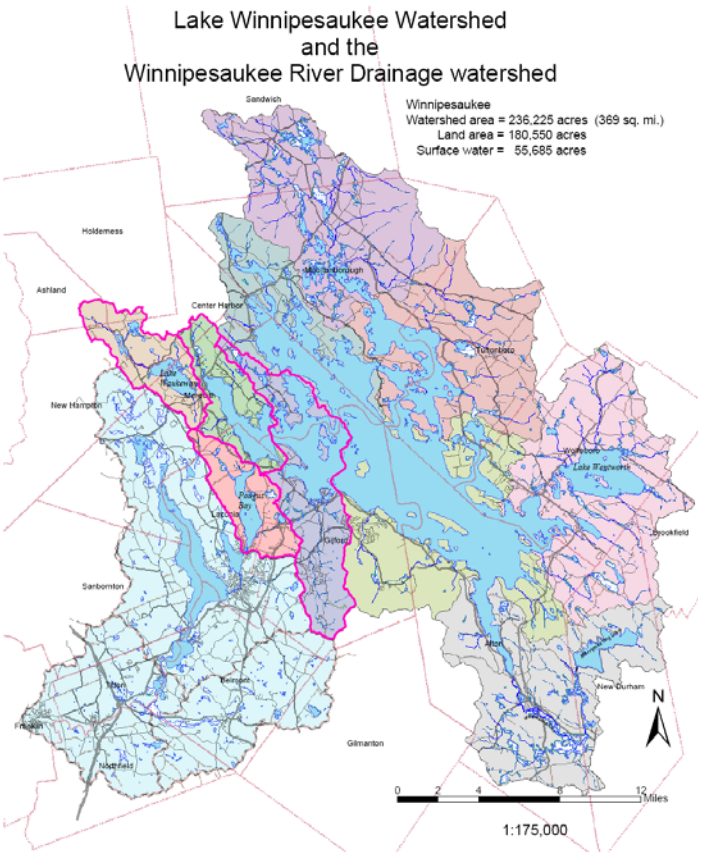
October 2010

Themes of the Plan

- Partnership Approach

  More than 10 years ago, focus groups held around the Lake Winnipesaukee Watershed developed a vision describing a public/private partnership that would bring all interests together to speak with one voice. A concern for the future of the watershed and the need to balance recreational uses, development, and the economy with protection of water quality, and healthy ecosystems was the consensus of the groups.

  Recognizing that no one entity can succeed in protecting the land and water resources of the watershed, and that success will only be realized through combining technical, financial, professional and volunteer resources, The Lake Winnipesaukee Watershed Association, Lakes Region Planning Commission, North Country Resource Conservation and Development Area Council, University of New Hampshire Center for Freshwater Biology, Center for the Environment at Plymouth State University, municipalities, Belknap County Conservation District, and the NH Department of Environmental Services have partnered to begin the process to achieve the long term goal of a watershed management plan for Lake Winnipesaukee.



- Subwatershed Approach

  The size of the Lake Winnipesaukee watershed, the morphology of the lake, and local municipal controls over planning, zoning, and conservation issues, are factors identified as prohibitive to developing a comprehensive watershed management plan. The strategy adopted by the partners to work at the subwatershed level with fewer communities began in 2006 with Meredith, Laconia, and Gilford coming together to form a Subwatershed Group with the facilitation of North Country Resource Conservation & Development Area Council. Meredith Bay, Paugus Bay, and Saunders Bay are the first grouping of subwatersheds to develop a watershed management plan, which is presented in the following summary.

Lake Winnipesaukee Watershed

The Lake Winnipesaukee watershed, located in Belknap and Carroll Counties in the lakes region of New Hampshire, drains to Lake Winnipesaukee, the largest freshwater body in the state with a size of 44,586 acres and total watershed area of 236,225 acres or 369 sq. miles. The watershed encompasses a total of eighteen communities; eight of which are shorefront communities comprising approximately 87% of the land area. The eight shorefront communities are Moultonborough, Tuftonboro, Wolfeboro, Alton, Gilford, Laconia, Meredith, and Center Harbor. Additional communities in the watershed include Sandwich, Tamworth, Ossipee, Brookfield, Middleton, New Durham, Gilmanton, New Hampton, Ashland, and Holderness.

The **Winnipesaukee River** watershed includes the Lake Winnipesaukee watershed plus an additional 116 sq. miles and 5 towns. The larger Winnipesaukee River watershed follows the Winnipesaukee River from the outlet at the Lakeport dam through Opechee Bay, Lake Winnisquam, Silver Lake, to where it joins the Pemigewasset River in Franklin. Additional communities in the Winnipesaukee River watershed include Sanbornton, Belmont, Tilton, Northfield, and Franklin.

The lake watershed boundary is characterized by the steep Ossipee Mountain range with elevations of 2990 ft at Mt. Shaw in the northeast, the floodplain of the Merrymeeting River with an elevation of 542 ft in the southeast, the Belknap Mountain Range with elevations of approximately 2400 ft. in the south, and hilly terrain in the northwest with average elevations of ~1200 ft.

Meredith Bay, Paugus Bay, and Saunders Bays watersheds form the western side of the Winnipesaukee watershed, comprising a little over 34,000 acres in total. Paugus Bay, which is the drinking water supply for the City of Laconia, is also the drainage portal for the lake.

Mission and Goals

Representatives from the Planning Board and Conservation Commissions of Meredith, Laconia and Gilford initially came together in 2006 to form the Meredith, Paugus, Saunders Subwatershed Advisory Committee. The committee adopted the following **mission statement**:

> "*Work collaboratively as stakeholders to assess issues and concerns that impact our shared watershed resources; develop a management plan that will educate, motivate and be a catalyst for action that protects those resources for the people and communities of the Lake Winnipesaukee Watershed.*"

Following up on the work begun in 2006, the communities came together in 2009-10 to state a **shared goal**:

"Lake Winnipesaukee is a shared resource. Our communities share the benefits of being located on "The Lake". We share the risks associated with degradation of this resource. We also share the responsibility of effective watershed stewardship, essential to the successful long term health of Lake Winnipesaukee."

The **fundamental goal** of this watershed management plan is to halt or minimize further water quality degradation attributable to nutrient inputs, primarily phosphorus in order to maintain our high quality water.

Current total phosphorus (TP) levels in each subwatershed bay are below the state standard of 8.0 µg/L established for a high quality water. We will work toward maintaining or improving current total phosphorus levels by stabilizing nutrient inputs through the reduction of nutrient sources and through managing landscape change to mitigate increased nutrient loads.

Water Quality and Health of the Lake

The Phosphorus Focus

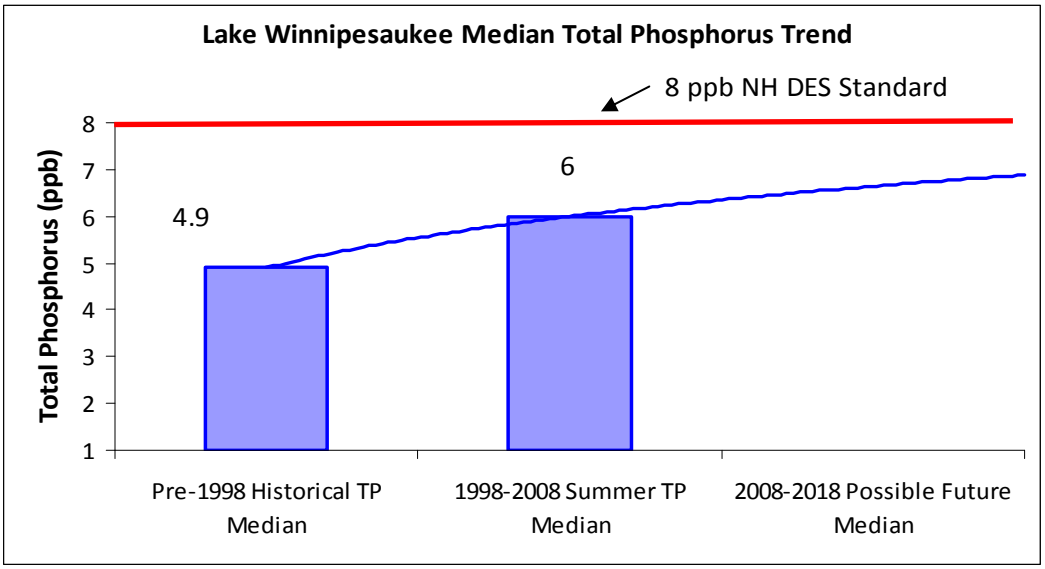
Phosphorus (P) is a naturally occurring element and a major nutrient required for biological productivity. It is found in all living plants, animals, and people (organic forms); as well as being present in soils and rock (inorganic forms). Although its existence is widespread in nature, it is not *naturally* abundant, and is the most limiting nutrient in freshwater ecosystems for aquatic plant productivity.

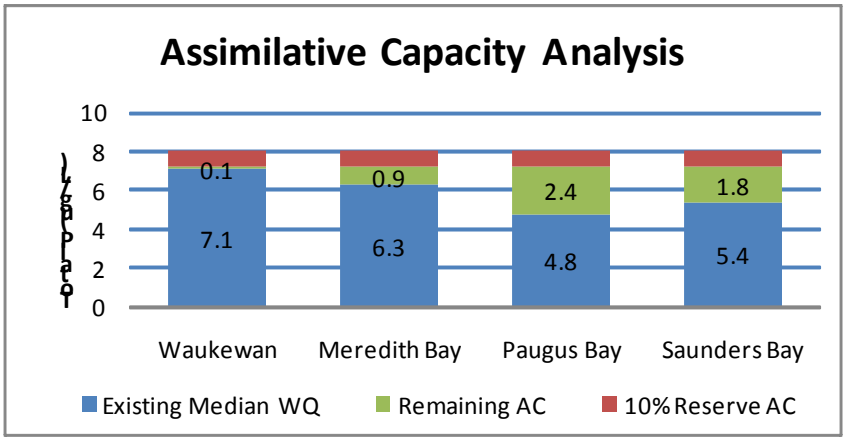
Increased P levels in freshwater can cause decreased water clarity, increased Chlorophyll-a levels, increased turbidity levels, accelerated lake eutrophication, etc. Increased levels of P in freshwater may also result in a

decline in property values, economic loss from decline in tourism due to decline in water clarity, public health risk due to potential of increased occurrence of cyanobacteria blooms, decline in swimming, fishing and boating use, and an increase in public expenditures to address water quality impairments.

Potential additional loading of phosphorus comes from human activities; fertilizers and agriculture are the major sources of P. Other sources come from development and construction activities due to erosion and sediment control issues. P does not exist freely in nature, but is found in compounds, and is bound up in soil by adhering to the surface of soil particles. Eroding streambanks, roadways, exposed soil on construction sites can be a major source of P in a large rain event.

Phosphorus water quality analyses were conducted on data available from NH DES, UNH, PSU, LWWA, and town records. The data was divided into two categories – historical data (> 10 years old) and summer data collected within the last 10 years. Per those data, the phosphorus trend in Lake Winnipesaukee increased (worsened) 1.1ppb in ten years.





As part of the management plan process, analysis was done on the existing water quality data for each of the three subwatersheds involved in Phase I to determine the median total phosphorus (P) and chlorophyll-a values, and to determine the assimilative capacity of the subwatersheds as compared to the State Standard for P.

The water quality data and assimilative capacity analysis support Lake Winnipesaukee's designation as a high quality water and oligotrophic classification.

2009 Water Quality Monitoring Results

A water quality monitoring study was done on the three subwatersheds in the study area to obtain some current water quality data with which to compare future data to. Previous to 2009, existing data for the three bays was relatively sparse.

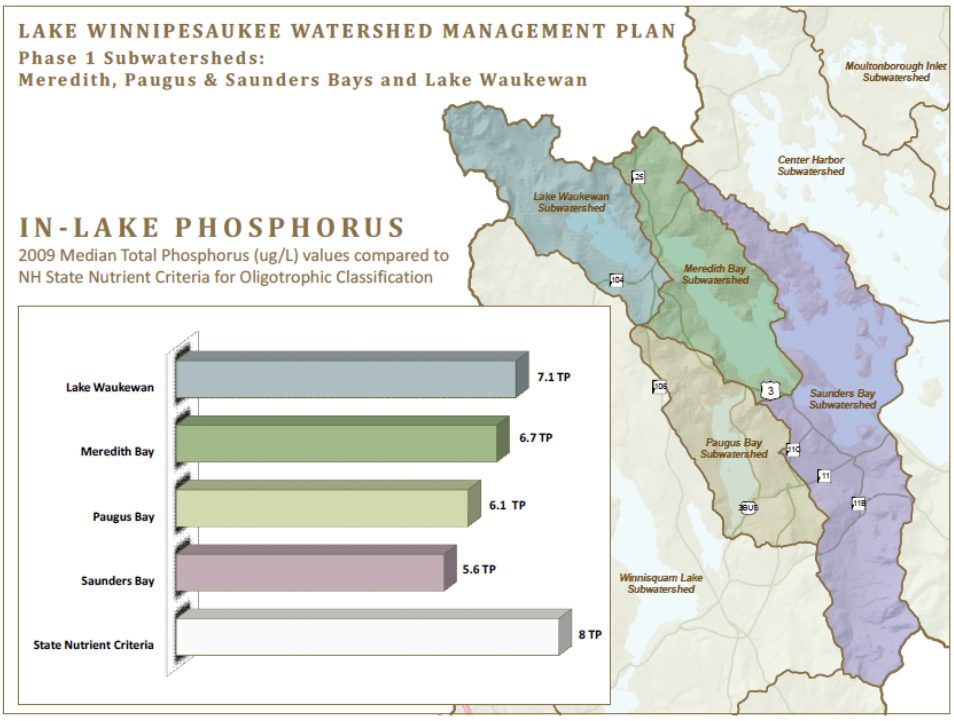
The table below shows the results of the 2009 summer sampling:

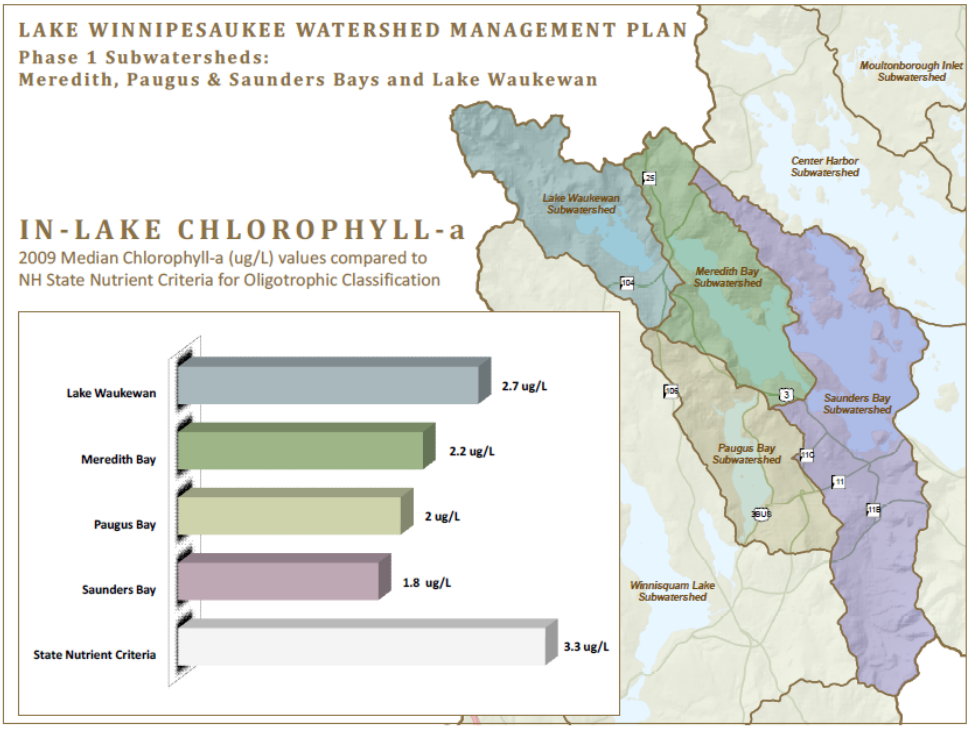
Summary of 2009 Water Quality Monitoring Results

	Meredith Bay	Paugus Bay		Saunders Bay	
Parameter	**Deep Lake**	**Shallow Sites**	**Deep Lake**	**Shallow Sites**	**Deep Lake**
Median Total Phosphorus (µg/L)	6.7	5.6	6.1	5.1	5.6
Mean Chlorophyll-α (µg/L)	2.2	2	2	1.8	1.8
Mean Secchi Disk depth (m)	7.1		9		9.7
Mean Dissolved Color (CPU)	9.8	10.4	7.4	8.3	8

Notes: µg/L = micrograms per liter
m = meters
CPU = chloroplatinate units

The graphs below summarize the results of the current phosphorus and chlorophyll-a levels for each subwatershed.



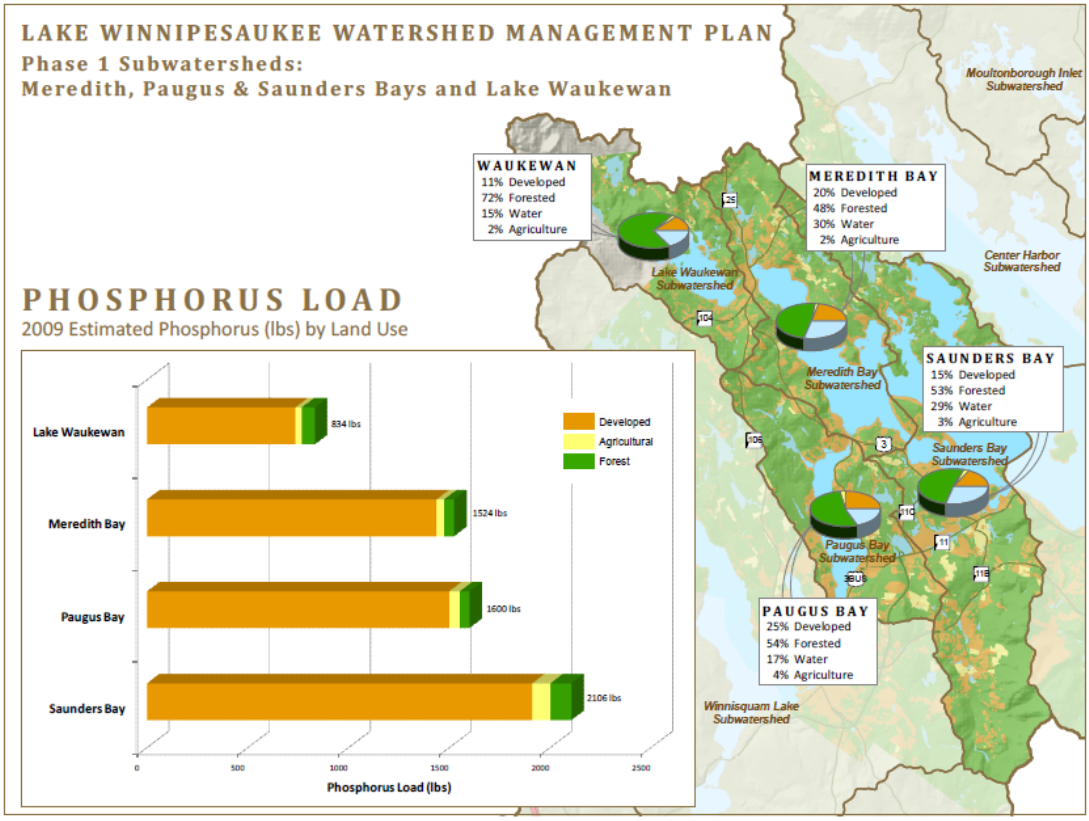


Land Use and In Lake Modeling

To estimate in-lake phosphorus values for each subwatershed, the phosphorus load coming from the land in the watershed needs to be determined. The estimated loads are based on land use, and the overall estimated phosphorus load is then input into a model that predicts in-lake P at spring overturn, when the lake water is fully mixed from surface to bottom.

2009 Land Use/Land Cover Table (acreage)					
Land Use	Waukewan	Meredith	Paugus	Saunders North	Saunders South
Urban	951.1	1799	1858	524	2229
Agriculture	196.3	205	277	51.2	476
Forest	6014	4180	4096.5	2859	6453.4
Water	1248	2617	1293.4	4260	1062.1

Below is a graph showing the phosphorus load by land use for each subwatershed in Plan 1.



Spring overturn occurs shortly after ice out, following which the lake water will begin to stratify into three distinct layers based on temperature; an upper or eplimnetic layer, middle layer (metalimnion), and lower layer (hypolimnion). On April 2, 2010 a group of volunteers, DES, UNH, and PSU scientists collected over 150 water samples from Lake Winnipesaukee at twelve (12) designated deep spots to determine phosphorus levels at spring overturn. As water samples at ice out had never been collected on the lake before, this offered a great opportunity to verify the models.

Summary of STEPL P loads and In Lake Trophic Response models vs. Ice out data

Subwatershed	Total Watershed Acreage	Total Land Acreage	**STEPL Model** 2009 P load		**In Lake Trophic Response Model** Predicted In-lake P	**Ice out Data 4/2/2010**
			lb/yr	kg/yr	µg/L	ug/L
Waukewan	8409	7161	834	379	8.9	
Meredith	8802	6183	1524	692	6.5	5.6
Paugus Bay	7525	6232	1600	726	6.2	6.8
Saunders	17855	12742	2106	956	5	5.5

Note: STEPL: Spreadsheet Tool for Estimating Pollutant Load

Results and Actions Identified

The results of the models indicate that in order to prevent increasing phosphorus levels in the lake, measures and actions should focus on limiting the phosphorus load coming from urban areas. Land use categories included within urban land use are: commercial, industrial, institutional, transportation, multi and single family residential, urban cultivated, vacant land, and open space. Within the urban land use, the transportation category (road network) and single family residential were the main sources of phosphorus. The transportation category is a large source of P due to the fact that it represents impervious areas and carries untreated stormwater from land surfaces to storm drains and catch basins that empty directly into associated waterbodies

The communities identified three main areas of concern on which to focus their efforts to limit pollutant loading to the lake; septic systems, erosion and sedimentation, and stormwater management. A total of 58 management measures were identified which fall under several categories; Community planning and development, Public education and outreach, best management practices for both the public and private sector, and funding needs.

Planning

Sixteen (16) planning strategies were identified; most of which will be the responsibility of the Planning Boards in each community to implement. Planning activities received high rankings due to the low cost and few legal obstacles associated with implementation. Some of the actions can be considered "housekeeping" items, such as "integration of Erosion and Sediment Control Regulations with Stormwater Regulations", and "strengthening the E&S Control Plan by moving it from Site Plan Review and Subdivision Regulations to an ordinance". Others address increased pollutant load associated with landscape change; by incorporating low impact development techniques into zoning and regulations, and requiring the use of Best Management Practices (BMPs), planning boards represent the first line of defense in protection of the lake's water quality.

Education/Stewardship

Under Education/Stewardship, two out of the ten (10) strategies recommend better communication and cooperation within and between communities. Several strategies target educating residential homeowners on septic systems, landscaping, and the importance of maintaining stream buffers. As residential land represents the largest percentage of urban land use in the study subwatersheds, management measures that target individuals and result in behavior change could have a significant impact in lowering pollutant loads.

Impacts from failing septic systems are one of the top concerns identified by the communities. According to EPA, failure rates for septic systems typically range between 1 and 5 percent each year but can be much higher in some regions. Future development in these subwatersheds could significantly impact potential pollutant loads from increased numbers of on site wastewater treatment systems, unless expansion of the Winnipesaukee River Basin program occurs.

Best Management Practices/Restoration Sites

One of the objectives stated in the goal statement is to reduce existing sources of excessive phosphorus. The communities listed a total of twenty six (26) actions that either incorporate best management practices at the local level or identify specific sites requiring mitigation. Estimating load reductions for some sites is not possible, as detailed assessments need to be conducted to determine specific actions and BMPs required.

However, in the Saunders Bay subwatershed, Gunstock Brook, 6.44 miles long, contributes the largest volume of water to Saunders Bay. Seven sites were identified requiring streambank stabilization or other corrective measures. Improvement of these sites has the potential to reduce the sediment load by approximately 149 tons, and the phosphorus load by 131 lbs.

Management measures that implement best management practices on roads can be effective in reducing pollutant loads. In the three subwatersheds studied, the road network acts as a vehicle or transportation mechanism for untreated stormwater; carrying runoff to catch basins and storm drains which in turn empty directly into the lake. Catch basin retrofits are recommended for off line systems; each deep sump catch basin is designed to treat 0.25 acre, and is effective mainly at removing total suspended solids. Areas such as Waukewan Street in Meredith, and Weirs Blvd. along Paugus Bay have numerous catch basins and storm drains which collect stormwater and outlet directly to the lake.

Evaluation and Sustainability

Putting the management plan into action is critical to achieving its objectives. **Long term monitoring** of the lake's health and measuring the success and weaknesses of the plan are also important. **Informing and involving the public** at the local level will be key to assure buy-in and support of adoption of land use regulations, as well as individual best management practices. Key to informing and involving the public will be providing a **resource for information**. The Winnipesaukee Gateway website will be that resource.

It is the intent and hope of this management plan that the strategies and best management practices identified by the communities become an action plan or road map to enable the communities to achieve the goal of halting or minimizing further water quality degradation due to nutrient inputs. In order to determine if the action plan is being implemented, interim, **measurable milestones** were identified that will need to be tracked and periodically reviewed to ensure continued progress in achieving the goals defined in the management plan.

Sustainability

Sustainability of the efforts begun here, and the implementation of the plan will require continuous oversight, outreach, education, financial support and public and private involvement of all stakeholders. Although many challenges still exist in achieving a comprehensive Lake Winnipesaukee Watershed Management Plan, with commitment, collaboration, and coordination, the vision described ten years ago to balance recreational uses, development, and the economy with protection of water quality, and healthy ecosystems will be realized.

It is everyone's responsibility to keep Lake Winnipesaukee a "beautiful water in a high place".