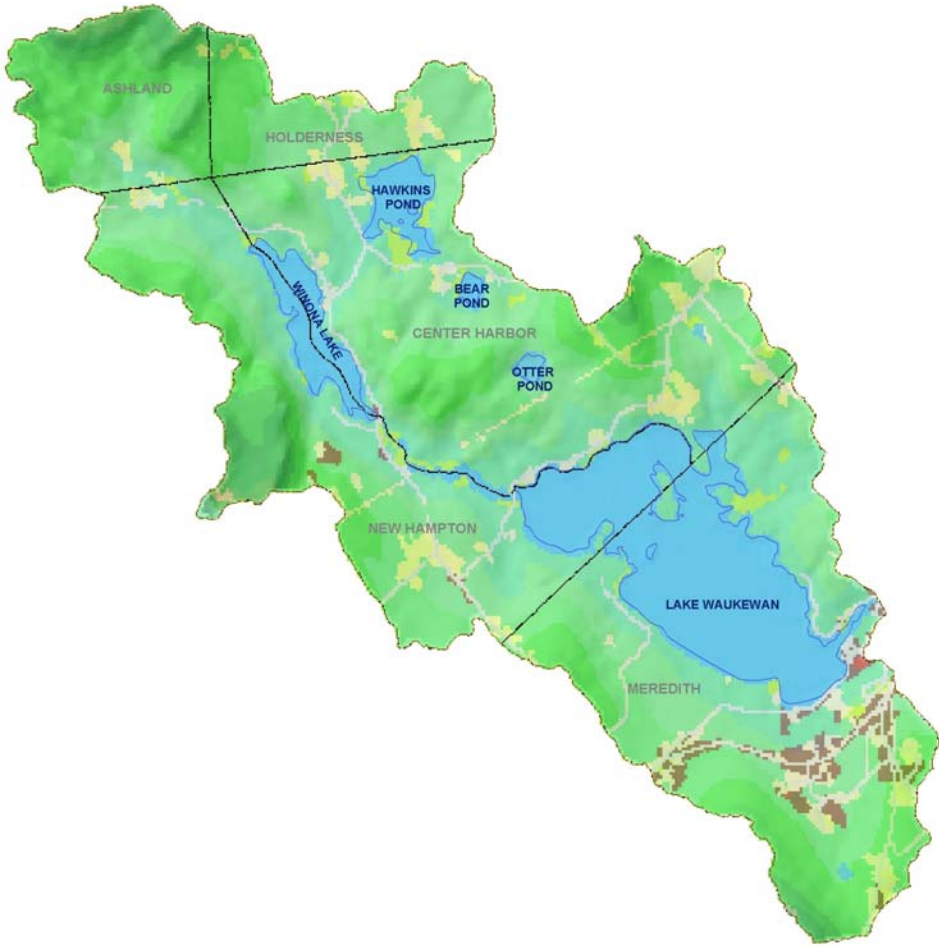
MANAGEMENT PLAN FOR THE WAUKEWAN WATERSHED



June 2005

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Protection Plan for the Waukewan Watershed

Adopted by the Waukewan Watershed Advisory Committee (WWAC):

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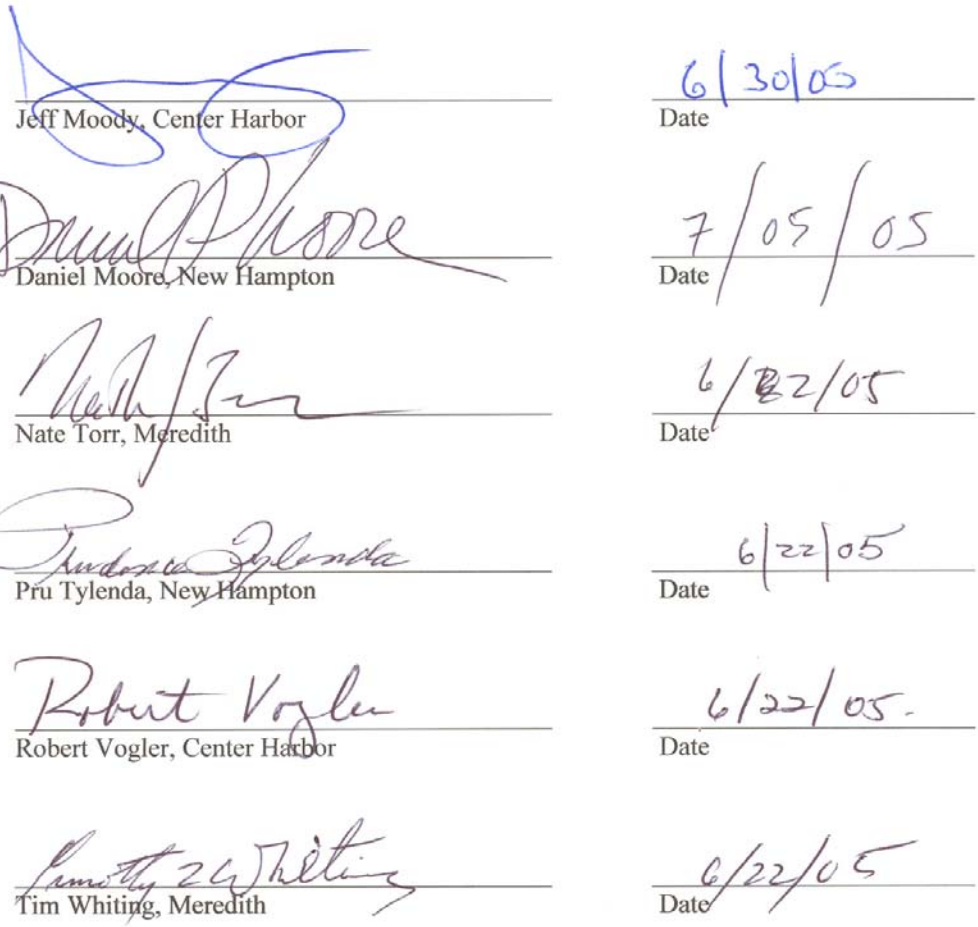

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Waukewan Watershed Advisory Committee

Dear Reader;

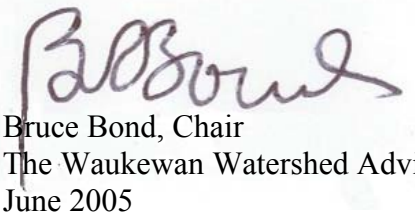
Recognizing the value and importance of preserving the water quality of the Lake Waukewan Watershed, the Town of Meredith initiated the formation of the Waukewan Watershed Advisory Committee in the Spring of 2004. A committee of 16 volunteer members was established, representing each of the five towns within the watershed (Ashland, Center Harbor, Holderness, Meredith and New Hampton) with members having diverse skills, talents and perspectives. The Committee met on a regular basis over the course of 2004 and recently completed its initial work on a proposed management plan for the Lake Waukewan Watershed.

While the quality of the water in the Waukewan Watershed is good, signs of potential trouble in the form of confirmed toxic algae blooms, decreasing dissolved Oxygen concentrations, increasing Phosphorous concentrations, and increasing conductivity values were noted during the course of our study. This evidence clearly suggests that human activities are having a negative influence on water quality.

The timing of this initiative is more than appropriate. We have learned that land use and our lakes and ponds are strongly linked, and that by making the protection of drinking water our prime goal, our recommendations will also result in the long term protection of plants, fish and other animals that are all part of the larger ecosystem. The committee recognizes that property owners and area visitors alike have historically used the waterbodies within the watershed for recreational purposes. Our recommendations are also intended to balance the need for water recreation opportunities with important water quality objectives. This balance will benefit the long term potential for continued fishing, swimming, boating and other forms of recreational activities.

The Management Plan for the Lake Waukewan Watershed is the result of many hours spent working by consensus to identify the issues, prioritize the risks and develop a list of activities that would substantially reduce the degradation of the water quality in the watershed. We have made recommendations that are both regulatory and non-regulatory in nature with the firm belief that much can be accomplished through increased public awareness. The Waukewan Watershed Advisory Committee believes that the implementation of this plan will go a long way to preserve the water quality throughout the Waukewan Watershed and looks forward to working with the five towns and all other interested parties to implement this plan.

Respectfully Submitted,



Bruce Bond, Chair
The Waukewan Watershed Advisory Committee
June 2005

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Acknowledgements

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Executive Summary

Managing water resources at a watershed scale has been identified by the United States Environmental Protection Agency and the New Hampshire Department of Environmental Services as ecologically sound and practical. This is because watersheds and subwatershed units are recognized as the most practical management units for the development of local plans. A watershed plan is a holistic framework which enables the application of management tools so that water resource protection goals can be met.

This watershed management plan addresses the prevalent concerns of the Waukewan Watershed as identified by the Waukewan Watershed Advisory Committee. The sixteen member committee represents a variety of skills and perspectives from the five watershed towns of Ashland, Center Harbor, Holderness, Meredith, and New Hampton. During the course of nine months, the Committee thoughtfully and methodically reviewed land uses in the watershed, identified potential threats and developed recommendations to address these concerns.

This management plan is divided into seven chapters. Chapter One defines the term "watershed", describes the purpose of this watershed management plan and the watershed approach, gives a brief history of watershed planning efforts in the Waukewan Watershed, describes the collaborative nature of this watershed project, and lastly identifies how this plan can be used.

Chapter Two provides a physical description of the watershed including its size, topography, characteristics of its ponds, streams and tributaries, wetlands, soils and geology. Land uses and water-based resources within the watershed are also described in this chapter. Water-based resources include lakes and ponds, boating, swimming resources, fish habitat and fisheries, drinking water supplies, and significant natural communities and rare, threatened and endangered species.

Chapter Three provides a brief overview of Federal and State water quality regulations including the New Hampshire surface water quality standards which determine the baseline quality that all surface waters of the State must meet in order to protect their "intended uses". Available water quality information is collated and presented in this chapter. Water quality information was gathered from the NH Lakes and Ponds Inventory, the Voluntary Lakes Assessment Program, and monitoring data from the Town of Meredith Water Department. These data sources indicate that water quality concerns in Lake Waukewan and Lake Winona include:

- Low dissolved Oxygen concentrations
- Increasing Phosphorus concentrations
- High conductivity values
- An increased occurrence of algae blooms and toxic algae
- Elevated Sodium and Chloride concentrations.

The New Hampshire Drinking Water Standards are presented and compared with water quality information from the Meredith Water Department.

Chapter Four briefly summarizes existing protection measures in the watershed. Zoning ordinances in the watershed towns were reviewed and a composite map of aggregate zoning district was produced (Figure 4.1). This review is not a qualitative review which examined effectiveness of these regulations. Instead this zoning review looked for the presence or absence of water resource protection techniques that can be

implemented through zoning. These techniques include density and lot size requirements, soil based lot sizing, wetland and stream buffer requirements, steep slope protection, shoreline protection regulations, septic setbacks, erosion control, and overlay districts. Many of these techniques are used by the watershed communities. **However, there is a noticeable lack of steep slope protection and erosion control throughout the watershed, a majority of the watershed area does not provide for wetland and stream buffers, and there is no cohesive watershed protection overlay.** Conservation land in the watershed is described and a map of conserved land presented. **Currently only 915 acres or 11.1% of the entire watershed area is protected for conservation purposes.** Chapter Four also addresses the administrative rule Env-Ws 386.49 "Protection of the Purity of the Water of Lake Waukewan and Its Watershed" . Provisions of the rule are discussed as well as efficacy and enforcement issues.

Chapter Five provides an inventory of potential sources of contamination in order to identify areas where remedial and preventative measures in the watershed are necessary. To develop this inventory, two types of pollution sources were reviewed: nonpoint and point pollution sources. Nonpoint sources of pollution contribute pollutants in an indirect pathway. Nonpoint source pollutants originate from rainwater or snowmelt washing over exposed pollutants on the land's surface or in soils. In contrast, point source pollution can be traced to a specific point of discharge, such as a pipe, channel, or ditch connected to a wastewater treatment plant, sludge lagoon, or landfill.

Chapter Six follows with a summary of the 3 step risk and priority analysis process used to identify top watershed protection priorities, based upon the inventory of potential sources of contamination presented in Chapter Five. From this process the Waukewan Watershed Advisory Committee identified 10 general areas of concern. These areas of concern include:

- Nonpoint source pollution from septic systems, site development, stormwater runoff, roads, residential heating fuel spills and lawn care;
- Lake contact threats associated with motor-boating, swimming and seaplanes;
- Point Sources associated with commercial and industrial activities and the Meredith Municipal Sewer System.

Chapter Six summarizes the risk analysis and priority setting process used to identify ten priority concerns in the watershed. This chapter presents the recommendations developed by the Waukewan Watershed Advisory Committee to address these water quality concerns. The recommendations are presented in a narrative form throughout the Chapter and summarized in Table 6.1. These recommendations can be addressed through programs and projects developed by the Waukewan Watershed partners including: watershed municipalities, New Hampshire Department of Environmental Services, Plymouth State University, University of New Hampshire, New Hampshire Fish and Game, and the Waukewan Watershed Advisory Committee, among others.

Lastly, Chapter Seven provides conclusions about the plan and planning process.

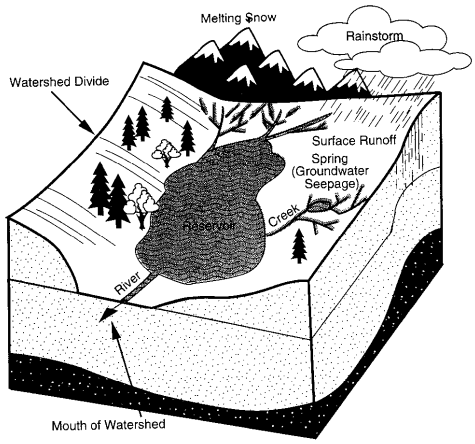
Chapter 1. Introduction

1.1 PURPOSE OF THE WATERSHED MANAGEMENT PLAN

Although more than 70% of the Earth's surface is covered by oceans, lakes, rivers, and other bodies of water, only a small fraction (2.4%) is fresh water. And of this small percentage of fresh water, nearly 90% is tied up in glaciers, ice caps, and snowfields. This means that of the fraction which is fresh water, only approximately .24% of the Earth's water is in fresh liquid form and thus available for human use. Preserving the purity of these fresh water resources has long been recognized as a worthwhile goal. Fresh water is often vulnerable to both natural and anthropogenic contamination. It is therefore critical that these resources be managed wisely for the benefit of present and future generations. In New Hampshire, there are approximately 60 surface sources (lakes, ponds, rivers, and reservoirs) which are used to supply water for public drinking water systems. These systems serve 40% of the State's population and the watersheds which drain to these sources span approximately 80% of New Hampshire (Model Rule for the Protection of Water Supply Watersheds, 2000).

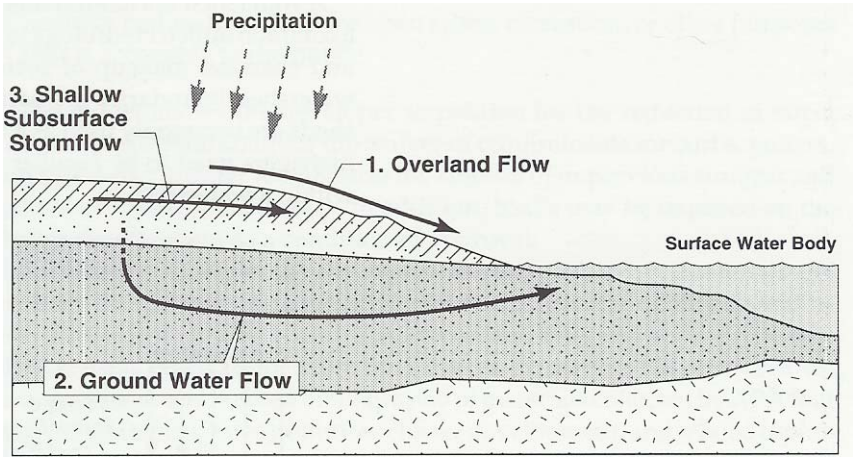
With this understanding of the limited nature of fresh water, this plan aims to increase the understanding of water resources in the Waukewan Watershed, and to provide a meaningful foundation for decision-making. A watershed can be defined as a natural unit of land within which all water drains to a common outlet (Figure 1.1).

Figure 1.1 Depiction of a watershed.



A watershed includes two components: a surface water drainage basin and a groundwater drainage basin. The surface drainage basin is the land area from which all surface water flows drain toward a surface waterbody. The groundwater drainage basin is the land area and subsurface through which groundwater drains to a surface waterbody at a lower elevation (Figure 1.2). The surface drainage basin may be larger or smaller than the groundwater drainage basin, depending on factors such as soils, slope, and surface cover. One of the most important concepts is that surface water and groundwater are inextricably linked. For example, groundwater and surface water interact where groundwater discharges to lakes, rivers and in areas where ground conditions impede the drainage of water, such as in wetlands. This means that management of contamination and pollution sources throughout a watershed will benefit both groundwater and surface water.

Figure 1.2 Paths of surface and groundwater flow.



Source: Jeer et al, 1997.

The Waukewan Watershed is defined as the area of land and complex of wetlands, ponds, and tributaries which drain to Lake Waukewan. Watersheds may occupy tens to hundreds of square miles and cover several jurisdictions. In this case, the Waukewan Watershed covers approximately 13 square miles or 8,275 acres, and portions of two counties and five communities.

Managing water resources at a watershed scale has been identified as ecologically sound and practical. This is because watersheds and subwatershed units are recognized as the most practical management units for the development of local plans. A watershed plan is a holistic framework which enables the application of management tools within each subwatershed so that the water resources goals for the entire watershed are met. Watersheds provide important goods and services that enrich our daily lives. They provide critical habitat for plants and animals, areas of scenic natural beauty, places to recreate and relax, they often facilitate transportation of goods and people, and provide fresh water necessary for human survival. So too, does the Waukewan Watershed enrich the lives of residents and visitors alike. For example, within this area there is important loon habitat and wonderful scenic vistas. Swimming and boating are popular seasonal activities. And lastly, the lake provides essential drinking water for approximately 3,000 residents and visitors in the Town of Meredith.

1.2 THE "WATERSHED APPROACH"

As early as the 1920's many federal agencies in the United States used watershed management for the purposes of controlling soil erosion and sedimentation. Increasingly, federal, state, and local agencies are focusing on non-point source pollution as a primary source of pollution to surface water and emphasizing the importance of planning at the watershed level. Watershed plans can work to improve water quality, manage recreational opportunities, maintain public health, or preserve the aesthetics of rivers and lakes. Community strategies for watershed planning have included the advent of partnerships and collaboration between the public, government agencies, and local organizations.

Communities throughout the United States are increasingly coming to understand the importance of protecting watersheds in order to protect their water

resources. As communities develop and the amount of watershed impervious cover increases in the form of parking lots, roads, and roof tops, the ability of a watershed to provide goods and services becomes impaired. This is because impervious surfaces collect and accumulate pollutants and when storm events occur, pollutants are more rapidly delivered to aquatic systems through runoff.

Monitoring and modeling studies indicate that pollutant loads are directly related to watershed imperviousness. Research has shown that when impervious cover exceeds 10%, pollutant loads increase causing stream channels to become unstable and easily eroded (Schueler, 2002). When watershed imperviousness exceeds approximately 26%, streams become "non-supporting" meaning channel stability and biodiversity cannot be fully maintained even with the implementation of stormwater practices or retrofits (Schueler, 2002). For these reasons, managing activities in a watershed is critical to its future well-being.

Through use of the "watershed approach", watershed associations, volunteer groups, government agencies and others can work together to protect ecosystem structure and function in order to safeguard water quality. In 1991 the United States Environmental Protection Agency defined the "watershed approach" as a coordinating framework for environmental management that focuses public and private sector efforts to address the highest priority problems within hydrologically-defined geographic area, taking into consideration both ground and surface water flow. According to New Hampshire Department of Environmental Services, "The watershed approach for management and planning is a strategy that has as its premise that many water quality and ecosystem problems are best solved at the watershed level rather than at the individual waterbody level."

The "watershed approach" used to develop this plan was guided by three overarching principles as identified by the Environmental Protection Agency: partnerships, geographic focus, and sound management recommendations based on strong science and data. In this case partnerships mean that the people most affected by management decisions are involved throughout the planning process and are an integral part of shaping key decisions. The geographic focus directs activities and resources within the specific management unit of the Waukewan Watershed. And lastly watershed stakeholders, primarily through the Waukewan Watershed Advisory Committee have developed a series of recommendations based upon available sound scientific data and an analysis and ranking of risks. As the recommendations in this plan are implemented, the goals and objectives of this plan should be evaluated for effectiveness and revised as needed. This plan represents one of many steps needed to protect the quality of water resources in the Waukewan Watershed.

1.3 HISTORY OF WATERSHED PLANNING IN THE WAUKEWAN WATERSHED

In the late 1970's the Lakes Region Planning Commission undertook a water quality management plan for the twenty-one communities in the region as part of a "208 Water Quality Program". The purpose of the report was to serve as a guide to the protection of the Lakes Region's valuable water resources and as an environmental impact statement. The report summarized technical and management strategies that could be used to protect the area's natural resources. In the late 1980's, watershed planning was conducted in the Waukewan Watershed at the instigation of the Meredith

Conservation Commission. The Commission recognized that land use changes in the surrounding watershed could negatively impact Lake Waukewan and its ability to serve as a water supply for the Town of Meredith. Together the Belknap County Conservation District and the North Country Resource Conservation and Development Area agreed to work with the Town of Meredith to collect current site specific land use and hydrologic data. It is interesting to note that many of the recommendations in these reports are still relevant today. For example, the Lakes Region Planning Commission identified a need for future study to determine the need for sewer line construction on the western shore of Lake Waukewan. The Waukewan Advisory Committee, as a part of their watershed evaluation during 2004, identified the same need for study.

This report represents a renewed interest in focussing protection efforts on the Waukewan Watershed.

1.4 PLANNING AS A COLLABORATIVE EFFORT

Planning through a collaborative process with local communities in the watershed, private organizations, and State and Federal government agencies is the most productive approach for developing solutions to New Hampshire's water quality challenges. The Town of Meredith Community Plan (2002) identified protection of water quality as a top priority. Specifically the plan highlighted the objective: "Develop consensus based, watershed and sub-watershed management plans for priority areas within the community. Particular emphasis should be placed on developing a unified approach to the Lake Waukewan watershed involving the five towns that comprise it." With this goal in mind the Town of Meredith approached NH Department of Environmental Services and New Hampshire Rural Water Association for assistance.

In January 2004, a working group was formed comprised of staff from the Town of Meredith, NH DES, and New Hampshire Rural Water Association, to develop a watershed planning strategy. The first objective of the working group was to host a Water Quality Workshop. This workshop served as an introduction to the watershed project by providing information on watershed statistics, water quality, and local public and private water supplies.

One outgrowth of the workshop was the formation of the Waukewan Watershed Advisory Committee. This 16 member committee was established to identify and assess threats to water quality throughout the watershed and to develop recommendations to address these threats. Members representing a variety of perspectives, disciplines, and communities were appointed by the Meredith Board of Selectmen to serve on the advisory committee. Since June 2004, the Committee has met at least twice monthly and completed the following tasks:

- A five-town field tour of the watershed
- A survey of waterfront property owners on Lake Winona and Lake Waukewan
- A survey of motorboat engine types on Lake Waukewan and Lake Winona
- Delineated (17) distinct sub-watershed areas
- Identified some of the hydrologic inflow points to Lake Waukewan
- Developed an inventory of potential contamination sources (PCS)
- Identified pollutants associated with the PCS's
- Reviewed potential impacts of the above pollutants on wetlands, fisheries, recreation and drinking water supplies
- Prioritized watershed risks and developed recommendations to address the risks

The recommendations presented in this plan were developed by the Committee after thoughtful and thorough examination of potential pollution sources and an analysis of risk associated with each potential pollution source was conducted. This process is discussed further in Chapter Six. Based upon the risk analysis, potential risks were ranked and watershed management priorities were developed. A detailed description of the risk analysis and prioritization process is presented in Chapter 6.

1.5 USE OF THIS PLAN

This watershed management plan may be used to:

- Serve as a guidance document to assist the communities of Ashland, Center Harbor, Holderness, Meredith, and New Hampton in their planning efforts to protect water quality in the Waukewan Watershed.
- Guide New Hampshire Department of Environmental Services and other state and federal agencies in their efforts to protect and improve State surface waters.
- Outline the primary water quality and drinking water protection issues, based upon existing data and local knowledge.
- Identify top watershed management concerns and recommendations to address these concerns.
- Provide background and context on the Waukewan Watershed and its water-based resources.
- Develop project ideas related to water quality or water resources improvements.
- Help identify technical or financial resources.
- Identify the technical or financial need of potential projects and partners.
- Support grant proposals.
- Provide guidance to local and regional planning and zoning processes.

It should be noted that this watershed plan represents the first step of a multi-stage process to protect the water resources in the Waukewan Watershed. As management activities are implemented and conditions change in the watershed, goals and objectives will need to be changed and the plan will need to be amended to reflect these changes. As watersheds are in a constant state of change, so too should management plans reflect their ever-changing nature.

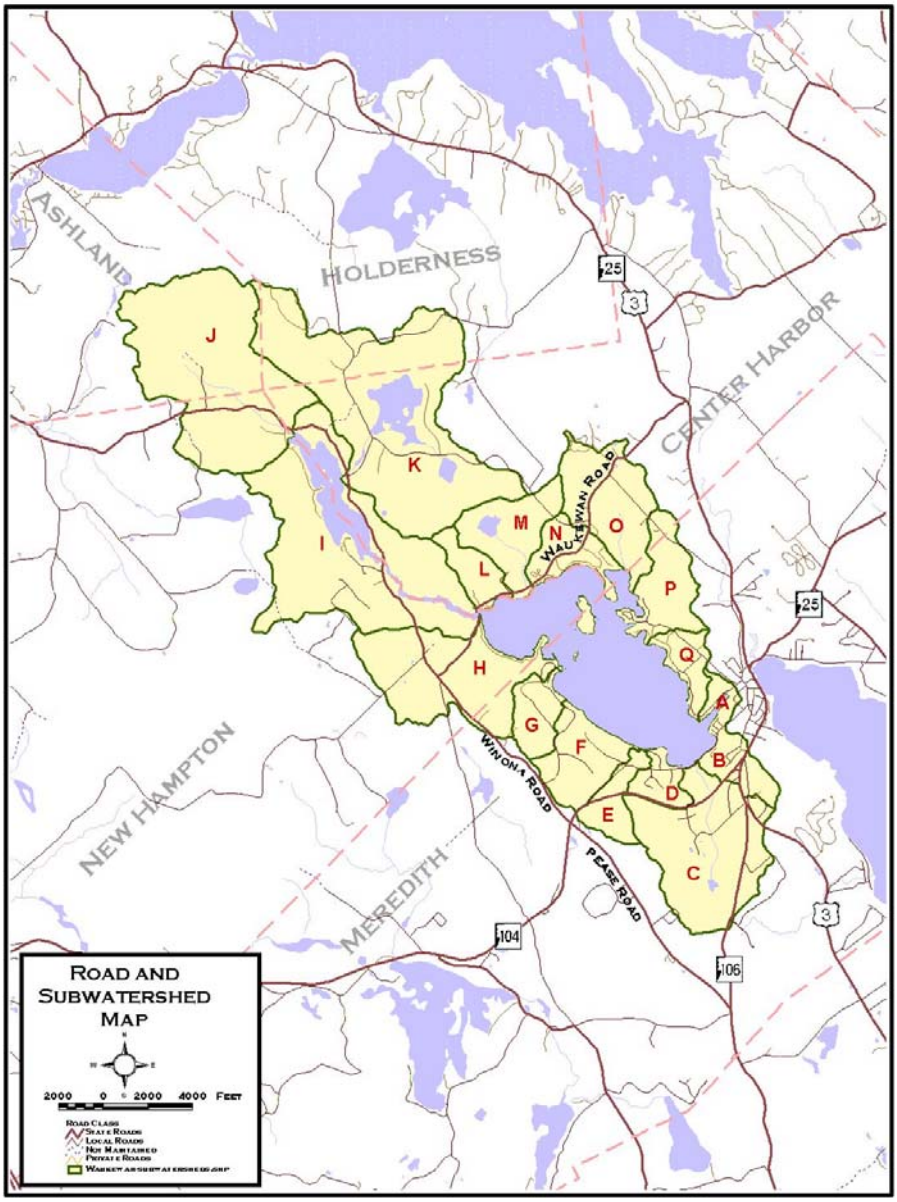
Chapter 2. Description of the Waukewan Watershed

2.1 PHYSICAL DESCRIPTION

General Description

The Lake Waukewan Watershed is a mostly intact watershed with good water quality and small amounts of development. This watershed is a medium-sized drainage basin in the upper Winnipesaukee Hydrological Unit (HUC # 100107000201). NH DES has classified the entire Winnipesaukee Watershed as "threatened."

Figure 2.1 The Waukewan Watershed.
(Map prepared by R. McCann, Town of Meredith IT/GIS)



The Waukewan Watershed spans 8,275 acres or 12.93 square miles and includes portions of Belknap and Grafton Counties and portions of the five towns of Ashland, Center Harbor, Holderness, Meredith and New Hampton (Table 2.1). For the purposes of this plan, the Waukewan Watershed boundary was determined as part of Meredith's Natural Resources Inventory analysis. The watershed was delineated using the Waukewan portion of a NH DES watershed base map. A contour map was overlaid on a 1998 Digital Orthophoto Quad (DOQ). In several places DOQ-evident stream drainageways were used to guide alignment and field reconnaissance was used to check several areas within the watershed (Van de Poll, Unpublished). The resulting delineation can be seen in Figure 2.1. The watershed was further delineated into 18 subwatersheds, based on primary drainage ways and natural topography. Ten of these subwatersheds contain defined stream channels that are recognizable as perennial at their point of inflow into a lake, pond or other stream. The subwatersheds range in size from 26.7 acres (Chapman Island) to 1,402 acres (Hawkins and Bear Ponds), with a mean of 385.3 acres.

Table 2.1. Municipalities, associated acreage and percent of land cover in the Waukewan Watershed, New Hampshire.

Municipality	Area (acres)	Percent of Watershed Area (%)
Ashland	699.2	8.4
Center Harbor	2370.2	28.6
Holderness	527.3	6.4
Meredith	2729.5	33.0
New Hampton	1949.0	23.6

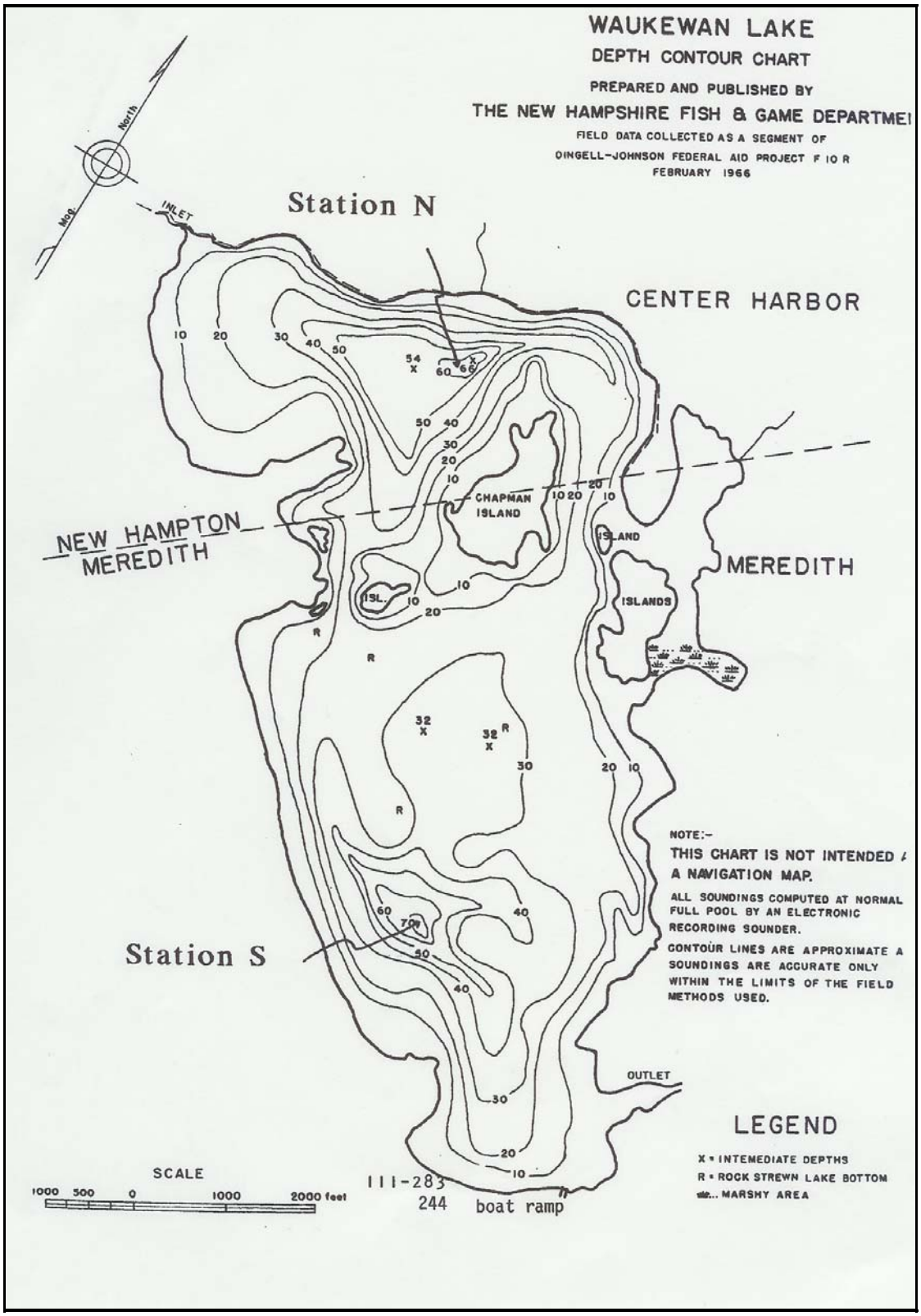
Terrain within the watershed ranges from steep slopes (47%) to rolling terrain. The average slope in the watershed is approximately 12%. Elevations range from 1,500 feet on Beech Hill near Sky Pond in New Hampton, to 540 feet at the Lake Waukewan outflow point in Meredith.

Characteristics of Ponds and Streams

There are five lakes and ponds in the watershed. Statistical information about the waterbodies is listed in Table 2.2. The two largest waterbodies in the watershed are Lake Waukewan and Lake Winona.

Lake Waukewan is a 953 acre waterbody with a mean depth of 22 feet and a maximum depth of approximately 70 feet. The lake is relatively long and narrow with a length to width ratio of 4.1. Lake Waukewan has a total shoreline length of 8.1 miles or 42,650 feet. The shores are largely developed with both year-round and seasonal residential development. The lake's bathymetry (or topography) is shown in Figure 2.2. Based upon this chart the lake is estimated to contain approximately 25 million cubic meters of water. It is fed by the outflow of the Snake River and five other inflows. Lake Waukewan's outlet flows through a channel into Meredith Bay. There are 7 islands in the lake, 5 of which have structures on them. NH DES classifies Lake Waukewan as a "natural lake with a dam". Water levels fluctuate approximately 12-15 inches annually. Water is drawn down every spring for flood control. During the summer and fall water levels are adjusted as needed.

Figure 2.2 Depth contour chart for Lake Waukewan.
(Source: NHDES Ponds and Lakes Inventory)



Lake Winona is a 154 acre waterbody with a mean depth of 21.6 feet and a maximum depth of approximately 47.9 feet. The Lake is very long and narrow with a length to width ratio of 10.1. Lake Winona has a total shoreline length of 3.1 miles or 16,404 feet. The shores are developed with both year-round and seasonal residential development. The lake's bathymetry (or topography) is shown in Figure 2.3. Based upon this chart the lake is estimated to contain approximately 4.1 million cubic meters of water. There are 6 inflows to the lake and the outflow leads to the Snake River. The lake has two islands. Both have structures on them. Lake Winona is classified as a "natural lake" by NH DES.

Figure 2.3 Depth contour chart for Lake Winona.
(Source: 2003 Volunteer Lakes Assessment Report, NHDES)

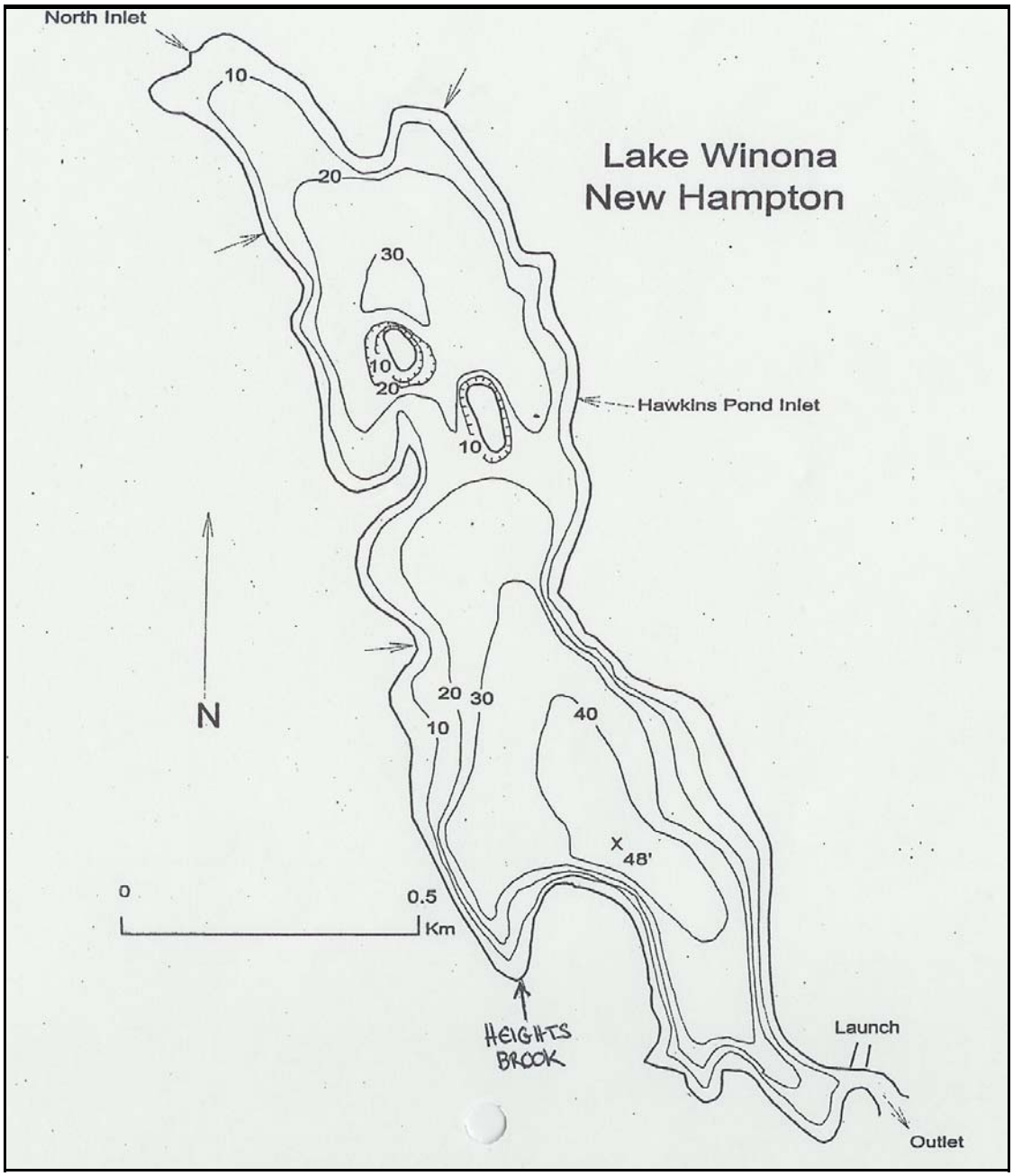


Table 2.2. List of waterbodies and associated characteristics in the Waukewan Watershed, New Hampshire.

Waterbody	Lake Area (acres)	Shore Length (miles)	Maximum Depth (feet)	Average Depth (feet)	Lake Type*	Location (subwatershed)
Otter Pond	12.4	.37	21.3	7.6	Natural	M
Bear Pond	13.0	.50	36.1	19.0	Natural	K
Hawkins Pond	92.0	1.8	32.8	11.2	Natural with dam	K
Lake Winona	154.0	3.1	47.9	21.6	Natural	I
Lake Waukewan	953.0	8.1	70.21	22.0	Natural with dam	A-H,L-Q

* Lake Type is determined by NH DES. There are three classifications: natural, natural raised by damming, and artificial. See map below for locations of waterbodies.

Figure 2.4 Locations of waterbodies in the Waukewan Watershed.

Table 2.3. List of tributaries and streams in the Waukewan Watershed, New Hampshire.

Map ID #	Tributary/Stream	Location (subwatershed)	Classification
1	Reservoir Brook	C	1st Order
2	Unnamed	E	1st Order
3	Unnamed (Waukewan Inlet)	G	
4	Saywood Brook	H	1st Order
5	Snake River	I	2nd or 3rd
6	Heights Brook	I	1st Order
7	Unnamed (Winona inlet)	I	Unknown
8	Unnamed (Winona inlet)	J	1st Order
9	Unnamed (Winona inlet)	I	1st Order
10	Unnamed (Winona inlet)	I	unknown
11	Unnamed (Hawkins outlet)	K	1st Order
12	Unnamed (Bear Pond outlet)	K	1st Order
13	Unnamed (Hawkins Pond inlet)	K	unknown
14	Unnamed (Otter Pond outlet)	M	1st Order
15	Unnamed (Perkins Cove inlet)	O	1st Order
16	Unnamed (Perkins Cove inlet)	P	unknown

Figure 2.5 Inflows to waterbodies in the Waukewan Watershed.

Information on streams and tributaries has been gathered from the NH DES Lakes and Ponds Inventory, NH GRANIT, and the preliminary natural resource inventory for the Town of Meredith. Together these sources indicate there are 8 inflows into Lake Waukewan, 5 into Lake Winona, and 2 into Hawkins Pond. The draft natural resources inventory for Meredith identified nine well-formed stream channels in the watershed. Most of these streams are classified as first order. They vary in type from mostly perennial to mostly intermittent. The largest stream is known as the Snake River (#5 on Figure 2.5), which runs from Lake Winona to Lake Waukewan. It has considerable width and several well-developed, beaver-mediated wetlands along it. The Snake River and associated wetland complex is significant for its water-holding capacity and ability to filter out pollutants that would otherwise flow into Lake Waukewan. Three other brooks have been found above Lake Winona, the smallest arising to the southwest of the lake (#6), one arising to the northwest (#9), and the third passing through Bear and Hawkins Ponds to the northeast of the lake (#'s 11,12). The remaining 5 streams all feed directly into Lake Waukewan, including the longest, Reservoir Brook in Meredith (#1), and Saywood Brook (#4) in New Hampton. The other three unnamed streams are mostly intermittent and contribute very little to the lake in terms of year-round flow. One flows out of Otter Pond to the north of the lake (#14), another flows out of several small ponds near the Waukewan Golf Course (#15), and the third flows into the southwest part of the lake (#2). Other intermittent stream and stormwater drainages that lead into the lake have yet to be identified. A draft map has been developed from the aforementioned references. An accurate map of inflows and outflows in the watershed is necessary.

Streams and tributaries not only serve as important sources of water for the lakes and ponds, but they can also serve as conduits for pollutants. The shorter the length of the stream or tributary, the greater the risk of pollutants reaching the receiving waters without adequate time for natural treatment. In addition, the amount of reaction time is reduced for shorter streams and tributaries in terms of spill response.

Wetlands

Wetlands represent a relatively small portion of the watershed. Excluding the lakes and ponds, only 5.9% of the watershed is comprised of palustrine (freshwater) wetlands, and most of these are forested swamps that either fall along the watershed boundary in undeveloped regions of the watershed, or lie along the stream drainage-ways. Approximately 38% of Lake Waukewan has aquatic bed wetlands less than 15 feet deep. These systems occur in the northwestern part of the Lake, around Chapman Island, and in Perkins Cove. A total of 249 wetland units have been identified in the watershed using digital 1998 aerial photographs (Van de Poll, Unpublished). Many of these wetland units are contiguous, and if lumped according to discrete wetland complexes, an approximate total of 100 wetland areas are recognized. Due to the relatively low drainage density (ratio of land area to water) the role of wetlands in mitigating effects of water-borne pollution becomes all the more significant. For example, lakeshore wetlands play an important function in controlling the largest sources of point and nonpoint pollution associated with seasonal and permanent residences along the shoreline. Preservation of these ecosystems and their functions is of paramount importance. **However, conservation land percentages in four of the five towns in the watershed is below statewide averages, and more specifically very little of the lakes' and ponds' shorelines are currently protected from development.**

Soils and Geology

There are approximately 26 soil types in the watershed. Approximately 3,795 acres or 52% of the watershed land area has soils which have limited capacity to support housing, roads, and septic systems, and assimilate water pollution discharges[1]. These sensitive soils, rated as "severe" in terms of their ability to support development, can be classified into three categories: hydric soils, shallow to bedrock soils, and soils on steep slopes (>25%) (Van De Poll, Unpublished)[2]. Hydric soils have high water tables during the growing season, and periodically saturate or flood at or above the surface. Depending upon the map used to identify hydric soils, there are approximately 500-540 acres of this soil condition. The second type of "severe" soils, are those that are shallow to bedrock. These soils are prevalent in the watershed. A total of 2,618 acres of soils that are less than 40 inches deep were identified. Shallow soils are more sensitive to water-borne pollution because of the speed with which pollutants can enter groundwater and bedrock aquifers. Included in this category are shallow soils on slopes between 8 and 25%. A third category is soils on steep slopes (i.e. ≥ 25%). Approximately 681 acres of steep slope soils occur in the watershed. These soils are notable in the northern portion of the watershed in the Town of Ashland.

When the area occupied by sensitive soils is combined with the amount of open water (lakes and ponds only) in the watershed, the total area of high environmental sensitivity equals 61% of the watershed. When ecologically significant stream, lake, pond, and wetland buffers are added (100 feet), this figure increases to 73.6% (R. Van De Poll, Unpublished). Subwatersheds with the most environmentally sensitive soils (e.g. subwatersheds I and J) have the least amount of development. Those subwatersheds with the best soils (e.g. subwatersheds B and C) have the most amount of development. Although the soils of these highly developed subwatersheds are less environmentally sensitive, their ability to minimize water pollution contributions to Lake Waukewan could be compromised during periods of excessive flooding and stormwater run-off.

Two types of bedrock geology are present in the Waukewan Watershed. Approximately half of the watershed is underlain by Kinsman Granodiorite. This classification is described as a foliated granite, granodiorite, tonalite, and minor quartz diorite, with the presence of characteristic megacrysts of potassium feldspar and locally abundant garnet. Kinsman Granidiorite occurs generally along the western side of the watershed in subwatersheds B, C, D, F, part of H, J, and I. The rest of the watershed is underlain by Winnipesaukee Tonalite, a gray massive to foliated tonalite with minor quartz diorite, granodiorite and associated tonalite and granite.

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[1] Environmental sensitivity can be roughly correlated with the suitability of a soil for development – i.e. the capability of a soil to receive roads, buildings, and septic systems. Soil suitability is typically rated as slight, moderate or severe.

[2] The soils map for the Waukewan Watershed was compiled by NHDES and the NRCS for both Belknap and Grafton Counties. The Belknap portion used for this analysis was an unverified draft that employs new soil taxonomy and field characteristics for soil complexes. It should be referred to as a guide only.

2.2 LAND USE

According to the draft Meredith natural resources inventory, land cover in the watershed is 73% forested with approximately 6,067 acres in either deciduous or evergreen forest. Forest cover is prevalent throughout much of the watershed except along the shoreline of the five lakes and ponds and on the southern and southeastern reaches of the watershed. Open water occupies nearly 15% or 1,245 acres of the watershed. Wetlands comprise almost 6% or 489 acres. Approximately 2% of the watershed is agriculturally based. Transportation and more densely developed land comprise about 4% of the watershed. More densely developed land cover occurs in subwatersheds Q, A, B, and D. The majority of the watershed is residential with pockets of commercial and industrial zoning (Figure 4.1).

No detailed survey of the population in the watershed has been conducted to date. However, a rough estimate of the watershed population is approximately 1,300 people[3]. Rates of population growth and development vary among the watershed communities. For example, the Town of Meredith has experienced significant residential and non-residential growth over the last decade (Meredith Community Plan 2002). In the Meredith portion of watershed, general land use development patterns include limited light industry in subwatersheds C, D, and E. There is a mix of residential densities throughout the remainder of the Meredith portion of the watershed, with the most intensive development directed towards areas with supporting infrastructure. In the other watershed communities there is limited development and minimal road building occurring.

2.3 WATER-BASED RESOURCES

The Waukewan Watershed provides many recreational opportunities in its associated lakes and ponds, and the Snake River. Recreation includes various types of boating activities and swimming during the summer months. During the winter skating, ice fishing, x-country skiing, snowmobiling, and dog sled racing are favored activities. Along Lake Waukewan's roughly 8.1 miles of shoreline are approximately 150 to 200 residences and camps. The earliest camps were established in the mid-1700's, and by the early 1800's a dam was erected that regulated the level of the lake as well as the flow of water through several canals that powered mills in the present downtown area of Meredith. Water resources in the watershed are also important for fish habitat and fisheries, significant natural communities and rare, threatened, and endangered species, drinking water supplies, and aesthetics. The fundamental purpose for protecting water quality in New Hampshire is to protect these uses and values.

Boating

On Lake Waukewan, the Town of Meredith owns and operates a public launch ramp which is open to all boaters. The most common boat on Lake Waukewan is the pontoon boat. These boats range in size from 16 to 28 feet. Most of the pontoon boats

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[3] A rough estimate of the watershed population was determined by multiplying the population per square mile data provided by NH Association of Regional Planning Commissions by the area of each town in the watershed.

are 20-24 feet long and powered by outboard engines (25-100 HP). Waterskiing and tubing are popular activities during the boating season. Waterskiing is popular on both sides of Chapman Island with boats turning around close to the intake for the Meredith Town water supply. Following pontoon cruising and waterskiing, sailing is the next most popular recreational activity. More recently kayaking and canoeing have gained increased popularity. Rowing, both as individuals and as clubs has gained popularity within the last five years. Recently the Winnipesaukee Rowing Club has become active on Lake Waukewan, using the lake as its primary training area. Waukewan is host to a number of fishing derbies. During these events, 5-10 high-powered outboard motorboats operate continuously across the lake. When the operators are not fishing, they operate their boats at high rates of speed. Boating on Waukewan occurs primarily during the months of May through September. During those months boating activity is typically greatest on weekends and holidays.

Lake Winona has a number of small outboard and inboard/outboard runabouts that are used occasionally for water skiing and tubing, but more commonly for sight-seeing or pleasure boating. Lake Winona is a popular destination for canoes, kayaks, and sailboats. Motor-boating on the Snake River is not encouraged. Kayaking and canoeing occurs more often. Boaters occasionally use 12 to 14 foot motor boats with low horse power on Hawkins Pond, although kayaks and canoes are typically preferred. Non-motorized car top boats are used relatively infrequently on Otter and Bear Ponds because these waterbodies are difficult to access.

In 1978 the Lakes Region Planning Commission recommended the elimination of power boating on Bear and Otter Pond for the purposes of eliminating pollution problems associated with boat engines, protecting aesthetic interests, and for reasons of safety (Lakes Region Planning Commission, 1978). The Commission also recommended that maximum horse power limits for powerboats be set for Hawkins Pond and Lake Winona for the purpose of reducing pollution from motorboats. The Commission reported that these two objectives could be accomplished through legislative action. None of these recommendations have been implemented.

Swimming

Numerous swimming opportunities exist along the shores of Lake Waukewan. Most notably is the town-owned and operated beach in Meredith on the southern shore of Lake Waukewan. The Meredith Town Beach is open to the general public. This is a narrow beach with limited beach frontage of approximately 150 feet. During times of high water, the beach is often underwater. In addition, there are many individual private beaches and docks, and community beaches associated with residential developments. For example, a 7-unit commercial colony called Pollard Shores Cottages has a beach located on the southwest shore of Lake Waukewan. The Winona Forest Association has a small common beach with 230 feet of frontage on the western shore. And lastly, the Lake Waukewan Association has a small common beach with approximately 152 feet of frontage on the west side of the Meredith town line with New Hampton. None of these beaches or swimming resources is located within the 400 foot isolation zone prescribed by Administrative Rule Env-Ws 386.49 (See Chapter Four, Section 4.4). This isolation zone prohibits wading, swimming, waterskiing, or similar water contact activities within 400 feet of the intake of the Meredith Water Department.

Fish Habitat and Fisheries

Lakes and ponds in the Waukewan Watershed maintain a variety of warm and coldwater fisheries and habitats (Viar, Pers. Comm). For example, Lake Waukewan hosts a two-tier fishery comprised of stocked rainbow trout as the coldwater component and largemouth and smallmouth bass, chain pickerel, and yellow and white perch as the primary warmwater component. Approximately 1,000 age-1 rainbow trout are stocked annually. Other species present in Lake Waukewan include common sunfish/ pumpkinseed, redbreast sunfish, common white sucker, brown bullhead, rainbow smelt, golden shiner, and bourbot (cusk).

Reportedly, within the past decade white perch were illegally transferred to Lake Waukewan. Likely this species was transferred from nearby Lake Winnipesaukee. Anglers' reports indicate that abundance of white perch has increased. However, it is unclear whether this introduction is responsible for this increase or if possible emigration from Lake Winona, via the Snake River, is the cause. Regardless, increases in white perch appear to have had a negative impact upon the rainbow smelt population (Viar, Pers. Comm.).

Lake Winona also hosts a two-tier fishery which is comprised of rainbow and brook trout as the coldwater component and largemouth and smallmouth bass, chain pickerel, and yellow and white perch as the primary warmwater component. Approximately 1000 age-1 rainbow and brook trout are stocked annually. Surplus brook trout (ages 2-3, 12-18 inches) are also stocked on a semi-annual basis and as available. Other species in Lake Winona include the common sunfish/pumpkinseed, redbreast sunfish, common white sucker, brown bullhead, and golden shiner. Hawkins Pond hosts a warmwater fishery consisting primarily of chain pickerel and yellow perch. Common sunfish/pumpkinseed, brown bullhead, and golden shiner are also present. Otter Pond hosts a warmwater fishery which consists primarily of chain pickerel and yellow perch. Brown bullhead, fallfish, and common white sucker are also present. Bear Pond hosts a warmwater fishery of chain pickerel and yellow perch; brown bullhead are also present.

The Snake River likely facilitates the movement of fish species between Lakes Waukewan and Winona and undoubtedly serves as an important spawning and nursery habitat for several fish species (e.g. chain pickerel, yellow and white perch, common white sucker). Holdover/stocked-resident trout species may also attempt to utilize this river to spawn from fall to early spring. However the ultimate contribution of these spawning efforts to the adult population is likely limited (Viar, Pers. Comm.).

In Spring 2005, fish species composition in Lake Waukewan will be reassessed by the NH Fish and Game Department.

Drinking Water Supplies

The majority of residences in the watershed are served by individual wells. Most residences have bedrock wells, some have dug wells, and others are supplied from untreated surface water. For example, a survey of shoreline residents around Lake Waukewan revealed that 12% of those surveyed use the lake as a drinking water source[4]. NH DES strongly cautions against use of untreated surface water from lakes,

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[4] The Waukewan Watershed Advisory Committee conducted a residential survey along the shorelines of Lakes Waukewan and Winona from August to September 2004.

ponds and streams for drinking water regardless of the apparent safety of this practice in the past. Even if past bacterial tests for a particular pond or stream may have shown good quality, quick shifts in wind direction coupled with poor sanitary practices of man or feces from passing animals can quickly contaminate any surface water source

In addition to private residential sources, there are 13 public water systems present in the watershed (Table 2.4). A public water system is defined as "a system for the provision to the public of piped water for human consumption if such system has at least 15 service connections or regularly serves an average of at least twenty-five individuals daily at least 60 days out of the year" (Chapter Env-ws 300 NH Drinking Water Rules). Public water systems are further classified into three types: community water systems, non-transient non-community systems, and transient/non-community systems. Community water systems serve at least 25 residents on a year round basis. Examples include municipal water systems, and systems at mobile home parks, condominiums, and single family housing developments. Non-transient non-community systems serve at least 25 people, for at least 6 months per year. These systems typically serve daycare facilities, schools, and commercial properties. Transient/non-community systems serve at least 25 people, for at least 60 days per year. These water systems serve restaurants, campgrounds, motels, recreational areas and services stations.

There are four active public water systems in the watershed (Figure 2.4). These systems include the water supplies for Mayo Farm Camping Area, Waukewan Golf Course, Meredith Water Department, and Annalee /Main Plant. Only the Meredith Water Department's system is supplied by a surface waterbody: Lake Waukewan. The other three systems get their water from bedrock wells.

Due to the connection between surface water and groundwater, protection of the watershed benefits all types of systems, whether they are public or private, or get their water from groundwater or surface water[5]. Source protection efforts, such as watershed planning, help to minimize the likelihood that contaminated water will enter a drinking water system. NH DES recommends that source protection plans be implemented for all public drinking water supplies. These plans should include management activities such as public education and land protection. One of the goals of the Waukewan Watershed Management Plan is to reduce the risk of contamination from entering drinking water systems.

Mayo Farm Camping Area

The water system for the campground is a transient/non-community system which serves up to 108 people per day. It has an 800 foot deep bedrock well which yields 3.5 gallons per minute. Potential sources of contamination within 500 feet of the well include a septic system, road, and aboveground storage tanks (NH DES SWAP Report 2001). Water sample test results taken from 5/17/2000 to 8/11/2004, were reviewed. During this time water samples met federal and state water quality standards.

Waukewan Golf Course

The golf course has a transient/non-community system which serves up to 200 people per day. This system has a 300 foot bedrock well which yields 35 gallons

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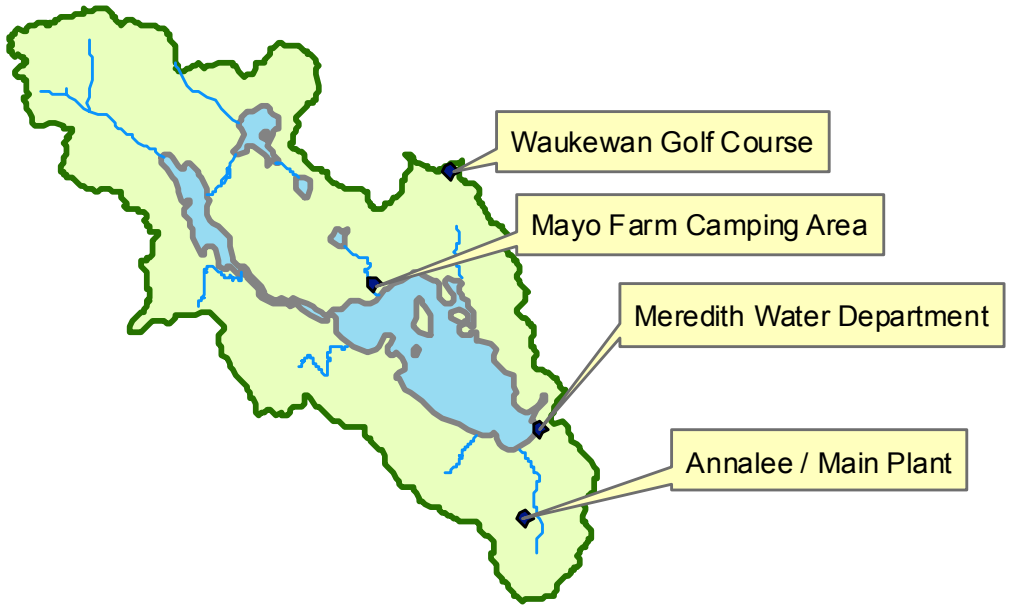
[5] See Chapter One for brief description of groundwater and surface water interconnections.

per minute. Potential sources of contamination within 500 feet of the well include a storage shed for fertilizer, a diesel fuel tank, and a parking lot (NH DES SWAP Report 2001). Water sample test results taken from 6/12/2000 to 5/24/2004, were reviewed. During this time, water samples met federal and state water quality standards.

Table 2.4 Public water systems in the Waukewan Watershed.

EPA ID	Water System Name	System Activity	System Type	Population Served	Source Type	Well Type	Well Depth (feet)
1525040-001	Kidworks	Inactive	Non-transient Non-Community	90	Groundwater	Bedrock	1000
0397030-001	Mayo Farm Camping Area	Active	Transient/ Non-Community	108	Groundwater	Bedrock	800
1526040-001	Annalee Gift Shop	Inactive	Non-transient Non-Community	16	Groundwater	Bedrock	350
1526020-001	Remcon/North Corp.	Inactive	Non-transient Non-Community	60	Groundwater	Bedrock	250
0397020-001	Waukewan Golf Course	Active	Transient/ Non-Community	200	Groundwater	Bedrock	300
1521010-001	Meredith Water Department	Active	Community	3000	Surface Water	N/A	N/A
1527140-001	Pollard Shore Cottages	Inactive	Transient/ Non-Community	25	Groundwater	Bedrock	--
1526050-001	Annalee/Main Plant	Active	Non-transient Non-Community	40	Groundwater	Bedrock	350
1526030-001	Town House	Inactive	Non-transient Non-Community	95	Groundwater	Bedrock	350
1526050-001	Annalee Chuck's Corner	Inactive	Non-transient Non-Community	95	Groundwater	Bedrock	350
1522120-001	Goldenview	Inactive	Non-transient Non-Community	N/A	Groundwater	N/A	N/A

Figure 2.6 Active public water systems in the Waukewan Watershed.

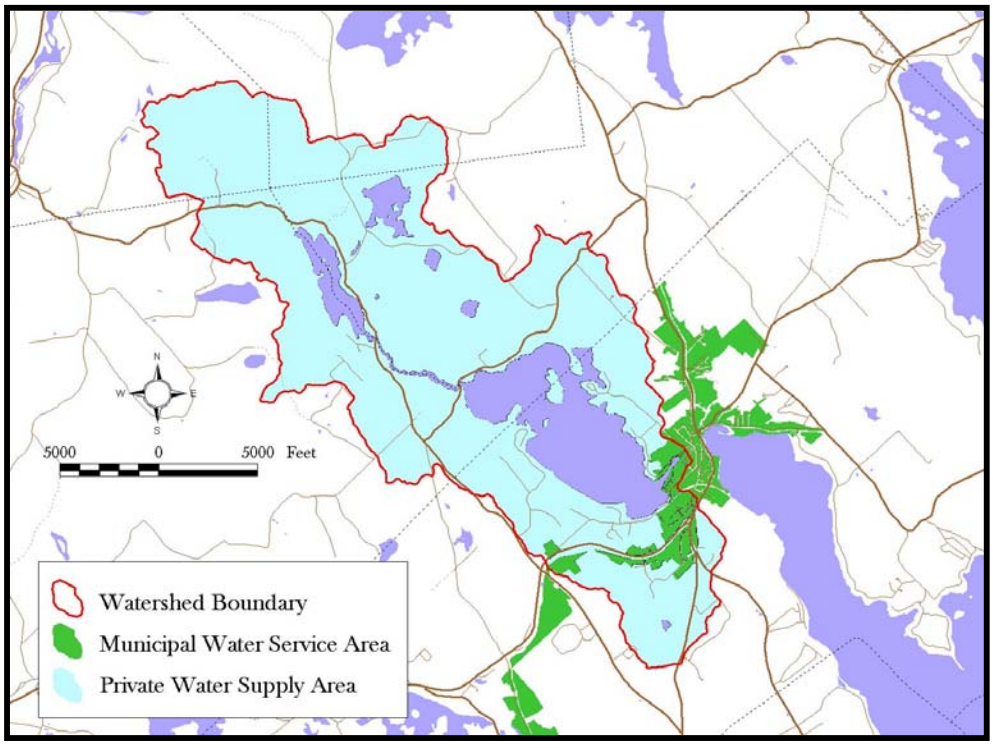


Meredith Water Department

Since 1895, the Town of Meredith has used Lake Waukewan as a source of drinking water. The Meredith Water Department operates a community system which gets its water from this surface waterbody. The system is maintained and operated by a competent, professional staff. Water quality meets federal and state water quality standards, and the system is in compliance with lead and copper requirements. NH DES has commended the Water Department for their exceptionally clean and well-maintained treatment plant (Mann, Pers. Comm.). This water system provides water for approximately 990 service connections and serves a population of approximately 3,000 people. Approximately 10 percent of the customer base is classified as commercial users. Water production averages approximately 400,000 gallons per day (gpd), with a maximum level of production of approximately 450,000 gpd during the summer months. Under ideal conditions, the plant is capable of producing a total of 1 million gpd.

Water is pumped from Lake Waukewan to a conventional package filtration plant. The intake is a 4 foot diameter screened structure which occurs at a depth of 35 feet, located approximately 1,500 feet off shore. Raw water is conducted via a 12-inch HDPE intake pipe and three raw water pumps to the filtration plant. The filtration plant has 4 conventional filter beds each capable of treating 250,000 gallons per day and are capable of working independently of each other. Raw water is treated with alum and filtered through one of four U.S. Filter Trident filter units. Filtered water goes to a 55,000 gallon baffled clearwell where it is treated with sodium hypochlorite for disinfection, caustic soda for pH adjustment, and Aquamag for corrosion control and color control. Following treatment, water is pumped to a 1 million gallon wire wound concrete storage tank.

Figure 2.7 Map of service area for the Meredith Water Department.
(Map prepared by R. McCann).



Water service is provided through 17.45 miles of water main piping, 2 water pressure booster stations, including the gravity feed from the water storage tank to approximately 950 customers or 990 service connections. There are 123 fire hydrants in the system to provide fire service protection. Pressures in the system range from 25 psi – 110 psi. The variation of pressures is caused by the landscape elevation changes in the area, the age, and the condition of the water main pipes. Water service is provided to the Meredith Village and highway corridors in and around the village. These corridors include the Route 3 corridor, south of the Center Harbor town line to the Route 104 junction, Route 25 from Route 3 easterly to Meredith Bay Village retirement community and the Mobil-on-the Run convenience store, and Route 104 westerly from Route 3 to Corliss Hill Road, to Meredith Center Road (Meredith Center). S E A Consultants Inc. has recently reviewed operations, treatment, distribution, and capacity issues associated with the water system. A final report with recommendations is completed in the Spring of 2005.

An Emergency Response Plan was created in 2003. This document is still current and details chain of command structure, a list of notification contacts, service and repair contacts, system components, alternate water sources, water conservation, and "return to normal operation" instructions. Copies of the Emergency Response Plan are located at the Town of Meredith municipal building and the NH DES Water Supply Engineering Bureau.

Backup Supplies for the Meredith Water System

The importance of maintaining the water quality in Lake Waukewan to protect its use as a public water resource cannot be over emphasized. Alternatives to this source are few. NH DES did investigatory research on alternative supplies and identified an aquifer with adequate water quantity located along Route 3. However, water quality is questionable. The location of this potential future source is less than ideal due to its location next to a highway. The Town of Meredith has researched interconnection with Laconia as a possible backup supply. Interconnection would be prohibitively expensive and cumbersome. If Lake Waukewan becomes contaminated and additional treatment is necessary to make suitable drinking water, operating costs for this system would significantly increase. The Meredith Water Department treatment plant can effectively treat for color, taste, pathogens (viruses, bacteria, and protozoan parasites), turbidity, and pH. Current treatment technology is not capable of removing contamination from toxic algae blooms, volatile organic chemicals or synthetic organic chemicals. To remove these pollutants, additional treatment technology is necessary.

Annalee / Main Plant

This water system is a non-transient non-community system which serves up to 40 people per day. It has a 350 foot bedrock well which yields 4 gallons per minute. There are potential sources of contamination within the well's sanitary radius including aboveground storage tanks and parking (NH DES SWAP Report 2001). Water sample test results taken from 1/22/1999 to 12/14/2004, were reviewed. During this time water samples met federal and state water quality standards. Water samples tested for Radon on 12/15/1999 and 10/16/2002 had results of 720 pCi/L. At this time there is no Maximum Contaminant Level (MCL) for radon. However, EPA and NH DES are in the

process of establishing rules. It is likely that NH DES will set the MCL at 300 pCi/L. Treatment is typically aeration.

Significant Natural Communities and Rare, Threatened, and Endangered Species

A database review was conducted by the New Hampshire Natural Heritage Bureau for significant natural communities and rare, threatened and endangered species in the Waukewan Watershed. The review identified two bird species of concern. The common loon *(Gavia immer)* has been recorded in several locations throughout the watershed including Hawkins Pond, and Lake Waukewan. This species is listed as "threatened" on the New Hampshire state list and is not on the federal list. There are records of nesting adults with surviving chicks on Hawkins Pond, and evidence of nesting adults with no surviving chicks hatched on Lake Waukewan. The Pied-billed Grebe *(Podilymbus podiceps)* was recorded on the Snake River in 1988. This species is listed as "endangered" on the New Hampshire state list and is not on the federal list. Information from this database review was based upon information gathered by qualified biologists and reported to the NH Natural Heritage Bureau. Many areas have never been surveyed or have only been surveyed for particular species. An on-site survey would provide better information on what species and communities are indeed present (Herrman, Pers. Comm.).

There is an historic record of plants including *Liparis loesellii* from "Winona Pond" in 1888, and a similarly old record of *Panax ginseng* from the same area (Van de Poll, Pers. Comm). These are most likely located on the west side of Winona Pond, below the ridge at the base of the steep talus slope. The entire cliff, outcrop and talus area is the likely area for rare plants in the watershed (Van de Poll, Pers. Comm.).

Chapter 3. Water Quality

3.1 INTRODUCTION

This chapter provides a brief overview of federal and state water quality regulations, summarizes available information on water quality for the lakes and ponds in the Waukewan Watershed, and presents information on the quality of finished drinking water from the Meredith Water Treatment Plant. "Finished" water is the water that has been treated by the Meredith Water Department treatment plant. "Raw" water is the term for untreated water from the lakes and ponds.

The data used to develop these summaries was collected from a number of different programs. The different programs often collected different parameters at different time periods. Analysis of this water quality data reveals areas of concern. Potential pollution sources and management recommendations are discussed in Chapters Five and Six, respectively. It is critical to maintain good water quality in both raw and finished water for numerous reasons including: safeguarding of fisheries, protecting recreational water resources, minimizing drinking water treatment costs, and protection of public health.

3.2 REGULATORY BACKGROUND

The State of New Hampshire has numerous statutes and rules that are designed to protect lakes. The laws are based on the philosophy that it is "easier, cheaper, and more logical to protect lakes from degradation than it is to restore degraded lakes" (State of New Hampshire 2000 Section 305(b) Water Quality Report). Over the past two decades NH DES has made a major effort to remove point discharges of sewage and waste from lakes and from tributaries to lakes. A brief summary of some of the laws and regulations that help protect New Hampshire lakes is presented in Table 3.1

Table 3.1 List of pertinent statutes established to protect New Hampshire lakes. (Source: State of New Hampshire 2000 Section 305(b) Water Quality Report).

Provision	Regulatory Authority
1. All lakes are classified at least Class B (RSA 485-A:11), the goal is that these waterbodies are suitable for fishing, swimming, and other recreational activities (RSA 485-A:8-II), and violations of assigned classifications are not allowed (RSA 485-A:12-II).	RSA 485-A:11 RSA 485-A:8-II RSA 485-A:12-II
2. No discharge is allowed to a lake without a permit. It is prohibited to discharge marine toilets into a lake (RSA 487:2).	RSA 485-A:13-I
3. Dumping of trash in or on the banks of a lake is prohibited.	RSA 487:2
4. Graywater (sink and shower wastes) from boats cannot be discharged into a lake.	RSA 487:3
5. No new point sources of phosphorus to lakes are allowed, and no new discharges of phosphorus to tributaries of lakes are allowed that would encourage weed or algae growth.	WS432.10
6. Existing high quality lakes shall be maintained at their existing high quality.	WS439.02

Provision	Regulatory Authority
7. No automobiles may be washed in or driven into any lake.	Uncodified regulation – may not be enforceable.
8. Automobiles and other petroleum powered vehicles lost through the ice into a lake must be removed.	RSA 485-A:14
9. Dredge and fill activities are not allowed in or around a lake without a permit.	RSA 482-A:3, 485-A:17
10. No construction or transportation of forest products (skidding etc.) can occur near a lake without a permit.	RSA 485-A:17
11. No earth moving activities are allowed near a lake without a permit.	RSA 485-A:17
12. No subsurface disposal system may be installed near a lake without a permit and without meeting minimum standards.	RSA 485-A:29
13. No pesticides applications are permitted within 25 feet of lakes without a permit (RSA 430:28-48) and the recommendation of DES (Pes 502, 601, 604).	RSA 430:28-48 Pes 502, 601, 604
14. Cottages near lakes or tributaries to lakes cannot be converted from seasonal to year-round use unless an application for approval of the sewage disposal system has been submitted and approved.	RSA 485-A:38
15. Cottages near lakes or tributaries to lakes cannot be expanded in size such that the load on the sewage disposal system is increased, unless an application for approval of the sewage disposal system is submitted.	RSA 485-A:38
16. No property with a sewage disposal system located within 200 feet of a great pond can be offered for sale until a licensed sewage disposal designer has performed a site assessment to determine if the site meets current standards for sewage disposal systems.	Relevant Law: RSA 4:40-a, 485-A:2, RSA 485-A:39 Relevant Adm. Rule: Env-Ws 1025
17. The Lakes Management and Protection Program established a lakes coordinator and lakes management advisory committee to prepare: (1) statewide lake management criteria and (2) guidelines for the development of local lake management and shoreland protection plans.	RSA 483-A
18. The Shoreland Protection Act provides minimum protective standards for activities occurring within 250 feet of lakes and ponds with a surface area of 10 acres or more.	RSA 483-B
19. No household cleaning products except those used in dishwashers shall be distributed, sold, or offered for sale in New Hampshire which contains a phosphorus compound in excess of a trace quantity.	RSA 485-A:56
20. No exotic aquatic weeds shall be offered for sale, distributed, sold, or imported, purchased, propagated, transported, or introduced in the state.	RSA 487:16a
21. Permits are also required for the following activities, and permits will not be issued if lake quality is to be endangered: a. Groundwater discharges b. Underground storage tanks c. Solid waste landfills d. Sludge pits e. Hazardous waste sites	 RSA 485-A:13 RSA 146-A RSA 149-M RSA 149-M RSA 147-A

Surface Water Quality Standards

Surface water quality in the United States is protected under the federal Clean Water Act. Federal standards promulgated under this act have been adopted by the State of New Hampshire in the form of surface water standards. The water quality standards establish the baseline quality that all surface waters of the State must meet in order to protect their intended uses. These standards are the yardstick for identifying where water quality violations exist and for determining the effectiveness of regulatory pollution control and prevention programs. The standards are composed of three parts: classifications, the criteria, and the anti-degradation regulations (State of New Hampshire 2000 Section 305(b) Water Quality Report). All three are described below.

Waterbody Classification

All State surface waters (i.e. perennial and seasonal streams, lakes, ponds, and tidal waters) have either a Class A or Class B classification. The majority of waters fall under the Class B classification. Class A waters are intended to be and generally are waters of the highest quality and are considered potentially usable for water supply after adequate treatment. Discharge of sewage or wastes is prohibited to Class A waters. Class B waters are considered acceptable for Aquatic Life Use, Fish Consumption, Primary Contact Recreation (i.e. swimming), Secondary Contact Recreation (i.e. minor water contact through activities such as boating), Wildlife, and after adequate treatment for use as water supplies. Each surface waterbody regardless of class must meet the following water quality criteria:

- The presence of pollutants in the receiving waters is not the basis for further introduction of pollutants. The failure of waters to meet certain criteria due to natural causes does not necessitate the modification of the assigned water use classification.

- All waters shall be free from pollutants in concentrations or combinations that settle to form harmful deposits; float; produce odor, color, taste, or turbidity that is not naturally occurring; result in the dominance of nuisance species, or prevent recreational activities.

- The level of radioactive materials shall not be in concentrations or combinations that would be harmful to human, animal, or aquatic life; would result in radionuclides in aquatic life exceeding recommended limits for consumption by humans; or would exceed EPA's Drinking Water Regulations.

- Tainting substances shall not be present in combinations that individually or in combination produce undesirable flavors in aquatic organisms.

- Toxic pollutants, unless naturally occurring, shall be in concentrations that will not injure plants, animals, humans, or aquatic life; persist in the environment; or accumulate to harmful levels in aquatic organisms.

(Source: State of New Hampshire 2000 Section 305(b) Water Quality Report)

Table 3.2 Designated Uses for New Hampshire Surface Waters. (Source: NH DES 2004 New Hampshire Consolidated Assessment and Listing Methodology).

Designated Use	NH DES Definition	Applicable Surface Waters
Aquatic Life	Waters that provide suitable chemical and physical conditions for supporting a balanced, integrated and adaptive community of aquatic organisms.	All surface waters
Fish Consumption	Waters that support fish free from contamination at levels that pose a human health risk to consumers.	All surface waters
Shellfish Consumption	Waters that support a population of shellfish free from toxicants and pathogens that could pose a human health risk to consumers.	All tidal surface waters
Drinking Water Supply	Waters that with conventional treatment will be suitable for human intake and meet state/federal drinking water regulations.	All fresh surface waters
Primary Contact Recreation (i.e. swimming)	Waters suitable for recreational uses that require or likely to result in full body contact and/or incidental ingestion of water.	All surface waters
Secondary Contact Recreation	Waters that support recreational uses that involve minor contact with the water.	All surface waters
Wildlife	Waters that provide suitable physical and chemical conditions in the water and the riparian corridor to support wildlife as well as aquatic life.	All surface waters

According to NH DES, all waterbodies in the watershed are classified as Class B waters. However, there are some questions regarding these classifications. These questions are raised by following sections of 1967 NH Chapter Law below.

> Winnipesaukee River watershed [Alton, Ashland, etc.]
> 1967, 311:1, XLVIII. All the surface waters of the Tuftonboro, and Wolfeboro, and the cities of Franklin and Laconia, from their sources to confluence with the Pemigewasset River to form the Merrimack River, except the sources of surface water supplies for Meredith and Tilton-Northfield, Class B.
>
> Knowles Pond and its tributaries [Northfield]
> 1967, 311:1, XXIII. Knowles Pond and all its tributaries, in the
>
> Unnamed Pond and its tributaries [Meredith]
> 1967, 311:1, XXII. An unnamed pond and all its tributaries, in the
>
> Unclassified State Surface Waters: Not Public water supplies
> 1967, 311:1 LXII. All other unclassified surface waters in the state not included in the above summary, but not public water supplies, Class B.
>
> Unclassified Surface Public Water Supplies
> 1967, 311:1, LXIII. All other surface public water supplies in the state not included in the above summary and which have not yet been so classified, Class A.

According to 1967 New Hampshire Chapter Law, "an unnamed pond and all its tributaries, in the town of Meredith, from their sources to the crest of the water supply dam" was determined as Class A. This unnamed pond is the manmade reservoir which is no longer in use. The 1967 Chapter Law also says that all previously unclassified surface public water supplies are established as Class A waterbodies. This means that if it can be established that a surface water source was active as of 1967 then the associated waterbody is Class A.

The New Hampshire State Board of Health adopted regulations to protect Lake Waukewan as "a source of public water supply" in 1929. Many of the provisions adopted in 1929 were carried over in Administrative Rule Env-Ws 386.49 Protection of the Purity of the Water of Lake Waukewan and Its Watershed which was amended in 1997. This demonstrates a history of protection afforded to this public drinking water source.

More recent documents indicate that the lake has been used as a source since at least 1963. The 1963 Meredith town report describes the "relocation of the main supply line from the reservoir" and discusses the termination of the reservoir's use. From 1963 onward Lake Waukewan became the system's sole water source.

If Lake Waukewan's classification is adjusted to reflect its history as a public water supply, it is likely that all the surface waterbodies in the watershed would be reclassified as Class A, not just the lake (K. Johnson, Pers. Comm.). A procedure is established to permit re-classification of a waterbody under Title L Water Management and Protection, Chapter 485-A, Water Pollution and Waste Disposal:

Section 485-A:10

> **485-A:10 Reclassification Procedure. –** After adoption of a classification for any surface water or section of such water by the legislature, the department may, by its own motion, or upon the petition of not less than 100 persons, legal inhabitants of the county or counties in which the surface water in question is situated, reinvestigate the conditions of pollution in said surface water or section of such water by following the procedure above outlined, and may at any time make recommendation to the legislature for reclassification.

Water Quality Criteria

The second major component of the water quality standards is the criteria. These are numerical or narrative criteria which define the water quality requirements for Class A and Class B waters. A waterbody that meets the criteria for its assigned classification is considered to meet its intended use (State of New Hampshire 2000 Section 305(b) Water Quality Report). Water quality criteria for each classification are found in RSA 485-A:8, I-V and in the State of New Hampshire Surface Water Quality Regulations (Env-Ws 1700).

Antidegradation

The purpose of the antidegradation provisions in the water quality standards is to preserve and protect the existing beneficial uses of the State's surface waters and to limit the degradation allowed in receiving waters. Antidegradation regulations are

included in Env-Ws 1708.08 to 1708.12 of the New Hampshire Surface Water Quality Regulations. Pursuant to RSA 485-A:2, X and RSA 485-A:2, XVI, discharges containing "sewage" or "wastes" are not allowed in Class A waters. Consequently, degradation of Class A waters is prohibited.

NH DES 305(b) Water Quality Report

Biennially, NH DES is required by the Environmental Protection Agency to assess surface water quality. NH DES uses assessment units as the basic unit of record for conducting and reporting the results of water quality assessments. Assessment units are intended to be representative of homogenous units. Sometimes assessment units represent an entire waterbody. In other instances, an assessment unit may represent a town beach, or portion of a waterbody, as is the case with the Meredith Town Beach. All surface waters were assessed by NH DES in 2004 to determine if they support their designated uses. During this reporting cycle, wildlife was not assessed because an assessment methodology for wildlife has yet to be developed.

There is a statewide fish consumption advisory or ban in effect for the general population for one or more fish species due to the atmospheric deposition of mercury. For this reason, all state waterbodies have been classified as "Not Supporting" the fish consumption designated use.

Table 3.3 summarizes 2004 NH DES information on use attainment status for the lakes and ponds within the Waukewan Watershed. Of note, Lake Waukewan was assessed as "Not Supporting" for aquatic life due to "non-native aquatic plants". This is attributed to the historic presence of invasive aquatic plants in the past. However, according to the NH DES Exotics Species Program Coordinator, the historic growth of milfoil has been eradicated and consequentially this impairment will be removed for the 2006 assessment reporting cycle. The Lake Waukewan Town Beach was assessed as "Not Supporting" primary contact recreation due to *Escherichia coli*.

Sampling at the Meredith Town Beach occurs approximately once per month from June to August . In 2000, two samples taken in June had *E. coli* results above the 88 per 100 ml threshold. This triggered a beach program advisory and in 2004 beach program advisories were used to determine designated use support. Therefore a beach was listed as "Not Supporting" primary recreation on the state's 303(d) list of impaired or threatened waters. Once a waterbody is listed, it can be removed by completing a Total Maximum Daily Load (TMDL) study or the source of the high E. coli measurements can be determined, rectified, and verified. A TMDL study quantifies the maximum amount of a pollutant(s) that a waterbody can receive and still meet water quality standards. The calculation must include a margin of safety to ensure that the waterbody can be used for the purposes the State has designated. The calculation must also account for seasonal variation in water quality. This study can help determine whether *E. coli* sources are primarily from swim loads or storm events, for example, and can help identify ways to better manage these sources. NH DES is scheduled to complete a TMDL study in 2013. If a community chooses, it may pay to conduct a TMDL study at an earlier date. Although the beach has been classified as "Not Supporting" primary recreation, this does not mean the beach is closed to swimming.

All of the lakes and ponds have been classified as "impaired" due to atmospheric deposition of mercury, and are required to complete a Total Maximum Daily Load study for mercury in the future.

Table 3.3 2004 List of Attainment Status for all uses of lakes and ponds within the Waukewan Watershed. (Source: State of New Hampshire Section 305(b) Water Quality Report).

Waterbody	Class	Use	Use Support Status	Suspected Pollution Sources	Impairment Category	Assessment Unit Category
Bear Pond	Class B	Aquatic Life	Insufficient Information		NA	5*
		Drinking Water	Not Assessed		NA	
		Fish Consumption	Not Supporting	Atmospheric Deposition - Mercury	5*	
		Primary Contact Recreation	Insufficient Information		NA	
		Secondary Contact Recreation	Insufficient Information		NA	
		Wildlife	Not Assessed		NA	
Lake Waukewan	Class B***	Aquatic Life	Not Supporting	Non-Native Aquatic Plants	4C**	5*
		Drinking Water	Fully Supporting		NA	
		Fish Consumption	Not Supporting	Atmospheric Deposition - Mercury	5*	
		Primary Contact Recreation	Insufficient Information		NA	
		Secondary Contact Recreation	Insufficient Information		NA	
		Wildlife	Not Assessed		NA	
Lake Waukewan – Town Beach	Class B	Aquatic Life	Insufficient Information		NA	5*
		Drinking Water	Not Assessed		NA	
		Fish Consumption	Not Supporting	Atmospheric Deposition - Mercury	5*	
		Primary Contact Recreation	Not Supporting	Escherichia coli	5*	
		Secondary Contact Recreation	Fully Supporting		NA	
		Wildlife	Not Assessed		NA	
Lake Winona	Class B	Aquatic Life	Fully Supporting		NA	5*
		Drinking Water	Not Assessed		NA	
		Fish Consumption	Not Supporting	Atmospheric Deposition - Mercury	5*	
		Primary Contact Recreation	Fully Supporting		NA	
		Secondary Contact Recreation	Fully Supporting		NA	
		Wildlife	Not Assessed		NA	
Hawkins Pond	Class B	Aquatic Life	Insufficient Information		NA	5*
		Drinking Water	Not Assessed		NA	
		Fish Consumption	Not Supporting	Atmospheric Deposition - Mercury	5*	
		Primary Contact Recreation	Fully Supporting		NA	
		Secondary Contact Recreation	Fully Supporting		NA	
		Wildlife	Not Assessed		NA	
Otter Pond	Class B	Aquatic Life	Insufficient Information		NA	5*
		Drinking Water	Not Assessed		NA	
		Fish Consumption	Not Supporting	Atmospheric Deposition - Mercury	5*	
		Primary Contact Recreation	Insufficient Information		NA	
		Secondary Contact Recreation	Not Assessed		NA	
		Wildlife	Not Assessed		NA	

* Impaired or threatened for one or more designated pollutants and requires a Total Maximum Daily Load (TMDL) Study. ** Does not require a TMDL.
*** See discussion under Classification section in this chapter.

Drinking Water Regulations

New Hampshire drinking water regulations are based on the Federal Safe Drinking Water Act (SDWA), enacted in 1974, and amended in 1986 and 1996. The Act requires that each state adopt standards that are no less stringent than the federal regulations. SDWA authorizes the Environmental Protection Agency to develop primary drinking water regulations that incorporate maximum contaminant levels (MCLs), maximum contaminant level goals (MCLGs), and treatment techniques for dozens of contaminants in order to protect public health.

Some of the contaminants have "chronic" effects which are the result of long term exposure. Consequently the MCLs for contaminants with chronic effects are established based on exposure over an average lifespan of seventy years. Contaminants which have more immediate or "acute" effects are based on short-term exposure. Examples of contaminants which cause acute effects are bacteria, pathogens, or viruses. These contaminants are also regulated to assure public health safety.

The New Hampshire Drinking Water Regulations mirror the SDWA regulations. They address the quality of finished water, before it is delivered to the consumer. Table 3.4 shows the MCLs of some common contaminants compared to the finished water from the Meredith Water Department. For more information about the contaminants, their sources, and potential effects see Appendix 1. Finished water sample results taken from 2000-2004 from the Meredith Water Department were reviewed. All parameters measured fell safely below the maximum contaminant levels established for all parameters. During this period, the Meredith Water Department consistently met state drinking water standards.

Table 3.4 NH DES Drinking Water Standards compared to samples taken from finished water from the Meredith Water Department. Sample results are from 2004. (Does not include aesthetic regulated secondary parameters).

Parameter	NH DES Maximum Contaminant Level (MCL)	Meredith Water Department Finished Water	Notes
Total Coliform	Absence	Absence	
Fecal Coliform	Absence	Absence	
E. Coli	Absence	Absence	
Total Alkalinity	n.e	8.7	Mean of four samples taken: 1/20/04, 2/19/04, 3/12/04 , and 6/14/04.
Asbestos	7 million fibers/L	~	
Specific Conductance	n.e	134.9 umhos/cm^2	
Arsenic	0.05 mg/L	<.001	
Barium	2.0 mg/L	.0062	
Cadmium	.005 mg/L	<.001	
Chromium	0.1 mg/L.	<.005	
Copper	1.3 mg/L	.091	Mean of samples taken in 2002
Cyanide	0.2 mg/L	<.01	
Fluoride	4.0 mg/L	<.20	
Iron	0.3 mg/L	<.05	
Lead	0.015 mg/L	.005	Mean of samples taken in 2002
Mercury	.002 mg/L	<.001	
Nickel	0.1 mg/L	<.005	
Nitrate (measured as Nitrogen)	10 mg/L	<.05	
Nitrite (measured as Nitrogen)	1.0 mg/L	<.05	
Selenium	0.05 mg/L	<.005	
Antimony	.006 mg/L	<.003	
Beryllium	.004 mg/L	<.002	
Thallium	0.002 mg/L	<.001	
Uranium	30ug/L	~	
Radium 226 +228	5 pCi/L	~	
Gross Alpha	15 pCi/L	<1	Sample taken in 2000.
Endin	0.000 mg/L	BDL	
Lindane	0.0002 mg/L	BDL	
Methoxychlor	0.04 mg/L	BDL	
Toxaphene	0.003 mg/L	BDL	
Glyphosate	0.7 mg/L	BDL	
Di(2-ethylhexyl) adipate	0.4 mg/L	BDL	
Oxamyl	0.2 mg/L	BDL	
Simazine	0.004 mg/L	BDL	
Di(2-ethylhexyl) phthalate	0.006 mg/L	BDL	
Picloram	0.5 mg/L	BDL	
Dinoseb	0.007 mg/L	BDL	
Hexachlorocyclopentadiene	0.05 mg/L	BDL	
Aldicarb sulfoxide	0.004 mg/L	BDL	
Aldicarb sulfone	0.002 mg/L	BDL	

Parameter	NH DES Maximum Contaminant Level (MCL)	Meredith Water Department Finished Water	Notes
Carbofuran	0.04 mg/L	BDL	
Aldicarb	0.003 mg/L	BDL	
Atrazine	0.003 mg/L	BDL	
Alachlor	0.002 mg/L	BDL	
Heptachlor	0.0004 mg/L	BDL	
Heptachlor Epoxide	0.0002 mg/L	BDL	
2,4 D	0.07 mg/L	BDL	
2,4,5 TP	0.05 mg/L	BDL	
Hexachlorobenzene	0.001 mg/L	BDL	
Benzo (a) pyrene (PAHs)	0.0002 mg/L	BDL	
Pentacholophenol	0.001 mg/L	BDL	
Chlordane	0.002 mg/L	BDL	
Methyl tertiary-butyl ether (MtBE)	0.013 mg/L	BDL	
1,2,4 Trichlorobenzene	0.07 mg/L	BDL	
Cis-1,2-Dichloroethylene	0.07 mg/L	BDL	
Chloroform	See note	24.6	Disinfection byproducts TTHM standard is 80 ppb using the average of these four parameters on a quarterly basis.
Bromoform	" "	BDL	
Bromodichloromethane	" "	BDL	
Chlorodibromomethane	" "	4.6	
Xylene, (total)	10 mg/L	BDL	
Dichloromethane (methylene chloride)	0.005 mg/L	BDL	
1,2 Dichlorobenzene (o)	0.6 mg/L	BDL	
1,4 Dichlorobenzene (para)	0.075 mg/L	BDL	
Vinyl chloride	0.002 mg/L	BDL	
1,1 Dichloroethylene	0.007 mg/L	BDL	
1,2 Dichloroethylene (trans)	0.1mg/L	BDL	
1,2 Dichloroethane	0.005 mg/L	BDL	
1,1,1, Trichloroethane	0.2 mg/L	BDL	
1,2-Dichloropropane	0.005 mg/L	BDL	
Trichloroethylene	0.005 mg/L	BDL	
1,1,2 Trichloroethane	0.005mg/L	BDL	
1,1,1,2-Tetrachoroethane	n.e	BDL	
Tetrachloroethylene	0.005 mg/L	BDL	
Monochlorobenzene (Chlorobenzene)	0.1 mg/L	BDL	
Benzene	0.005 mg/L	BDL	
Toluene	1 mg/L	BDL	
Ethylbenzene	0.7 mg/L	BDL	
Styrene	0.1 mg/L	BDL	

n.e. – MCL not established. Reporting is required.
BDL - below detection limit

3.3 SUMMARY OF RAW SURFACE WATER QUALITY DATA

Water quality in waterbodies throughout the watershed has been investigated at various times by the New Hampshire DES Lakes and Ponds Inventory Program and the Volunteer Lake Assessment Program (VLAP). For example, water quality in Lake Waukewan has been examined annually by the Volunteer Lake Assessment Program from 1991-2004 and by NH DES Lakes and Ponds Inventory Program in 1982 and 1994. Every year VLAP volunteers collect data from five sampling stations in Lake Waukewan (Figure 3.1). Water quality in Lake Winona has been examined annually by the Volunteer Lake Assessment Program from 1987-2004. VLAP volunteers take samples from five stations in this waterbody (Figure 3.2). NH DES Lakes and Ponds Inventory Program gathered data for Lake Winona in 1977 and 1987, and the University of New Hampshire sampled in 1986 and 1987.

Currently, there are no volunteer assessments being completed on Hawkins, Bear and Otter Ponds. NH DES Lakes and Ponds Inventory Program gathered water quality data for Hawkins Pond in 1977 and 1997; Bear Pond in 1990, and Otter Pond in 1994. Because of the periodic nature of this sampling, results serve as a "snapshot" in time of water quality. A VLAP monitoring program has recently been started for the Snake River. Data has been collected for the Snake River since 2002.

This section of the report synthesizes water quality information from the above sources. For Lake Waukewan and Lake Winona, the majority of the results reported here are from the VLAP Program. These results are discussed because they represent a useful long-term dataset. Snapshot data from the NH DES Lakes and Ponds Inventory Program are presented for Nitrogen, Sodium, and Chloride for all waterbodies. Since there are no VLAP programs occurring in Hawkins Pond, Bear Pond, or Otter Pond, data from NH DES Lakes and Ponds Inventory Program are presented.

The forementioned studies report that the majority of waterbodies in the watershed have "clear" waters, "exceptional" water clarity, and generally low turbidity. However, other parameters measured indicate that the delicate balance of lake and pond health is changing. **For example, in Lake Waukewan mean conductivity values increased 50-69% since 1991, the first recorded significant toxic algae bloom occurred in November 2004, dissolved Oxygen concentrations in the hypolimnion (lower layer) during the month of July are typically low to anoxic, and Phosphorus concentrations in the hypolimnion are increasing.** In Lake Winona, mean conductivity values increased 68-71% since 1987, dissolved Oxygen values in the hypolimnion have historically been low to anoxic, and Phosphorus concentrations in the hypolimnion are increasing." A detailed summary of each parameter follows.

Figure 3.1 Monitoring Stations where biological and chemical parameters are measured by Volunteer Lake Assessment Volunteers in Lake Waukewan. (Source: NH DES)

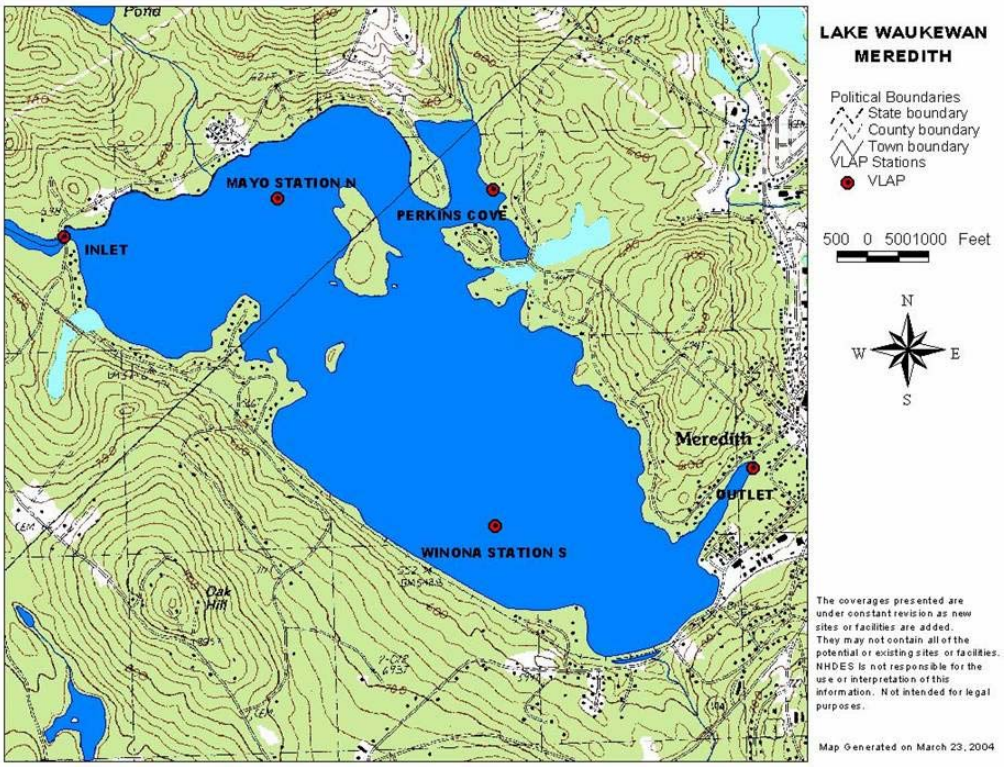
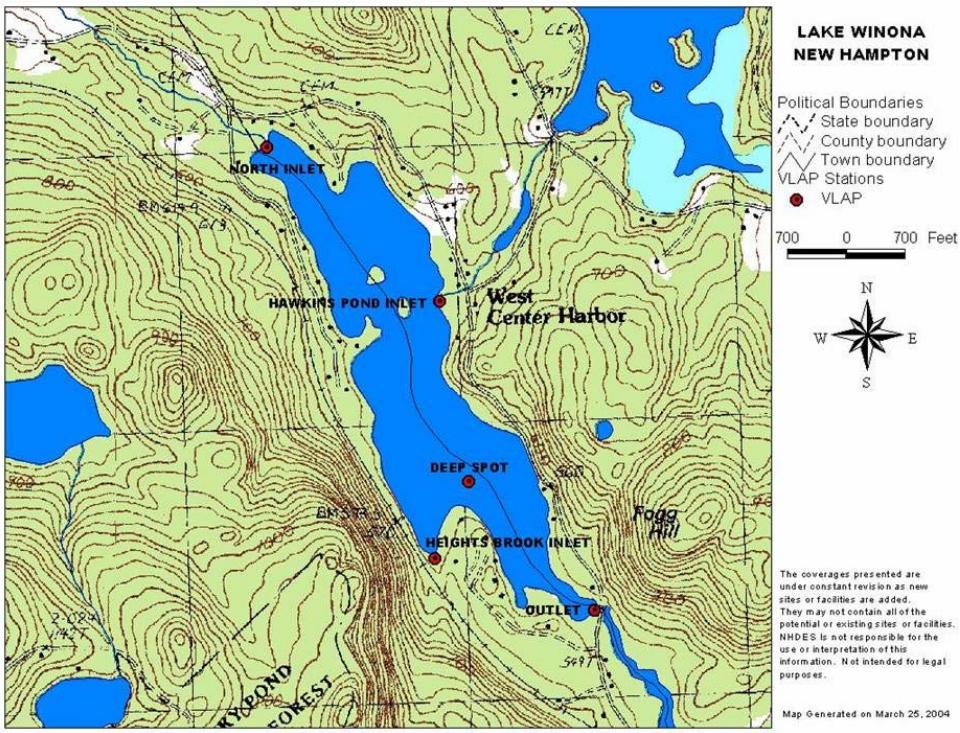


Figure 3.2 Monitoring Stations where biological and chemical parameters are measured by Volunteer Lake Assessment Volunteers in Lake Winona. (Source: NH DES)



Trophic Levels and Flushing Rate

Lakes typically go through a natural aging process as the result of sedimentation processes and nutrient additions. Trophic level or lake "age" is determined by a number of factors including water transparency, nutrient enrichment, planktonic growth, presence of aquatic plants, types of fishery (cold or warm), and dissolved Oxygen content. As lakes age, the aforementioned characteristics change. For example, oligotrophic waterbodies are considered to be in an early stage of development. Waterbodies in this trophic stage are characterized by clear water, low nutrient enrichment, low productivity, few aquatic plants, presence of a coldwater fishery and high dissolved oxygen content. Eutrophic waterbodies on the other hand, have high nutrient enrichment, high productivity as evidenced by much planktonic growth, extensive aquatic plant beds, sediment accumulation on the lake bottom, have warmwater fish species, and are susceptible to algae blooms and summer fish kills. Mesotrophic characteristics fall somewhere in between eutrophic and oligotrophic.

NH DES Lakes and Ponds Inventory reports have classified most of the lakes in New Hampshire into one of three trophic classes: oligotrophic, mesotrophic, and eutrophic. Lake Waukewan was classified as "oligotrophic" in 1994, Lake Winona and Otter Pond were classified as "mesotrophic" in 1987 and 1994 respectively, and Bear Pond and Hawkins Pond were classified as "eutrophic" in 1990 and 1997 respectively. However, if Lake Winona had been sampled later in summer the lake would have been classified as eutrophic because of the lower concentration of dissolved oxygen. (NH DES Lakes and Ponds Inventory). It has been some time since the lakes and ponds were originally classified. It is likely that some have changed trophic class since their original classification.

Another important parameter which relates to trophic level is the flushing rate. The flushing rate is the number of times a lake flushes (i.e., a volume of water equal to the lake's volume passes through the lake) in one year, expressed to the nearest 0.1 times/year. This rate incorporates the amount of inflow with the waterbody volume in order to produce a measure of lake water exchange (Jeer et Al., 1997). The flushing rate is important to consider when examining the effect of pollution loads, nutrient additions, or water diversions. In general, the lower a lake's flushing rate, the more susceptible the waterbody is to nutrient or pollutant additions. This is because nutrients or pollutants are less likely to be flushed from the waterbody.

NH DES has determined that the median flushing rates for New Hampshire lakes and ponds is 3.0 times/year. The flushing rates for all the waterbodies in the watershed are slower than this median (Table 3.5) For example, because of the relatively small amount of perennial stream discharging into Lake Waukewan, New Hampshire Department of Environmental Services estimates that the flushing rate of water in the lake to be fairly low (0.6 times/year). For comparison, the flushing rate for Paugus Bay is approximately 13 times per year. Paugus Bay serves as the source for Laconia's public drinking water supply. It takes approximately 20 months for the water in Lake Waukewan to be entirely replaced. This flushing rate is significant because it affects that amount of time potential contaminants or nutrients can remain in this waterbody. The combination of relatively shallow depths and slow turnover rates make Lake Waukewan susceptible to eutrophic conditions and algal blooms. Lakes with shallow depths are more easily warmed during the summer months and the slow flushing rate allows for accumulation of nutrients which in turn can lead to eutrophication. The slow

flushing rate elevates the critical role that the lakeshore wetlands play in mitigating pollution discharges into or above the lake.

Some watershed residents have questioned the accuracy of the Lake Waukewan flushing rate. A more refined analysis of flushing rate is warranted.

Table 3.5 Trophic level and flushing rate for waterbodies in the Waukewan Watershed, New Hampshire.

Water body	Trophic Classification	Flushing Rate** (yr^{-1})	Year Classified
Otter Pond	Mesotrophic	1.80	1994
Bear Pond	Eutrophic	1.60	1990
Hawkins Pond	Eutrophic	1.70	1997
Lake Winona	Mesotrophic*	1.60	1987
Lake Waukewan	Oligotrophic	0.60	1994

*If Lake Winona had been sampled later in summer the lake would have been classified as eutrophic because of the lower concentration of dissolved oxygen. (NH DES Lakes and Ponds Inventory).
** Flushing Rate: The number of times a lake flushes (i.e., a volume of water equal to the lake's volume passes through the lake) in one year, expressed to the nearest 0.1 times/year.

Chemical and Biological Parameters

pH

The parameter pH is a measure of hydrogen ions in the water, or in general terms, the acidity. pH is measured on a logarithmic scale of 0 to 14. The lower the pH, the more acidic the solution, due to the higher concentration of Hydrogen ions. Lake pH is important for the survival and reproduction of fish and other aquatic species. There are several reasons and conditions which affect waterbody acidity. For example, many lakes exhibit lower pH values in deeper waters than nearer the surface. Decomposition carried out by bacteria in the lake bottom causes the pH to drop, while photosynthesis in the upper layers can cause pH to increase. A difference in pH from surface to bottom layers is greatest in a thermally stratified lake. Waterbody pH may be influenced by wetlands where tannic and humic acids are released to the water by decaying plants, thereby creating more acidic waters (VLAP, 2003). After the acidic spring-time snow melt or a significant rain event, surface water may have a lower pH than deeper waters and may take several weeks to recover.

New Hampshire lakes historically have had pH values in the mid to upper sixes, in most cases. A pH of between 6.5 and 7.0 is ideal (VLAP, 2003). As the pH decreases to between 5 and 6, many fish and aquatic organisms become stressed, and some species disappear because they are unable to tolerate acidic conditions. Fish typically are unable to tolerate acidic conditions below a pH of 5. The mean pH value for the epilimnion (upper layer) in New Hampshire lakes and ponds is 6.6, which indicates that the surface waters in the state tend to be slightly acidic.

Annual sampling data collected by the VLAP volunteers for Lake Waukewan, Lake Winona, and the Snake River indicate that water in these waterbodies is "slightly acidic" but "satisfactory" for aquatic life purposes. In 2004, mean pH ranged from 6.09 in the hypolimnion to 6.74 in the epilimnion at the Mayo Deep Spot Station and from 6.24 in the hypolimnion to 6.85 in the epilimnion at the Winona Deep Spot Station. At the deep spot in Lake Winona, pH ranged from 6.12 in the hypolimnion to 6.7 in the epilimnion during an August sampling event. Similarly, the 2004 monitoring season for the Snake River found pH values that ranged from 6.25 at site 3, to 6.48 at site 4.

Acid NeutralizingCapacity (ANC)

Alkalinity is the measure of a lake's capacity to neutralize acid inputs. This value is often referred as "acid neutralizing capacity (ANC). New Hampshire has had historically low alkaline waters because of the State's granitic bedrock and there is some evidence that overall alkalinity has decreased in recent years. If the buffering capacity of a lake is lost, conditions for aquatic life will be adversely affected by acid rain inputs (NH DES, 2005).

The mean ANC for New Hampshire lakes and ponds is 6.6 mg/L (VLAP 2004 Report). ANC data for waterbodies in the watershed was in the "moderately vulnerable" range (2.1-10 mg/L). ANC values have remained relatively stable in Lake Waukewan, ranging from 5.9 to 8.3 mg/L over the thirteen year sampling history. Similarly in Lake Winona, ANC values have remained relatively stable ranging from 3.5 to 6.7 mg/L during the eighteen year sampling history.

Table 3.6 Acid Neutralizing Capacity Ranges for New Hampshire Lakes and Ponds. (Source: NH DES Lakes and Ponds Inventory. Note: This scale is also used by VLAP for 2004. Prior to 2004, VLAP used a different scaling system).

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

Total Phosphorus

Total phosphorus is a measure of all the forms of Phosphorus (organic and inorganic) present. Phosphorus, along with nitrogen is a plant limiting nutrient, meaning that the amount of available Phosphorus influences the amount of algae growth that can occur. Phosphorus concentration directly relates to trophic state. For example, values less than 10 ug/L are considered "ideal" and generally indicate oligotrophic conditions. Values greater than 20 ug/L are considered "more P than desirable" and indicate eutrophic conditions. Mesotrophic conditions exist between these two values and are considered "average." Values in excess of 40 ug/L are considered "excessive."

Phosphorus is an important indicator of pollution because this nutrient occurs naturally at very low levels in lakes and ponds in New Hampshire. The median summer total Phosphorus concentration in the epilimnion of New Hampshire lakes and ponds is 12 ug/L. The median summer total Phosphorus concentration in the hypolimnion of

New Hampshire lakes and ponds is 14 ug/L.

Limited data for Otter Pond suggested Phosphorus levels indicative of mesotrophic conditions (Table 3.7). Bear Pond had Phosphorus levels predominantly in the mesotrophic range. Hawkins pond data ranged from the oligotrophic conditions to eutrophic conditions. Phosphorus has been measured by the VLAP volunteers for thirteen years at Winona Station and Mayo Station in Lake Waukewan. Concentrations have remained relatively stable and indicative of oligotrophic conditions in the epilimnion. In the hypolimnion, concentrations have increased from oligotrophic values to values indicative of mestrophic conditions. Increased Phosphorus levels in the hypolimnion may, in part, be due to low dissolved Oxygen levels during the summer. When Oxygen levels are depleted to less than 1 mg/L in the hypolimnion (as has frequently occurred at the Mayo Station), Phosphorus is released from the sediment layer into the water column. This process is referred to as "internal phosphorus loading." A similar pattern was found in Lake Winona where the epilimnion had phosphorus values representative of oligotrophic conditions and the hypolimnion had values in the mesotrophic range. Dissolved Oxygen levels in the hypolimnion of Lake Winona are also considered "low." Sampling at the Hawkins Pond Outlet and Heights Brook Inlet on Lake Winona measured Phosphorus levels indicative of eutrophic conditions during 2004.

Monitoring tributaries to a waterbody after snow-melt and during rain events can help to determine the source of Phosphorus loading. Better quantification of the source and timing of addition of this nutrient can create a better understanding of the lake's functioning and help to identify tools for better lake management.

Nitrogen

Data for Nitrogen concentrations in the watershed waterbodies is limited to two sampling periods for each waterbody. Nitrogen was measured as Nitrite, Nitrate and total Kjedhal Nitrogen (NH DES Lakes and Ponds Inventory). These data indicate that Nitrogen concentrations were approximately average for Lake Waukewan, Otter Pond, Bear Pond, and Hawkins Pond. Concentrations were slightly more elevated for Lake Winona. Possible Nitrogen sources include leachate from septic systems and residential lawns.

Sodium

The median value for Sodium concentration in New Hampshire Lakes is 3.1 mg/L. Data for Sodium concentrations in the watershed waterbodies is limited to two sampling periods for each waterbody (NH DES Lakes and Ponds Inventory). All of the waterbodies in the Waukewan Watershed have greater values than the state median for Sodium, except for Otter Pond. The highest Sodium values in the watershed were found in Bear Pond with 8.5 mg/L and Lake Waukewan with 8.0 mg/L Sodium (NH DES Lakes and Ponds Inventory).

Chloride

Typically the Chloride content in New Hampshire lakes is naturally low. Waterbodies located in remote areas away from development generally have Chloride concentrations < 2 mg/L. Higher values are generally the result of salt inputs from road corridors and septic inputs. The median value for Chloride for New Hampshire lakes is

4 mg/L. The maximum value is 198 mg/L. Chloride values for waterbodies in the Waukewan Watershed ranged from < 2mg/L in Otter Pond to 16 mg/L in Bear Pond. Lake Waukewan had a concentration of 13 mg/L and Lake Winona had a concentration of 7 mg/L (NH DES Lakes and Ponds Inventory). Chloride was measured as part of the NH DES Lakes and Ponds Inventory and has not been measured recently. Current levels are likely higher.

Mercury

New England reportedly has the highest deposition rates of Mercury in the country (10-30 micrograms per square meter). Major sources of Mercury deposition in New England are from the emissions of municipal waste incinerators, coal and oil boilers, and medical waste incinerators (USGS 2003). Studies conducted by the New Hampshire Department of Health and Human Services (DHHS) indicate that some freshwater fish in the state contain varying levels of Mercury and pose a potential health risk. A statewide advisory is in effect which recommends that people limit their fish consumption. The advisory is based on a thorough review of more than 1,200 freshwater fish sampled from 150 waterbodies throughout the state.

Conductivity

Conductivity is the measure of the ability of water to conduct an electrical current. This value is determined primarily by the number of ionic particles present. Traditionally the soft waters of New Hampshire have had low conductivity values. Lakes that are particularly sensitive to the effects of acid rain tend to have lower values (NH DES 2005). High conductivity values can indicate that pollution is occurring from sources such as road salt, faulty septic systems, agricultural runoff, or urban runoff (VLAP 2003).

Conductivity values cannot be classified according to good and bad values because of variations in watershed geology (VLAP Report 2003). However, values in New Hampshire lakes which exceed 100 uMhos/cm are generally indicative of anthropogenic effects. A lake's conductivity typically remains constant throughout the seasons. Any major changes over the course of several years or within a very short period of time may indicate significant impacts. For example, if conductivity values suddenly increase within a six month period, erosion may be the cause. Conductivity values less than 50 uMhos/cm are typical of oligotrophic lakes. The mean conductivity value for New Hampshire lakes is 62.1 uMhos/cm.

VLAP has been monitoring conductivity values in Lake Waukewan since 1991. From 1991 to 2004, mean conductivity values for all sampling points including the epilimnion, metalimnion, and hypolimnion, inlet, outlet, and Perkins cove, increased anywhere from 50-69%. For example, in 1991, mean conductivity in the epilimnion at Mayo Station was measured as 71.6 uMhos/cm. In 2004, mean annual conductivity at the Mayo Deep Spot Station was 112.73 uMhos/cm, and at the Winona Deep Spot Station was 113.40 uMhos/cm. These values are indicative of anthropogenic effects. A similar trend was also found in Lake Winona. VLAP has monitored conductivity levels in Lake Winona since 1987. From 1987 to 2004 mean conductivity values for the epilimnion, metalimnion, and hypolimnion increased 68-71%. In 1987 conductivity in the epilimnion was measured at 47.4 uMhos/cm. In 2004, mean conductivity in the epilimnion was measured as 79.88 uMhos/cm. Similarly, monitoring at the Hawkins

Table 3.6 Raw water sample results for selected biological and chemical parameters for waterbodies in the Waukewan Watershed.

Water-body	pH	Acid Neutralizing Capacity	Phosphorus	Conductivity	Dissolved Oxygen	Chlorophyll-a	Cyanobacteria
Otter Pond*	Satisfactory	Moderately Vulnerable	Mesotrophic Conditions	Less than average amount	Low	More than desirable	No data
Bear Pond**	Satisfactory	Moderately Vulnerable	Mesotrophic to Eutrophic Conditions	Greater amounts than average	Anoxic in the hypolimnion	More than desirable	No data
Hawkins Pond***	Satisfactory	Moderately Vulnerable	Oligotrophic to Eutrophic Conditions	Average	Anoxic in the hypolimnion	More than desirable	No data
Lake Winona[t]	Satisfactory	Moderately Vulnerable	Oligotrophic Conditions - Epilimnion Mesotrophic Conditions - Hypolimnion **Eutrophic Conditions - Hawkins Pond Outllet and Heights Brook Inlet**	Greater amounts than average	**Low oxygen in hypolimnion**	Oligotrophic Conditions	1992- relative abundance of *Anabaena* was 18%
Lake Waukewan[t]	Satisfactory	Moderately Vulnerable	Oligotrophic Conditions - Lake Waukewan Inlet, epilimnion, Perkins Cove Mesotrophic Conditions - Lake Waukewan Outlet, hypolimnion In 2002 eutrophic conditions measured in Hypolimnion at Mayo Station.	**"Human Impacted" according to NH DES.**	**Low with a history of anoxic conditions during July at Mayo Station.** **Sign of Lake's "aging and declining health".**	Oligotrophic Conditions	Recorded *Anabaena* bloom November 2004. 1991 - relative abundance of *Anabaena* was 11% 2002 – relative abundance of *Anabaena* was 22%
Snake River[t]	Satisfactory	No data	Oligotrophic to Mesotrophic Conditions	Greater amounts than average	No data	No data	No data

* Based on NH DES Lakes and Ponds Inventory data from 1994 and 1995. **Based on NH DES Lakes and Ponds Inventory data from 1990 and 1991. *** Based on NH DES Lakes and Ponds Inventory data from 1997 and 1998. [t] Based on 2004 VLAP Report.

Pond Inlet, North Inlet and the Outlet have shown a 45-68% increase in conductivity values. VLAP monitoring on the Snake River has found that conductivity values increase gradually from the outlet of Lake Winona to the inlet of Lake Waukewan.

For Bear Pond, Otter Pond, and Hawkins Pond conductivity data are available from two sampling dates. For Bear Pond conductivity values ranged from 78.3 to 89.5 uMhos/cm in the epilimnion in 1990 and 1991. Conductivity values in the epilimnion for Otter Pond were 28.6 uMhos/cm and 32.2 uMhos/cm in 1994 and 1995, respectively. Conductivity values the Hawkins Pond epilimnion were 50.3 uMhos/cm and 61.0 uMhos/cm in 1997 and 1998, respectively.

In the 2003 VLAP report, NH DES recommended that VLAP monitoring groups conduct stream surveys and storm event sampling along the inlets in order to determine what may be causing these increases.

Dissolved Oxygen and Temperature

The presence of dissolved Oxygen is critical to bottom-dwelling organisms as well as fish and amphibians. Many species, such as trout, are intolerant of low Oxygen conditions. Temperature affects the concentration of dissolved Oxygen. For instance, water can hold more Oxygen at colder temperatures than warm ones. The concentration of dissolved Oxygen will fluctuate with the seasons, having a higher dissolved Oxygen concentration in the winter, spring, and fall. During the summer dissolved Oxygen concentrations tend to decrease, particularly in the hypolimnion (lower water layer). Dissolved Oxygen is typically not replenished in the hypolimnion until lake turnover in the fall. Extremely low levels of dissolved Oxygen or in cases where there is no Oxygen at all (anoxic conditions) are detrimental to living biota. When dissolved Oxygen concentrations fall below 1 mg/L, Phosphorus which was previously unavailable becomes released, driving up Phosphorus concentrations (VLAP 2004).

In Lake Waukewan, dissolved Oxygen concentrations were low and sometimes anoxic in the hypolimnion. Mayo Station has had notable periods of anoxic conditions during July due to very low dissolved Oxygen levels. According to the 2004 VLAP report this is a sign of the "lake's aging and declining health." In Lake Winona dissolved Oxygen concentrations were also low to anoxic in the hypolimnion at the deep spot in the lake.

Apparent Color

Color is a visual measure of the color of the water. Color is generally caused by decaying organic matter or by naturally occurring metals, such as iron or manganese, in soils. A highly colored lake generally has extensive wetlands along the shore or within the waterbody's watershed, and often a mucky bottom. These conditions are also often associated with eutrophic waters. Color units from 0-25 indicate clear waters, units from 25-40 are a light tea color, units 40-80 represent a tea color, and > 80 is considered highly colored. The NH state median value is 28 color units. The NH Lakes and Ponds inventory reported that Lake Waukewan, Lake Winona, Hawkins Pond, and Otter Pond have waters classified as "clear." Bear Pond's color is classified as a "light tea" color.

Transparency

Transparency is a measure of water clarity and is influenced by the quantity of algae, color, and particulate matter in a waterbody. The mean transparency of New

Hampshire lakes is 3.7 meters. "Exceptional" clarity is classified as >4.5 meters, "good" water clarity ranges from 2-4.5 meters, and poor clarity is < 2 meters.

Lake Waukewan typically has had "exceptional" water clarity. For example, in 2003, mean transparency results were 6.7 meters. According to the VLAP data, the water clarity has not significantly changed since monitoring began in 1991. Lake Winona typically has had "exceptional" water clarity. For example, in 2003, mean transparency results were 5.8 meters. According to the VLAP data, the water clarity has not significantly changed since monitoring began in 1985.

Turbidity

Turbidity in water is caused by suspended matter such as clay, silt, and algae, causing light to be scattered and absorbed rather than transmitted in straight lines through the water. Turbid conditions can have negative impacts on aquatic species, pose public health risk when conditions are present in drinking water, and pose challenges to the drinking water resource manager during water treatment. High turbidity readings are often found in water adjacent to construction sites, or logging sites. In result, during rain events unstable soils erode and cause turbid conditions downstream.

Turbidity has been monitored for approximately eight years in Lake Waukewan. In the epilimnion, turbidity values have ranged from 0.2-0.5 NTU's. The average reading during this history is closer to 0.3 NTU's. Turbidity has also been monitored for approximately eight years in Lake Winona. In the epilimnion, turbidity values have ranged from 0.2-0.7 NTU's. The average reading during this history is closer to 0.4 NTU's. The median value for turbidity in New Hampshire lakes and ponds is 1.0 NTU's. The minimum value is <0.1 NTU's. Both lakes have turbidity readings less than the state average.

Algal Abundance

Chlorophyll-a concentration is as an indicator of algae abundance. Because algae contain the green pigment chlorophyll, the concentration of chlorophyll found in the water gives an estimation of the concentration of algae. While algae are naturally present in all lakes and ponds, an excessive amount of any type is not welcomed. Algal concentrations may increase with an increase of Phosphorus additions from nonpoint sources from the watershed. These nonpoint sources may include leaky septic systems and fertilized lawns.

Generally a concentration of chlorophyll-a of < 4 mg/m^3 indicates that water quality conditions are "good" and representative of oligotrophic lakes. NH DES classifies a chlorophyll-a concentration of 5.1-15 mg/m^3 as "more than desirable", and a concentration > 15 mg/m^3 as "nuisance amounts" as indicative of eutrophic conditions. The mean chlorophyll-a concentration for New Hampshire lakes is 7.02 mg/m^3.

The 2004 VLAP report for Lake Waukewan reported mean chlorophyll-a concentration for Mayo Station as 2.05 mg/m^3 and 1.69 for Winona Station mg/m^3. Over the thirteen year monitoring period, chlorophyll-a measurements have typically been reflective of "good" water conditions associated with oligotrophic lakes.

In Lake Winona, the mean concentration of chlorophyll-a has not significantly changed since 1987 and concentrations have consistently remained below the state median. In 2004, VLAP reported mean chlorophyll-a concentration for Lake Winona as

3.04 mg/m^3. The chlorophyll-a results Lake Winona are reflective of "good" water conditions associated with oligotrophic lakes.

Phytoplankton

Phytoplankton can serve as indicator species of general lake quality. An abundance of cyanobacteria (blue-green algae), such as *Anabaena*, *Aphanizomenon*, *Oscillatoria*, or *Microcystis* may indicate excessive phosphorus concentration or that the lake ecology is out of balance. On the other hand diatoms such as *Asterionella*, *Melosira*, and *Tabellaria* or golden-brown algae such as *Dinobryon* or *Chrysosphaerella* are typical phytoplankton of New Hampshire's less productive lakes. In shallow warm waters with minimal wave action (such as a cove), filamentous green algae, may grow in a form that looks like a mass of green cotton candy (VLAP 2003).

Phytoplankton populations go through a natural succession over the course of the growing season. For example, in the spring diatom algae are most abundant. During the months of May and June green algae are typically the dominant species. From mid to late summer, blue green algae often dominate. Many factors influence this succession including light, nutrients, water temperature, and the amount of grazing from zooplankton. Lake Waukewan has been sampled at the two monitoring locations. Eight of these sampling events took place during the month of July when green algae are typically most abundant. Over the course of the eleven year sampling history, the golden-brown algae, *Chrosophaerella,* were most frequently encountered followed by diatoms *Asterionella*, *Tabellaria*, and *Rhizosolenia* which occurred with equal frequency. All of these algae species are typical of New Hampshire's less productive lakes, suggesting good water quality. There were, however, two recorded samplings of toxic blue-green algae (i.e. *Anabaena)*. Both occurrences, May 1991 and July 2002, were recorded at the Lake Mayo Station (Table 3.7).

On Lake Winona there were 16 annual sampling events for phytoplankton from 1988 to 2003. Eleven of these sampling events took place during the month of July. Over the course of this sampling history, the golden-brown algae *Chrysosphaerella* and *Dinobryon* were most frequently encountered. As mentioned previously, golden-brown algae are typical of New Hampshire's less productive lakes. Their presence suggests good water quality. There was one notable sampling of the toxic algae *Anabaena* in July of 1992.

Cyanobacteria

Cyanobacteria are a type of blue-green algae. Cyanobacteria have been identified in some of the oldest fossils known on Earth (3.5 billion years old). Today, they are one of the largest and most important groups of bacteria. Cyanobacteria are rich in chemical diversity. For example, the cyanobacterium, *Spirulina,* has long been valued for its protein content. However, other species of cyanobacteria can produce populations that are toxic to humans and animals. Typically, as nutrient concentrations in a waterbody increase, so does the abundance of cyanobacteria.

Cyanobacteria naturally occur in all New Hampshire lakes and ponds and are part of the aquatic food web. In New Hampshire, four of the most common cyanobacteria include: *Anabaena, Aphanizomenon, Oscillatoria*, and *Microcystis*. *Anabaena* and *Aphanizomenon* produce neurotoxins that can interfere with nerve function almost immediately upon ingestion. *Oscillatoria*, and *Microcystis* are best

associated with producing hepatotoxins which attack liver function.

Cyanobacteria typically form in shallow, warm, slow-moving or still water. A mass of cyanobacteria in a body of water is called a bloom. When a bloom rises to the surface of the water, it is known as *surface scum* or a *surface water bloom*.

As mentioned in the previous section, *Anabaena* has been occasionally found during VLAP monitoring in Lakes Waukewan and Winona. In November 2004 a significant algal bloom was observed in the southern end of Lake Waukewan. A water sample taken from the area of the algal bloom had a concentration of 13.2 micrograms/ liter of hepatotoxin microcystin. According to Jim Haney, Professor and Chair of the Zoology Department at University of New Hampshire, this was a high value for a New Hampshire lake. The World Health Organization recommends a maximum concentration in drinking water of 1 microgram per liter. Federal and State standards for cyanobacteria have not yet been established.

The presence of cyanobacteria serves as a reminder of a waterbody's delicate balance (VLAP WINONA 2003). According to the VLAP report, watershed residents should continue to act proactively to reduce nutrient loading into the lake by eliminating fertilizer use on lawns, by keeping a natural buffer along the lake shoreline, revegetating cleared areas along the shoreline, and properly maintaining septic systems and roads. In addition, NH DES recommends that residents observe the lake in September and October during the time of fall lake turnover in order to document any algal blooms that may occur. Cyanobacteria have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and current tend to "pile" cyanobacteria into scums that accumulate in downwind sections of a lake. If a bloom occurs, the NH DES VLAP coordinator should be contacted.

The cyanobacteria normally decay in the late fall and repopulate the lake in the spring. Blooms are prevalent in the late summer and fall, although they can also occur in the spring even under the cover of ice during the winter (Haney, Pers. Comm.). The shallow depth of Lake Waukewan makes this lake naturally susceptible to cyanobacteria blooms.

Most municipal water treatment plants do not regularly look for cyanobacterial toxins in the water supply. Once cyanobacteria are detected in a water supply, treatment plants can remove them in a number of ways. Conventional water treatment facilities can remove the cells by adding chemicals that bind them together. As the cells clump together, they become heavier and fall to the bottom of the reservoir or tank, where they can be easily filtered out. While this method will remove cells, it will not remove potentially harmful cyanobacterial toxins. These can be removed using certain oxidation procedures or activated charcoal. Further research in this area is required.

The best way to avoid the problems associated with cyanobacterial blooms is to prevent blooms from forming. This can be done by reducing the input of nutrients, such as phosphates, into the water source.

Bacteria

Surface waters contain a variety of microorganisms including bacteria, fungi, protozoa, and algae. Most of these occur naturally and have no impact on human health. However, where warm blooded animals such as humans, ducks, geese, beaver, or pets are present, health risks from water contact are present. Warm blooded animals

contribute bacteria to surface waterbodies through fecal waste. Sources of fecal waste may be from leaky septic systems or sewer pipes, runoff from wildlife areas, or heavily used swimming beach areas (VLAP 2003).

Certain types of bacteria serve as indicators of the presence of fecal contamination and may also be used as an indicator species for the presence of other pathogens, such as viruses or protozoa like *Giardia* or *Cryptosporidum.* Some pathogens, particularly the protozoans such as *Cryptosporidum,* are difficult to treat because they are so small that they often pass through filters and are resistant to chlorine treatment. Currently, reliable methods are not available to water system operators to readily test for these pathogens. Fecal coliform analysis supplemented with analysis for *Escherichia coli (E. coli)* are the most reliable indicators available for identifying fecal wastes.

Water at the Meredith Town beach has typically been sampled approximately once per month from June to August for *E. coli* and total fecal coliform. The *E. coli* concentration at the town beach is typically lower than the state standard for designated beaches (88 counts per 100 ml). However, there were two years (i.e. 1992, 2000) where measurements exceeded the state standard. As previously mentioned, by exceeding the state standard for designated beaches, NH DES placed the Meredith Town Beach on the 303(d) list of impaired or threatened waters and is required to conduct a Total Maximum Daily Load study.

In 2003, bacteria samples were taken at the Hawkins Pond Inlet and North Inlet in Lake Winona. The *E. coli* concentration was very low (10 counts or less), which is much less than the state standard of 406 counts per 100 ml for recreation surface waters that are not designated beaches.

Invasive and exotic plant species

Lake Waukewan has had small patches of the exotic species, milfoil, in the outlet channel, well downstream of the main lake. A patch was treated and eradicated in 1982. A new patch was discovered in 1994 and was subsequently treated in 1995 (NH DES Lakes and Ponds Inventory). The lake has a successful "Weed Watchers" group that has monitored for any re-appearance of milfoil.

No reports of invasive species were found for Lake Winona, Otter Pond, Bear Pond, or Hawkins Pond.

3.4 CONCLUSIONS

There are multiple signs that Lake Waukewan and Lake Winona are aging and declining in health. As mentioned in this chapter, the VLAP Program has identified trends in decreasing dissolved oxygen concentrations in the hypolimnion coupled with increasing Phosphorus concentrations. The volunteers have measured more than a 50% increase in conductivity levels in both lakes over the course of their sampling history. Furthermore, the VLAP volunteers have consistently found toxic algae species present in their phytoplankton sampling. For example, in Lake Waukewan there has been a doubling of the percent of *Anabaena* species measured from 1991 to 2002 and in 2004 a toxic algae bloom occurred in the southern end of Lake Waukewan.

In addition to the concerns raised by these results, there is a demonstrated need for more information about these waterbodies. For example, the accuracy of the flushing rate for Lake Waukewan has been questioned, persistent and intermittent

tributaries and streams have yet to be mapped, and only snapshot water quality data are available for Otter Pond, Bear Pond and Hawkins Pond. The water quality of watershed tributaries and stormwater has yet to be determined.

Much work needs to be done to safeguard the future health of these waterbodies. Chapter Six presents the recommendations of the Waukewan Watershed Advisory Committee to address many of the water quality concerns raised in this chapter.

Chapter 4. Existing Protection Measures

4.1 INTRODUCTION

In addition to the regulations discussed in Chapter 3 on water quality, protective measures have been adopted by various watershed towns. This chapter provides information on protective measures including local regulatory controls, land use controls, and information on protected land.

4.2 REGULATORY PROTECTION

Local regulations can help protect water quality by directing development away from ecologically sensitive areas, by guiding the location of construction and development projects, and by prohibiting high risk land uses in specific areas. Local regulations include zoning bylaws and ordinances, subdivision regulations, local health ordinances, and site plan review regulations.

Zoning

Zoning regulates land use, including the size, shape, and permitted uses of lots and structures. Zoning controls where people live and where they work. The purpose of this land use control mechanism is to separate incompatible land uses in order to protect the public from health risks and to guide development to appropriate districts.

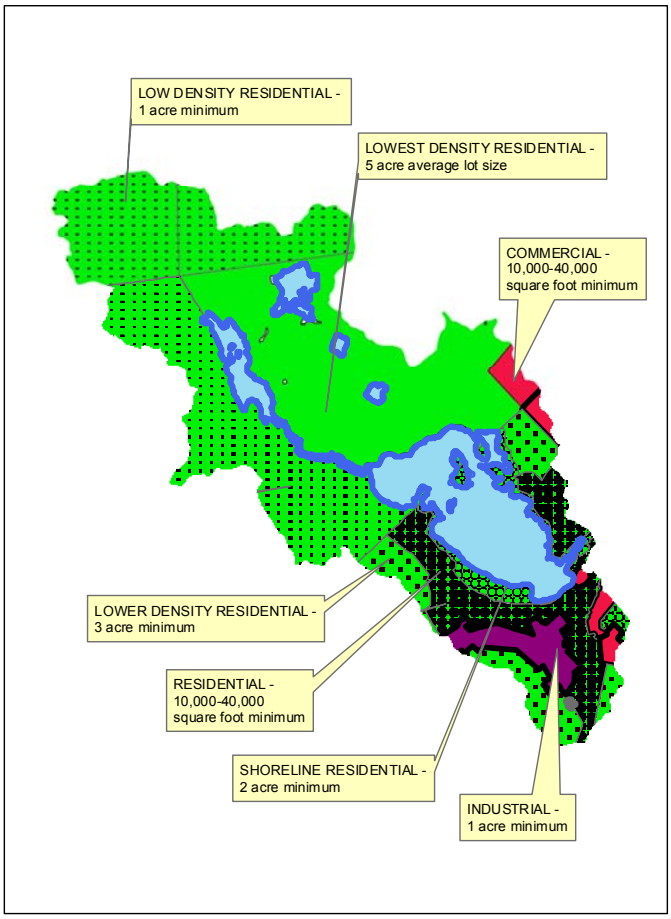
Ideally, zoning regulates land use in order to meet the goals set forth in a municipality's master plan. In a master plan, a community describes how it wants to look in the future. It is the zoning regulations that help implement this vision. For example, the Town of Meredith Community Plan (2002) identified protection of water quality as a top priority. Specifically the plan highlighted the objective: "Develop consensus based, watershed and sub-watershed management plans for priority areas within the community." In order for this objective to be met in Meredith, the town's zoning ordinances need to support this vision.

In 1978, the Lakes Region Planning Commission published the "Lakes Region Water Quality Management Plan". The 1978 report reviewed zoning ordinances of towns in the Lakes Region, including the five towns in the Waukewan Watershed. The report outlined the need for adoption of ordinances to protect water quality including: soil based lot sizing, wetlands protection, steep slope ordinances, erosion control ordinances, and local subsurface/health ordinances. Since that time, communities have made progress in adopting many of these ordinances.

For the purposes of this plan, zoning ordinances in the watershed towns were reviewed to look for the characteristic water resource protection techniques listed above. This review was not a qualitative review which examined effectiveness of these regulations. This review merely checked for the presence or absence of zoning tools. The following sections describe the status of the implementation of these water protection mechanisms. This process revealed that zoning districts among the five towns were not uniform. For example, several types of rural residential districts exist with slightly different requirements. In order to get a better understanding of the types of zoning districts and minimum lot size requirements within the watershed, zoning information from the five watershed towns was aggregated into seven general categories and mapped to create a watershed zoning map (Figure 4.1). The zoning categories

include: High Density Residential (10,000-40,000 square foot minimum), Low Density Residential (1 acre minimum), Shoreline Residential (2 acre minimum), Lower Density Residential (3 acre minimum), Lowest Density Residential (5 acre average lot size), Industrial (1 acre minimum), and Commercial (10,000-40,000 square foot minimum).

Figure 4.1 Map of zoning types and minimum lot sizes in the Waukewan Watershed.



Zoning District Type and Lot Size

Approximately 75% of the watershed is zoned for residential purposes. Within the residential zones, one acre zoning is most prevalent followed by five acre average lot size. The five acre average lot size allows, for example, subdivision of a ten acre parcel into two parcels whose average acreage equals five acres. This means one parcel could be six acres and the other four acres. Approximately 75% of the shoreline of Lake Waukewan is zoned for shoreline residential (two acre minimum lot size). The remaining 25% of the shoreline is divided between one acre residential zoning in New Hampton and five acre average residential zoning in Center Harbor. Approximately half of the Lake Winona shoreline is zoned for five acre average lot size (in Center Harbor) and the other half is one acre minimum lot size (in New Hampton). There is some light industrial land use in the watershed as well as some commercial land use. For example, there is light industrial zoning in subwatersheds C, D, E, and F in the Town of Meredith. There is commercial zoning in subwatersheds B, C, P and O in the towns of Meredith and Center Harbor (See Figure 2.1 which depicts subwatersheds).

Lower density residential zoning (three acre minimum), provides better protection of water resources than high density residential zoning because larger lot sizes can help to limit impervious area associated with residential development. Imperviousness, as mentioned in Chapter One, hinders the natural rate of the hydrological cycle. As residential development becomes more dense, negative impacts on water resources tend to increase from the addition of more cars, roads, residential heating fuel storage, pets, and other sources of waste material. Commercial and industrial land uses typically have the greatest impacts on water quality because these zones tend to create large amounts of impervious cover and they tend to create the greatest amounts of unfiltered stormwater.

More development is permitted throughout much of the watershed in the future. A build-out analysis would provide additional clarity on the quantity and types of development that can occur under current zoning.

Lot Coverage

Lot coverage was reviewed for the watershed municipalities. The amount of lot coverage permitted varied by district and community. For example the lowest lot coverage was for the General Residential, Agricultural, and Rural district in New Hampton. This district requires a minimum lot size of one acre and allows for 20% coverage of the lot. Lot coverage was highest in the Business and Industry district in Meredith. Minimum lot size in this district is one acre and permitted lot coverage is 75%.

Soils Based Lot Sizing

All of the watershed communities have provisions in their zoning ordinances to determine lot size based upon soils and slope characteristics. The purpose of soil based lot sizing is to determine appropriate lot size that safeguards public health. This determination is based upon soil texture, slope, and the ability of a site to process nitrogen in leachate from septic systems.

Wetland and Stream Buffers

Buffers are the single most effective protection for water resources (Connecticut River Joint Commissions, 1998). Buffers consist of strips of vegetated land along wetlands, streams, lakes, and ponds. These transition zones filter polluted runoff and are often complex ecosystems that provide important habitat. Buffers catch and filter out pollutants such as sediments, nutrients, and debris from surface runoff. Depending upon the width and species composition in a buffer zone, 50-100% of the sediments and nutrients will settle out and be absorbed by plants. Wider forested buffers are more effective than narrow grassy buffers. Buffers also help to regulate surface water flow by slowing the velocity of runoff. By slowing the rate of surface flow, water can infiltrate and recharge groundwater resources. Buffers also help to stabilize banks which, in turn, helps to limit erosion. Plant roots in the buffer zone help to hold soil together.

The majority of the Lake Waukewan shoreline no longer has a natural buffer. Currently only two communities in the watershed have provisions in their zoning for wetland and stream buffers. These communities are Center Harbor and Meredith.

Steep Slope Protection

Steep slopes are highly vulnerable to erosion. When erosion occurs, sediment is transported to nearby waterbodies. Increased sediment loading can lead to increased turbidity in waterbodies. Turbidity has numerous negative effects on fisheries, water supplies, wetlands, and recreation (Jeer et al. 1997). For example, sediment additions can lead to increased surface water temperatures. High temperatures result in decreased dissolved oxygen concentrations in the water and have negative impacts on fisheries. Increased sediment loads may also negatively impact water supplies by damaging water treatment equipment, thereby driving up the cost of operation. In addition, sediments can require increased drinking water disinfection treatment which in turn can lead to unhealthful disinfection byproducts.

None of the watershed towns have provided for steep slope protection in their zoning.

Erosion Control

Erosion control is another important factor to consider when protecting water quality. Erosion control measures help to prevent increased sediments loads and the negative effects described above. Erosion control measures can require the implementation of best management practices on construction sites. In the Waukewan Watershed, only the town of Meredith has erosion control measures in its zoning ordinance. Other towns may have erosion control measures in other regulatory provisions. Further research would be helpful.

Shoreline Protection Regulations

Shoreline protection regulations are intended to protect the shoreline of surface waterbodies. Municipalities can enact regulations which are more stringent than RSA 483-B, NH Shoreland Protection Act. Ashland and Holderness do not have any waterbodies in the watershed. Both Center Harbor and Meredith have shoreline protection regulations. For example, the Town of Meredith requires a 65-foot setback from lakes and ponds, prohibits underground or outside storage of fossil fuel (except natural or propane gas), prohibits clear-cutting, and selective cutting is only permitted with erosion controls. New Hampton does not have any shoreline protection regulations in its zoning.

Septic setbacks

Septic setbacks protect water quality by requiring a specified distance from waterbodies. State regulations exist which determine these distances. Some municipalities such as Center Harbor and Meredith have chosen to adopt local regulations, as well. For example, Center Harbor requires a 100 foot setback. Meredith requires a 75-125-foot setback from waterbodies. The benefit of having these local controls is they bring attention to implementation of septic setbacks.

Protection Overlay Districts

Protection overlay districts can be created to provide specialized protection for wetlands, floodplains, water supplies or watersheds. These districts isolate and protect specific resources that are not adequately covered in existing zoning regulations. As the name implies, overlay districts are laid on top of existing zoning for the purpose of

protecting critical areas. The underlying zoning remains, however, the overlay district adds supplemental requirements and provides additional protection to the resource of interest. For example, overlay protection zones can prohibit high-risk activities and land uses or require performance standards that reduce the threat of negative water quality impacts (NEIWPCC, 2000).

Some of the watershed towns have implemented protection overlay districts to afford protection to lakes, rivers, or wetlands. For example, the Town of Ashland has enacted overlay districts to protect the Pemigewasset River, Little Squam Lake, and Squam River. Center Harbor has adopted a wetlands conservation overlay ordinance. The town of Holderness has adopted an overlay district to provide protection for the Pemmigewasset River. However, there is no overlay district which provides for consistent and continuous protection for the Waukewan Watershed across the five towns. A watershed protection overlay district would provide for coordinated and effective protection.

Subdivision Regulations

Subdivision regulations can play a significant role in protecting water resources. Subdivision regulations set forth design and engineering standards and construction practices for proposed projects. Project plans must meet these standards in order to gain subdivision plan approval. When subdivision regulations are developed with water resources in mind, these regulations can promote better stormwater drainage and runoff control, environmentally sensitive sewage disposal, and promote designs which implement erosion and sedimentation controls (NEIWPCC 2000). For example, subdivision regulations can limit septic system siting and use in areas with poorly drained soil; others may require preservation of open space as part of new development projects. Subdivision regulations may also reduce the amount of impervious cover, or provide guidelines for management of stormwater runoff. These regulations may, for example, require that post development groundwater recharge be equal to predevelopment recharge. Subdivision regulations of the five watershed towns were not reviewed as part of this management plan. This review would be helpful to better analyze the protection afforded to water resources by subdivision regulations and to address the potential need for coordination among watershed communities.

Site Plan Review

The purpose of the site plan review process is to promote development which is compatible with a community's character and infrastructure. The site plan review process focuses on ensuring that environmental factors such as pollution, noise, and odor are addressed, that natural features are protected, solid waste and waste water disposal are well-managed, and sediment and erosion control is incorporated into development projects. The site plan review process can serve as a vehicle for better protecting water quality if it encourages designs which maintain the hydrological cycle and/or promote techniques to better manage stormwater. The site plan review processes in the five watershed towns were not analyzed as part of this watershed management plan. This analysis is warranted in the future.

Health Ordinances

RSA 147:1, I authorizes local health officers to make regulations (or ordinances)

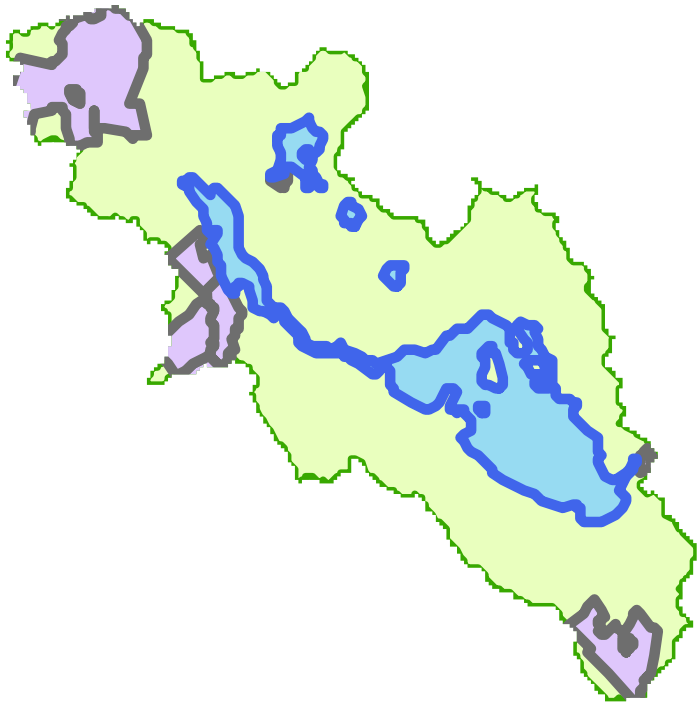
that in their judgement are required for the health and safety of the people (NH DES, 1995). Protection of public drinking water supplies clearly falls within this broad grant of power. A health ordinance is typically relatively easy to adopt. It takes effect after it is approved by a municipality's Board of Selectmen, recorded by the town clerk, and published in a newspaper of general circulation in the town, or when copies have been posted in two or more public places in town (NH DES, 1995). Health ordinances were not reviewed as part of this plan. A review would be helpful in the future.

4.3 LAND PROTECTION

Land ownership for the purpose of conservation is one of the most effective ways to protect water resources. Land ownership through fee simple ownership or conservation easements provides the most control over land use activities. Fee simple ownership refers to complete ownership of all the "bundle of rights associated with a property. A conservation easement is a permanent legal agreement between a land-owner and a public agency or private nonprofit conservation organization. Conservation easements can limit or restrict how land can be used. By placing a conservation easement on a property, the landowner transfers some of the development rights to a responsible third party, such as a land trust. The land trust is then responsible for ensuring that the easement restrictions are met.

Approximately 915 acres, 11.1% of the watershed, or 13% of the watershed land area is protected as either public or private conservation land (Figure 4.2). Conservation land is clustered in 5 subwatersheds. There are 3 larger clusters of conservation land in subwatersheds C, I, and J. These parcels occur in the towns of Meredith, New Hampton, and Ashland, respectively. Two smaller protected areas occur in subwatersheds K and A in the towns of Center Harbor and Meredith respectively.

Figure 4.2 Conservation land in the Waukewan Watershed.



The conservation parcels are protected either publicly or privately. Protection class varies. Some parcels can be partially developed, whereas others have permanent development restrictions. Approximately 80% of the conservation land exists in areas where severe development restrictions are present. Less than 1% of all lakeshores and pond shores are protected, whereas 85% of them are developed (Van de Poll, Unpublished).

Many water departments throughout the state own or purchase land in order to protect water supplies. Water systems and associated customers who have had the foresight to purchase land to protect their sources are likely to benefit from reduced public health risks and lower treatment costs. NH DES promotes this practice through the land protection grants program. Notably, the Meredith Water Department does not currently own any watershed land for the purpose of protecting the source of its water.

To better protect water resources into the future, key properties for conservation should be identified and conserved by a variety of partners.

4.4 OTHER PROTECTIVE MEASURES

Nearly all water supply watersheds extend beyond the municipalities that they serve, making protecting of these resources challenging. In 1898, a law was passed which gave the NH Board of Health the authority to develop administrative rules to better protect water supply watersheds. In 1929, regulations were adopted for "Protection of the purity of the water of Lake Waukewan in the towns of Meredith and Center Harbor." These regulations prohibited various activities. For example:

> Article 1. No privy, pigpen, stable or other building or structure in which horses, cattle, swine, or other animals or fowls are kept shall be built, continued or maintained within seventy-five feet of any bay, cove, or inlet thereto, or within seventy-five feet of any stream tributary to said lake, bays, coves, or inlets.

Currently RSA:23 gives NH DES the authority to adopt rules to protect active surface water supply sources. The forementioned administrative rule was updated and adopted in 1997 (Appendix 2). Env-Ws 386.49 retains much of the original flavor of the 1929 regulations. For example, article one is reflected in section (h)(2). The most notable difference is that the distance has been changed from seventy-five feet to "200 feet of Lake Waukewan or adjacent wetlands". Currently Env-Ws 386.49 provides for 32 restrictions. Some of the restrictions include:

- A 125 foot setback for privies, toilets, sinks, drains, or subsurface septic disposal systems
- A 200 foot setback from Lake Waukewan for the disposal of dead animals, kitchen waste, swill, garbage, or human or animal waste.
- A 200 foot setback for the location of hazardous waste
- An isolation zone which prohibits wading, swimming, waterskiing, or similar water contact activities within 400 feet of the intake of the Meredith Water Department.
- A leash law exists for dogs and pets on the Waukewan shoreline and pets are prohibited from swimming in the water.

- The cutting and taking of ice from Lake Waukewan and the adjacent wetlands is prohibited except by permission of the Meredith Board of Selectmen.
- Highway motor vehicles are not permitted on the ice of Lake Waukewan except by permission from the board of selectmen in the town where the entrance and exit are to be made.
- No horseback riding is permitted on the shoreline.

NH DES is in the process of updating these administrative rules. Enforcement of the current rule has been challenging, particularly for the Meredith Water Department. Issues surrounding regulatory authority and enforcement have been obstacles. Many of the restrictions appear outdated, while others have never been fully implemented. For example, the 400 foot body contact setback for the Water Department intake has never been fully realized and its current effectiveness is questionable.

While this rule discourages body contact, there is no restriction on potentially high risk activities such as motor-boating. Pollution from 2-cycle carbureted engines has been demonstrated to be of significant concern in other surface water supplies around the country. Approximately 30% of the fuel from these inefficient engines is directly vented to the water. Approximately half of this material is volatilized, and the remaining 15% is directly added to the water (Correll, 1999). These are a few of the issues that need to be addressed during the rule update.

4.5 CONCLUSIONS

It is important to note that while the purpose of protective measures such as local regulatory controls, land use controls, and administrative rules may be valid, without adequate enforcement, protective measures are ineffective. Implementation of existing protective measures is necessary to safeguard water quality within the watershed.

Chapter 5. Inventory of Potential Pollution Sources in the Waukewan Watershed

5.1 INTRODUCTION

An inventory of potential sources of contamination was created in order to identify areas where remedial and preventative measures in the watershed are necessary. The inventory was developed from a variety of sources. These sources include NH DES source water assessment reports for public drinking water supplies, a database search using the NH DES on-line OneStop Database, review of information provided by GRANIT GIS data layers, a windshield survey of the watershed, a best management practices survey of commercial and industrial businesses, a survey of residential land uses, and a motorboat survey for Lake Waukewan and Lake Winona.

Three types of pollution sources were reviewed as part of this inventory: nonpoint sources of pollution, point sources, and lake contact sources. Nonpoint source pollution is the primary source of contamination for surface water and groundwater (Jeer et al., 1997). Nonpoint sources of pollution contribute pollutants in an indirect pathway. As rainwater or snowmelt wash past exposed pollutants on the land's surface or in soils, water transports these pollutants into surface water or groundwater, later emerging in streams, lakes, and coastal waters (Jeer et al., 1997). This type of pollution is the accumulated result of many small actions whose origins are difficult to trace. Nonpoint source pollution may come from many places and many different types of land use including agricultural land uses, residential development, and transportation corridors.

In contrast, point source pollution can be traced to a specific point of discharge, such as a pipe, channel, or ditch connected to a wastewater treatment plant, sludge lagoon, or landfill (Jeer et al., 1997). Point sources are usually directly piped and often require permits. For the purposes of this plan, commercial, industrial, and municipal activities which require a state permit are considered to be a point source due to their known location. In comparison to nonpoint sources, point sources are often more readily managed by direct regulatory management.

Lake contact sources of pollution include recreational activities such as swimming, boating activities, snowmobiling, and use of the lake by float planes. Recreational use of source waters and the supporting land-based infrastructure necessary to support recreational activities increase the potential for microbial, physical, and chemical contaminants to enter the drinking water supply (AWWA, 2004).

5.2 REVIEW OF NONPOINT POLLUTION SOURCES

Seven general categories of nonpoint source pollution were identified in the watershed. These sources include:

- Site Development and Lot Conversion
- Agricultural Land Use
- Recreation Activities
- Residential Land Use
- Transportation Corridors

- Stormwater Management
- Utility Right-of Ways

Site Development and Lot Conversion

Site development and lot conversion occur or have the potential to occur throughout the watershed. The Lakes Region is one of the fastest growing regions in New Hampshire. During site development and lot conversion the ground is typically disturbed altering vegetation and hydrological processes. Site development and lot conversion can be sources of sediment if drainage, grading, and re-vegetation are not well-planned and controlled. The sediment that is washed into surface waters from construction sites is considered to be the greatest single nonpoint source pollutant (Jeer et al. 1997). Impacts of sedimentation on fisheries include reduction in water clarity, increases in water temperature which decrease dissolved oxygen levels, and filling in of spawning habitat. Impacts of sedimentation on wetlands include reduction in flood storage capacity. Sedimentation can also have negative impacts on drinking water supplies by damaging water treatment pumps, increasing treatment costs, and increasing the production of unhealthful disinfection byproducts.

Agricultural Land Use

According to the NH DES Source Water Assessment, agricultural land use in the watershed was assessed as a "medium" threat. This classification was based upon computer-interpreted satellite imagery. For the purposes of this inventory, golf courses and timbering are included under agricultural land use. A review and ground-truthing by the Waukewan Watershed Advisory Committee found limited agricultural land in the watershed. For example, a horse farm and portions of a golf course are located in Center Harbor. Small scale timbering currently occurs on a very limited basis throughout the watershed.

Recreation Activities

Recreation activities occur on the waterbodies and surrounding land base. Water contact activities include motor-boating, use of private watercraft, use of seaplanes, swimming, fishing, sailing, kayaking, canoeing and other non-motorized boating. During the winter snowmobiling, ice fishing, and dog-sledding occur. Recreational activities on the land base include hunting, use of all terrain vehicles, horseback riding, and mountain biking. Of all of these activities motor-boating, swimming, and use of seaplanes pose the greatest threats. A more detailed description of lake contact threats is discussed in section 5.4 Lake Contact Sources of Pollution.

Residential Land Use

Residential land use poses threats to water resources from several sources. For example, potential contamination sources include residential fuel storage, septic systems, landscape care, and household hazardous waste.

Residential Heating Fuel Storage

Residential heating fuel tanks are potential sources of contamination because they are prone to leaks due to line breakage, corrosion, and fitting and filter leaks (Freill, 2004). Over-filling of tanks is also a concern. The primary pollutants associated with

residential heating fuel are volatile organic chemicals which can have negative impacts on fisheries and human health.

The location of residential heating fuel tanks is significant. For example, residential heating fuel tanks consist of aboveground storage tanks which are located outside and inside tank installations which are usually located in a basement. There are two common concerns associated with outside tanks. Aboveground storage tanks should be located on an impermeable surface to prevent leaching of fuel spills into the groundwater and the tank themselves should be protected from harsh weather conditions. Tanks may tip over or become damaged due to ice and snow. Often tanks are not located on an impermeable surface and do not have weather protective structures. Inside tanks are typically located in finished or unfinished basements. Finished basements provide some spill or leak containment. In contrast, unfinished basements do not have a physical barrier which helps to contain spills. Finished basements may also have sump pumps to alleviate wet conditions. Although useful for removing water, sump pumps can accidentally pump fuel or fuel-contaminated water into groundwater resources or directly into surface water.

In order to gain a better understanding of potential sources of contamination associated with residential land use concerns, the Waukewan Watershed Advisory Committee conducted a survey of homeowners along the shorelines of Lake Waukewan and Lake Winona. Personal interviews were conducted from August to September in 2004 to assess types of drinking water used, recreational use of the lakes, septic system use and maintenance, and information about residential heating fuel storage.

Shoreline residents were asked questions about their fuel source, the age of the storage tank, and the occurrence of fuel spills. Along the shoreline of Lake Waukewan approximately 37% of the respondents use fuel oil, 27% use a combination of electric and another energy source such as wood or kerosene, 23% use propane, 7% wood, and 6% heat only with kerosene. For those homeowners that use fuel oil, 13% of respondents did not know how old their storage tank was. Approximately 12% indicated that their tank was older than 25 years old, 26% indicated their tanks were 15 to 25 years old, 26% indicated their tanks were 5 to 15 years old, and 23% indicated their tanks were less than 5 years old. Although tanks can last somewhat longer, warrantees for state of the art double walled tanks are for approximately ten years. Along the shoreline of Lake Winona 23% of respondents use propane, 16% use wood, 26% use oil, 13% use kerosene in combination with wood or propane, 10% use electricity for their heat source, 6% use electric heat and wood, and 6% have no heat source. For those households with oil heat, 22% have tanks older than 25 years old, 22% are 15 to 22 years old, 34% are 5 to 15 years old, and 22% are less than 5 years old.

Three known residential oil spills have occurred in the watershed: one in subwatershed K in Center Harbor, one in subwatershed P in Meredith and one in subwatershed A in Meredith. Two of the reported spills were reported in the GIS data provided by NH DES. This data indicated that the spill in subwatershed K has been classified as “closed” by NHDES and one in subwatershed P has been assigned for staff management. The third spill was reported during the residential survey.

Wastewater Disposal

Everything that goes down the drain, into the toilet, dishwasher, and clothes washing machine goes to some type of waste water disposal system. In the watershed there are two general categories of wastewater disposal systems: a system associated with an individual home and a municipal sewer system. The majority of households in the watershed dispose of their waste water using individual systems which include septic systems, cesspools, and holding tanks. Of these three types of disposal systems, septic systems are the most common. At the southern end of the watershed in subwatersheds A, B, C, D, and E, a municipal sewer system is present.

When wastewater disposal systems fail they can be sources of bacteria, viruses, and protozoa which can cause gastrointestinal illness. They can also be sources of pollutants from improper disposal of household hazardous waste. Both types of systems, sewers and individual wastewater disposal systems are capable of failure. Municipal sewer systems are typically managed by professional staff. Individual systems, on the other hand, often receive less attention after they have been installed. Typically the homeowner is responsible for ensuring proper system operation and maintenance. Septic systems should be maintained by pumping out wastes approximately every 3-5 years.

When septic systems function properly they can process household organic waste and destroy disease-producing bacteria. The most commonly approved system consists of a septic tank connected to a leach field. Wastewater first flows to the septic tank where heavy solids sink to the bottom. Grease, oils, and lighter solids rise to the top where they form a layer of scum. Beneficial bacteria which are naturally present in materials that are flushed into the system, decompose the biodegradable waste. Liquids flow from the tank to the leach field where unhealthful bacteria, viruses, and some phosphorus are removed. Eventually the filtered water flows to the water table (CRJC, 1994). A failed system jeopardizes public health, is a neighborhood nuisance, and negatively impacts water quality in the watershed.

According to the NH DES Source Water Assessment Report, septic systems were assessed as having a “High” risk for Lake Waukewan. A residential survey conducted by the Waukewan Watershed Advisory Committee along the shoreline of Lake Waukewan found that 69% of survey respondents had septic systems, 24% were connected to a municipal sewer, 3% had cesspools, 3% had holding tanks, and 1% did not know what type of wastewater disposal system they had. Of those respondents with septic systems, 15% responded that the systems were installed prior to 1967, 8% were installed between 1967-1975, 19% were installed from 1975-1985, and approximately 50% were installed after 1985. Approximately 8% of respondents did not know when their system was installed. Respondents with septic systems were asked if they would be interested in sewer service if it became available. Approximately 80% of respondents responded “yes”, 16% responded “no” and 4% responded “maybe”.

Along the shoreline of Lake Winona 80% of respondents had septic systems and 20% had holding tanks. Approximately 23% of the systems were installed before 1967, 13% were installed between 1967 and 1985, and 61% were installed after 1985.

It is difficult to assess current levels of septic system maintenance in the watershed. None of the watershed communities collect information on septic system maintenance. There are no septic system maintenance ordinances, tracking programs, or municipal septic system programs present in the watershed. The purpose of septic

system ordinances is to promote inspection and periodic pump-outs to prevent system failure. A tracking program is a non-regulatory way to ensure that septic systems are functioning. The program typically requires registration of all systems and encourages routine system inspections and pumpings. Under a municipal system, the municipality assumes responsibility for maintenance and repair of septic systems. Homeowners are charged an annual fee for this service.

Prior to executing a purchase and sale agreement for any "developed waterfront property" using a septic disposal system, an owner is required to engage a permitted subsurface sewer or waste disposal system designer to perform an on-site assessment study (RSA 485-A:39). "Developed waterfront property" means any parcel of land which is contiguous to or within 200 feet of a great pond as defined in RSA 4:40-a and upon which stands a structure suitable for either seasonal or year-round human occupancy. A “great pond” is defined in RSA 4:40 as "... a public waterbody of more than 10 acres." The site assessment study is required whenever any part of the property is within 200 feet of the great pond, not merely when the structure or the septic disposal system is within 200 feet of the water. Relevant Law includes RSA 4:40-a, 485-A:2, 485-A:39 and Administrative Rule Env-Ws 1025.

Of the five watershed towns only Meredith has established a hardship fund for septic system repair/replacement.

Lawn care

Nutrients and pesticides are common pollutants associated with lawn care and gardening activities. Pesticides are sources of synthetic organic chemicals. These chemicals can be washed from lawns during a rain event, transported to surface water where they can bioaccumulate in fish tissue. Once these chemicals enter the drinking water supply they can pose potential health risks. Fertilizers are a source of nutrients such as Nitrogen and Phosphorus. Excess additions of these nutrients to waterbodies can result in increased frequency and mass of algal blooms. Algal blooms tend to increase water treatment costs, cause odors and poor taste and in some cases the blooms can be toxic.

Much of the natural shoreline of Lake Waukewan has been removed and replaced with lawns. The Shoreland Protect Act requires that limestone be used to fertilize lawns within 25 feet of the reference line of a great pond. Further from the shore, beyond 25 feet of the reference line only low Phosphate, slow release Nitrogen fertilizer or lime can be used. As part of the residential survey, the Waukewan Watershed Advisory Committee asked shoreline residents about fertilizer use within the last year. Along the shores of Lake Waukewan, approximately 76% had not used fertilizer, 20% had used fertilizer, and 4% did not have lawns. A similar pattern was found for respondents living on the shores of Winona. Approximately 78% had not used fertilizer, 9% had used fertilizer and 13% did not have lawns.

Transportation Corridors

Transportation corridors include roads, highways, and railroad right-of ways. Roadways serve as potential sources of contamination because these impervious surfaces accumulate de-icing materials and chemicals from automobiles. Stormwater runoff carries these pollutants to nearby waterways and groundwater.

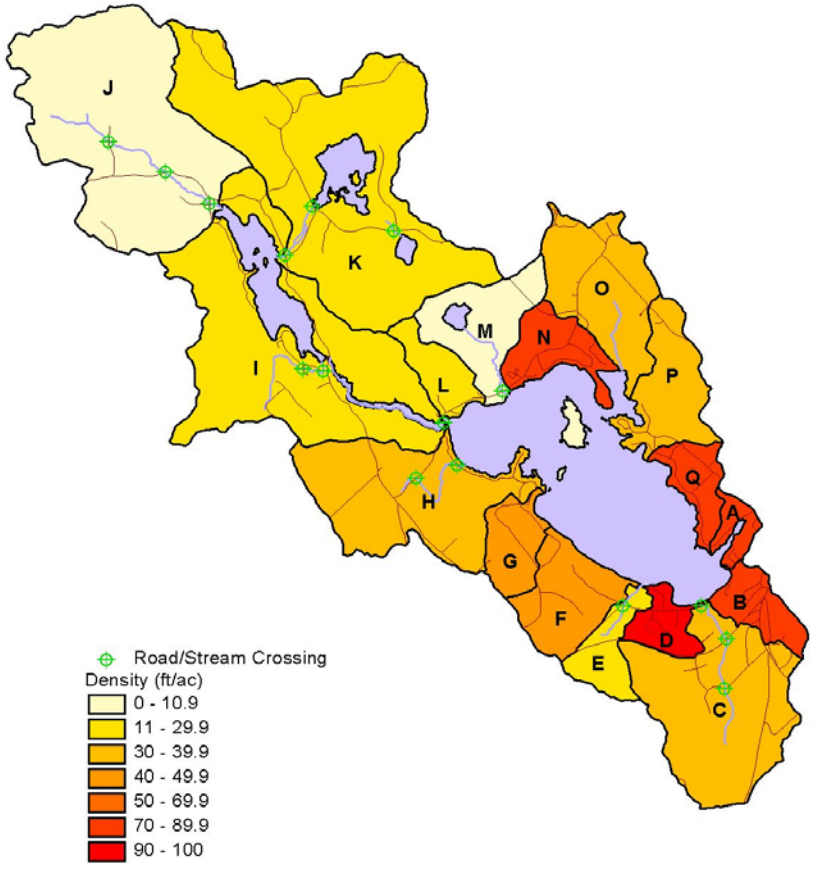
In the watershed, there are approximately 52 miles of roads. Some subwatersheds

have higher densities of roadways than others. For example, subwatersheds A, B, D, N, and Q have road densities greater than 70 feet per acre (Figure 5.1). In addition, where roadways cross streams, the potential for stormwater runoff to enter surface water without adequate treatment increases. In the watershed there are 16 documented road and stream crossings. The number of intersections is greatest in subwatersheds C, J, and K where there are three documented crossings per subwatershed.

The NH DES Source Water Assessment report ranked transportation corridors as having a "medium" risk in the watershed. Water quality data collected by the Volunteer Lake Assessment Program for Lake Waukewan found specific conductivity levels to be at levels indicative of "human impact". In Lake Winona conductivity levels were above the state average. Conductivity is a measure of water's ability to conduct electricity, and therefore a measure of the water's ionic activity and content. The higher the concentration of ionic (dissolved) constituents, the higher the conductivity level is of the water.

Conductivity is generally found to be a good measure of the concentration of total dissolved solids (TDS) and salinity in a waterbody. Road salt, non-point source pollution (for example, agricultural run-off) and industrial inputs tend to increase conductivity levels as their intensity and frequency increase. Because of the elevated conductivity levels present in Lake Waukewan and Lake Winona, and the number of road and stream crossings, contaminants from roadways is one of the primary suspected sources.

Figure 5.1 Map of road density by subwatershed and road and stream crossings in the Waukewan Watershed. (Map prepared by R. McCann, Town of Meredith).



Also present in the watershed is a railroad right-of-way. The right-of-way passes along the western shores of Lake Waukewan and Lake Winona traveling though subwatersheds B, C, D, E, F, G, H, I, and J (Figure 5.2). Railroad right-of-ways can be sources of organic chemicals and sediments. Pesticides are often used to eliminate vegetation on railroad right-of-ways and erosion can result from improper railroad bed and culvert maintenance. In the Waukewan Watershed stockpiles of used railroad ties are located along the right-of-way, which in many case are in close proximity to surface water. Creosote is commonly used to preserve the railroad ties from deterioration. Creosote is a mixture of many chemicals. Coal-tar creosote is the most widely used wood preservative in the United States. About 300 chemicals have been identified in coal-tar creosote. The major chemicals in coal-tar creosote that can cause harmful health effects are polycyclic aromatic hydrocarbons (PAHs), phenol, and cresols. Some creosote components are taken up by plants to a limited extent. More commonly, they absorb to plant roots. Both terrestrial and aquatic animals have been observed to bioaccumulate creosote components. Some components of creosote (for example, phenols and nitrogenous bases such as aniline, toluidines and xylidines) are water soluble. They migrate easily from contaminated soils or ties.

Stormwater Management

Stormwater runoff occurs when the capacity of soils and vegetation to absorb water from precipitation is exceeded and water flows across the land's surface. In developed areas, natural vegetation and permeable soils are replaced by tracts of impervious surfaces such as roads, parking lots, rooftops, driveways, sidewalks, and compacted fill. Because water cannot penetrate the impervious surfaces, it runs off into gutters and storm drains picking up toxins and suspended solids along the way. In undeveloped areas, water infiltrates the soil where some pollutants can be treated by natural processes. In contrast, in developed areas, the rate of stormwater runoff increases allowing for less time for natural pollutant treatment and increasing the volume of water flow.

According to the Environmental Protection Agency, contaminated stormwater discharges are responsible for the impairment of one-third of all assessed waters in the United States. Common stormwater pollutants include sediments, toxic chemicals (e.g. cyanide, phenolics, and trichloroethylene), metals, oxygen depleting chemicals, fecal coliform, oil, grease, pesticides, fertilizers, and trash (Ballestero et al., 2005).

Little is known about the quality and location of stormwater runoff in the watershed. No water quality monitoring of stormwater has occurred and the identification and location of stormwater inflows is in the very early stages. Also important for determining the potential volume of stormwater runoff is the percent impervious cover present in the watershed. Percent impervious cover has yet to be determined for the Waukewan Watershed. Research has shown that percent of imperviousness cover in a watershed can be used to estimate current and future water quality of subwatersheds (Zielinski, 2002).

Utilities

There are two potential sources of contamination associated with utilities in the watershed: power-line right-of-ways and a sewer system. Pesticides are commonly sprayed to manage vegetation growth on the right-of-ways. Pesticides are sources of

synthetic organic chemicals. Prior to spraying, utilities are required to give notice to municipalities. There is a power-line which runs through Center Harbor and New Hampton in subwatersheds I, L, M and O.

The Meredith Sewer System is another potential source of contamination. When sewer systems malfunction or sewer lines rupture, they can be sources of bacteria, viruses, and nutrients. The Meredith Sewer System is present in subwatersheds A, B, C, and D. Through proper monitoring and maintenance of the sewer system, potential sources of pollution can be minimized.

Table 5.1 Sources of potential contamination by subwatershed in the Waukewan Watershed, New Hampshire.

Subwatershed	Pollution Sources
A	Roads Dense Residential Development Municipal Sewer Residential Heating Tank Leak
B	Roads Residential Land Use Municipal Sewer Railroad Right-of-Way Swimming Beach 1- NH DES PCS Inventory Site (funeral home) 1- Underground Storage Tank 1- Groundwater Hazards Inventory Site (water treatment plant - underground injection control)
C	Roads Municipal Sewer Railroad Right-of-Way 7 – NH DES PCS Inventory sites (i.e. metal working, earth excavation equipment, medical center, animal hospital, hair salon, cleaning service, manufacturing) 3-Underground Storage Tanks 2- RCRA site (soft sculpture doll factory, plastic mold manufacturer) 1- Hazardous Waste site (unassigned)
D	Roads Municipal Sewer Railroad Right-of-Way 2- NH DES PCS Inventory Site (street cleaning service, cleaning service)
E	Roads Municipal Sewer Residential Development Railroad Right-of-Way 3- NH DES PCS Inventory sites (2 general service and repair shops, metal working shop) 1- Ground Water Hazard site (a removed leaking underground storage tank) 1- RCRA site (digital printing machine manufacturer)
F	Roads Residential Development Railroad Right-of-Way 1 - NH DES PCS Inventory Site (Manufacturing) 1 - RCRA Site (lumberyard)
G	Roads Residential Development Railroad Right-of-Way Swimming Beach
H	Roads Residential Development Railroad Right-of-Way

Subwatershed	Pollution Sources
I	Roads Residential Development Power-line Right-of-Way Railroad Right-of-Way
J	Roads Residential Development Railroad Right-of-Way
K	Roads Residential Development Sand and Gravel Operation Residential Heating Tank Leak 1 – RCRA Site (Machine Shop)
L	Roads Residential Development Power-line Right-of-Way
M	Roads Residential Development Power-line Right-of-Way
N	Roads Residential Development Swimming
O	Roads Residential Development NH DES PCS Inventory (general service and repair shop) Golf Course
P	Roads Residential Development Residential Heating Tank Leak
Q	Roads Residential Development

5.3 REVIEW OF POINT POLLUTION SOURCES

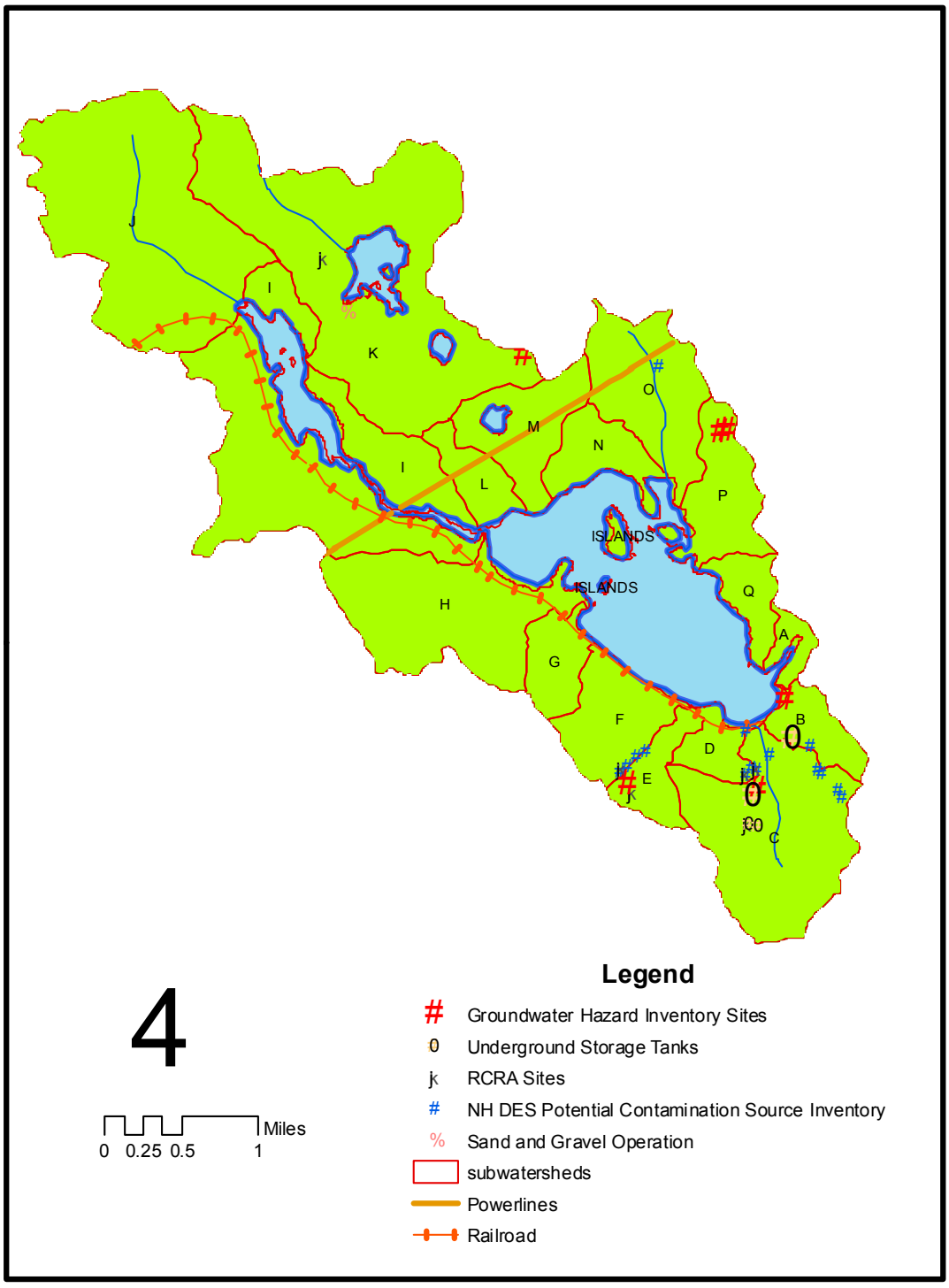
As mentioned previously commercial, industrial, and municipal activities which require a state permit were considered to be point sources as part of this plan because they are potential sources of contamination and they have a known location. This inventory of point sources in the watershed was created by conducting a state database review using the NH DES OneStop on-line database, a Best Management Practices Survey of Commercial and Industrial entities, a windshield survey, and reviewing available GRANIT GIS data layers. This review found a total of 35 commercial and industrial sites. The majority of sites were located in the Town of Meredith. Many of these include Meredith's largest employers. Facilities include: auto repair shops, color ink machinery manufacturer, ink manufacturer, nursing home, metals and plastics manufacturing, soft sculpture doll manufacturing, a street sweeping service, a building materials store, among others. The primary pollutants of concern from these sources include: volatile organic chemicals, synthetic organic chemicals, and metals.

This review found that five of these facilities were classified as "hazardous waste handlers" or Resource Conservation and Recovery Act (RCRA) sites. These sites store, manage, or generate hazardous substances which are, for example, ignitable, corrosive, or toxic. These sites are located in subwatersheds C, E, and K. All but two of these sites have been assigned to NH DES project managers for oversight.

There are four known underground storage tanks in the watershed. The locations of these tanks were identified by the Underground Storage Tank GIS data layer provided by NH DES and from information collected during the inventory of commercial and

industrial businesses conducted by the Meredith Water Department. One underground storage tank is located in Subwatershed B, two are located in subwatershed C, and one is located in subwatershed D. Underground storage tanks are considered a risk to water resources due to the potential for leaks, spills, and vapor leaks. Petroleum leaks and spills are sources of volatile organic chemicals.

Figure 5.2 Map of potential sources of contamination.



5.4 LAKE CONTACT SOURCES OF POLLUTION

Motor-boating

According to the NH DES Source Water Assessment Report for Lake Waukewan and the Meredith Water Department, "motorboats, particularly those using two-stroke outboard motors, present a potential threat of contamination of water supplies by gasoline. While gasoline contains many compounds, of particular concern is MtBE, a highly soluble chemical which is a possible human carcinogen and has been shown to produce cancer in laboratory animals". MtBE can cause kidney and liver damage and creates an increased risk of cancer (NH DES Analytical Requirements for Community Public Water Supplies, 2004). Although EPA has placed MtBE on the Drinking Water Contaminant Candidate List, the Agency has not yet set a maximum contaminant level for this compound. In 2000, NH DES adopted a drinking water standard of 13 ug/liter for MtBE.

According to the Meredith Water Department, volatile organic chemical tests (which include measurement of MtBE) have not detected MtBE near or above 13 ug/ liter. Prior to the 2005 boating season, the Meredith Water Department conducted volatile organic chemical tests during the month of February, as prescribed by the testing schedule established by NH DES Water Supply Engineering Bureau. The boating season typically runs from May to October.

A 2004 survey of motorboat engine types conducted by the Waukewan Watershed Advisory Committee found that approximately 80% of the outboard motors regularly used on Lake Waukewan were carbureted two-cycle engines. Approximately 88% of the outboard motors on Lake Winona are carbureted two-cycle engines. Carbureted two-cycle engines are particularly inefficient because they exhaust approximately 30% of their unburned fuel directly into the water (Correll, 1999). Roughly half of the exhausted fuel, depending on water and air temperatures, immediately evaporates while approximately 15% persists in the water column for some amount of time (Kratzenberg, 1997). Two-cycle engines can be used by both motorboats and private watercraft.

The American Water Works Association recommends that utilities and other responsible parties monitor water quality to assess the impacts of recreation activities such as motor-boating. In addition, AWWA advises that the water utility should work with other stakeholders to develop an integrated plan to evaluate and, if necessary, mitigate water quality impacts (AWWA, 2004). The American Water Works Association discourages body contact recreation and use of polluting two-cycle gasoline engines in sources that supply public drinking water (AWWA, 2004).

Swimming

Use of lakes for water-based recreational sports, such as swimming, may be considered an asset by many communities. However, in many cases lakes which are used for swimming are also used as the primary source for drinking water supplies. These dual objectives can lead to resource use conflicts. Swimming poses a risk for drinking water supplies which use surface water as a primary source. Swimming is a known source of fecal contaminants in lakes and reservoirs that permit this activity (Stewart et al., 2002). During swimming activities, swimmers may accidentally

introduce pathogens, such as *cryptosporidium,* that are resistant to treatment. A recent study on the public health consequences of body-contact recreation found that the placement of recreational activities is an important factor in safeguarding public health. For example by locating swimming activities at a distance from water intake structures, the level of pathogens that enter a drinking water treatment plant can be attenuated (Stewart et al.).

Seaplanes

Lake Waukewan is used for seaplane training purposes and transportation to homes along the shore. Seaplane operations on Lake Waukewan represent less of an environmental risk than carbureted two-cycle engines because seaplane engine exhaust is discharged to the air. In addition, aviation fuel is not mixed with oil so there is less oil present in seaplane exhaust. Furthermore, aviation fuel does not contain MtBE like gasoline powered engines (Seaplane Pilots Association, 2000). Unlike motorboats, seaplanes are required to have annual inspections, pilots are trained and certified, and there is limited contact time with the waterbody.

Although the risk to water resources is less than that of carbureted two-cycle engines, seaplanes do pose a level of risk to Lake Waukewan. For example, Lake Waukewan is used by pilots-in–training to practice take-offs, landings, and touch-and-go's on the lake's surface. Use by pilots-in-training represents a higher level of risk than use by experienced pilots. If a catastrophic seaplane crash were to occur near the intake of the Meredith Water Supply, the effects could be significant and costly. Accidents have occurred in other surface waterbodies that serve as water supplies in New Hampshire. For example, in the last decade a seaplane crash occurred in Lake Sunapee Lake Sunapee is the source of drinking water for the Town of Sunapee.

Chapter 6. Recommendations for Resolving Local Water Quality Concerns

6.1 INTRODUCTION

This chapter summarizes the risk and priority setting process used to identify watershed concerns and the recommendations developed by the Waukewan Watershed Advisory Committee. Specific recommendations have been identified and are listed as "objectives" below. In order to help implement these objectives, the committee developed concrete tasks or "strategies". These objectives will be shared with watershed municipalities and others with the goal that the recommendations from this plan will be implemented.

6.2 IDENTIFICATION OF RISKS AND PRIORITIZATION

In order to assess risks in the watershed, an inventory of potential sources of contamination was created (see Chapter 5 for methodology). This list was evaluated by the Waukewan Watershed Advisory Committee using a data-driven 3-step risk assessment and priority setting process. The first step was to summarize the types of pollutants associated with each pollution source. The committee researched the types of pollutants associated with various sources and the potential effects of these pollutants on fisheries, water supply, wetlands, and recreation. The second step was to assign the pollutant source an overall risk based upon factors including: proximity to waterbodies, spatial area occupied by the source, magnitude of potential effects of the pollutants, likelihood to migrate to a public water system, likelihood to migrate to a private water system, and compliance of the facility. The third step was to identify existing regulatory authority established to manage these pollutant sources and to reflect on the effectiveness of these statutes and regulations in the watershed. Information from these three steps was considered when prioritizing watershed concerns. Each Committee member identified eight of their highest watershed concerns based upon this process. The Committee's concerns were ranked based upon the number of times a concern was mentioned and depending upon where the concern appeared in a member's list of priorities. This process yielded ten primary concerns. They are listed in order of priority:

1. Septic Systems
2. Site Development
3. Motor-boating
4. Stormwater
5. Roads
6. Residential Heating Fuel Storage
7. Lawn Care
8. Discarded Railroad Ties
9. Meredith Sewer System
10. Body Contact in a Surface Water Supply

Recommendations were developed for each pollution source listed above. While recommendations were being developed to address these concerns, a list of associated

miscellaneous concerns evolved. These include the need for additional research and monitoring, limiting seaplane use of Lake Waukewan, and continuation of the Waukewan Watershed Advisory Committee.

6.3 RECOMMENDATIONS FOR IMPROVING WATER QUALITY

The Committee's recommendations or "objectives" have been classified under five general goals. These goals are:

GOAL #1: Reduce pollution from nonpoint sources in the watershed.

GOAL #2: Reduce pollution from water contact activities.

GOAL #3: Reduce pollution from point sources.

GOAL #4: Increase understanding of the watershed through research and monitoring.

GOAL #5: Continue watershed protection activities and continue to raise awareness about the watershed.

Each objective is followed by a number of "strategies". Strategies are specific actions which can be implemented in order to meet the objective. The overall emphasis is on improving water quality by addressing specific issues and identifying particular tasks. The strategies are being developed from the ground up, and some may evolve as they are implemented.

The objectives and strategies are listed in a "report card" format which specifies potential lead agencies, partners, funding sources, timeline and benchmarks. When it comes time to review the efficacy of watershed protection activities, this format can aid in the evaluation process. Goals, objectives and strategies are presented as a narrative in this chapter and also summarized in Table 6.2.

Figure 6.1 Report card format of goals, objectives, and strategies.

GOAL: (to improve water quality)

- **Objective** (To implement effective practices that will improve water quality)

Strategy (The specific practice that can be implemented to achieve the objective)

- **Potential Lead Agency and Partners:** Describes a likely candidate for implementing the strategy and highlights potential partners.
- **Potential Funding Sources:** Identifies potential sources for financial support
- **Time frame:** The anticipated time it will take for either implementation of the strategy or to bring about the desired outcome of implementation.
- **Benchmark:** The desired outcome of the strategy.

GOAL #1: REDUCE POLLUTION FROM NONPOINT SOURCES IN THE WATERSHED.

GOAL #1: To reduce nonpoint source pollution.

· Objectives (Listed from highest priority)

1. Reduce nutrient, bacteria, and virus inputs from septic systems that enter water resources.

2. Reduce the amount of sediments from site development.

3. Reduce the quantity of pollutant inputs (e.g. salts, nutrients, metals, oils, volatile organic compounds) from stormwater runoff.

4. Reduce the quantity of pollutant inputs (e.g. salts, nutrients, metals, oils, grease, and volatile organic compounds) from road systems.

5. Reduce sources of volatile organic chemicals from residential heating fuel storage and use.

6. Reduce nutrient inputs and sources of synthetic organic chemicals from lawn and garden care.

Nonpoint source pollution represents the primary source of contamination of surface water and groundwater (Jeer et al. 1997). This type of pollution originates from rainwater or snowmelt washing past exposed pollutant sources and transporting sediments and/or chemicals to water resources. The pollution may come from many places including constructions sites, lawns, gardens, industrial sites, streets, and farms. Nonpoint source pollution can have major impacts on public health through the contamination of drinking water supplies. Pollutants may flow directly into surface water or slowly infiltrate into the ground, emerging later in wells, streams, lakes, and coastal waters. Reducing the quantity of nonpoint source pollution often requires a multi-pronged approach specifically designed to meet the conditions found in individual communities or regions. As discussed in Chapters 3 and 5, there are a number of nonpoint sources which are contributing pollutants in the Waukewan Watershed. These pollutants are likely contributing to decreased dissolved oxygen levels, increased phosphorus and sodium concentrations, and increased conductivity values in Lake Waukewan and Lake Winona. Six objectives have been identified to decrease the inputs of pollutants from sources that affect these types of water quality parameters.

- ***Objective #1: Reduce nutrient, bacteria, and virus inputs from septic systems.***

  Rationale

  Septic systems are used to treat wastewater from toilets, washbasins, bathtubs, washing machines, and other water-consumptive items. Septic systems are comprised of a septic tank and a leaching facility. The septic tank provides for some treatment and the separation of solids and liquids. The leaching facility serves to dispose of liquid wastes. The effectiveness of septic systems strongly depends on proper design, proper construction, site conditions and timely inspection and maintenance. When septic systems are not functioning properly, they can be sources of bacteria, viruses, and nutrients, such as phosphorous and nitrogen. Septic system failure is likely to result in human contact with human excrement and possible exposure to infectious organisms capable of causing diseases such as dysentery, infectious hepatitis, meningitis, typhoid, various types of diarrheal illnesses,

and other diseases (Jeer et al., 1997). Nutrient inputs from septic systems contribute to algal blooms and eutrophication of ponds, lakes, and coastal estuaries.

When septic systems are improperly used to dispose of household hazardous waste (e.g. paints, oil/grease, cleaners, solvents), septic systems can also be a source of polluting volatile organic compounds. The most commonly identified volatile organic compounds identified in septic system effluent include benzene, toluene, dichloromethane, and chloroform (Jeer et al., 1997). These chemicals can pass through a septic system and reach ground or surface waters where they exert toxic effects on organisms.

Although many municipalities in the watershed have improved the efficacy of on-site sewage disposal regulatory programs, most have not implemented a comprehensive management approach which addresses everything from installation, operation, maintenance, monitoring, and education.

Strategies

A. Develop and implement a septic system inspection program. The goal of this program is to identify failed systems in the 250 foot shoreline zone around Lake Waukewan and Lake Winona, in order to promote system repair or replacement.

- **Potential Lead Agencies:** Watershed Municipalities
- **Potential Funding Sources:** NH DES Drinking Water Source Protection Program, NH Watershed Assistance Grants, EPA Targeted Watershed Grants Program
- **Time frame:** Implement program by 2007.
- **Benchmark:** A septic system inspection program is identifying failed systems in the 250 foot shoreline zone of Lakes Waukewan and Winona.

B. Educate homeowners about septic systems use and maintenance.

- **Potential Lead Agency and Partners:** Watershed Municipalities, Waukewan Watershed Advisory Committee, Meredith Water Department, Home Owners Associations, and Lake Associations.
- **Potential Funding Sources:** In-kind support, NH DES Small Outreach and Education Grant Program for Nonpoint Source Pollution.
- **Time frame:** On-going
- **Benchmark:** Homeowners are educated about septic system use and maintenance by educational brochures, information on local access television channel, articles in home owner association and lake association newsletters, and articles in local papers.

C. Create a water quality monitoring program to identify failing septic systems along the shorelines.

- **Potential Lead Agency and Partners:** Watershed Municipalities, Plymouth State University, Waukewan Watershed Advisory Committee, Interlakes High School, Interlakes Environmental Science.
- **Potential Funding Sources:** NH DES Watershed Assistance grant program, NH DES Drinking Water Source Protection Program
- **Time frame:** Develop program by 2007.
- **Benchmark:** A program has been created to identify failing septic systems along the shorelines of Lake Waukewan and Lake Winona.

D. Tie replacement of septic systems to the building permit process.

- **Potential Lead Agency and Partners:** Watershed Municipalities
- **Potential Funding Sources:** N/A
- **Time frame:** Encourage watershed communities to adopt this measure by 2007.
- **Benchmark:** Watershed communities will amend their building permit review process to include reviews of septic system capacity and functioning. When deemed necessary as part of this process, septic system augmentation, repair or replacement will be required.

E. Establish a finance program for cases of economic hardship.

- **Potential Lead Agency and Partners:** Watershed Municipalities, NH DES, Private Sector.
- **Potential Funding Sources:** undeclared.
- **Time frame:** 2007.
- **Benchmark:** A finance program(s) to assist with economic hardship cases will be established in the watershed communities for septic system replacement.

- ***Objective #2: Reduce pollution from site development projects.***

Rationale

New residential, commercial and industrial development can increase levels of nonpoint pollution and can negatively impact naturally occurring hydrologic functions. Site disturbance can increase erosion and sedimentation. Increases in sediment loads can increase surface water temperatures, decrease dissolved oxygen content, and cause turbidity problems. Sediments may also carry nutrients such as phosphorus that can stimulate plant growth in lakes and ponds. Increases in impervious cover (roofs, roads, sidewalks, parking lots etc.) associated with new development increase the amount of stormwater runoff, reduce natural infiltration and increase nonpoint pollution. Natural vegetated areas that buffer the impact of increased runoff and pollution levels are often reduced by development.

The Lakes Region is one of the fastest growing regions in New Hampshire. The five watershed communities are desirable communities to live in and are readily accessible via a network of state and local roads. Large areas within the Waukewan Watershed remain undeveloped and will continue to be the object of future development pressure.

Strategies

A. Adopt a watershed overlay district which directs development away from ecologically sensitive areas, guides construction and development, and prohibits high risk land uses.

- **Potential Lead Agencies:** Watershed Municipalities
- **Potential Funding Sources:** NH DES Drinking Water Source Protection Program
- **Time frame:** Adopt ordinances by 2007.
- **Benchmark:** All watershed communities have adopted a watershed overlay which protects the Waukewan Watershed.

B. Identify and conserve key properties which protect drinking water supplies and sensitive ecological features in the watershed.

- **Potential Lead Agencies and Partners:** Conservation Commissions, Land Trusts, Lakes Region Conservation Trust
- **Potential Funding Sources:** NH DES Drinking Water Supply Land Grant Program, local funding mechanisms such as general fund appropriations and legislatively approved tax increases, the federal Land and Water Conservation Fund, Land and Community Heritage Investment Program (LCHIP), private sources, and Lakes Region Conservation Trust.
- **Time frame:** Ongoing
- **Benchmark:** Parcels are purchased to protect drinking water supplies and significant ecological features through fee simple acquisition, conservation easements, tax incentives, or other funding techniques.

C. Require erosion controls best management practices through the development review process, including construction inspection and site stabilization.

- **Potential Lead Agencies and Partners:** Planning Boards, Code Enforcement Officers
- **Potential Funding Sources:** N/A
- **Time frame:** 2007
- **Benchmark:** Watershed communities will update the development review process to include erosion controls from construction to site stabilization. Site design should ensure that after stabilization, erosion

and sedimentation are no greater than before construction (to the extent possible).

D. Adjust the Site Plan Review/Subdivision Review Processes to encourage designs which maintain existing hydrologic processes and functions.

- **Potential Lead Agencies:** Planning Boards
- **Potential Funding Sources:** N/A
- **Time frame:** 2007
- **Benchmark:** Watershed communities update site plan review and subdivision review processes to incorporate stormwater management techniques that protect water quality and quantity (e.g. Low Impact Development).

E. Encourage better site design for residential lot conversion which incorporates best management practices for stormwater management and erosion control. Update the Building Permit process and provide education to promote these changes.

- **Potential Lead Agencies:** Planning Boards
- **Potential Funding Sources:** N/A
- **Time frame:** 2007
- **Benchmark:** The building permit process in the watershed municipalities is adjusted to promote implementation of stormwater management and erosion control when lots are converted to residential use. Educational materials are developed to foster better site development.

F. Educate residents and contractors about the sensitivities of shoreline areas and the provisions of New Hampshire's Shoreland Protection Act.

- **Potential Lead Agencies and Partners:** Conservation Commissions, Home Owner Associations and Lake Associations, NH DES
- **Potential Funding Sources:** In-kind
- **Time frame:** 2007
- **Benchmark:** Educational materials will be developed and distributed to residents and contractors to increase awareness about the NH Shoreland Protection Act.

G. Watershed communities which border the same waterbody should work cooperatively to protect this resource by employing a single code enforcement officer for purposes of permitting, inspection, and compliance.

- **Potential Lead Agencies:** Watershed Municipalities
- **Potential Funding Sources:** In-kind
- **Time frame:** 2007
- **Benchmark:** Watershed communities which border the same waterbody will employ a single code enforcement officer for purposes of permitting, inspection, and compliance.

- ***Objective #3: Reduce the quantity of pollutant inputs (e.g. salts, nutrients, metals, oils, volatile organic compounds) from stormwater runoff.***

Rationale

Developed land contributes large amounts of contaminants to waterbodies via stormwater runoff. Developed areas are characterized by a higher percentage of impervious surface coverage. As water runs off, it picks up pollutants accumulated from leaking vehicles, atmospheric deposition and from human activity. Pollutants typically found in stormwater include nutrients, suspended solids, bacteria, hydrocarbons, metals, pesticides and salts.

When land is developed, its natural capability to filter pollutants is reduced. The velocity of stormwater typically increases (as compared to natural conditions) which in turn can cause flooding, erosion and turbidity. As runoff volume increases, natural rates of groundwater infiltration decrease. Groundwater is an important source of drinking water and replenishment of this resource is critical. Groundwater also naturally discharges into streams, lakes, and ponds that support aquatic systems. Alteration of these naturally occurring processes can have negative consequences throughout the hydrological cycle.

Precipitation is the major transport mechanism for nonpoint source pollution. A direct relationship exists between the timing and magnitude of precipitation events and the resulting level of stormwater runoff. Factors which affect the rate at which precipitation becomes runoff include soil moisture conditions at the time of precipitation, vegetation type and density, and amount of impervious surface (Jeer et al. 1997). Larger and more intense rain events carry more pollutants and generally the first inch of rain creates a "first flush" which carries most of the pollutants into downgradient waters.

Strategies

A. Implement a comprehensive stormwater management plan in the watershed which prevents potential harmful and destructive effects of stormwater runoff.

- **Potential Lead Agencies and Partners:** Watershed Municipalities, NH DES, NH DOT, University of New Hampshire.
- **Potential Funding Sources:** NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Time frame:** 2006

- **Benchmark:** Watershed communities implement stormwater management programs which includes catch basin inventories, maintenance schedules and maps are prepared of all pipes/culverts and road/stream crossings.

B. Review effectiveness of existing stormwater regulations and practices in the five watershed communities, and update the regulations as necessary.

- **Potential Lead Agencies and Partners:** Watershed Municipalities, NH DES, NH DOT, University of New Hampshire.
- **Potential Funding Sources:** NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Time frame:** 2006
- **Benchmark:** A review is completed.

C. Work cooperatively to ensure that stormwater Best Management Practices are incorporated in all land use activities including land use planning, zoning, and subdivision/site plan reviews.

- **Potential Lead Agencies and Partners:** Watershed Municipalities, Planning Boards, NH DES
- **Potential Funding Sources:** N/A
- **Time frame:** 2006
- **Benchmark:** Communities work cooperatively to ensure Best Management Practices are incorporated in land use planning, zoning, and subdivision/site plan reviews and existing stormwater problems are corrected.

D. Ensure consistent application of the provisions of the Shoreland Protection Act to ensure watershed and lake protection and for ease and consistency of enforcement.

- **Potential Lead Agencies and Partners:** Watershed Municipalities, NH DES
- **Potential Funding Sources:** N/A
- **Time frame:** On-going
- **Benchmark:** Shoreland Protection Act provisions are consistently applied.

E. Protect natural areas that are essential for the control of stormwater runoff (see strategy 2B above).

- **Potential Lead Agencies and Partners:** Conservation Commissions, Land Trusts

- **Potential Funding Sources:** NH DES Drinking Water Supply Land Grant Program, local funding mechanisms such as general fund appropriations and legislatively approved tax increases, federal Land and Water Conservation Fund.
- **Time frame:** On-going
- **Benchmark:** Natural areas that are essential for control of stormwater runoff are conserved.

F. In locations throughout the watershed, where stormwater inflows have been identified as transporting volatile organic chemicals, install mechanisms which absorb and/or separate petroleum based products from stormwater runoff.

- **Potential Lead Agencies and Partners:** Watershed Municipalities, NH DOT, Departments of Public Works, Meredith Water Department
- **Potential Funding Sources:** NH DES Source Protection Grant Program, NH DES Watershed Assistance Grant Program
- **Time frame:** 2007
- **Benchmark:** Inflows will no longer transport volatile organic chemicals.

G. Educate homeowners, contractors, businesses and local officials about stormwater and runoff issues.

- **Potential Lead Agencies and Partners:** Chambers of Commerce, Conservation Commissions, Home Owner Associations, Lake Associations, Watershed Communities, Meredith Water Department, NH DES, Waukewan Watershed Advisory Committee
- **Potential Funding Sources:** NH DES Small Outreach and education Grants for Nonpoint Source Pollution
- **Time frame:** Ongoing
- **Benchmark:** Education and outreach program on stormwater and runoff issues occurring.

H. Correct existing stormwater problems and restore degraded areas (e. g. eroded stream banks).

- **Potential Lead Agencies and Partners:** Watershed Municipalities, NH DES
- **Potential Funding Sources:** NH DES Drinking Water Source Protection Grants, NH DES Watershed Restoration Grants
- **Time frame:** 2007
- **Benchmark:** Stormwater problem areas are identified and corrected and degraded areas (such as eroded stream bank/channels) have been restored.

I. Get technical assistance and possible grant funding to implement these strategies while collaboratively involving planning boards from each of the five watershed communities.

- **Potential Lead Agencies and Partners:** Planning Boards, NH DES, University of New Hampshire, NH DOT
- **Potential Funding Sources:** NH DES Drinking Water Source Protection Grants, NH DES Watershed Assistance Grants
- **Time frame:** 2005
- **Benchmark:** Stormwater strategies are implemented.

- ***Objective #4: Reduce the quantity of pollutant inputs (e.g. salts, nutrients, metals, oils, grease, and volatile organic compounds) from road systems.***

Rationale

Roads provide for the movement of people, goods and services important to our daily lives. However roads also consist of impervious surfaces which accumulate pollutants associated with transportation. Pollutants such as, nutrients, metals, oils and grease, salts and volatile organic compounds typically accumulate on roads and are flushed into surface water during rain events. Road drainage systems typically collect sources of contaminants including wet and dry deposition, soil erosion, street dirt and litter, leaf litter, and animal waste (Jeer et al, 1997). Stormwater from drainage systems (open ditches or closed culverts) flows into intersecting tributaries, which eventually feed receiving ponds or lakes. Potential spills of hazardous materials during transport or vehicular accidents along highways also represent high risks to water quality as many of our highways run alongside or drain into streams, ponds or lakes. De-icing of bridges represents a particularly challenging situation, since bridges are often located directly over surface waterbodies, where there is little opportunity for pollutant attenuation prior to runoff into the water.

There are approximately **52** miles of public roads throughout the Waukewan Watershed maintained by either NH DOT or the five communities. Many of these roads intersect with perennial streams and/or are adjacent to sensitive shoreline areas. Several subwatersheds have greater road-to-area ratios and numbers of tributary crossings suggesting that water quality may be of higher concern in these areas (Figure 5.1). Water quality data collected by the VLAP program indicates that sodium and conductivity levels have significantly increased in Lake Waukewan and Lake Winona. For example, conductivity values have been consistently recorded in Lake Waukewan above 100 uMhos/cm, a threshold indicative of anthropogenic effects. Septic system failures and deicing materials typically contribute to creating high conductivity values.

Strategies

A. Implement a comprehensive and collaborative road maintenance

management program in the watershed which safeguards public safety, identifies ecologically sensitive areas, identifies corresponding low salt zones, and uses techniques for minimizing the use of deicing materials.

- **Potential Lead Agencies and Partners:** Watershed Municipalities, NH DES, NH DOT, University of New Hampshire.
- **Potential Funding Sources:** NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program
- **Time frame:** 2006
- **Benchmark:** A road maintenance management program is established which includes street sweeping practices, calibration of salt spreaders, limited application of salt in sensitive areas, and mapping of sensitive areas for use by highway departments.

B. Encourage new road designs that limit imperviousness and minimize negative environmental effects.

- **Potential Lead Agencies and Partners:** Boards of Selectmen, Planning Boards, NH DES, NH DOT, University of New Hampshire.
- **Potential Funding Sources:** undeclared
- **Time frame:** 2005
- **Benchmark:** Road design and construction will limit imperviousness by reducing road widths and implementing other Low Impact Development techniques.

C. Dispose of material from street sweeping, cleaning of catch-basin sumps, and snow collection in an environmentally sound manner.

- **Potential Lead Agencies and Partners:** Watershed Communities, Departments of Pubic Works
- **Potential Funding Sources:** N/A
- **Time frame:** 2005
- **Benchmark:** Street maintenance materials are properly managed.

D. Recommend that the State prohibit transport of hazardous materials cargoes and petroleum transport trucks through the watershed (excluding Route 104, Route 3, and Route 25). Residential delivery is not included.

- **Potential Lead Agencies and Partners:** Watershed Municipalities, NH DOT
- **Potential Funding Sources:** N/A
- **Time frame:** 2005
- **Benchmark:** Transport of hazardous materials is prohibited in the watershed.

E. Develop an Emergency Response Spill Plan for the watershed which protects Lake Waukewan as a source of public drinking water.

- **Potential Lead Agencies and Partners:** Meredith Water Department, Watershed Municipalities, Fire Departments
- **Potential Funding Sources:** N/A
- **Time frame:** 2005
- **Benchmark:** Emergency Response Plan is created and in effect.

- ***Objective #5: Reduce inputs of volatile organic chemicals from residential heating fuel storage and use.***

Rationale

There are approximately 250,000 oil heat customers in the State of New Hampshire, the majority of which are residential use. Residential and small business owners predominately store their heating oil in small above ground tanks (275-gallon). Residential heating tanks located outside are prone to line breakage and tank corrosion. Inside tank installations are prone to tank corrosion, overfills, and fitting and filter leaks (Freill, 2004). Management of residential heating fuel is a necessary component of nonpoint source pollution management.

Strategies

A. Adopt an ordinance which requires that new installations for residential heating fuel storage and replacements must have either double-walled tanks or secondary containment, be weather protected if located outdoors, and have encapsulated lines.

- **Potential Lead Agencies and Partners:** Watershed Municipalities, Code Enforcement Officers, Fire Departments, NH DES Waste Management
- **Potential Funding Sources:** N/A
- **Time frame:** 2006
- **Benchmark:** An ordinance is adopted by all watershed municipalities.

B. Ensure local enforcement of state code requirements for oil burning equipment installations and tank replacements (e.g. fill alarms with audible whistle, use of UL approved tanks, protected lines).

- **Potential Lead Agencies and Partners:** Code Enforcement Officers, Fire Departments
- **Potential Funding Sources:** N/A
- **Time frame:** 2006
- **Benchmark:** Practices are implemented.

C. Encourage or where necessary require inspection and testing of residential heating fuel tanks.

- **Potential Lead Agencies and Partners:** Oil Industry
- **Potential Funding Sources:** N/A
- **Time frame:** 2006
- **Benchmark:** Residential tanks are inspected and tested in the watershed.

D. With the assistance of local home heating fuel distribution companies, create a database of existing residential fuel tanks which include an inventory of tank age, type, volume etc.

- **Potential Lead Agencies and Partners:** Meredith Planning Department, Oil Industry
- **Potential Funding Sources:** NH DES Drinking Water Source Protection Program
- **Time frame:** 2006
- **Benchmark:** Residential tanks are inventoried.

E. Educate homeowners about spill liability, methods of secure storage and spill prevention, how to get tanks inspected, changes in consumption rates, how sump pumps can contaminate water resources, what to do if a leak is found, and permit and code requirements.

- **Potential Lead Agencies and Partners:** Watershed Municipalities, Meredith Water Department, Home Owner Associations and Lake Associations, Waukewan Advisory Committee
- **Potential Funding Sources:** NH Small Outreach and Education Grants for Nonpoint Source Pollution
- **Time frame:** 2006
- **Benchmark:** Residents are well-informed about spill liability, secure storage, tank inspection, detecting possible leaks, and know what to do if a leak occurs.

F. Educate local residential heating fuel distributors about the locations of public water supplies in the watershed and inform them about their susceptibility to spills. Remind companies about spill reporting requirements.

- **Potential Lead Agencies and Partners:** Meredith Planning Department
- **Potential Funding Sources:** N/A
- **Time frame:** 2005
- **Benchmark:** Distributors know where public water supplies are

located in the Waukewan Watershed, recognize their susceptibility to spills, and are well aware of spill reporting requirements.

G. Encourage fire chiefs in the watershed to collaborate with others to develop education materials.

- **Potential Lead Agencies and Partners:** Meredith Planning Department
- **Potential Funding Sources:** N/A
- **Time frame:** 2005
- **Benchmark:** Educational materials are developed.

- ***Objective #6: Reduce nutrient and synthetic organic chemical inputs from lawn and garden care.***

Rationale

Application of fertilizers and pesticides in residential areas can pose threats to water resources. Once applied to the land's surface, fertilizers and pesticides can be transported by precipitation into surface water and groundwater. Lawn care and gardening activities can result in cumulative water quality impacts. For example, phosphorus and nitrogen from fertilizers can promote algae blooms and reduce dissolved oxygen levels. Increased rates of algae blooms can have negative impacts on fisheries and water supplies. The amount of fertilizer that leaches into groundwater can range from 2-60 percent depending on factors such as type of fertilizer, method of application, soil conditions, and climate (Jeer et al. 1997). Results from a residential survey conducted by the Waukewan Watershed Advisory Committee found that 26% of respondents in the Waukewan shoreline zone fertilize their lawn.

Data from the Volunteer Lakes Assessment Program for Lake Waukewan and Lake Winona has shown increasing phosphorus levels in the hypolimnion. This indicates that great care should be taken in managing nutrient sources, such as lawn care, in the watershed.

Strategies

A. Educate homeowners and businesses about lawn care and landscaping techniques which minimize impacts on water resources. Education should include topics such as water conservation, native plant species, low maintenance grasses, and use of lawn and garden chemicals and fertilizers.

- **Potential Lead Agencies and Partners:** Waukewan Watershed Advisory Committee, Meredith Water Department, Home Owner Associations, Lake Associations, Belknap County Conservation District.

- **Potential Funding Sources:** NH DES Small Outreach and education Grants for Nonpoint Source Pollution
- **Time frame:** 2006
- **Benchmark:** Homeowners and residents are better educated about lawn care and landscaping techniques which safeguard water resources. A do's and don'ts factsheet will be developed and distributed. Factsheets will be available at town offices, libraries, and websites.

GOAL #2: REDUCE POLLUTION FROM LAKE CONTACT ACTIVITIES.

- ***Objective #1: Reduce sources of pollution from motor-boating activities on Lake Waukewan.***

Rationale

Recreational use of surface water drinking sources increases the potential for microbial, physical, and chemical contaminants to enter drinking water produced from these source waters (AWWA 2004). Motor-boating is one type of recreational use. Motorboat engines, particularly inefficient 2-cycle engines, typically exhaust 30% of their fuel as unburned fuel directly into the water (Correll, 1999). Approximately half of the exhausted fuel, depending on water and air temperatures, immediately evaporates. The remaining half persists in the water column (Kratzenberg, 1997). The gasoline constituents of the exhaust, including benzene, toluene, ethylbenzene, and xylene, may continue to evaporate from the water's surface. However, if the aforementioned constituents mix to more than a 3.3 foot depth, the evaporation rate slows. This is of concern because gasoline constituents can mix up from 9 to 12 foot depths and persist for up to two days (Miller and Fiore, 1997).

MtBE, also present in exhaust, is slightly more soluble than other gasoline constituents. MtBE can rapidly mix in water and persist in the water column (Office of Water Drinking Water Advisory Fact Sheet, 1997). In 1998, EPA classified MtBE as a possible human carcinogen and placed it on the Drinking Water Contaminant Candidate List (EPA Federal Register, col. 63, no. 40, 1998). MtBE can cause kidney and liver damage and creates an increased risk of cancer (NH DES Analytical Requirements for Community Public Water Supplies, 2004). Water quality research conducted at Lake Tahoe revealed that a single pass of a conventional marine engine measured concentrations of benzene, xylene, and MtBE that exceeded California's Department of Health drinking water standards (Correll, 1999).

Although research is far from conclusive, studies have shown that marine exhaust can negatively impact wildlife. Small boats and personal watercraft are maneuverable and capable of accessing shallow and remote areas typically occupied by wildlife. Laboratory experiments have shown that fish exposed to low concentrations of gasoline constituents can suffer

genetic and reproductive defects (Correll, 1999).

In response to air and water quality concerns, the US Environmental Protection Agency has banned the manufacture of carbureted 2 cycle engines effective January 1, 2006. The ban extends only to the manufacture of the high-polluting engines, not their use. Although manufacturing is banned, without a "buy back program", 2-cycle engines will persist in use for many years.

There are other issues associated with motor-boating that represent potential threats to water quality. For example, fueling, in-lake boat washing, sanitary wastes, increased wave action and invasive aquatic weeds can all have detrimental effects on water quality, if not carefully addressed.

There have been instances of exotic aquatic species in the watershed. For example, Lake Waukewan was treated for exotic milfoil control with 2, 4-D (granular) at the outlet channel in 1982 and 1995. Lake Winona was treated to control nuisance algal growth with copper sulfate in 1966 and 1967. Invasive aquatic species can be spread by boats that visit multiple waterbodies.

Motorboat enthusiasts including shorefront property owners, fishermen and visitors, have used Lake Winona and Lake Waukewan for many years. To date, water quality samples which measure gasoline constituents in Lake Waukewan have been taken during the winter months when motor-boating activities are absent. Samples taken at this time detected low levels of MTBE. The Meredith water treatment plant filters and disinfects raw water from Lake Waukewan but is not currently capable of treating volatile organic chemicals associated with gasoline constituents.

Communities should give strong consideration to the potential for water quality degradation as a result of recreational activities, the level of increased risk and customer acceptance of that risk, the current level of treatment, and the availability of additional treatment requirements, uncertainties, and costs that may be incurred (AWWA 2004). "A Model Rule for Protection of Water Supply Watersheds", developed by NH DES, recommends that communities consider the appropriateness of recreational uses of water sources and quotes a survey by the American Water Works Association which found that water managers reported the most effective watershed control measures are obtaining land ownership in the watershed and restricting the recreational use of surface waters.

Strategies

A. After careful consideration, implement a phased requirement prohibiting 2-cycle carbureted engines on Lake Waukewan.

- **Potential Lead Agencies and Partners:** Watershed Municipalities, Waukewan Watershed Advisory Committee, NH DES, Environmental Protection Agency, Marine Industry, Home Owners Associations, Lake Associations, Meredith Water Department.
- **Potential Funding Sources:** EPA Targeted Watersheds Grant Program

- **Time frame:** On-going
- **Benchmark:** Two-cycle engines no longer contribute pollutants to Lake Waukewan.

B. Educate boaters who have inboard motors to use oil absorbing pillows or "bilge snakes" to prevent pollutants from entering the lake.

- **Potential Lead Agencies and Partners:** Watershed Municipalities, Waukewan Watershed Advisory Committee, NH DES, Marine Industry, Home Owners Associations, Lake Associations, Meredith Water Department.
- **Potential Funding Sources:** In-kind, The Ittleson Foundation,
- **Time frame:** On-going
- **Benchmark:** Powerboat owners in the watershed have and use absorbing pillows and or snakes in their boat bilges.

C. Encourage enforcement of RSA 270-D:2 "General Rules for Vessels Operating on Water".

- **Potential Lead Agencies and Partners:** NH Marine Patrol, Waukewan Watershed Advisory Committee, NH DES, Home Owners Associations, Lake Associations, Watershed Municipalities.
- **Potential Funding Sources:** undeclared.
- **Time frame:** On-going
- **Benchmark: Boaters will abide by the rules for operating vessels on water** including slowing to headway speed when within 150 feet from:
    (1) Rafts, floats, swimmers.
    (2) Permitted swimming areas.
    (3) Shore.
    (4) Docks.
    (5) Mooring fields.
    (6) Other vessels.

D. Provide temporary restrooms in appropriate access sites for boating enthusiasts.

- **Potential Lead Agencies and Partners:** Town of Meredith,
- **Potential Funding Sources:** General Appropriations
- **Time frame:** On-going
- **Benchmark:** Restroom facilities are available at access points for boating enthusiasts.

E. Educate boaters (residents and visitors) that Lake Waukewan is a public drinking water source, about safe fueling practices, the availability of MtBE-free gasoline, servicing and cleaning of boats, and invasive species prevention.

- **Potential Lead Agencies and Partners:** Town of Meredith, Meredith Water Department, Waukewan Advisory Committee, Home Owners Associations, Lake Associations
- **Potential Funding Sources:** NH DES Milfoil and other Exotic Plant Prevention Grants.
- **Time frame:** On-going
- **Benchmark:** An educational and outreach campaign is on-going.

F. Work with various event/activity sponsors to ensure that events associated with Lake Waukewan limit risks to this public drinking water source.

- **Potential Lead Agencies and Partners:** Town of Meredith, NH Fish and Game
- **Potential Funding Sources:** N/A
- **Time frame:** On-going
- **Benchmark:** Risks to water quality are reduced during events associated with Lake Waukewan.

G. Maintain and support the Lake Host program.

- **Potential Lead Agencies and Partners:** Waukewan Shore Owners Association, Town of Meredith, Meredith Water Department, NH Lakes Association
- **Potential Funding Sources:** NH DES Grants for Exotic Aquatic Plants, NH DES Milfoil and Other Exotic Plant Prevention Grants
- **Time frame:** On-going
- **Benchmark:** Lake Host program is supported and maintained.

- ***Objective #2: Reduce the potential risk of pollutants from swimming activities in Lake Waukewan.***

Rationale

Swimming in surface water supplies can result in increased concentrations of pathogens, increases in waterborne illnesses for downstream consumers, and may result in increased treatment costs (Stewart et. al., 2002). Recreationists may unintentionally introduce pathogens while swimming. Negative impacts can be minimized through facility improvement and education.

Strategies

A. Provide permanent restroom facilities at the Meredith Town Beach on Lake Waukewan. The purpose of these facilities is to protect water quality, not to increase usage of this beach. The current parking capacity and beach area should not be further expanded.

- **Potential Lead Agencies and Partners:** Meredith Recreation Department, Meredith Water Department
- **Potential Funding Sources:** NH DES Drinking Water Source Protection Grant Program
- **Time frame:** 2008
- **Benchmark:** Restroom facilities are available at the Meredith Town Beach.

B. Educate swimmers about the importance of Lake Waukewan as a public water supply and about healthy swimming etiquette (e.g. use of restrooms, no diapers allowed in lake).

- **Potential Lead Agencies and Partners:** Meredith Recreation Department, Meredith Water Department
- **Potential Funding Sources:** Undeclared.
- **Time frame:** 2005 and on-going
- **Benchmark:** Education and outreach is conducted.

- ***Objective #3: Amend and post Administrative Rule Env-Ws 386.49 <u>Protection of the Purity of the Water of Lake Waukewan and Its Watershed</u>.***

Rationale

This rule was originally adopted by the NH State Board of Health on September 17, 1929. The rule was revised in 1996 and re-adopted in 1997. However, the rule remains inadequate in addressing current concerns. For example, the 400 foot body contact setback needs to be re-examined, there is currently no management of pollution from motorboats, and questions remain on many enforcement issues.

Strategies

A. Post prohibitions outlined by NH DES Administrative Rule Env-Ws 386.49 at public access points at the Meredith Town Beach, Meredith boat ramp, the informal launch area on Lake Winona, the boat ramp at Hawkins Pond in Center Harbor, and homeowner association beaches and boat ramps.

- **Potential Lead Agencies and Partners:** Meredith Water Department, Town of Meredith, Town of Center Harbor,

- **Potential Funding Sources:** Meredith Water Department
- **Time frame:** 2005
- **Benchmark:** Signs are posted in the above locations.

B. Update NH DES Administrative Rule Env-Ws 386.49 <u>Protection of the Purity of the Water of Lake Waukewan and Its Watershed</u>.

- **Potential Lead Agencies and Partners:** Meredith Water Department, Waukewan Watershed Advisory Committee, Watershed Municipalities
- **Potential Funding Sources:** N/A
- **Time frame:** 2005
- **Benchmark:** Rule is updated to reflect current needs and increase protection of Lake Waukewan.

- ***Objective #4: Reduce the risk of water quality contamination from seaplanes.***

Rationale

Seaplanes represent a potential risk to water quality. Although seaplanes do not contribute exhaust directly into the water, a catastrophic accident has the potential to contaminate water resources with substances such as volatile organic chemicals. Lake Waukewan is currently used as a seaplane "landing strip" by residents and pilots-in-training.

Strategies

A. The Meredith Selectmen should write a letter to entities which provide aviation training in the watershed and request that they discontinue use of Lake Waukewan as a flight training area. A copy of this letter should be sent to the Seaplane Pilots's Association.

- **Potential Lead Agencies and Partners:** Meredith Board of Selectmen
- **Potential Funding Sources:** N/A
- **Time frame:** 2005
- **Benchmark:** Letter sent to aviation training centers and Seaplane Pilots' Association.

B. Fueling of airplanes and establishment of commercial seaplane bases should be prohibited in the Waukewan Watershed.

- **Potential Lead Agencies and Partners:** Watershed Municipalities, Watershed Planning Boards
- **Potential Funding Sources:** N/A
- **Time frame:** 2006

- **Benchmark:** Fueling and commercial seaplane bases are not permitted in the watershed.

GOAL #3: REDUCE POLLUTION FROM POINT SOURCES.

- ***Objective #1: Reduce pollutant inputs from commercial and industrial sources.***

Rationale

Point source pollution can be traced to a single point of discharge, such as a pipe, channel, or ditch connected to a waste water treatment plant, sludge lagoon, or landfill. Point sources may contribute a number of pollutants including sediments, nutrients, volatile organic chemicals, and metals. It is important that these sources be managed using Best Management Practices, through collaborative partnerships with local businesses.

Strategies

A. Five facilities classified as "hazardous waste handlers" or Resource Conservation and Recovery Act sites (RCRA) are present in the watershed. Two of these sites are "unassigned" by NH DES. Request that NH DES assign project managers to the two "unassigned" sites. Review progress of all sites annually.

- **Potential Lead Agencies and Partners:** Meredith Water Department, Town of Meredith, Waukewan Watershed Advisory Committee, NH DES
- **Potential Funding Sources:** N/A
- **Time frame:** On-going
- **Benchmark: "**Unassigned" sites are assigned NH DES project managers. Status of all RCRA sites in the watershed is monitored annually.

B. The Meredith Water Department plans to collaborate and facilitate protection of water quality with commercial and industrial businesses in the watershed. To meet this objective, the Water Department will implement a voluntary Best Management Practices survey program. The Department will develop an inventory of businesses in the watershed, work with businesses to ensure that best management practices are implemented and provide information and education about source protection. To carry out this volunteer collaborative program, the Water Department will request training from NH DES.

- **Potential Lead Agencies and Partners:** Meredith Water Department, Town of Meredith, Waukewan Watershed Advisory

Committee, Local Businesses, NH DES.
- **Potential Funding Sources:** Meredith Water Department
- **Time frame:** On-going
- **Benchmark:** There is a voluntary Best Management Practices Survey Program in the watershed.

C. There are two businesses in the watershed that have floor drains. Floor drains serve as potential conduits for groundwater pollution and should be avoided or eliminated where possible. Determine where these floor drains discharge to. Develop a spill prevention plan if necessary to keep certain types of spills from entering the floor drain.

- **Potential Lead Agencies and Partners:** Meredith Water Department
- **Potential Funding Sources:** Meredith Water Department
- **Time frame:** 2005
- **Benchmark:** Floor drainage is known. Floor drains are either eliminated or a spill prevention plan is developed.

D. The Meredith Water Department will distribute educational packets to businesses and industries within the watershed. These packets will provide information about safeguarding water quality and information about implementing Best Management Practices.

- **Potential Lead Agencies and Partners:** Meredith Water Department
- **Potential Funding Sources:** Meredith Water Department
- **Time frame:** 2005
- **Benchmark:** Educational packets have been distributed to business and industries in the watershed.

- ***Objective #2: Reduce potential pollutant inputs from discarded railroad ties along the western shore of Lake Waukewan.***

Rationale

Discarded railroad ties treated with creosote may serve as sources of pollution. Old railroad ties have been discarded on the right-of-way along the western shore of Lake Waukewan.

Strategies

A. The Town of Meredith should send a letter to the NH DOT Railroad Bureau and owners of the railroad requesting that all stockpiles of abandoned railroad ties along the railroad right-of-way around Lake Waukewan be removed.

- **Potential Lead Agencies and Partners:** Town of Meredith, NH DOT, Railroad owners
- **Potential Funding Sources:** N/A
- **Time frame:** 2005
- **Benchmark:** Letters have been sent and railroad ties are removed.

- ***Objective #3: Reduce potential pollutant inputs from the Meredith sewer system.***

  Rationale

  When sewer systems run properly, they help protect water quality. When they fail they can be sources of pollutants such as pathogens, nutrients, and metals.

  Strategies

  A. Make appropriations for a feasibility study to examine expansion of the Meredith sewer system around the southwest end of Lake Waukewan.

  - **Potential Lead Agencies and Partners:** Town of Meredith, New Hampton, homeowners and lake associations, NH DES
  - **Potential Funding Sources:** Town of Meredith
  - **Time frame:** 2006
  - **Benchmark:** Study completed.

  B. Coordinate wastewater planning with local agencies and boards to ensure that public sewers in the watershed are used to solve water pollution problems and not as a means to induce further development.

  - **Potential Lead Agencies and Partners:** Town of Meredith
  - **Potential Funding Sources:** N/A
  - **Time frame:** On-going.
  - **Benchmark:** Planning is coordinated.

  C. Ensure that the Meredith sewer system is designed to minimize potential groundwater infiltration and pollution.

  - **Potential Lead Agencies and Partners:** Town of Meredith
  - **Potential Funding Sources:** Undeclared
  - **Time frame:** On-going.
  - **Benchmark:** Design is reviewed to minimize groundwater infiltration and pollution.

  D. Refocus the sewer initiative to address Lake Waukewan concerns. Put the sewer main under the railroad right-of-way along the West

Shore of Lake Waukewan to Winona Shores and Winona Forest Association and create a recreational path on top.

- **Potential Lead Agencies and Partners:** Town of Meredith
- **Potential Funding Sources:** Undeclared
- **Time frame:** 2008
- **Benchmark:** Sewer initiative refocused to address Lake Waukewan concerns. A recreational path has been developed on top of the sewer main on the railroad right-of-way.

GOAL #4: INCREASE UNDERSTANDING OF THE WATERSHED THROUGH RESEARCH AND MONITORING.

- ***Objective #1: Develop monitoring programs, conduct research and resolve questions, safeguarding water quality in the watershed.***

Rationale

Understanding of natural resources will lead to better management of the Waukewan Watershed.

Strategies

A. Develop a detailed drainage network map of persistent and intermittent streams and tributaries that can be used to guide water quality monitoring, road maintenance, stormwater management, development, review, and emergency response planning.

- **Potential Lead Agencies and Partners:** Watershed Municipalities, Waukewan Watershed Advisory Committee, Plymouth State University, Interlakes High School, Interlakes Elementary School
- **Potential Funding Sources:** In-kind contributions, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program, federal Targeted Watersheds Grant Program, private sources
- **Time frame:** 2006
- **Benchmark:** All tributaries and streams in the watershed are identified, inventoried, and mapped.

B. Establish a long-term, comprehensive point testing protocol of all the tributaries leading to Lake Waukewan and Lake Winona. Focus monitoring on tributary and storm drain inflows, storm events, and the effectiveness of existing stormwater treatment practices. Determine the quality of stormwater runoff at a subwatershed level. Identify areas with impaired or potentially impaired water quality.

- **Potential Lead Agencies and Partners:** Watershed Municipalities, Waukewan Watershed Advisory Committee, Plymouth State

University, NH DES, Interlakes High School, Interlakes Elementary School

- **Potential Funding Sources:** In-kind contributions, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program, federal Targeted Watersheds Grant Program, private sources
- **Time frame:** Begin in 2005
- **Benchmark:** Establish a long-term tributary monitoring program.

C. Implement a monitoring program to assess concentrations of gasoline constituents including volatile organic chemicals and MtBE in Lake Waukewan from February to September.

- **Potential Lead Agencies and Partners:** Meredith Water Department, UNH, NH DES
- **Potential Funding Sources:** Meredith Water Department
- **Time frame:** Underway
- **Benchmark:** Baseline data collected for concentrations of gasoline constituents, including MtBE, present in Lake Waukewan during boating season (from February to September).

D. Increase inspections and monitoring of aquatic invasive species.

- **Potential Lead Agencies and Partners:** NH DES, Waukewan Watershed Advisory Committee, Conservation Commissions, Home Owner Associations, Lake Associations
- **Potential Funding Sources:** NH DES Control Grants for Exotic Aquatic Plants, Milfoil and Other Exotic Plant Prevention Grants
- **Time frame:** Begin in May 2005
- **Benchmark:** A routine monitoring program is implemented that allows for the immediate detection and management if and when an exotic species is identified in Lake Waukewan.

E. Conduct a build-out analysis for the watershed.

- **Potential Lead Agencies and Partners:** Watershed Municipalities, Regional Planning Commissions
- **Potential Funding Sources:** NH DES Regional Environmental Planning Program
- **Time frame:** 2006
- **Benchmark:** A buildout analysis has been completed.

F. Determine current and future amounts of impervious cover by subwatershed, based upon current zoning in the watershed. Use this information to develop impervious cover limits which safeguard water quality in the watershed.

- **Potential Lead Agencies and Partners:** Meredith Planning Department, University of New Hampshire, Lakes Region Planning Commission

- **Potential Funding Sources:** NH DES Regional Environmental Planning Program
- **Time frame:** Begin in May 2005
- **Benchmark:** Impervious cover analysis completed.

G. Further research is needed to assess whether or not the drinking water intake in Lake Waukewan should have an isolation zone, demarcated by buoys, in which motorized activity should not occur.

- **Potential Lead Agencies and Partners:** Waukewan Watershed Advisory Committee, NH DES, NH Marine Patrol
- **Potential Funding Sources:** Undeclared.
- **Time frame:** 2006
- **Benchmark:** Research completed.

H. Bring together town, county, and state officials to clarify questions regarding jurisdiction of activities associated with Lake Waukewan. Investigate issues regarding authority, enforcement, and compliance.

- **Potential Lead Agencies and Partners:** Meredith Water Department, New Hampshire Rural Water Association, NH DES, NH Marine Patrol
- **Potential Funding Sources:** Undeclared.
- **Time frame:** 2005
- **Benchmark:** Meeting(s) conducted and issues resolved.

GOAL #5: CONTINUE WATERSHED PROTECTION ACTIVITIES AND CONTINUE TO RAISE AWARENESS ABOUT THE WATERSHED.

Objective #1: Implement the management plan for the Waukewan Watershed.

Rationale

Watershed protection is most successful where local communities have active citizens who promote watershed protection and safeguard water quality. Water quality protection and improvements will occur by implementation of this plan and by increasing awareness of watershed issues.

Strategies

A. Continue the Waukewan Watershed Advisory Committee to help shepherd the implementation of the watershed management plan.

- **Potential Lead Agencies and Partners:** Watershed Municipalities, Meredith Board of Selectmen, Waukewan Watershed Advisory Committee, NH DES
- **Potential Funding Sources**: In-kind, Watershed Municipalities, NH DES Drinking Water Source Protection Grant, federal Targeted Watershed Grant Program
- **Time frame:** 2005-2008
- **Benchmark:** Committee helps to shepherd implementation of watershed management plan.

- ***Objective #2: Improve awareness of water quality and water resources protection in the watershed.***

  Rationale
  When citizens and businesses have a better understanding of water quality issues, they are more likely to safeguard them

  Strategies

  A. Continue to inform residents and businesses in the greater Waukewan area about water quality and quantity issues via the media.

  - **Potential Lead Agencies and Partners:** Waukewan Watershed Advisory Committee, Meredith Water Department, Home Owners Associations, Lake Associations, Meredith Planning Department
  - **Potential Funding Sources:** Undeclared
  - **Time frame:** Ongoing
  - **Benchmark:** Education and outreach information distributed through a number of venues.

Table 6.2 List of Recommended Watershed Management Activities for the Waukewan Watershed, New Hampshire. Recommendations developed by the Waukewan Watershed Advisory Committee.

Goal	Objective	Strategy	Potential Lead Agencies and Partners	Potential Funding Sources	Timeframe
1. Reduce pollution from nonpoint sources.	**#1. Reduce pollution from septic systems.**	A. Implement a septic system inspection program.	Watershed Municipalities	NH DES Drinking Water Source Protection Program, NH Watershed Assistance Grants, EPA Targeted Watershed Grants Program	2007
		B. Educate homeowners about septic systems use and maintenance.	Watershed Municipalities, Meredith Water Department, Home Owners Associations, and Lake Associations.	In-kind support, NH DES Small Outreach and Education Grant Program for Nonpoint Source Pollution.	On-going
		C. Create a water quality monitoring program to identify failing septic systems along the shorelines.	Watershed Municipalities, Plymouth State University	NH DES Watershed Assistance grant program, NH DES Drinking Water Source Protection Program	2007
		D. Tie replacement of septic systems to the building permit process	Watershed Municipalities	N/A	2007
		E. Establish a finance program for cases of economic hardship.	Watershed Municipalities, NH DES, Private Sector	Undeclared	2007
	#2. Reduce pollution from site development projects.	A. Adopt a watershed overlay district which directs development away from ecologically sensitive areas, guides construction and development, and prohibits high risk land uses.	Watershed Municipalities	NH DES Drinking Water Source Protection Program	2007
		B. Identify and conserve key properties to protect drinking water quality and sensitive ecological features. Use fee simple acquisition, conservation easements, tax incentives, transfer of development rights, and other tools to fund these conservation projects.	Conservation Commissions, Land Trusts	NH DES Drinking Water Supply Land Grant Program, local funding mechanisms such as general fund appropriations and legislatively approved tax increases, federal Land and Water Conservation Fund.	On-going
		C. Require erosion controls best management practices through the development review process, including construction inspection and site stabilization.	Planning Boards Code Enforcement Officers	N/A	2007

Goal	Objective	Strategy	Potential Lead Agencies and Partners	Potential Funding Sources	Timeframe
		D. Adjust the Site Plan Review and Subdivision Review Processes to encourage designs which maintain existing hydrologic processes and functions.	Planning Boards	N/A	2007
		E. Encourage better site design for residential lot conversion which incorporates best management practices for stormwater management and erosion control. Update the Building Permit process and provide education to promote these changes.	Planning Boards	N/A	2007
		F. Educate residents and contractors about the sensitivities of shoreline areas and the provisions of the New Hampshire's Shoreland Protection Act.	Conservation Commissions, Home Owner Associations and Lake Associations, NH DES	In-kind	2007
		G. Watershed communities which border the same water body should work cooperatively to protect this resource by employing a single code enforcement officer for purposes of permitting, inspection, and compliance.	Watershed Municipalities	In-Kind	2007
	#3. Reduce the quantity of pollutant inputs (e.g. salts, nutrients, metals, oils, volatile organic compounds) from stormwater runoff.	A. Implement a comprehensive stormwater management plan in the watershed which prevents potential harmful and destructive effects of stormwater runoff.	Watershed Municipalities, NH DES, NH DOT, University of New Hampshire.	NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program	2006
		B. Review effectiveness of existing stormwater regulations and practices in the five watershed communities, and update the regulations as necessary.	Watershed Municipalities, NH DES, NH DOT, University of New Hampshire	NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program	2006
		C. Work cooperatively to ensure that stormwater Best Management Practices are incorporated in all land use activities including land use planning, zoning, and subdivision/site plan reviews.	Watershed Municipalities, Planning Boards, NH DES	N/A	2006
		D. Ensure consistent application of the provisions of the Shoreland Protection Act to ensure watershed and lake protection and for ease and consistency of enforcement.	Watershed Municipalities, NH DES	N/A	On-going

Goal	Objective	Strategy	Potential Lead Agencies and Partners	Potential Funding Sources	Timeframe
		E. Protect natural areas that are essential for the control of stormwater runoff (see strategy 2B above).	Conservation Commissions, Land Trusts	: NH DES Drinking Water Supply Land Grant Program, local funding mechanisms such as general fund appropriations and legislatively approved tax increases, federal Land and Water Conservation Fund.	On-going
		F. In locations throughout the watershed, where stormwater inflows have been identified as transporting volatile organic chemicals, install mechanisms which absorb and/or separate petroleum based products from stormwater runoff.	Watershed Municipalities, NH DOT, Departments of Public Works	NH DES Source Protection Grant Program, NH DES Watershed Assistance	2007
		G. Educate homeowners, contractors, businesses and local officials about stormwater and runoff issues.	Chambers of Commerce, Conservation Commissions, Home Owner Associations, Lake Associations, Watershed Communities, Meredith Water Department, NH DES	NH DES Small Outreach and education Grants for Nonpoint Source Pollution	On-going
		H. Correct existing stormwater problems and restore degraded areas (e.g. eroded stream banks).	Watershed Municipalities, NH DES	NH DES Drinking Water Source Protection Grants, NH DES Watershed Restoration Grants	2007
		I. Get technical assistance and possible grant funding to implement these strategies while collaboratively involving planning boards from each of the five watershed communities.	Planning Boards, NH DES, University of New Hampshire, NH DOT	NH DES Drinking Water Source Protection Grants, NH DES Watershed Assistance Grants	2005
	#4. Reduce the quantity of pollutant inputs (e.g. salts, nutrients, metals, oils, grease, and volatile organic compounds) from road systems.	A. Implement a comprehensive and collaborative road maintenance management program in the watershed which safeguards public safety, identifies ecologically sensitive areas, identifies corresponding low salt zones, and uses techniques for minimizing the use of de-icing materials.	Watershed Municipalities, NH DES, NH DOT, University of New Hampshire.	NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program	2006
		B. Encourage new road designs that limit imperviousness and minimize negative environmental effects.	Boards of Selectmen, Planning Boards, NH DES, NH DOT, University of New Hampshire.	Undeclared	2005

Goal	Objective	Strategy	Potential Lead Agencies and Partners	Potential Funding Sources	Timeframe
		C. Dispose of material from street sweeping, cleaning of catch-basin sumps, and snow collection in an environmentally sound manner.	Watershed Communities, Departments of Pubic Works	N/A	2005
		D. Recommend that the State prohibit transport of hazardous materials cargoes and petroleum transport trucks through the watershed (residential delivery not included).	Watershed Municipalities, NH DOT	N/A	2005
		E. Develop an emergency response spill plan for the watershed which protects Lake Waukewan as a source of public drinking water.	Meredith Water Department, Watershed Municipalities, Fire Departments	N/A	2005
	#5. Reduce inputs of volatile organic chemicals from residential heating fuel storage and use.	A. Adopt an ordinance which requires that new installations for residential heating fuel storage and replacements must have either double-walled tanks or secondary containment, be weather protected if located outdoors, and have encapsulated lines.	Watershed Municipalities, Code Enforcement Officers, Fire Departments, NH DES Waste Management	N/A	2006
		B. Ensure local enforcement of state code requirements for oil burning equipment installations and tank replacements (e.g. fill alarms with audible whistle, use of UL approved tanks, protected lines).	Code Enforcement Officers, Fire Departments	N/A	2006
		C. Encourage or where necessary require inspection and testing of residential heating fuel tanks.	Oil Industry	N/A	2006
		D. With the assistance of local home heating fuel distribution companies, create a database of existing residential fuel tanks which is an inventory of tank age, type, volume etc.	Meredith Planning Department, Oil Industry	NH DES Drinking Water Source Protection Program	2006

Goal	Objective	Strategy	Potential Lead Agencies and Partners	Potential Funding Sources	Timeframe
		E. Educate homeowners about spill liability, methods of secure storage and spill prevention, how to get tanks inspected, changes in consumption rates, how sump pumps can contaminate water resources, what to do if a leak is found, and permit and code requirements.	Watershed Municipalities, Meredith Water Department, Home Owner Associations and Lake Associations, Waukewan Advisory Committee	NH Small Outreach and Education Grants for Nonpoint Source Pollution	2006
		F. Educate local residential heating fuel distributors about the locations of public water supplies in the watershed and inform them about their susceptibility to spills. Remind companies about spill reporting requirements.	Meredith Planning Department	N/A	2005
		G. Encourage fire chiefs in the watershed to collaborate with other to develop education materials.	Meredith Planning Department	N/A	2005
	#6. Reduce nutrient and synthetic organic chemical inputs from lawn and garden care.	A. Educate homeowners and businesses about lawn care and landscaping techniques which minimize impacts on water resources. Education should include topics such as water conservation, native plant species, low maintenance grasses, and use of lawn and garden chemicals and fertilizers.	Waukewan Watershed Advisory Committee, Meredith Water Department, Home Owner Associations, Lake Associations, Belknap County Conservation District.	NH DES Small Outreach and education Grants for Nonpoint Source Pollution	2006
GOAL #2: Reduce pollution from water contact activities.	**#1: Reduce sources of pollution from motor-boating activities on Lake Waukewan.**	A. Implement a phased requirement prohibiting 2-cycle carbureted engines on Lake Waukewan.	Watershed Municipalities, Waukewan Watershed Advisory Committee, NH DES, Marine Industry, Home Owners Associations, Lake Associations, Meredith Water Department	EPA Targeted Watersheds Grant Program	On-going
		B. Educate boaters who have inboard motors to use oil absorbing pillows or "bilge snakes" to prevent pollutants from entering the lake.	Watershed Municipalities, Waukewan Watershed Advisory Committee, NH DES, Marine Industry, Home Owners Associations, Lake Associations, Meredith Water Department.	In-kind, The Ittleson Foundation,	On-going

Goal	Objective	Strategy	Potential Lead Agencies and Partners	Potential Funding Sources	Timeframe
		C. Post prohibitions outlined by NH DES Administrative Rule Env-Ws 386.49 at public access points at the Meredith Town Beach, Meredith boat ramp, and the boat ramp at Hawkins Pond in Center Harbor.	Meredith Water Department, Town of Meredith, Town of Center Harbor,	Meredith Water Department	2005
		D. Encourage enforcement of RSA 270-D:2 "General Rules for Vessels Operating on Water".	NH Marine Patrol, Waukewan Watershed Advisory Committee, NH DES, Home Owners Associations, Lake Associations, Watershed Municipalities.	Undeclared	On-going
		E. Update NH DES Administrative Rule Env-Ws 386.49 Protection of the Purity of the Water of Lake Waukewan and Its Watershed.	Meredith Water Department, Waukewan Watershed Advisory Committee, Watershed Municipalities	N/A	2005
		F. Provide temporary restrooms in appropriate access sites for boating enthusiasts.	Town of Meredith	General Appropriations	On-going
		G. Educate boaters (residents and visitors) that Lake Waukewan is a public drinking water source, about safe fueling practices, use of MTBE-free gasoline, servicing and cleaning of boats, and invasive species prevention.	Town of Meredith, Meredith Water Department, Waukewan Advisory Committee, Home Owners Associations, Lake Associations	NH DES Milfoil and other Exotic Plant Prevention Grants.	On-going
		H. Work with various event/activity sponsors to ensure that events associated with Lake Waukewan limit risks to this public drinking water source.	Town of Meredith, NH Fish and Game	N/A	On-going
		I. Maintain and support the Lake Host program.	Waukewan Shore Owners Association, Town of Meredith, Meredith Water Department	NH DES Grants for Exotic Aquatic Plants, NH DES Milfoil and Other Exotic Plant Prevention Grants	On-going
	#2. Reduce the potential risk of pollutants from swimming activities in Lake Waukewan.	A. Provide permanent restroom facilities at the Meredith Town Beach on Lake Waukewan. The purpose of these facilities is to protect water quality, not to increase usage of this beach. The current parking capacity and beach area should not be further expanded.	Town of Meredith Recreation Department	NH DES Drinking Water Source Protection Grant Program	2008

Goal	Objective	Strategy	Potential Lead Agencies and Partners	Potential Funding Sources	Timeframe
		B. Educate swimmers about the importance of Lake Waukewan as a public water supply and about healthy swimming etiquette (e.g. use of restrooms, no diapers allowed in lake).	Town of Meredith Recreation Department, Meredith Water Department	Undeclared.	2005
	#3. Reduce the risk of water quality contamination from seaplanes.	A. The Meredith Selectmen should write a letter to entities which provide aviation training in the watershed and request that they discontinue use of Lake Waukewan as a flight training area.	Meredith Board of Selectmen	N/A	2005
		B. Fueling of airplanes and establishment of commercial seaplane bases should be prohibited in the Waukewan Watershed.	Watershed Municipalities, Watershed Planning Boards	N/A	2006
GOAL #3: Reduce pollution from point sources.	**#1: Reduce pollutant inputs from commercial and industrial sources.**	A. Five facilities classified as "hazardous waste handlers" or Resource Conservation and Recovery Act sites (RCRA) are present in the watershed. Two of these sites are "unassigned" by NH DES. Request that NH DES assign project managers to the two "unassigned" sites. Review progress of all sites annually.	Meredith Water Department, Town of Meredith, Waukewan Watershed Advisory Committee	N/A	On-going
		B. The Meredith Water Department plans to collaborate and facilitate protection of water quality with commercial and industrial businesses in the watershed. To meet this objective, the Water Department will implement a voluntary Best Management Practices survey program. The Department will develop an inventory of businesses in the watershed, work with businesses to ensure that best management practices are implemented and provide information and education about source protection. To carry out this volunteer collaborative program, the Water Department will request training from NH DES.	Meredith Water Department, Town of Meredith, Waukewan Watershed Advisory Committee, Local Businesses	Meredith Water Department	On-going

Goal	Objective	Strategy	Potential Lead Agencies and Partners	Potential Funding Sources	Timeframe
		C. There are two businesses in the watershed that have floor drains. Floor drains serve as potential conduits for groundwater pollution and should be avoided or eliminated where possible. Determine where these floor drains, drain to. Develop a spill prevention plan if necessary to keep certain types of spills from entering the floor drain.	Meredith Water Department		
		D. The Meredith Water Department will distribute educational packets to businesses and industries within the watershed. These packets will provide information about safeguarding water quality and information about implementing Best Management Practices.	Meredith Water Department	Meredith Water Department	2005
	#2. Reduce potential pollutant inputs from discarded railroad ties along the western shore of Lake Waukewan.	A. The Town of Meredith should send a letter to the NH DOT Railroad Bureau and owners of the railroad requesting that all stockpiles of abandoned railroad ties along the railroad right-of-way around Lake Waukewan be removed.	Town of Meredith	N/A	2005
	#3. Reduce potential pollutant inputs from the Meredith sewer system.	A. Make appropriations for a feasibility study to examine expansion of the Meredith sewer system around the southwest end of Lake Waukewan.	Town of Meredith	Town of Meredith	2006
		B. Coordinate wastewater planning with local agencies and boards to ensure that public sewers in the watershed are used to solve water pollution problems and not as a means to induce further development.	Town of Meredith	N/A	On-going
		C. Ensure that the Meredith sewer system is designed to minimize potential groundwater infiltration and pollution.	Town of Meredith	Undeclared	On-going
		D. Refocus the sewer initiative to address Lake Waukewan concerns. Put the sewer main under the railroad right-of-way and create a recreational path on top.	Town of Meredith	Undeclared	2008

Goal	Objective	Strategy	Potential Lead Agencies and Partners	Potential Funding Sources	Timeframe
GOAL #4: Increase understanding of the watershed through research and monitoring.	**#1: Develop monitoring programs, conduct research and resolve questions, safeguarding water quality in the watershed.**	A. Develop a detailed drainage network map of streams and tributaries that can be used to guide water quality monitoring, road maintenance, stormwater management, development, review, and emergency response planning.	Watershed Municipalities, Waukewan Watershed Advisory Committee, Plymouth State University	In-kind contributions, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program, federal Targeted Watersheds Grant Program	2005
		B. Establish a long-term, comprehensive point testing protocol of all the tributaries leading to Lake Waukewan and Lake Winona. Focus monitoring on tributary and storm drain inflows, storm events, and the effectiveness of existing stormwater treatment practices. Determine the quality of stormwater runoff at a subwatershed level. Identify areas with impaired or potentially impaired water quality.	Watershed Municipalities, Waukewan Watershed Advisory Committee, Plymouth State University, NH DES	In-kind contributions, NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grant Program, federal Targeted Watersheds Grant Program	Begin in 2005
		C. Implement a monitoring program to assess concentrations of gasoline constituents including MTBE in Lake Waukewan from May to September.	Meredith Water Department, UNH, NH DES	Meredith Water Department	Begin in May 2005
		D. Increase inspections and monitoring of aquatic invasive species.	NH DES, Waukewan Watershed Advisory Committee, Conservation Commissions, Home Owner Associations, Lake Associations	NH DES Control Grants for Exotic Aquatic Plants, Milfoil and Other Exotic Plant Prevention Grants	Begin in May 2005
		E. Conduct a build-out analysis for the watershed.	Watershed Municipalities, Regional Planning Commissions	NH DES Regional Environmental Planning Program	2006
		F. Determine current and future amounts of impervious cover by subwatershed, based upon current zoning in the watershed. Use this information to develop impervious cover limits which safeguard water quality in the watershed.	Meredith Planning Department, University of New Hampshire	NH DES Regional Environmental Planning Program	Begin in May 2005
		G. Further research is needed to assess whether or not the drinking water intake in Lake Waukewan should have an isolation zone, demarcated by buoys, in which motorized activity should not occur.	Waukewan Watershed Advisory Committee, NH DES, NH Marine Patrol	Undeclared.	2006

Goal	Objective	Strategy	Potential Lead Agencies and Partners	Potential Funding Sources	Timeframe
		H. Bring together town, county, and state officials to clarify questions regarding jurisdiction of activities associated with Lake Waukewan. Investigate issues regarding authority, enforcement, and compliance.	Meredith Water Department, New Hampshire Rural Water Association, NH DES	Undeclared.	2005
GOAL #5: Continue watershed protection activities and continue to raise awareness about the watershed.	**#1. Implement the management plan for the Waukewan Watershed.**	A. Continue the Waukewan Watershed Advisory Committee in order to help shepherd the implementation of the watershed management plan.	Watershed Municipalities, Meredith Board of Selectmen, Waukewan Watershed Advisory Committee	In-kind, Watershed Municipalities, NH DES Drinking Water Source Protection Grant, federal Targeted Watershed Grant Program.	2005-2008
	#2. Improve awareness of water quality and water resources protection in the watershed.	A. Continue to inform residents and businesses in the greater Waukewan area about water quality and quantity issues via the media.	Waukewan Watershed Advisory Committee, Meredith Water Department, Home Owners Associations, Lake Associations, Meredith Planning Department	Undeclared	On-going

Chapter 7. Conclusion

Many different individuals, groups and agencies were involved in the process of developing the strategies in this watershed management plan. The next step is to share this plan with the town boards, citizens, and businesses in the watershed municipalities with the goal of plan implementation. It is important that the Waukewan Watershed Advisory Committee continue to exist in order to shepherd implementation of these recommendations. As evidenced by this plan, the Committee has already played an important role in developing watershed awareness, identifying current concerns, and has begun to plan for the future of the Waukewan Watershed. By having a "shepherd", the recommendations in this plan are more likely to be implemented.

No planning process is complete without a review of the benchmarks set forth in a management plan. These benchmarks outlined in Chapter 6 should be revisited periodically to evaluate whether strategies have been successfully implemented in order to keep the plan current and practical. For this plan to be successful, benchmarks will need to be met or exceeded.

This watershed management plan represents one step of a multiple stage process to protect water quality. As strategies are implemented and goals and objectives are met, new ones will need to be developed and the watershed plan will need to be amended to reflect these changes.

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Appendix 1:
Analytical Requirements for
Community Public Water Systems

Department of Environmental Services (DES) Drinking Water Program

Analytical Requirements for Community Public Water Systems

May 3, 2004

The parameters listed in the table below must be analyzed and reported to DES. The water system is responsible for sample collections, reporting, and ensuring that the correct analytical methods are used. Contact DES at (603) 271-3303 with questions and for the most recent guidance.
The laboratory must:

1. Use EPA approved drinking water methods
2. Have current drinking water certification and /or accredited for analyses
3. Identify all subcontracted analyses, laboratories and their certification or accreditation
4. Comply with Env-Ws 322.11, **"Reporting Data from Commercial or Other Laboratories"**.

Parameter	Group	SDWIS contaminant ID#	MCL (mg/l)	Trigger (mg/l)	Source	Health Effects---at levels above the MCL
E. Coli	Bio		Absent		Human & animal fecal waste	May cause gastro-intestinal illness
Fecal Coliform	Bio		Absent		Human & animal fecal waste	May cause gastro-intestinal illness
Total Coliform	Bio		Absent		Naturally present in the environment	None, indicates possible presence of other bacteria
Total Alkalinity	IOCU	1927	n.e.		Naturally present in the environment	
Asbestos [h] (fiber>10 micrometers)	IOC	1094	7 million fibers per liter (MFL)	If Detected	Decay of asbestos cement in water mains; erosion of natural deposits	Increased risk of developing benign intestinal polyps
Specific Conductance	IOC	1064	n.e.			
Arsenic [i]	IOC	1005	0.01[i]	0.005	Geological; pesticide residue, industrial waste	Skin damage, circulatory system problems, carcinogen
Aluminum[d]	IOC	1002	0.05[d]	0.05		
Barium	IOC	1010	2.0	1.0	Geological; oil/gas drilling, painting, industrial waste	Muscular weakness, increase in blood pressure
Cadmium	IOC	1015	0.005	0.0025	Geological; mining, smelting, metal finishing; runoff from waste batteries and paints	Kidney damage
Chloride[d]	IOC	1017	250[d]	250	Wastewater, road salt, water softeners, corrosion	None, aesthetic
Chromium	IOC	1020	0.1	0.05	Used in electroplating, steel proc, synthetic fibers; erosion of natural deposits	Allergic dermatitis
Copper[c]	IOC	1022	90% of trigger	1.3	Corrosion of household plumbing; erosion of natural deposits	Gastrointestinal distress; liver or kidney damage
Cyanide (as free C)	IOC	1024	0.2	0.1	Used in electroplating, steel proc, plastics, synthetic fibers	Neurological, thyroid
Fluoride [a]	IOC	1025	4.0 [a]	2.0	Geological; additive to drinking water, toothpaste	Skeletal damage
Fluoride [d]	IOC	1025	2.0 [d]	2.0		

Parameter	Group	SDWIS contaminant ID#	MCL (mg/l)	Trigger (mg/l)	Source	Health Effects---at levels above the MCL
Iron[d]	IOC	1028	0.3[d]	0.3	Geological	None, aesthetic
Lead[e]	IOC	1030	90% of trigger	0.015	Corrosion of household plumbing; erosion of natural deposits	Delays in physical or mental development in infants and children
Manganese[d]	IOC	1032	0.05[d]	0.05	Geological	None, aesthetic
Mercury	IOC	1035	0.002	0.001	Geological; used in mfg. of paint, paper, fungicides	Nervous system disorders, kidney
Nickel	IOC	1036	0.1	0.05	Geological; electroplating, battery production, ceramics	Heart, liver, skin, weight loss
Nitrate (as N)	IOC	1040	10.0	5	Geological; fertilizer, sewage, feedlots	Methemoglobinemia, "Blue Baby Syndrome"
Nitrite (as N)	IOC	1041	1.0	.5	Geological; fertilizer, sewage, feedlots	Methemoglobinemia, "Blue Baby Syndrome"
Selenium	IOC	1045	0.05	0.025	Geological; by-product of copper mining/smelting	Numbness in fingers or toes; circulatory problems, hair or fingernail loss
Silver[d]	IOC	1050	0.10[d]	0.10		
Sodium[d]	IOC	1052	100-250[d]	250	Road salt, septic system (salt from softeners)	Aesthetic, except high blood pressure and/or heart disease
Sulfate[d]	IOCU	1055	250[d]	250	Naturally occurring	Diarrhea
Sulfide[d]	IOC	n.e.	0.05[d]	0.05		
Antimony	IOC	1074	0.006	0.003	Geological; flame retardants, ceramics, pesticides	Increase in blood cholesterol; decrease in blood sugar
Beryllium	IOC	1075	0.004	0.002	Geological; used in high thermal conductivity materials	Intestinal lesions
Thallium	IOC	1085	0.002	0.001	Geological; electronics industry, alloys and glass mfg	Kidney, liver, or intestinal lesions; blood chemistry; hair loss
Zinc[d]	IOC	1095	5[d]	5	Galvanized pipes	Possible presence of other health related heavy metals
Tot. Hard.($CaC0_3$)[d]	IOC	1915	n.e.		Naturally occurring	
Calcium Hardness[d]	IOC	1918	n.e.		Naturally occurring	
pH[d]	IOC	1925	6.5-8.5[d]	8.5	Precipitation and geology	None, aesthetic
Uranium (Mass)	Rad	4006	30 ug/L		Decay of natural and man-made materials	Increased risk of cancer; kidney problems
Radium 226[e]	Rad	4020	n.e.		Erosion of natural deposits	
Radium 228[e]	Rad	4030	n.e.		Erosion of natural deposits	
Radium 226 & 228 (Combined)	Rad	4010	5 piC/l	If Detected	Erosion of natural deposits	Increased risk of cancer

Parameter	Group	SDWIS contaminant ID#	MCL (mg/l)	Trigger (mg/l)	Source	Health Effects---at levels above the MCL
Analytical Gross Alpha[e]	Rad	4002	n.e.		Erosion of natural deposits and radioactive materials decay of natural and non-made materials	
Compliance Gross Alpha	Rad	4000	15 piC/l	If Detected	Erosion of natural deposits and radioactive materials decay of natural and non-made materials	Increased risk of cancer
Beta Particles[j]	Rad	4100	4 mrem/yr	If Detected	Decay of natural and man-made deposits	Increased risk of Cancer
Endrin	SOC	2005	0.002	If Detected	Banned Pesticide	Liver problems
Lindane	SOC	2010	0.0002	If Detected	Insecticide used on seed, lumber, livestock, restricted 1983	Liver or kidney problems
Methoxychlor (DMDT, Martate)	SOC	2015	0.04	If Detected	Insecticide used on fruit trees, vegetables, livestock	Reproductive difficulties
Toxaphene	SOC	2020	0.003	If Detected	Insecticide used on cotton and cattle; prohibited in 1982	Liver or kidney problems; increased risk of cancer
Dalapon [h]	SOC	2031	0.2[h]	If Detected	Herbicide	Kidney problems
Diquat[h]	SOC	2032	0.02[h]	0.02	Herbicide	Cataracts
Endothall[h]	SOC	2033	0.1[h]	0.1	Herbicide	Stomach intestinal problems
Glyphosate	SOC	2034	0.7	If Detected	Herbicide	Kidney problems; reproductive difficulties
Di(2-ethylhexyl)adipate	SOC	2035	0.4	If Detected	Plastics	General toxic effects or reproductive difficulties
Oxamyl (Vydate)	SOC	2036	0.2	If Detected	Insecticide used on apples, potatoes, & tomatoes.	Slight nervous system effects
Simazine	SOC	2037	0.004	If Detected	Herbicide	Blood problems
Di(2-ethylhexyl)phthalate	SOC	2039	0.006	If Detected	Plastics	Liver and reproductive problems; increased risk of cancer
Picloram	SOC	2040	0.5	If Detected	Herbicide	Liver problems
Dinoseb	SOC	2041	0.007	If Detected	Herbicide	Reproductive difficulties
Hexachlorocyclopentadiene	SOC	2042	0.05	If Detected	Waste By-Product in mfg of Chlorinated Pesticides	Kidney or heart problems
Aldicarb sulfoxide	SOC	2043	0.004	If Detected	Degraded from Aldicarb by Plants	Nervous system problems
Aldicarb sulfone (aldoxy carb)	SOC	2044	0.002	If Detected	Degraded from Aldicarb by Plants	Nervous system problems
Carbofuran (Furadon, 4F)	SOC	2046	0.04	If Detected	Soil fumigation, Insecticide on corn, cotton	Nervous system, reproductive, headache, sweating, nausea
Aldicarb (Temik)	SOCU	2047	0.003	If Detected	Insecticide used on cotton, potatoes	Sweating, leg weakness, nausea, nervous system
Atrazine (Atranx, Crisazina)	SOC	2050	0.003	If Detected	Herbicide, weed control	Cardiovascular system or reproductive problems

Parameter	Group	SDWIS contaminant ID#	MCL (mg/l)	Trigger (mg/l)	Source	Health Effects---at levels above the MCL
Alachlor (Lasso)	SOC	2051	0.002	If Detected	Herbicide used on corn, soybeans	Eyes, liver or spleen problems; anemia; increased risk of cancer
2,3,7,8 TCDD (Dioxin) [h]	SOC	2063	0.00000003[h]	If Detected	Combustion emissions	Reproductive difficulties; increased risk of cancer
Heptachlor	SOC	2065	0.0004	If Detected	Banned insecticide	Liver damage; increased risk of cancer
Heptachlor epoxide	SOC	2067	0.0002	If Detected	Breakdown product of heptachlor	Liver damage; increased risk of cancer
2,4-D	SOC	2105	0.07	If Detected	Herbicide to control broad leaf weeds	Kidney, liver, or adrenal gland problems
2,4,5 TP (Silvex)	SOC	2110	0.05	If Detected	Herbicide (prohibited in 1984)	Liver problems
Hexachlorobenzene	SOC	2274	0.001	If Detected	Fungicide, wood preservatives	Liver or kidney problems; reproductive difficulties; increased risk of cancer
Benzo (a) pyrene (PAHs)	SOC	2306	0.0002	If Detected	Fossil fuel, wood, coal, or tar burning	Reproductive difficulties; increased risk of cancer
Pentachlorophenol	SOC	2326	0.001	If Detected	Wood preservative and herbicide	Liver or kidney problems; increased risk of cancer
Polychlorinated biphenyls (PCB) [h]	SOC	2383	0.0005[h]	If Detected	Waste chemical runoff; old transformer	Skin changes; immune deficiencies; reproductive or nervous system deficiencies; increased risk of cancer
Dibromochloropropane (DBCP) [h]	SOC	2931	0.0002[h]	If Detected	Soil fumigation on soybeans, corn; prohibited in 1977	Liver or kidney problems; increased risk of cancer
Ethylenedibromide (EDB) [h]	SOC	2946	0.00005[h]	If Detected	Gas additive; soil fumigant, solvent, prohibited in 1984	Reproductive, liver, or kidney problems, increased risk of cancer
Chlordane	SOC	2959	0.002	If Detected	Banned Insecticide for termite control	Liver or CNS problems; increased risk of cancer
Methyl tertiary-butyl ether (MtBE) [g] Methyl tertiary-butyl ether (MtBE)[d]	VOC VOC	2251 2251	0.013[g] 0.020[d]	If Detected 0.020	Gasoline additive	Kidney or liver damage; increased risk of cancer
Tertiary amyl methyl ether (TAME) [e] (2-methoxy-2-methylbutane)	VOCU	0003	n.e.		Gasoline additive	
Tertiary butyl alcohol (TBA) [e]	VOCU	0004	n.e.		Gasoline additive	
Ethyl tertiary butyl ether (ETBE) [e]	VOCU	0005	n.e.		Gasoline additive	
Di-isopropyl ether (DIPE)$_e$	VOCU	0006	n.e.		Gasoline additive	
1,2,4-Trichlorobenzene	VOC	2378	0.07	If Detected	Mfg of herbicides, dye carrier	Adrenal gland problems
1,2-Dichloroethylene (cis)	VOC	2380	0.07	If Detected	Industrial extraction solvent	Liver problems
Chloroform[f]	VOCU	2941	n.e.[f]		Disinfection by product	Increased risk of cancer
Bromoform[f]	VOCU	2942	n.e.[f]		Disinfection by product	Increased risk of cancer
Bromodichloromethane[f]	VOCU	2943	n.e.[f]		Disinfection by product	Increased risk of cancer
Chlorodibromomethane[f]	VOCU	2944	n.e.[f]		Disinfection by product	Increased risk of cancer

Parameter	Group	SDWIS contaminant ID#	MCL (mg/l)	Trigger (mg/l)	Source	Health Effects---at levels above the MCL
Xylene (total)	VOC	2955	10.0	If Detected	Paint and Ink solvent: gas refining by-product	Nervous system damage
Dichloromethane (methylene chloride)	VOC	2964	0.005	If Detected	Solvent	Increased risk of cancer; liver problems
1,2 Dichlorobenzene (o)	VOC	2968	0.6	If Detected	Industrial chemicals	Liver, kidney, or circulatory system problems
1,4 Dichlorobenzene (para)	VOC	2969	0.075	If Detected	Used in insecticides, moth balls, air deodorizers	Anemia; liver, kidney, or spleen problems
Vinyl chloride	VOC	2976	0.002	If detected	Leaching from PVC pipes; plastics factory discharge	Increased risk of cancer
1,1-Dichloroethylene	VOC	2977	0.007	If Detected	Industrial extraction solvent	Liver problems
1,2-Dichloroethylene (trans)	VOC	2979	0.1	If Detected	Industrial extraction solvent	Liver problems
1,2 Dichloroethane	VOC	2980	0.005	If Detected	Industrial extraction solvent	Increased risk of cancer
1,1,1-Trichloroethane	VOC	2981	0.200	If Detected	Industrial solvent/degreaser	Nervous system, circulatory, or liver problems
Carbon tetrachloride	VOC	2982	0.005	If Detected	Industrial solvent/degreaser	Liver problems; increased risk of cancer
1,2-Dichloropropane	VOC	2983	0.005	If Detected	Industrial solvent	Increased risk of cancer
Trichloroethylene	VOC	2984	0.005	If Detected	Waste from dry cleaning materials; industrial solvent	Liver problems; increased risk of cancer
1,1,2-Trichloroethane	VOC	2985	0.005	If Detected	Industrial solvent	Kidney, liver, or immune system problems
1,1,1,2-Tetrachoroethane	VOCU	2986	n.e.			
Tetrachloroethylene	VOC	2987	0.005	If Detected	Dry cleaning, industrial solvent	Liver problems; increased risk of cancer
Monochlorobenzene (Chlorobenzene)	VOC	2989	0.1	If Detected	Industrial solvent	Liver or kidney problems
Benzene	VOC	2990	0.005	If Detected	Gas additive; Industrial solvent	Anemia; increased risk of cancer
Toluene	VOC	2991	1.0	If Detected	Gas additive; Industrial solvent	Kidney, nervous system, or liver problems
Ethylbenzene	VOC	2992	0.7	If Detected	Gas additive	Kidney or liver problems
Styrene	VOC	2996	0.1	If Detected	Plastic mfg; resins used in H2O treatment equip	Liver, kidney, or circulatory system problems

Abbreviations:

MCL- The **M**aximum **C**ontaminant **L**evel allowed in drinking water
SDWIS – **S**afe **D**rinking **W**ater **I**nformation **S**ystem
Bio - biological
Rad - radiological parameter
IOC - inorganic parameter/compound
IOCU - inorganic parameter/compound unregulated

SOC - synthetic organic compound
SOCU - synthetic organic compound unregulated
VOC - volatile organic compound
VOCU - volatile organic compound unregulated
n.e. - not established-reporting is required

Footnotes:

[a]Fluoride has a secondary MCL of 2.0 mg/L, and a primary MCL of 4.0 mg/L
[b]pH is expressed in units of hydrogen ion activity
[c]Lead and Copper samples are collected in tap water samples throughout the distribution system
[d]Aesthetic Regulated Secondary MCLs
[e]Recommended additional reporting parameters
[f]Total MCLs combined equals 0.100 mg/L
[g]MtBE has a secondary MCL of 0.020 mg/L and a primary MCL of 0.013 mg/L
[h]State waiver in place-sampling required for initial water quality testing only
[i]The Arsenic MCL of 0.01 mg/L became effective on January 22, 2004. Systems in existence prior to that date are required to meet this MCL by January 22, 2006. Systems that became operational between January 22, 2004 and January 22, 2006 must meet the 0.01 mg/L MCL at the time of operational approval.
[j]Beta particle testing required only for systems deemed vulnerable by the Department and notified that testing is mandatory.

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Appendix 2:
Env-Ws 386.49: Protection of the Purity of the Water of Lake Waukewan and Its Watershed

Env-Ws 386.49 Protection of the Purity of the Water of Lake Waukewan and Its Watershed.

(a) The purpose of this rule is to protect the purity of the water of Lake Waukewan which is the principle drinking water supply for the town of Meredith.

(b) This rule shall be effective within the Lake Waukewan watershed above the Lake Waukewan dam, which is located at approximate latitude 43 39'17", longitude 71 30'12", in the towns of:

(1) Ashland;

(2) Center Harbor;

(3) Holderness;

(4) Meredith; and

(5) New Hampton.

(c) Any person violating these rules shall, in accordance with RSA 485:26, be guilty of a misdemeanor if a natural person or guilty of a felony if any other person.

(d) Under the provisions of RSA 485:24, the town of Meredith and its agents may enter at reasonable times any land or property within the drainage areas associated with the tributary to the Lake Waukewan public water supply in the towns of Ashland, Center Harbor, Holderness, Meredith, and New Hampton for the purpose of investigating or inspecting sewage and drainage systems and other sources of potential water contamination.

(e) Where any provision of these rules is in conflict with state law or other local ordinances, the more stringent provision shall apply. These rules shall not amend or alter any federal or state law or rule or local ordinance or rule.

(f) Any deviations from these rules shall be by written consent of the division, in accordance with Env-Ws 386.04 and the town of Meredith. These provisions shall not apply to employees of the board of water commissioners engaged in the performance of necessary duties for the protection and control of said lake.

(g) The town of Meredith shall post a summary of the prohibitions contained in (h) below at all public access locations where persons might reasonably be expected to access Lake Waukewan or its tributaries. This posted summary may also contain any prohibitions enacted by local ordinance. A complete set of these rules shall be available and on file at the Center Harbor, Meredith and New Hampton town clerk's office.

(h) These restrictions shall include:

(1) Grandfathering of existing land uses shall be subject to the following. Existing uses as of June 14, 1993 may be continued by the landowner; such continued use shall be subject to any other rules which may limit the continuance of an existing use. If a change in use occurs or expansion is

proposed, the rule requirements shall be met. A change in use shall include, but not be limited to, a change from seasonal to year round use, higher intensity of campsites, units or domestic farm animals. Discontinuance of a grandfathered use for two consecutive years shall result in termination of any/all grandfathered rights. The intent of these rules, to improve and maintain protection of Lake Waukewan, shall be considered at all times;

(2) A person shall not build or maintain any pigpen, stable, or other building or structure in which horses, cattle swine or other animals or fowl are kept within 200 feet of Lake Waukewan or adjacent wetlands;

(3) A person shall not build or maintain any privy, toilet, sink drain or subsurface septic disposal system or discharges therefrom, within 125 feet of Lake Waukewan. Existing properly functioning septic systems within 125 feet of the shoreline may remain in place. If failure occurs, the repair or replacement system shall be in accordance with Env-Ws 1000;

(4) A person shall not deposit any dead animals, or parts thereof, food or any perishable articles that will decay and no kitchen waste, swill, garbage, human or animal waste into or upon said water or ice, or placed in, upon or within 200 feet of the waters or ice of Lake Waukewan or adjacent wetlands;

(5) A person shall prepare and follow an animal waste management plan if any one property within 200 feet of Lake Waukewan or adjacent wetlands has more than 5 adult livestock, 10 immature livestock, or 50 poultry, the owners approved by the Belknap County Conservation District;

(6) A person shall not place any hazardous waste, as defined in RSA 147-A, such as solid, semi-solid, liquid or contained gaseous waste, or any combination of wastes which pose a threat to human health or the environment in or within 200 feet of the water or ice of Lake Waukewan or adjacent wetlands. State of New Hampshire hazardous waste laws shall be strictly enforced;

(7) A person shall not place any solid waste, as defined in Env-Wm 100 through Env-Ws 1000, in, upon, or within 200 feet of the water or ice of Lake Waukewan or any adjacent wetlands;

(8) A person shall not place any chemical waste, such as, but not limited to gasoline, paint, fertilizer or similar waste in, upon, or within 200 feet of the water or ice of Lake Waukewan or adjacent wetlands;

(9) A person shall conduct all pesticide applications, as defined in RSA 430, made on land areas which contribute surface water runoff either directly to Lake Waukewan or indirectly by running into adjacent wetlands, in strict accordance with the rules of the New Hampshire pesticide control board;

(10) A person shall conduct all fertilizer applications, as defined in RSA 431, made on land areas which contribute surface water runoff either directly or ultimately to Lake Waukewan or adjacent wetlands, in strict accordance with Pes 100 through 900;

(11) A person shall perform all forestry or timber harvesting activities conducted within the Lake Waukewan watershed in strict compliance with state of New Hampshire rules Res 5301 and Res 5401 and in consultation with a state or county forester as required in RSA 227-J;

(12) A person shall not wade, swim, waterski or perform any similar water contact activities, within 400 feet of the intake of the Meredith water department;

(13) A person shall not discharge from a vessel, cruiser, boat, houseboat, wharf or a structure of any kind, whether on or in the water or on the ice, or any tank or receptacle thereon or therein contained, any excrement, urine or any waste, nor shall any such waste be left in, on, or within 200 feet of the waters or ice of Lake Waukewan or adjacent wetlands. All boats or structures of any kind used on the water or on the ice that are equipped with toilet, lavatory or other waste fixtures shall be provided with water-tight tanks for the temporary storage of such wastes. The aforementioned tanks shall be maintained as required by RSA 487 and the contents thereof shall be disposed of into a municipal sewerage system or any approved sewage disposal system on shore;

(14) A person shall not moor, anchor or otherwise secure any occupied vessel, cruiser, boat or houseboat of any kind on or to the water or ice, or tied to the shore of Lake Waukewan or adjacent wetlands for an overnight period or any part of an overnight period;

(15) A person, firm or corporation shall not cut and take ice from Lake Waukewan or adjacent wetlands except by permission of, and under the direction of the appropriate board of selectmen as prescribed in RSA 485:54;

(16) A person shall operate off-highway recreational vehicles on the water or ice of Lake Waukewan or adjacent wetlands or upon any land of the Towns within the watershed in strict compliance with the laws of the state of New Hampshire, as defined in RSA 215-A. The use of any land belonging to any of the towns within the watershed or any frozen or non-frozen surface of Lake Waukewan or adjacent wetlands by the owner or operator of any OHRV shall be done at their own risk;

(17) A person shall not use highway motor vehicles on the waters or ice of Lake Waukewan or adjacent wetland except by written permission by the board of selectmen of the town where each entrance or exit is to be made;

(18) Nothing in these rules shall be construed to prevent access to Lake

Waukewan for fishing purposes, so long as the intent of the rules is observed;

(19) A person shall place any garbage, refuse or trash of any kind brought from home, camp or place of business in or near public waste containers. Refuse resulting from picnicking on or adjacent to the Lake Waukewan or adjacent wetlands shall be deposited in approved containers;

(20) A person shall not break bottles or deposit refuse or wastes of any description into Lake Waukewan or adjacent wetland;

(21) A person shall only kindle charcoal fires or portable propane grills or maintained such within 75 feet of the Lake or adjacent wetlands;

(22) A person shall not sell food or drink or merchandise of any kind on town property, unless written permission is granted from the appropriate board of selectmen;

(23) A person shall keep dogs and other pets on a leash while adjacent to the shoreline. Pets shall not be left unattended and shall not be permitted in the water;

(24) A person shall not ride horse-back along the shoreline;

(25) An unauthorized person shall not enter upon or remain on Meredith town property adjacent to Lake Waukewan between the hours of 9:00 pm and 6:00 am;

(26) A person shall not possess or consume any alcoholic beverage or other controlled substances on Meredith town property;

(27) A person shall not remove or damage any structure, sign, plant, tree, or natural feature on town land;

(28) A person shall not conduct special or group activities on town property unless the activity shall be authorized by the appropriate board of selectmen;

(29) A person shall not obstruct or damage an emergency access gates. Violators shall be subject to towing at the owner's expense, as defined in RSA 265:69;

(30) A person shall not enter restricted areas that have been so posted as "no Trespassing";

(31) A person shall obey the requests made by authorized officials of the appropriate town in matters of safety and orderliness; and

(32) A person shall not tent, camp or use of recreational vehicles overnight, or use trailers and campers within 125 feet of Lake Waukewan or adjacent wetland.