Round Lake
Draft Management Plan

PREPARED FOR:
THE ROUND LAKE WATERSHED ENHANCEMENT SOCIETY

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1.0 Executive Summary

Round Lake is located east of the Town of Smithers, within the Regional District of Bulkley-Nechako in the Skeena Region. In response to water quality concerns in the watershed, local residents formed the Round Lake Watershed Enhancement Society (RLWES), to compile ideas and work with other organizations to improve watershed health.

The overall mission of this lake management planning process is to "promote the understanding, protection, restoration and thoughtful and comprehensive management of Round Lake, its associated wetlands and watershed". This management plan is intended to provide long-term direction to the RLWES as it undertakes projects to improve the quality of the watershed. To date, the planning process has opened communication links between numerous stakeholders, and has created a local awareness of lake management and watershed health.

Priority Issues in the Round Lake watershed

At the beginning of the management planning process, stakeholders identified seven priority issues related to watershed health:

1. Lake and stream impacts from development
2. Conservation of waterfowl and wildlife habitat
3. Increasing sedimentation rates
4. Threats to drinking water quality
5. Poor water quality for swimming
6. Loss of fish habitat due to oxygen depletion
7. Public education

Goals and Objectives

To address the priority issues, 3 goals were identified and objectives were created to provide direction for achieving each goal:

Goal 1: Reduce impacts of watershed development to protect water quality for drinking, recreation and other uses

- Objective 1.1: Increase public awareness about watershed health issues
- Objective 1.2: Continue monitoring to further identify and confirm sources of water quality degradation
- Objective 1.3: Reduce sediment inputs to the lake
- Objective 1.4: Reduce fecal contaminant inputs to the lake
- Objective 1.5: Reduce nutrient inputs to the lake

Goal 2: Conserve and enhance habitat for aquatic life

- Objective 2.1: Increase public awareness about aquatic ecosystems and fisheries issues

- Objective 2.2: Research and gather information about past and current fish populations, habitat quality and overall aquatic ecosystem health
- Objective 2.3: Participate in activities that preserve and restore fish habitat and improve overall aquatic ecosystem health in the Round Lake watershed

Goal 3: Conserve and enhance riparian habitat for waterfowl and wildlife

- Objective 3.1: Increase public awareness about conservation of waterfowl and wildlife habitat
- Objective 3.2: Research and document information about past and current waterfowl and wildlife habitat and populations
- Objective 3.3: Participate in activities that preserve and restore waterfowl and wildlife habitat in the Round Lake watershed

Plan Recommendations

For each objective, a comprehensive list of remedial actions was compiled and stakeholders reviewed and discussed the advantages and disadvantages of each action. RLWES, resource managers and other stakeholders determined which actions were realistic and likely to be effective in the Round Lake watershed. The actions focus on 3 key areas of lake and watershed management: public education initiatives, data collection and monitoring and practical activities; some highlights are summarized below.

Increase public awareness about watershed health issues, aquatic ecosystems and fisheries issues and conservation of waterfowl and wildlife habitat:

- Build and maintain a constituency of involved citizens
- Distribute newsletter
- Distribute educational materials at trade shows, fairs and other local events
- Install public education signage at Round Lake boat launch
- Improve distribution of drinking water quality and other lake data to the public

Continue monitoring:

- Organize a volunteer lake monitoring program
- Monitor lake levels
- Conduct deep station water quality sampling in 2004 to monitor nutrient levels
- Continue deep station Secchi disk monitoring program
- Monitor dissolved oxygen (D.O.) levels around the lake
- Identify and monitor sources of fecal contamination entering the lake
- Survey the main tributary, outlet and lakeshore
- Conduct loon survey

Pursue Practical Activities:

- Pursue funding options to implement recommended projects
- Advocate best management practices for sediment and erosion control for public roads
- Encourage and support farmers who wish to create an Environmental Farm Plan (EFP)
- Participate in regional planning initiatives including the RDBN's Smithers-Telkwa Rural Official Community Plan (OCP) project
- Invite a Health Officer to speak about onsite sewage systems
- Provide Round Lake Recreation Commission with input about lake health issues
- Participate in riparian restoration initiatives
- Organize an annual clean up day

2.0 Lake Management Planning – Purpose and Mission

2.1 Impetus for the Plan

Water quality sampling at Round Lake has revealed that the lake waters are oxygen deficient, and that nutrient, sediment, and fecal contaminant inputs from the watershed are of concern to lake health. These inputs can result in unwanted algal blooms, affect fish populations and can significantly compromise drinking water quality and the recreational value of Round Lake. In response to these and other concerns, watershed residents formed the Round Lake Watershed Enhancement Society (RLWES), so that local residents could compile ideas and work with other organizations to improve watershed health.

2.2 Mission

The mission of this lake management planning process is to devise methods:

"To promote the understanding, protection, restoration and thoughtful and comprehensive management of Round Lake, its associated wetlands and watershed"

2.3 Purpose of the Planning Process

The creation of a Lake Management Plan (LMP) was proposed to ensure that informed decisions about lake management are made. The plan will provide long-term direction to the RLWES as it undertakes projects to help bring about changes to the nutrient, sediment and fecal contaminant inputs to the lake and improve the quality of the watershed. The planning process involved consensus-building and communication among stakeholders (RLWES, agricultural organizations and other resource managers) and created a local awareness of lake management and watershed health. With a consensus-based document, RLWES will have better access to funding opportunities for lake improvement projects.

The lake management planning process is ongoing. This document will provide the long-term direction necessary to achieve the overall mission. The plan is intended to act as a handbook and reference guide. It identifies priority issues and concerns of stakeholders regarding water quality and ecosystem health. It outlines in detail, the actions and resources required to implement those remedial actions selected by stakeholders. It is intended that the society and other resource managers will refer to the document on an ongoing basis. It is important to remember that this document does not indicate completion of the lake management planning process. As recommendations in the plan are implemented, the planning process will continue with assessments and revisions occurring at regular intervals (Section 3 provides more details on the entire process).

To date, the lake management planning process has served other important purposes. They include:

- Developing communication links between the RLWES, multiple levels of government, agricultural associations and other local residents and stakeholders
- Creating awareness in the community about issues affecting water quality in the lake and watershed, and motivating people to get involved
- Identifying opportunities for volunteer-driven actions, and setting the stage for a volunteer program to monitor lake conditions

If the management planning process is successful and the plan contributes to a healthier watershed with functioning ecosystems, everyone will benefit. Area residents will see an enhanced quality of life, an aesthetically pleasing lake, and improved fish and wildlife habitat and recreational opportunities and government officials will be able to comfortably make decisions which represent the best interests of involved stakeholders.

3.0 Lake Management Planning - Methods

3.1 Strategic Planning

Problem solving can be approached using short-term or long-term strategic thinking (Spitzer, 1991). In general, short-term approaches treat only the symptoms of a problem, and are *relatively* simple and often appear to be the least expensive. Long-term approaches tend to require continuing commitment, treat the causes of the problem and may be expensive. For solving complex problems, however, they are often the most practical and efficient approach that can be used.

Developing management strategies for environmental protection is complex because many relationships and interactions exist within ecosystems that we still do not completely understand. Therefore, careful study and determination of a long-term plan of action to protect environmental and social values associated with Round Lake and its watershed is required.

In addition to employing a long-term approach, lake management planning must also consider economic and social consequences associated with any proposed technical solution. For example, dealing with accelerated lake eutrophication will not be solved by employing short-term solutions that treat the symptoms of the problem. While “in-lake” treatment methods may form an important part of the overall solution, a long-term sustainable solution needs to look beyond the symptoms and treat the underlying causes: nutrient, sediment and fecal contaminant inputs from the surrounding watershed.

3.2 Consensus Building

Due to the number of concerns and the variety of the stakeholders, consensus-building is an important part of the lake management planning process. A successful lake management program begins with a LMP that has widespread support from stakeholders and involves all interested groups and regulatory agencies throughout the planning process (Gibbons et al., 1994). There is no substitute for local knowledge of the lake's problems and/or a lifetime of observations of a lake.

In the Round Lake management planning process consensus-building was achieved through the RLWES and the group has served as a primary voice for the community. The RLWES also distributed a survey to build consensus and to clarify what issues require action. The results of the survey formed the basis of the planning process. Interested parties were involved throughout the planning process and regular meetings were held so that stakeholders had the opportunity to provide input: during identification of the issues, during creation of plan goals, and when potential remedial actions were identified and evaluated.

3.3 Project Partners

Stakeholders identified in the Round Lake Management Plan (RLMP) project include various government agencies (Ministry of Water, Land and Air Protection, Regional District of Bulkley-Nechako, Ministry of Agriculture, Food & Fisheries, Land and Water B.C., and Community Futures Development Corporation of Nadina), lake user-groups (Round Lake Recreation Commission), and agricultural organizations (Bulkley Valley Cattlemen's Association and Dairymen's Association, Smithers Farmer's Institute and the B.C. Agriculture Council). A list of contacts and stakeholders involved in the RLMP is included in Appendix A.

3.4 Project Process

A strategic approach similar to the framework outlined by Rast and Holland (1988) was used for the RLMP (Figure 1, pg 11). It has been modified from its original form to reflect the actual process of creating this management plan. The management planning framework consists of the following steps:

Step 1: Identify local problems and prioritize issues of concern – concerns were identified and prioritized by members of the RLWES, natural resource managers/scientists and other stakeholders, and through a survey distributed to watershed residents and lake users. The top 7 issues will be discussed in this plan and are described in Section 5.0.

Step 2: Establish lake management goals and objectives– 3 goals were devised to encompass the 7 issues identified in Step 1. Objectives were then defined for each of the goals to provide direction. Section 6.0 provides details.

Step 3: Analyze the Round Lake system – physical, chemical and biological information was gathered for the watershed. Background information is presented in Section 4.0 and the 2002-2004 data report is in Appendix B.

Step 4: Identify remedial actions – a list of possible remedial actions were identified for each objective and the costs and benefits of each action were researched. Descriptions of each action are included in Section 7.0.

Step 5: Conduct an analysis of remedial actions – the analysis considered the values and judgements made by key experts and stakeholders. RLWES reviewed the advantages and disadvantages of each action to conclude which best suited their purposes. The process is described in Section 7.0.

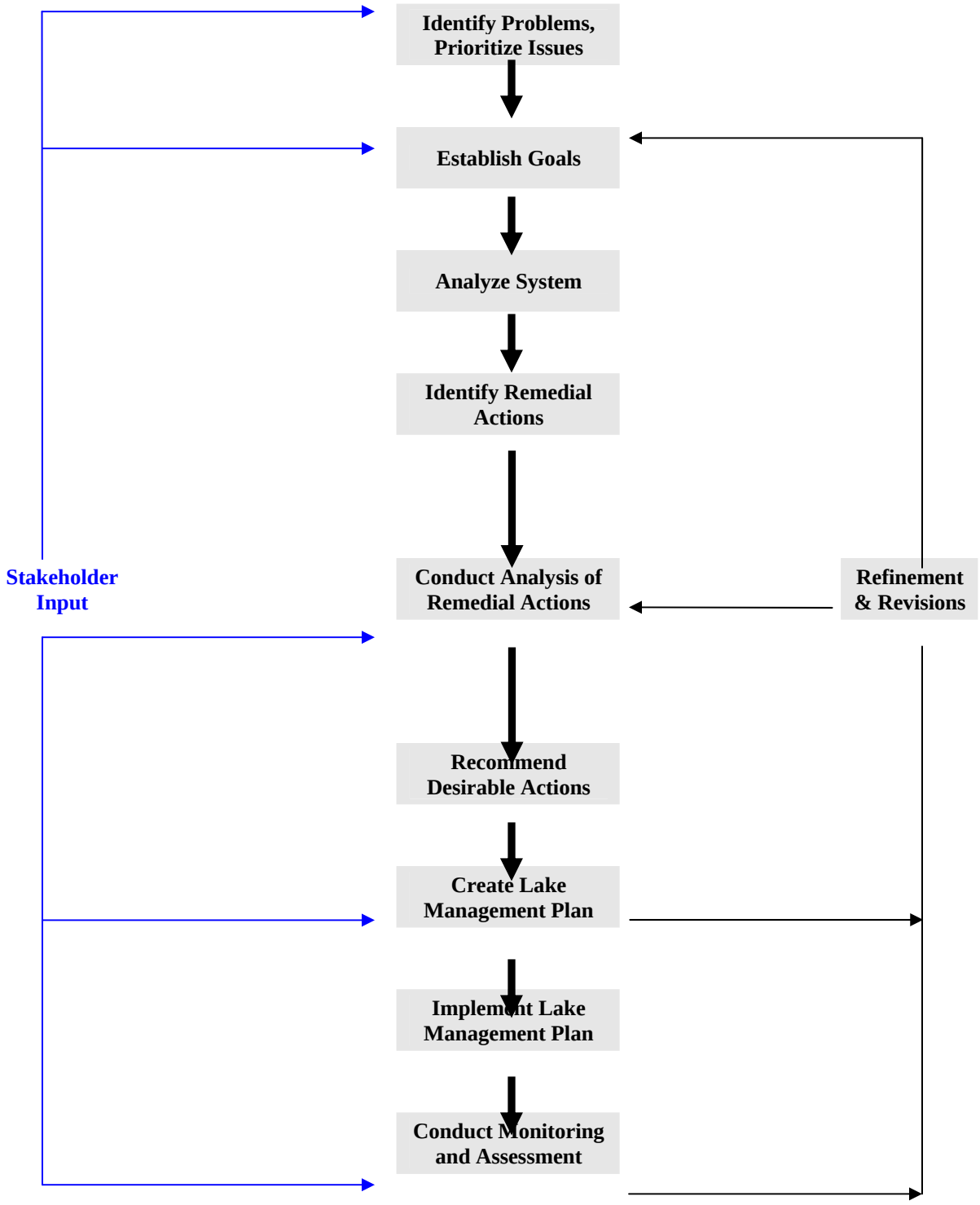
Step 6: Provide recommendations – with the help of resource mangers, RLWES selected the most feasible actions that addressed the priority issues. These actions and information about implementation are summarized in Sections 8.0 and 9.0.

This management plan represents completion of Step 6 in the management planning process. The framework shown in Figure 1 includes 2 additional steps, which are critical parts of the ongoing process. It is anticipated that management planning for the Round Lake watershed will continue through Steps 7 and 8.

Step 7: Plan implementation –RLWES will continue its efforts to generate support in the community and gather resources to undertake activities recommended in the plan. It is important to continue meeting to organize activities, and to ensure activities are implemented successfully.

Step 8: Assessment (and revisions) – as the RLMP is implemented, regular meetings should be scheduled to review and update the management plan and to make necessary changes or additions as new information or issues arise.

Figure 1. The Lake Management Planning Process



(Modified from Rast and Holland, 1988).

4.0 Round Lake: Background Information

This section includes a description of Round Lake, including maps, lake characteristics, hydrometric, and water quality data and a summary of measurement methods and sample locations.

4.1 Watershed Characteristics

Round Lake is located approximately 24 km southeast of the Town of Smithers (Figure 2). The lake lies at 54° 39' N latitude, 126° 55' W longitude and is located within the Regional District of Bulkley-Nechako in the Skeena Region.

The Round Lake watershed drainage basin has an area of approximately 27 km² (Figure 3) and a perimeter of 5.3 km. Round Lake watershed is surrounded by private lands used for agriculture (grain and forage and cattle farming) and residential purposes. Figure 4 shows general land uses and forest types around the lake.

Figure 2: Location of Study Area

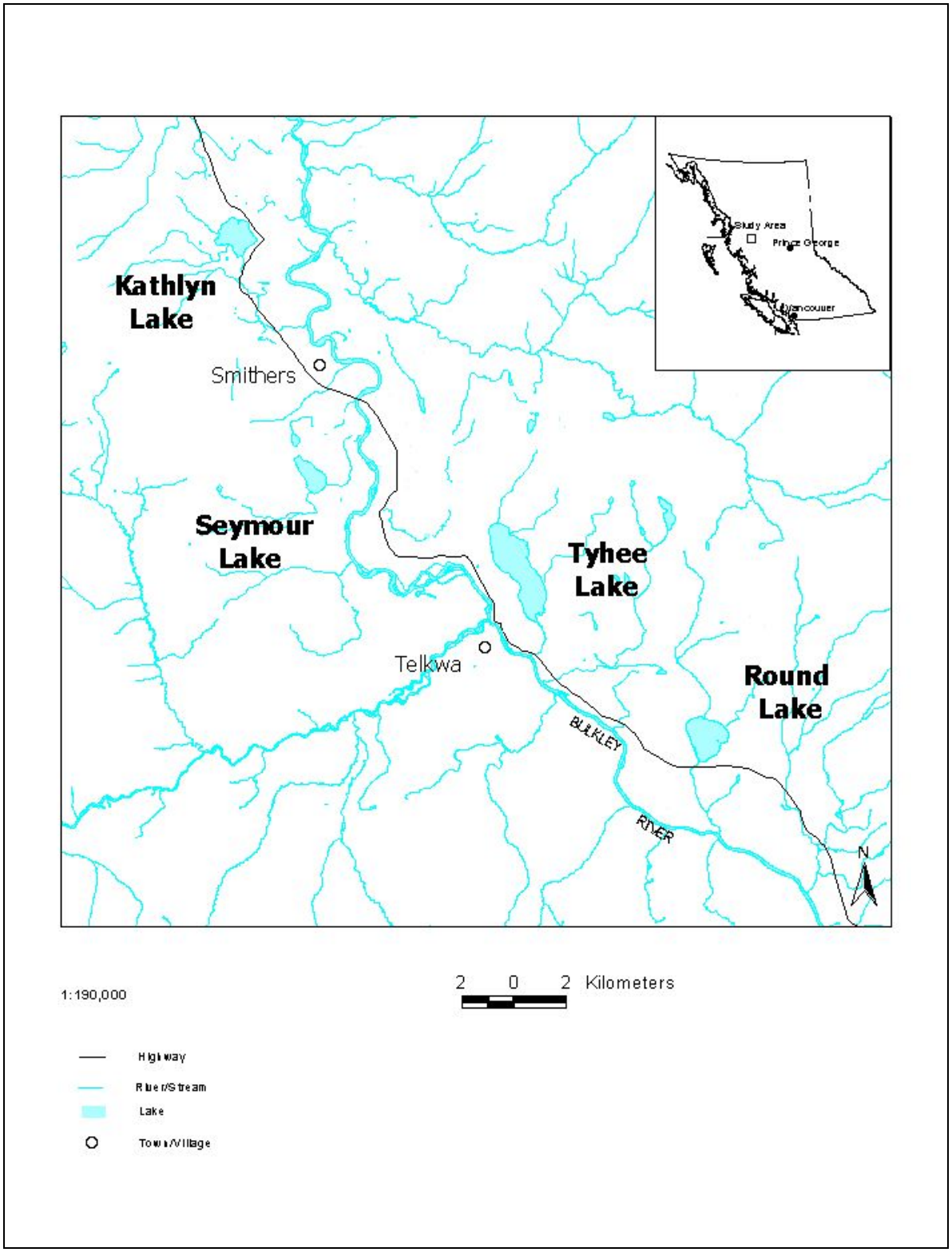


Figure 3: Round Lake Watershed Boundary

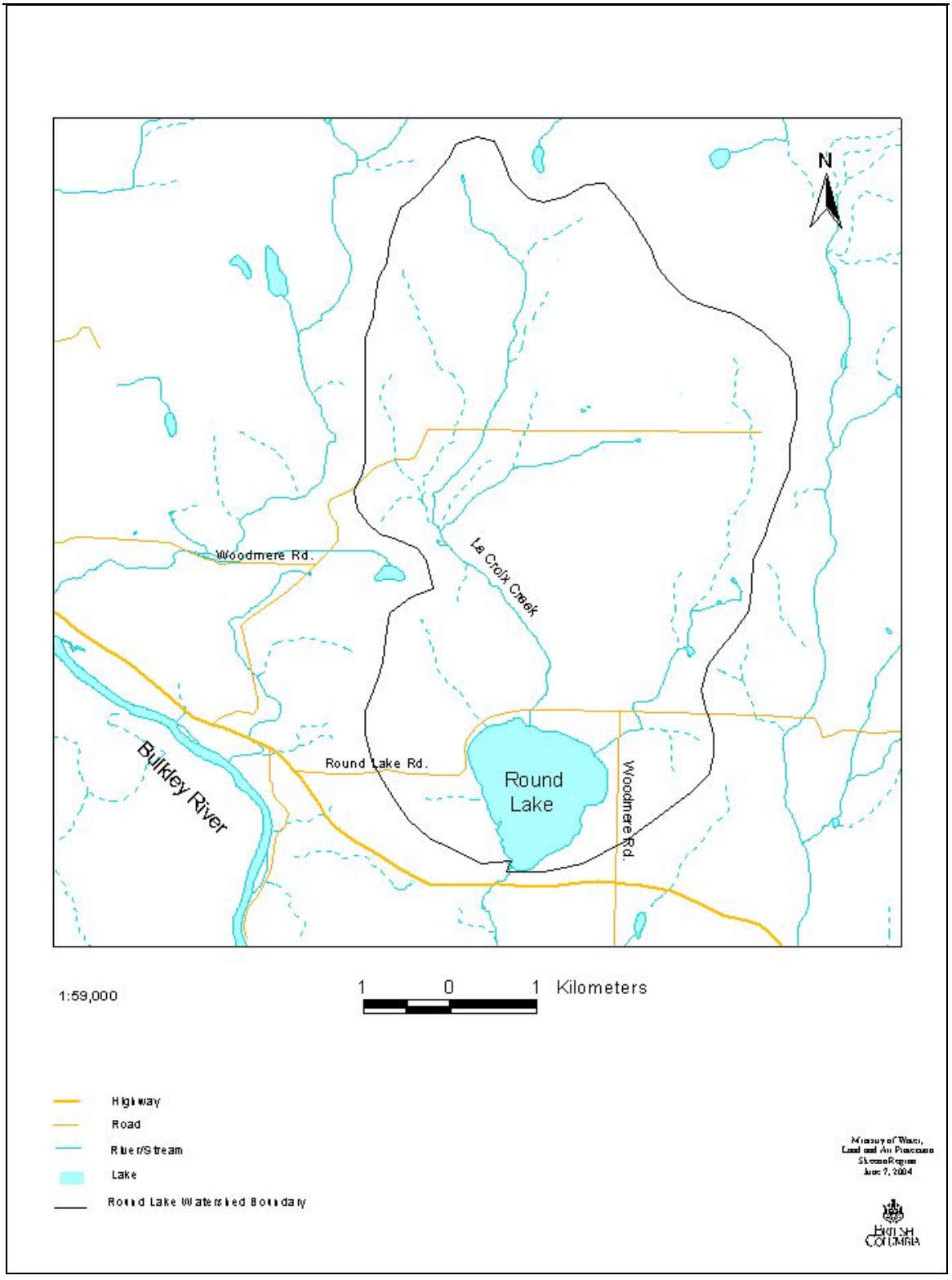
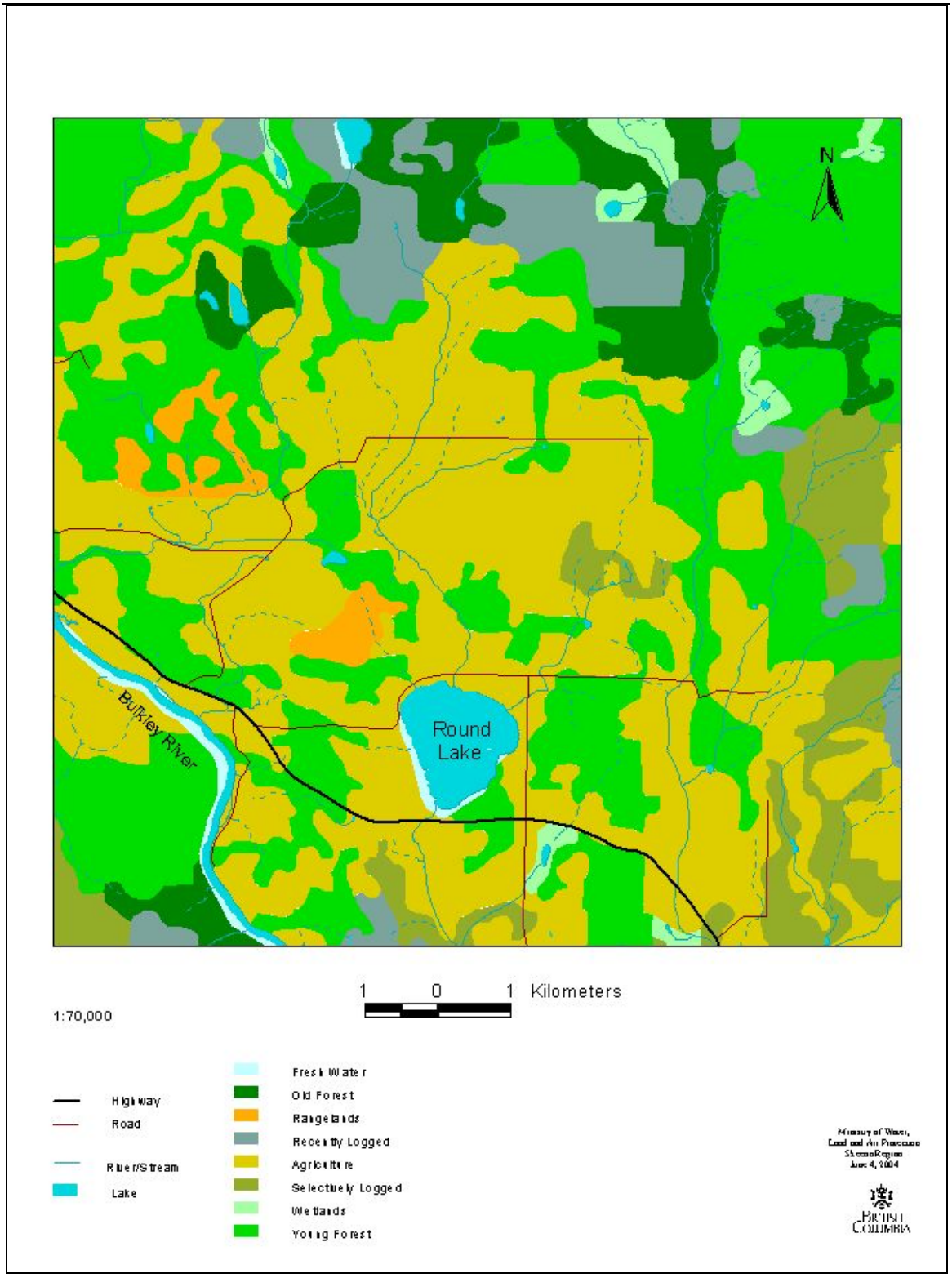


Figure 4: Land uses and forest types in the Round Lake watershed



4.2 Watershed Hydrology

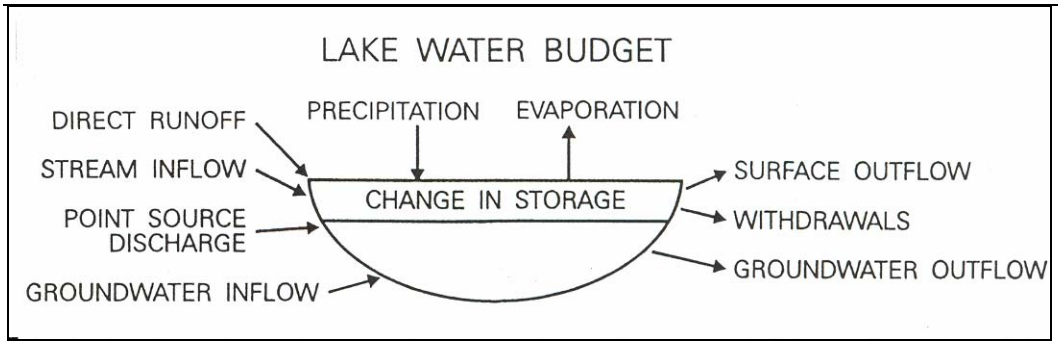
Sources of Water Inflows and Outflows

Water carries sediment, nutrients, and other dissolved substances into and out of lakes, therefore an understanding of lake hydrology is required to analyse water quality problems. A basic water balance equation can be expressed as:

Inflow + precipitation = outflow + evaporation + change in storage

Figure 5 illustrates possible water flows that contribute to the total water budget.

Figure 5: Schematic Water Budget (Holdren et al., 2001)



Inflows to Round Lake include:

- *Precipitation*: water falling directly onto the surface of the lake as rain or snow
- *Direct runoff*: water that enters after flowing over the land surface
- *Groundwater flow*: water that enters after flowing through pores and spaces in the soil
- *Stream flow*: the main tributary is intermittent and a number of smaller intermittent streams and culverts also drain into Round Lake
    - La Croix Creek is the main inflow and drains into the north side of the lake. When it is running, the creek flows approximately 3 km before it reached the lake.

Outflows from Round Lake include:

- *Lake Outlet*:
    - La Croix Creek also drains from the south of the lake into the Bulkley River
- *Groundwater outflow*: water that leaves via pores and spaces in the soil
- *Withdrawals*: water supply, irrigation, etc.
- *Evaporation*

4.3 Lake Characteristics

Morphometric Data

Round Lake has a regular shoreline, no islands and one main basin. Morphometric characteristics of the lake are summarized in Table 1.

Table 1: Summary of Lake Characteristics for Round Lake (Boyd et. al.,1985).

Maximum Depth	20.4 m
Mean Depth	9.6 m
Volume	17516 dam^3
Surface Area	1.82 km^2
Elevation	579 m
Shoreline Length	5.3 km
Water Retention Time	3.1 yr
Watershed Size	27 km^2

Flushing Rate and Water Retention Time

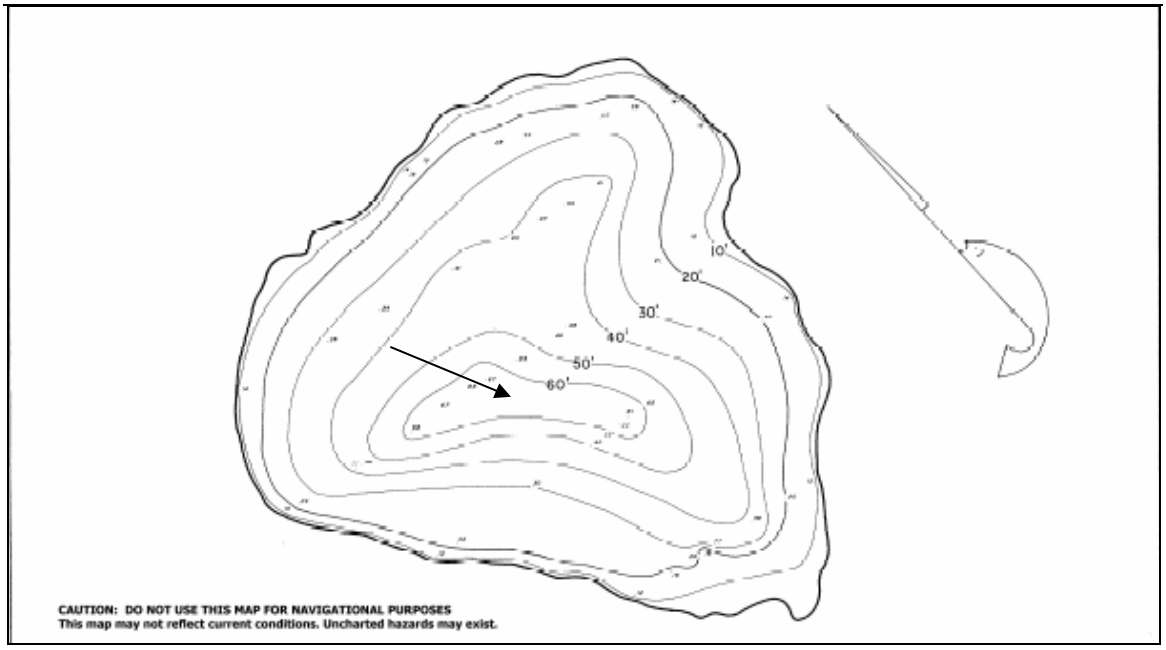
Flushing rate describes how fast water passes through a lake basin, relative to lake volume. The average lake flushing rate of Round Lake was estimated by Boyd et al. (1985) to be once every three years or longer. The main inflow to the lake is intermittent, which probably contributes to the low flushing rate.

Water retention time is the average time that a given molecule of water remains within the lake basin. Retention times are dependent on the bathymetric characteristic of the lake basin (lake size, shape and depth). This is estimated to be an average of 3.1 years in Round Lake. Other Smithers area lakes average water retention time estimates include 1.15 years in Kathlyn Lake and 5 years in Tyhee Lake (Boyd et al., 1985).

Bathymetry

A bathymetric map is a contour map of the depths in a lake basin. The bathymetry of Round Lake is relatively simple, with one main basin and a maximum depth of approximately 20 m. Figure 6 shows the bathymetric map for Round Lake. The arrow indicates the deep station water quality sampling site.

Figure 6: Round Lake Bathymetric Map and Deep Station Site



4.4 Water Quality

Water quality samples have been periodically collected at Round Lake Deep Station over the past 20 years. Comprehensive samples were recently collected over the 2002 and 2004 period. The recent sampling included determination of temperature and dissolved oxygen profiles and analysis of pH, specific conductance, total metals, nutrients and chlorophyll a (a measure of algal biomass). Some of these parameters are discussed below as they pertain to trophic state. The raw data and a more detailed report are available in Appendix B.

Trophic State

Trophic state is an indicator of water quality. The amount of algae and aquatic plant growth, water transparency, chlorophyll a levels, phosphorus concentration, dissolved oxygen in the hypolimnion (bottom layer of a thermally stratified lake), and populations of other organisms such as aquatic insects and fish, are all indicators of trophic state.

Lakes can be divided into three categories based on trophic state; oligotrophic, mesotrophic, and eutrophic. These categories reflect a lake's biological productivity and nutrient and clarity levels. Lakes with abundant aquatic life (mainly algae and aquatic plants), high nutrient concentrations and low dissolved oxygen levels are called *eutrophic* and are usually relatively shallow and warm in the summer. Lakes which produce little aquatic life are called *oligotrophic*. These lakes have lower nutrient levels, and are characteristically deep and cold, usually with clear water and rocky shores. *Mesotrophic* lakes are waterbodies in transition between oligotrophic and eutrophic. There is a

continuum of trophic states that ranges from ultra-oligotrophic through mesotrophic to hyper-eutrophic.

Eutrophication is the natural "aging" of small lakes. This is a slow process associated with the gradual build-up of organic matter, nutrients and sediments in lake basins. Over long periods of time, an open lake will first become a marsh, and then eventually fill in completely and become a terrestrial ecosystem (Rast and Holland, 1988). Throughout this process, rooted plant biomass will increase, water clarity will become reduced, the lake volume will decrease and algal blooms can become more frequent.

Cultural Eutrophication is a term used to describe the accelerated rate of the eutrophication process due to human settlement, clearing of forests, and development within a lake's watershed (Rast and Holland, 1988). These activities increase the rate of nutrient enrichment and biomass production by increasing sediment and nutrient inputs to the lake. A lake that is undergoing cultural eutrophication can be managed to reduce the rate of change and /or restored so that it will again have water quality that is more characteristic of its natural, pre-development state. However, if cultural eutrophication is left unmanaged, the result may be significant ecological changes (water quality degradation) and a reduction in appeal of the lake for residents and recreational user-groups.

Table 2 is an index for trophic classification based on total phosphorus measurements, chlorophyll a, and water clarity. Table 3 shows that Round Lake currently has relatively high phosphorus concentrations, high levels of chlorophyll a, and average water transparency. The lake also experiences seasonal low dissolved oxygen levels throughout the water column. Together, these factors indicate that Round Lake is between mesotrophic and-eutrophic.

Table 2: Trophic classification based on chlorophyll a, water clarity measurements, and total phosphorus values (Adapted from Lillie and Mason, 1983).

Trophic class	**Total phosphorus** (ug/l)	**Chlorophyll a** (ug/l)	**Secchi Disc** (m)
Oligotrophic	3	2	3.7
	10	5	2.4
Mesotrophic	18	8	1.8
	27	10	1.8
Eutrophic	30	11	1.5
	50	15	1.2

Table 3: Round Lake chlorophyll a, water clarity measurements, and total phosphorus values (based on 2002-2004 sampling results)

Round Lake	**Total phosphorus** (ug/l)	**Chlorophyll a** (ug/l)	**Secchi Disc** (m)
Concentrations:	40	14.4	2.0

Temperature

Of all the properties of a lake, temperature has the greatest influence on the biology and chemistry of the lake system. The density of water is directly related to temperature. As the surface waters warm in the spring, they become lighter than the cooler, denser water at the bottom of the lake. As this process continues, the density difference between the surface and bottom waters becomes too great for the wind to mix. The occurrence of warm surface waters overlying cold bottom waters is referred to as *thermal stratification*.

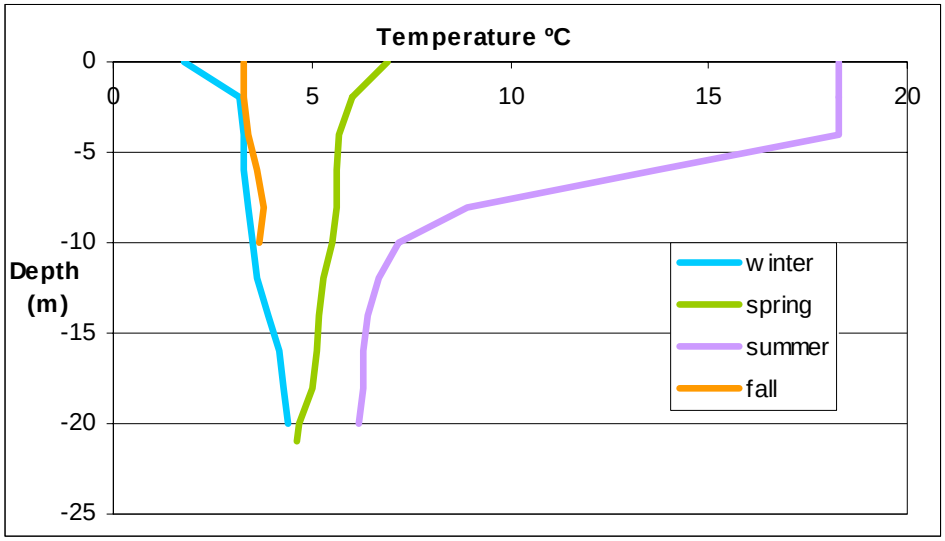
Three distinct layers are formed during summer stratification: the *epilimnion* (the upper, warm, and well mixed area), the *metalimnion* (the middle layer of rapidly decreasing water temperature and density also known as the thermocline), and the *hypolimnion* (the uniformly cold, dense, and unmixed bottom layer). Mixing becomes easier in the fall, as the surface waters cool and the temperature differences between layers decreases. When the water reaches uniform temperatures and density at all depths, this destratification is referred to as *fall turnover*.

Thermal stratification also occurs in the winter months to a lesser degree. The temperature in the hypolimnion during the winter is generally around 4° C (at water's maximum density), while the cooler temperatures in the epilimnion are actually less dense. During the winter (when an ice layer forms on top) the water then re-stratifies in reverse order. When the ice layer melts in the spring, the wind action re-circulates the lake water, which is referred to as *spring turnover* (Holdren et al., 2001).

Temperature profiles reveal whether a lake thermally stratifies and how often and complete the stratification is. Several factors can affect the extent of summertime stratification within a lake, including lake depth, winds and spring temperatures.

Round Lake has relatively warm temperatures throughout the summer and strong thermal stratification occurs during July and August. Lake temperature measurements were recorded at the Deep Station Site at regular depth intervals between 2002 and 2004. Figure 7 illustrates typical seasonal temperature profiles of Round Lake. Temperatures are stratified in the summer and uniform (the lake is well mixed) in spring. In the winter, bottom water temperatures were slightly warmer than temperatures near the surface (temperatures closer to 4° C are generally denser).

Figure 7: Seasonal Temperature Profiles in Round Lake



(Note: Complete fall temperature profile could not be obtained due to equipment failure)

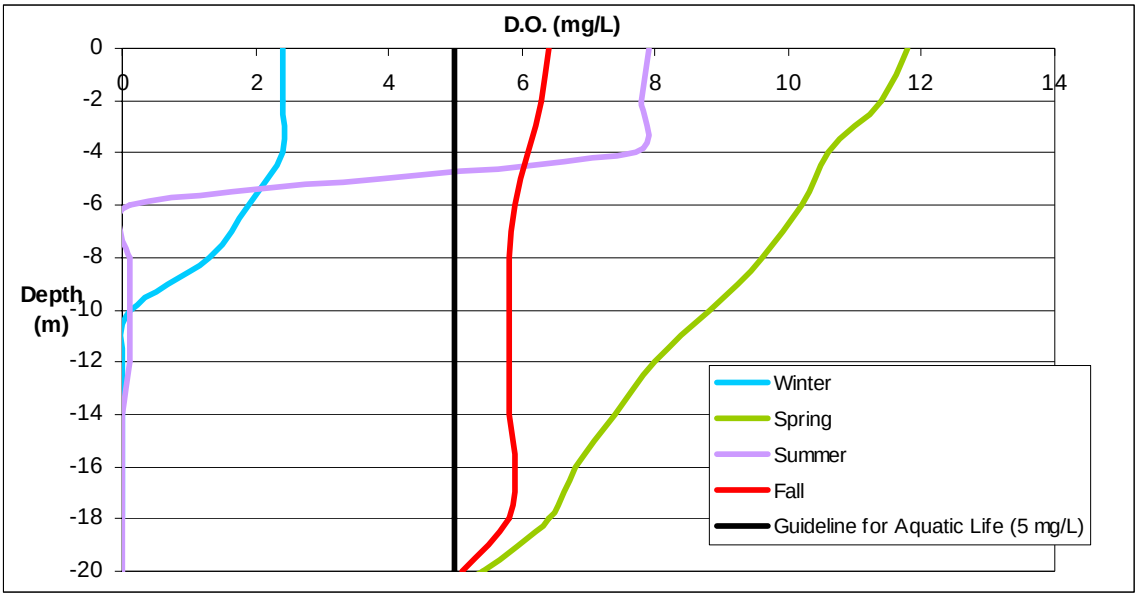
Dissolved Oxygen (D.O.)

The amount of oxygen in the water is an important indicator of overall lake health (Cavanagh et al., 1997). The oxygen enters the water through exchange at the surface waters from wind mixing the epilimnion, photosynthesis, and the inflow of oxygen rich water into the lake through streams. Cold water holds more oxygen than warm water, so as the temperature of water increases, oxygen is released to the air (Cooke et al., 1993).

When lakes become stratified in the summer and winter, low D.O. levels can cause stress on aquatic organisms and have been attributed to fish kills in severe circumstances. If the water at the lake bottom (hypolimnion) is oxygenated, phosphorus is trapped in the sediments. When D.O. levels are low in the hypolimnion, it encourages the release of phosphorus into the water column which can lead to an increase in algal and macrophyte growth (Holdren et al., 2001). When the plants and algae blooms die, they sink to the bottom of the lake and decompose, further reducing the oxygen content of the water, and creating an ongoing cycle of oxygen depletion.

The D.O. guideline for the protection of fresh water aquatic life is 5 mg/L. Concentrations below 5 mg/L will generally not support healthy fish populations and can lead to fish kills. Dissolved oxygen profiles throughout 2002 and 2004 indicated that Round Lake has a poorly oxygenated water column, especially throughout the summer months. Figure 8 shows typical seasonal D.O. concentrations in Round Lake compared to the 5 mg/L guideline (Round Lake is approximately 20 m deep).

Figure 8: Seasonal Dissolved Oxygen Concentrations in Round Lake



Transparency/Secchi Depth

The transparency (or clarity) of a lake is based on the transmission of light through water. It is related to the density of algae and total suspended solids within the water column. Water transparency is usually measured using a black and white Secchi disk. The disk is lowered into the water column to the point where it is no longer visible and the depth is recorded. Another depth is recorded after raising the disk until it just becomes visible and the two depths are then averaged for the *Secchi depth*, or *Secchi transparency* of the lake (Holdren et al., 2001). The assumption is that the greater the Secchi depth, the better the water quality of the lake. Lakes with low Secchi values tend to be very productive (eutrophic) while lakes with high values tend to be less productive (oligotrophic).

The average of Secchi depths measured at Round Lake Deep Station in the summers of 2002 and 2003 is 2.0 m.

Nutrients

Aquatic life has several requirements for survival and growth. For algae and aquatic plants these requirements include sunlight, oxygen, hydrogen, carbon, nitrogen, phosphorus and other micronutrients. The ratio of carbon (C): nitrogen (N): phosphorus (P) by weight in plants is 40C:7N:1P and this is the ratio that is needed in their environment for growth (Wetzel, 1983). If sunlight and other micronutrients are available for growth, then phosphorus will be the first major nutrient to limit growth. Additional phosphorus that enters the lake environment will result in increased levels of photosynthesis, and growth of algae and aquatic plants. If phosphorus is in excess within

the lake, then there will be a high level of photosynthesis until nitrogen becomes scarce and thus the next limiting nutrient (Wetzel, 1983).

Phosphorus-Limited Lakes

Most lakes in North-Central B.C. are phosphorus-limited, and a few are co-limited by phosphorus and nitrogen. Generally, in waters with N:P ratios of less than 5:1, nitrogen is limited. Ratios of 5-15:1 indicate no limitation or co-limitation and ratios of greater than 15:1 indicate phosphorus limitation (Nordin, 1985). Boyd et. al., (1985) reported that Round Lake is limited by phosphorus. Data collected between 2002 and 2004 also indicates phosphorus limitation.

Round Lake Phosphorus Concentrations

Round Lake has a site-specific water quality objective for total phosphorus. The average phosphorus concentration at the deep station should be less than or equal to 15 µg/L at spring turnover (Boyd et. al., 1984). The water quality objective was not met during spring turnover in 2003 or 2004 and average concentrations at other times of the year were often higher. As discussed above, low levels of dissolved oxygen facilitate the release of nutrients from the sediments. Figure 9 shows elevated summer and winter total phosphorus concentrations that coincide with severely oxygen depleted bottom waters. Figure 10 shows average spring phosphorus concentrations for lakes in the Smithers area.

Figure 9: Average Total Phosphorus Concentrations in Round Lake 2002-2004

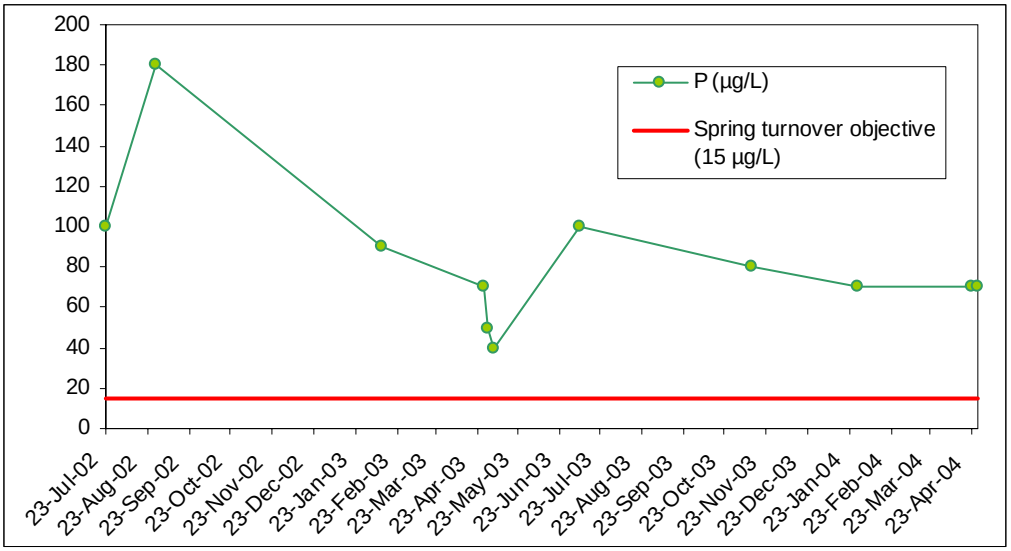
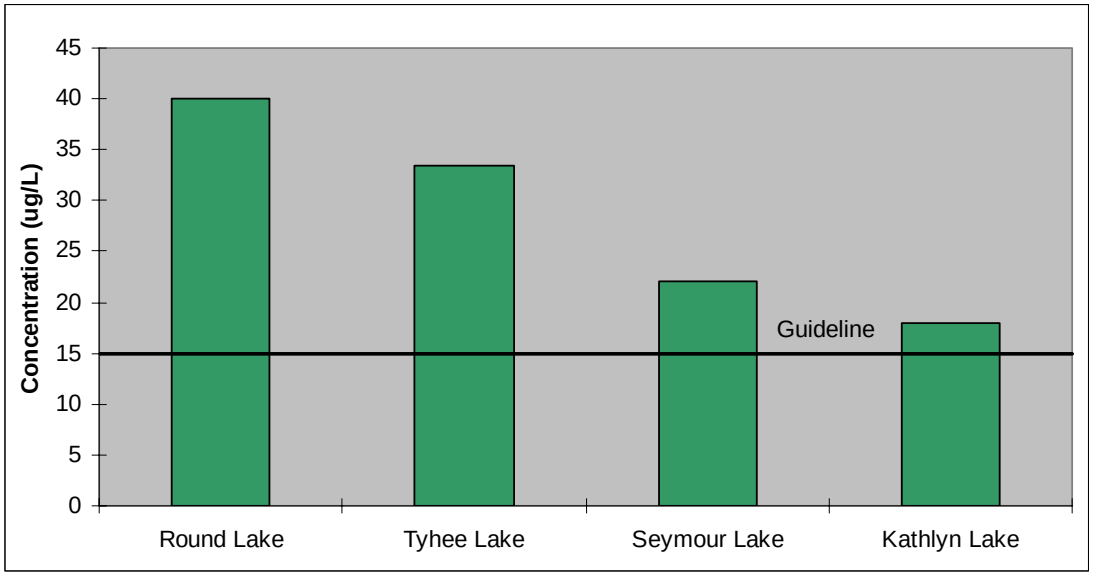


Figure 10: Average Total Phosphorus Concentrations during Spring Turnover in 2003



Internal and External Sources of Nutrients

Because phosphorus is the nutrient that regulates the general trophic status of the lake, it is important to determine the internal (in lake) and external (outside the lake) sources of this nutrient. Internal sources of phosphorus include nutrient cycling through plant growth and decay, and sediments. The chemical equilibrium in the lake, and especially at the sediment-water boundary, dictates how much phosphorus is released from the sediments. Phosphorus is re-suspended into the water under reducing (low oxygen) conditions at the sediment-water boundary.

External sources of nutrients can be classified as either "point" or "non-point" sources. Both can contribute significant amounts of nutrients to aquatic systems. Non-point sources cannot be traced to a specific origin or starting point but seem to enter the lake system from many places. There are three major non-point sources of nutrients: those that are carried by overland flow during snow melt, flood or storm events (often originating from agriculture, forestry, urban development, and mining); those that are deposited from dust in the atmosphere (during rainfall events); and those sources seeping into the lake from deep and shallow groundwater flow (onsite septic system leachate). External point sources include direct discharge into the lake from specific, identifiable pipes, points or outfalls. These sources are generally more readily measurable than non-point nutrient sources (Holdren et al., 2001).

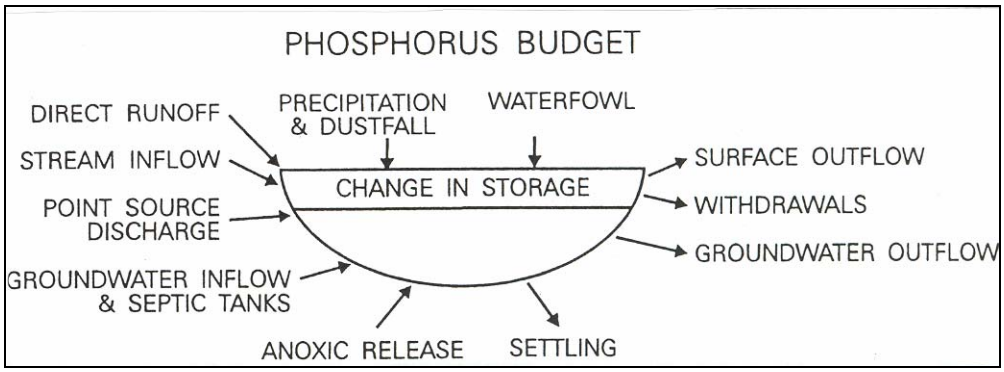
Nutrient Budgets

A nutrient budget is a quantitative assessment of nutrients moving into, being retained in, and moving out of an aquatic system (Holdren et al., 2001). It describes both the sources (and sinks) and quantities of nutrients in aquatic ecosystems. Since phosphorus is central to the productivity of lakes, many nutrient budgets focus on phosphorus loading. Figure

11 illustrates external and internal phosphorus sources that may contribute to the total budget.

One way to calculate a nutrient budget is by sampling and calculating loading rates from all possible sources of nutrients including atmospheric deposition, streams, septic tanks, agriculture, direct discharges and internal loading (McKean, 1986). This process is labour intensive and costly due to extensive laboratory analyses.

Figure 11: Schematic phosphorus budget (Holdren et al., 2001)



An estimated phosphorus budget was produced for Round Lake from information gathered during the 2003 tributary and Deep Station water sampling programs. Appendix B contains the details of the phosphorus budget.

Other Physical and Chemical Water Quality Parameters

Metals

The total metals concentrations observed in Round Lake Deep Station samples do not pose a concern to drinking water or aquatic life. Water quality guidelines for metals were met in most samples. Iron and manganese concentrations did exceed guidelines on a number of occasions, but do not pose an immediate concern to aquatic life or drinking water. The iron and manganese concentrations observed in Round Lake may stain laundry and plumbing fixtures and cause undesirable tastes in drinking water.

Turbidity

Failures to meet the drinking water guideline for turbidity were common in Round Lake. Since elevated turbidity levels can compromise disinfection systems, drinking water from the lake may require higher levels of treatment, such as filtration, to reduce turbidity prior to disinfection.

Biological Characteristics

Microbiological Indicators

Detection of potential pathogenic microorganisms involves sampling for fecal indicator bacteria, such as *E. coli*, *Enterococci* and fecal coliforms. These indicators provide an estimate of the degree of fecal contamination in the water from human and animal wastes. Although the indicators themselves are generally not pathogenic, when counts are high, there is a greater chance that disease-causing organisms are also present.

Three sites were tested around Round Lake in 2002 and 2003. *E. coli*, *Enterococci* and fecal coliforms were detected at least once at every site. Since pathogens may be present, Round Lake water is not safe to drink untreated. This is generally true of all surface water sources. For more information see the report *Drinking Water Source Quality Monitoring: Bulkley Valley* (Downie, in prep.).

Algae

Algae are single celled, photosynthetic organisms that form the base of aquatic food chains. Abundance of algae is primarily based on light, temperature, and concentration of nutrients. Chlorophyll a measurements are recognized as a useful estimate of algal growth in lakes. The maximum mean summer chlorophyll a concentration objective for Round Lake is 4 µg/L (Boyd et al. 1985). Historically, concentrations have been much higher (1982 growing season mean (May to October) was 15.5 µg/L). Based on the 2002 summer samples, the mean summer concentration in Round Lake is estimated to be 14.4 µg/L. Both concentrations are significantly above the objective and indicate that Round Lake is eutrophic. See Appendix B for 2002 and 2003 monthly averages and historical data from 1982 to 1992.

Algal biomass and species diversity is also a good indicator of the trophic status of the lake. Algae species present in 1982 indicated that the algal community in the lake was dominated by blue-green algae generally considered indicators of eutrophic conditions and a nuisance for recreation (Boyd, 1985). In addition, a recent sediment core algal analysis (see Section 5 for further details) indicates that algal populations in the lake have been historically dominated by species with affinities for meso-eutrophic conditions (Cumming, 2004).

Algae Blooms

Algae blooms, especially blue green algae, are important to note because they may be toxic if ingested by wildlife, livestock or humans (Province of British Columbia, 2001). An algae bloom occurs when conditions are favourable (most often during hot, calm weather), and algae increase dramatically and they become easy to see. When blue-green algal blooms occur, huge numbers of algae accumulate on the surface of lakes and ponds resembling thick *pea soup* and are often blue-green in colour. Although blooms occur

naturally, water bodies which have been enriched with plant nutrients from municipal, industrial and agricultural sources are particularly susceptible. It is advisable not to drink untreated water from water bodies prone to blue green algal blooms, regardless of whether noticeable blooms are present. In addition to possible health risks from algal blooms, there are other gastrointestinal illnesses which can also be contracted by drinking untreated water.

Zooplankton

Zooplankton are microscopic single or multi-celled animals that form an integral part of the aquatic ecosystem. Not only does zooplankton form a major food source for fish and invertebrates, they also act like grazers on the algae community. Zooplankton can significantly increase the clarity of the water by feeding on algae (Holdren et al., 2001).

In the summers of 2002 and 2003, vertical zooplankton hauls were collected at the Deep Station Site (three 20 m hauls on each collection date). Although the samples were not analysed for species composition, the samples were sent to Blake Matthews at the University of Victoria, for a study that measures the nitrogen isotope composition of the zooplankton and relates it to watershed activities and nutrient conditions in the lake. See Appendix C for preliminary results of the study and further information about Round Lake zooplankton.

Aquatic Plants

Aquatic plants provide the most productive and important habitat in a lake. There are different types of growth forms for aquatic plants, including submergent, emergent, floating-leaved, and free floating. Aquatic plant growth is affected by temperature, light penetration, nutrients, bottom slope and sediment type (for rooted types). Rooted plants tend to rely primarily on nutrients found in the sediment while free floating forms have conducting cells to transport nutrients through their stems and draw upon nutrients found in the water (Holdren et al., 2001). An Aquatic Plant Guide for Round Lake has been compiled based on a report published in 1980, and is available in Appendix D.

In 1992, Dr. Pat Warrington again carried out a brief survey of Round Lake. Extensive beds of *Ceratophyllum demersum* and *Myriophyllum sibiricum* were observed all around the shoreline. These surfacing plants, and the filamentous green algae that generally covers them, take all of their nutrients from the water column, indicating that there are considerable nutrients in the water column and likely a large reservoir in the sediments as well (Warrington 1992). Warrington suggested nutrient management to address excessive aquatic plant growth, as phosphorus levels at Round Lake would cause rapid plant re-growth, rendering any weed control measures futile. For further information about macrophytes found in British Columbia see Warrington's *Identification Keys to the Aquatic Plants of British Columbia* on the web at: http://wlapwww.gov.bc.ca/wat/wq/plants/plantkey/key.html.

Fish

Burbot, prickly sculpin, longnose sucker, northern pikeminnow, and peamouth chub have been observed in Round Lake (B.C. Fisheries, 2004). The lake was stocked with rainbow trout fingerlings from 1956 until 1991 when cutthroat trout were used instead. Recent stocking included the addition of 3000 cutthroat in both 2002 and 2003. For complete stocking records visit: http://iwww.bcfisheries.gov.bc.ca/fishinv/db/default.asp or http://wlapwww.gov.bc.ca/fw/fish/hatch-stock/recent/intro-recent.html. Round Lake is considered to have moderate fishing pressure.

Terrestrial wildlife and waterfowl

The Round Lake watershed has been identified as important over-wintering habitat for moose in the Bulkley Valley Landscape Unit Plan (Province of British Columbia, 2004). Other animals observed in the area include deer and black bears and a variety of furbearers. Small mammals and amphibians provide the foundation of the food chain for many furbearers and birds of prey.

The Round Lake watershed provides important habitat for waterfowl. The lake is utilized by various species of migratory geese and ducks, and the wetlands and lake provide essential breeding grounds for waterfowl such as mallards and loons. A preliminary survey of loon nesting areas in May 2004 indicated that at least 3 nesting pairs presently utilize the lake. Birds of prey found in the area include bald eagles, osprey, and hawks. Numerous smaller non-game birds such as red-winged black birds inhabit the watershed and are an important part of outdoor recreation opportunities in the area.

4.5 Inferring Lake History with a Sediment Core

Effective management of aquatic resources requires long-term environmental data so that background conditions can be determined. The results from sediment coring can provide long term data on ecosystem conditions and changes, and can be used to assess and compare past and present ecosystem health.

On March 20, 2003 a sediment core sample was obtained from Round Lake deep basin. The sediment core was shipped to Dr. Brian Cumming at Queen's University for analysis. A combination of lead isotope (Pb 210) dating, diatom assemblage analysis and nutrient concentration analyses of the core slices allowed for inferences to be made about past and present nutrient concentrations in the lake and thus provide an estimate of the degree of human influence since development began. Complete results are available in the report *Assessment of Changes in Total Phosphorus in Round Lake, BC: A Paleolimnological Assessment* (see Appendix E). The highlights of the report are summarized below:

- Diatom-inferred total phosphorus (TP) estimates indicate stable mid-summer mesotrophic-eutrophic conditions (between 19 to 20 µg/l) during the last 200 years of the lake's history.

- The core indicates that sediment delivery rates began to slowly increase in the 1950's with larger increases in the 1980's. Around 1996, a change in the content ratio of the sediment composition occurred.

- In the case of Round Lake, practical mitigation targets to reduce further sedimentation to the lake and maintain the current water quality should be pursued.

A more detailed analysis of the sediment core is also available in Appendix E.

5.0 Priority Issues in the Round Lake Watershed

The water quality and sediment core data presented in Section 4.0 was compiled and analysed to gain an understanding of the Round Lake system. A survey was also distributed to watershed residents to determine the views of people who live, work and recreate in the Round Lake watershed (see Appendix F for a copy of the survey and summary of results). Together, the survey results and the water quality and sediment core data provided guidance for the planning process and were used in identifying priority issues to be addressed in the Lake Management Plan.

This Lake Management Plan will deal primarily with seven priority issues, which are examined below. Other issues listed in the survey but not discussed in the plan are included in Appendix F and should be periodically reviewed and re-prioritized as necessary.

5.1 Lake and stream impacts from development

Based on survey results, lake and stream impacts from development are a high concern in the Round Lake watershed. Activities such as tree removal, planting lawns and non-native vegetation, road construction and riparian and soil movement by livestock usually result in the loss of riparian areas (shoreline and streamside vegetation), greater shoreline and stream erosion, and increases in sediment and nutrient inputs to the lake. Air photos show much of the land in the Round Lake watershed has been cleared, and a long-time watershed resident noted that the main inlet appears more turbid now than in the past. The links between watershed development, waterfowl and wildlife habitat, sedimentation rates, and water quality highlight the importance of investigating and practicing low-impact activities around the lake.

5.2 Conservation of waterfowl and wildlife habitat

Survey results indicate that conservation of waterfowl and wildlife habitat is a high concern for watershed residents. A survey respondent and long-time lake resident noted fewer waterfowl offspring and current absence of muskrat populations around the lake. Loss of riparian area habitat can result in less species diversity and can impact water quality and the aesthetic value of the lake. Healthy and diverse wildlife populations reflect a healthy ecosystem and a higher quality of life for watershed residents.

5.3 Increasing sedimentation rates

The sediment core results show sediment delivery to the lake has been slowly increasing since the 1950's. The root systems of trees and shrubs help stabilize soil and prevent erosion, reduce nutrient inputs and buffer the impact of rainy seasons and flooding by storing water. When these areas are destroyed, higher sedimentation rates can result, which can affect drinking water quality and recreational activities like swimming. Increases in suspended solids can also cause habitat degradation for fish, affect fry

survival and reduce growth rates. It can also reduce the abundance of aquatic insects (Larkin et al., 1998). Increased sediment delivery and the nutrients that accompany the sediment often promote excessive aquatic plant growth.

5.4 Threats to drinking water quality

Many lakeshore residents continue to draw water from the lake for drinking and other domestic uses, and recent studies have noted drinking water source quality concerns at Round Lake (Downie, in prep. and Remington, 2002). At Round Lake, possible threats to drinking water quality include fecal contamination from old on-site sewage disposal systems and agricultural runoff, high turbidity in runoff from watershed development and blue green algae blooms that can result from high nutrient levels. Fecal contaminants are also known to have adverse effects on livestock health, so reducing contaminant inputs is essential for maintaining the health of people and animals in the Round Lake watershed.

5.5 Poor water quality for swimming

The safety of swimmers and the aesthetic value of the lake is a concern for stakeholders and users of Round Lake. The perceived decreasing recreational value of Round Lake, particularly for swimming, is a concern for many lake users. Fecal contamination and algae blooms can pose a health risk to swimmers, and algae blooms and excessive plant growth affect the aesthetic value of the lake.

5.6 Loss of fish habitat due to oxygen depletion

Recent water quality results show that Round Lake experiences severe oxygen depletion during the summer and winter months even at near-surface depths. Low dissolved oxygen (D.O.) levels will generally not support healthy sport fish populations and can lead to fish kills. Survey respondents were very concerned about the effect of oxygen depletion on fish populations. Oxygen depletion at bottom depths also promotes the release of nutrients stored in lake sediments making them more readily available for plant and algae growth.

5.7 Public education

The RLWES advocates public education about water quality and healthy waterfront living to help decrease the rate of water quality degradation in Round Lake. Protecting waterfowl and wildlife habitat, drinking water and recreational values and reducing sedimentation to the lake relies largely on public education and providing individuals with the tools and knowledge to practice low impact activities and development in the watershed.

6.0 Lake Management Goals

The priority issues identified in Section 5.0 relate primarily to watershed development and its impacts on water quality and habitat. The following 3 goals were defined to address the 7 priority issues. A comprehensive management approach should consider 3 key types of actions: public education initiatives, data collection and monitoring, and practical activities. Under each goal below is a series of objectives that will encompass these aspects.

Goal 1: Reduce impacts of watershed development to protect water quality for drinking, recreation and other uses

- Objective 1.1: Increase public awareness about watershed health issues
- Objective 1.2: Continue monitoring to further identify and confirm sources of water quality degradation
- Objective 1.3: Reduce sediment inputs to the lake
- Objective 1.4: Reduce fecal contaminant inputs to the lake
- Objective 1.5: Reduce nutrient inputs to the lake

Goal 2: Conserve and enhance habitat for aquatic life

- Objective 2.1: Increase public awareness about aquatic ecosystems and fisheries issues
- Objective 2.2: Research and gather information about past and current fish populations, habitat quality and overall aquatic ecosystem health
- Objective 2.3: Participate in activities that preserve and restore fish habitat and improve overall aquatic ecosystem health in the Round Lake watershed

Goal 3: Conserve and enhance riparian habitat for waterfowl and wildlife

- Objective 3.1: Increase public awareness about conservation of waterfowl and wildlife habitat
- Objective 3.2: Research and document information about past and current waterfowl and wildlife habitat and populations
- Objective 3.3: Participate in activities that preserve and restore waterfowl and wildlife habitat in the Round Lake watershed

7.0 Lake Management Remedial Actions

Each goal listed in section 6.0 contains objectives that describe general types of actions to protect and enhance the quality of the watershed. For each objective, there are a number of specific remedial actions that can be implemented. A comprehensive list of actions were compiled and researched, and the advantages and disadvantages of each are recorded in the table below. Note that the actions in the table represent a range of lake management actions that were **considered** and not necessarily recommended for the Round Lake watershed.

7.1 Defining Potential Actions

The Option of Doing Nothing

Before presenting the list of potential remedial actions for the Round Lake watershed, it is important to note that "Do nothing" is a viable management approach in certain circumstances. Stakeholders should always consider the consequences of doing nothing as a basis of comparison for the potential effects of implementing a lake management program (Rast and Holland, 1988). The "Do nothing" option can highlight cases where a management program is desirable, and other cases where a program may not be required or should be postponed until further information permits a better analysis of options. In the case of Round Lake, instead of stating "Do nothing", this plan will recommend further monitoring and assessment so that decisions about when to act (if ever) can be made.

Other Lake Management Actions

Lake management approaches may treat the symptoms of a problem, or can treat the causes, in an attempt to restore lake conditions. Treating only the symptoms of a problem will result in short-term solutions. Until causes of the problem are addressed, the symptoms will continually reappear.

Three reoccurring themes are highlighted in this lake management plan: increasing public education, conducting further monitoring to identify current and potential sources of water quality degradation, and implementing hands-on remedial action. Increasing public awareness on all aspects of the ecosystem is a long-term solution to bringing about a positive change in behaviour around the watershed. Further monitoring will help identify where management approaches are most useful, and is important in the early stages of lake management. This information is important for planning other remedial actions and using limited resources wisely. Overall, a combination of actions is required to maximize the effectiveness of lake preservation and protection.

7.2 Analysis of Potential Actions

The tables below describe *possible* remedial actions considered in this planning process. To evaluate the remedial actions, RLWES and other stakeholders examined the advantages and disadvantages of each option. The notions of long-term sustainability financial restrictions, ecological concerns and effectiveness of each action were considered. It is recognized that many issues are interrelated and share certain aspects, and change or action taken on one issue can affect others both directly and indirectly.

Goal 1: Reduce impacts of watershed development to protect water quality for drinking, recreation and other uses

Objective 1.1: Increase public awareness about watershed health issues

The advantages and disadvantages common to each public education action include:

- ✓ Step towards a long-term solution
- ✓ Relatively inexpensive to implement
- x Difficult to measure the success of the action or for residents to see specific results (improved water quality, etc.)

Remedial Action	Description	Cost Estimate: Financial $ / Time 🕔	Advantages	Disadvantages
A. Build and maintain a constituency of involved citizens	• Continue regular RLWES public meetings to keep the public informed and involved in stewardship activities and use preferred methods listed below to keep the public informed • Continue to enlist new membership	$ 🕔 🕔 🕔	• Promoting and maintaining community involvement is vital to implementing recommendations of the RLMP • Builds the community's capacity to steward the watershed • New memberships can raise funds for the society	• Small local population base makes it difficult to significantly increase membership • Requires ongoing commitment (renewal of memberships etc.)
B. Distribute newsletter	• Keep residents and lake users informed by distributing a newsletter that includes RLWES activities and lake education material	$ 🕔	• Can partner with other organizations (ex. Round Lake Recreation Commission, Telkwa newsletter) • Ability to reach a large number of people in a short time	• Must have cooperation from other society to insert RLWES information in their newsletter
C. Distribute educational materials at trade shows, fairs and other local events	• Create a mobile display including brochures and handouts to exhibit at local events	$ 🕔 🕔	• Partnering with other organizations (CFDC Nadina, other lake societies etc.) can lower costs of booth rental • Some display material has already been created • Educational materials are readily available (brochures easily attained from stewardship groups and government agencies) • Provides an opportunity to speak with residents and recruit members and volunteers • Information on a variety of issues can be displayed • Can reach a large number of people in a short time	• Booth rental fee (approx. $100-$500)
D. Distribute brochures by mail or door-to-door hand out	• Encourage beneficial management practices (BMPs) in the watershed through a mail-out or hand-out of brochures that focus on "friendly" waterfront practices that will help limit sediment, nutrient and contaminant inputs to the watershed	$ 🕔 🕔	• Opportunity to enlist membership • Can reach a large number of people in a short time • Provides an opportunity to speak with residents and recruit members and volunteers	• Must be careful to come across as informative and not preach to the residents • Distribution should be limited to small doses to avoid 'information overload' • Going door- to-door may irritate residents
E. Organize information sessions	• Invite guest speakers (ex. Living by Water or BCLSS) to local venues to talk about watershed health issues • Invite locals, school groups, NWCC and other organizations to increase public participation	$ $ 🕔 🕔	• Can collaborate with other societies to share costs • Can involve participants in hands-on activities	• Possible cost • Must be careful to come across as informative and not preach to the residents • Sometimes difficult to arrange for guest speakers to get 'up north'
F. Plan an annual lake awareness day	• Hold a lake awareness event (possibly in conjunction with another Round Lake event) that includes hands-on activities, fundraising	$	• Opportunity to speak with residents and recruit members and volunteers • Can offer information on a variety of issues	• Time commitment to organize such an event (may be less work to join in on a project with another society)

	draws or contests where rewards include stewardship-based prizes (ex. Handbook for Waterfront Living)	🕓 🕓	• Effective way to reach a large number of people in a relatively short time • Provides an opportunity to speak with residents and recruit members and volunteers	
G. Install public education signage at Round Lake boat launch	• Obtain and post signs about lake health topics like boat maintenance and cleaning to avoid introduction of invasive aquatic plants and boat related pollution, awareness of waterfowl habitat areas etc.	$ 🕓	• Serves as an on-site reminder to lake users • Can reach people who may not have received other educational materials because they live outside of the watershed	• Visually unappealing • Need co-operation of Recreation Commission
H. Encourage the implementation of lake curriculum at Quick Elementary School	• Work with Quick Elementary to implement lake curriculum and get kids actively involved and interested in lake stewardship	$ 🕓	• Kids programs target future watershed residents at a young age and help promote long-term stewardship attitudes • Educational materials are readily available; school science curriculum already exists for Tyhee Lake at the Telkwa Elementary School	• Requires acceptance of Quick Elementary teachers and school board
I. Involve NWCC Natural Resource Program students in Round Lake watershed issues	• Contact program teachers and encourage projects that involve Round Lake issues • Invite NWCC students to become involved in watershed events	$ 🕓	• Will promote and maintain community involvement • Can result in data collection	• Dependant on class timing and project curriculum • Natural Resource Program is currently on hold at the Smithers campus
J. Improve distribution of drinking water quality and other lake data to the public	• Advocate that WLAP, NHA and RDBN make information related to water quality and drinking water more accessible to the public • Include brochures available from these agencies at RLWES events	$ 🕓 🕓	• Awareness of drinking water issues will help protect public health	• May take time to coordinate and implement a program
K. Inform residents that approval from Land and Water BC (LWBC) is required before changes on or around shorelines are made	• Ensure lake residents are aware that changes like importing sand, or building a dock require a permit from LWBC • LWBC will advise residents on how to make their projects environmentally sound • LWBC can advise residents of any other agency that may need to be contacted	$ 🕓 🕓	• Can help avoid accidentally introducing harmful materials to the lake • Will help protect water quality for all uses	• Relies on voluntary application for permits; some residents may be reluctant to do this

Objective 1.2: Continue monitoring to further identify and confirm sources of water quality degradation

The advantages and disadvantages common to each monitoring action include:

- ✓ Improved understanding of the system will help in making appropriate recommendations
- ✓ Collection process can be public educational tool and will help build community capacity to manage watershed
- ✓ Lobbying support from other agencies will be more effective with background data
- x Does not actually reduce amount of sediment, nutrient or fecal contaminant inputs to the system

Remedial Action	Description	Cost Estimate: Financial $ / Time🕓	Advantages	Disadvantages
A. Organize a volunteer lake monitoring program	• Recruit, organize and train volunteers who will be readily available to assist with monitoring projects	$	• Inexpensive • Will help ensure continuance of lake monitoring actions (below)	• Requires time commitment • Must recruit volunteers • Technical assistance is needed in some cases to

	• Make use of knowledge of past volunteers and government staff and available training opportunities	🕓 🕓 🕓	• Protocols already created for some sampling methods • Some volunteer training already in place	further train volunteers • Need ongoing support – some programs may require long term data collection
B. Monitor lake levels	• Use the gauge at the south end of the lake to monitor water levels	$ 🕓	• No lab costs involved • Easily implemented with volunteers • Can track seasonal and annual changes in lake levels over time • Historical data exists for comparison	• Long- term project • Requires time commitment
C. Conduct deep station water quality sampling in the summer of 2004 to monitor nutrient levels	• Conduct deep station sampling at surface, middle and bottom depths • Work with WLAP and volunteers to continue water quality sampling so that summer nutrient levels can be verified	$ 🕓 🕓	• Inexpensive for RLWES (equipment can be borrowed and lab costs often covered by WLAP) • Additional data is needed to help verify previous data • Sampling protocol already created • Some volunteer training already in place	• Requires 3-4 sample collections during the summer months
D. Continue deep station Secchi disk monitoring program	• Use the Secchi disk method over a number of years as an inexpensive way to document long-term changes in water clarity	$ 🕓 🕓	• RLWES has Secchi disks • Volunteers are already trained • No lab costs involved • Can track seasonal and annual changes in water clarity over time • Can also use this method at stream inflow and lakeside sites to identify where turbidity is greatest, which *may* indicate elevated sediment input	• Data collection is somewhat subjective • Does not differentiate reason for poor water clarity (algae vs. sediment caused turbidity)
E. Use sediment trap method to identify and monitor sources of sediments entering the lake	• Use sediment traps at a number of sites around the lake to identify if sedimentation rates are greater in certain areas and to further investigate sediment composition • Investigate possible stream and lakeside sources	$ $ 🕓 🕓 🕓	• Inexpensive for RLWES (lab costs often covered by WLAP) • Will provide further data to validate sediment core results • Will help identify locations were future efforts should be concentrated • Can use knowledge of other lake societies (ex. Lakelse Watershed Society) who have done this type of monitoring	• Takes time to create a useful data set • May need to purchase materials to make traps or borrow equipment • Trap retrieval can be difficult if water clarity is poor • Lab costs involved with sediment analysis
F. Survey the main tributary and lakeshore	• Survey the main tributary and lakeshore to identify areas where erosion problems exist, and where elevated nutrient and contaminant inputs may be occurring	$ 🕓 🕓	• Inexpensive • Can use volunteers • Need this information to identify priority areas for riparian restoration projects • May identify other problems (ex. garbage in the lake, inlet or ditches)	• Technical assistance may be needed • Survey and documentation protocols should be developed first
G. Identify and monitor sources of fecal contamination entering the lake	• Further investigate the use of new bacterial source tracking technologies to isolate exact sources of microbiological contamination	$ $ $ 🕓 🕓 🕓	• Will provide a comprehensive and credible data set • Results are definitive • Source tracking will help identify were future efforts should be concentrated • Will help address drinking water quality and human health issues identified around Round Lake	• Funding sources uncertain • Requires sample design protocol and technical assistance before any program is started • New technology, little background knowledge exists

Objective 1.3: Reduce sediment inputs to the lake

Remedial Action	Description	Cost Estimate: Financial $ / Time 🕓	Advantages	Disadvantages
A. Pursue funding options to implement recommended projects	• Investigate funding options and write proposals • Form partnerships and work with other stakeholders to secure funding	$ 🕓 🕓 🕓 🕓	• The RLMP can be used as leverage for funding proposals • Stakeholders and partners in the RLMP project can support each others requests for resources • Low financial cost • Further funding is necessary to implement some recommended actions	• Difficult to find funding • Time-consuming • May cost stakeholders "in-kind" contributions in the form of volunteer labour or $$
B. Advocate best management practices for sediment and erosion control for public roads	• Meet with Ministry of Transportation (MoT) and highway maintenance contractors to discuss concerns and options • Investigate if roads have proper drainage and if water is not flowing for long periods of time along ditches	$?? 🕓 🕓	• Range of costs depending on activity (RLWES probably would not have to bear much of the cost)	• Requires technical expertise and cooperation with MoT
C. Encourage Beneficial Management Practices (BMP's) for all landowners in the watershed	• Implement public education initiatives (Objective 1.1) to encourage beneficial management practices (BMPs) for rural development within the watershed that minimizes sediment delivery to the lake • Encourage (BMP's) for agricultural operations in the watershed by supporting stewardship activities (see below)	$ 🕓 🕓	• Relatively low cost • Implementation of BMP's are capable of reducing sediment, nutrient and contaminant inputs	• Relies heavily on voluntary compliance and acceptance by land owners
D. Encourage and support farmers who wish to become involved in an Environmental Farm Plan (EFP)	• Support farmers and agricultural groups that want to become involved in EFP through volunteer labor, partnerships or assistance in grant applications • Recognize the efforts of farmers who implement BMPs and EFP projects	$ $ 🕓 🕓 🕓	• Will increase partnerships within the community if people work together toward a unified goal • Some practices are very effective at reducing sediment, nutrient and fecal contaminant inputs without diminishing agricultural return • Potential to make a noticeable difference because agricultural operations that do not implement BMPs can contribute significant amounts of nutrients to water bodies • Funding is available through the EFP program to help pay for the implementation of BMPs	• Relies on voluntary action on the part of farmers • Will involve a cost to farmers (costs will vary with management strategy)
E. Participate in regional planning initiatives including the RDBN's Smithers-Telkwa Rural Official Community Plan (OCP) project	• Participate in regional land use planning and zoning initiatives to ensure that Round Lake watershed issues are considered • Staying active in public review and consultation of the OCP will help ensure that planning processes endorse activities that do not result in water quality degradation in the watershed	$ 🕓 🕓	• No cost to RLWES for supporting initiatives and getting involved in consultation/review • Most initiatives will likely only require a small time commitment by one or two people • OCP is an ideal initiative to get involved with as it may address lakeshore development issues • OCP process is already underway and RDBN encourages input from stakeholders and stewardship groups	• RLWES members may not have technical expertise to provide feedback on some reviews • Difficult to measure success of the program or for residents to see specific results (improved water quality, etc.)
F. Participate in riparian restoration initiatives	• Use the information gathered from the lakeshore and tributary survey (Action F in Objective 1.2) and tributary water quality data to identify areas that are best suited for riparian restoration	$ $ $ 🕓 🕓 🕓	• Riparian areas help stabilize soil and prevent erosion, reduce nutrient and contaminant inputs and buffer the impact of rainy seasons and flooding • Will address other lake issues like waterfowl and	• Costs can be high if materials need to be purchased • Technical assistance may be required • Dependant upon property owners willingness to participate

	• Identify property owners that are willing to participate • Use the knowledge of habitat specialists, local nurseries and other resources (ex. Living by Waters handbook, CFDC Nadina watershed library) to help implement projects		wildlife habitat, improve overall water quality for aquatic life • Aesthetic improvement • Can use volunteer labour and donated materials to lower costs • Riparian projects can produce measurable results	• Must locate priority areas to make best use of resources

Objective 1.4: Reduce fecal contaminant inputs to the lake

The advantages and disadvantages common to each option include:

✓ Human and livestock health will be better protected from bacteria-caused disease

Remedial Action	Description	Cost Estimate: Financial $ / Time🕓	Advantages	Disadvantages
A. Implement Actions in Objective 1.3 that reduce sediment inputs to the lake	• In many cases, fecal contaminant sources are the same as sediment sources, and inputs occur at the same time	• See above	• See above	• See above
B. Install a sewage system	• Install a community sewage treatment plant	$ $ $ $ $ 🕓 🕓 🕓 🕓	• Result in reduction of fecal and nutrient inputs to the lake from domestic sources	• Very expensive • Involves extensive studies and public consultation • Lake residents would bear large portion of the cost • Low population density would likely not support such an undertaking
C. Invite a Health Officer to speak about onsite sewage systems	• Invite a Health Officer to speak to watershed residents about onsite sewage system issues such as proper maintenance as there may be homes in the watershed that require improvement of their septic system	$ 🕓	• Will raise public awareness about the importance of septic system maintenance • Will improve communication between watershed residents and Northern Health • Can use this opportunity to promote voluntary septic system assessments	• On-site sewage system maintenance relies on voluntary action of property owners
D. Conduct an assessment of septic systems	• Assess septic systems on or near lakefront or near tributaries with the help of a regional Health Officer as there may be homes around the lake that require improvement of their septic system (septic leakage may be coming into contact with and contaminating drinking water)	$ 🕓 🕓 🕓	• Will raise public awareness about the importance of septic system maintenance • Will result in better regulation & compliance	• May create public dissatisfaction • Assessment must be voluntary and many residents may be reluctant to have this done • On-site sewage system maintenance relies on voluntary action of property owners

Objective 1.5: Reduce nutrient inputs to the lake

The advantages and disadvantages common to each option include:

- ✓ Reduction of nutrient inputs can help reduce algae growth
- ✓ Human and livestock health will be better protected from algae blooms

Remedial Action	Description	Cost Estimate: Financial $ / Time🕓	Advantages	Disadvantages
A. Implement Actions in Objective 1.3 that reduce sediment inputs to the lake	• In many cases, nutrient sources are the same as sediment sources, and inputs occur at the same time	• See above	• See above • Will address external phosphorus loading to the lake • Generally less expensive than installing mechanical devices in the lake (see below)	• See above
B. Implement selected Actions in Objective 1.4 that reduce fecal contaminant inputs to the lake	• In many cases, nutrient sources are the same as fecal contaminant sources, and inputs occur at the same time	• See above	• See above • Will address external phosphorus loading to the lake • Generally less expensive than installing mechanical devices in the lake (see below)	• See above
C. Install Hypolimnetic Aeration system	• Install a Hypolimnetic Aeration system that provides oxygen to the hypolimnetic (bottom) layer of water in the lake to limit the anoxic conditions that promote release of phosphorus from sediments • May involve removal, treatment and return of the hypolimnetic water, or injection of air, either through and airlift design or a down - flow injection design	$ $ $ $ 🕓 🕓 🕓 🕓	• Can reduce internal phosphorus loading which can help reduce algal biomass • Can increase D.O. levels and reduces the possibility of winter and summer fish kills	• Expensive (initial costs and annual maintenance and pumping costs) • Improper installation can damage the ecosystem • Only addresses internal phosphorus loading, not external loading • May not result in significant changes because Round Lake is naturally eutrophic • Requires a long-term commitment (10 years) • Liability issues exist with operation of system and with open water in winter
D. Install Artificial Circulation /Destratification system	• Install a Circulation system to provide oxygen throughout the water in the lake and limit the anoxic conditions that promote release of phosphorus from sediments (focus on complete circulation) • This may involve pumps, water jets or injection of compressed air to the lake water	$ $ $ $ 🕓 🕓 🕓	• Increases D.O. levels and reduces the possibility of winter and summer fish kills	• Expensive • Only addresses internal phosphorus loading, not external loading • Can increase the temperature of the lake and reduce fish habitat during the summer • Requires a long-term commitment
F. Install sediment cover	• On small beach segments, install geo-textile material on top of sediment, and cover with fresh sand to help reduce the internal loading of phosphorus from the sediment and kill rooted plants to improve beach quality for wading and swimming	$ $ $ 🕓 🕓	• Cover impedes oxygen depletion in water layers near the sediment • Decreases the rate of release of phosphorus, iron and ammonium from the sediment	• Not suitable for large areas (better suited for aquatic plant control in swimming areas) • Only addresses internal phosphorus loading, not external loading • Requires careful installation to hold covers down • Expensive; Can cost up to ~$20,000 / acre
G. Install hypolimnetic withdrawal system	• Removal of water from the hypolimnion of the lake instead of surface water that would normally leave via the surface outlet	$ $ $ $ $ 🕓 🕓 🕓	• Removes phosphorus from water column before it becomes available to plants and algae • Reduces the extent of anoxic conditions in the hypolimnion and sediment interface	• Expensive • Restoration effects require long time scale to be evident • Possible negative downstream effects from high nutrient and low D.O. concentrations • May decrease lake water levels • May effect lake temperature and reduce fish habitat

Goal 2: Conserve and enhance habitat for aquatic life

Objective 2.1: Increase public awareness about aquatic ecosystems and fisheries issues

Remedial Action	Description	Cost Estimate: Financial $ / Time🕓	Advantages	Disadvantages
A. Implement public education actions in Objective 1.1	• Implement selected public education initiatives, with a focus on aquatic life • Work in partnership with organizations that focus on fisheries and aquatic life (ex. WLAP Fish and Wildlife branch) to get access to specific resources • Ensure lake residents are aware that LWBC must be consulted before changes to the shoreline are made	$ 🕓 🕓	• See above	• See above

Objective 2.2: Research and gather information about past and current fish populations, habitat quality and overall aquatic ecosystem health

Remedial Action	Description	Cost Estimate: Financial $ / Time🕓	Advantages	Disadvantages
A. Record local knowledge	• Contact long-time residents and document their recollections of past fish populations, habitat quality and overall aquatic ecosystem health	$ 🕓 🕓	• Inexpensive • Can provide a comparison to current fish populations and overall aquatic ecosystem health • Helps identify trends	• Collection of information takes time • This type of information is subjective
B. Research previous reports	• Research and compile past reports by government and wildlife organizations	$ 🕓 🕓	• Inexpensive • Stocking records are easily accessible • Will contribute to RLWES library of information	• Background information may be difficult to track down • Very few studies exist for the watershed
C. Implement a survey via a log book at the boat launch	• Implement a small scale creel census via a log book at the boat launch • Consult with WLAP fisheries staff for necessary materials and log book template	$ 🕓	• Inexpensive • Can provide information about catch numbers, species, lengths, anecdotal information (ex. Taste of fish etc.) • Can improve public awareness • Old log book creel census exists for comparison	• Informal – does not provide as good data as a quantitative creel census • No guarantee that all anglers use the log book • May be subject to vandalism
D. Implement a creel census through interviews with anglers	• Conduct a creel census by interviewing anglers throughout the year (during different times of the week, holidays, and seasons) • Use volunteers to collect the data	$ 🕓 🕓 🕓	• Inexpensive • Can provide more accurate data than a log book • Can be used to verify log book data • Can improve public awareness	• Time consuming • If no use or poor catch for effort is discovered, may influence government's decision to continue stocking
E. Conduct fish sampling	• Obtain fish samples and conduct fish health assessments	$ $ 🕓 🕓 🕓	• Can provide good information about general health of fish and growth rates for future stocking	• Technical expertise required • WLAP fish and wildlife staff have limited time and resources • Lab costs

F. Monitor dissolved oxygen (D.O.) levels around the lake	• Implement a volunteer D.O. monitoring program to identify if some areas in the lake have greater D.O. concentrations than others • Survey at many locations and during different seasons	$ 🕓 🕓	• Inexpensive • Easy sampling protocol and volunteers already trained • Questions related to fish survival may be answered (may find pockets with high D.O. concentrations) • Easily implemented by volunteers (can monitor in conjunction with deep station data collection)	• Data collection takes time • Careful documentation of sites required (need GPS to accurately mark sites)
G. Survey the main inlet and outlet	• Assess where any riparian restoration projects would be most beneficial along the main inlet and outlet (similar to Action F in Objective 1.2 with a focus on aquatic habitat at the inlet and outlet)	$ 🕓 🕓 🕓	• Inexpensive • Simple project that can provide good data • Need this information to before planning any restoration project • Can use volunteers	• Technical assistance may be needed • Survey and documentation protocols should be developed first • Advisable to contact property owners prior to survey
H. Conduct an aquatic plant survey	• Inventory aquatic plants to note if invasive species exist in Round Lake • Volunteers can observe and record aquatic species using a boat or wading survey	$ 🕓 🕓 🕓	• Will provide a better understanding of what plant species exist (help confirm if *Elodea* or other invasive species inhabit the lake) • Some sampling protocols already developed	• Round Lake is highly productive aquatic plant population already, and a survey will be time consuming • Repetition of survey required in future to note if species composition and abundance has changed
I. Sample benthic invertebrate	• Implement a benthic invertebrate sampling program at the main tributary and outlet to obtain information about species composition and abundance • Aquatic insects are good indicators of overall ecosystem health (classification systems exist that link species to various pollutants)	$ $ 🕓 🕓	• May help isolate causes of water quality degradation and influences in the system that may be affecting aquatic life	• Technical assistance with sampling is required • Cost of lab analysis
J. Sample zooplankton populations	• Conduct zooplankton sampling at the deep station during the summer to obtain information about species composition and abundance • Zooplankton are good indicators of overall ecosystem health	$ $ 🕓 🕓	• Provides information on food chain health • Relatively easy to sample	• Technical assistance with sampling is required • Cost of lab analysis

Objective 2.3: Participate in activities that preserve and restore fish habitat and improve overall aquatic ecosystem health in the Round Lake watershed

Remedial Action	Description	Cost Estimate: Financial $ / Time🕓	Advantages	Disadvantages
A. Decrease sediment, nutrient and fecal contaminant inputs to the lake through actions in Objective 1.3, 1.4 and 1.5	• Focus on implementing riparian restoration initiatives (Action F Objective 1.3) along the main inlet and outlet to be of immediate maximum benefit to aquatic life	• See above	• See above • Can help regulate temperature and improve water quality for aquatic life • Promote healthy habitat for spawning and rearing	• See above
B. Provide Round Lake Recreation Commission with input about lake	• Promote partnership with the Recreation Commission to ensure that management of public access site does not adversely impact	$	• Future decisions will consider overall lake health • Clean site will lessen impacts on fish, wildlife and overall water quality and reduces attraction for	• Cooperation of the Rec. Commission is needed • May create public dissatisfaction (most people are accustomed to sandy beaches)

health issues	water quality or fish and wildlife habitat • Promote proper disposal of fishing line and garbage • Promote maintenance of natural beach area (avoid sand importation)	🕓	bears and ravens (predators of waterfowl nesting sites) • Some options (not importing sand) will reduce sediment input to the lake and avoid silting fish habitat • Aesthetic improvement • Garbage can already available nearby (at the hall)	• Garbage can must be maintained
C. Implement an aquatic plant strategy to protect against invasive species	• Introduction of invasive species is a concern along the highway 16 corridor (*Elodea* has been introduced to most other lakes in the area) • Results of aquatic plant survey (above) should note if invasive species already exist in Round Lake • To prevent introduction (or increase spread) take action through public education efforts in Objective 1.1	$ 🕓	• Most effective *before* the problem exists; once introduced, it is very difficult to reverse growth, so actions to prevent introduction are critical	• See above (Objective 1.1, possible problems with public education efforts)
D. Organize an annual clean up day	• Boat around the perimeter of the lake on an annual basis and remove any garbage that has collected along the shoreline or in the water • If necessary (large pieces) coordinate efforts to remove the garbage • A preliminary boat survey has identified some large pieces of garbage floating in the lake	$ 🕓 🕓	• Inexpensive • Increased aesthetic value • Simple project that can make an immediate difference • Will ensure removal of hazardous materials and lessen impacts on water quality • Public education tool	• May be difficult to remove large objects • Need land owners permission to walk on property if removing large objects
E. Install aeration system (Action C or D in Objective 1.5)	• See above	$ $ $ $ 🕓 🕓 🕓	• See above • Increased D.O. levels may increase overall fish survival • Can decrease the possibility of winter and summer fish kills	• See above • No evidence of fish kills, indicating that D.O. levels are sufficient for survival and aeration is currently unnecessary • Better suited in systems that have a self sustaining fish population (are naturally productive) rather than lakes with a stocked fish population

Goal 3: Conserve and enhance riparian habitat for waterfowl and wildlife

Objective 3.1: Increase public awareness about conservation of waterfowl and wildlife habitat

Remedial Action	Description	Cost Estimate: Financial $ / Time	Advantages	Disadvantages
A. Promote beneficial wildlife management practices in the watershed by implementing public education actions in Objective 1.1	• Implement selected public education initiatives and work in partnership with organizations that focus on waterfowl and wildlife issues (ex. Ducks Unlimited, Canadian loon Survey and WLAP) to get access to specific resources • Promote retention of remaining riparian areas with aspen and willow and cattail and reed beds • Promote respective boating practices to void wildlife disturbance and harassment	$ 🕓 🕓	• See above	• See above

Objective 3.2: Research and document information about past and current waterfowl and wildlife habitat and populations

Remedial Action	Description	Cost Estimate: Financial $ / Time	Advantages	Disadvantages
A. Record local knowledge	• Contact long-time residents and document their recollections of past wildlife populations and sightings	$ 🕓 🕓	• Inexpensive • Can provide a baseline for comparison to current waterfowl and wildlife populations	• Collection of information takes time • This type of information is subjective
B. Research previous reports	• Research and compile past reports by government and wildlife organizations	$ 🕓 🕓	• Inexpensive • Can provide a baseline for comparison to current waterfowl and wildlife populations • Will contribute to RLWES library of information	• Background information may be difficult to track down • Very few studies exist for the watershed
C. Conduct waterfowl (loon) survey	• Conduct survey to track the number of loons returning to the lake annually, number of hatching and surviving chicks, and if nesting and rearing areas remain the same from year to year • Use data to create waterfowl management strategy	$ 🕓 🕓 🕓	• Will indicate if population is increasing or decreasing • Will promote awareness that loons will only nest in cattail reed beds and this habitat must be protected • Using volunteers improves public awareness and serves as an educational tool	• Technical assistance required to develop monitoring protocol, and interpret results • A few years of data collection through the summer is desirable, so time commitment is required • Nesting sites are very sensitive, so great care must be taken to avoid any disturbance during survey
D. Survey riparian areas to locate any bald eagle or osprey nesting sites	• Conduct survey to identify any important nesting sites for eagle or osprey • Can identify these trees with signs to ensure their protection	$ 🕓 🕓	• Can improved some recreational bird viewing opportunities • Can help promote maintenance of riparian areas	• Survey takes time commitment

Objective 3.3: Participate in activities that preserve and restore waterfowl and wildlife habitat in the Round Lake watershed

Remedial Action	Description	Cost Estimate: Financial $ / Time🕓	Advantages	Disadvantages
A. Create a Waterfowl Management Strategy	• When adequate monitoring and information gathering is complete create a strategy that identifies where important habitat areas exist, if no motor zones or nesting platforms are necessary, and recommends other options to protect waterfowl	$ 🕓 🕓	• A waterfowl management strategy would provide useful direction	• Requires support and initiative from WLAP biologists or other technical experts
B. Keep boat launch small	• Advocate that the standard of the boat launch remains the same to help minimize lake use by larger vessels	$ 🕓	• Lake will be exposed to less traffic • Can reduce likelihood that invasive species are introduced • Will benefit waterfowl habitat and chick survival	• May create controversy
C. Advocate for horse power size restriction	• motor size restriction is deemed an important factor in waterfowl habitat preservation, and if it is also considered a public safety issue, advocate a horse-power restriction • Provide public consultation to WLAP and coast guard if a proposal to limit motor size is desired	$ 🕓	• Smaller boats usually disrupt waterfront less • Will likely be easier to impose if boat launch stays as is	• May create controversy • May be difficult to implement this for conservation purposes; usually no legal authority unless a public safety issue is brought forth • Personal water craft may still be used (these small vessels can do serious damage as they can get closer to shorelines than big boats)
D. Implement riparian restoration activities (Action F in Objective 1.3)	• See above	$ $ $ 🕓 🕓 🕓	• See above • Riparian restoration can address many issues simultaneously • Improved habitat will help increase diversity and overall ecosystem health	• See above

8.0 Recommendations for 2004 – 2005

RLWES chose remedial actions that best address the priority issues and goals of the plan, and can be implemented given local constraints. Also chosen were actions that would help them to more clearly define other less-understood issues, so that appropriate solutions can be implemented in the future. The recommended remedial actions are considered priorities for the near future. Other options should be revisited when opportunities for other projects and financial capabilities of the society expand.

The tables below categorize the recommendations into three sections: public education initiatives, monitoring and data collection and other lake management actions. They also explain the rationale for selection and the commitment required by RLWES for successful implementation of each action.

Public education initiatives:

Recommended Action	Rationale	Implementation
Build and maintain a constituency of involved citizens (1.1/A)	• This step is vital to implementing recommendations of the RLMP	• RLWES will continue to schedule regular public meetings and implement selected public education actions below
Distribute newsletter (1.1/B, 2.1/A, 3.1/A)	• Relaying information through a newsletter is a simple, low cost way to keep residents and local lake users informed	• RLWES will pursue a partnership with the Round Lake Recreation Commission to include a short section with RLWES updates in the Rec. newsletter (two newsletters about Round Lake issues/events may be 'information overload' for some residents and end up going unnoticed) • Lake education materials (information about general watershed health issues, aquatic life and waterfowl and wildlife issues) will be included within the newsletter
Distribute educational materials at trade shows, fairs and other local events (1.1/C, 1.3/C, 2.1/A, 3.1/A)	• Presence at local events is an effective way to reach a large number of people in a short time and provides an opportunity to recruit new members and volunteers • This method of information distribution can encompass all topics related to the three goals	• RLWES will put together a mobile display including brochures and handouts to set up at local events • BMPs, aquatic life and waterfowl and wildlife issues will be highlighted • Lake residents will also be made aware that permits from LWBC must be obtained before changes to the shoreline are made • RLWES will focus efforts on events held at Round Lake Hall, but will also pursue a booth at the Fall Fair (in partnership with another organization) • Brochures and other resources can be obtained from BCLSS, BC Wildlife Federation, Ducks Unlimited, Living by Water, government agencies etc.
Install public education signage at Round Lake boat launch (1.1/G, 2.1/A, 3.1/A)	• Signage at the boat launch will serve as an on-site reminder to lake users • This technique will reach people who may not have received other educational materials because they live outside of the watershed	• It is important to ensure that Recreation Commission accepts this plan of action • RLWES should work with WLAP to obtain any pre-made signs that pertain to issues at Round Lake (ex. Information about invasive aquatic plants and boat related pollution, awareness of waterfowl habitat areas etc.) • If pre-made signs are unavailable, contact local sign company to make some (costs are low and could be funded by WLAP or RLWES) • Templates may be available from BC Parks
Improve distribution of drinking water quality and other lake data to the public (1.1/J)	• Awareness of drinking water issues will help protect public health • Protecting human health is a government priority and should be an important concern for RLWES	• WLAP, NHA and RDBN should make information related to water quality and drinking water more accessible to the public by partnering with RLWES • Include brochures and data reports available from these agencies in RLWES display, at AGMs and other public events • Contact: A.J. Downie (WLAP, Water Quality Technician - 847-7277) or Marcy Iwanyk (Smithers Area EHO - 250-638-2222)

Continue monitoring and data collection:

Recommended Action	Rational	Implementation
Organize a volunteer lake monitoring program (1.2/A)	• It is necessary to focus on information-gathering so that most appropriate hands-on remedial actions can be identified and planned • Further monitoring and data collection will be the focus of 2004 activities • This will help ensure continuance of lake monitoring when government resources are limited	• RLWES will recruit volunteers at meetings and public events and organize them to be readily available to assist with monitoring projects • Organize and inventory equipment (boats, Secchi disk, field note book, D.O. meter, water sampling equipment) • Equipment should be stored in a secure location accessible to all volunteers • Participate in training opportunities and make use of knowledge of past volunteers, government staff and BCLSS
Monitor lake levels (1.2/B)	• Can track seasonal and annual changes in lake levels over time • Easy to implement with volunteers- very little training involved • No lab costs involved	• 1-2 volunteers should commit to this task • This program should use the gauge at the south end of the lake to monitor water levels, and monitoring should be conducted at regular intervals • Field book should be stored in a secure location (accessible to all volunteers – if more than one person is monitoring) • Requires a commitment to monitoring in the future at similar intervals
Conduct deep station water quality sampling in the summer 2004 to monitor nutrient levels (1.2/C)	• Another set of summer samples will help verify previous data	• RLWES volunteers will work with WLAP to conduct deep station sampling • At least 2 volunteers should commit to this task (if more that 2 volunteers, assign sample dates to divide up work load) • Requires a 3 samples between June, July and August to collect the data set • Sampling protocols, equipment and lab cost supplied by WLAP • Sampling protocol available in Appendix X • Contacts: Julia Kokelj (WLAP Lake Planner - 847-7256) or A.J. Downie (WLAP Water Quality Technician - 847-7277)
Continue deep station Secchi disk monitoring program (1.2/D)	• Can track seasonal and annual changes in water clarity over time • East to implement –volunteers already trained • No lab costs involved	• 1-2 volunteers should commit to this task • Requires a boat, Secchi disk, field book, GPS (or good site descriptions) • BCLSS has provided sampling protocol • Contact: Dawn Roumieu (BCLSS - 250-717-1212)
Monitor dissolved oxygen (D.O.) levels around the lake (2.2/F)	• Questions related to fish survival may be answered • Can monitor in conjunction with deep station data collection	• 1-2 volunteers should commit to this task • This can be implemented in conjunction with deep station or Secchi monitoring; it does not require set dates • Requires boat, D.O. meter, GPS, field book • Careful documentation of sites is required (need GPS to accurately mark sites)
Survey the main tributary, outlet and lakeshore (1.2/F, 2.2/G)	• This information is the necessary first step required before any riparian restoration project is planned • Will help identify where limited resources should be focused	• RLWES should organize a survey of the main tributary and lakeshore to identify areas where erosion problems exist, elevated nutrient and contaminant inputs may be occurring, and habitat restoration projects would be most beneficial; technical assistance is available • Information should be recorded; photographs of problem areas should be taken, observations of interest noted on watershed maps and data sheets and aerial photos should be used for comparison • Contact: Rick Heinrichs (Ecosystem Specialist - 847-5985)
Identify and monitor sources of fecal contamination entering the lake	• This type of sampling will provide a comprehensive and credible data set with	• This is a WLAP driven initiative • WLAP will further investigate the use of new source tracking technologies to isolate exact

(1.2/G)	definitive results • Will help identify were future efforts should be concentrated • Will help address drinking water quality and human health issues identified around Round Lake	sources of microbiological contamination • Additional funding sources should be sought, and sample design protocol needs to be developed • RLWES should provide volunteer assistance if necessary
Conduct loon survey (3.2/C)	• Will help assess if population is increasing or decreasing or if habitat restoration is required • Background data is needed to create waterfowl management strategy	• Preliminary survey has been completed by J. Kokelj and L. Vanderstar • They will continue to survey known and suspected loon sites on a monthly basis through the summer • Canadian Lakes Loon Survey templates will be used to document information • Visit (http://www.bsc-eoc.org/cllsmain.html) for more information • Contact: Julia Kokelj (847-7256) or Len Vanderstar (WLAP, Ecosystem Specialist - 847-7326)

Other lake management activities:

Recommended Action	Rational	Implementation
Pursue funding options to implement recommended projects (1.3/A)	• Further funding is necessary to implement some recommended actions	• Possible funding sources are listed in Appendix G • RLWES should investigate funding options and write proposals (the RLMP can be used as leverage for funding proposals) • RLWES should form partnerships and work with other stakeholders to secure funding
Advocate best management practices for sediment and erosion control for public roads (1.3/B)	• Road construction has likely influenced water quality and minimizing these effects can help decrease sediment inputs	• RLWES should meet with MoT and highway maintenance contractors to discuss concerns and options and obtain technical expertise • Contact: Daryl Nolan (Environmental Services, Ministry of Transportation - 250-565-6484)
Encourage and support farmers who wish to become involved in an Environmental Farm Plan (EFP) (1.3/D)	• Doing an EFP will show farmers how they can improve their practices (ex. implement BMPs) to reduce sediment, nutrient and fecal contaminant inputs without diminishing agricultural return • Potential to make a noticeable difference because agricultural operations that do not implement BMPs can contribute significant amounts of sediment, contaminants and nutrients to water bodies	• RLWES will show support to farmers that want to become involved in an EFP through: volunteer labor support or assistance in grant applications if necessary • RLWES will recognize the efforts farmers who implement EFP projects by showcasing positive efforts on mobile display at local events • Contact: Leah Sheffield (MAFF, Resource Stewardship Agrologist - 847-7247)
Participate in regional planning initiatives including the RDBN's Smithers-Telkwa Rural Official Community Plan (OCP) project (1.3/E)	• OCP process is already underway and RDBN encourages input from stakeholders and stewardship groups • OCP may address lakeshore development issues that RLWES can provide input on to ensure that Round Lake watershed issues are considered	• RLWES will remain on the OCP mailing list to stay informed about the process • Send a representative to OCP meetings that can report back to the group and can provide clear and concise input and suggestions when opportunities arise • Contact: Crissy Isabelle (RDBN Planner - 250-692-3195)
Invite a Health Officer to speak about onsite sewage systems	• Some homes around the lake may require improvement of their on-site sewage systems	• RLWES should invite a Health Officer to speak to watershed residents about onsite sewage system issues such as proper maintenance

(1.4/C)	• Will raise public awareness about the importance of septic system maintenance • Step toward better protection of human and livestock health	• Use Round Lake Hall to ensure easy access for local residents • At the meeting, RLWES and NHA can promote voluntary septic system assessments • Contact: Marcy Iwanyk (Smithers Area EHO - 250-638-2222)
Provide Round Lake Recreation Commission with input about lake health issues (2.3/B)	• Will ensure Recreation Commission decisions consider overall lake health	• RLWES will work to promote a partnership with the Recreation Commission and ask that the Commission accept input about lake health issues from RLWES before making changes to lakeshore (such as considering the effects of importing sand for the beach area and advocating that the standard of the boat launch remains the same) • This will ensure that management of public access site does not adversely impact water quality or fish and wildlife habitat • RLWES and the Recreation Commission will promote proper disposal of fishing line and garbage • RLWES will ensure the Recreation Commission is aware that permits from LWBC must be obtained before changes to the shoreline are made
Organize an annual clean up day (2.3/D)	• Simple project that can make an immediate difference • Will ensure removal of hazardous materials and lessen impacts on water quality	• A preliminary boat survey has identified some large pieces of garbage floating in the lake • 2-3 volunteers with access to a boat are required • Volunteers will boat around the perimeter of the lake on and remove any garbage that has collected along the shoreline or in the water • If necessary efforts should be coordinated with property owners to remove larger pieces of garbage • Efforts should be documented (ideally with before and after photos)
Participate in riparian restoration initiatives (1.3/F, 2.3/A, 3.3/D)	• Riparian areas help stabilize soil and prevent erosion, reduce nutrient and contaminant inputs and buffer the impact of rainy seasons and flooding • Will address other lake issues like waterfowl and wildlife habitat, improve overall lake water quality for aquatic life	• Information from survey (Action E Objective 1.2) and tributary water quality data can be used to identify areas that are suited for riparian restoration • RLWES will identify property owners that are willing to participate • When planning projects, RLWES should use the knowledge of habitat specialists, local nurseries and other resources (ex. Living by Waters handbook, CFDC Nadina watershed library), try to obtain discounts or donated materials from nurseries, and use technical expertise of WLAP staff to assist with project design • Contact: Rick Heinrichs (Ecosystem Specialist - 847-5985)

9.0 Management Plan Implementation

9.1 Immediate Actions for 2004-2005

To monitor progress and avoid overwhelming volunteers, it is important for RLWES to set achievable short-term goals. The general tasks and considerations for RLWES in 2004 and 2005 are listed below. Other options should be revisited at future meetings and as more information becomes available. Some tasks only need to be performed once or twice to collect specific information or as one-time public awareness efforts, while other actions are ongoing, and will continue on an annual basis.

Action: Increase public awareness
Public education efforts should begin as opportunities arise. Work can begin with organization of a display unit, and upcoming local newsletter deadlines should be investigated. Public education will be on-going, and can evolve as updates about RLWES activities and reports with new data become available.

Action: Continue monitoring and data collection
Most RLWES efforts in 2004 will focus on further monitoring. This is dependant on the establishment of a reliable base of volunteer monitors to test, observe and record the changes occurring in Round Lake. Data collection and volunteer monitoring should be initiated as soon as possible because they will provide information required for planning other management actions. For example, at this stage of the process, surveying the main tributary, outlet and lakeshore is necessary before riparian restoration projects can begin, and may also identify other problems or issues that should be considered in the future.

Action: Implement other management activities
Some management actions depend on collaboration with and initiative by other organizations. Other actions such as implementing riparian restoration projects depend mostly on RLWES action and require pre-planning such as data collection, fundraising, and organization of volunteers.

Sub-Committees/Task delegation

Placing volunteers in groups (sub-committees) or delegating tasks to groups or individuals will clearly divide the work load and ensure that projects are completed. RLWES has a small membership base, so sub-committees may be small or limited to one or two people. It is important to make sure that each sub-committee is responsible for completing a set of well-defined tasks. It is expected that formation of the following sub-committees will help aid in the implementation of the recommendations in this plan:

- Fundraising
- Sampling and Monitoring
- Public Education
- Membership

Efforts should be made to keep each of the sub-committees active and a periodic evaluation of each group's status can help keep the committees on track.

9.2 Resources

Financial Support

For long-term sustainability of the LMP goals, a funding strategy should be developed. When monitoring and management actions are chosen, the level and duration of funding needed must be identified. As discussed above, a committee should be struck to formulate the financial strategy. Some options for raising funds include:

- Relating projects to current government programs (for example, the provincial government's emphasis on drinking water source protection may equate to increased funding for water quality monitoring)
- Applying for grants or loans from public agencies and other organizations
- Voluntary donation, from individuals and businesses
- Collecting revenue in the form of membership dues from individuals and businesses
- Entering into partnerships with corporations and organizations
- Conducting fund-raising events, selling merchandise, etc.

Appendix G contains a list of potential funding sources.

Volunteer Groups

Committed volunteers are essential to the success of the plan. Therefore, a membership program is needed that is flexible enough to accommodate more than one level of participation (both volunteers and financial contributions). In addition to lakeshore residents, other volunteer groups can assist with implementation of the plan. For the Round Lake Management Plan this may include, but is not limited to:

- Other lake protection societies in the region
- Local youth and service clubs (4H, Boy and Girl Scouts, Rod and Gun Club etc.)
- B.C. Lake Stewardship Society (BCLSS)
- Round Lake Recreation Commission
- Katimavik volunteers

Regulatory Agencies

Prior to undertaking activities that may alter aquatic habitat, it is essential to identify all affected regulatory agencies and obtain the necessary approvals. Land and Water B.C. (LWBC) will direct applicants to any other regulatory agencies that need to be contacted

such as the Ministry of Water, Land and Air Protection or the Department of Fisheries and Oceans. These agencies should be kept informed of activities around the lake as recommendations are implemented. Approvals are required for any activity which may alter aquatic habitat, including changes to waterfront property, and installation of permanent dock structures or water intakes. When applying for approvals:

- Visit LWBC website for detailed information (http://www.lwbc.bc.ca/)
- Include a deadline for which the approval is needed as it will allow the agency to prioritize incoming applications for approval
- Sufficient time should be allowed for the agencies to respond

* Other lakeshore residents and land owners should also be made aware that LWBC must be contacted for necessary approvals. This can help avoid habitat destruction or accidental introduction of hazardous chemicals to the lake.

9.3 Plan Review and Revisions

This document does not indicate completion of the lake management planning process. It is hoped that the RLWES will continue to generate support in the community and gather resources to undertake activities recommended in the plan. As recommendations in the plan are implemented, the planning process will continue with evaluation and revision steps as needed.

After the first year of implementation, there should be a review of the plan by lake management experts. The reviewers should include regulators who may be called upon in some way to implement the various management recommendations. Plan review is an important priority, and can be accomplished with assistance from the WLAP, Environmental Protection Division.

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