The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Hilda Lake

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2007 Report

Completed with support from:

Alberta Lake Management Society

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> *Water is integral to supporting and maintaining life on this planet as it moderates the climate, creates growth and shapes the living substance of all of Earth's creatures. It is the tide of life itself, the sacred source.* David Suzuki (1997). The Sacred Balance.

Alberta Lake Management Society's Lakewatch Program

Lakewatch has several important objectives, one of which is to collect and interpret water quality on Alberta Lakes. Equally important is educating lake users about their aquatic environment, encouraging public involvement in lake management, and facilitating cooperation and partnerships between government, industry, the scientific community and lake users. Lakewatch Reports are designed to summarize basic lake data in understandable terms for a lay audience and are not meant to be a complete synopsis of information about specific lakes. Additional information is available for many lakes that have been included in Lakewatch and readers requiring more information are encouraged to seek these sources.

ALMS would like to thank all who express interest in Alberta's aquatic environments and particularly those who have participated in the Lakewatch program. These people prove that ecological apathy can be overcome and give us hope that our water resources will not be the limiting factor in the health of our environment.

Acknowledgements

The Lakewatch program is made possible through the dedication of volunteers and the Lakewatch Chairs, Théo Charette and Ron Zurawell. We thank Jason Mawson, who volunteered his time to collect field data during 2007. Numerous Alberta Environment staff also contributed to successful completion of the 2007 program. We would like to thank Jill Anderson and Wendy Markowski who were summer interns with ALMS in 2007. Project Technical Coordinator, Megan McLean was instrumental in planning and organizing the field program. Technologists, Mike Bilyk, Brian Jackson and John Willis were involved in the logistics planning and training aspects of the program. Doreen LeClair was responsible for data management. Théo Charette (ALMS Director) was responsible for program administration and planning. Théo Charette, Ron Zurawell (Limnologist, AENV), and Lori Nuefeld prepared the original report, which was updated by Heather Powell for the 2007 report. Alberta Environment and Lakeland Industry and Community Association (LICA) financially supported the Lakewatch program.

Hilda Lake

Hilda Lake (**Figure 1**) is located in the Beaver River Basin in the northeast corner of Alberta. It is fed by Crane (Moore) Lake upstream and drains into Ethel Lake downstream, eventually feeding the Beaver River, which then winds through Saskatchewan ultimately to Hudson Bay. The lake is accessed via Highway 897 connecting to a municipal road off the southeastern shore of the lake.

Figure 1. Hilda Lake, AB. Photo: Vien Lam

Hilda Lake is situated in rolling land characteristic of the low boreal mixedwood (**Table 1**): dominant trembling aspen, white spruce and jack pine occur on high ground, while black spruce and tamarack appear in low-lying areas. Birch and balsam poplar are also evident as well as many areas of muskeg (Trew, Yonge, and Kaminski, 1981). The lake supports some sport fish species, including Northern pike and walleye, and to a lesser extent yellow perch and burbot. Lake cisco and white suckers are also present. A 1986 census showed breeding Northern pike ranging from 2 – 12 years of age and walleye from 4 – 6 years of age (R. L. and L. Environmental Services Ltd, 1986). Good to excellent permanent wetland habitat surrounds part of the lake as well as shorelines suitable for recreation. Much of the watershed is crown land, with most development near the lake itself. This includes two campsites and two multi-lot rural subdivisions (Alberta Environment Historical Library).

Table 1. Summary of details describing the low boreal mixed wood ecoregion surrounding Hilda Lake (from Strong and Leggat, 1992).

Low Boreal Mixedwood Characteristics*		
Vegetation	Aspen, succeeding to White Spruce	
Summer	Average Temp (ºC)	13.8
	Average Min. Temp (ºC)	7
	Average Max. Temp (ºC)	20.4
	Month of Max. Precipitation	July
	Total Summer Precipitation (mm)	235
Winter	Average Temp (ºC)	-11
	Average Min. Temp (ºC)	-16
	Average Max. Temp (ºC)	-5.3
	Total Winter Precipitation (mm)	61
Total Annual Precipitation		380

* Precipitation numbers are median values.

The watershed of Hilda Lake is small and surface run-off is low, with most of the total annual inflow coming from direct rainfall. Areas of muskeg probably intercept the movement of surface water to the lake. Analysis of the lake water in the early 1980's suggested that groundwater plays an important role in lake inputs, as water chemistry results revealed high sodium and potassium levels typical of groundwater in the surrounding Sand River Formation. Hilda Lake is moderately productive (mesotrophic) and tends towards algal blooms in autumn.

Lake shape and depth result in water layers stratifying in warm summer months (**Figure 2**, **Table 2**). It is likely that factors including landscape position and a small surface area contribute to the water column never mixing completely throughout the deepest parts of the lake (Trew, Yonge, and Kaminski, 1981).

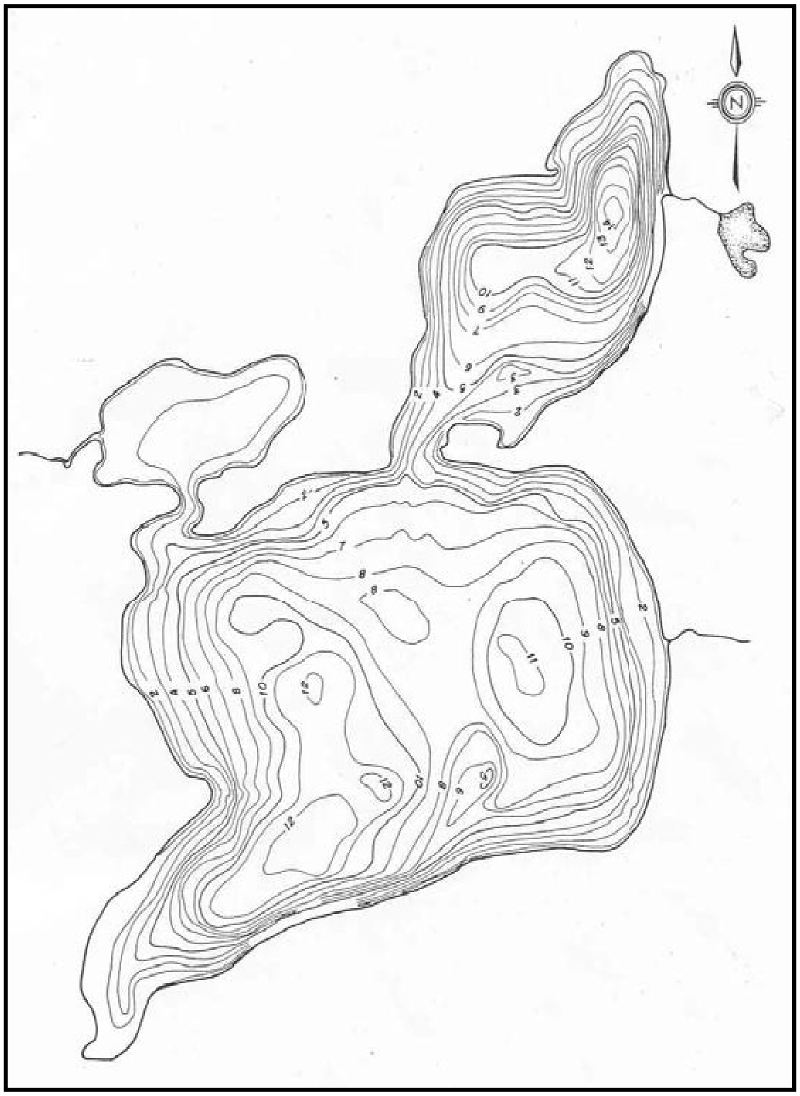

Figure 2. Bathymetric map of Hilda Lake. Alberta Environment Historical Library.

Concerns over low water levels led to the creation of the Hilda Lake Water Management Study in 1990. The steering committee sought to create long-term solutions aimed at stabilizing water levels in the lake. Proposed alternatives included controlling beaver populations, installing a structure at the outlet of upstream Moore Lake, temporary pumping of water from downstream Ethel Lake and improvements made to the existing structures on Hilda Lake. The lake was also included in a study of 23 lakes in the Beaver River drainage basin throughout the 1980's, where mixing regimes and water quality were summarized from a 9-year sampling effort (Chow-Fraser, P. and D.O. Trew, 1990).

Table 2. Physical characteristics of Hilda Lake, Alberta.

Lake surface area	3.62 km sq.
Drainage basin	37.2 km sq.
Mean depth	6.2 m
Maximum depth	approx. 14 m

Methods

Lakes monitored under the Alberta Lake Management Society's Lakewatch program are all monitored using standard Alberta Environment procedures: composite samples are collected from numerous sites around the lake and water is profiled at the deep water spot in each lake once per month through the warmer months. This usually results in 4 sampling trips per open-water season. On each trip, the deep-water profiles include measurements for temperature and dissolved oxygen recorded from lake surface to lake bottom, as well as maximum depth. A Secchi depth is also measured, from which the range of the euphotic zone is estimated. Once the euphotic zone depth is known, the composite samples are collected for lab analyses. After the water has been analyzed, results are examined for trends and summarized.

Water Levels

Water level in Hilda Lake is monitored by Environment Canada since 1980 under a joint federal-provincial hydrometric agreement.

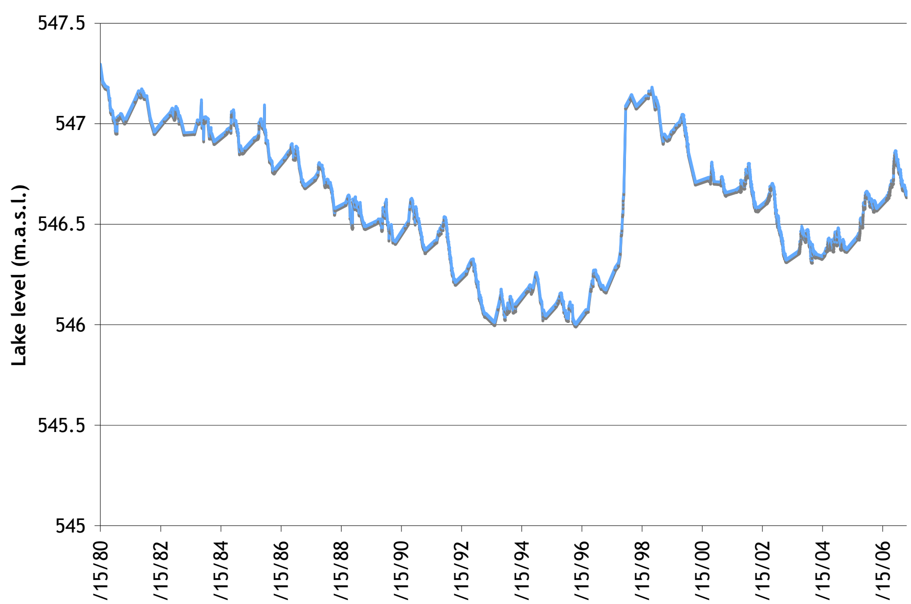

Figure 3. Historical water level elevation (meters above sea level (m.a.s.l.)) of Hilda Lake, Alberta.

Water level steadily declined from the early 1980s to 1997, when it reached a low of 446.2 m above sea level (**Figure 3**). Water level then rose quickly following 1997, which is one of the wettest years on record.

Water levels decreased due to drought experienced recently. However, water levels rose between 2004 and 2006.

Results

Water Temperature and Dissolved Oxygen

Water temperature and dissolved oxygen profiles in the water column can provide information on water quality and fish habitat. Please refer to the end of this report for descriptions of technical terms.

Hilda Lake was thermally stratified between July and September 2007 (**Figure 4**). Surface water temperature peaked at 21.3º C on 10 July and declined to 13.5º C on 20 September 2007. Water depth was 10 m in July and increased to 13 m in September. As water depth increased, the depth at which water was well-oxygenated also increased from 5 m in July to 7 m in late August (**Figure 4**). The oxygen content of the water column declined at ≥5 m depth, but remained above 5 mg/L. A reduction in oxygen near the lake bottom is the result of oxygen-consuming decomposition. Hilda Lake did not overturn within the time frame of the sampling dates. The oxygen level in surface layers of Hilda Lake was within the acceptable range for surface water quality, according to Alberta Environment guidelines (DO ≥ 5.0 mg/L).

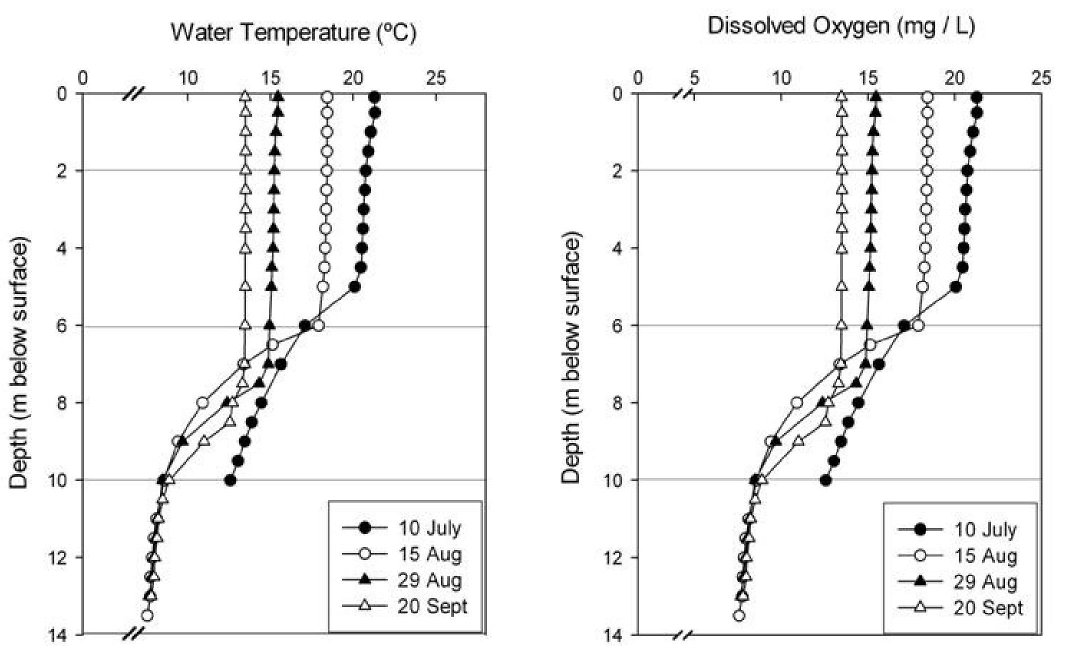

Figure 4. Water temperature (°C) and dissolved oxygen (mg /L) profiles for Hilda Lake during the summer of 2007.

Water clarity and Secchi Depth

Water clarity is influenced by suspended materials, both living and dead, as well as dissolved coloured compounds in the water column. During the melting of snow and ice in spring, lake water can become turbid (cloudy) from silt transported into the lake. Lake water usually clears in late spring but then becomes more turbid with increased algal biomass as the summer progresses. The easiest and most widely used measure of lake water clarity is the Secchi disk depth.

Hilda Lake is moderately deep lake compared to many shallow lakes found in northern Alberta. Compared to shallow lakes, Hilda Lake appears relatively clear, with average Secchi depth = 2.2 m. During the summer of 2007, light penetrated to ~18% of the total lake depth (**Table 1**), thus algal growth was limited to the top layers of the lake. As algal growth increased over the summer, suspended solids were removed, which resulted in slightly clearer water in August (maximum Secchi disk depth = 2.5 m on 29 August). Water clarity was lowest on 20 September (Secchi disk depth 1.8 m) when dead algae began to decompose. In general, water clarity has not varied much over the past quarter-century.

Water chemistry

Based on lake water characteristics, Hilda Lake is classified as mesotrophic (see *A Brief Introduction to Limnology* at the end of this report,). This is evidenced by total phosphorus (TP) concentrations, which ranged from 17 to 32 µg/L over the course of the summer (**Figure 5**). TP concentrations may have been high in July due, in part, to the low water levels. As lake water levels increased, TP concentrations declined. Chlorophyll *a* concentrations were mostly in the mesotrophic range, and ranged from 2.6

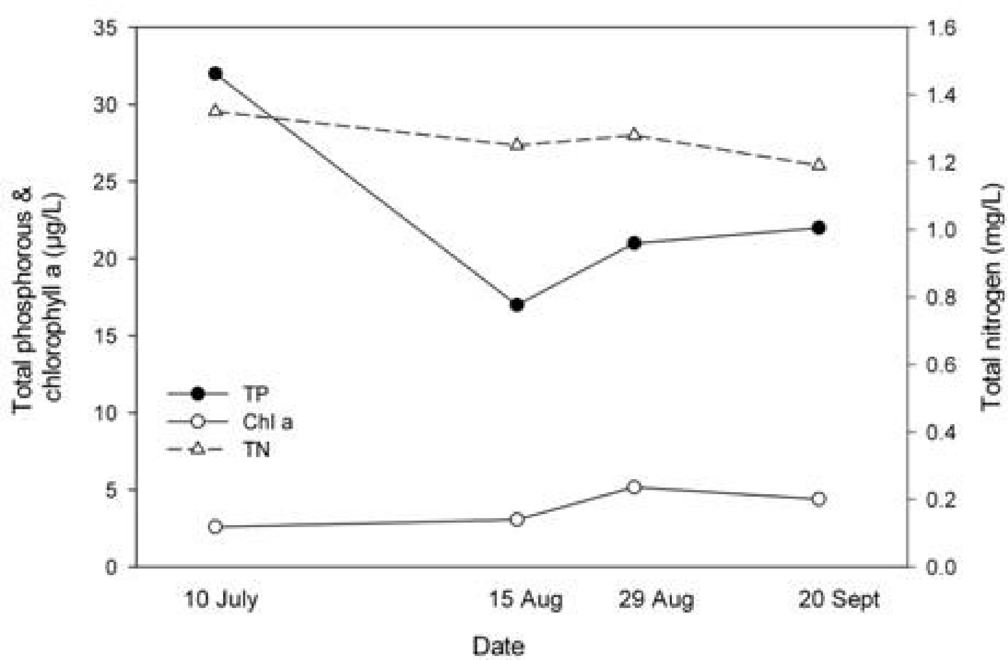

Figure 5. Total phosphorus, total nitrogen, and chlorophyll *a* (a measure of algae biomass) concentrations for Hilda Lake during the summer of 2007.

to 5.7 μg/L during the summer. Thus, in July and early August, Hilda Lake was moderately unproductive or oligotrophic (e.g. chl *a* < 3.5 μg/L). After 15 August, Hilda Lake was moderately productive, or mesotrophic (e.g. chl *a* = 3.5 - 9 μg/L). Total Kjeldahl nitrogen concentration averaged 1.3 mg/L, which is within the hypereutrophic range. Lakes in Alberta are naturally productive and Hilda Lake is below average in nutrient concentrations and algae biomass. Total phosphorus and chlorophyll *a* concentrations were stable during summer 2007. Furthermore, total nitrogen and phosphorus concentrations have not changed over the past quarter century.

Hilda Lake is well protected from acidification; its pH of 8.9 is well above that of pure water (i.e., pH 7). Hilda is a hardwater lake and ion concentrations are relatively high (**Table 3**). Dominant ions include sodium, bicarbonate, carbonate and sulphate. The concentrations of mineral ions increased over the past quarter century. These ions are supplied by weathering in the watershed and from groundwater inflows. The observed increase in sulphate indicates the potential for increased groundwater discharge, relative to surface runoff. Reduced water level can also cause a higher concentration of ions. Due to a 20-year drought, these two scenarios are likely.

The average concentrations of various heavy metals (as total recoverable concentrations) in Hilda Lake during the summer of 2007 were below CCME guidelines for the Protection of Freshwater Aquatic Life. Iron, manganese, and selenium concentrations were higher in 2007 than in other years, although concentrations did not exceed CCME guidelines (**Appendix 1**).

Table 3. Mean water chemistry values in Hilda Lake, summer 2007, compared to values reported in previous years.

Parameter	1980	1981	2004	2005	2006	2007
TP (µg/L)	-	26	29	19	20	23
Total dissolved P (µg/L)	-	13	6.8	6.5	10.6	7.5
Chlorophyll-*a* (µg/L)	10	7.2	4.8	3.6	3.0	3.81
Secchi disk depth (m)	2.6	2.4	2.8	2.75	2.75	2.2
TN (mg/L)	1.4	1.2	1.4	1.3	1.3	1.3
NO_{2+3} (µg/L)	6.4	5.8	3.1	11.7	14	<5
NH_4 (µg/L)	52	65	14	17	18	17.8
Dissolved organic C (mg/L)	16	18	21	-	-	22.3
Ca (mg/L)	19	20	16	16	18	19
Mg (mg/L)	38	37	55	53	52	-
Na (mg/L)	77	72	116	114	116	110.7
K (mg/L)	6.9	7.0	10	9.9	10	10.2
SO_4 (mg/L)	17	20	38	35	37	34.3
Cl (mg/L)	22	21	34	32	32	32.5
CO_3 (mg/L)	-	-	47	42	41	34.7
HCO_3 (mg/L)	-	-	444	441	445	456
pH	8.6	8.4	9.0	8.9	8.9	8.9
Conductivity (µS/cm)	671	666	892	883	883	871
Total dissolved solids (mg/L)	419	433	535	518	526	521
Total suspended solids (mg/L)	2.0	3.2	2.5	-	-	-
Total Alkalinity (mg/L $CaCO_3$)	325	328	442	431	433	431

Note: TP = total phosphorus, Chla = chlorophyll *a*, TN = total Kjeldahl nitrogen, NO_{2+3} = nitrate+nitrite, NH_4 = ammonium, Ca = calcium, Mg = magnesium, Na = sodium, K = potassium, SO_4 = sulphate, Cl = chloride, CO_3 = carbonate, HCO_3 = bicarbonate.

From *Atlas of Alberta Lakes* (Mitchell and Prepas, 1990).

References

Alberta Environment. 2006. Cold Lake-Beaver River surface water quality state of the basin report. Alberta Environment Report. 65 pp.

Anglers' Atlas web site: http://www.anglersatlas.com/

Chow-Fraser, P. and D.O. Trew. 1980. A compendium of limnological data for 23 lakes in the Beaver River watershed. Alberta Environment Report. 201 pp.

McGregor, C.A. 1983. An ecological inventory of the shorelines of selected lakes in the Cold Lake region. Alberta Environment and Natural Resources Report. 46 pp.

Mitchell, P. 1994. Volunteer citizens lake monitoring program (1993) Sandy, Burnstick and Islet Lakes. Alberta Environmental Protection Report. 29 pp.

Mitchell, P. and E. Prepas, eds. 1990. Atlas of Alberta Lakes. University of Alberta Press.

Nurnberg, G.K. 1996. Trophic state of clear and colored, soft and hardwater lakes with special consideration of nutrients, anoxia, phytoplankton and fish. Lake and Reservoir Management 12(4):432-447.

Strong, W.L. and K.R. Leggat. 1992. Ecoregions of Alberta. Alberta Forestry, Lands and Wildlife Report. 59 pp. 1 map.

Vollenweider, R.A., and J. Kerekes, J. 1982. Eutrophication of Waters. Monitoring, Assessment and Control. Organization for Economic Co-Operation and Development (OECD), Paris. 156p.

Welch, E.B. 1980. Ecological Effects of Waste Water. Cambridge University Press.

Appendix 1

Mean concentrations of metals in Hilda Lake, summer 2007, compared to previous years. CCME Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (total)	1981	2004	2005	2006	2007	Guidelines
ALUMINUM µg/L	35	12	5.055	10.975	9.6	100[a]
ANTIMONY µg/L	-	0.049	0.045	0.041	0.044	6[e]
ARSENIC µg/L	-	2.3	2.21	1.95	2.13	5
BARIUM µg/L	-	21	20.75	21.3	21.6	1000[e]
BERYLLIUM µg/L	< 1	0.0013	<0.003	<0.003	0.004	100[d,f]
BISMUTH µg/L	-	0.0013	0.00475	0.02	0.002	-
BORON µg/L	-	265	250.5	278.5	219.5	5000[e,f]
CADMIUM µg/L	< 1	0.026	0.0028	0.005	0.008	0.085[b]
CHROMIUM µg/L	-	0.61	0.3365	0.3395	0.342	-
COBALT µg/L	< 1	0.023	0.014	0.029	0.034	1000[f]
COPPER µg/L	0.75	0.46	0.265	0.322	1.48	4[c]
IRON µg/L	33	6.2	3.4	8.93	25.3	300
LEAD µg/L	5.5	0.125	0.059	0.055	0.111	7[c]
LITHIUM µg/L	-	65	65.35	68.65	53.8	2500[g]
MANGANESE µg/L	10	3.8	6.935	6.64	10.23	200[g]
MOLYBDENUM µg/L	-	0.7	0.647	0.668	0.608	73[d]
NICKEL µg/L	< 10	0.0025	<0.005	<0.005	0.056	150[c]
SELENIUM µg/L	-	0.21	0.24	0.37	0.578	1
SILVER µg/L	< 1	0.00025	0.00245	0.0031	<0.0005	0.1
STRONTIUM µg/L	-	109	104	106	105.5	-
THALLIUM µg/L	-	0.0021	0.01335	0.00735	0.002	0.8
THORIUM µg/L	-	0.0103	0.1455	0.0088	0.011	-
TIN µg/L	-	0.058	0.04	<0.03	0.041	-
TITANIUM µg/L	-	0.67	0.697	0.882	0.974	-
URANIUM µg/L	-	0.168	0.176	0.176	0.177	100[e]
VANADIUM µg/L	0.5	0.363	0.272	0.270	0.21	100[f,g]
ZINC µg/L	7.5	7.3	1.55	1.04	0.959	30
FLUORIDE mg/L	-	0.26	0.22	-	-	1.5

With the exception of fluoride (which reflects the mean concentration of dissolved fluoride only), values represent means of total recoverable metal concentrations.

[a] Based on pH ≥ 6.5; calcium ion concentration $[Ca^{+2}]$ ≥ 4 mg/L; and dissolved organic carbon concentration [DOC] ≥ 2 mg/L.

[b] Based on water Hardness of 300 mg/L (as $CaCO_3$).

[c] Based on water Hardness > 180 mg/L (as $CaCO_3$).

[d] CCME interim value.

[e] Based of Canadian Drinking Water Quality guideline values.

[f] Based of CCME Guidelines for Agricultural Use (Livestock Watering).

[g] Based of CCME Guidelines for Agricultural Use (Irrigation).

A Brief Introduction to Limnology

Indicators of water quality

The goal of **Lakewatch** is to collect water samples necessary to determine the water quality of lakes. Though not all encompassing, the variables measured in **Lakewatch** are sensitive to human activities in watersheds that may cause impacts to water quality. For example, nutrients such as phosphorus and nitrogen are important determinants of lake productivity. The concentrations of these nutrients in a lake are affected (typically elevated) by land use changes such as increased crop production or livestock grazing. Elevated nutrient concentrations can cause increases in undesirable algae blooms resulting in low dissolved oxygen concentrations, degraded fish habitat and production of noxious odors. Large increases in nutrients over time may also indicate sewage inputs, which in turn, may result in other human health concerns such as harmful bacteria or protozoans (e.g. *Cryptosporidium*).

Temperature and mixing

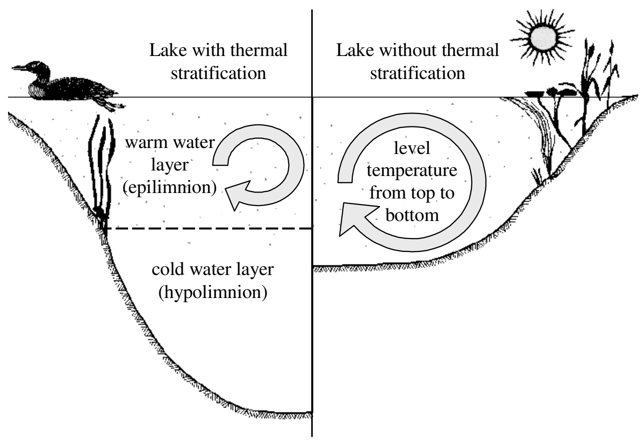

Figure 6: Difference in the circulation of the water column depending on thermal stratification.

Water temperature in a lake dictates the behavior of many chemical parameters responsible for water quality (Figure 6). Heat is transferred to a lake at its surface and slowly moves downward depending on water circulation in the lake. Lakes with a large surface area or a small volume tend to have greater mixing due to wind. In deeper lakes, circulation is not strong enough to move warm water to depths typically greater than 4 or 5 m and as a result cooler denser water remains at the bottom of the lake. As the difference in temperature between warm surface and cold deeper water increases, two distinct layers are formed. Limnologists call these layers of water the **epilimnion** at the surface and the **hypolimnion** at the bottom. A third layer, known as the metalimnion, provides an effective barrier between the epi- and hypolimnion**.** The metalimnion reflects a rapid transition in water temperature known as the **thermocline**. A thermocline typically occurs when water temperature changes by several degrees within one-meter of depth. The thermocline acts as an effective physico-chemical barrier to mixing between the hypolimnion and epilimnion, restricts downward movement of elements, such as oxygen, from the surface into the hypolimnion. In the fall, surface waters begin to cool and eventually reach the same temperature as hypolimnetic water. At this point the water mixes from top to bottom in what is called a **turnover** event. Surface water cools further as ice forms and again a thermocline develops this time with 4° C water at the bottom and 0° C water on the top.

In spring another turnover event occurs when surface waters warm to 4° C. Lakes with this mixing pattern of two stratification periods and two turnover events are called **dimictic** lakes. In shallower lakes, the water column may mix from top to bottom most of the ice-free season with occasional stratification during periods of calm warm conditions. Lakes that mix frequently are termed **polymictic** lakes. In our cold climate, many shallow lakes are **cold monomictic** meaning a thermocline develops every winter, there is one turnover event in spring but the remainder of the ice-free season the lake is polymictic.

Dissolved Oxygen

Oxygen enters a lake at the lake surface and throughout the water column when produced by photosynthesizing plants, including algae, in the lake. Oxygen is consumed within the lake by respiration of living organisms and decomposition of organic material in the lake sediments. In lakes that stratify (see temperature above), oxygen that dissolves into the lake at the surface cannot mix downward into the hypolimnion. At the same time oxygen is depleted in the hypolimnion by decomposition. The result is that the hypolimnion of a lake can become **anoxic**, meaning it contains little or no dissolved oxygen. When a lake is frozen, the entire water column can become anoxic because the surface is sealed off from the atmosphere. Winter anoxic conditions can result in a fish-kill, which is particularly common during harsh winters with extended ice-cover. Alberta Surface Water Quality Guidelines state dissolved oxygen concentrations (in the epilimnion) must not decline below 5 mg/L and should not average less than 6.5 mg/L over a seven-day period. However, the guidelines also require that dissolved oxygen concentrations remain above 9.5 mg/L in areas where early life stages of aquatic biota, particularly fish, are present.

General Water Chemistry

Water in lakes always contains substances that have been transported by rain and snow or have entered the lake in groundwater and inflow streams. These substances may be dissolved in the water or suspended as particles. Some of these substances are familiar minerals, such as sodium and chloride, which when combined form table salt, but when dissolved in water separate into the two electrically charged components called ions. Most dissolved substances in water are in ionic forms and are held in solution due to the polar nature of the water molecule. Hydrophobic (water-fearing) compounds such as oils contain little or no ionic character, are non-polar and for this reason do not readily dissolve in water. Although hydrophobic compounds do not readily dissolve, they can still be transported to lakes by flowing water. Within individual lakes, ion concentrations vary from year to year depending on the amount and mineral content of the water entering the lake. This mineral content can be influenced by the amount of precipitation and other climate variables as well as human activities such as fertilizer and road salt application.

Phosphorus and Nitrogen

Phosphorus and nitrogen are important nutrients limiting the growth of algae in Alberta lakes. While nitrogen usually limits terrestrial plants and plants and algae of tropical lakes, phosphorus is usually in shortest supply in temperate lakes. Even a slight increase of phosphorus in a lake can, given the right conditions, promote algal blooms causing the water to turn green in the summer and impair recreational uses. When pollution originating from livestock manure and human sewage enters lakes not only are the concentrations of phosphorus and nitrogen increased but nitrogen can become a limiting nutrient which is thought to cause blooms of toxic algae belonging to the cyanobacteria. Not all cyanobacteria are toxic, however, the blooms can form decomposing mats that smell and impair dissolved oxygen concentrations in the lake.

Chlorophyll-a

Chlorophyll-a is a photosynthetic pigment that green plants, including algae, possess enabling them to convert the sun's energy to living material. Chlorophyll-a can be easily extracted from algae in the laboratory. Consequently, chlorophyll-a is a good estimate of the amount of algae in the water. Larger aquatic plants, known as macrophytes, rather than algae, dominate some highly productive lakes. In these lakes, chlorophyll-a and nutrient values taken from water samples do not include productivity from large aquatic plants. As a result, lakes like Chestermere, which are dominated by macrophytes, reflect lower-nutrient trophic states than would otherwise result if macrophyte-based chlorophyll were included. Unfortunately, the productivity and nutrient cycling contributions of macrophytes are difficult to sample accurately and are therefore not typically included in trophic state indices.

Secchi Disk Depth

Lakes that are clear are more attractive for recreation, whereas those that are turbid or murky are considered by lake users to have poor water quality. Secchi disk depth is the oldest, simplest, and quickest quantitative measure of water clarity. A Secchi disk is a black and white disk that is lowered down through the water column until it can no longer be seen. Secchi disk depth is the midpoint between the depth at which it disappears when lowered and reappears when it is pulled up again. The Secchi disk depth in lakes with high algal biomass will generally be low. Secchi disk depth, however, is not only affected by algae, high concentrations of suspended sediments, particularly fine clays or glacial till common in plains or mountain reservoirs of Alberta, also impact water clarity. Mountain reservoirs may have exceedingly shallow Secchi disk depths despite low algal growth and nutrient concentrations.

The euphotic zone, calculated as twice the Secchi disk depth, is the portion of the water column that has sufficient light for aquatic plants to grow. Murky waters, with shallow Secchi depths, can prevent aquatic plants from growing on the lake bottom. Aquatic plants are important because they ensure clear lake water by reducing shoreline erosion and stabilizing lake bottom sediments. Many lakes in Alberta are shallow and have bottom sediments with high concentrations of nutrients. Without aquatic plants, water quality may decline in these lakes due to murky, sediment-laden water and excessive algal blooms. Maintaining aquatic plants in certain areas of a lake is often essential for ensuring good water clarity and a healthy lake as many organisms, like aquatic invertebrates and fish, depend on aquatic plants for food and shelter.

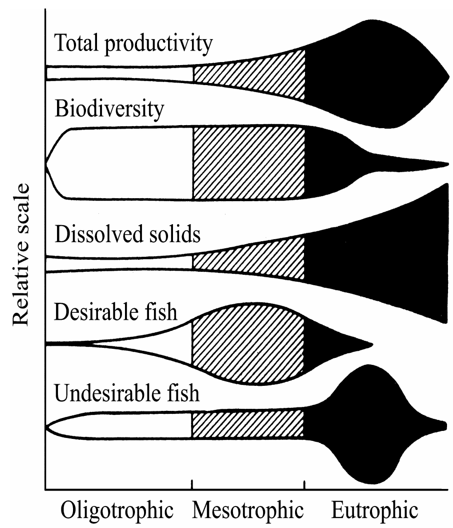

Figure 7: Suggested changes in various lake characteristics with eutrophication. From "Ecological Effects of Wastewater", 1980.

Trophic State

Trophic state is a classification system for lakes that depends on fertility and is a useful index for rating and comparing lakes. From low to high nutrient and algal biomass (as chlorophyll-a) concentrations, the trophic states are: oligotrophic, mesotrophic, eutrophic and hypereutrophic. The nutrient and algal biomass concentrations that define these categories are shown in Table 2 and a graph of Alberta lakes compared by trophic state can be found on the ALMS website. A majority of lakes in Alberta are meso- to eutrophic because they naturally contain high nutrient concentrations due to our deep fertile soils. Thus, lakes in Alberta are susceptible to human impacts because they are already nutrient-rich; any further nutrient increases can bring about undesirable conditions illustrated in Figure. 7.

Table 2: Trophic status based on lake water characteristics

Trophic state	Total Phosphorus (µg/L)	Total Nitrogen (µg/L)	Chlorophyll a (µg/L)	Secchi Depth (m)
Oligotrophic	< 10	< 350	< 3.5	> 4
Mesotrophic	10 - 30	350 - 650	3.5 - 9	4 - 2
Eutrophic	30 - 100	650 - 1200	9 - 25	2 - 1
Hypereutrophic	> 100	> 1200	> 25	< 1

Note: These values are from a detailed study of global lakes reported in Nurnberg, 1996. Alberta Environment uses slightly different values for TP and CHL based on those of the OECD reported by Vollenweider and Kerekes (1982). The AENV and OECD cutoffs for TP are 10, 35 and 100; for CHL are 3, 8 and 25. AENV does not have TN or Secchi depth criteria. The corresponding OECD exists for Secchi depth and the cutoffs are 6, 3 and 1.5 m.