MINISTRY OF ENVIRONMENT
PROVINCE OF BRITISH COLUMBIA

SKEENA-NASS AREA

LAKELSE LAKE
WATER QUALITY ASSESSMENT AND OBJECTIVES

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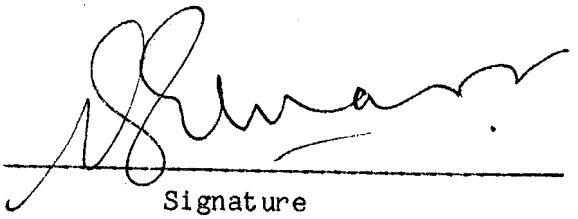
Approved by Ministry: Feb. 3, 1986
Date



Signature
Deputy Minister

INTRODUCTION

This study assesses the water quality of Lakelse Lake which drains into the Skeena River in the vicinity of Terrace, British Columbia (Figure 1). The Lakelse watershed is one of the more important salmon rearing and migration areas in the province. It is also a popular recreational area, and development for recreation and logging is predicted to increase. There is therefore a need to develop water quality objectives where designated water uses are threatened either now or in the future, and to present lake management strategies which can be adopted to protect the existing water quality.

A detailed technical appendix was prepared and forms the basis for the results and conclusions presented in this report.

HYDROLOGY

The annual flushing rate of the lake was estimated to be five to six times per year. The high flushing rate is caused by the lake's large watershed, and the high annual precipitation for the area. A large percentage of the precipitation occurs during the winter as snow, causing maximum water input during the spring and summer months.

The lake is oriented in a north-south direction (Figure 1). There are several inflowing streams, some of the more important being Williams and Schulbuckhand Creeks. The lake drains from the south-west via the Lakelse River, which flows into the Skeena River.

WATER USES

There is only one water licence on Lakelse Lake. It provides drinking water for the provincial campground at the north end of the lake. There are 20 domestic water licences located on inflowing streams. The majority are located on the east side of the lake drawing from small unnamed inflow streams. The remaining water licences on streams are one irrigation

licence, four metallurgical reserve (hotsprings) licences and two conservation licences for the operation of fish counting fences on Williams and Schulbuckhand Creeks.

The lake serves as an important recreational centre for the residents of the Terrace-Kitimat-Prince Rupert area. The most popular recreational uses in decreasing order of importance are swimming, picnicking, sunbathing, camping, and fishing. In 1973, a total of 1 800 000 recreational activity-days were spent at the lake. The majority occurred in June through September. The annual benefit to residents of the Terrace-Kitimat-Prince Rupert area was estimated in 1973 to be $6 700 000. Assuming a similar volume of use, the recreational value was estimated at $17 000 000 in 1984.

Cutthroat trout are the main catch of the lake's recreational fishery. Winter-run steelhead trout overwinter in Lakelse Lake prior to spawning downstream from the lake. Both the summer and winter-run steelhead fishery are important, but fishing is restricted to fly fishermen in the Lakelse River downstream from the lake.

The Lakelse watershed is also important for anadromous salmonids. A majority of the returning pink and chinook adults spawn below Lakelse Lake, and their fry do not use the lake for rearing. The coho spawn above and below the lake, and coho fry will utilize the lake for up to two years. The sockeye exclusively use the tributaries of the lake for spawning and their fry utilize the lake for one year. The numbers of salmonids annually caught by the commercial fishery, which are attributable to the Lakelse watershed, average 1 100 000 pink, 300 chinook and 25 000 coho.

In total, the Lakelse watershed represents 35 percent of the total Skeena River fishery for all species. In 1984 the value of this fishery was estimated to be $1 800 000.

WASTE DISCHARGES

Historically, the Skoglund Hotsprings Resort discharged sewage effluent to Lakelse Lake via a drainage ditch. The effluent was subjected to primary treatment and chlorination. The hotel was closed and dismantled in 1978. At present there are no direct discharges of effluent within the Lakelse watershed. Diffuse wastes from logging and septic tank tile fields are the only sources affecting the water quality of the lake.

The suitability of the soils around Lakelse Lake for the renovation of septic effluent (Figure 2) was determined by their physical characteristics (permeability, depth of soil, texture) and their chemical characteristics (phosphorus adsorption ability).

The majority of soils around Lakelse Lake are moderate to poor for the renovation of septic tank effluent. Only a small portion of the Lakelse Lake shoreline on the west shore near the outlet has soils considered good for the renovation of effluent. Approximately 250 houses are located within the watershed. The majority are located near the foreshore, on soils with moderate to poor suitability. As a general guide, and in the absence of more detailed information, septic tank tile fields should be set back from the lake and inflow streams as follows: 35 m for soils with good suitability, 90 m for soils with moderate suitability and 175 m for soils with poor suitability.

The main concern of logging within the Lakelse Lake watershed is the siltation of spawning and rearing streams. There has not been any data collection within the Lakelse Lake watershed to quantify the impact of logging. A total of 4 700 ha have been cut to date throughout the watershed over the past 30 years. An additional 2 900 ha of logging is proposed principally within the Williams and Hatchery Creek watersheds.

WATER QUALITY

Water quality data have been collected since 1974 by both the Federal and Provincial Governments. Maximum lake surface temperatures did not exceed 17°C, an optimal growing temperature for salmonids. Dissolved oxygen concentrations were typical of well flushed lakes. Summer concentrations did not drop below 50 percent saturation (6.5 mg/L) in the bottom waters.

Water clarity, measured by turbidity and Secchi disc, was relatively good during nonfreshet periods. Well flushed lakes typically have higher turbidity during freshet. The turbidity range for Lakelse Lake during freshet period was 1 to 2 NTU. High turbidity results were also recorded in November and December of 1974. High watershed runoff did not precede this particular period. Consequently, the high turbidities were probably the result of man's activity within the watershed and not due to flood conditions.

The Lakelse Lake area receives small amounts of acid precipitation generated from industrial sources. The aluminum smelter and to a lesser degree the pulp mills at Kitimat and Prince Rupert, are the major sources of acid-generating air pollutants. The majority of rain samples collected at Terrace Airport were mildly acidic. A few highly acidic results have been measured during the summer months. Storm movements in the fall, winter, and spring are predominately from the north, i.e. from Terrace towards Kitimat. In the summer, storm movements are reversed causing more acidic rain in the Terrace area.

Lakelse is considered a soft water lake with low to moderate sensitivity to acid rain. However, acid loading rates are not sufficiently high to pose a hazard to fisheries or drinking water supplies, and fluoride emissions should not pose an acidification problem to the lake or inflow streams.

Nitrogen and phosphorus are the critical micronutrients in freshwaters. Phosphorus was determined to be the nutrient limiting phytoplanktonic growth

and hence biological productivity in Lakelse Lake. Total phosphorus concentrations were typically below 0.010 mg/L. The 1983 and 1984 spring overturn phosphorus concentrations were 0.008 to 0.010 mg/L.

Abnormally high total phosphorus concentrations were observed from November 1974 through May 1975. Maximum concentrations reached 0.066 mg/L in May. Subsequent flushing reduced the concentrations below 0.010 mg/L, a level typical for the lake.

Two observations may explain the high phosphorus results recorded in 1974-75. One was the association of the phosphorus peak with high turbidity results. The other was a small forest fire (1 ha) at the south end of the lake in August on which 2.4 tonnes of fire retardant containing some phosphate was used. Leaching of the retardant and other materials from the burnt area is thought to be responsible for the elevated phosphorus and turbidity results.

The algal standing crop of a lake is usually estimated by chlorophyll a. Only one year of chlorophyll a data is available. The mean summer chlorophyll a for Lakelse Lake was 0.0025 mg/L in 1974. The concentration of chlorophyll a is determined by the phosphorus concentration. Increased phosphorus loading will result in increased chlorophyll a (manifested by algal blooms) which can affect water quality. The chlorophyll a levels in 1974 were ideal for supporting water contact recreation and a cold water fishery.

Lakelse Lake is considered to be oligotrophic because of its low phosphorus concentrations, low oxygen depletion rates of the bottom waters, and low chlorophyll a results. These attributes, in association with the lake's good water clarity, collectively determine the recreational and fisheries importance of the lake.

PROVISIONAL WATER QUALITY OBJECTIVES

Provisional water quality objectives were established to protect the most sensitive water uses of Lakelse Lake and are summarized in Table 1.

The objectives are based on preliminary working criteria for water quality and on available data on ambient water quality, waste discharges, water uses and limnological characteristics. The objectives will remain provisional until receiving water monitoring programs provide adequate data, and the Ministry has established approved water quality criteria for the characteristics of concern.

The objectives can be considered as policy guidelines for resource managers to protect water uses in the specified water bodies. For example, they can be used to draw up waste management permits and plans, regulate water use or plan fisheries management. They can also provide a reference against which the state of water quality in a particular water body can be checked.

Water quality objectives have no legal standing. This is due to the natural variability of the aquatic environment, and the difficulty of attributing contamination that exceeds the objective to particular sources for legal purposes, and thus proving violations and their causes. Hence, although water quality objectives should be used when determining effluent permit limits, they should not be incorporated as part of the conditions in a waste management permit.

Depending on the circumstances, water quality objectives may already be met in a water body, or may describe water quality conditions which can be met in the future. To limit the scope of the work, objectives are only being prepared for waterbodies and for water quality characteristics which may be affected by man's activity, now and in the foreseeable future.

The designated water uses to be protected in Lakelse Lake are:

- aquatic life (anadromous fish rearing habitat, recreational freshwater fishery)
- primary contact recreation
- drinking water supply

The designated water uses of the tributaries to Lakelse Lake are:

- aquatic life (salmonid spawning and rearing - anadromous and nonanadromous species)
- drinking and irrigation water supplies
- primary contact recreation in the Lakelse Lake hotsprings

Two water quality objectives are proposed for fecal coliform bacteria. The first objective is proposed to ensure that no water treatment in addition to disinfection is required for drinking water. The second is to ensure safe recreation at beaches, and throughout the lake.

The provisional water quality objective for fecal coliform bacteria near or in water intakes is: not more than 10 percent of at least 5 samples from each site in any 30-day period, should have a fecal coliform density greater than 10/100 mL (i.e., the 90th percentile should be ≤10/100 mL).

The provisional objective for fecal coliform bacteria samples taken at public beaches during the summer months is: a maximum running log mean of 200/100 mL, calculated from at least 5 weekly samples taken during the recreation season, and not more than 10 percent of samples during any 30-day period to exceed 400/100 mL.

Although no bacterial data are available, there seems no reason to believe that these objectives are not presently being met. Monitoring will be required to check the situation.

Nuisance algal growth in lakes, as measured for example by chlorophyll a, is usually the result of excessive phosphorus in a lake. Algae can cause taste and odours in drinking water, aesthetic problems, poor water clarity, and hypolimnetic oxygen depletion which results in loss of fisheries habitat and possible winter or summer kill situations.

Water quality objectives are proposed for the mean summer concentration of chlorophyll a and total phosphorus. These objectives are: average chlorophyll a 0.003 mg/L and average total phosphorus 0.010 mg/L, both applicable over the spring and summer period.

The averages should be calculated from at least monthly samples taken in the period May to August. For the measurement of total phosphorus, 3 discrete samples should be taken each month at the deepest part of the lake at 0.5, 6, and 30 m depths. Samples for measurement of chlorophyll a can be taken at the same time and site and should consist of a composite of samples taken at depths of 0, 2, 4 and 6 m, or a composite sample from 0 to 6 m using a tygon tube.

An objective is also proposed for the dissolved oxygen content of the hypolimnion in order to maintain the cold water fishery and zooplankton habitat of the lake. The dissolved oxygen content should not drop below 6.0 mg/L, at any point greater than 5 m above the sediment-water interface.

A turbidity objective is proposed for Lakelse Lake, the inflow streams used for domestic water supplies, and streams important for salmonid spawning in areas subject to logging. For streams with both domestic water supplies and salmonid spawning, the objective for domestic water supplies should apply.

The provisional turbidity objective for the lake and the inflow streams with domestic water supplies is an average of 1 NTU, and a maximum 5 NTU. The objective is set to ensure that the water quality is suitable for domes-

tic water supply (the most sensitive use) with no water treatment in addition to disinfection (i.e., no removal of turbidity or suspended residues is required). Because the freshet values are variable from year to year, and the results can exceed the 5 NTU objective, no turbidity objective is proposed for domestic water supplies during freshet. The turbidity objectives should apply to any discrete sample (surface or bottom) collected anywhere during nonfreshet periods.

The turbidity objective for spawning streams is as follows: the induced turbidity should not exceed 5 NTU when background turbidity is ≤50 NTU, nor should the induced turbidity be more than 10% of background when background is >50 NTU.

MONITORING RECOMMENDATIONS

A summary of recommended water quality monitoring is given in Table 2. Monitoring is required to determine whether provisional water quality objectives are being met, and to provide ambient data to fill important data gaps. The amount of monitoring that can be done will depend on project priorities and availability of funds.

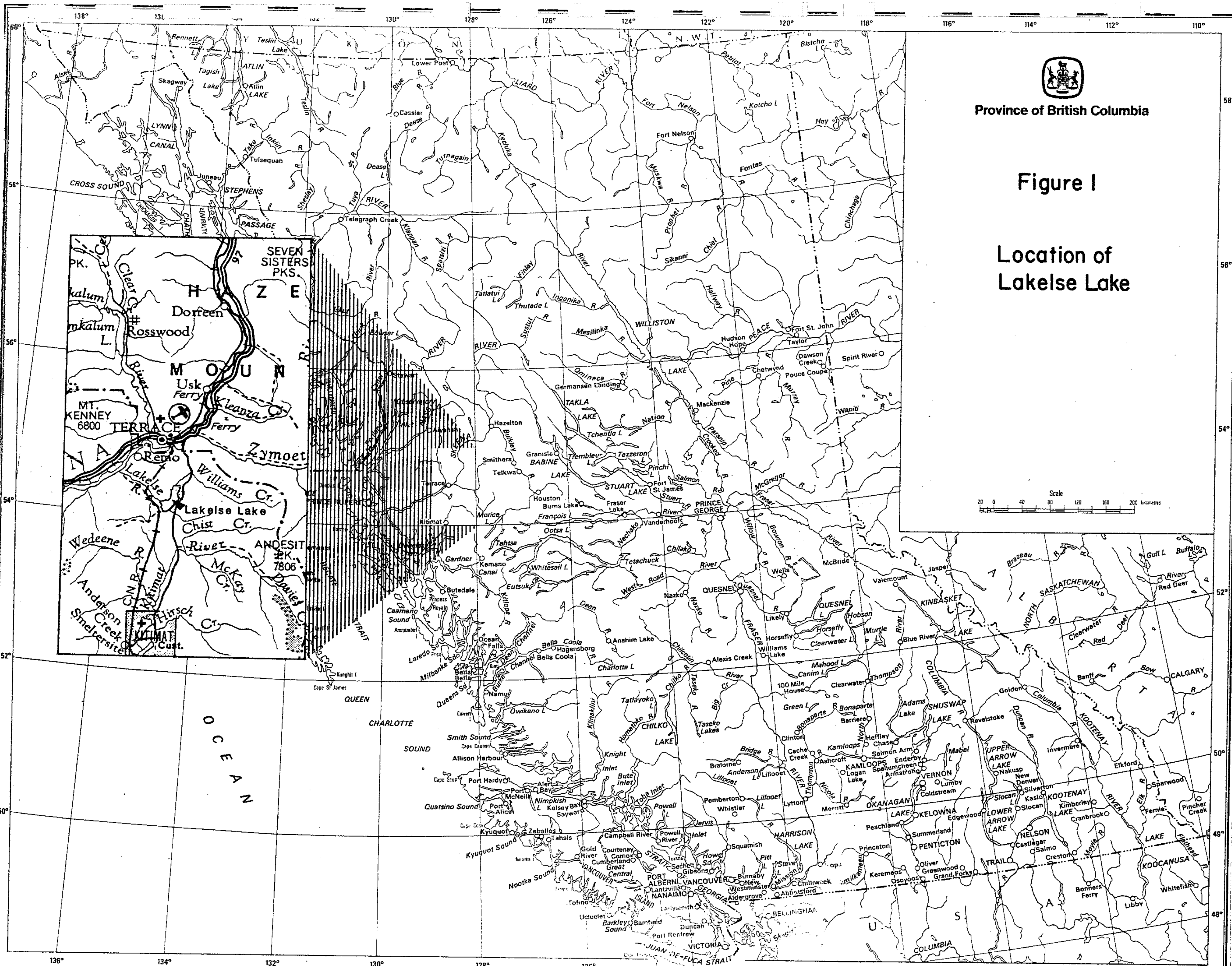


Figure I

Location of Lakelse Lake

Drawn and ... by Mapping Section, Surveys and Mapping Branch, Ministry of Environment, Victoria, British Columbia

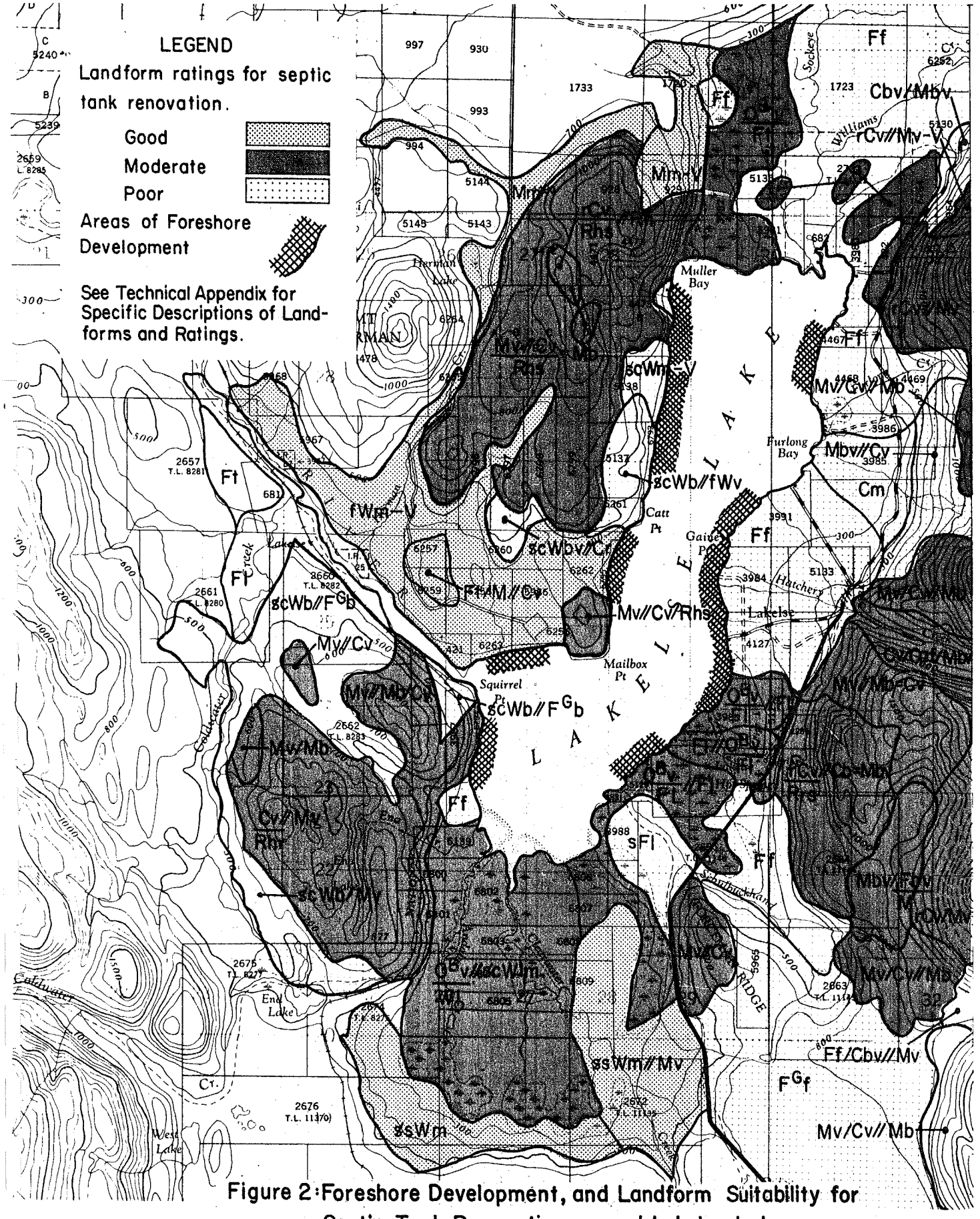


Figure 2: Foreshore Development, and Landform Suitability for Septic Tank Renovation around Lakelse Lake.

TABLE 1

PROVISIONAL WATER QUALITY OBJECTIVES FOR LAKELSE LAKE AND TRIBUTARIES

Water Bodies		Lakelse Lake	Tributaries to Lakelse Lake
Designated Water Uses		Drinking water, aquatic life and recreation	Drinking water, aquatic life, recreation and irrigation
Fecal Coliforms[1]	Near water intakes	≤10/100 mL 90th percentile	
	At bathing beaches	≤200/100 mL geometric mean ≤400/100 mL 90th percentile	
Turbidity[2]		≤1 NTU average 5 NTU maximum	See footnote 4
Total Phosphorus[3]		≤0.010 mg/L average	not applicable
Chlorophyll *a*[3]		≤0.003 mg/L average	not applicable
Dissolved Oxygen		>6.0 mg/L @ 5m above sediment	not applicable

[1] the geometric mean and 90th percentile are calculated from at least 5 weekly samples taken in a period of 30 days. The drinking water objective (10/100 mL) applies year-round and the recreation objective (200-400/100 mL) applies during the recreation season.

[2] the average is calculated from at least 5 weekly samples taken in a period of 30 days and applies to any point of the water body. The objectives do not apply during the freshet season.

[3] the average is calculated from a set of samples, taken mostly in the period May to August at a site over the deepest part of the lake. For total phosphorus discrete samples taken at depths of 0.5, 6, and 30 m should be analyzed. For chlorophyll *a*, a composite of samples taken at depths of 0, 2, 4 and 6 m should be analyzed.

[4] for streams with domestic water supplies: ≤ 1 NTU average
5 NTU maximum

for streams without water licences: The induced turbidity shall not exceed 5 NTU when background turbidity is ≤50 NTU nor shall the induced turbidity be more than 10 % of background when background is >50 NTU.

TABLE 2

RECOMMENDED WATER QUALITY MONITORING FOR LAKELSE LAKE AND TRIBUTARIES

SITES	FREQUENCY AND TIME	CHARACTERISTICS TO BE MEASURED
Near water intakes	5 weekly samples over 30 days, any time of year	Fecal coliforms
Bathing beaches	5 weekly samples over 30 days, in the recreation season	Fecal coliforms
At any point in the water body	5 weekly samples over 30 days, excluding freshet period	Turbidity
Over the deepest part of the lake, at 0.5 6 and 30 m depths	Monthly, May to August	NH_3-N, NO_3-N organic-N, total-N ortho-P, total dissolved-P, total P, Secchi disc reading
Over the deepest part of the lake, at 1 m intervals	Monthly, May to August	Temperature and Dissolved oxygen profiles
Over the deepest part of the lake, composite of 0, 2, 4 and 6 m depths	Monthly, May to August	Chlorophyll a