SYLVAN LAKE

REGULATION STUDY

Alberta Environment
Planning Division
August, 1978.

Alberta

ENVIRONMENT

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October 3, 1978

Mr. Peter G. Melnychuk, P. Eng.
Assistant Deputy Minister
Environmental Engineering Support Services
Alberta Environment

Dear Mr. Melnychuk:

I am pleased to submit the attached report to you entitled "Sylvan Lake Regulation Study."

Based on the report I would recommend that no further action on regulating the level of Sylvan Lake or releasing water to Cygnet Lake be taken at this time.

The recommendation with respect to control of land in the outlet area raises some concerns (see Item #4, Page 39). Assuming this recommendation refers to "provincial control" a precedent could be established which may not be desirable if applied on a province wide basis.

I would further recommend that the report be released for public review.

Respectfully submitted,

Allan Strome

A. R. Strome, P. Eng.
Director

ARS/is

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August 25, 1978

A.R. Strome
Director
Water Resources Management Division
Alberta Environment

Dear Mr. Strome

We are pleased to transmit to you the report entitled "Sylvan Lake Regulation Study", prepared by the Planning Division. At your request, the study was carried out to determine the desirability and need for regulating the water level of Sylvan Lake and to determine the feasibility, cost and impact of regulation. The primary purpose of regulation would be to enhance the recreational capabilities of Sylvan Lake.

The study considered several alternatives for regulation and assessed their effects on the natural and social environment of the area. The effects of supplying water from Sylvan Lake to maintain favorable water levels for waterfowl on Cygnet Lake and the effects of releasing effluent from the Town of Sylvan Lake sewage lagoon were also assessed.

The study found that none of the alternatives studied for regulating the water levels of Sylvan Lake would provide a satisfactory solution to the problems of fluctuating water levels. Stabilization of water levels cannot be achieved without importing water to Sylvan Lake which would cost in the order of $8,000,000.00. Expenditures of this magnitude should be considered in light of other possibilities for enhancing the recreational potential of the lake.

Annual releases of water from Sylvan Lake to Cygnet Lake for wildlife purposes would lower the water levels on Sylvan Lake during prolonged dry periods and result in adverse effects on boating and aesthetic quality of the shoreland. The study found that fall releases of effluent from the Town of Sylvan Lake sewage lagoons would not significantly effect water quality in Sylvan Creek, Cygnet Lake or the Red Deer River.

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The study committee, made up of representatives from local authorities and associations, has reviewed the report and agrees with the conclusions and recommendations. They feel that no further action on regulating the lake levels or releasing water to Cygnet Lake should be taken at this time. The Committee also strongly supported the recommendation that the report be made available to the public and that public opinion be considered prior to making a decision on construction of works or further study.

We trust that this meets with your approval.

C. L. Primus

C.L. Primus
Director
Planning Division

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I. INTRODUCTION

A. General

Sylvan Lake, located twelve miles northeast of the City of Red Deer, is one of central Alberta's most important recreation lakes. Because of the easy access and the natural amenities of the lake, the lake is extensively utilized and a large number of recreation facilities have been developed. Water levels of the lake have fluctuated over a wide range and these fluctuations have detracted from the full benefits of the natural amenities of the lake. Alberta Environment was requested to investigate the feasibility of regulating the outflow from Sylvan Lake and thereby reduce water level fluctuations. This report assesses the implications of regulating the lake at various alternative levels for the primary purpose of improving the recreation capability. The effects of supplying water from Sylvan Lake to maintain favorable levels for wildlife purposes on Cygnet Lake and the effects of releasing effluent from the Town of Sylvan Lake sewage lagoon are also assessed.

1) Sylvan Lake

Sylvan Lake is a relatively large and deep lake compared to other lakes in the central Alberta area, having sixteen square miles of surface area, 21 miles of shoreline and a maximum depth of 60 feet. The drainage area of Sylvan Lake is 58 square miles. Runoff from this area is conveyed to the lake through several small intermittent streams. Sylvan Creek provides the outlet from the lake which drains through Cygnet Lake to the Red Deer River. The shoreline of Sylvan Lake varies from a gently sloping sandy beach on the south end of the lake to near vertical banks of sandstone, 50 to 70 feet high on the east shore. Most of the north shore of the lake is low and marshy with native vegetation. The west shoreline is primarily low, rocky banks with some gently sloping sandy areas.

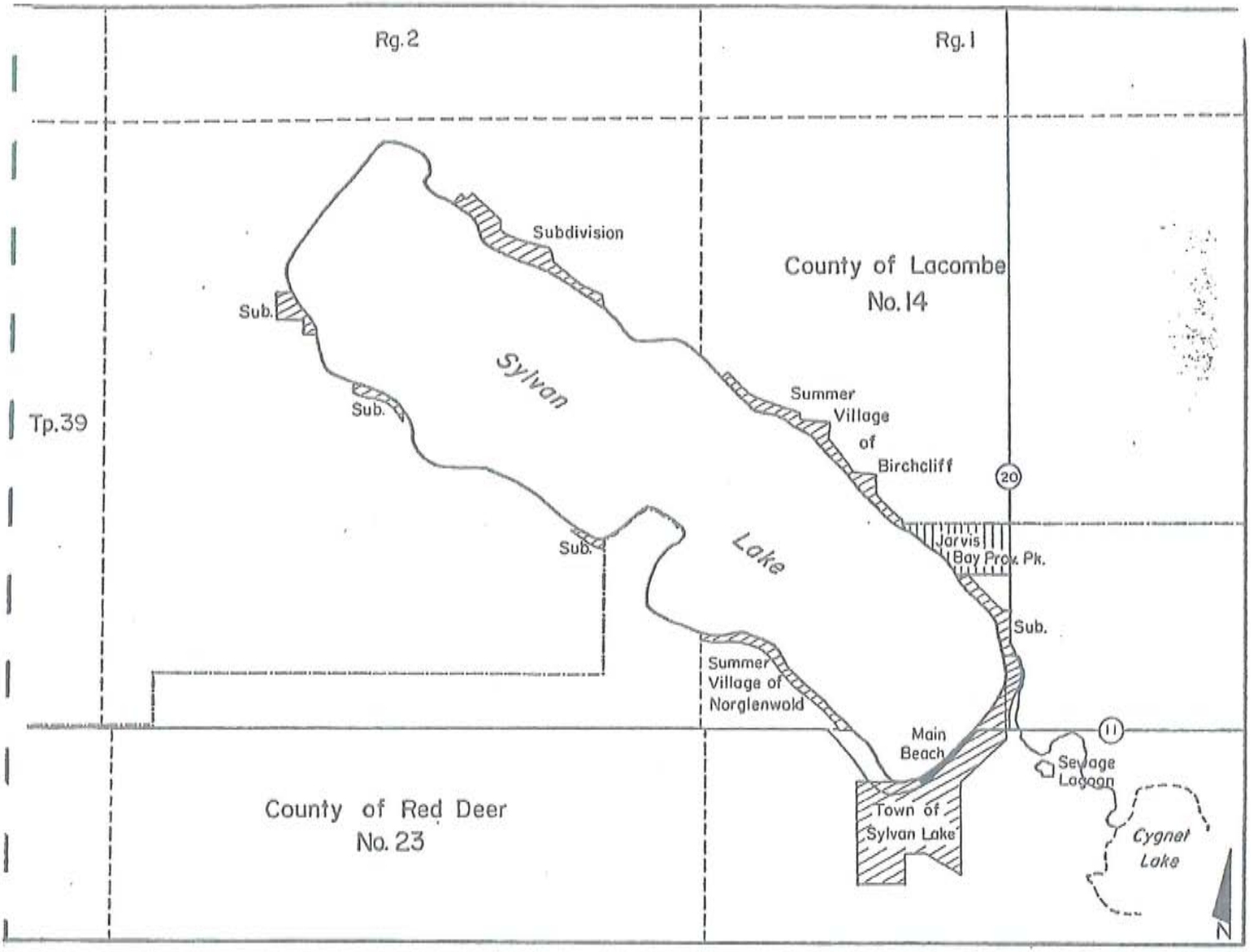
Biologically, Sylvan Lake is classified as moderately eutrophic. It supports populations of yellow perch, northern pike, walleye, burbot and white suckers. In addition, breeding and nesting areas are provided for some species of waterfowl.

Sylvan Lake is one of the most intensively developed lakes in the Province of Alberta. The recreation facilities around the lake include public beaches, picnic grounds, a provincial park, golf courses, commercial campgrounds, motels, a marina, institutional camps and cottage subdivisions (Figure 1). Surveys carried out in 1976 indicated that recreational use of the lake that year was in the order of 432,000 user-days during the May to October season. The Town of Sylvan Lake, located south of the lake, maintains a public beach and provides a full range of commercial services. The Summer Village of Birchcliff is on the east, and the Summer Village of Norglenwold is on the southwest shoreline. The other municipalities bordering the lake are the Counties of Red Deer and Lacombe.

2) Cygnet Lake and Sylvan Creek

Cygnet Lake, located downstream of Sylvan Lake, is a small, shallow lake with a surface area of 500 acres and an average depth of less than one foot. The lake is designated as a wildlife sanctuary. It provides a breeding and nesting area for several species of waterfowl.

A control structure was constructed on this lake in 1975-76 and the channel of Sylvan Creek was upgraded from Cygnet Lake to the Red Deer River. The work was carried out by the Cygnet Lake Drainage District on a cost-sharing basis with Alberta Environment and the works were licensed to the District. The project reclaimed about 2,000 acres of deeded agricultural land from periodic flooding and confined Cygnet Lake to elevation 3056.0



KEY MAP OF SYLVAN LAKE

Figure 1.

feet which approximates the boundaries of Crown land in the lake. The outlet control structure can be operated for backflood irrigation at the discretion of the Cygnet Lake Drainage District Board. In 1976, Ducks Unlimited (Canada) Ltd., dredged some channels to create deeper water and created nesting islands to improve habitat on Crown land in the Cygnet Lake area.

Normal runoff is sufficient to fill and maintain the lake at or near its full supply level in most years, as detailed in Appendix A. However, supplemental water would be required if the lake is to be held near this elevation every year to maintain the wildlife habitat. Since the lake is very shallow, its value for wildlife purposes rapidly decreases for levels lower than it s full supply level.

In addition to the work carried out on Cygnet Lake, a channel was excavated from the Town of Sylvan Lake sewage lagoons to Cygnet Lake to allow periodic releases from the lagoons. The channel is designed to handle flood flows, including overflow from Sylvan Lake, up to the 1:50 year event.

B. Study Background

Water levels on Sylvan Lake were fairly high in 1974. These levels stimulated local discussion of concerns related to shoreline erosion and the reduction in beach area. Following requests from the Town of Sylvan Lake, the Summer Villages of Birchcliff and Norglenwold, the Association of Sylvan Lake Summer Cottage Owners and individual residents, the Department of the Environment held a public meeting to discuss the need to study the control of Sylvan Lake water levels.

The peak water level in 1974 was 3073.3. Analysis of recorded levels for the period 1955 to 1974 indicates that the lake had a mean

elevation of about 3072.7 feet above sea level. The highest recorded level was 3075.0 feet in July of 1955 and the lowest level was 3071.0 feet in 1964. There were no reports of direct damage to shoreline structures in 1974 or 1955, however, high levels reduce the beach area available for recreation use and increase shoreline erosion.

The reduction in beach area is particularly noticeable on the heavily utilized main beach in the Town of Sylvan Lake. As shown on Figure 2, a typical profile of the main beach, the slope is flat and the area of exposed beach is very sensitive to water level fluctuations. While no conclusions can be drawn from a profile at a single location at a particular point in time since beach conditions are continually changing due to wave action, Figure 2 shows that there would be no beach at levels above the mean lake level and over 200 feet of beach at the minimum water level. The main beach is heavily utilized by people from the local area as well as the Edmonton and Calgary areas. The Town of Sylvan Lake has indicated that controlling the water level so that about 200 feet of beach is exposed would maximize the potential of the beach. This would require regulation of the water level at about 3071.5. Users of beaches on the northeast part of the lake feel that water levels near the long-term mean (3072.7) provides the best beach and swimming conditions.

The areas of most extensive erosion are on the east and west shores fronting the cottage subdivisions. While no permanent buildings have been affected, erosion of lawns and undercutting trees result in financial loss and an unsightly appearance to the shoreline.

Low water levels have also been a cause of concern to recreation users as evidenced by complaints related to difficulties in lauching boats,

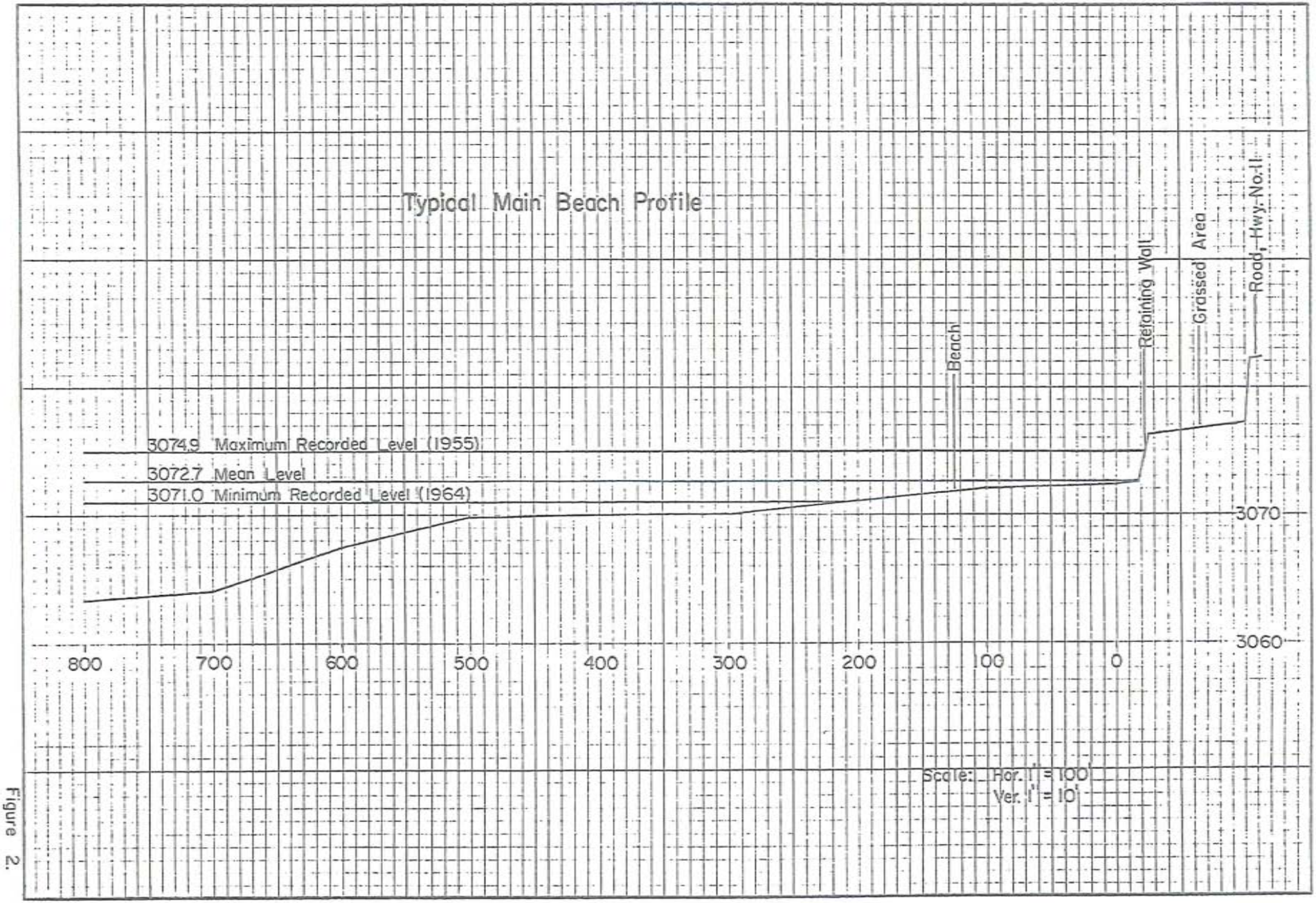

Typical Main Beach Profile
Retaining Wall
Grassed Area
Road, Hwy. No. 1
Beach
3074.9 Maximum Recorded Level (1955)
3072.7 Mean Level
3071.0 Minimum Recorded Level (1964)
3070
3060
800
700
600
500
400
300
200
100
0
Scale: Hor. 1" = 100'
Ver. 1" = 10'

Figure 2.

poor water quality resulting in increased algae growth, unsightly shorelines due to exposed mudflats and decayed vegetation, isolated ponds of stagnant water, and poorer fishing during periods of low water levels.

None of the problems identified were severe in a monetary sense, however, fluctuating water levels do detract from the full value of the recreational experience for users of the lake. In view of this, it was felt that a regulation study was required. It was agreed to proceed with the study under guidance of a committee made up of representatives of municipalities and organizations having an interest in the lake.

C. Objectives and Scope of the Study

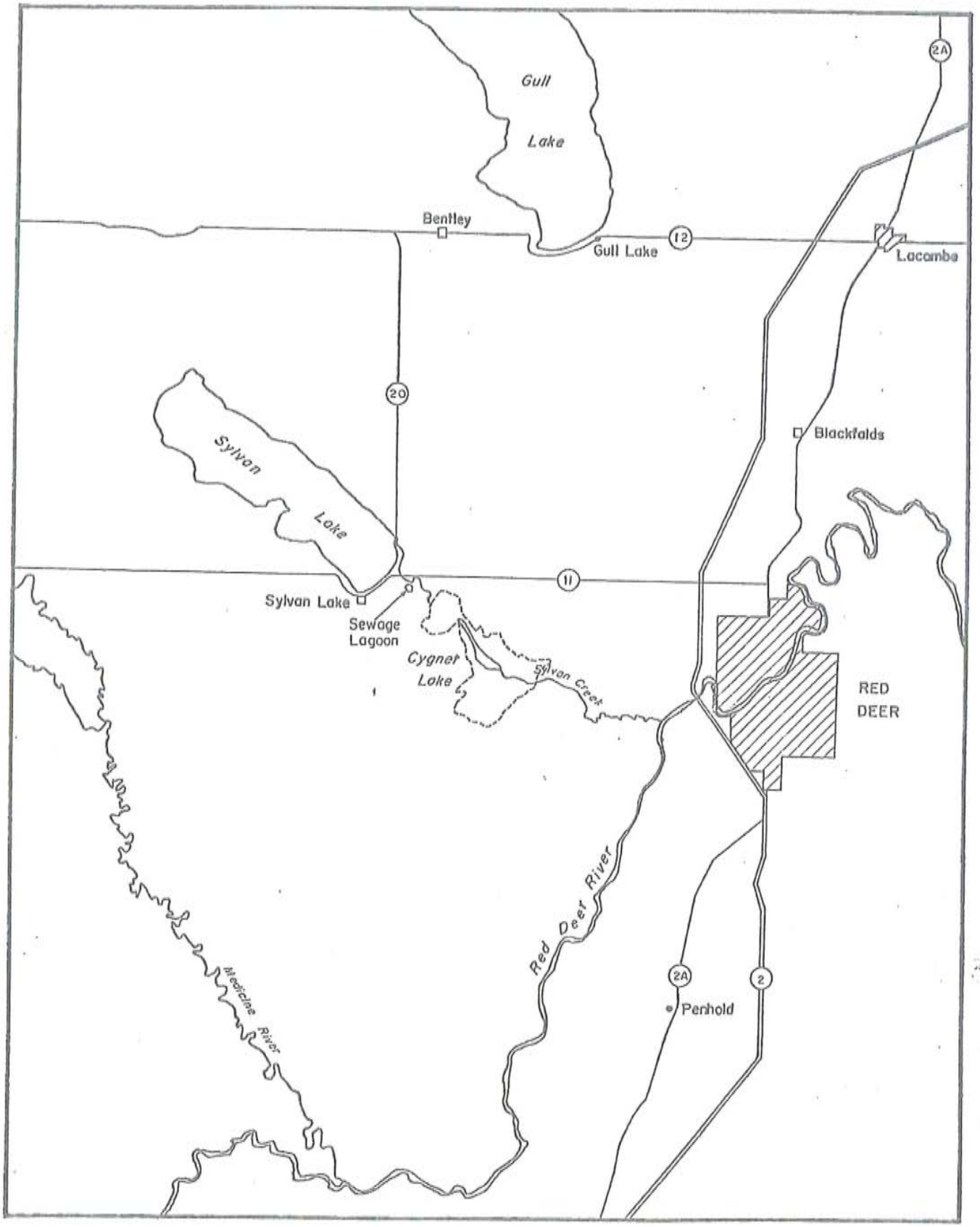
The objectives of the study are threefold:

1) to assess the need for and implications of regulating the water levels of Sylvan Lake,
2) to assess the effect of releasing water from Sylvan Lake to maintain desirable water levels on Cygnet Lake, and
3) to determine the effect of periodic releases from the Town of Sylvan Lake sewage lagoon on water quality in Cygnet Lake and the Red Deer River.

The primary focus of the study is on Sylvan Lake. Since regulation of Sylvan Lake would have downstream effects, Cygnet Lake and Sylvan Creek were also considered in the study. The study area is shown on Figure 3. It involves investigations related to hydrology, water quality, recreation, fish and wildlife, groundwater and erosion. Engineering studies were also carried out to provide preliminary designs and cost estimates for structures.

D. Study Organization

A Committee was formed to guide the study and to assure that all



LOCATION PLAN

Figure 3.

aspects and concerns were considered. Membership on this committee included the following representatives of municipalities and organizations around the lake:

S.N. Swainson	County of Red Deer
T. Gyori	County of Lacombe
E. Dietrich	Town of Sylvan Lake
G. Hancock	Summer Village of Birchcliff
K.G. Pugh	Summer Village of Norglenwold
G. Hughes	Association of Summer Cottage Owners
D. Raymond	Summer Villages of Norglenwold & Birchcliff
N. Russell	The Breakers Community Association

The study was coordinated by Planning Division of the Department of the Environment. Various other branches of the Department of the Environment as well as the Department of Recreation, Parks and Wildlife and the Red Deer Regional Planning Commission were involved in the technical aspects of the study either in an advisory capacity or by carrying out or supervising a study component.

Terms of reference for the studies necessary to determine the feasibility, cost, and impact of various alternatives were formulated by the agency with the appropriate expertise and the project coordinator. The terms of reference were reviewed by the committee and the study progress was monitored on a monthly basis.

The agencies responsible for studies in their area of expertise are as follows:

Hydrology	Technical Services Division, Alberta Environment

Preliminary Structure Design and Cost	Design & Construction Division, Alberta Environment
Shoreline Erosion	Technical Services Division, Alberta Environment
Groundwater	Earth Sciences & Licencing Division, Alberta Environment
Fish and Wildlife	Fish and Wildlife Division, Dept. of Recreation, Parks and Wildlife
Water Quality	Water Quality Division, Alberta Environment
Recreation	Red Deer Regional Planning Commission and Provincial Parks Division, Dept. of Recreation, Parks and Wildlife

E. Alternatives Considered

The study considered regulating water levels by means of a weir at the outlet of the lake. Weirs with alternative crest widths of 16, 24 and 36 feet and crest elevations of 3073.3, 3072.7, 3072.0 and 3071.0 were considered in the analyses. These alternative crest elevations were selected on the basis of informal input from the local committee and technical advisors. The effect on Sylvan Lake of supplying water to Cygnet Lake for wildlife purposes was determined considering both the existing conditions at Sylvan Lake and with an outlet structure. Considerations related to importing water to Sylvan Lake were beyond the scope of the study, however, some general comments on this possibility are provided.

II. ANALYSES

A. Hydrology [1]

A hydrology study was carried out to assess the hydrologic impact of several alternatives for controlling the water levels of Sylvan Lake and to provide information for the design of works. The study involved flood and drought analyses and simulation studies to determine the effect of various water management options on Sylvan Lake water levels.

Water levels on Sylvan Lake have been recorded during the past 20 years (Figure 4). The mean lake level during the summer months has been 3072.7 feet (geodetic datum). Maximum and minimum recorded levels were 3075.0 (July 1955) and 3071.0 (October 1964) respectively. The natural outlet from the lake is at elevation 3073.3. Since this level was exceeded in only three of the past 20 years, the lake can essentially be considered to be in a closed basin.

Hydrographs of inflow to Sylvan Lake for various magnitude floods were estimated and routed through Sylvan Lake alternatively assuming 16 foot, 24 foot and 36 foot weirs at the outlet. Because the surface area of the lake is large in comparison to the drainage area, the size of the outlet control structure does not appreciably affect the peak lake level. Indeed, the differences are so small that they do not warrant consideration of a weir wider than 16 feet.

Typical of a lake without outflow, extreme water levels on Sylvan Lake are a result of a series of wet or dry years rather than a single

1. Summary of study carried out by Hydrology Branch, Technical Services Division, Alberta Department of the Environment.

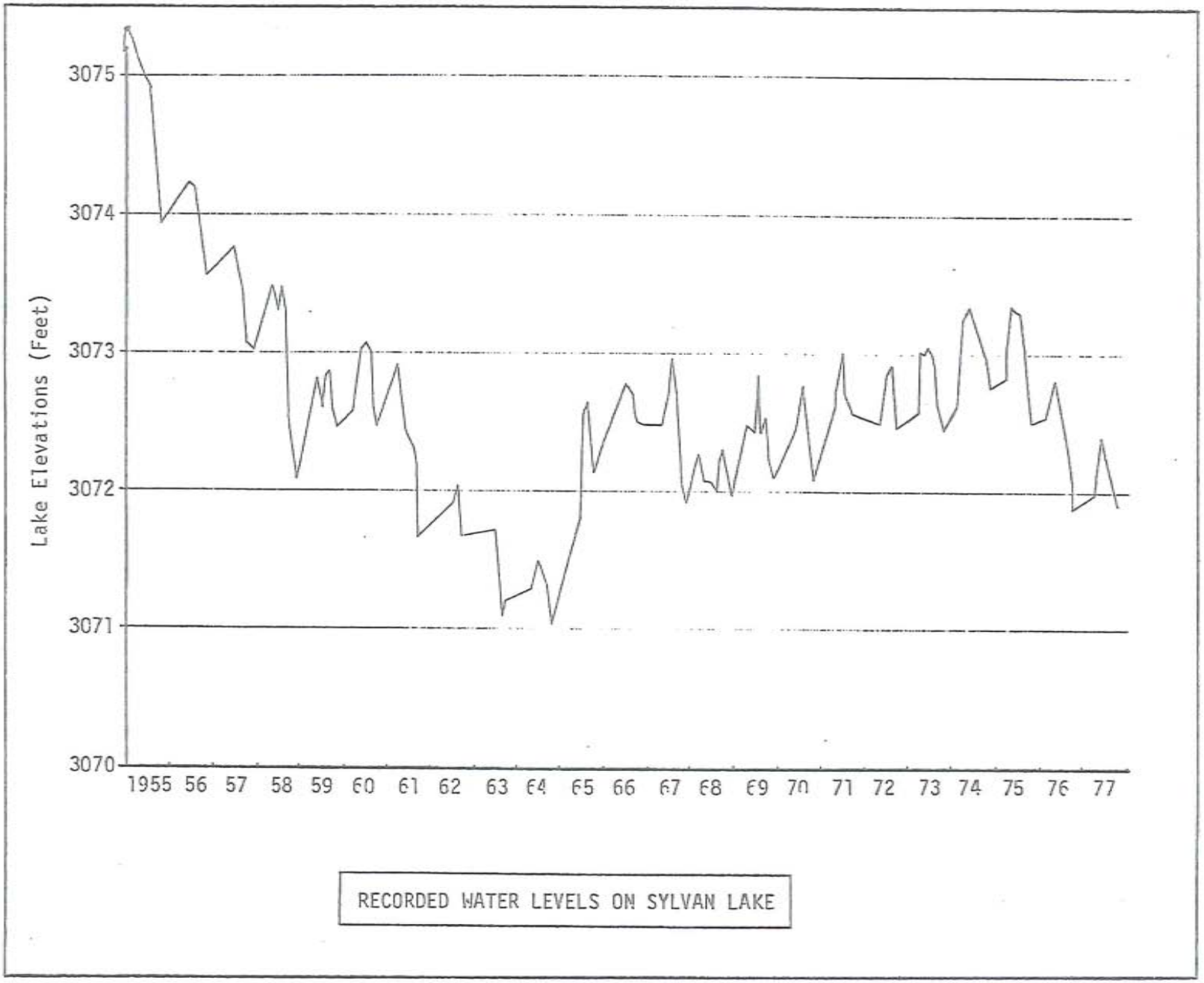

Lake Elevations (Feet)
3075
3074
3073
3072
3071
3070
1955 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
RECORDED WATER LEVELS ON SYLVAN LAKE

Figure 4.

annual event. The provision of an outlet structure and downstream channel improvement would control the accumulation of water in the lake and limit the rise in water levels to an acceptable maximum. However, this control of upper levels would be achieved at the expense of a lower mean annual lake level and lower minimum levels during prolonged droughts. The structure would lower the mean annual level, but the lake would still fluctuate about this lower mean level with the same range as under present conditions. Recession of water levels due to a series of dry years cannot be alleviated without importation of water.

The hydrology study simulated the water levels of Sylvan Lake for the period 1962 to 1974 assuming an outlet weir with various alternative crest elevations. The results of the study are summarized in Table 1. The simulation period is too short to conclusively determine the long-term means and ranges of fluctuations. However, it is sufficient to indicate that the ranges of fluctuations considering various alternatives for regulating the outflow would be very similar to the natural range of fluctuations.

The hydrology study also assessed the implications of supplying water from Sylvan Lake to maintain the water level of Cygnet Lake at elevation 3056.0. Based on average evaporation during the months May to October inclusive, a release of up to 400 acre feet could be required to maintain Cygnet Lake at elevation 3056.0. Releasing just enough water to replace evaporation would require continual manipulation of the riparian works to meet the changing rate of evaporation during the summer. A more practical way to operate the works would be to provide a constant release sufficient to meet evaporation needs most of the time recognizing that there will be times when Cygnet Lake would drop slightly below the desirable level, but

TABLE 1

RESULTS OF SIMULATION STUDY: 1962 - 1974

Alternative	Mean Summer Level	Maximum Level	Minimum Level	Range (ft)
1. Existing Conditions	3072.7	3073.5	3071.0	2.5
2. Weir[1] with Crest at:				
a) 3073.3	3072.5	3073.4	3071.1	2.3
b) 3072.7	3071.9	3072.9	3070.5	2.4
c) 3072.0	3071.3	3072.3	3069.9	2.4
d) 3071.0	3070.4	3071.4	3068.9	2.5

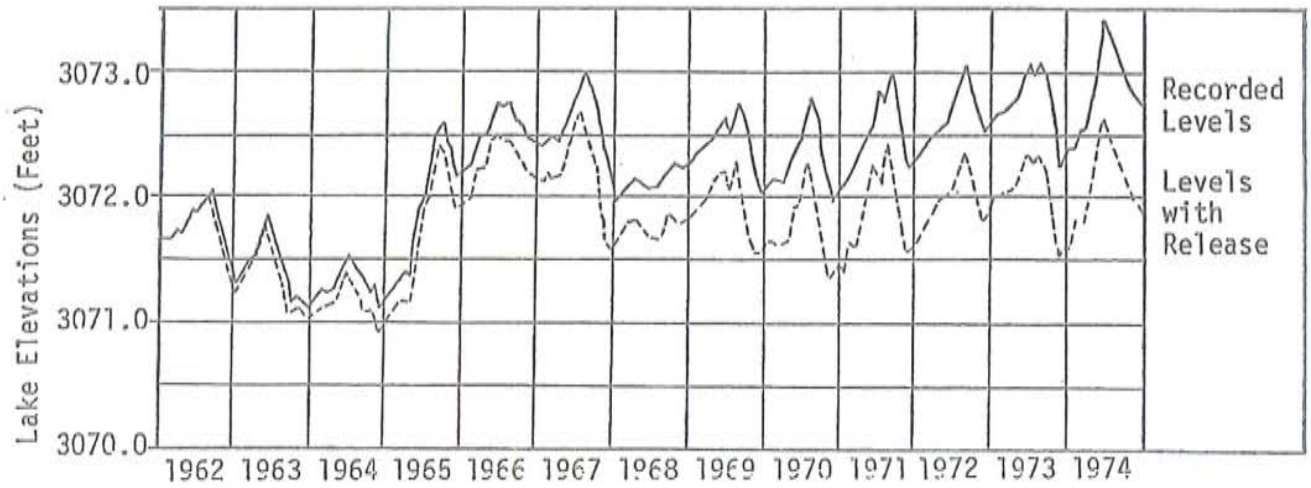
1. 16-foot weir assumed.

a greater percentage of the time Cygnet Lake would be full and there would be some spill out of the lake. A constant release of 2.0 cfs for six months each year (about 720 acre feet) was selected for study purposes. A release of 720 acre feet would lower the level of Sylvan Lake by about 0.07 feet or 0.87 inches in any one year. While this effect would not appear to be significant on an annual basis, it would accumulate over a series of dry years. Based on a simulation study, supplying 720 acre feet per year to Cygnet Lake could lower the level of Sylvan Lake by 0.85 feet in the 13-year period, 1962 to 1974, as shown in Figure 5. The difference between the natural water level and the controlled water level would continue to increase until one of two things happen:

1) The surface area of the lake is reduced to the point where the difference in evaporation is sufficient to offset the 720 acre foot release. This would not occur until the lake is about 6.0 feet below its natural level.

2) A series of wet years causes lake levels to rise to the point where spill would occur.

The most recent spill from Sylvan Lake occurred about 20 years ago. If a 720 acre foot release to Cygnet Lake was made each year for the past 20 years, Sylvan Lake would be about 1.3 feet lower than the present lake level. This difference would continue to increase until a series of wet years causes spill to occur. Based on historical levels, the lake would probably spill before the surface area of the lake is reduced to the extent that the difference in evaporation offsets the 720 acre foot release.



EFFECTS OF RELEASE TO CYGNET LAKE ON SYLVAN LAKE LEVELS

Figure 5.

B. Water Quality [1]

A water quality study was carried out to assess the existing quality of Sylvan Lake, Cygnet Lake and Sylvan Creek, to determine the effects of regulation of Sylvan Lake on water quality and to comment on the effect of effluent discharges from the Town of Sylvan Lake sewage plant.

Chemical and biological analyses of water samples collected from October, 1972 to September, 1974 showed that Sylvan Lake is moderately eutrophic. Regulation of lake levels by construction of a weir at the outlet will have little effect on the chemical and biological water quality of the lake. The distribution of rooted aquatic plants in the littoral zone might be altered somewhat, but likely not to the extent that it would be a serious problem.

Sampling and inspection of Cygnet Lake in the spring and early summer of 1976 indicated that the lake is very eutrophic. The organic and inorganic nutrients that stimulate the growth of algae and rooted aquatic plants find their way into Cygnet Lake in a number of ways. Nutrients are contained in the runoff from surrounding farmlands and woodlands, in the soil carried into the lake as dustfall, as well as in the sewage effluent from the Town of Sylvan Lake. The rich organic sediments of the lake bottom are also a significant source of nutrients.

If a control structure is constructed at the outlet of Sylvan Lake there may be some temporary water quality benefits for Cygnet Lake during the period when Sylvan Lake is adjusting to a lower long-term mean and more water than normal is spilled. Following this initial effect, there would be

1. Summary of report prepared by Pollution Control Division, Environmental Protection Services, Alberta Department of the Environment.

no appreciable change in the quantity, frequency or quality of water spilled from Sylvan Lake.

The discharge of sewage effluent to Cygnet Lake would not have an appreciable effect on the growth of algae because of the timing of the discharge and the abundance of nutrients from other sources. In the late fall when the effluent is released, biological productivity is low because of cooler temperatures and the relatively lower solar radiation on the lake. During the winter the lake freezes solid and nutrients in the water do not contribute to plant growth. During the spring runoff, water in the lake at the time of freeze-up is flushed to the Red Deer River and is not available during the spring and summer when almost all the algae and plant growth takes place.

Construction of a control structure at the outlet of Sylvan Lake would not significantly affect the water quality in the Red Deer River. Also, the discharge of effluent from the Town of Sylvan Lake lagoons would not have a significant effect on water quality in the Red Deer River.

C. Recreation [1]

The recreation study provided an inventory of existing recreation facilities and an estimate of usage, outlined the effects of various operating procedures on recreation on Sylvan Lake and suggested the most desirable recreation level for the lake.

In 1976 there were approximately 2,000 developed recreation units (a facility for four people) around Sylvan Lake. Of these, 251 were institutional camp units, 480 commercial recreation facilities, 152 provincial park campsites and 1,149 cottage lot provisions. In addition, the main

1. Summary of report prepared by W.G.A. Shaw, Senior Associate Planner, Red Deer Regional Planning Commission.

beach supported a maximum of 600 units of informal day use groups.

From a number of surveys it was estimated that the total May-October recreation use of Sylvan Lake is in the order of 432,000 user-days. The distribution of use is estimated as follows:

Institution Camps	45,300 user-days
Commercial Recreation Facilities	87,900 user-days
Jarvis Bay Provincial Park	42,300 user-days
Main Beach Day Users	50,880 user-days
Cottages	196,700 user-days

The origin of users indicates that Sylvan Lake is truly a provincial recreation resource. Of the 862 identified cottage property owners, nearly 70 percent come from Edmonton and Calgary. Forty percent of the main beach users, who might be expected to be predominantly regional and local day-users, are from the two major metropolitan centers.

From a recreational point of view, a lake level of about 3071.5 during the recreation season appears to be optimal. At this level, desirable sandy beaches along publicly-owned shorelands would be exposed and the erosion and ice problems identified by some property owners would be alleviated. At the same time, other shoreline areas around the remainder of the lake would generally not be undesirable for either the general public or private use, and, on the whole, would not be aesthetically displeasing.

Hydrology studies indicate that regulation at 3071.5 would result in lower than natural levels during prolonged dry periods. These low levels would have negative effects on recreation and aesthetics which would tend to offset any benefits of regulation that would accrue during normal or wet climatic conditions. The management plan for Sylvan Lake prepared by

the Red Deer Regional Planning Commission indicated that the recreation use of Sylvan Lake could nearly triple and still be within the capabilities of the lake to support such use without regulation of lake levels. For these reasons it is felt that, from a recreation viewpoint, construction of a control structure at the outlet of Sylvan Lake is not warranted at this time.

Releasing water from Sylvan Lake to maintain favorable levels for wildlife on Cygnet Lake would also affect recreation on Sylvan Lake to some extent. Supplying 720 acre feet of water annually to Cygnet Lake would only reduce the level of Sylvan Lake by 0.8 inches in any one year; however, the effect would be cumulative. In the 13-year simulated period (1962-1974) supplying 720 acre feet to Cygnet Lake each year would reduce the level of Sylvan Lake by 0.85 feet below the recorded water level by 1974. The recreation study concluded that supplying Cygnet Lake is not in the best long-term interest of recreation users around Sylvan Lake since an annual release would cause lower than natural levels on Sylvan Lake during prolonged dry periods and adversely affect boating and the aesthetic quality of the shoreline.

D. Fish [1]

The aquatic resources of Sylvan Lake, Cygnet Lake and Sylvan Creek were studied to identify species and populations of fish, to determine the effect that various regulation alternatives for Sylvan Lake and supplying water to Cygnet Lake would have on fish habitat and populations, and to assess the effect of the operation of the Sylvan Lake sewage facility on the aquatic environments of Cygnet Lake and Sylvan Creek.

1. Summary of report prepared by Aquatic Environments Ltd. for Alberta Department of the Environment.

The study concluded that Sylvan Lake has an abundant and diverse aquatic flora and fauna including populations of yellow perch and northern pike - two sport fish species. Although summerkill affects some fish species, the plant and animal communities of the lake appear to be healthy. Indicator species which characterize trophic conditions in the lake imply a moderately high level of productivity in Sylvan Lake.

The size of the littoral zone, the shallow productive area of a lake, and the submerged and emergent vegetation occupying the zone are important to the sport fish species. The littoral zone provides optimum habitat for many of the fish species found in Sylvan Lake. The effect of various regulation alternatives on the littoral zone was used as an indicator of the effect on fish species in the lake.

To maintain the vegetation and the range of habitats available to fish in the littoral zone, some degree of water level fluctuation is important. Since the area of the littoral zone of Sylvan Lake, expressed as a percentage of the total water surface area, is largest between elevations 3072.0 and 3073.0, the study concluded that, from a fisheries point of view, it is desirable to have water levels in Sylvan Lake continue to fluctuate within the historical range with the mean water level remaining near the historical mean.

The provision of an outlet weir at or above elevation 3073.0 will not have any major effect on the fish populations in Sylvan Lake. Crest elevations lower than 3073.0 coupled with water supply to Cygnet Lake would lower the mean level of Sylvan Lake and may reduce the size of the littoral zone enough to affect fish populations.

It is felt that the withdrawals of 750 acre feet of water annually from Sylvan Lake to maintain water levels in Cygnet Lake will, in itself, have no major effects on the aquatic resources of Sylvan Lake. Although over a long period of time the withdrawal would lower the mean water level of Sylvan Lake, aquatic life can adapt to small, gradual changes in water levels.

Cygnet Lake and Sylvan Creek are not utilized by fish populations probably because of high summer temperatures, poor water quality and insufficient depth or flow in winter to prevent freezing.

E. Wildlife [1]

Wildlife studies were carried out to determine species and populations of wildlife in the Sylvan Lake, Cygnet Lake and Sylvan Creek areas and to determine the effects of various regulation alternatives.

Small emergent vegetation and adjoining sedge and grass areas sustained the highest concentrations of wildlife at Sylvan Lake. These areas support muskrats, provide feeding and/or nesting areas for waterfowl, and provide valuable cover for waterfowl broods; however, they are limited to narrow zones in a few locations. Most of the shore is steep, has unsuitable bottom characteristics or has been subject to human alterations.

Regulation of the lake to lower water levels would reduce habitat (at least temporarily) for those species that nest on or over water. However, present limitations on wildlife at Sylvan Lake seem to be related more to the extent of development and use of the area as a resort than to

1. Summary of report prepared by Fish and Wildlife Division, Alberta Department of Recreation, Parks and Wildlife.

water levels. Providing lower and more stable water levels on the lake will provide new beach areas, more swimmers and boaters and, possibly, incentive for further "weed" removal - all to the detriment of wildlife. Lake fluctuations as they have occurred in the past have discouraged human exploitation of some areas of the lake, and it is these areas that remain as "wildlife islands". From a wildlife point of view, no regulation of water levels would be the preferred recommendation. However, if a decision is made to regulate the lake, some areas should be reserved for wildlife.

The study indicated that Cygnet Lake presently supports a larger waterfowl population than Sylvan Lake; however, it is predicted that Cygnet Lake will have a limited life span due to organic enrichment and a high rate of deposition of organic sediments. The lake has an average depth of one foot. Soundings indicate that approximately seven inches of material has been deposited since 1920.

For purposes of wildlife management, it would be desirable to backflood Cygnet Lake to elevation 3065.5 each spring to maintain a wide emergent zone, then allow it to drop naturally to 3056.0 and maintain this level throughout the summer and fall with water from Sylvan Lake.

F. Groundwater [1]

A groundwater investigation was carried out to identify the groundwater flow patterns in the vicinity of Sylvan Lake and to predict the effect of various lake level regulation alternatives on groundwater levels.

Groundwater flows into Sylvan Lake at the north end and out through the south end. Depending on climatic conditions, the net effect

1. Summary of report prepared by EBA Engineering Consultants Limited for Alberta Department of the Environment.

of groundwater can either increase or decrease lake levels. However, the contribution to the lake from groundwater is negligible compared with precipitation, evaporation and runoff. Lowering the lake level would tend to increase groundwater inflow and decrease outflow. Raising or lowering the lake level will result in similar changes in groundwater levels in the surrounding area. Fluctuations in the groundwater levels are considerably less than those of the lake level and they decrease in amplitude away from the lake. It appears that the increase or decrease in the groundwater levels some two miles from the lake is less than 15 percent of the corresponding change in the lake level. Consequently, changes in the elevation of the water table resulting from lower lake levels would have a negligible effect on well yields and are not a major factor in deciding whether or not to regulate the levels of the lake.

G. Erosion [1]

A study of shoreline processes on Sylvan Lake was conducted to identify the location and extent of lakeshore erosions and to predict the effect of water level regulation on erosion.

The responses to questionnaires circulated to cottage owners indicate that average shoreline erosion around Sylvan Lake is about 0.5 feet per year. At this rate of erosion over the entire shoreline, an average of about 1.3 acres of land would be lost to erosion each year.

Assuming the existing shoreline is in a state of equilibrium, regulation that does not appreciably change the mean water level should not result in any significant change in the rate of erosion. Regulating the

1. Summary of study by River Engineering Branch, Technical Services Division, Alberta Department of the Environment.

lake at an elevation greater than the long term level will result in an increased rate of erosion.

Shoreline erosion can be reduced by reducing peak water levels, and by construction of suitable shoreline protective works. Distribution of information on water levels, rates of erosion and simple protective measures would assist property owners to become aware of the problem and to construct and maintain suitable protective works.

H. Preliminary Designs & Cost Estimates [1]

Preliminary designs and cost estimates were prepared to determine the feasibility and cost of constructing a control structure at the outlet of Sylvan Lake and constructing a facility for supplying water to Cygnet Lake.

A structure using a 16-foot semi-fixed weir was designed to provide for control of the lake level with provisions to prevent the passage of fish downstream and a riparian outlet for releases to Cygnet Lake. The outlet channel would require some improvement to provide an effective gradient for spill and releases. The elevation of the fixed crest and the stop log configuration would be established prior to construction and would not significantly affect the cost of the structure.

Two construction mediums were analyzed: 1) reinforced concrete, and 2) steel sheet piling. Geotechnical studies indicate that either of the two mediums could be used. A reinforced concrete structure was estimated to cost about $102,000; a sheet piling structure was estimated to

1. Summary of study by Design & Construction Division, Alberta Department of the Environment.

cost about $94,500.00. All costs were based on 1976 unit costs and include a 20 percent allowance for contingencies.

The provision for a riparian release to Cygnet Lake independent of a control structure at the outlet of Sylvan Lake was designed considering: 1) pumping from Sylvan Lake to Sylvan Creek, and 2) provision of a conduit for gravity flow. The capital cost for the pumping scheme was estimated to be $18,400.00. In addition to this there would be an annual operation and maintenance cost associated with the pumping facility. This additional cost was not estimated. The gravity facility was estimated to cost about $44,300.00.

Although the capital cost of the gravity facility is greater than that of the pump facility, it would have a lower operation and maintenance cost and be easier to operate.

III EVALUATION

Several alternative weir widths and crest elevations for regulating Sylvan Lake water levels have been identified and analyzed with respect to their ability to improve the recreation capability of the lake and to determine their effect on the natural and social environment. Some of these alternatives have been eliminated based on their cost and ineffectiveness in achieving the objectives of regulation. The hydrologic analysis determined that the size of the outlet structure did not appreciably affect the peak lake level experienced during large floods. Alternatives considering 24-foot and 36-foot weirs were therefore dropped in favor of a less costly 16-foot weir. Four alternative crest elevations were considered: 3073.3, 3072.7, 3072.0, and 3071.0.

The effects of an annual release of 720 acre feet from Sylvan Lake to Cygnet Lake and the discharge of sewage effluent from Sylvan Lake sewage lagoons to Cygnet Lake were also evaluated.

The effects of regulation of Sylvan Lake at selected levels, stabilization of Cygnet Lake and the discharge of sewage effluent have been evaluated based upon the results of the various component studies and considerable subjective judgment. The natural environment, essentially expressed as resources, is evaluated separately from the social environment, which is expressed as man's activities (Table 2). In general, the natural and social effects are closely related. For instance, a beneficial effect on the fishery resource would be expected to be accompanied by a beneficial effect on angling. The elements of the natural environment that were considered to affect the social environment are shown in Table 2.

An evaluation matrix (Table 3) has been prepared to summarize the

TABLE 2

INTERACTION MATRIX SHOWING THE ELEMENTS OF THE NATURAL ENVIRONMENT THAT AFFECT THE SOCIAL ENVIRONMENT

SOCIAL ENVIRONMENT	NATURAL ENVIRONMENT						
	low levels -receding shoreline	high levels -erosion and flooding	wildlife	fish	water quality	groundwater	aesthetic quality
Swimming and Beach use	X	X			X		
Boating	X						X
Wildlife viewing	X		X				X
Angling	X			X	X		
Hiking	X	X	X				X
Cottage Use	X	X	X	X	X		X

TABLE 3

EVALUATION MATRIX SHOWING EFFECTS* OF VARIOUS INTERVENTIONS

ON THE NATURAL AND SOCIAL ENVIRONMENTS

INTERVENTION	NATURAL ENVIRONMENT											SOCIAL ENVIRONMENT							Estimated Cost ($1,000)
	SYLVAN LAKE						CYGNET L.			Sylvan Cr. water quality	groundwater levels	SYLVAN LAKE						Cygnet Lake Wildlife Viewing	
	high levels - erosion and flooding	low levels - receding shore-line	wildlife	fish	water quality	aesthetic quality	wildlife	water quality	aesthetic quality			swimming and beach use	boating	wildlife viewing	angling	hiking	cottage use		
A. Regulation of Sylvan L.																			
1. Weir Crest 3073.3	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	94.5
2. Weir Crest 3072.7	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	94.5
3. Weir Crest 3072.0	+	-	.	-	.	-	.	.	.	.	.	.	-	.	-	.	.	.	94.5
4. Weir Crest 3071.0	++	--	-	--	+	--	.	+	.	.	.	-	--	-	--	-	-	.	94.5
B. Release to Cygnet L.**	+	--	.	-	.	--	++	+	+	.	.	-	--	.	-	.	-	++	44.3
C. Effluent Discharge	.	.	.	.	.	.	.	-	.	-	.	.	.	.	.	.	.	.	

* existing situation is considered to be the environmental base.
** evaluated considering unregulated Sylvan Lake - with regulation, effects of A and B can be combined.

LEGEND

. negligible effect
\+ minor beneficial effect
++ significant beneficial effect
\- minor detrimental effect
-- significant detrimental effect

effects of various activities of man on the existing natural and social environments. The matrix uses an arbitrary and simple index to provide an indication of the nature and significance of the change from the existing environmental base as a result of various interventions on the environment. An intervention may enhance the environment (have positive (+) effects) or it may degrade the environment (have negative (-) effects). The significance of the effect is indicated by the number of positive or negative signs with one sign (+ or -) indicating a minor effect and two signs (++ or --) indicating a significant effect. A negligible effect is indicated by a dot (·).

The effects of various alternatives for regulating Sylvan Lake were assessed considering the resulting maximum, minimum and mean water levels given in Table 1 (page 14). None of the alternatives offer a completely satisfactory solution to the problems being experienced on the lake and differences among the alternatives are difficult to assess. Whether a particular effect is minor or significant is solely a matter of judgment.

It is felt that the first three alternatives given in Table 3 (weir crests at 3073.3, 3072.7 and 3072.0) would not have a significant effect on either the natural or the social environment. Alternative 1 would provide some control of high water levels resulting in minor benefits with respect to shoreline erosion, flooding of beaches, aesthetic quality and cottage use during high runoff years. Alternatives 2 and 3 would have beneficial effects during a series of high runoff years and detrimental effects during low runoff years. Over the long term these effects would tend to offset each other and, on the balance, none of the effects are

expected to be significant.

Alternative 4 would provide flood control benefits but would have a significant negative effect on the fishery resource and the aesthetic quality of the shoreline because of the extremely low water levels that would be experienced in dry periods. The low water levels would lead to a significant adverse effect on angling and boating.

An annual release of 720 acre feet from Sylvan Lake to Cygnet Lake could enhance waterfowl habitat in the Cygnet Lake area. However, the cumulative effect of annual releases during prolonged dry periods could have a significant adverse effect on the aesthetic quality and boating on Sylvan Lake. Based on the simulation study carried out in the hydrologic analysis, supplying 720 acre feet per year to Cygnet Lake could lower the level of Sylvan Lake by 0.85 feet in the 13-year period 1962 to 1974. The difference between the natural water level and the controlled water level would continue to increase until a series of wet years causes lake levels to rise to the point where spill would have occurred under natural conditions. From a review of historical lake levels and hydrology studies, it is felt that the differences between natural water levels and levels that could occur if an annual release were made could be well in excess of one foot over a prolonged dry period.

Release of water from the Town of Sylvan Lake sewage lagoons to Cygnet Lake would have a minor adverse effect on water quality in Cygnet Lake and Sylvan Creek provided the release is made in the fall. The effect would not be significant because of the abundance of nutrients from other sources and because the effluent would be released at a time when biological

productivity is low. During spring runoff, effluent and other water in the lake at the time of freeze-up would be flushed to the Red Deer River and would not be in the lake during spring and summer when almost all of the algae growth takes place. Discharge of effluent from the sewage lagoons would not have a significant effect on water quality in the Red Deer River.

From a review of the evaluation matrix it is evident that none of the regulation alternatives offer a satisfactory solution to the problem of fluctuating water levels. A weir with crest elevation lower than the natural outlet (3073.3) would provide some flood control but would also significantly lower the minimum levels which, in the event of a prolonged drought, would have negative effects on the natural and social environment.

A weir with crest elevation at 3073.3 would provide some control of high water levels without seriously lowering the minimum levels and the mean lake level would remain about the same as under present conditions. Hydrology studies indicated that if a weir with crest elevation at 3073.3 had existed for the period 1946 to 1974, the peak level experienced in 1955 (3075.0) would have been reduced by about 0.6 feet and the minimum level experienced in 1964 (3071.0) would have been reduced by about 0.1 feet. The usefulness of the lake for recreation purposes would not be significantly improved with this alternative. Construction of a 16-foot weir at the outlet would cost about $94,500.00. The control structure would be used only once every 10 to 20 years and, with such infrequent use, maintenance of the structure and channel would be a problem. Silt, vegetation and debris may seriously impair the effectiveness of the channel for flood control purposes. Also, with a structure in place, conflicts in

operation and claims of mismanagement can be anticipated.

Stabilization of water levels cannot be achieved without importing water to the lake in dry years. Based on the results of a recent study to assess the possibility of using Sylvan Lake for offstream storage of Red Deer River water for water supply purposes, a pump diversion scheme would cost in the order of $8,000,000.00. Further investigations would be required to establish the size of pump and pipeline required, firm up cost estimates, and assess the environmental implications. A pump diversion from the Red Deer River in combination with a controlled outlet would minimize fluctuations above and below the desirable range of water levels on Sylvan Lake and would provide water for Cygnet Lake. This type of regulation would come closest to what has been suggested as the optimum situation for recreation usage around Sylvan Lake. It would provide more beach area especially at the south end of the lake and adjacent to some of the bays around the lake. Exposure of new beach areas would take the pressure off some of the backshore for sunbathing and would therefore free these areas for other pursuits such as picnicking and games. The exposure of new beaches would tend to reduce the density of use of existing beaches and possibly contribute to higher levels of recreation satisfaction through less crowded conditions.

The Sylvan Lake Management Plan prepared in 1977 by the Red Deer Regional Planning Commission indicates that the carrying capacity of the lake is approximately three times the existing level of use. This plan was developed without considering regulation of lake levels. In other words, even if the lake is not regulated, it can support up to three times its existing recreational use. It is foreseen, however, that to reach this

capacity some shoreland alterations at strategic locations would be required to enhance beach conditions and improve access to the water.

Although stabilization of the level of Sylvan Lake by importing water from the Red Deer River could, in general, increase the recreation potential of the lake, the cost would be extremely high. If major expenditures such as this are considered for Sylvan Lake, they must be viewed in light of other possibilities for enhancing the recreation potential of the lake. The purchase of shoreland for public recreation use, shoreland improvement such as beach development, and construction of recreation facilities would possibly do more for enhancing recreation on Sylvan Lake at a lesser cost than stabilizing water levels.

Releasing or pumping water from Sylvan Lake to Cygnet Lake would lower the levels on Sylvan Lake during prolonged dry cycles resulting in adverse effects on boating and the aesthetic quality of the shoreland. Occasionally, favorable levels for wildlife on Cygnet Lake cannot be obtained without augmenting its natural supply. Cygnet Lake is very shallow and during prolonged dry periods it essentially becomes a mudflat of little value for waterfowl.

Sources other than Sylvan Lake for augmenting the supply to Cygnet Lake include the Red Deer or Medicine Rivers, but pump facilities from these sources can be expected to cost in the order of $500,000.00. It is possible that sufficient groundwater supplies could be developed to offset the evaporation demand on the lake. Based upon the results of a recent study[1], using groundwater would have the same effect as if the water

1. "Feasibility of Groundwater and Offstream Storage for Municipal and Industrial Supplies - Red Deer Area", EBA Engineering Consultants Ltd. (prepared for Planning Division, Alberta Department of the Environment), December 1976.

was taken directly from Sylvan Lake and would be much more expensive. Reducing the water demand by surcharging Cygnet Lake by 0.5 feet during spring runoff and allowing it to drop naturally to its full supply level before importing water to maintain that level is worthy of further consideration. This would reduce the impact on Sylvan Lake, however, land control and other considerations related to this alternative may rule it out.

Importing water only when Sylvan Lake is above a certain elevation, such as 3072.0, would also reduce the negative effect on Sylvan Lake, however, water for Cygnet Lake would not be available during dry periods when natural water bodies are low and wildlife habitat is particularly scarce.

IV. SUMMARY OF FINDINGS

The findings of this study can be summarized as follows:

1) The water level of Sylvan Lake has fluctuated over a four-foot range in the past 20 years. Extreme water levels, whether high or low, detract from the full potential of the recreation resources of the area. High levels result in a reduction in beach areas, erosion of shoreland and flooding of private property. Low levels adversely affect fishing, boating and the aesthetic quality of the shoreline.

2) Water levels on Sylvan Lake between 3071.5 and 3072.0 would appear to be most desirable for recreation. These levels are somewhat lower than the mean recorded level for the past 20 years which was 3072.7.

3) None of the alternatives studied for regulating the water levels of Sylvan Lake offer a satisfactory solution to the problem of fluctuating water levels. A weir with crest elevation at 3073.3 would provide minor control of high water levels, however, the cost, the difficulties in maintaining the structure and the channel because of infrequent use, and the operational conflicts that could arise would appear to outweigh the benefits that could be realized.

4) Stabilization of water levels cannot be achieved without importing water to Sylvan Lake. Based on the results of a recent study to assess the possibility of using Sylvan Lake for offstream storage of Red Deer River water for water supply purposes, a pump diversion scheme would cost in the order of $8,000,000.00. Expenditures of this magnitude should be considered only in light of other alternatives for

enhancing the recreation potential of the lake such as the purchase of shoreland for public use, improvement of beach areas, and development of recreation facilities.

5) Releasing or pumping water from Sylvan Lake to maintain favorable water levels on Cygnet Lake will significantly benefit waterfowl in the Cygnet Lake area, however, it would also lower the water levels on Sylvan Lake during prolonged dry periods resulting in adverse effects on boating and the aesthetic quality of the shoreland. A facility to provide for a gravity release from Sylvan Lake to Cygnet Lake would cost about $44,000.00.

6) Favorable water levels for wildlife on Cygnet Lake are maintained approximately 80% of the time without augmenting its natural supply. Developing alternative sources of supply other than Sylvan Lake would cost in the order of $500,000.00. Reducing the Cygnet Lake demand for water by surcharging the lake 0.5 feet during the spring runoff and allowing it to drop naturally to its full supply level before importing water from Sylvan Lake to maintain that level is worthy of further consideration. However, land control and other considerations related to this alternative may rule it out. The Cygnet Lake control structure is licenced to the Cygnet Lake Drainage District and changes in operation would have to be negotiated with the license.

7) Release of water from the Town of Sylvan Lake sewage lagoons to Cygnet Lake will not significantly affect water quality in Cygnet Lake, Sylvan Creek or the Red Deer River provided that the release to Cygnet Lake is made in the fall just prior to freeze-up.

V. RECOMMENDATIONS

1) It is recommended that new construction of permanent buildings below the highest recorded water level (3075.0) with some additional allowance for wind set-up, wave run-up and ice push-up be prohibited unless some regulation is provided. In areas where there is potential for erosion and bank slumping, minimum set-back for permanent buildings should be established.

   This measure would aid municipalities in issuing building permits on new and established subdivisions to help reduce property damage in the event of the return of high water levels and extensive erosion of shoreland. The allowance for wind set-up, wave run-up and ice push-up, and the minimum set-back for erosion protection, would vary depending upon the location of the development. On recent subdivisions, the public reserve is generally adequate to allow for this protection. Where sufficient reserve does not exist, municipalities can control the set-back when issuing building permits.

2) It is recommended that information in the form of a handbook or brochure be prepared and made available to lakeshore property owners to encourage and provide guidance in constructing and maintaining suitable shoreline protection works.

   Information should include lake level data, data on shoreline recession, a description of ice effects and simple typical designs for shoreline protective works. Property owners, particularly new owners, would become more aware of long-term water level fluctuations and natural shoreline processes and they would be less likely to make property improvements

in flood or erosion susceptible areas. At the very least, it would discourage them from constructing unsuitable shoreline protective works.

3) In view of the importance of Sylvan Lake as a recreation resource, it is recommended that the water quality be monitored on a regular basis so that changes in water quality can be detected and sources of pollution identified to allow for remedial action.

4) It is recommended that control of land in the outlet area be obtained to permit maintenance and weed control so that the channel capacity is not reduced.

This measure would prevent obstruction to flow in the event of the return of high water levels.

5) It is recommended that this report be made available to the public and their comments be solicited and considered prior to making a decision on construction of works or further study.

APPENDIX A

Alberta MEMORANDUM

ENVIRONMENT--PLANNING--CALGARY

FROM J.R. Hart
Red Deer River Basin Planner

OUR FILE REFERENCE 3135

YOUR FILE REFERENCE

DATE December 20, 1978

TO R. Hilton
Branch Head Regional Services

TELEPHONE

SUBJECT Cygnet Lake Hydrology

Hydrology Branch has now completed the study on Cygnet Lake requested in Al Strome's memo dated July 25, 1978. The results of the study are attached hereto.

The study is complete and well documented. The elevation-duration curves (Figure 4) show the lake to be remarkably stable. With FSL at 3056.0, the lake will be within 0.2 feet of its optimal level 80 per cent of the time during the summer months (April to October, inclusive).

A possible weakness in the study is the flow estimates - particularly during the summer months. However, without recorded data it would be difficult to improve the estimates. I suggest that regular staff gauge readings be taken to substantiate the hydrology. Perhaps arrangements could be made for a local farmer to read the gauge or alternatively, Water Resource Management or Wildlife personnal at Red Deer.

If you have questions regarding the study we suggest that you contact Frank Davies of Hydrology Branch.

J.R. Hart
Red Deer River Basin Planner

JRH/gr

c.c. Dave Blair
Carl Primus
Al Strome
Earl Dean

Alberta MEMORANDUM

ENVIRONMENT

FROM J.R. Card, P. Eng.
Branch Head
Hydrology Branch

OUR FILE REFERENCE

YOUR FILE REFERENCE

DATE September 14, 1978

TO J.R. Hart, P. Eng.
Red Deer River Basin Planner

TELEPHONE

SUBJECT Cygnet Lake Hydrology

The following is in response to your memo of August 3, 1978 requesting a water balance study on Cygnet Lake. The objective of the study was to determine the magnitude and frequency of fluctuation from given water levels. From subsequent discussions with yourself, we learned that a 12 ft. broadcrested weir with crest elevation of 3056.0 was established in 1975. There is the capability of raising it by stop logs to 3057.0.

From previous studies of theSylvan Lake area which included Cygnet Lake, natural inflow hydrogaphs for various frequencies were given for Cygnet Lake, see "Sylvan Lake Regulation Study". Monthly runoff data was also produced for Sylvan Lake. The size of the two drainage systems are similar. Sylvan's watershed area excluding lake is 42.0 sq. miles. Cygnet's watershed area excluding lake is 36.0 sq. miles. Review of the annual discharges for the head waters of the Blindman River and the discharges for the rest of the basin down to Blackfalls was made. Flows produced as runoff to Sylvan were adjusted to take into account the area difference between Sylvan and Cygnet Lake. Discharge differences between the head waters and lower drainage areas were also accounted for in the adjustment to produce monthly runoff into Cygnet Lake. Using the data, a water balance was calculated for Cygnet Lake for the period 1961-1974 (fourteen years) and is presented in Figure 1. Actual Lake levels May - September 1976 and May 17th, 1978 were also obtained. Figure 1 shows the water balance trace assuming initial elevation 3056.0, 3056.5 and 3057.0. The actual elevation confirmed earlier indications from the Sylvan report that spring discharges would normally fill the lake to 3056.0

Minimum annual elevations for the trace period are given in Table 1.

. . . . 2

TABLE 1

Estimated Annual Minimum Lake Level For

Cygnet Lake With A 12 Ft. Weir May-October
(Based on Monthly Data)

YEAR	CREST ELEVATION		
	3056.0	3056.5	3057.0
1961	3055.64	3055.87	3056.18
1962	3055.81	3056.24	3056.67
1963	3056.00	3056.50	3057.0
1964	3055.90	3056.42	3056.94
1965	3056.00	3056.50	3057.02
1966	3056.0	3056.50	3057.05
1967	3055.25	3055.55	3056.1
1968	3056.01	3056.20	3056.56
1969	3055.98	3056.50	3056.89
1970	3055.54	3055.88	3056.49
1971	3055.54	3055.90	3056.40
1972	3055.58	3056.27	3056.82
1973	3055.88	3056.21	3056.65
1974	3055.93	3056.32	3056.80
Record 1976	3055.36		

Keeping in mind that the data represents month data, the maximum deviations below crest during May to October period were 0.75, 0.80, 0.90 ft. respectively for 3056.0, 3056.5, and 3057.0 crest elevations. The maximum recorded in 1967 was 0.64 ft. deviation below crest. The average was 0.2 ft. It is difficult to assign frequencies to this data, however, our estimate for the data given is that it is within the 1:20 year return period. With respect to back flooding, Table 2 gives the maximum annual monthly elevations for the trace period.

. . . . 3

TABLE 2

Estimated Maximum Annual Lake Elevation For

Cygnet Lake With A 12' Weir
(Based on Monthly Data)

YEAR	CREST ELEVATION		
	3056.0	3056.5	3057.0
1961	3056.79	3057.28	3057.75
1962	3056.15	3056.83	3057.16
1963	3056.37	3057.08	3057.52
1964	3056.18	3056.70	3057.21
1965	3056.74	3057.34	3057.80
1966	3056.56	3057.12	3057.60
1967	3056.34	3057.04	3057.50
1968	3056.04(Apr.)	3056.20(Apr.) 3056.67(Aug.)	3056.56(Apr.) 3059.09(Sept.)
1969	3056.36	3057.04	3057.50
1970	3056.28	3057.01	3057.49
1971	3056.59	3057.22	3057.72
1972	3056.17	3056.97	3057.35
1973	3056.48	3057.11	3057.58
1974	3056.61	3057.24	3057.73
1978 May 17	3056.20		
Average	0.40	0.55	0.53

The maximum elevation above crese was 0.8 ft. and average at 0.40 ft. above crest.

The flood hydrographs for the 20, 50, and 100 year return periods were also routed through the lake and are shown in Figures 2 & 3. Maximum elevations for the crests at 3056.0, 3056.5, 3057.0 are shown in Table 3.

. . . . 4

TABLE 3

Cygnet Lake Levels After Routing Flood Hydrographs

Through The Lake With 12' Weir

RETURN PERIOD	MAXIMUM ELEVATION					
	CREST ELEVATION					
	3056.0		3056.5		3057.0	
	No Sylvan Flow	Sylvan Flow	No Sylvan Flow	Sylvan Flow	No Sylvan Flow	Sylvan Flow
1:100	3059.11	3059.20	3059.34	3059.44	3059.63	3059.74
1:50	3058.83	3058.92	3059.05	3059.15	3059.33	3059.44
1:20	3058.61	3058.71	3058.83	3058.94	3059.10	3059.22

Therefore, the expected rise above the crest elevation for 1:100 year flood is 3.11, 2.84, and 2.63 ft. for initial elevations of 3056.0, 3056.5 and 3057.0 respectively. The above is assuming no outflow from Sylvan Lake. Estimates from Sylvan Lake outflow under natural conditions for a 1:100 year flood is about 40 c.f.s. maximum. Expected rise above crest will be 2.74 which is about a 0.1 ft. increase. This is relatively unimportant compared to the main hydrograph.

With a 12 ft. weir, the lake can be expected to drop about 1.5 ft. in 30 days after a major spring flood event. Thus the water level will not have dropped completely to crest elevation within 30 days after a 1:20 - 1:100 runoff event but should return to crest within 30 days after an inflow event of less than 1:10 return period. It is assumed that the initial water elevations would be at crest elevation when implying this.

If the 1:100 year flood started at elevation 3056.0, it would rise to 3059.20 and be back to 3057.9 in 20 days and about 3057.5 in 30 days. The 1:20 year flood starting at 3056.0 would rise to 3058.71 and be back to 3057.67 in 20 days and about 3057.2 in 30 days.

From the above analysis, the lake is expected to range on monthly basis from 3056.5 to 3055.5 in a normal year (Figure 4). Wet years will be higher. Dry years will be lower. The frequency of drought events is difficult to determine as data is not available to really analyse this.

One point to be stressed is that a single free flow weir has problems meeting both objectives of being able to pass the high discharges of a flood event and maintaining the lake level during drought events. The 12 ft. weir is a compromise between these two opposing objectives. To achieve lake stability from both drought and floods, a different type of weir is needed plus some consciousness managing of the lake levels.

Franklin D Davies

Frank Davies, P. Ag.
Hydrologist
(for) J.R. Card, P. Eng.
Branch Head
Hydrology Branch

FDD/bjk

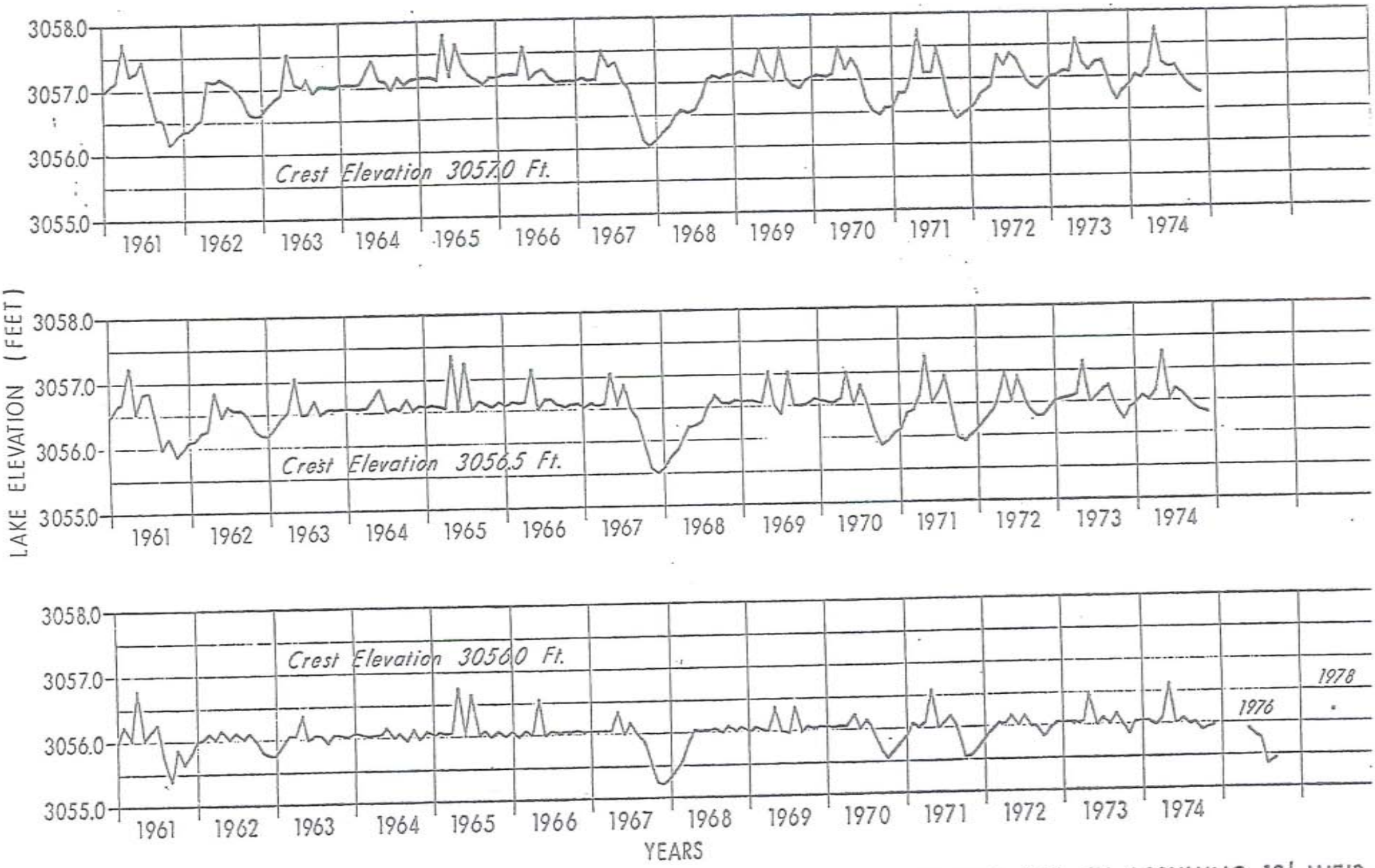
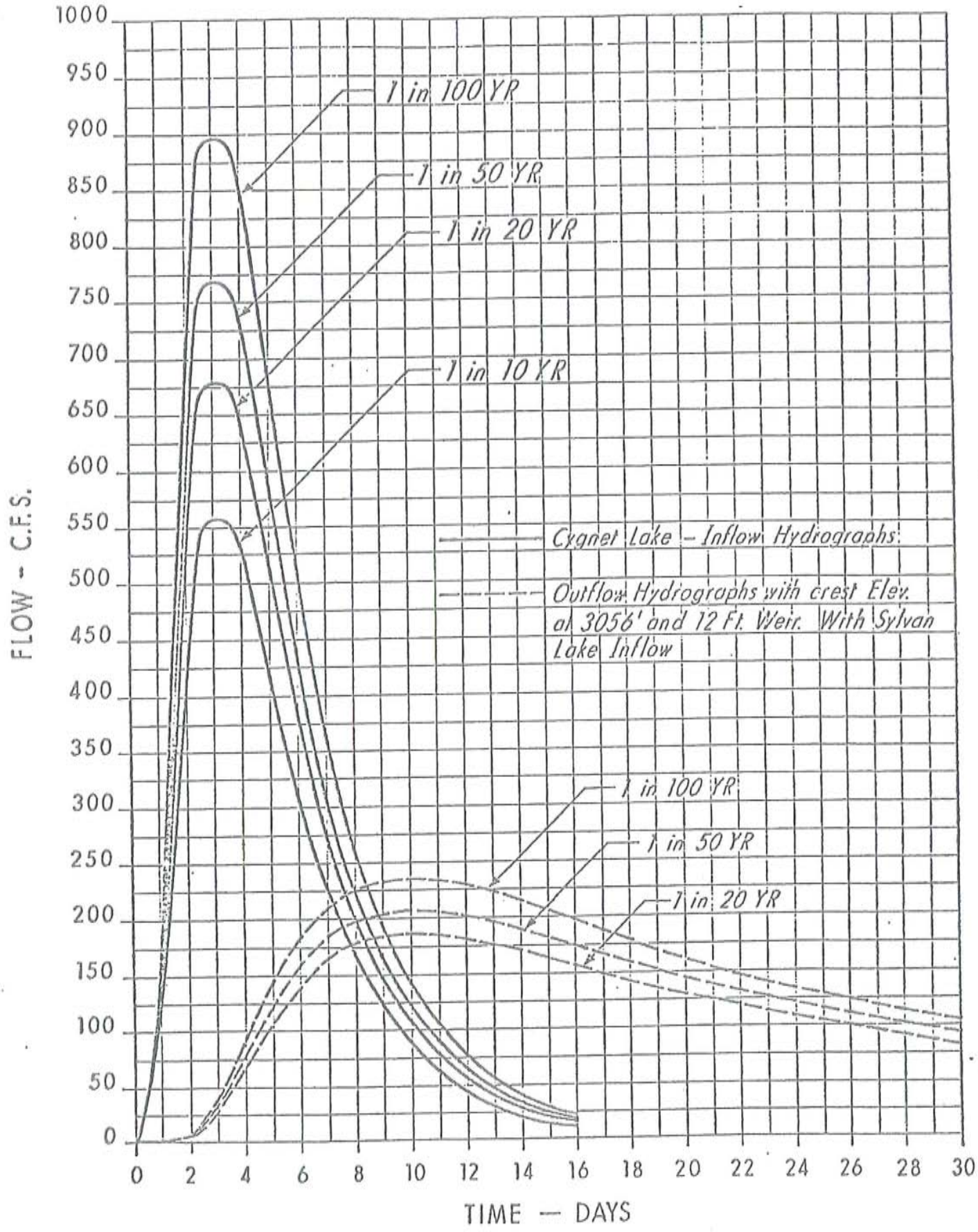


FIG. 1 - CYGNET LAKE - LAKE LEVEL SIMULATION OF MONTH INFLOWS 1961-74 ASSUMING 12' WEIR


1 in 100 YR
1 in 50 YR
1 in 20 YR
1 in 10 YR
Cygnet Lake – Inflow Hydrographs
Outflow Hydrographs with crest Elev. at 3056' and 12 Ft. Weir. With Sylvan Lake Inflow
1 in 100 YR
1 in 50 YR
1 in 20 YR
FLOW - C.F.S.
TIME — DAYS
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
0
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4
6
8
10
12
14
16
18
20
22
24
26
28
30

FIGURE 2

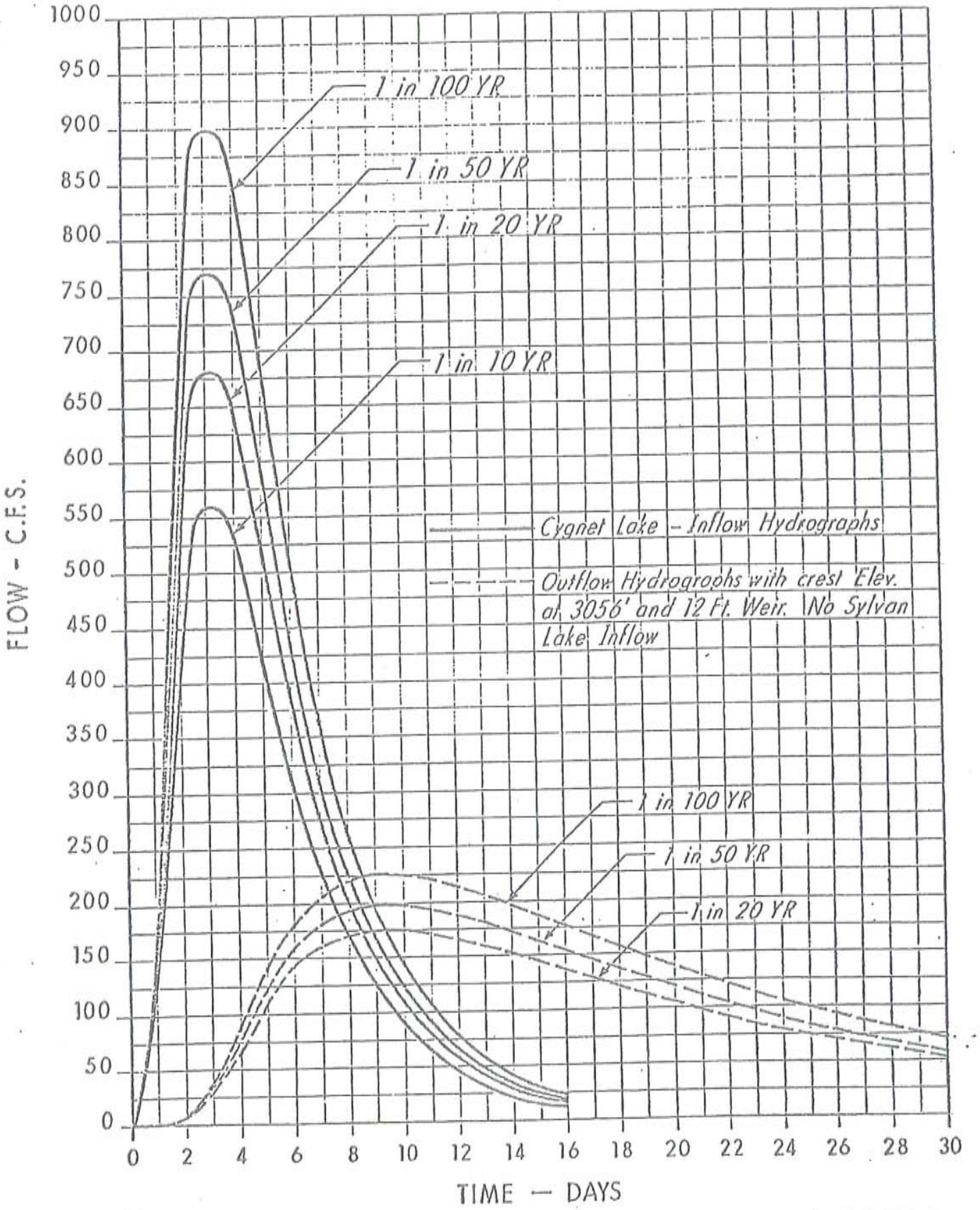
1 in 100 YR
1 in 50 YR
1 in 20 YR
1 in 10 YR
Cygnet Lake - Inflow Hydrographs
Outflow Hydrographs with crest Elev. at 3056' and 12 Ft. Weir. No Sylvan Lake Inflow
1 in 100 YR
1 in 50 YR
1 in 20 YR
FLOW - C.F.S.
TIME — DAYS
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30

FIGURE 3

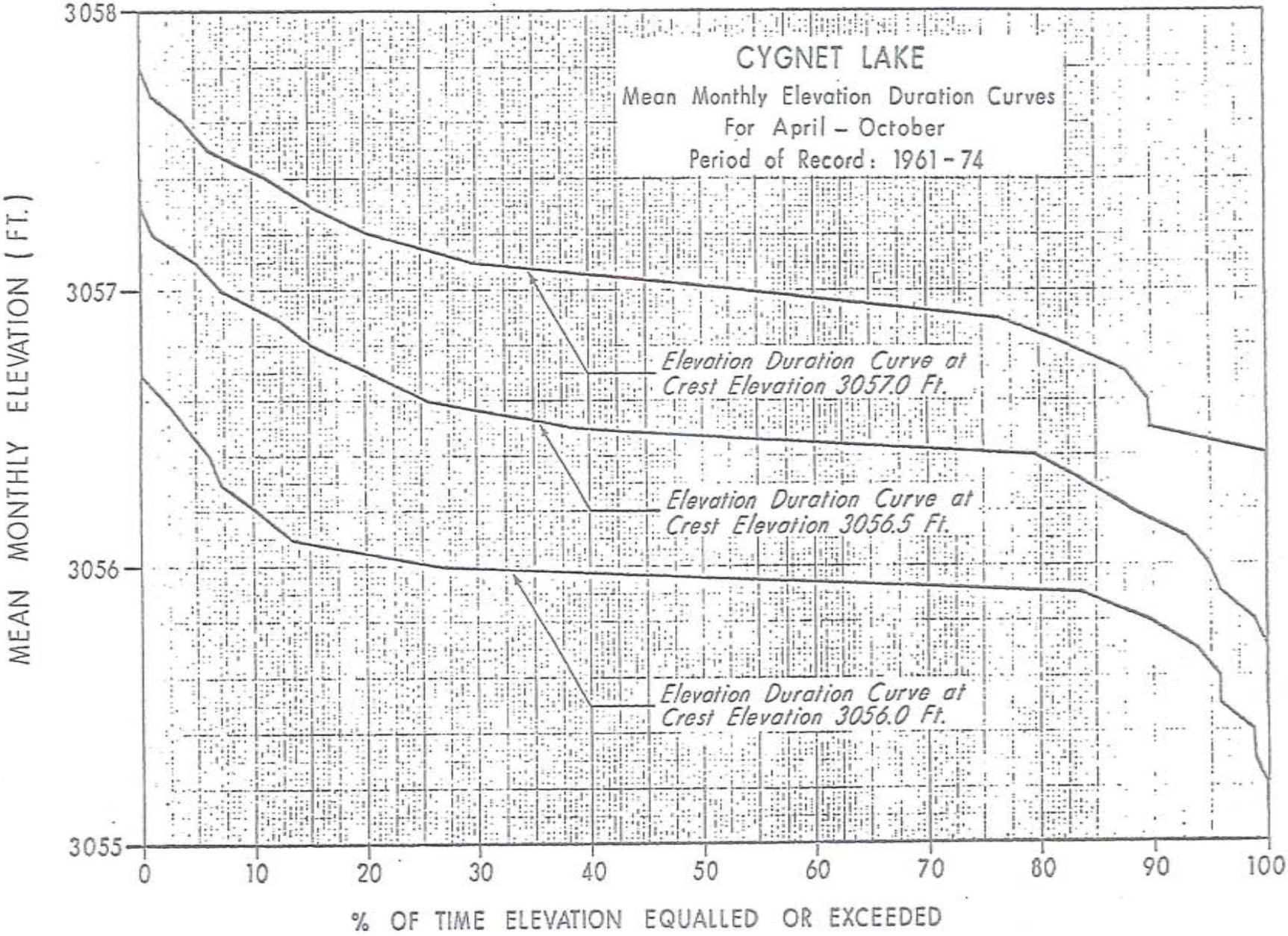
CYGNET LAKE
Mean Monthly Elevation Duration Curves
For April – October
Period of Record: 1961-74
Elevation Duration Curve at Crest Elevation 3057.0 Ft.
Elevation Duration Curve at Crest Elevation 3056.5 Ft.
Elevation Duration Curve at Crest Elevation 3056.0 Ft.
MEAN MONTHLY ELEVATION (FT.)
3058
3057
3056
3055
0
10
20
30
40
50
60
70
80
90
100
% OF TIME ELEVATION EQUALLED OR EXCEEDED

FIGURE 4