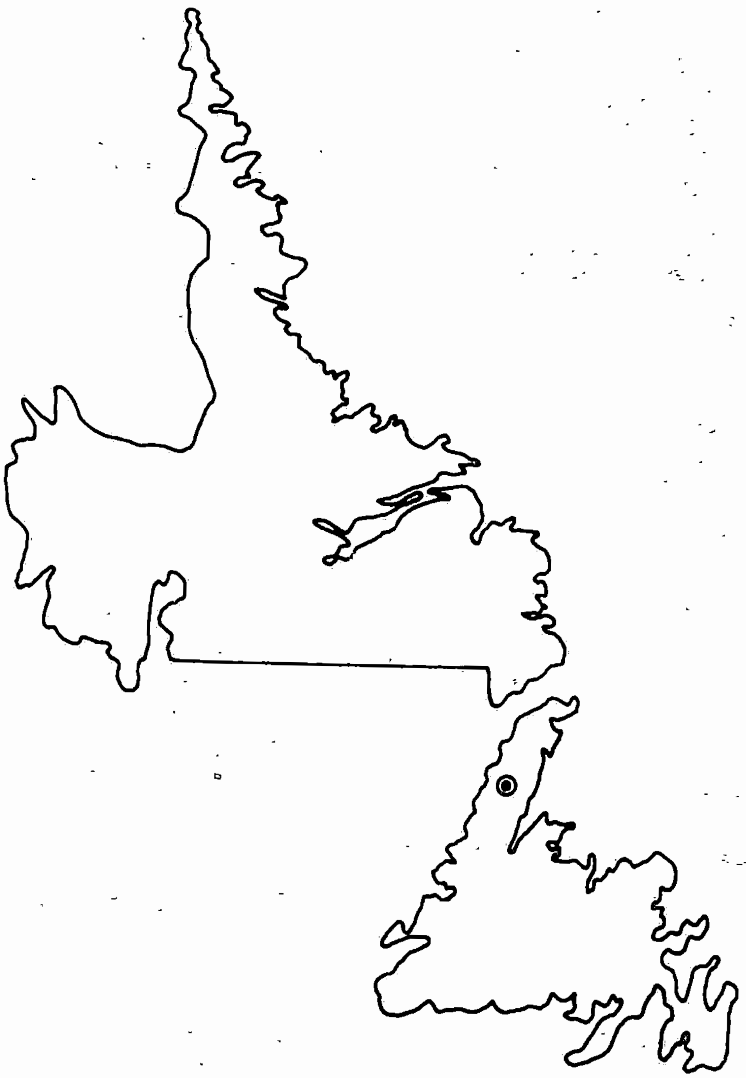
HYDRO

NEWFOUNDLAND AND LABRADOR HYDRO

LAKE MICHEL HYDRO DEVELOPMENT



FEASIBILITY STUDY

AND

COST ESTIMATE

ENGINEERING AND CONSTRUCTION DEPARTMENT
NEWFOUNDLAND AND LABRADOR HYDRO

CIMFP Exhibit P-01028

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HYDRO

NEWFOUNDLAND AND LABRADOR HYDRO
Head Office: St. John's, Newfoundland A1A 2X8 • Telephone (709) 737-1400 • Telex 016-4503

1982 July 27

Mr. L. J. Cole
Vice-President, Engineering & Construction
Newfoundland and Labrador Hydro
P.O. Box 9100
St. John's, Newfoundland
A1A 2X8

RE: Lake Michel Hydro Development
Feasibility Study and Cost Estimate

Dear Mr. Cole:

We present herewith our report on the Feasibility Study and Cost Estimate for the Lake Michel Development on the Great Northern Peninsula.

This report takes the form of three volumes; (1) the main report, (2) drawings and (3) the Work Definitions and Detailed Cost Estimate.

The report was based on the conceptual development outlined in The Four Rivers Study, prepared by ShawMont Newfoundland Limited in 1979. The information in the Study has been supplemented with additional field information, updated cost data based on unit prices being tendered on the ongoing major projects and budget quotations from suppliers. Survey information has been obtained in sufficient detail to undertake conceptual design for most structures.

The cost is given for one (1) - 12 000 kW Unit operating under a net head of 271 metres.

You will note that the Direct Costs for the project has increased substantially since the budget estimate last year. We point out that all previous estimates prepared by our Department were based on the cost given in The Four Rivers Study, adjusted for the change in schedule and escalated in accordance with the escalation figures provided for this type of construction.

We have included the Detailed Cost Estimate in the report as a separate volume. However, we suggest this document not be given wide circulation outside Hydro.

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In order to complete the civil work in the 1985 construction season and to have the plant generating power to the spring runoff of 1986, a decision on the project will have to be made by May 1, 1983.

Prior to that date the tender documents for the road and major equipment will have to be prepared for release shortly thereafter. Work on preparation of these documents must start by March 1, 1983.

A study of the deletion of the Omega Diversion aspect of this project confirmed the feasibility of utilizing the diversion. We therefore feel that the project as outlined is the most feasible for development.

We trust that this report will enable the Environmental Assessment to proceed so that a decision on the project can be made.

We wish to express our thanks to the people throughout the Engineering and Construction Department who worked on this assignment and who put in long hours to compile and edit the report.

Yours very truly,

for John J Carnell

L. G. Sturge, P. Eng.
Manager of Engineering

JJC/jc


HYDRO
LAKE MICHEL DEVELOPMENT
[GENERAL LAYOUT]
TO HAWKES BAY
TRANSMISSION LINE (ALTERNATIVE No 1a)
TRANSMISSION LINE (ALTERNATE No. 1)
LEGEND
ACCESS ROAD
TRANSMISSION LINE
FLOODED AREA
WATERSHED
BORROW PIT
LONG RANGE MOUNTAINS
EXIST. ACCESS ROAD
PIPELINE
POWERHOUSE
PENSTOCK
SURGE TANK
INTAKE STRUCTURE
LAKE MICHEL RESERVOIR
HEADPOND DAM & SPILLWAY
HEADPOND RESERVOIR
OMEGA DIVERSION CANAL
OMEGA DIVERSION DAM & SPILLWAY
OMEGA RESERVOIR
OMEGA DIVERSION DRAINAGE AREA 20 km2
LAKE MICHEL DRAINAGE AREA 83 km2
FSL 402.0 m
FSL 492.5 m
FSL 523.0 m
LAKE MICHEL CONTROL STRUCTURE
LAKE MICHEL CUT OFF DAMS

NEWFOUNDLAND AND LABRADOR HYDRO

LAKE MICHEL HYDRO DEVELOPMENT

"FEASIBILITY STUDY AND COST ESTIMATE"

PREPARED BY:

ENGINEERING AND CONSTRUCTION DEPARTMENT
NEWFOUNDLAND AND LABRADOR HYDRO
P.O. Box 9100
ST. JOHN'S, NEWFOUNDLAND A1A 2X8

1982 05 31

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1 INTRODUCTION

1 INTRODUCTION

Purpose

The preparation of this Report was undertaken by the Engineering and Construction Division to meet the requirement of Newfoundland and Labrador Hydro to review the feasibility of the Lake Michel Hydro Development and confirm the validity of the Project.

Intent of Study

The intent of the study was to confirm the technical feasibility of the Project, to gather information for input to the Environmental Impact Statement (E.I.S.), and to update the Capital Cost and Construction Schedule for the Project.

Information for E.I.S.

Information required for the Environmental Impact Statement (E.I.S.) included:-

- Description of the Project;
- Identify road alternatives and stream crossing requirements;
- Identify material requirements and borrow sources;
- Identify land requirements.

Previous Engineering Studies

The following Report was reviewed and referred to during the course of the work.

1. ShawMont Newfoundland Limited Report # SMR-9-79 on the Hydro-Electric Potential Study for Dry Pond Brook, Pinware Brook, Lake Michel and Cloud River.

Report SMR-9-79 covers the overall concepts and general arrangements, hydrology and regulation studies for the Development and was used as the basis for the present study.

Scope of Work

In the fall of 1981 and early 1982, the Engineering and Construction Division carried out field and office programs to meet the terms of the study.

Scope of Work (cont'd.)

The Field Program included:-

- Control and Engineering Surveys;
- Field investigation and test pit work;
- Geotechnical review of structure sites.

The Office Program included:-

- Aerial photo interpretation work;
- Preparation of plans and profiles of recent surveys;
- Review of all structures using latest field data;
- Determination of quantities and review of costs;
- Review of Construction Schedule;
- Optimization studies of some of the structures.
- Preparation of report and updated Capital Cost Estimate.

Some optimization studies were undertaken during the office work and the updated cost estimate was prepared using the latest field data to confirm quantities using the recommended schemes for the various facilities and structures, conceptual designs in the previous ShawMont Newfoundland Limited report and updated unit prices.

Changes in elevations in the ShawMont Report were made which relates to the control survey carried out in 1981 to bring all information to one permanent geodetic datum.

Because of the size of the Project and the rough terrain, engineering survey work was limited to layout of structures and centreline profile work. This information was sufficient to allow updating of the Capital Cost Estimate, however, further engineering work including optimization of the penstock route and cross-section survey of all structure sites is required prior to final design work.

2 SUMMARY AND CONCLUSIONS

2 SUMMARY AND CONCLUSIONS

(a) The Lake Michel Hydro Development is technically feasible at the proposed site.

(b) The scheme selected to form the basis of the Capital Cost Estimate for the proposed Lake Michel Hydro Development is defined as follows:-

Installed Capacity	12 MW
Number of Units	1
FSL (Lake Michel)	Elevation 523.0 m
FSL (Lake Omega)	Elevation 492.5 m
FSL (Head Pond)	Elevation 402.0 m
TWL (maximum)	Elevation 113.0 m
Rated Flow	5.3 m^3/s

(c) The energy production at Lake Michel is as follows:-

Capacity	12 MW
Energy:	
Average	62.2 gwh/yr
Firm	34.9 gwh/yr

(d) The selected scheme consists of regulating the flow from Lake Michel to the Head Pond, diverting the flow of Lake Omega to the Head Pond and thence via the generating station to Lake Gamma.

Major components of the Project are the Lake Michel Control Structure, Omega Dam, Omega Canal, Head Pond Dam, Intake, Penstock, Surge Tank, Powerhouse and Tailrace.

(e) The total cost of the Project is:-

	$ x 1,000
Total Direct Cost	23,100
Management and Engineering Costs	3,511
Owner Administration	896
Contingency	4,038
Sub-total	31,545

(e)	(cont'd.)	$ x 1,000
	Escalation	11,851,000
	Interest During Construction	5,175,000
	TOTAL	48,571,000

The cost of transmission and telecontrol is not included in this Report.

(f) Geotechnical field investigations have established the existence of competent foundation conditions within the vicinity of the main structures. The availability of construction materials in sufficient quantities for the Project within the Project area has been established.

(g) The optimum full supply levels (FSL) for the Project reservoirs are in the range of 402.0 m for the Head Pond, 492.5 m for the Omega Diversion and 523.0 m for the Lake Michel Reservoir. These should be refined and confirmed at the next phase of engineering.

(h) A three year construction schedule was developed for the project with the in-service date being December, Year 3. This is shown on Drawing B1-124-C-12.

To meet this date, the engineering necessary to keep essential contracts on schedule should start in early May, Year 1.

Critical items in the schedule are the selection of unit, the award of turbine contract and the construction of the site access road.

3 DESCRIPTION OF STUDY AREA

3 DESCRIPTION OF STUDY AREA

3.1 Location and Access

The area of the proposed development is centrally located on the northern peninsula approximately 35 km east of Daniel's Harbour and 160 km southwest of St. Anthony. The area is situated between Lake Michel and Western Blue Pond which comprise part of the River of Ponds drainage area. Principal lakes and rivers within the development area include Lake Michel which forms the new reservoir, Lake Omega which forms part of a diversion, Lake Gamma into which the tailrace would discharge and Lake Michel River which will transmit flow to the head pond.

The site is remote and access to the site for geotechnical and survey investigation can be partly gained by a series of existing woods roads built by Bowater Newfoundland Limited and thence over land by tracked vehicle. More reasonable access to the site is by helicopter. Details of the alternative routes considered for permanent access are given in Section 7 of this report.

3.2 Proposed Development

The proposed Lake Michel Hydro Development will develop a portion of the available head between Lake Michel and Western Blue Pond.

At present, flows pass from Lake Michel to Western Blue Pond directly via a system of small ponds and streams.

The Lake Michel Hydro Development provides for the utilization of flow from Lake Michel and the surrounding area as well as the diversion of a portion of the flow from Lake Omega. Both flows will converge to the head pond and then via a low pressure and high pressure penstock to the powerhouse. This will be accomplished by constructing a dam/spillway structure at Lake Michel, a dam/spillway structure and a canal at Lake Omega, a dam/spillway and intake at the head pond and a low/high pressure penstock.

The proposed development is shown on Drawing B1-124-C-1 and is discussed in detail under Section 6 of this report.

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3.3 Hydrology

The Lake Michel drainage area is a humid region with high precipitation. The land surface is generally poorly drained with many lakes and bogs. These result in a significant amount of natural runoff regulation.

No hydrological records are available for the 83 km^2 (103 km^2 with diversion) Lake Michel catchment area. However, hydrological studies and records are available for the Cat Arm River which is an adjacent watershed. Records and studies available cover the period from 1958 to 1978.

3.4 Topography and Geology

The development area is located in rugged terrain which has been heavily glaciated. The upper plateau has an irregular surface comprising bedrock ridges and small depressions which sustain little vegetation. In contrast the steeply sloping stream valley and colluvial slopes support well-developed vegetation and bedrock exposures are limited. Granitic boulders up to 2 m in diameter are common over the whole site. A land form outline of the area is shown on Drawing B1-124-C-3.

The area is underlain by coarse-grained granite which is typically massive. A thin veneer of glacial drift covers the major portion of the plateau areas below the crests of the hills. Accumulations of boulders and weathered materials predominate on the valley slopes. No areas of mass instability, structural faults or other major geological problems have been detected.

The penstock route traverses terrain with variable and often difficult topographic and surficial ground conditions. Along several sections of the initial route the valley wall is too steep for practical penstock construction. In addition, disturbance of the surficial boulders at several locations on the steep slopes would promote instability. The final alignment of the penstock route will require careful selection to minimize construction and stabilization problems.

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3.4 Topography and Geology (cont'd.)

Foundation conditions at the majority of structure sites should be straightforward providing good construction practices are followed. Large boulders and rock blocks will have to be removed at a number of locations and rock excavation will be required frequently.

Substantial lengths of construction road will be required but should not create major problems, although road construction materials are scarce on the plateau. Materials suitable for earth structure and road construction exist along the proposed access road routes, but moderate haul distances are necessary to reach the plateau locations.

4 HYDROLOGY

4 HYDROLOGY

4.1 General

Hydrologic studies were undertaken to establish a nineteen or twenty year long sequence of monthly flows (1958/59-1978) - inputs needed for flow regulation studies to determine average, firm and secondary flows and storage requirements. Storage requirement and volume curves were formulated from this information and are shown on Figures 3-3, 8-1A and 8-2A. This period includes both the lowest flow years and the severest seasonal droughts observed in the more than sixty years that systematic flow records have been kept in Newfoundland; moreover observations on rivers having low term flow records (Exploits River and Grand Lake) indicate that average flows for these study periods should be almost identical with the long term (fifty + years) average.

Flood frequency analyses were also carried out to establish design floods for spillways and construction floods for unwatering works.

Technical literature on the control of river ice was reviewed to identify solutions to ice problems which may be encountered on the study rivers. Discussions were also held with engineers from other Newfoundland utilities to enquire about their operating experience in dealing with ice problems at hydro plants on the Island.

The climate of the Island of Newfoundland is typically a maritime climate with extremes of temperature moderated by the surrounding ocean. The Island is affected by two major oceanic currents--the Gulf Stream passing to the south of the Island and the Labrador Current which circulates through the Strait of Belle Isle and along north and northeast coasts. Labrador is subject to a continental climate regime modified somewhat in coastal areas by proximity to the ocean.

Abrupt changes in elevation also affect climate on a more local scale with appreciably high precipitation occurring on coastal mountain ranges and colder temperatures, greater snow accumulations and later spring

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4.1 General (cont'd.)

runoffs noticeable in zones above elevation 300 m. A further feature of the climate of Newfoundland and Labrador is the presence of Artic drift ice and icebergs which frequently block the coast of Labrador, Strait of Belle Isle, north and northeast coasts in the spring and early summer and interrupt coastal shipping. These general climatic features are illustrated in Table 4.1 which summarizes climatic normals from a meteorological station at Daniel's Harbour, located near the development.

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Table 4.1 - Climatic Characteristics

ITEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN.
Mean Daily Temp. °C	-6.8	-7.4	-4.4	0.2	5.1	9.8	14.4	14.6	10.8	6.1	2.1	-3.2	3.4
Mean Rainfall mm	21	12	12	28	62	80	78	107	82	78	78	23	661
Mean Snowfall mm	625	597	480	285	51	0	0	0	2.5	15	208	549	2812
Mean Total PPT mm	80	71	59	56	67	80	78	107	82	80	100	80	940

4.1 General (cont'd.)

The topography of Western Newfoundland is characterized by the following major uplift areas; a central plateau with a general elevation of 300 m, peaks in the Annieopsquotch Mountains rising somewhat above 600 m, and the Long Range Mountains which form the spine of the Great Northern Peninsula. In this area plutonic and intrusive rocks predominate with varying occurrence of metamorphic rocks where these basal masses have been subject to alteration. Metamorphic and sedimentary rocks are more prevalent along the margins of these masses.

The entire Province has been subject to glacial action with the consequent alteration of drainage patterns. Unorganized drainage and widespread areas of bog interspersed with small lakes and ponds is typical of plateau areas. Tree cover tends to be scanty in plateau areas, but valleys and lower slopes are covered with thick stands of spruce and fir. The mantle of overburden is usually thin and underlying rocks generally impervious.

4.2 Drainage Areas

Drainage areas have been determined by planimetry from 1:50,000 scale maps. Table 4.2, below shows Project drainage area:-

Table 4.2 - Drainage Areas (sq. km)

Parent D.A.	Diversion D.A.	Total D.A.
83	20	103

4.3 Synthesis of Flow Records

Flow records were unavailable for the Lake Michel Hydro Development area, therefore, it was necessary to synthesize monthly flows. Relatively long term records are available on an adjacent river system having similar drainage areas and physiographic characteristics. Synthesis of the flow records was therefore on the basis of simple drainage area proration.

Flow into the development area originates entirely on the Long Range Mountain plateau at elevations in excess of 300 m and the orographic

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4.3 Synthesis of Flow Records (cont'd.)

effect of lower annual temperatures will significantly alter seasonal flow patterns relative to rivers, such as the Torrent, draining zones of lesser elevation. This temperature related modification of seasonal flow patterns was clearly observed in earlier studies on the Cat Arm River.*

4.4 Flood Frequency Analysis

Design floods for development area were estimated by the transportation of flood statistics obtained from the frequency analyses of the stream flow data from the nearby Cat Arm River. A log normal distribution was assumed in these analyses and the curves fitted by the method of moments. Design floods were based on "parent" drainage area as shown in Table 4.2.

Table 4.3 - Flood Peaks (Daily Maxima) cu.m. per sec.

Return Period (years)				
2	10	20	100	1,000
44	64	72	94	141

Selection of design floods are made in accordance with the U.S. Army Corps of Engineers Design Flood Criteria.** Where the Maximum Probable Flood (MPF) Method is recommended, floods of equivalent return periods are used: specifically for 1/2 MPF and 1 in 1,000 year flood and for the MPF a 1 in 10,000 year flood is used. These equivalents were established in other flood studies for small watersheds in Newfoundland.

The selection of design floods for individual structures is discussed under Section 6 of this report.

4.5 Ice Problems

The most common icing problem affecting the operation of hydro plants is the clogging of intake trash racks with accumulations of frazil ice which

* "Prefeasibility Study. Cat Arm Development", ShawMont Newfoundland Limited, Report No. SM-12-1977.

**"Recommended Guidelines for Safety Inspection of Dams" U.S. Army Corps of Engineers, Department of the Army, Washington, D.C.

4.5 Ice Problems (cont'd.)

occurs when inflow is super cooled, the result of critical temperature gradients combined with open water conditions. The accepted solution to this problem is to provide a tranquil head pond and adequate intake submergence to facilitate the formation and maintenance of a stable ice cover over the power plant head pond. Newfoundland Light and Power indicate some of their plants experience occasional frazil problems before the ice covers have the time to develop. The plants affected, mainly those along the "Southern Shore" have head pond configurations which expose power plant intakes to winds from the northwest quadrant which is the prevailing direction of the coldest winds.

Discussions with Bowater Power Company Limited revealed another type of problem, the filling of Watson Brook head pond with loose river ice carried down by winter or spring freshets. Watson Brook's head pond has filled to the point where flow velocities under the ice have reached a magnitude sufficient to entrain debris from the reservoir bottom which would be drawn into the power plant intake unless power production was curtailed.

The Lake Michel Hydro Development provides a head pond of sufficient surface area and depth to sustain the desired ice covers.

4.6 Monthly Flows

Monthly inflows to the reservoirs in the development were required for input to a regulation study of the system in order to assess the energy output of the proposed development. These records were synthesized as outlined in Section 4.3 and are included in Appendix D along with the resulting regulation study.

5 GEOTECHNICAL CONSIDERATIONS

5 GEOTECHNICAL CONSIDERATIONS

5.1 Program of Investigation

The program of investigation consisting of geologic surface observation and test pits was carried out in October, 1981. Geologic observation was carried out at all structure sites except at the Lake Michel dam/ spillway structure. To evaluate the quantity of the small amount of earth fill required six possible borrow sites were identified (see Drawing B1-124-C-4). Test pitting was carried out at these sites (see Drawing B1-124-C-5) and one representative sample from each was tested for grain size distribution. The results of these tests are included in Appendix A.

5.2 Construction Materials

Aerial photo interpretation was first undertaken to identify and locate potential sources of borrow materials using sterographic aerial photographs. To supplement the aerial photo study, test pits were excavated. As the only structure requiring granular borrow was the Omega Dam, only borrow areas in the general area of the structure were investigated. All other structures required either rockfill for timber crib or concrete. It was felt that due to the geology, construction materials for these types of construction would be available from quarries that would be developed in the immediate structure area or from excavation from the structures themselves.

Several deposits were found in the vicinity of Western Blue Pond. Most were found to fall in the category of sand-gravel mixtures and are generally good for gravels and filters. One deposit was found to meet the requirements for impervious fill and one was identified as a sand. Further excavation and testing is required to verify the consistency and suitability of these materials.

Preliminary investigation indicates that there is an ample supply of gravel, fine filter, coarse filter and impervious fill available without the need for major mechanical processing. (See Appendix B.) The sand deposit, if used for concrete sand would need minor processing.

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5.2 Construction Materials (cont'd.)

The locations of these deposits are shown on Drawing B1-124-C-4 and are summarized in Table 5.1.

Table 5.1 - Borrow Area Information

Area	Volume	Classification	Possible Use
1	600,000	Sand-Gravel	Gravel
2	400,000	Silt-Sand	Impervious
3	300,000	Sand	Concrete Sand
4	500,000	Sand-Gravel	Coarse Filter/Gravel
5	300,000	Gravelly Sand	Coarse Filter/Gravel
6	250,000	Sandy Gravel	Fine Filter

Locations of quarries for all the structures will be field located at the time of construction but it is foreseen that they will be located very near to those structures and most likely located within the land requirements shown on Drawing B1-124-C-2.

5.3 Lake Michel Dam, Spillway and Cut-Off Dams

The proposed dam and spillway site is in a small northeast-southwest oriented valley and the relief is in the order of 20 m. The overburden on both banks is shallow, varing from 1 m to about 2 m. The overburden consists of a thin layer of organics, over large boulders and some gravels. It is felt from preliminary observation that granitic bedrock should be encountered at an average depth of 2 m and will serve as an adequate foundation for the proposed structure. The two proposed cut-off dams have the same geologic structure and are located in isolated low areas around the reservoir perimeter.

5.4 Omega Dam and Spillway

The proposed dam and spillway site is in a small north-south oriented valley and the relief is in the order of 30 m. A thin veneer of glacial drift overlies the bedrock and medium to large granitic boulders are scattered over the ground. Granitic bedrock should be encountered at approximately 0.5 m depth and will serve as an adequate foundation for the proposed structure.

5.5 Omega Canal

The omega canal will be about 800 m in length and will run in a predominantly east-west direction through a ridge between Lake Omega and a series of small ponds draining to the head pond. The first 450 m is to be excavated through granite bedrock with little overburden. The maximum excavation through this area is in the order of 22 m. The last 350 m is to be excavated through an area of small ponds and bogs which overlay granitic bedrock. Excavation is in the order of 1-3 m but will probably be affected by the poor drainage of the area. The bedrock will provide adequate side support for the canal.

5.6 Head Pond Dam and Spillway

The head pond dam and spillway site is in a small east-west oriented valley and the relief is in the order of 15 m. A thin organic layer over medium to large granitic boulders exists in the structure area. Granitic bedrock is expected to be encountered at approximately 2 m depth and will serve as an adequate foundation for the structure.

5.7 Intake

The intake is to be constructed in the same general area as the head pond dam and is located in a relatively high granitic bedrock portion of the valley. Granitic bedrock is expected to be encountered at approximately 0.5 m depth and will serve as an adequate foundation for the structure.

5.8 Penstock

The penstock route extends 2.4 km in a general north-south direction along the side slope of a deep valley. The first 350 m of the route from the intake transverses gently sloping terrain which is strewn with medium to large granitic boulders. Overburden is estimated to be in the order of 0.5 m. The next 250 m of the route extends along a side hill with slope approaching 55°. Granitic bedrock outcrops are evident in this area. Slope stability in this general area needs further investigation as it is difficult to determine detached rock blocks from solid masses of bedrock in this area. The next 700 m traverses steep sideslopes with frequent granitic bedrock sideslopes. Again sideslope stability should be investigated. The next 150 m traverses a modern sideslope area that

5.8 Penstock (cont'd.)

has no significant bedrock outcrops. Overburden is estimated to be shallow however. The remaining 1,000 m consists of a steep downslope, in the order of 20-30°, with several vertical cliffs. Overburden is expected to be relatively shallow.

The surge tank will be located at a distance of approximately 1,400 m from the intake. Granitic bedrock exists at shallow depth at this location and will serve as an adequate foundation for the structure.

Due to the type of terrain further optimization of this route is necessary to achieve the most stable foundation for this structure.

5.9 Powerhouse and Tailrace

The proposed powerhouse site is located at the base of a rock slope near the shoreline of Lake Gamma. The site is located on a fan deposit comprising coarse granular debris from the slope above. No bedrock outcrop was observed but medium to large boulders are common on the surface. Granitic bedrock underlies the area and is expected to be encountered at moderate depth. The coarse granular material is expected to be adequate as a foundation with some foundation preparation work.

The tailrace excavation will be mainly in coarse granular material and granitic boulders below the existing water level of Lake Gamma.

5.10 Access Roads

The approximately 40 km of access roads will be constructed over relatively flat areas with the exception of a short section ascending the plateau and the section of construction road for the penstock. No major problems of a geotechnical nature are expected to affect the road construction.

6 PROJECT DESCRIPTION

6 PROJECT DESCRIPTION

6.1 General

The scheme selected to be the basis of the Capital Cost Estimate is defined by the following parameters:-

Installed Capacity	12 MW
Number of Units	1
FSL (Lake Michel)	Elevation 523.0 m
FSL (Lake Omega)	Elevation 492.5 m
FSL (Head Pond)	Elevation 402.0 m
TWL (Maximum)	Elevation 113.0 m
Rated Flow	5.3 m^3/s

A general description of the principal features of the development is given below and shown on Drawings B1-124-C-1, 7, 8, 9 and 11 and Figure 8-9A.

6.2 Access Roads

A study of access roads to the development site and structure sites was undertaken. Alternative routes to the Powerhouse area were considered and are detailed in Section 7.

(a) Permanent Access Roads

The selected arrangement consists of access to the general area by a system of woods road originating at Hawkes Bay. From there a 5.0 km section of woods road is to be upgraded. From that point all construction will be new.

A 13.0 km section is to be constructed along the southern edges of Flat Pond and Western Blue Pond and thence along the south eastern edge of Lake Gamma. To gain access to the powerhouse a bridge crossing is required at the powerhouse site. This route consists of relatively level topography with adequate construction materials and minor stream crossings.

Access to the head pond structures is by a relatively steep section rising to the plateau where these structures are located. The 7.0 km route leaves the powerhouse access road near the southern

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6.2 Access Roads (cont'd.)

(a) Permanent Access Roads (cont'd.)

extremity of Western Blue Pond and traverses the plateau slope to minimize grades. Once on the plateau the most direct route to the head pond structures is followed. The head pond section of road crosses the spillway structure and stops at the intake. No stream crossings are encountered on this route.

These roads will be of low profile construction and will have a 6 m gravel driving surface.

(b) Temporary Access Roads

The selected arrangement consists of two roads, one each to the Omega structures and the Lake Michel structures.

Access to the Omega structures is by a relatively level 3.0 km road which exits the head pond access road approximately 1 km west of the spillway and runs in a general southerly direction to the Omega structures. Construction should be relatively straightforward as there are no stream crossings.

Access to the Lake Michel structures is by a 10.8 km relatively rugged section of road traversing the watershed boundary to a point where the road crosses the main stream from Lake Michel. From there the road extends directly to the Lake Michel area. One major stream crossing is to be encountered where a bridge is envisaged, although fording may be possible. Within the Lake Michel area a 1.2 km section of road is to be built along the water line of Lake Michel to the two cut-off dams.

These roads will be of low profile construction. All the roads will have a 5 m gravel driving surface with the exception of the road to the cut-off dams which will have a 4 m gravel driving surface. It was initially felt that an all-terrain vehicle route could be used, but further review of the amount of materials to be transported to the area ruled out this option. The amount of

6.2 Access Roads (cont'd.)

(b) Temporary Access Roads (cont'd.)

work at the site has increased substantially from that originally envisaged and thereby a good quality road is necessary.

6.3 Lake Michel Structures

(a) Lake Michel Control Structure

The Lake Michel control structure is located on the outlet stream from Lake Michel. The structure is of timber crib, rockfill construction. The 162 m length of the structure is composed of a 125 m spillway section and two abutments with a total length of 37 m. One of the abutments contains the control equipment. An entrance and exit channel is provided for the control equipment.

The structure rises to a dam crest of 525 m and a spillway crest of 523 m. Freeboard in the absence of wind wave analyses was assumed as 2 m.

The abutment sections comprise 8 m wide timber crib sections filled with rockfill and sheeted on the upstream face. The abutments will rise to a maximum height of 6.5 m. The base will be dowelled to prepared bedrock. A partial or total seepage cutoff will be achieved by utilizing a grout curtain at the face of the dam.

The spillway section is similar in construction to the abutments but will be 6 m wide and will have a sheeted inclined face to relieve ice pressure. The spillway will rise to a maximum height of 4.5 m and is 125 m long. The spillway is designed to pass the 1:1000 year flood at a water level of 523.5 m.

The control structure will consist of a gated 0.9 m diameter culvert embedded in the north abutment. Approach and exit channels will be excavated to and from the culvert. Flow for the design of the control structure is taken as 95% of the project firm flow.

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6.3 Lake Michel Structures (cont'd.)

(a) Lake Michel Control Structure (cont'd.)

The whole structure will have a wedge of impervious fill on the upstream face to prevent seepage between the rock and timber crib and will have a wedge of boulder till on the downstream face to disperse the energy of the spill water and thus prevent erosion.

The cofferdams will consist of rockfill, transition and impervious zones and will be relatively low. Unwatering flow will be directed through the previously constructed control section. The cofferdams will also serve as access to the cut-off dams located on the far side of the structure.

(b) Lake Michel Cut-Off Dams

The two Lake Michel cut-off dams are located in two low areas on the perimeter of Lake Michel approximately 1 km to the southeast. Both cut-off dams are of timber crib, rockfill construction. Cut-off dam #1 has a crest length of 45 m and cut-off dam #2 has a crest length of 30 m.

Both cut-off dams rise to a crest elevation of 524 m and have 1 m of freeboard. As water levels rarely reach the base of the dams, a 1 m freeboard was used. Over topping of these structures was not considered important due to the type of construction.

Both dams comprise 4 m wide timber crib sections filled with rock fill and sheeted on the upstream face. Dam #1 will have a maximum height of 4 m and Dam #2 will have a maximum height of 1.5 m. Seepage will be minimzed by minimal foundation preparation and an upstream wedge of impervious fill.

Unwatering will be accomplished by pumping as normal water levels do not reach these structures.

(c) Construction

The north abutment containing the control structure will be completed

6.3 Lake Michel Structures (cont'd.)

(c) Construction (cont'd.)

in the dry along the approach and exit channels. Upon completion of this phase the upstream cofferdams will be built allowing completion of the remainder of the structure. At this point, construction of the access road to the cut-off dams can start and shortly thereafter the cut-off dams can be completed.

6.4 Omega Structures

(a) Omega Dam and Spillway Structure

The Omega dam and spillway structure is located on the western side of Lake Omega. The structure will be of hybrid construction, the deeper southern most portion near the river will consist of rolled rockfill with an impervious core section. On the northern bank of the river where the embankment height diminishes to 5 m or less, a homogenous earthfill section will be used. A transition zone will not be necessary as the spillway will be located where this transition would usually take place. The spillway will be the concrete gravity type with concrete walls on both sides.

The dam will have a crest elevation of 494.5 m, a crest length of 500 m and a maximum height of 8 m and will require about 35,000 cubic metres of fill. The spillway is 50 m long and has a crest elevation of 492.5 m. The spillway is designed to pass the 1:1000 year flood at a water level of 493.1 m.

Unwatering of the structure will be accomplished by a long low cofferdam which will direct flow into a short rock channel with a gated upstream section. This section is designed to pass the 1:20 year construction flood and will be closed off after the spring flood and then only after the structure is complete. Final closure where the channel passes through the spillway will be accomplished immediately after closure of the upstream gate. This channel provides a likely position for a flow compensation valve if one is required.

6.5 Omega Structures (cont'd.)

(b) Omega Diversion Canal

The Omega diversion canal is located on the eastern side of Lake Omega and extends in a general east-west direction. The 800 m long canal will be excavated through a low saddle on the perimeter of Lake Omega. It was determined by field investigator that overburden was very shallow and bedrock was essentially at the surface. The volume of excavation, some of which can be utilized in the construction of the Omega dam will be about 77,000 cubic metres.

The canal will have an entrance invert of 492.3 m, slope of 0.3 percent, bottom width of 4 m and side slopes of 4 vertical to 1 horizontal. Where excavation exceeds 10 m, a 2 m bench is required to prevent overburden and falling rock from blocking the canal. The canal will pass, at a full supply level of 492.5 m, a design flow of 1 cubic metre per second with a velocity not exceeding 0.8 metres per second. The design flow was obtained by proportioning the maximum tailrace flow at the powerhouse on the basis of drainage area; the maximum turbine flow is about 130 percent of the average runoff from the entire Project area.

The canal will discharge into a small stream valley which drops steeply into the head pond. Flow through the canal will be uncontrolled but a concrete weir at the canal entrance will prevent degradation of the canal invert during times of high runoff.

Unwatering of the canal will not be extensive as the existing lake level will not rise to the canal invert until impoundment. The only unwatering required will be in the area where excavation extends through several small bogs and ponds near the downstream end of the canal. These can be drained by excavating a drainage ditch from the downstream end of the canal.

(c) Construction

The unwatering channel will be excavated in the dry after which the upstream and downstream cofferdams will be constructed. After the

6.4 Omega Structures (cont'd.)

(c) Construction (cont'd.)

site is pumped dry, the earth fill dam and concrete spillway can be completed except for the small section of spillway spanning the unwatering channel. This will be closed off after all Omega structures are complete.

The canal excavation can start as soon as access is possible as it is not affected by the construction of the other structures. Ideally construction should start before construction of the dam as some of the excavated rock can be used for dam construction.

6.5 Head Pond Structures

(a) Head Pond Dam and Spillway

The head pond dam and spillway is located on the northern side of the head pond. The structure will be of timber crib, rock fill construction with a homogenous earth fill section where the height diminishes to 2 m or less. The earth fill section will abut the timber crib abutment to the west of the spillway section. The spillway will be a suppressed section of the timber crib section and will be gravity flow type.

The dam will have a crest elevation of 404 m, a crest length of 210 m and a maximum height of 4 m. The earth fill section will require about 5500 cubic metres of fill. The spillway is 100 m long and has a crest elevation of 402 m. The spillway is designed to pass the 1:1000 year flood at a water level of 403.0 m.

There is a requirement for infrequent crossings of this spillway after construction. Several alternatives such as a downstream bridge, incorporated bridge or incorporated catwalk were considered but proved to be prohibitively costly. Therefore, the scheme selected was to slope the abutments of the spillway such that a vehicle could cross the spillway deck in periods of little or no flow.

The abutment and spillway sections will comprise 6 m wide timber crib sections filled with rockfill and sheeted on the upstream face as

6.5 Head Pond Structures (cont'd.)

(a) Head Pond Dam and Spillway (cont'd.)

well as the spillway surface. The base will be dowelled to prepared bedrock. A partial or total seepage cutoff will be achieved by utilizing a grout curtain at the face of the dam. An impervious fill wedge will be placed at the front of the dam to minimize seepage between the grout curtain and dam face. Rock till will be placed on the downstream side to prevent erosion.

The remainder of the dam will be of homogenous earth fill type.

Unwatering will be accomplished in the same manner as for the Omega dam and spillway.

(b) Intake

The intake structure is located on the northern side of the head pond approximately 300 m west of the head pond dam and spillway. The structure will be located in a low rock area and is completely embedded in rock with the exception of the top 2 m. The intake will consist of a standard bellmouth intake reduced to a 1.5 m diameter valve which connects to the 1.5 m diameter pipeline. The structure will have provided steel stoplogs for emergency repairs. The structure will be of mass reinforced concrete construction with an insulated 4 m by 4 m manhole for access to the valve and related equipment. Pressure transducers will be provided for water level and trash rack differential measurements and a 150 mm diameter air vent pipe to allow pipeline draining.

A small earth fill dyke will be required on each side of the intake to prevent damage of the penstock by possible wave run-up in the intake area.

Unwatering will be accomplished by leaving a rock plug in the intake channel and pumping out any surface runoff or seepage. The rock plug will be removed only after installation of the intake valve.

6.6 Penstock

The penstock is located on the eastern slope of the main stream from the head pond and is oriented in a general north-south direction. The line consists of a low pressure penstock approximately 1.4 km long and a high pressure penstock approximately 1.0 km long. The low pressure penstock will be a completely buried 1.5 m diameter steel pipe and the high pressure penstock will be a partially buried, partially above ground, 1.5 m diameter steel pipe.

The low pressure penstock route traverses a route as described in Section 5 of this report. The excavation will be completely in rock and will provide for a minimum grade to minimize excavation. Where a side cut occurs a construction road bed will also be excavated to allow placement of the pipe. After placement on a prepared sand bed the pipe will be backfilled with select granular material to 1 m over the top of the pipe and then further backfilled with 1 m of rock backfill or to original grade. Anchor block will be provided on all major bends and side drainage will be provided where necessary.

The high pressure penstock route traverses a route as described in Section 5 of this report. Excavation will be minimal in this section and access will be impossible by conventional means. Saddles will be provided for the pipe support. The saddles will be of concrete dowelled to the bedrock. Anchor blocks will also be provided at all major bends. Construction will be by use of a cable hoist system which will allow construction materials and personnel to be transported either from the top or bottom.

The penstock will be of welded steel construction and will have three different wall thicknesses. The first 1641 m will be 6 mm thick, the next 200 m will be 10 mm thick and the last 500 m will be 13 mm thick. The high pressure section that will be on saddles will be provided with standard pipe insulation to protect against freezing. Burying of the remainder of the pipe will provide for adequate insulation for that section.

Unwatering of this structure is not expected to be a problem as only surface run-off or ground water seepage can be expected. This can be handled by

6.6 Penstock (cont'd.)

standard pumping procedures where required. Where small streams cross the route, culverts may have to be installed to prevent future erosion of the pipe bedding or cover.

6.7 Surge Tank

The surge tank is located on the edge of the bill approximately 1 km south of Lake Gamma. The tank is located at the transition between the pipeline and the penstock.

In order to limit the height of the riser-section and thereby limit the overall height of the surge tank, a 1.2 m diameter riser section will be constructed along the side of the hill and thus only the surge tank will be vertical.

The surge tank will be of the restricted orifice type with a diameter of 4.3 metres and a height of 22 metres. It will be designed to limit the pressures in the pipeline/penstock to 30% above and below static.

6.8 Powerhouse

(a) Arrangement

The surface powerhouse located on the northern end of Lake Gamma at the base of a hill, is an indoor type. The powerhouse layout is developed for one turbine governor unit rated at 12 MW. Electrical Details are shown on Drawing A3-124-E-1. The substructure consists of reinforced concrete founded on rock, and the superstructure consists of insulated metal siding and roofing on structural steel framing.

The nominal dimensions of the machine hall are 16 m long, 8 m wide and 7 m to the roof from the generator floor. The bottom of the draft tube is 7.5 m below the generator floor.

A service bay is provided at one end of the powerhouse at the generator floor level for erection and maintenance of the units. One 30 tonne overhead crane will traverse the full length of the powerhouse and will be capable of lifting the generator rotor, the heaviest component to be handled during erection and maintenance.

6.8 Powerhouse (cont'd.)

(a) Arrangement (cont'd.)

A control room and a communications room are located at the generator floor level on the upstream side. The generator circuit breakers and station service switchgear are situated at this level on the upstream side of the units. A lunchroom and washroom, sufficient in size for a regular maintenance staff, are provided along with a battery room and a storage room. An equipment room housing excitation transformers, accumulator tanks and governor actuator tanks, terminal room and an electrical shop are also provided.

The main sump is located on the downstream side of the powerhouse and contains the drainage, cooling water, unwatering and fire protection pumps.

The main transformers and station service transformers are located outdoors adjacent to the upstream wall of the powerhouse at the generator floor level. Appropriate blast wall protection and oil retention measures will be provided.

(b) Turbine and Generator

The turbine will be of the Francis type and will have a rated capacity of 12 MW at 900 r/min operating under a net head of 271 m. The turbine will be equipped with an electrohydraulic governor connected to the wicket gate servomotors by a high pressure oil system.

The generator will be rated at 12 MW, 4160 V, 900 r/min and 0.9 lagging power factor.

There will be air cooled with air-to-water heater exchangers located on the periphery of the stator frame.

Excitation of the generator field will be from static exciter equipment, consisting of an indoor dry type transformer, thyristor convertor and electronic automatic voltage regulator.

6.8 Powerhouse (cont'd.)

(c) Mechanical Services

The powerhouse will be provided with all essential mechanical services such as cooling water, oil handling system, compressed air, fire protection, potable water, drainage and unwatering, sewage, heating and ventilating system.

(d) 4160 Volt Equipment

Cable bus duct and outdoor wall mounted bushings will be used to bring power to the outdoor, 4160 V generator breaker.

Tap offs will be provided for surge protection equipment, station services, upstream power and excitation equipment.

(e) Station Services

Station services will be provided at 600 V, 3 Ø and 120/240 V, 1 Ø through one 75 KVA, 4160/600 V indoor transformer ONAN rating. This supply will be maintained during shutdowns, by a standby diesel generator and automatic transfer switch. Building services will be supplied at 120/240 V single phase from the 600 V, 3 phase system.

(f) Main Transformer

One main transformer, rated at 12/15/20 MVA, will be located outdoors, to step up the voltage to 69 kV. Lightning arrestors will be used at the high voltage bushings.

(g) Switchyard

A wood pole switchyard will accommodate the main transformer generator breaker and associated disconnects and ground switches. Wall mounted bushings will connect the generator bus to the outdoor overhead lines. (Refer to Drawing A3-124-E-1.)

(h) Upstream Structures

Power for the intake and surge tank structures will be supplied from the generator bus at 4160 Volt. Tech cable from the powerhouse

6.8 Powerhouse (cont'd.)

(h) Upstream Structures (cont'd.)

will be run alongside the penstock to the intake and the surge tank. No power is required at the spillway structure.

6.9 Tailrace Channel

Flows will be conveyed downstream from the plant by a tailrace channel into Lake Gamma.

The tailrace channel from the plant into Lake Gamma is approximately 200 m long and is excavated mostly in coarse granular material with numerous boulders. Bedrock excavation may be necessary but is expected to be shallow.

Unwatering of the tailrace will be done in conjunction with the unwatering of the powerhouse. A plug will be left in the tailrace channel to allow for conventional draining of the construction site. This can be removed as soon as construction is complete above the existing water level.

6.9 Land Requirements

For the structures outlined above, the land requirements are shown on Drawing B1-124-C-2, and are outlined as follows:-

Block #1	Lake Michel Cutoff Dams	2.2 ha
Block #2	Lake Michel Dam and Control Structure	10.0 ha
Block #3	Omega Diversion Dam	21.0 ha
Block #4	Omega Diversion Canal	22.5 ha
Block #5	Intake, Penstock, Powerhouse and Head Pond Dam	86.0 ha
Block #6	Permanent Access Roads	120.0 ha
Block #7	Temporary Access Roads	75.0 ha
Block #8	Construction Camp	4.0 ha

7 ALTERNATIVE ARRANGEMENTS

7 ALTERNATIVE ARRANGEMENTS

7.1 General

Alternative arrangements and comparative cost estimates of the Project components were developed in order to select the preferred scheme for the Capital Cost Estimate. This section discusses the development of the alternative arrangements and the comparative cost estimates. The segments of the Project that warranted optimization at this level of study were the access road routes, the omega structures FSL, the head pond dam and spillway crossing and the penstock routing.

7.2 Access Roads

A study of access roads to the development sites and structure sites (see Drawing B1-124-C-6) was undertaken. Alternative routes to the powerhouse area were considered and consisted of the following:-

Route DBC - This route traverses the northern side of Western Blue Pond, crosses a narrow waterway between Lake Gamma and Western Blue Pond and entered to the powerhouse site via the southern side of Lake Gamma.

Route ABC - This route traverses the southern side of Flat Pond via existing woods roads, then along the southern side of Western Blue Pond and then along the southern side of Lake Gamma. This route includes Section EB which has to be built to gain access to the head pond and omega areas.

Access to the start of the new roads is via existing fair condition woods roads from Hawkes Bay. These roads extend in a general southerly direction to an area approximately 15 km from the powerhouse site.

Another alternative was initially proposed similar to route DBC but extending along the north side of Lake Gamma. Extreme ruggedness of terrain quickly proved that this route was unacceptable. Route ABC was selected on the basis of the following summary:-

Route	Length (km)	Cost ($ x 1,000)
DBC	15	2299
ABC (excluding EB)	14	1456

7.2 Access Roads (cont'd.)

Access from the powerhouse to the head pond structures and omega structures could follow only one route. This route leaves at Point B and travels along the base of the plateau and ascends the plateau at a point where the grade would be the least (Point E). This route is shown as EFH and FGL. Other alternatives were originally considered but the steepness of the plateau slopes in all other areas except route EFH were too severe to permit construction. Route FGL is relatively short and is the shortest route possible. The length of this scheme is 10 km and will cost $1,430,000.

Access from the head pond area to Lake Michel could follow only two routes, HIJ or GIJ.

Route HIJ extends from the general area of the omega structures along the watershed boundary to Point I, common to both routes, crosses the main stream from Lake Michel and then extends directly to Lake Michel. Stream crossings are very rare along this route.

Route GIJ extends from the intake structure and traverses to the north of the main stream from Lake Michel, crossing many tributaries of that stream, to Point I and thence follows the same alignment as Route HIJ.

Both routes seem equally attractive as shown below but Route GIJ was selected for estimate purposes because of the absence of stream activity involved in construction of this road as well as a reduction in traffic flow through the head pond area during and after construction. A more detailed analysis of these routes should be undertaken before a final decision is made.

Route	Length (km)	Cost ($ x 1,000)
GIJ	11	995
HIJ	11	1050

Access from Lake Michel to the Lake Michel cut-off dams is by the most direct route and will consist of a 1 km road costing $60,000.

7.2 Access Roads (cont'd.)

The total scheme selected involves 25 km of permanent access roads and 15 km of temporary access roads at a total cost of $3,941,000. Site construction roads near structures are included in the individual structure unit prices. Sufficient materials should be found along or near the proposed route with the possible exception of the Lake Michel access road where material is expected to be relatively scarce and may have to be trucked from deposits for distances up to 5 km. In all cases the source of road topping is located at borrow areas 1 or 4 and will have to be trucked. Other than the steep haul up to the plateau, road construction should not be a serious problem.

7.3 Omega Structures

(a) General

The Omega Diversion system required two separate optimizations. The first was to optimize the FSL of the diversion to minimize the cost of the scheme. The second was to check whether the cost of energy was raised or lowered by deletion of the diversion; a raising of the cost would confirm the feasibility of the diversion.

(b) FSL Optimization

In the light of site condition changes from the original proposal as well as price changes, the FSL of the diversions needed to be optimized. Two schemes were possible for the diversion and were optimized separately; the lower priced being the optimum.

Scheme 1 - Canal, Dam and Spillway in locations as outlined in Section 6.

Scheme 2 - Canal and Dam as per Scheme 1 but with the Spillway located in a low area 1 km to the south of the Dam.

The optimization of each scheme is outlined in Tables 7.1 and 7.2 and is shown on Figure 1 of Appendix C.

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7.3 Omega Structures (cont'd.)

(b) FSL Optimiation (cont'd.)

Table 7.1

Scheme 1 Optimization

FSL (m)	Cost ($ x 1,000)
494.5	2987
493.5	2190
492.5	2187
491.5	2268
490.5	3515

Table 7.2

Scheme 2 Optimization

FSL (m)	Cost ($ x 1,000)
496.5	3281
495.5	3030
494.5	2987
493.5	3380

The optimum scheme is therefore Scheme 1 with a FSL of 492.5 m costing $2,187,000. More detailed refining of this optimization will be necessary at the next phase of engineering. Outlines of Scheme 1 (492.5) and Scheme 2 (496.5) are shown in Drawings B1-124-C-9 and 10 respectively.

Using the previous optimization the feasibility of the diversion is then checked and outlined in Table 7.3.

7.3 Omega Structures (cont'd.)

(b) FSL Optimization (cont'd.)

Table 7.3

Omega Diversion Energy Cost

	Project with Diversion	Project without Diversion
Total Capital Cost	$48,571,000	$43,973,000
Annual Costs	6,460,000	5,848,000
Install Capacity	12,000 kW	12,000 kW
Annual Firm Energy	34.9 gWh	28.1 gWh
Annual Average Energy	62.2 gWh	53.7 gWh
Cost of Firm Energy	185 mills/kWh	208 mills/kWh
Cost of Average Energy	104 mills/kWh	109 mills/kWh

The Project with the diversion produces energy at a lesser cost than without the diversion, therefore the feasibility of the diversion is confirmed.

7.4 Head Pond Dam and Spillway

(a) General

The head pond dam required, at this stage of engineering, only two optimizations, type of construction and crossing requirements. Optimization of the FSL was not considered as observation indicated that raising or lowering the FSL significantly, would increase drastically the amount of work on the head pond structure.

how much 1m?

(b) Type of Construction

Only two types of construction were considered practical for construction of the structure. These are concrete or timber crib. Cost estimates that both alternatives produce a comparable cost, in the order of 1.3 million. It was therefore decided to use the timber alternative for estimate purposes due to ease of construction. In both cases where the structure is low, a homogenous earth fill embankment will be used.

7.3 Head Pond Dam and Spillway (cont'd.)

(c) Crossing Requirements

The requirement for permanent access over the head pond dam and spillway can take three forms.

1. Full Time Vehicle Access

Full time vehicle access requires the use of a standard bridge. Two schemes are possible; an incorporated bridge or a downstream bridge. The incorporated bridge regardless of spillway construction would cost $1,300,000. as compared to the preferred downstream bridge costing $675,000.

2. Full Time Personnel Access

Full time personnel access requires only the use of a standard catwalk structure over the spillway. This scheme would cost $150,000.

3. Occasional Vehicle and Personnel Access

Occasional vehicle and personnel access requires that during times of little or no flow over the spillway, a vehicle could drive across the spillway crest. This would only require modification to the spillway abutments (sloping). As this modification would be done in the original construction no cost increase is foreseen.

As full time access is not feasible for the whole year (i.e. during winter) and as the degree of maintenance of the intake will be low, it is felt that the occasional access alternative is the most attractive and is the scheme used for the estimate.

7.5 Penstock

(a) General

The only optimization at this stage of engineering was carried out in the field during the baseline survey. (See Drawing B1-124-C-8.) During the survey the best route was chosen giving particular attention to grades, excavation requirements, and slope stability (Scheme B). Several variances from the line finally chosen in the field occurred

7.5 Penstock (cont'd.)

(a) General (cont'd.)

but were abandoned for the above reasons. Another route shown as Scheme A initially chosen was also abandoned for the above reasons. Based on the field information some route changes differing from the route surveyed are suggested and are shown as Scheme C. This scheme is based on field observations and should be reviewed and resurveyed at the next stage of engineering.

(b) Route Alignment

From the field information it was evident that the survey line was generally the only reasonable route from the intake to the powerhouse. Refinements of the route alignment are suggested to decrease the quantity of excavation and to avoid slope instability.

(c) Gradelines

To minimize headloss by the addition of bends in the penstock and to reduce excavation quantities the low pressure penstock section was considered to follow a minimum downslope from the intake to a point near the surge tank location. From the surge tank to the powerhouse, construction would be difficult, therefore it is necessary to follow the natural ground surface as much as possible, again eliminating excavation quantities.

8 CAPACITY AND ENERGY

8 CAPACITY AND ENERGY

8.1 General

Regulation studies of the Project scheme were carried out for the period 1958 - 1978, as indicated in Section 4 of this report. A firm flow of 2.02 cubic metres per second and an average flow of 3.29 cubic metres per second were established for the scheme outlined in Section 6. This study is included in Appendix D.

8.2 Energy Calculations

Firm Energy

Average Net Head	287.0 metres
Firm Flow	2.02 cu. m. per sec.
Overall Plant Efficiency	0.70
Firm Energy	34.9 gWh per year

Secondary Energy

Average Net Head	285.5 metres
Average Flow	3.29 cu. m. per sec.
Overall Plant Efficiency	0.77
Averal Annual Energy	62.2 gWh per year
Secondary Energy	27.3 gWh per year

The following efficiencies were assumed:

Turbine (operating to produce firm energy only)	0.78
Turbine (operating to produce firm and secondary energy)	0.86
Generator	0.96
Transformer	0.99
Plant	0.99
Water Utilization	0.95

8.3 Energy Costs

Total Capital Cost	$48,571,000
Annual Costs	$ 6,460,000
Installed Capacity	12,000 kW
Annual Firm Energy	34.9 gWh
Annual Secondary Energy	27.3 gWh
Total Annual Energy	62.2 gWh
Cost of Firm Energy	185.1 mills/kWh
Cost of Average Energy	103.9 mills/kWh

13.3% ACF

8.4 Head Losses

Head losses, calculated to arrive at the average net heads, were based on standard engineering formula relating head loss to pipe diameter, pipe length, pipe flow, number of bends, etc.

For the production of firm energy a head loss of 2 m was calculated and a head loss of 3.5 m was calculated for the production of average energy.

9 ENGINEERING AND CONSTRUCTION SCHEDULE

9 ENGINEERING AND CONSTRUCTION SCHEDULE

9.1 General

Schedules of engineering and construction activities, shown on Drawing B1-124-C-12 indicate the development going on line by December, Year 3. This is based on a project release of May 01 in Year 1.

The project will be constructed in two phases. The first phase will consist of completing access to the head pond and powerhouse as well as completing some preliminary site work, such that the second year's work can start as early as possible.

The second phase will consist of completing all structures in a two year period. The first year of this period will consist of partial completion of the penstock as well as the completion of the civil aspects of the intake and powerhouse. Access to the Omega and Lake Michel structures will be completed in this year. The second year of this period will consist of completion of all upstream structures as well as the remaining penstock work.

The construction of dams is scheduled such that placement of impervious and filter materials occurs in July-August and placement of concrete is complete before winter. Initial work on dams must also occur after the spring runoff. Major powerhouse mechanical work can not start until April of Year 3 due to delivery schedules.

In order to achieve the on-power date for the development, it will be necessary to construct the main civil works in accordance with the following schedule:-

- access to intake and powerhouse August, Year 1 to December, Year 1.
- intake and powerhouse civil works, May, Year 2 to December, Year 2.
- penstock, May, Year 2 to October, Year 3.
- reservoir clearing, May, Year 2 to July, Year 2.
- construction camp, May, Year 2 to July, Year 2.
- head pond dam, Omega structures and Lake Michel structures, May, Year 3 to November, Year 3.

9.1 General (cont'd.)

- electrical and mechanical, January, Year 3 to November, Year 3.

9.2 Contract Packages

To achieve this construction schedule, construction work would be divided into a few interrelated work packages to ensure efficient execution of the work. These work packages would be:-

Contract 1

Access Roads and Site Preparation - A preliminary contract which would include construction of the main access roads and clearing and stripping of the main structure sites. The value of this contract will be approximately $4.3 million.

Contract 2A and 2B

Civil Works - Normally a main civil works contract would be awarded to undertake: construction and operation of a camp, construction of project roads, all earthworks, concrete works, architectural works and landscaping. Where the project includes two geographically separate structure sites or sub-projects, two secondary civil works contracts would be awarded. One will incorporate all the structures relating to dams, namely the Lake Michel structures, the Omega structures and the Head Pond dam and spillway. The value of this contract would be approximately $5.2 million. The other, valued at approximately $4.9 million would incorporate the intake, the penstock and the powerhouse structures.

Contract 3

Penstock Construction - The penstock comprises an important component of the overall construction work. It would be advantageous to employ a specialist contractor for this work rather than leave it as the responsibility of the civil works contractor. The value of this contract would be approximately $3.7 million.

Contract 4

Equipment Contracts - These contracts would include the design, supply, transportation, erection and testing of the major pieces of equipment including but not limited to turbines, valves, generator, etc. The total value of these contracts would be approximately $4.0 million.

9.2 Contract Packages (cont'd.)

Contract 5

Electrical and Mechanical Erection - A single erection contract would be awarded for the installation of electrical and mechanical auxiliaries valued at approximately $1.0 million.

Obviously these separate contracts, though conceived as separate entities will have to fit into the master construction schedule.

9.3 Turbine and Generator

The eary start of May 01 in Year 1, on the turbine and generator contract is essential to meet the on-power date of December in Year 3, and to obtain the turbine data relating to the powerhouse design.

9.4 Site Access

Contract documents for access roads will be awarded by July, Year 1, to ensure access to the intake and powerhouse by May in Year 2. The remainder of the access will be complete in Year 2, to provide access to Lake Michel and the Omega structures by early Year 3.

9.5 Construction Camps

In the first year of construction it is envisaged that the road contractor will use a floating/moving type camp that will move as construction progresses.

Once access to the site is accomplished a main construction camp will be provided near the intersection of the head pond and Omega structure access roads, which will comprise the major work centre of the project. Clearing and road contractors will provide their own separate floating/ moving camps as required.

The camp will provide accommodation and dining facilities for approximately 150 persons. The camp will provide a cafeteria-style dining hall, a recreation complex, a guest house, central laundry, fire hall, first aid post, fire truck and ambulance.

9.5 Construction Camps (cont'd.)

In ground water services for potable water and fire protection will be provided. The water will be obtained from a nearby suitable source and will be chlorinated. A sewage system will be provided, including a package sewage treatment plant. Cost associated with contractor's accommodations are included in the structure costs and the cost of the Owner's accommodations are included in the management and engineering cost.

9.6 Construction Power

Construction power at each structure site will be by portable diesel power plants and will be the responsibility of individual contractors. Power for the construction camp will also be by a diesel power plant.

9.7 Lake Michel Structures

Tenders will be called and a contract awarded by June of Year 3. The major consideration in the schedule of this structure is to avoid the spring runoff and yet complete impoundment by use of the fall runoff.

9.8 Omega Structures

Tenders will be called and awarded by June of Year 3. The major consideration in the schedule of this structure is again to avoid the spring runoff and yet complete impoundment by use of the fall runoff. Excavation of the canal must be started prior to rockfill placement of the dam in order to utilize some of the excavated rock.

9.9 Head Pond Structures

Tenders for the intake structure will be called and awarded by May of Year 2 so that the pipeline/penstock construction can begin in Year 2.

Tenders for the head pond dam structure will be called and awarded by May of Year 3. The major consideration in the schedule of this structure is to avoid the spring runoff. Impoundment should not pose a problem in the head pond reservoir.

9.10 Penstock/Surge Tank

Tenders for the civil works portion of these structures will be called and awarded by May of Year 2. The excavation and concrete work for these structures must be at least fifty percent complete before installation of the pipe can begin. The contract for installation of the pipe must be awarded by July of Year 2 to ensure complete installation and backfill by November of Year 3.

9.11 Powerhouse and Tailrace

Tenders for the civil works portion of this structure will be awarded by May of Year 2 although complete turbine and generator information may not be available at that time. The schedule will also have to be co-ordinated with the placement of the penstock. Receipt of major embedded parts such as the draft tube or spiral case can be expected around October of Year 2. All of the above has to be co-ordinated with the award of the turbine generator contract, to ensure the proper scheduling of the placement of components. Information from the turbine manufacturer, regarding the foundation design will be necessary before May of Year 2. With these factors in mind the earliest possible turbine/generator contract award date is necessary and is August of Year 1, to ensure an on-power date of December, Year 3.

9.12 Mechanical and Electrical Services

Mechanical and electrical services must be co-ordinated with the installation of the turbine/generator. This will occur from May to December, Year 3, therefore the electrical/mechanical contract should be awarded by March, Year 3.

10 CAPITAL COST ESTIMATES AND CASH DISBURSEMENTS

CIMFP Exhibit P-01028

HYDRO

SYSTEMS PLANNING

FILE NO. ______

SUBJECT ______

MADE BY ______ DATE ______ PAGE ____ OF ____

FEASIBILITY STUDY p. 10.1

LAKE MICEEL

JAN 1982$ DIRECT COSTS = $31,545,000

TO JAN 1998$ ESCAL @ $\frac{1.414}{.854}$ => 20,685,000

I.D.C. @ 10%

1983	→	2,920,000
1984	→	12,990,000
1985	→	15,635,000
		31,545,000

10 CAPITAL COST ESTIMATES AND CASH DISBURSEMENTS

10.1 General

Capital Cost Estimates have been prepared for the selected layout of the development outlined in Section 6 of this report. This estimate totals $48.6 million and is summarized in Table 10.1 below. These figures include all direct costs, engineering and management, Owner's costs, contingencies, escalation and interest during construction.

Table 10.1

Summary Cost Estimate by Facility

		Estimate Base Cost January 1982 Dollars
1.	Energy Structures	4,139,000
2.	Power Structures	15,020,000
3.	Permanent Support	2,886,000
4.	Temporary Support	1,055,000
5.	Management and Engineering	3,511,000
6.	Owner Administration	
	a) Owner's Costs	430,000
	b) Corporate Overheads	466,000
7.	Escalation	11,851,000
8.	Interest During Construction	5,175,000
9.	Contingency	4,038,000
Total Project Estimate -		48,571,000

10.2 Basis of Estimate

(a) Civil Works

.1 Quantities

Basic material quantities used in preparing the Cost Estimate have been determined from recent engineering plans and profiles produced from the 1981 Engineering Survey Program, using the conceptual development and structure drawings from The Four Rivers Study produced by ShawMont Newfoundland Limited in 1979.

Refinement to the conceptual development in the Four Rivers Study were made using information obtained by aerial photo interpretation (A.P.I.), Geotechnical Reconnaissance Study, and subsurface investigation (test pits) work undertaken in 1981.

The main access roads quantities are based upon typical sections that are felt to be appropriate for the actual field conditions.

.2 Unit Prices

The unit prices in January 1982 dollars applied to civil quantities have been obtained from updated cost data based on unit prices being tendered on the ongoing major projects such as The Upper Salmon Development and Cat Arm Development, prices experienced on other similar projects on the Island, and review of recent Cost Estimates for the Cat Arm Development.

The prices for the major earthworks and the large structures recognize the efficiencies of the large scale operations and the remoteness of the Lake Michel Hydro Project.

(b) Electrical and Mechanical

The method of estimating employed in the definitive estimate, all in January 1982 dollars for electrical and mechanical equipment, may be generally categorized as follows:-

10.2 Basis of Estimate (cont'd.)

(b) Electrical and Mechanical (cont'd.)

a) Cost estimates were requested where feasible from suppliers and budget costs received were used and modified based on whether the specific supplier is likely to be a low tenderer or whether other factors are applicable as below.

b) Previous tenders and purchase/contract prices for other projects were evaluated in relation to Lake Michel Hydro requirements and with due account for escalation to January 1982.

c) Adjustments made for the special and specific requirements for Lake Michel Hydro Development as foreseen from the feasibility study and field investigations.

d) Costs also recognized in some cases increases, identified by formally or informally quoted prices where these prices have significantly exceeded the recognized escalation rates over the comparison periods used.

e) Transportation rates for major equipment have been estimated for foreign trans-oceanic shipments where such is likely to occur. Most other rates are predicated on deliveries from Ontario.

10.3 Management and Engineering

Management and engineering costs during the design and construction period is based on 15% of the direct costs. This cost includes the cost of office design, field engineering, construction supervision and job administration. It also includes such indirect costs as field office expenses, board and lodgings of field personnel, construction site services, vehicles, materials testing, etc.

10.4 Owner's Costs

The total estimate includes an amount equal to 1.0 percent of the estimated construction costs to cover the Owner's own project administration costs.

10.5 Contingencies

Based on the level of estimating and the amount of site data still required

10.5 Contingencies (cont'd.)

for more accurate assessment of the quantities, a contingency amount of 15 percent has been added to the total of the construction and indirect costs for the Project.

10.6 Escalation and Financing

Escalation during the construction period and interest during construction are based on the following values.

Escalation Rate (%)		Interest During Construction Rate (%)	
1982-3	11.192	1982	16.0
1983-4	10.385	1983	15.5
1984-5	10.388	1984	15.0
1985-6	10.388	1985	14.5

10.7 Cash Disbursement Schedule

A monthly cash disbursement schedule is shown on Appendix E. The schedule reflects the proposed construction schedule and includes retention payments for the major contracts in accordance with the legal requirements. The cost of transmission is excluded.

11 PROGRAM OF ONGOING STUDIES

11 PROGRAM OF ONGOING STUDIES

11.1 General

Several studies and investigations are required in the early stages of the next phase of engineering to firm up the project and to provide sufficient data for detailed final design and data for tenderers.

11.2 Reservoir Full Supply Levels

It has been noted in the project description of this report that the optimum reservoir F.S.L.'s are in the range of elevation 523.0 m for Lake Michel, 492.5 m for Lake Omega and 402.0 m for the Head Pond. Studies should be undertaken to optimize these water levels using all relevant additional data included in proposed future investigations.

11.3 Geotechnical Investigations

The 1982 geotechnical program should be augmented in early summer of 1982. The program objectives should be:

- appropriate testing of soil samples taken during the 1981 field program to confirm sources of potential impervious, granular and concrete aggregate materials.
- boreholes, rock probes and test pits at structure sites as recommended by the geotechnical consultant in his report (see Appendix A).

11.4 Field Surveys

Profiles and cross-sections should be completed for final design and layout of all civil works including stream crossings. Underwater contours of the tailrace entry to Lake Gamma and the intake canal area will also be required.

11.5 Facilities

Further design of the penstock alignment and grades should be done based on the field information from Section 11.4. Based on the final alignment and grades further design of the penstock and surge tank will be necessary to optimize penstock material, diameters and wall thicknesses as well as surge tank diameter and height.

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11.5 Facilities (cont'd.)

The powerhouse location and tailrace arrangement needs further design based on the further geotechnical investigations to firm up foundation conditions.

The possible types of turbines arrangement needs to be finalized (1-12MW or 2-6MW, Pelton or Francis, etc.) as this affects the powerhouse size and layout requirements.

11.6 Hydrology

Optimization of flows available and power output should be carried out by further regulation studies based on unit flow requirements as well as reservoir F.S.L. optimization.

11.7 Ice Studies

A field program should be commenced to collect water temperature data and other data relating to the formation of ice in the intake area and tailrace. The data and the thermal regime of rivers and lakes in the project area should be analyzed to establish ice related criteria for the project. The potential for frazil ice production should also be studied.

APPENDIX A

GEOTECHNICAL INFORMATION

A-1 Report on Preliminary Geotechnical reconnaissance. Lake Michel Hydro Development.

A-2 Lake Michel Hydro Development Visual Classification of Soil Samples.

A-3 Particle Size Distributions of Soil Samples.

APPENDIX A-1

REPORT ON PRELIMINARY GEOTECHNICAL RECONNAISSANCE

LAKE MICHEL HYDRO DEVELOPMENT

General

The development area is located in rugged terrain which has been heavily glaciated. The upper plateau has an irregular surface comprising bedrock ridges and small depressions which sustain little vegetation. In contract the steeply sloping stream valley and colluvial slopes support well-developed vegetation and bedrock exposures are limited. Granitic boulders up to 2 m in diameter are common over the whole site.

The area is underlain by coarse-grained granite which is typically massive. A thin veneer of glacial drift covers the major portion of the plateau areas below the crests of the hills. Accumulations of boulders and weathered materials predominate on the valley slopes. No areas of mass instability, structural faults or other major geological problems have been detected.

The penstock route traverses terrain with variable and often difficult topographic and surficial ground conditions. Along several sections of the initial route the valley wall is too steep for practical pipeline construction. In addition disturbance of the surficial boulders at several locations on the steep slopes would promote instability. The final alignment of the penstock route will require careful selection to minimize construction problems and future risk.

Foundation conditions at the majority of structure sites should be straightforward providing good construction practices are followed. Large boulders and rock blocks will have to be removed at a number of locations, and rock excavation will be required frequently.

Substantial lengths of construction road will be required but should not create major problems, although road construction materials are scarce on the plateau. Materials suitable for earth structure and road construction are present along the proposed access road routes, but moderate haul distances are necessary to reach the plateau locations.

Penstock

The following comments relate to the cut line along the initial alignment selected for these components. The first 350 m of the route from the intake traverses gently sloping terrain which is stewn with large to medium boulders, but bedrock outcrop is rare. Farther along the cut line sidehill conditions prevail with the slope angle varying considerably with elevation, and at some locations approaching 55 degrees. In addition accumulations of boulders near the surface are marginally stable where the steep slopes prevail. Operation of construction equipment in such areas would be very difficult and the long term stability of such deposits would be questionable.

Beyond 350 m from the intake along the cut line the side slope flattens somewhat above the line with bedrock outcrops farther upslope. Typically the bedrock is relatively massive granite with major joint sets oriented sub-horizontal and near-vertical. The sub-horizontal joints are typically spaced 0.3 to 1 m and dip up to 15 degrees southwest. The near-vertical joints are generally wide spaced (1 to 2 m) and strike at roughly 40 and 140 degrees Az. Exposed rock surfaces are moderately weathered, and weathering along the joint surfaces has resulted in the formation of open joints (typically to 50 mm) and tabular rock blocks. In some locations loosened blocks are in evidence but for the most part the bedrock is relatively intact. No evidence of recent mass movement was noted, but several detached rock blocks have tumbled downslope.

Between 350 and 600 m from the intake along the route an alignment at an elevation somewhat above the cut line would probably result in fewer construction and potential stability problems. Rock excavation will be required, however, at some sections. The overall stability of the slopes in this area would be improved by permanently draining a small pond some 45 m above the cut line.

Between 600 and 1300 m along the route the cut line crosses two very steep sections of the valley wall about 1050 and 1250 m from the intake. Along this section of the route rock outcrop is common upslope from the cut line. Realignment of the route to be east should be considered along this section (600 - 1330 m) to avoid the very steep, boulder-strewn areas.

The final 150 m of the cut line route to be surge tank traverses a moderate

Penstock (cont'd.)
cross slope without significant rock outcrops, and construction should be relatively straightforward.

Vegetation is moderate to heavy over the whole valley wall. Care should be taken to minimize disturbance of this material on the slopes since its presence is beneficial to surfacial stability.

Considerable attention should be given to optimizing a route for the penstock. In general construction will be more practical if the alignment is located where relatively flatter slopes exist or a bedrock bench. The optimum pipeline route may require significant rock excavation, but this alternative is considered preferable to partial embankment construction on the steep bouldery slopes or elaborate stabilization measures. Consideration should be given to setting the initial grade of the penstock intake at the highest practical elevation to permit greater flexibility of alignment farther along the route. In consideration of stability during construction and long term it is recommended that the penstock not be supported on accumulated boulders where the natural surface slope exceeds 33 degrees. (1 1/2 h:1v).

Adequate support for the surge tank will be provided by bedrock which is reasonably close to the ground surface above the intake to the penstock.

The proposed penstock alignment traverses a heavily-wooded and moderately steep slope of the escarpment falling about 230 m at an average slope of about 28 degrees. The boulders and colluvial debris covering the major portion of the slope face appear relatively stable. Disturbance of the boulders at several locations, however, will create locally unstable areas. Several bedrock outcrops were noted in the upper half of the penstock route but none were observed in the lower half. Minor relocation of this portion of the alignment should not result in significantly improved foundation or construction considerations.

Powerhouse/Tailrace
These facilities are located in a fan deposit at the toe of the escarpment mainly comprising coarse granular debris from the slope above. No bedrock

Powerhouse/Tailrace (cont'd.)

outcrop was observed but medium to large boulders are common on the surface and along the adjacent stream bed. Vegetative cover is moderate near the toe of the escarpment and along the stream.

Granite bedrock underlies this area but the rock surface is anticipated at moderate depth. Foundation support for the powerhouse from the coarse granular material would probably be adequate, but some foundation preparation would be required. The tailrace excavation will be mainly in coarse granular material and boulders. Excavation for structures below river level will require extensive dewatering.

Head Pond - Spillway/Intake

Medium to large granitic boulders predominate in the vicinity of the pipeline intake and are common along the shoreline of the pond. Bedrock outcrop is not obvious in the immediate area but overburden is expected to be shallow. Pond water depths in the vicinity of the intake appear shallow.

At the proposed spillway location the streambed comprises small to large granite boulders and tabular rock blocks. Stream flow passes over an apparent bedrock sill but it was not possible to determine whether or not several of the larger rock blocks were detached. Weathering of the bedrock typically occurs along the joint surfaces resulting in separation of individual blocks. Support of the proposed timber crib spillway structure on the underlying bedrock should be reasonably straightforward. Foundation preparation will include the removal of large boulders, and grouting of the bedrock may be required.

Eastward from the stream an organic-filled depression exists which will require filling if the level of the head pond is to be raised significantly. The height of structure required at this location will depend on the pipeline intake elevation desired.

Lake Omega - Diversion Dam

Granite bedrock is exposed in the stream bed near the dam axis and along the shoreline to the northeast about 100 m. The rock is generally massive with

Lake Omega - Diversion Dam (cont'd.)

prominent joint sets sub-horizontal and near-vertical striking roughly at 0^o, 40 and 100^o Az. Moderate weathering along the joint surfaces has resulted in the formation of tabular rock blocks which are typically horizontal along the stream bed. A thin veneer of glacial drift overlies the bedrock, and medium to large granitic boulders are scattered over the ground surface and continuously along the lake shoreline. Above-surface vegetation is sparse but the ground surface is covered for the most part by organic mat.

Foundation conditions appear reasonably straightforward for an earth/rock embankment structure of low to medium height. The crest elevation of this structure will depend on the final grade selected for the diversion canal. Foundation preparation will include the removal of boulders and rock blocks, and possibly grouting of the underlying bedrock to minimize seepage. Northeastward along the dam axis excavation of unsuitable material may be required at several localized depressions. The major portion of the proposed structure alignment is above the existing lake level and foundation dewatering requirements during construction should be minimal. The proposed spillway site and canal at Lake Omega and the control structure site at Lake Michel were not examined during the visit reported herein. Foundation conditions at the spillway are expected to be generally similar to those described at the diversion dam however. From a verbal description of conditions at the Lake Michel control structure it is anticipated that adequate support for the proposed timber structure will be provided, but a substantial volume of boulder excavation within the foundation area will probably be necessary in addition to possibly foundation grouting.

Proposed Borrow Areas - South Access Road

A visual examination of test pits in potential borrow areas previously identified along the tentative south access route was carried out. In each case one test pit considered representative of two or three which has been dug in each deposit was examined.

Water in the pits limited direct observations but the materials excavated were examined. General descriptions of the mineral soils observed and comments regarding suitability are summarized below. Deposits are identified as on Drawing B1-124-C-4 and 5.

Proposed Borrow Areas - South Access Road (cont'd.)

Borrow Area 1 - Fine to medium sand, trace grave, trace silt - suitable for embankment fill.

Borrow Area 2 - Silt, trace sand, wet, suitable as impervious zone material only if water content reduced.

Borrow Area 3 - Well-graded sand to gravelly sand, trace silt probably suitable as filter material.

Borrow Area 4 - Silty fine sand, trace organics, wet - generally unsuitable at present water content.

Borrow Area 5 - Sand with some gravel to gravelly sand, trace silt, wet - possibly suitable as filter material.

Utilization of these deposits will be improved if drainage is provided prior to removal of the materials. Additional comments regarding material characteristics and suitability will be made after the test pit samples are made available for examination and testing.

High quality granular and impervious materials are not generally present on the plateau, although several thin deposits of glacial drift suitable for use as general fill are present. The massive granite bedrock is competent and is suitable for use as rock fill, slope protection and crib ballast.

Additional Geotechnical Investigation

Additional field data will be necessary for final design and costing for this project. As requested, recommendations for the extent of additional geotechnical investigation are presented herein based on the conditions observed on site.

Penstock Route	- Visual evaluation and mapping along route after office optimization based on topographic information.
Surge Tank	- Two sampled boreholes to determine bedrock and overburden characteristics.
Tailrace	- Machine-dug test pits at maximum 100 m intervals.
Head Pond Spillway	- Two sampled boreholes to determine bedrock characteristics. Geological mapping.
Lake Omega Dam	- Three to four sampled boreholes to determine bedrock and overburden. If lake level to be raised substantially

Additional Geotechnical Investigation (cont'd.)

	machine - dug test pits or additional borings required along northerly portion of structure. Gelogical mapping.
Lake Omega Spillway	- Visual examination, possibly supplemented by one or two sampled borings if conditions not obvious.
Lake Omega Canal	- Visual examination and surface mapping.
Lake Michel Control Structure	- Visual examination, possibly supplemented by one or two sampled boreholes if conditions not obvious.
Borrow Areas	- Four to six machine - dug test pits per deposit to confirm quantities.
Access Roads	- Visual examination and surface mapping.

APPENDIX A-2

LAKE MICHEL HYDRO DEVELOPMENT

VISUAL CLASSIFICATION OF SOIL SAMPLES

General

(a) Soils classified by Unified Soil Classification System (Modified).

(b) Soils identified in a particular use category are generally not suitable in a higher category as listed in code below.

(c) E-type soils will typically be difficult to place and compact when wet.

(d) I-type soils will be unsuitable for general embankment construction because of susceptibility to disturbance when wet.

(e) Soils classified SM are moderately to slightly frost susceptible.

(f) Soils classified ML are highly frost susceptible.

Suitability Code

F - Filter or Select Granular

R - Road Surfacing

E - Embankment Fill

I - Semipervious to relatively impervious

1 - Suitable

2 - Acceptable - possibly requiring minor processing

3 - Probably acceptable with considerable processing.

CIMFP Exhibit P-01028

APPENDIX A-2

PROPOSED LAKE MICHEL HYDRO DEVELOPMENT

VISUAL CLASSIFICATION OF SOIL SAMPLES

Area	Pit* No.	Sample No.	Depth (m)	Description (Visual)	USC Class. (Visual)	Suitability (Preliminary)
1	LM-001	1	0.9	SILT & SAND - fine to coarse sand, some gravel, sl. plastic dk. brn., wet.	SM-ML	I-2
1	LM-002	1	0.9	SILT & SAND - fine to medium sand, tr. gravel, some friable lumps, moist, lt. brn.	SM-ML	I-2
1	LM-003	1	1.5	SAND - gravelly, some silt, fine to med. gravel, dk. brn.	SM	E-I
2	LM-004	1	0.9	SAND - gravelly, fine to coarse sand and gravel, tr. to some silt, well-graded, grey, moist.	SW-SM	R-2 F-3
2	LM-005	1	0.9	SILT - sandy, sl. plastic, tr. organics; some hard, friable lumps; dk. brn.	ML	I-2
2	LM-006	1	0.9	SILT - tr. fine sand, tr. clay, sl. plastic, lt. brn., dry (med. strength).	ML	I-2
2	LM-006	1	0.6	SILT & SAND - fine to med. sand, tr. gravel, tr. organics, sl. plastic, dk. brn, wet.	SM-ML	I-2
3	LM-007	1	0.9	SAND - gravelly, fine to med. sand and gravel, tr. to some silt, tr. organics, dk. brn.	SW-SM	R-2 F-3

*Refer to Drawing B1-124-C-5.

APPENDIX A-2 (cont'd.)

PROPOSED LAKE MICHEL HYDRO DEVELOPMENT

VISUAL CLASSIFICATION OF SOIL SAMPLES

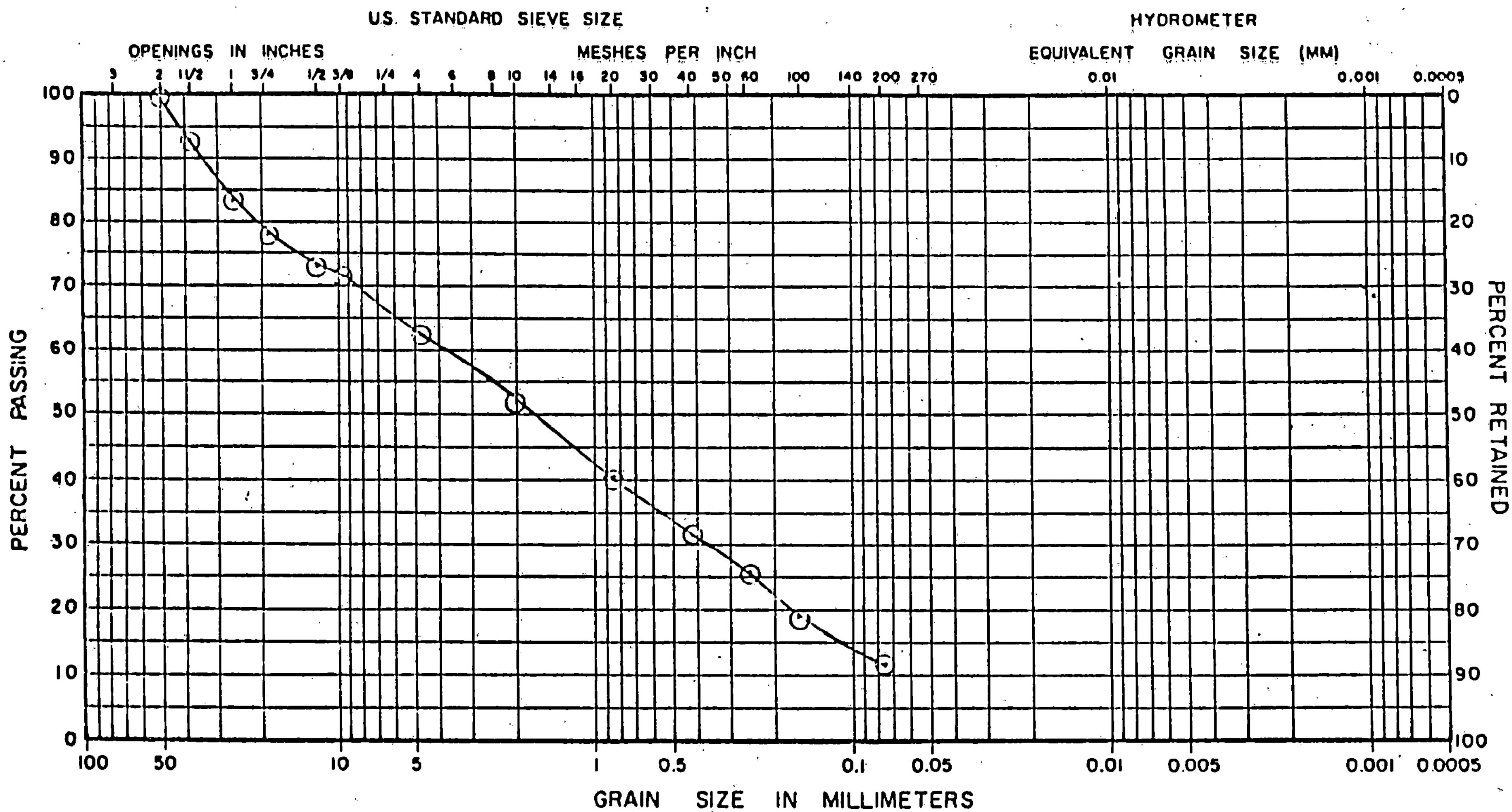
Area	Pit* No.	Sample No.	Depth (m)	Description (Visual)	USC Class. (Visual)	Suitability (Preliminary)
3	LM-008	1	0.9	SAND - gravelly, fine to coarse sand &	SM	R-2
4	LM-009	1	1.2	SAND - fine to coarse, some silt, tr. gravel, well-graded, tr. organics, dk. brn., wet.	SM	E-1
4	LM-009	2	1.5	SAND - silty, fine to coarse sand, tr. gravel, tr. organics, dk. grey, wet.	SM	E-2
4	LM-010	1	1.2	GRAVELLY SAND - fine to coarse sand &	SW	F-2
5	LM-011	1	0.9	SAND - some gravel, tr. to some silt, fine to coarse sand, well-grade tr. organics, dk. brn.	SW-SM	R-2 F-3
6	LM-012	1	0.9	GRAVEL - sandy, fine to coarse gravel, med. to coarse sand, tr. silt well-graded, tr. organics, dk. brn.	GW	F-2

NOTE:- Suitability rating assumes that material available has a water content near or less than the optimum value for compaction.

*Refer to Drawing B1-124-C-5.

GRAIN SIZE DISTRIBUTION

APPENDIX A-3



GRAVEL		SAND			SILT & CLAY
Coarse	Fine	Coarse	Medium	Fine	

UNIFIED SOIL CLASSIFICATION SM

AREA	TESTPIT	SAMPLE	DEPTH	DESCRIPTION
1	LM-003	1	1.5m	SAND & GRAVEL - some silt, brown

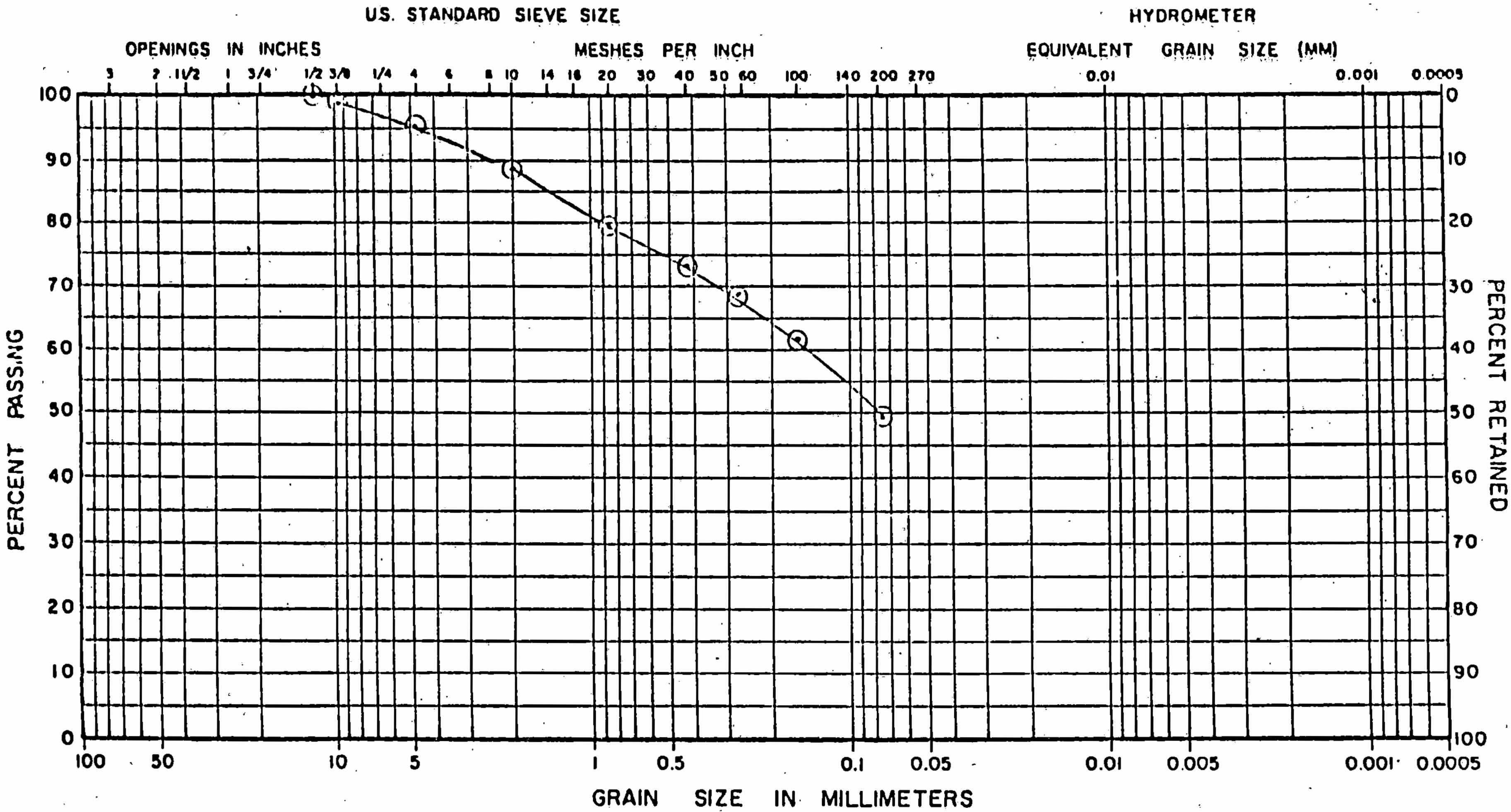
Natural Moisture Content - 15.8%

Lake Michel Hydro Development
82/03/03

APPENDIX 1
FIGURE 1
PROJECT N81-[illegible]

GRAIN SIZE DISTRIBUTION

APPENDIX A-3



GRAVEL		SAND			SILT & CLAY
Coarse	Fine	Coarse	Medium	Fine	

UNIFIED SOIL CLASSIFICATION
SM-ML

AREA	TESTPIT	SAMPLE	DEPTH	DESCRIPTION
2	LM-006	2	0.6m	SILT & SAND - trace gravel, trace organics, slightly plastic, dark brown

LAKE MICHEL HYDRO DEVELOPMENT
82/03/03

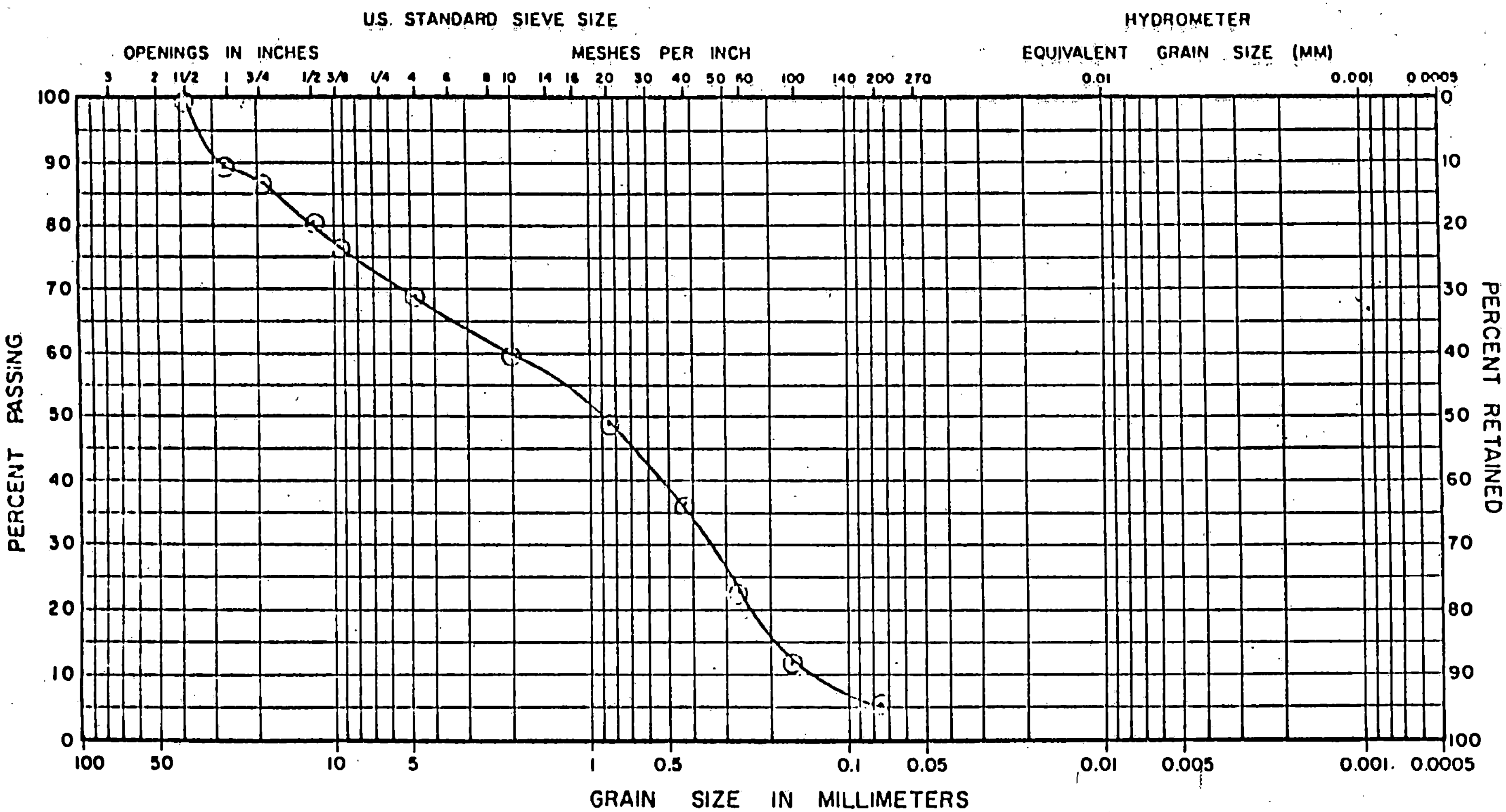
Natural Moisture Content 59.7%

(washed on #200 sieve)

PROJECT N81-4(A)
FIGURE 2
APPENDIX 1

GRAIN SIZE DISTRIBUTION

APPENDIX A-3



GRAVEL		SAND			SILT & CLAY
Coarse	Fine	Coarse	Medium	Fine	

UNIFIED SOIL CLASSIFICATION SW

AREA	TESTPIT	SAMPLE	DEPTH	DESCRIPTION
3	LM-008	1	0.9m	SAND - some gravel, trace silt, brown,

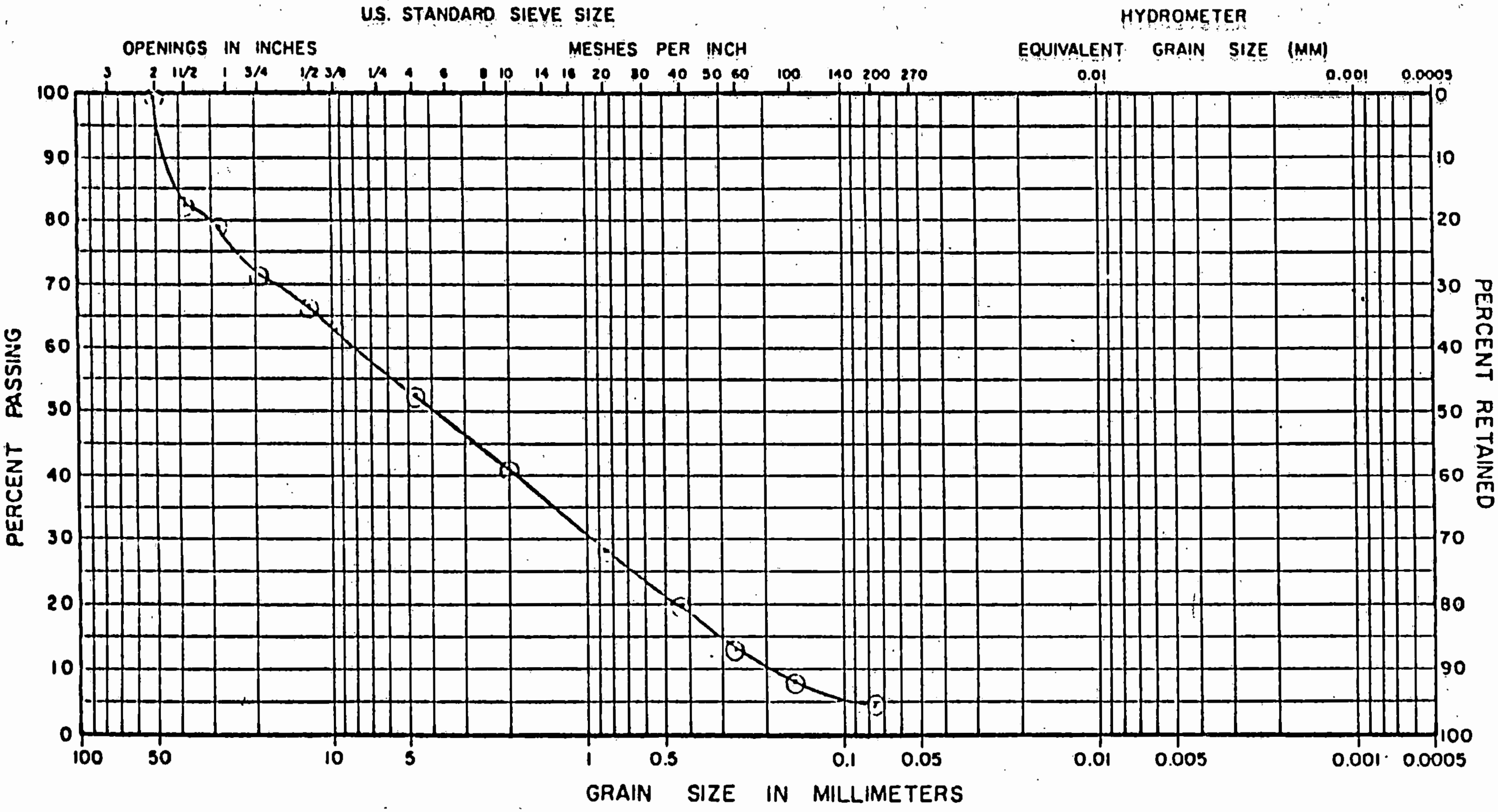
Natural Moisture Content - 9.5%

Lake Michel Hydro Development
82/03/03

PROJECT M81-4[illegible]
FIGURE 3
APPENDIX 1

GRAIN SIZE DISTRIBUTION

APPENDIX A-3



GRAVEL		SAND			SILT & CLAY
Coarse	Fine	Coarse	Medium	Fine	

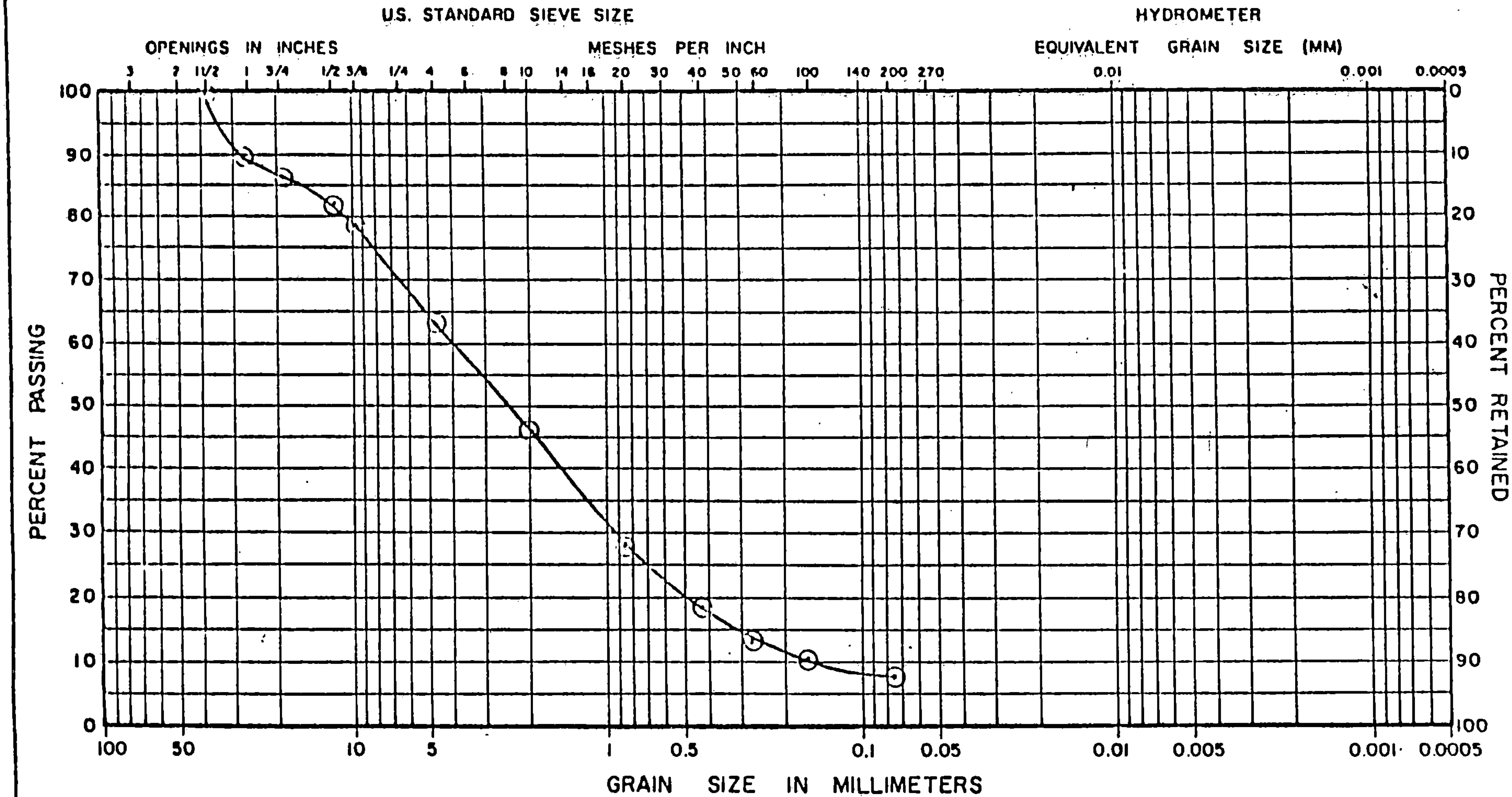
UNIFIED SOIL CLASSIFICATION
GW-SW

AREA	TESTPIT	SAMPLE	DEPTH	DESCRIPTION
4	LM-010	1	1.2m	SAND & GRAVEL - trace silt, brown

Natural Moisture Content - 11.9%

Lake Michel Hydro Development
82/03/03

PROJECT N81-4G..
FIGURE 4
APPENDIX 1



GRAIN SIZE DISTRIBUTION

APPENDIX A-3

GRAVEL		SAND			SILT & CLAY
Coarse	Fine	Coarse	Medium	Fine	

UNIFIED SOIL CLASSIFICATION
SW-SM

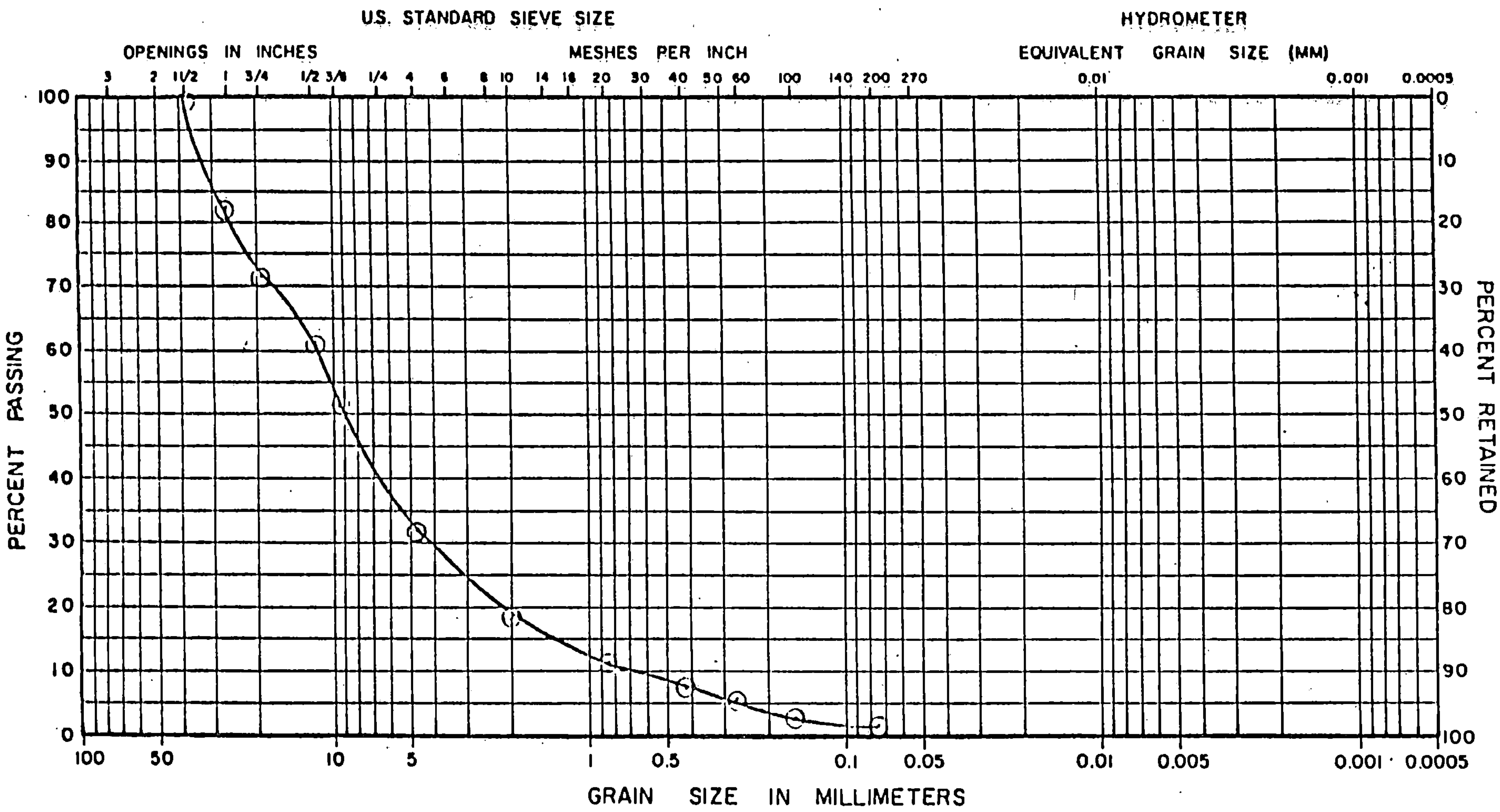
AREA	TESTPIT	SAMPLE	DEPTH	DESCRIPTION
5	LM-011	1	0.9m	GRAVELLY SAND - trace silt, brown Natural Moisture Content - 15.0%

Lake Michel Hydro Development
82/03/03

APPENDIX	FIGURE	PROJECT
1	5	N81-4CA

GRAIN SIZE DISTRIBUTION

APPENDIX A-3



GRAVEL		SAND			SILT & CLAY
Coarse	Fine	Coarse	Medium	Fine	

UNIFIED SOIL CLASSIFICATION

AREA	TESTPIT	SAMPLE	DEPTH	DESCRIPTION	
					GW
6	LM-013	1	0.9m	SANDY GRAVEL - trace silt, brown	
				Natural Moisture Content - 11.3%	

Lake Michel Hydro Development
82/03/03

APPENDIX 1
FIGURE 6
PROJECT N81-46A

APPENDIX B

BORROW MATERIAL INFORMATION

APPENDIX B-1

MATERIAL SPECIFICATION

A. Impervious Fill (Zone 1)

1. Description

Materials for impervious fill shall consist of a well graded glacial till obtained from approved borrow areas. The minus No. 4 size fraction shall contain not less than 20% passing the No. 200 sieve size.

2. Borrow Areas

Borrow Area No. 2 will be utilized as the source of material for the Lake Omega Dam and the Head Pond Dam. This material requires no processing for use in the dams.

B. Fine Filter (Zone 2)

1. Description

Filter material shall consist of a well graded, processed, free draining mixture of sand and gravel. The filter material shall range within 40 to 70 percent gravel sizes graded from 75 mm to 10 mm. The remaining minus 10 mm material shall comprise 30 to 60 percent of the material and shall contain not more than 2 percent passing the 200 mesh size.

2. Borrow Areas

Borrow Area No. 6 will be utilized as the source of material for the Lake Omega Dam. This material may require some screening to remove oversize material.

C. Coarse Filter and Gravel (Zone 3)

1. Description

Materials for coarse filter shall consist of a well graded sand and gravel with approximately 20 percent greater than 75 mm and not more than 7 percent passing the 200 mesh size. The maximum size shall be 2/3 the thickness of the lift being placed (300 mm).

C. Coarse Filter and Gravel (cont'd.)

2. Borrow Areas

Borrow Area No. 4 will be utilized as a source of material for the Lake Michel Dam and Head Pond Dam. This material will require no processing for use in the dams.

D. Rockfill (Zone 4)

1. Description

Materials for rockfill shall consist of particles of hard, durable, dense rock which shall be well graded within the following limits:-

Materials Size (mm)	Percent Finer Than by Weight
600	100
300	80 - 100
50	40 - 75
25	0 - 50
12	0 - 30
3	0 - 10

Material finer than a No. 100 sieve will not exceed 5 percent by weight of the fraction passing the 500 mm sieve.

2. Borrow Areas

Excavated rock from the canal area will be utilized as rockfill for the Lake Omega Dam; excavated rock from the penstock will be utilized as rockfill for the Head Pond Dam; and quarried rock from a quarry to be established near the structure will be utilized as rockfill for the Lake Michel Dams.

E. Rip Rap (Zcne 5)

1. Description

Rip rap material shall consist of particles of hard, durable, dense rock which shall be well graded within the following limits:-

E. Rip Rap (Zone 5)

1. Description (cont'd.)

Materials Size (mm)	Percent Finer Than by Weight
900	100
600	90 - 100
300	35 - 60
50	0 - 5

Particles less than 2 inches in size shall comprise not more than 5 percent by volume of the material placed.

2. Borrow Areas

Excavated rock from the canal area will be utilized as rip rap for the Lake Omega Dam and excavated rock from the penstock will be utilized as rip rap for the Head Pond structures.

APPENDIX B-2
MATERIAL REQUIREMENTS AND SOURCE

STRUCTURE ZONE	MATERIAL* SOURCE	QUANTITY REQUIRED (m^3)	PROCESSING REQUIRED	MATERIAL AVAILABLE (m^3)	REMARKS
1. Lake Michel Dams					
- rockfill	Quarry	5,000	Crushing	Unlimited	
2. Lake Omega Dam					
- impervious	Borrow Area 2	19,000	None	400,000	May need drying.
- fine filter	Borrow Area 6	1,000	Screening	250,000	Alt. Borrow Areas 1 & 5.
- coarse filter	Borrow Area 4	1,000	None	500,000	Alt. Borrow Areas 1 & 5.
- rockfill	Excavation (canal)	13,000	Crushing	77,000	
- rip rap	Excavation (canal)	1,000	Selection	77,000	
3. Head Pond Dam					
- rockfill	Excavation (P.S.)	3,000	Crushing	175,000	
- impervious	Borrow Area 2	5,000	None	400,000	May need drying.
- coarse filter	Borrow Area 4	1,000	None	500,000	Alt. Borrow Areas 1 & 5.
4. Penstock					
- select backfill	Borrow Areas 3 & 4	34,000	None	800,000	Area 3-Sand,Area 4-Gravel.
- Rockfill	Excavation (P.S.)	27,000	Crushing	175,000	
5. Roads					
- rockfill	Quarry	119,000	Crushing	Unlimited	Quarries Opened as req'd.
- base coarse	Borrow Areas 4,7&8	45,000	None	850,000	Alt. Borrow Areas 1 & 5.
- topping	Borrow Areas 4,7&8	23,000	Screening	850,000	Alt. Borrow Areas 1 & 5.
6. Concrete (All Strs.)					
- gravel	Borrow Area 4	1,000	Washing & Screening	500,000	Alt. Borrow Areas 1 & 5.
- sand	Borrow Area 3	800	Washing & Screening	300,000	

*Refer to Drawing B1-124-C-4.

APPENDIX C

OMEGA DIVERSION

F.S.L. OPTIMIZATION

LAKE MICHEL HYDRO DEVELOPMENT

OMEGA DIVERSION OPTIMIZATION

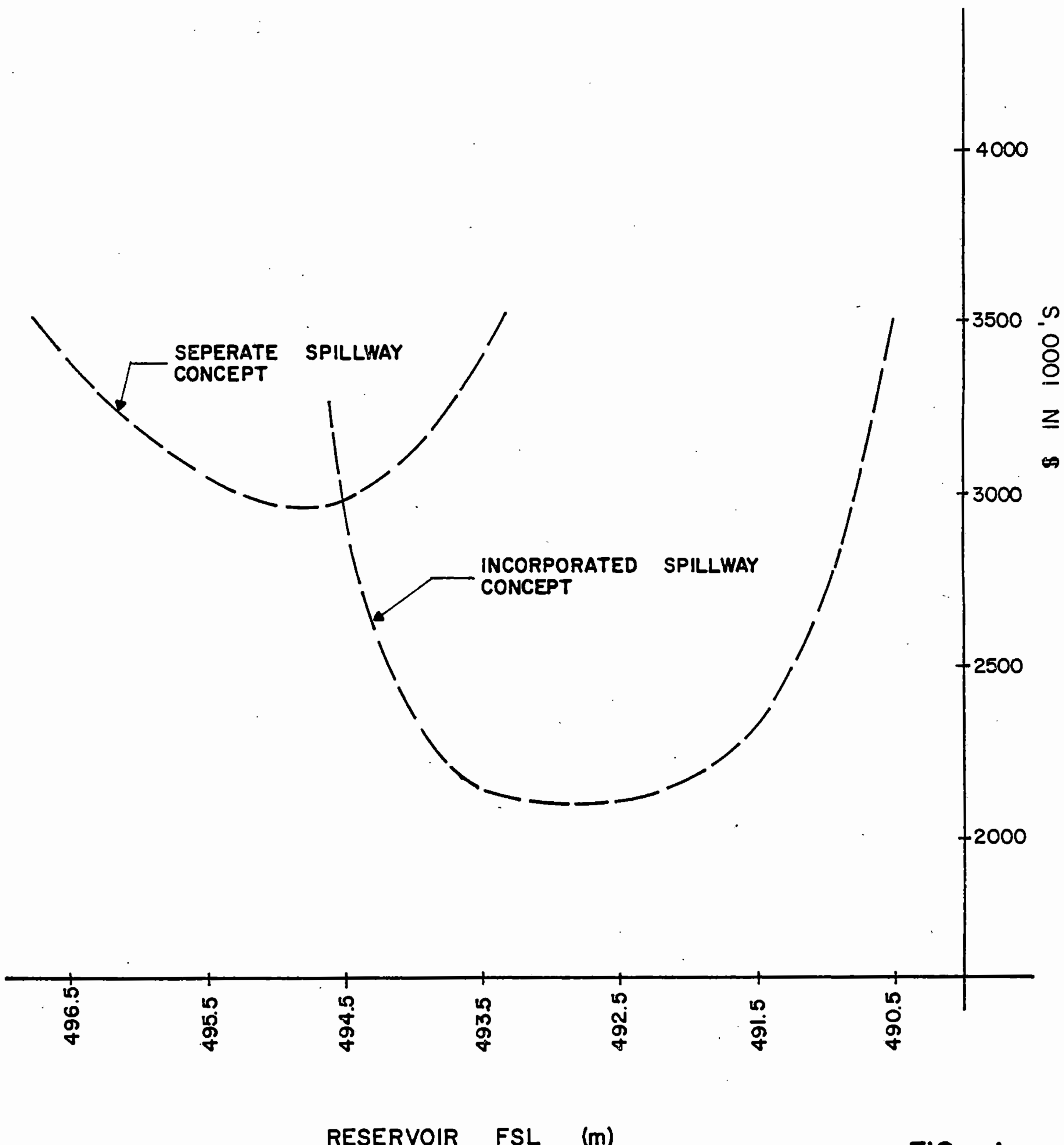


FIG. 1

CIMFP Exhibit P-01028

APPENDIX D

HYDROLOGICAL INFORMATION

MONTHLY AND ANNUAL MEAN FLOWS FOR LAKE MICHEL

Drainage Area 103 sq. km.

Flows in cu. m/s

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1958							1.11	2.99	4.67	3.57	5.32	2.16	
1959	0.56	0.40	0.19	3.92	10.5	9.6	1.86	1.27	1.46	3.05	4.26	4.41	3.46
1960	0.94	1.11	0.38	2.73	14.4	5.3	0.81	0.40	1.21	3.83	2.40	1.49	2.92
1961	0.35	0.16	0.43	2.57	13.6	7.3	2.89	1.33	2.70	6.05	3.21	1.30	2.88
1962	0.72	0.89	0.56	4.89	11.6	15.1	1.86	2.92	1.27	2.86	8.05	2.21	4.41
1963	4.26	0.97	0.27	3.19	18.1	7.5	2.46	3.19	3.13	2.73	4.38	2.86	4.76
1964	0.38	0.52	0.56	5.46	12.3	14.8	3.81	2.05	1.40	2.16	3.11	1.70	4.02
1965	0.97	0.24	2.73	1.33	8.1	19.9	1.81	2.18	1.16	3.78	4.94	0.78	3.99
1966	0.62	0.62	1.00	2.37	10.5	13.4	1.16	2.05	2.46	6.75	3.54	1.49	3.83
1967	0.71	0.32	0.24	0.49	12.6	13.2	1.16	0.71	2.51	4.05	5.22	1.30	3.54
1968	0.49	1.70	2.67	5.69	8.9	9.1	1.33	1.65	2.83	2.95	2.97	2.54	3.57
1969	1.35	4.38	1.11	0.97	14.4	19.1	1.19	2.57	1.81	2.97	5.67	6.81	5.28
1970	1.78	0.72	0.30	0.46	17.0	5.5	0.81	0.71	1.75	2.76	4.67	1.73	3.18
1971	0.62	0.46	0.38	8.89	21.7	4.5	1.86	2.95	2.37	5.25	4.62	1.16	4.56
1972	0.59	0.40	1.73	1.40	11.4	19.9	3.08	2.00	3.57	4.57	2.30	2.08	4.42
1973	0.38	0.62	0.89	1.11	18.2	10.9	4.67	4.00	2.05	2.35	3.02	4.70	4.41
1974	0.46	0.19	0.22	0.71	7.0	18.9	2.57	1.30	1.65	3.45	2.67	2.08	3.43
1975	0.40	0.13	0.32	1.78	14.9	10.6	0.72	2.21	2.21	4.48	5.62	2.99	3.86
1976	2.59	2.37	3.51	6.24	14.7	5.5	1.97	1.95	2.18	3.58	4.13	2.55	4.27
1977	1.37	0.56	0.46	2.65	13.4	26.3	5.43	2.62	2.97	7.80	2.33	3.48	5.8
1978	5.59	0.40	0.16	0.49	17.9	8.0							
Mean	1.26	0.83	0.91	2.87	13.0	12.2	2.13	2.05	2.27	3.95	4.12	2.49	4.03

APPENDIX D1

LAKE MICHEL REGULATION STUDY APPENDIX D2 Work Sheet

SUMMARY SHEET

INPUT DATA:

Study Period July 1, 1958 to June 30, 1978		=	240 months
Average Basin Flow		=	4.03 cms
Drainage Area Ratios:	– Lake Michel Reservoir	=	0.311
	– Omega Reservoir	=	0.495
	– Omega Diversion	=	0.194
Reservoir Volumes	– Lake Michel Reservoir	=	7.61 cms.mos.
	– Omega Reservoir	=	0.65 cms.mos.

Maximum Plant Flow = 5.30 cms
Firm Flow = 2.02 cms

$\frac{kW}{cms}$ Ratio = 2141

Rule Curve Points cms.mos.

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
4.36	2.80	1.30	1.00	3.76	7.04	5.77	4.14	3.32	5.10	6.20	5.67

RESULTS:

Total Spill at Omega Diversion	=	50.80			cms.mos.
Total Plant Spill	=	130.84			"
Total Plant Flow	=	788.88			"
Total Basin Flow	=	970.52			"
Average Spill at Omega Diversion	=	0.21			cms
Average Plant Spill	=	0.54			cms
Average Plant Flow	=	3.29			cms
Average Basin Flow	=	4.04			
Firm Energy Output	=	4325	kW	37.9	(gWh p.a.)
Secondary Energy Output	=	2712	kW	23.7	(gWh p.a.)
Average Energy Output	=	7037	kW	61.6	(gWh p.a.)
Plant Capacity Factor (Firm)	=	36.0	%		
Plant Capacity Factor (Avg.)	=	58.6	%		

LAKE MICHEL — ALTERNATIVE

WORK SHEET 3

YEAR 1958		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s							1.11	2.99	4.67	3.57	5.32	2.16	
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s							0.35	0.93	1.45	1.11	1.65	0.67	
OUTFLOW	m^3/s							1.62	2.56	2.09	0.00	0.07	1.20	
VOLUME	m^3/s-mos							5.	4.14	3.71	4.62	6.20	5.67	
W.L.	m							526.7	[illegible]	526.1	526.4	526.8	526.6	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s							0.22	0.58	0.91	0.69	1.01	0.42	
SPILL	m^3/s							0.00	0.00	0.00	0.00	0.05	0.00	
OMEGA RESERVOIR:														
INFLOW	m^3/s							2.38	4.62	5.30	2.46	3.71	2.69	
OUTFLOW	m^3/s							2.38	4.62	5.30	2.46	3.71	2.69	
VOLUME	m^3/s-mos							0.65 —	—	—	—	—	— 0.65	
W.L.	m							924.0 —	—	—	—	—	— 924.0	
PLANT FLOW	m^3/s							2.38	4.62	5.30	2.46	3.71	2.69	[illegible]
SPILL AT PLANT	m^3/s							0.00	0.00	0.00	0.00	0.00	0.00	[illegible]

YEAR 1959		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	0.56	0.40	0.19	3.92	10.5	9.6	1.86	1.27	1.46	3.05	4.26	4.41	[illegible]
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	0.17	0.12	0.06	1.22	3.27	2.99	0.58	0.39	0.45	0.95	1.32	1.37	
OUTFLOW	m^3/s	1.63	1.74	1.89	0.98	0.00	0.21	1.85	2.02	1.27	0.00	0.00	1.29	
VOLUME	m^3/s-mos	4.21	2.59	0.76	1.00	4.27	7.04	5.77	4.14	3.32	4.27	5.59	5.67	
W.L.	m	526.3	525.8	525.5	525.4	526.3	527.0	526.7	526.2	526.0	526.3	526.6	526.6	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.11	0.08	0.04	0.76	1.21	1.17	0.36	0.25	0.28	0.59	0.83	0.86	
SPILL	m^3/s	0.00	0.00	0.00	0.00	0.83	0.69	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]
OMEGA RESERVOIR:														
INFLOW	m^3/s	2.02	2.02	2.02	3.68	6.40	6.14	3.13	2.90	2.28	2.10	2.94	4.33	
OUTFLOW	m^3/s	2.02	2.02	2.02	3.68	6.40	6.14	3.13	2.90	2.28	2.10	2.94	4.33	
VOLUME	m^3/s-mos	0.65 —	—	—	—	—	—	—	—	—	—	—	— 0.65	
W.L.	m	924.0 —	—	—	—	—	—	—	—	—	—	—	— 924.0	
PLANT FLOW	m^3/s	2.02	2.02	2.02	3.63	5.30	5.30	3.13	2.90	2.28	2.10	2.94	4.33	[illegible]
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	1.10	0.84	0.00	0.00	0.00	0.00	0.00	0.00	

LAKE MICHEL — ALTERNATIVE

YEAR 1960		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	0.94	1.11	0.38	2.73	14.4	5.3	0.81	0.40	1.21	3.83	2.40	1.49	[illegible]
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	0.29	0.35	0.12	0.25	4.48	1.65	0.25	0.12	0.38	1.19	0.75	0.46	
OUTFLOW	m^3/s	1.60	1.91	1.76	1.51	0.00	0.09	1.52	1.75	1.20	0.00	0.37	[illegible]	
VOLUME	m^3/s-mos	4.36	2.80	1.16	1.00	5.48	7.04	5.77	4.14	3.32	4.51	4.80	4.5[illegible]	
W.L.	m	[illegible]	525.9	525.5	525.4	526.6	527.0	526.7	526.7	526.0	526.3	526.4	[illegible]	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.18	0.22	0.07	0.53	1.36	1.01	0.16	0.08	0.23	0.74	0.47	0.29	
SPILL	m^3/s	0.00	0.00	0.00	0.00	1.43	0.02	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]
OMEGA RESERVOIR:														
INFLOW	m^3/s	2.25	2.67	2.02	2.89	8.49	3.72	2.08	2.03	2.03	2.64	2.02	2.02	
OUTFLOW	m^3/s	2.25	2.67	2.02	2.89	8.49	3.72	2.08	2.03	2.03	2.64	2.02	2.02	
VOLUME	m^3/s-mos	0.65	—	—	—	—	—	—	—	—	—	—	0.65	
W.L.	m	924.0	—	—	—	—	—	—	—	—	—	—	924.0	
PLANT FLOW	m^3/s	2.25	2.67	2.02	2.89	5.30	3.72	2.08	2.03	2.03	2.64	2.02	2.02	[illegible]
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]

YEAR 1961		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	0.35	0.16	0.43	2.57	13.6	7.3	2.89	1.33	2.70	6.05	3.21	1.30	[illegible]
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	0.11	0.05	0.13	0.80	4.23	2.27	0.90	0.41	0.84	1.88	1.00	0.40	
OUTFLOW	m^3/s	1.78	1.91	0.96	0.25	0.00	0.01	2.17	2.04	1.66	0.52	0.00	1.12	
VOLUME	m^3/s-mos	2.69	0.83	0.00	0.55	4.78	7.04	5.77	4.14	3.32	4.68	5.68	[illegible]	
W.L.	m	525.9	525.4	525.2	525.3	526.4	527.0	526.7	[illegible]	526.0	526.4	526.6	[illegible]	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.07	0.03	0.08	0.50	1.33	1.08	0.56	0.26	0.52	1.03	0.62	[illegible]	
SPILL	m^3/s	0.00	0.00	0.00	0.00	1.31	0.23	0.00	0.00	0.00	[illegible]	0.00	0.00	[illegible]
OMEGA RESERVOIR:														
INFLOW	m^3/s	2.02	2.02	1.25	2.02	3.06	4.71	4.16	2.96	3.52	4.55	2.21	2.02	
OUTFLOW	m^3/s	2.02	2.02	2.02	2.02	7.30	4.71	4.16	2.96	3.52	4.55	2.21	2.02	
VOLUME	m^3/s-mos	0.65	0.65	-0.11	-0.11	0.65	—	—	—	—	—	—	0.65	
W.L.	m	924.0	924.0	922.0	922.0	924.0	—	—	—	—	—	—	924.0	
PLANT FLOW	m^3/s	2.02	2.02	2.02	2.02	5.30	4.71	4.16	2.96	3.52	4.55	2.21	2.02	[illegible]
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]

LAKE MICHEL — ALTERNATIVE

YEAR 1962		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	0.72	0.89	0.56	4.89	11.6	15.1	1.86	2.92	1.27	2.86	8.05	2.21	[illegible]
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	0.22	0.28	0.17	1.52	3.61	4.70	0.58	0.91	0.39	0.89	2.50	0.69	
OUTFLOW	m^3/s	1.52	1.41	1.63	1.59	0.00	2.26	1.85	2.54	1.21	0.05	0.20	1.43	
VOLUME	m^3/s-mos	3.66	2.53	1.07	1.00	4.61	7.04	5.77	4.14	3.32	4.16	6.46	5.67	
W.L.	m	526.1	525.8	525.4	525.4	526.4	527.0	526.7	526.2	526.0	526.2	526.8	526.6	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.14	0.17	0.11	0.95	1.25	1.39	0.36	0.57	0.25	0.55	1.11	0.43	
SPILL	m^3/s	0.00	0.00	0.00	0.00	1.00	1.54	0.00	0.00	0.00	0.00	0.45	0.00	[illegible]
OMEGA RESERVOIR:														
INFLOW	m^3/s	2.02	2.02	2.02	4.96	6.99	11.12	3.13	4.55	2.09	2.02	5.30	3.00	
OUTFLOW	m^3/s	2.02	2.02	2.02	4.96	6.99	11.12	3.13	4.55	2.09	2.02	5.30	3.00	
VOLUME	m^3/s-mos	0.65	—	—	—	—	—	—	—	—	—	—	0.65	
W.L.	m	924.0	—	—	—	—	—	—	—	—	—	—	924.0	
PLANT FLOW	m^3/s	2.02	2.02	2.02	4.96	5.30	5.30	3.13	4.55	2.09	2.02	5.30	3.00	170.57
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	1.69	5.82	0.00	0.00	0.00	0.00	0.00	0.00	11.45

YEAR 1963		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	4.26	0.97	0.27	3.19	18.1	7.5	2.46	3.19	3.13	2.73	4.38	2.86	244.3
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	1.32	0.30	0.08	0.99	5.63	2.33	0.77	0.99	0.97	0.85	1.36	0.89	
OUTFLOW	m^3/s	2.36	2.13	1.83	1.04	0.00	1.92	2.04	2.62	1.79	0.14	0.00	0.61	
VOLUME	m^3/s-mos	4.63	2.80	1.05	1.00	6.63	7.04	5.77	4.14	3.32	4.03	5.39	5.67	
W.L.	m	526.4	525.9	525.4	525.4	526.9	527.0	526.7	526.2	526.0	526.2	526.6	526.6	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.83	0.19	0.05	0.62	1.50	1.09	0.48	0.62	0.61	0.53	0.85	0.55	
SPILL	m^3/s	0.00	0.00	0.00	0.00	2.01	0.36	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]
OMEGA RESERVOIR:														
INFLOW	m^3/s	5.30	2.80	2.02	3.24	10.46	6.73	3.73	4.82	3.95	2.02	3.02	2.58	
OUTFLOW	m^3/s	5.30	2.80	2.02	3.24	10.46	6.73	3.73	4.82	3.95	2.02	3.02	2.58	
VOLUME	m^3/s-mos	0.65	—	—	—	—	—	—	—	—	—	—	0.65	
W.L.	m	924.0	—	—	—	—	—	—	—	—	—	—	924.0	
PLANT FLOW	m^3/s	5.30	2.80	2.02	3.24	5.30	5.30	3.73	4.82	3.95	2.02	3.02	2.58	[illegible]
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	5.16	1.43	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]

LAKE MICHEL — ALTERNATIVE

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YEAR 1964		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	0.38	0.52	0.56	5.46	12.3	14.8	3.81	2.05	1.40	2.16	3.11	1.70	[illegible]
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	0.12	0.16	0.17	1.70	3.83	4.60	1.18	0.64	0.44	0.67	0.97	0.53	
OUTFLOW	m^3/s	1.76	1.66	1.63	1.59	0.00	2.57	2.45	2.27	1.26	0.53	0.00	0.85	
VOLUME	m^3/s-mos	4.03	2.53	1.07	1.18	5.01	7.04	5.77	4.14	3.32	3.46	4.43	4.11	
W.L.	m	526.2	525.8	525.4	525.5	526.5	527.0	526.7	526.2	526.0	526.1	526.3	526.2	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.07	0.10	0.11	1.01	1.28	1.37	0.74	0.40	0.27	0.42	0.60	0.33	
SPILL	m^3/s	0.00	0.00	0.00	0.05	1.11	1.50	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]
OMEGA RESERVOIR:														
INFLOW	m^3/s	2.02	2.02	2.02	5.30	7.37	11.27	5.08	3.68	2.22	2.02	2.14	2.02	
OUTFLOW	m^3/s	2.02	2.02	2.02	5.30	7.37	11.27	5.08	3.68	2.22	2.02	2.14	2.02	
VOLUME	m^3/s-mos	0.65											0.65	
W.L.	m	924.0											924.0	
PLANT FLOW	m^3/s	2.02	2.02	2.02	5.30	5.30	5.30	5.08	3.68	2.22	2.02	2.14	2.02	253.2[illegible]
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	2.07	5.97	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]

YEAR 1965		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	0.97	0.24	2.73	1.33	8.1	19.9	1.81	2.18	1.16	3.78	4.94	0.78	[illegible]
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	0.30	0.07	0.85	0.41	2.52	6.19	0.56	0.68	0.36	1.18	1.54	0.24	
OUTFLOW	m^3/s	1.35	1.85	0.83	1.10	0.00	2.28	1.83	2.31	1.22	0.00	0.00	1.48	
VOLUME	m^3/s-mos	3.06	1.28	1.30	0.61	3.13	7.04	5.77	4.14	3.28	4.46	5.99	4.75	
W.L.	m	526.0	525.5	525.5	525.3	526.0	527.0	526.0	526.2	526.0	526.3	526.7	526.4	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.19	0.05	0.53	0.26	1.11	1.57	0.35	0.42	0.23	0.73	0.96	0.15	
SPILL	m^3/s	0.00	0.00	0.00	0.00	0.46	2.29	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]
OMEGA RESERVOIR:														
INFLOW	m^3/s	2.02	2.02	2.71	2.02	5.12	13.70	3.08	3.81	2.02	2.60	3.40	2.02	
OUTFLOW	m^3/s	2.02	2.02	2.71	2.02	5.12	13.70	3.08	3.81	2.02	2.60	3.40	2.02	
VOLUME	m^3/s-mos	0.65											0.65	
W.L.	m	924.0											924.0	
PLANT FLOW	m^3/s	2.02	2.02	2.71	2.02	5.12	5.30	3.08	3.81	2.02	2.60	3.40	2.02	289.39
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	0.00	8.40	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]

LAKE MICHEL — ALTERNATIVE

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YEAR 1966		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m³/s	0.62	0.62	1.00	2.37	10.5	13.4	1.16	2.05	2.46	6.75	3.54	1.49	[illegible]
LAKE MICHEL RESERVOIR:														
INFLOW	m³/s	0.19	0.19	0.31	0.74	3.27	4.17	0.36	0.64	0.77	2.10	1.10	0.46	
OUTFLOW	m³/s	1.59	1.59	1.33	0.67	0.00	1.39	1.63	2.27	1.59	0.32	0.00	0.99	
VOLUME	m³/s-mos	3.35	1.95	0.93	1.00	4.27	7.04	5.77	4.12	3.32	5.10	6.20	5.67	
W.L.	m	526.0	525.7	525.4	525.4	526.3	527.0	526.7	526.2	526.0	526.5	526.8	526.6	
OMEGA DIVERSION:														
DIVERTED FLOW	m³/s	0.12	0.12	0.19	0.46	1.21	1.32	0.23	0.40	0.48	1.06	0.69	0.22	
SPILL	m³/s	0.00	0.00	0.00	0.00	0.83	1.28	0.00	0.00	0.00	0.25	0.00	0.00	[illegible]
OMEGA RESERVOIR:														
INFLOW	m³/s	2.02	2.02	2.02	2.30	6.40	9.35	2.43	3.68	3.28	4.72	2.44	2.02	
OUTFLOW	m³/s	2.02	2.02	2.02	2.30	6.40	9.35	2.43	3.68	3.28	4.72	2.44	2.02	
VOLUME	m³/s-mos	0.65											0.65	
W.L.	m	524.0											524.0	
PLANT FLOW	m³/s	2.02	2.02	2.02	2.30	5.30	5.30	2.43	3.68	3.28	4.72	2.44	2.02	326.92
SPILL AT PLANT	m³/s	0.00	0.00	0.00	0.00	1.10	4.05	0.00	0.00	0.00	0.00	0.00	0.00	39.6[illegible]

YEAR 1967		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m³/s	0.71	0.32	0.24	0.49	12.6	13.2	1.16	0.71	2.51	4.05	5.22	1.50	[illegible]
LAKE MICHEL RESERVOIR:														
INFLOW	m³/s	0.22	0.10	0.07	0.15	3.92	4.11	0.36	0.22	0.78	1.26	1.62	0.40	
OUTFLOW	m³/s	1.53	1.80	1.85	1.03	0.00	0.99	1.63	1.85	1.60	0.00	0.00	1.12	
VOLUME	m³/s-mos	4.36	2.66	0.88	0.00	3.92	7.04	5.77	4.14	3.32	4.58	6.20	5.48	
W.L.	m	526.3	525.8	525.4	525.2	526.2	527.0	526.7	526.2	526.0	526.4	526.8	526.6	
OMEGA DIVERSION:														
DIVERTED FLOW	m³/s	0.14	0.06	0.05	0.10	1.29	1.31	0.23	0.14	0.49	0.79	1.00	0.25	
SPILL	m³/s	0.00	0.00	0.00	0.00	1.16	1.25	0.00	0.00	0.00	0.00	0.01	0.00	20.33
OMEGA RESERVOIR:														
INFLOW	m³/s	2.02	2.02	2.02	1.37	7.53	8.83	2.43	2.34	3.33	2.79	3.59	2.02	
OUTFLOW	m³/s	2.02	2.02	2.02	2.02	6.88	8.83	2.43	2.34	3.33	2.79	3.59	2.02	
VOLUME	m³/s-mos	0.65	0.65	0.65	0.00	0.65							0.65	
W.L.	m	524.0	524.0	524.0	522.0	524.0							524.0	
PLANT FLOW	m³/s	2.02	2.02	2.02	2.02	5.30	5.30	2.43	2.34	3.33	2.79	3.59	2.02	362.10
SPILL AT PLANT	m³/s	0.00	0.00	0.00	0.00	1.58	3.53	0.00	0.00	0.00	0.00	0.00	0.00	44.74

LAKE MICHEL — ALTERNATIVE

YEAR 1968		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	0.49	1.70	2.67	5.69	8.9	9.1	1.33	1.65	2.83	2.95	2.97	2.54	47.5[illegible]
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	0.15	0.53	0.83	1.77	2.77	2.83	0.41	0.51	0.88	0.92	0.92	0.7[illegible]	
OUTFLOW	m^3/s	1.68	1.68	2.33	1.46	0.00	0.16	1.68	2.14	1.70	0.00	0.00	0.28	
VOLUME	m^3/s-mos	3.95	2.80	1.30	1.61	4.37	7.04	5.77	4.14	3.32	4.24	5.16	5.67	
W.L.	m	526.2	525.9	525.5	525.6	526.3	527.0	526.7	526.2	526.0	526.3	526.5	526.6	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.10	0.33	0.52	1.02	1.15	1.15	0.26	0.32	0.55	0.57	0.58	0.44	
SPILL	m^3/s	0.00	0.00	0.00	0.08	0.58	0.61	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]
OMEGA RESERVOIR:														
INFLOW	m^3/s	2.02	2.85	4.17	5.30	5.55	5.82	2.60	3.28	3.65	2.03	2.05	2.03	
OUTFLOW	m^3/s	2.02	2.85	4.17	5.30	5.55	5.82	2.60	3.28	3.65	2.03	2.05	2.03	
VOLUME	m^3/s-mos	0.65											0.65	
W.L.	m	324.0											324.0	
PLANT FLOW	m^3/s	2.02	2.85	4.17	5.30	5.30	5.30	2.60	3.28	3.65	2.03	2.05	2.03	[illegible]
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	0.25	0.52	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]

YEAR 1969		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	1.35	4.38	1.11	0.97	14.4	19.1	1.19	2.57	1.81	2.97	5.67	6.81	533.9[illegible]
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	0.42	1.36	0.35	0.30	4.48	5.94	0.37	0.80	0.56	0.92	1.76	2.12	
OUTFLOW	m^3/s	1.73	2.28	2.49	1.35	0.00	3.63	1.64	2.43	1.38	0.00	0.00	1.08	
VOLUME	m^3/s-mos	4.36	3.44	1.30	0.25	4.73	7.04	5.77	4.14	3.32	4.24	6.01	7.04	
W.L.	m	526.3	526.1	525.5	525.2	526.4	527.0	526.7	526.2	526.0	526.3	526.7	527.0	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.26	0.85	0.22	0.19	1.36	1.54	0.23	0.50	0.35	0.58	1.02	1.06	
SPILL	m^3/s	0.00	0.00	0.00	0.00	1.43	2.16	0.00	0.00	0.00	0.00	0.08	0.26	25.53
OMEGA RESERVOIR:														
INFLOW	m^3/s	2.66	5.30	3.25	2.02	8.49	14.62	2.46	4.20	2.63	2.05	3.83	5.52	
OUTFLOW	m^3/s	2.66	5.30	3.25	2.02	8.49	14.62	2.46	4.20	2.63	2.05	3.83	5.52	
VOLUME	m^3/s-mos	0.65											0.65	
W.L.	m	324.0											324.0	
PLANT FLOW	m^3/s	2.66	5.30	3.25	2.02	5.30	5.30	2.46	4.20	2.63	2.63	3.83	5.30	447.56
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	3.19	9.32	0.00	0.00	0.00	0.00	0.00	0.22	58.24

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YEAR 1970		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	1.78	0.72	0.30	0.46	17.0	5.5	0.81	0.71	1.75	2.76	4.67	1.73	[illegible]
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	0.55	0.22	0.09	0.14	5.29	1.71	0.25	0.22	0.54	0.86	1.45	0.54	
OUTFLOW	m^3/s	3.23	1.78	1.81	1.22	0.00	0.00	1.48	1.85	1.36	0.12	0.00	0.83	
VOLUME	m^3/s-mos	4.36	2.80	1.08	0.00	5.29	7.00	5.77	4.14	3.32	4.06	5.51	5.22	
W.L.	m	526.3	525.9	525.4	525.2	526.5	527.0	526.7	526.2	526.0	526.2	526.6	525.5	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.35	0.14	0.06	0.09	1.46	1.01	0.16	0.14	0.34	0.54	0.91	0.34	
SPILL	m^3/s	0.00	0.00	0.00	0.00	1.84	0.05	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]
OMEGA RESERVOIR:														
INFLOW	m^3/s	4.46	2.28	2.02	1.54	9.87	3.74	2.04	2.34	2.57	2.02	3.22	2.02	
OUTFLOW	m^3/s	4.46	2.28	2.02	2.02	9.22	3.74	2.04	2.34	2.57	2.02	3.22	2.02	
VOLUME	m^3/s-mos	0.65	0.65	0.65	0.17	0.65	—	—	—	—	—	—	0.65	
W.L.	m	924.0	924.0	924.0	922.5	924.0	—	—	—	—	—	—	924.0	
PLANT FLOW	m^3/s	4.46	2.28	2.02	2.02	5.30	3.74	2.04	2.34	2.57	2.02	3.22	2.02	[illegible]
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	3.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]

YEAR 1971		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	0.62	0.46	0.38	8.89	21.7	4.5	1.86	2.95	2.37	5.25	4.62	1.16	626.8
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	0.19	0.14	0.12	2.76	6.75	1.40	0.58	0.92	0.74	1.63	1.44	0.36	
OUTFLOW	m^3/s	1.59	1.70	1.76	0.00	3.10	1.40	1.85	2.55	1.56	0.27	0.00	1.22	
VOLUME	m^3/s-mos	3.82	2.26	0.62	3.39	7.04	7.04	5.77	4.14	3.32	4.68	6.12	5.26	
W.L.	m	526.2	525.7	525.3	526.0	527.0	527.0	526.7	526.2	526.0	526.4	526.8	526.5	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.12	0.09	0.07	1.14	1.64	0.87	0.36	0.57	0.46	1.00	0.90	0.23	
SPILL	m^3/s	0.00	0.00	0.00	0.58	2.57	0.00	0.00	0.00	0.00	0.01	0.00	0.00	30.55
OMEGA RESERVOIR:														
INFLOW	m^3/s	2.02	2.02	2.02	5.55	15.48	4.50	3.13	4.58	3.19	3.88	3.18	2.02	
OUTFLOW	m^3/s	2.02	2.02	2.02	5.55	15.48	4.50	3.13	4.58	3.19	3.88	3.18	2.02	
VOLUME	m^3/s-mos	0.65	—	—	—	—	—	—	—	—	—	—	0.65	
W.L.	m	924.0	—	—	—	—	—	—	—	—	—	—	924.0	
PLANT FLOW	m^3/s	2.02	2.02	2.02	5.30	5.30	4.50	3.13	4.58	3.19	3.88	3.18	2.02	[illegible]
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.25	10.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]

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YEAR 1972		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	0.59	0.40	1.73	1.40	11.4	19.9	3.08	2.00	3.57	4.57	2.30	2.08	[illegible]
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	0.13	0.12	0.54	0.44	3.55	6.19	0.96	0.62	1.11	1.42	0.72	0.65	
OUTFLOW	m^3/s	1.61	1.74	1.44	1.06	0.00	3.37	2.23	2.25	1.93	0.06	0.44	0.59	
VOLUME	m^3/s-mos	3.83	2.21	1.30	0.68	4.23	7.04	5.77	4.14	3.32	4.68	4.96	5.02	
W.L.	m	526.2	525.7	525.5	525.3	526.3	527.0	526.7	526.2	526.0	526.4	526.5	526.5	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.11	0.08	0.34	0.27	1.24	1.57	0.60	0.39	0.69	0.89	0.45	0.40	
SPILL	m^3/s	0.00	0.00	0.00	0.00	0.97	2.29	0.00	0.00	0.00	0.00	0.00	0.00	33
OMEGA RESERVOIR:														
INFLOW	m^3/s	2.02	2.02	2.64	2.02	6.89	14.80	4.35	3.63	4.39	3.21	2.02	2.02	
OUTFLOW	m^3/s	2.02	2.02	2.64	2.02	6.89	14.80	4.35	3.63	4.39	3.21	2.02	2.02	
VOLUME	m^3/s-mos	0.65											0.65	
W.L.	m	924.0											924.0	
PLANT FLOW	m^3/s	2.02	2.02	2.64	2.02	5.30	5.30	4.35	3.63	4.39	3.21	2.02	2.02	56[illegible]
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	1.59	9.50	0.00	0.00	0.00	0.00	0.00	0.00	83[illegible]

YEAR 1973		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	0.38	0.62	0.89	1.11	18.2	10.9	4.67	4.00	2.05	2.35	3.02	4.70	732.78
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	0.12	0.19	0.28	0.35	5.66	3.39	1.45	1.24	0.64	0.73	0.94	1.46	
OUTFLOW	m^3/s	1.76	1.59	1.41	1.20	0.00	2.01	2.08	2.54	2.43	0.40	0.00	0.38	
VOLUME	m^3/s-mos	3.38	1.98	0.85	0.00	5.66	7.04	6.41	5.11	3.32	3.65	4.59	5.67	
W.L.	m	526.0	525.7	525.4	525.2	526.6	527.0	526.8	526.5	526.0	526.1	526.4	526.6	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.07	0.12	0.17	0.22	1.51	1.22	0.91	0.78	0.40	0.46	0.59	0.91	
SPILL	m^3/s	0.00	0.00	0.00	0.00	2.02	0.89	0.00	0.00	0.00	0.00	0.00	0.00	36.75
OMEGA RESERVOIR:														
INFLOW	m^3/s	2.02	2.02	2.02	1.96	10.52	8.63	5.30	5.30	3.84	2.02	2.08	3.62	
OUTFLOW	m^3/s	2.02	2.02	2.02	2.02	10.46	8.53	5.30	5.30	3.84	2.02	2.08	3.62	
VOLUME	m^3/s-mos	0.65	0.65	0.65	0.59	0.65							0.65	
W.L.	m	924.0	924.0	924.0	923.8	924.0							924.0	
PLANT FLOW	m^3/s	2.02	2.02	2.02	2.02	5.30	5.30	5.30	5.30	3.84	2.02	2.08	3.62	602.49
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	5.16	3.33	0.00	0.00	0.00	0.00	0.00	0.00	92.17

LAKE MICHEL — ALTERNATIVE

YEAR 1974		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	0.46	0.19	0.22	0.71	7.0	18.9	2.57	1.30	1.65	3.45	2.67	2.08	773.2[illegible]
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	0.14	0.06	0.07	0.22	2.18	5.88	0.80	0.40	0.51	1.07	0.83	0.65	
OUTFLOW	m^3/s	1.70	1.89	1.87	1.53	0.00	1.02	2.07	2.03	1.33	0.00	0.18	0.59	
VOLUME	m^3/s-mos	4.11	2.28	0.49	0.00	2.18	7.04	5.77	4.14	3.72	4.39	5.04	5.10	
W.L.	m	526.2	525.7	525.3	525.2	525.7	527.0	526.7	526.2	526.0	526.3	526.5	526.5	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.09	0.04	0.04	0.14	1.07	1.53	0.50	0.25	0.32	0.67	0.52	0.40	
SPILL	m^3/s	0.00	0.00	0.00	0.00	0.29	2.13	0.00	0.00	0.00	0.00	0.00	0.00	33.[illegible]
OMEGA RESERVOIR:														
INFLOW	m^3/s	2.02	2.02	2.02	2.02	4.54	11.91	3.84	2.93	2.47	2.38	2.02	2.02	
OUTFLOW	m^3/s	2.02	2.02	2.02	2.02	3.71	11.91	3.84	2.93	2.47	2.38	2.02	2.02	
VOLUME	m^3/s-mos	0.65	0.65	0.65	0.18	0.65	—	—	—	—	—	—	0.65	
W.L.	m	524.0	524.0	524.0	522.0	524.0	—	—	—	—	—	—	524.0	
PLANT FLOW	m^3/s	2.02	2.02	2.02	2.02	3.71	5.30	3.84	2.93	2.47	2.38	2.02	2.02	635.2[illegible]
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	0.00	6.61	0.00	0.00	0.00	0.00	0.00	0.00	9[illegible].7[illegible]

YEAR 1975		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	0.40	0.13	0.32	1.78	14.9	10.6	0.72	2.21	2.21	4.48	5.62	2.99	[illegible]
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	0.12	0.04	0.10	0.55	4.63	3.30	0.22	0.69	0.69	1.39	1.75	0.93	
OUTFLOW	m^3/s	1.74	1.93	1.69	0.55	0.00	0.89	1.52	2.29	1.51	0.03	0.23	1.46	
VOLUME	m^3/s-mos	3.48	1.59	0.00	0.00	4.63	7.04	5.74	4.14	3.32	4.68	6.20	5.67	
W.L.	m	526.1	525.5	525.2	525.2	526.2	527.0	526.7	526.2	526.0	526.4	526.8	526.6	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.08	0.03	0.06	0.35	1.38	1.21	0.14	0.43	0.43	0.87	1.02	0.58	
SPILL	m^3/s	0.00	0.00	0.00	0.00	1.51	0.85	0.00	0.00	0.00	0.00	0.07	0.00	41.60
OMEGA RESERVOIR:														
INFLOW	m^3/s	2.02	2.02	1.91	1.78	8.75	7.35	2.02	3.81	3.03	3.12	4.03	3.52	
OUTFLOW	m^3/s	2.02	2.02	2.02	2.02	8.11	7.35	2.02	3.81	3.03	3.12	4.03	3.52	
VOLUME	m^3/s-mos	0.65	0.65	0.54	0.30	0.65	—	—	—	—	—	—	0.65	
W.L.	m	524.0	524.0	523.7	522.9	524.0	—	—	—	—	—	—	524.0	
PLANT FLOW	m^3/s	2.02	2.02	2.02	2.02	5.30	5.30	2.02	3.81	3.03	3.12	4.03	3.52	673.45
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	2.81	2.05	0.00	0.00	0.00	0.00	0.00	0.00	103.64

LAKE MICHEL — ALTERNATIVE

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YEAR 1976		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	2.59	2.37	3.51	6.24	14.7	5.5	1.97	1.95	2.18	3.58	4.13	2.55	87[illegible]
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	0.81	0.74	1.09	1.94	4.57	1.71	0.61	0.61	0.68	1.11	1.28	0.79	
OUTFLOW	m^3/s	2.12	2.30	2.59	1.17	0.00	1.31	1.88	2.24	1.50	0.00	0.00	0.3[illegible]	
VOLUME	m^3/s-mos	4.36	2.80	1.30	2.07	6.64	7.04	5.77	4.14	3.32	4.43	5.72	5.67	
W.L.	m	526.3	525.9	525.5	525.7	526.9	527.0	526.7	526.2	526.0	526.3	526.7	526.6	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.50	0.46	0.68	1.04	1.37	1.01	0.38	0.38	0.42	0.69	0.80	0.43	
SPILL	m^3/s	0.00	0.00	0.00	0.17	1.48	0.05	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]
OMEGA RESERVOIR:														[illegible]
INFLOW	m^3/s	3.90	3.93	5.01	5.30	8.65	5.05	3.24	3.58	3.00	2.47	2.85	2.60	
OUTFLOW	m^3/s	3.90	3.93	5.01	5.30	8.65	5.05	3.24	3.58	3.00	2.47	2.85	2.60	
VOLUME	m^3/s-mos	0.65											0.65	
W.L.	m	924.0											924.0	
PLANT FLOW	m^3/s	3.90	3.93	5.01	5.30	5.30	5.05	3.24	3.58	3.00	2.47	2.85	2.60	719.63
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	3.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	106.99

YEAR 1977		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	1.37	0.56	0.46	2.65	13.4	26.3	5.43	2.62	2.97	7.80	2.33	3.48	940.98
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	0.43	0.17	0.14	0.82	4.17	8.18	1.69	0.81	0.92	2.43	0.72	1.08	
OUTFLOW	m^3/s	1.74	1.73	1.70	1.06	0.00	6.31	1.69	3.49	1.96	0.34	0.41	1.13	
VOLUME	m^3/s-mos	4.36	2.80	1.24	1.00	5.17	7.04	7.04	4.36	3.32	5.41	5.72	5.67	
W.L.	m	526.3	525.9	525.5	525.4	526.5	527.0	527.0	526.3	526.0	526.6	526.7	526.6	
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	0.27	0.11	0.09	0.51	1.32	1.82	1.01	0.51	0.58	1.10	0.45	0.68	
SPILL	m^3/s	0.00	0.00	0.00	0.00	1.28	3.28	0.04	0.00	0.00	0.41	0.00	0.00	48.31
OMEGA RESERVOIR:														
INFLOW	m^3/s	2.68	2.12	2.02	2.89	7.95	21.15	5.39	5.30	4.01	5.30	2.02	3.53	
OUTFLOW	m^3/s	2.68	2.12	2.02	2.89	7.95	21.15	5.39	5.30	4.01	5.30	2.02	3.53	
VOLUME	m^3/s-mos	0.65											0.65	
W.L.	m	924.0											924.0	
PLANT FLOW	m^3/s	2.68	2.12	2.02	2.89	5.30	5.30	5.30	5.30	4.01	5.30	2.02	3.53	765.45
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	2.65	15.85	0.09	0.00	0.00	0.00	0.00	0.00	125.58

LAKE MICHEL — ALTERNATIVE

YEAR 1978		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s	5.59	0.40	0.16	0.49	17.9	8.0							97[illegible]
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s	1.71	0.12	0.05	0.15	5.57	2.49							
OUTFLOW	m^3/s	1.52	3.22	1.91	1.68	0.00	1.02							
VOLUME	m^3/s-mos	5.80	2.80	0.94	0.00	5.57	7.04							
W.L.	m	526.7	525.[illegible]	525.4	525.4	526.6	527.0							
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s	1.02	0.08	0.03	0.10	1.49	1.11							
SPILL	m^3/s	0.07	0.00	0.00	0.00	1.98	0.44							55.
OMEGA RESERVOIR:														[illegible]
INFLOW	m^3/s	5.30	3.49	2.02	1.43	10.36	6.09							
OUTFLOW	m^3/s	5.30	3.49	2.02	2.02	9.77	6.09							
VOLUME	m^3/s-mos	0.65	0.65	0.65	0.06	0.65	0.65							
W.L.	m	924.0	924.0	924.0	922.2	924.0	924.0							
PLANT FLOW	m^3/s	5.30	3.49	2.02	2.02	5.30	5.30							788.[illegible]
SPILL AT PLANT	m^3/s	0.00	0.00	0.00	0.00	4.47	0.79							130.[illegible]

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	CUMULATIVE VALUES
BASIN FLOW	m^3/s													
LAKE MICHEL RESERVOIR:														
INFLOW	m^3/s													
OUTFLOW	m^3/s													
VOLUME	m^3/s-mos													
W.L.	m													
OMEGA DIVERSION:														
DIVERTED FLOW	m^3/s													
SPILL	m^3/s													
OMEGA RESERVOIR:														
INFLOW	m^3/s													
OUTFLOW	m^3/s													
VOLUME	m^3/s-mos													
W.L.	m													
PLANT FLOW	m^3/s													
SPILL AT PLANT	m^3/s													

APPENDIX E

COST AND CASH SCHEDULES

CAPITAL BUDGET PROPOSAL

CAPITAL COST ESTIMATE & CASH FLOW REQUIREMENTS

1983 FISCAL YEAR, PREPARED 1982-06-03

($'s x 1,000)

PREPARED BY: J. J. CARNELL

APPROVED BY:

LAKE MICHEL HYDRO DEVELOPMENT

(Project Description)

Capital Cost Estimate (Budget)

PERIOD	Energy Structures	Power Structures	Permanent &Temporary Support	Management & Engineering	Owner's Cost	Contingency	Escalation	Corporate Overheads		SUB TOTAL	I D C	TOTAL PROJECT	CASH FLOW "Excl. IDC"
PRIOR YR. END													
19 83 Jan.													
Feb.													
Mar.													
Apr.													
May	-	-	-	20	120	3	4	-		147	-	147	120
June	-	-	-	100	20	18	25	1		164	2	166	51
July	-	-	145	60	10	32	48	2		297	3	300	152
Aug.	-	-	292	41	10	51	80	1		475	5	480	100
Sept.	-	-	292	41	10	51	84	3		481	7	488	274
Oct.	-	-	584	81	10	101	172	5		953	12	965	483
Nov.	-	5	584	82	10	102	182	6		971	18	989	544
Dec.	-	5	-	-	10	2	4	10		31	27	58	968
TOTAL	-	10	1897	425	200	360	599	28		3,519	74	3,593	2,692
19__ 1st. Qtr.													
2nd. Qtr.													
3rd. Qtr.													
4th. Qtr.													
TOTAL													
BEYOND													
TOTAL PROJECT													

LAKE MICHEL HYDRO DEVELOPMENT

(Project Description)

CAPITAL BUDGET PROPOSAL

CAPITAL COST ESTIMATE & CASH FLOW REQUIREMENTS

1984 **FISCAL YEAR, PREPARED** 1982-06-03

($'s x 1,000)

PREPARED BY: J. J. CARNELL

APPROVED BY:

Capital Cost Estimate (Budget)

PERIOD	Energy Structures	Power Structures	Permanent & Temporary Support	Management & Engineering	Owner's Cost	Contingency	Escalation	Corporate Overheads		SUB TOTAL	IDC	TOTAL PROJECT	CASH FLOW "Excl. IDC"
PRIOR YR. END	-	10	1897	425	200	360	599	28		3,519	74	3,593	2,692
19 84 Jan.	-	-	-	-	-	-		8		8	37	45	826
Feb.	-	-	-	-	-	-		-		-	43	43	7
Mar.	-	38	-	-	10	7	15	1		71	43	114	14
Apr.	-	-	-	-	10	1	3	1		15	44	59	71
May	40	434	584	161	10	184	414	1		1,828	45	1,873	15
June	37	524	584	140	10	195	452	3		1,945	47	1,992	258
July	40	1243	292	212	10	270	650	18		2,735	60	2,795	1,797
Aug.	37	901	292	154	10	209	522	28		2,153	87	2,240	2,738
Sept.	37	1141	292	179	10	249	642	21		2,571	116	2,687	2,015
Oct.	40	1163	-	203	10	212	567	24		2,219	143	2,362	2,347
Nov.	37	1158	-	169	10	206	568	28		2,176	174	2,350	2,715
Dec.	-	740	-	187	10	141	400	24		1,502	206	1,708	2,282
TOTAL	268	7342	2044	1405	100	1674	4,233	157		17,223	1,045	18,268	15,085
19__ 1st. Qtr.													
2nd. Qtr.													
3rd. Qtr.													
4th. Qtr.													
TOTAL													
BEYOND													
TOTAL PROJECT	268	7352	3941	1830	300	2034	4832	185		20742	1119	21861	17777

CAPITAL BUDGET PROPOSAL

CAPITAL COST ESTIMATE & CASH FLOW REQUIREMENTS

1985 **FISCAL YEAR, PREPARED** 1982-06-03

($'s x 1,000)

PREPARED BY: J. J. CARNELL

APPROVED BY:

LAKE MICHEL HYDRO DEVELOPMENT

(Project Description)

Capital Cost Estimate (Budget)

PERIOD	Energy Structures	Power Structures	Permanent & Temporary Support	Management & Engineering	Owner's Cost	Contingency	Escalation	Corporate Overheads		SUB TOTAL	I D C	TOTAL PROJECT	CASH FLOW "Excl. IDC"
PRIOR YR. END	268	7352	3941	1830	300	2034	4,832	185		20,742	1,119	21,861	17,777
19 85 Jan.	-	91	-	44	10	22	64	27		258	229	487	2,520
Feb.	-	-	-	12	10	4	10	8		44	249	293	610
Mar.	-	159	-	6	10	26	82	3		286	256	542	92
Apr.	-	128	-	20	10	24	76	4		262	260	522	104
May	624	1219	-	85	10	291	958	5		3,192	265	3,457	203
June	819	1727	-	269	10	424	1,436	14		4,699	276	4,975	1,193
July	755	1135	-	283	10	327	1,138	39		3,687	306	3,993	3,675
Aug.	840	1127	-	255	10	335	1,194	43		3,804	353	4,157	3,990
Sept.	541	961	-	267	10	267	976	39		3,061	401	3,462	3,630
Oct.	292	610	-	217	10	169	635	42		1,975	447	2,422	3,811
Nov.	-	-	-	123	10	20	77	34		264	491	755	2,960
Dec.	-	511	-	100	20	95	373	23		1,122	523	1,645	1,810
TOTAL	3871	7668	-	1681	130	2004	7,019	281		22,654	4,056	26,710	24,598
1986 1st. Qtr.								16		16		16	
2nd. Qtr.													
3rd. Qtr.													
4th. Qtr.													
TOTAL													
BEYOND													
TOTAL PROJECT	4139	15020	3941	3511	430	4038	11851	482		43412	5175	48587	42375

PREPARED BY J.J. CARNELL *J.J. Carnell*

APPROVED BY ____________

PROJECT DESCRIPTION LAKE MICHEL HYDRO DEVELOPMENT

CAPITAL BUDGET PROPOSAL
CASH FLOW ESTIMATE
1983 FISCAL YEAR
(x 1,000)

DATE 82 06 03

ACCOUNT DESCRIPTION	JAN.	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
ENERGY STRUCTURES					-	-	-	-	-	-	-	-	-
POWER STRUCTURES					-	-	-	-	-	-	-	-	-
PERMANENT & TEMPORARY SUPPORT					-	-	-	-	145	292	292	584	1313
SUB-TOTAL DIRECT CONSTR					-	-	-	-	145	292	292	584	1313
ENGINEERING & MANAGEMENT					-	20	100	60	41	41	81	82	425
OWNER'S COSTS					120	20	10	10	10	10	10	10	200
SUB-TOTAL					120	40	110	70	196	343	383	676	1938
CONTINGENCY					-	6	17	11	29	51	57	101	272
SUB-TOTAL					120	46	127	81	225	394	440	777	2,210
ESCALATION						4	23	18	46	84	98	181	454
SUB-TOTAL					120	50	150	99	271	478	538	958	2,664
CAPITALIZED EXPENSE					-	1	2	1	3	5	6	10	28
CASH FLOW					120	51	152	100	274	483	544	968	2,692
I.D.C.					-	2	3	5	7	12	18	27	74
TOTAL COST					120	53	155	105	281	495	562	995	2,766
ACCUMULATED CASH FLOW					120	171	323	423	697	1180	1724	2692	

PREPARED BY J. J. CARNELL JJCarnell

APPROVED BY

PROJECT DESCRIPTION LAKE MICHEL HYDRO DEVELOPMENT

CAPITAL BUDGET PROPOSAL
CASH FLOW ESTIMATE
1984 FISCAL YEAR
(x 1,000)

PAGE 2 OF 4

DATE 82-06-03

ACCOUNT DESCRIPTION	JAN.	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
ENERGY STRUCTURES	-	-	-	-	-	-	40	37	40	37	37	40	231
POWER STRUCTURES	5	5	-	38	-	-	413	950	812	993	1177	1213	5606
PERMANENT & TEMPORARY SUPPORT	584	-	-	-	-	-	584	584	292	292	292	-	2628
SUB-TOTAL DIRECT CONSTR.	589	5	-	38	-	-	1037	1571	1144	1322	1506	1253	8465
ENGINEERING & MANAGAMENT	-	-	-	-	-	161	140	212	154	179	203	169	1218
OWNER'S COSTS	-	-	10	10	10	10	10	10	10	10	10	10	100
SUB-TOTAL	589	5	10	48	10	171	1187	1793	1308	1511	1719	1432	9783
CONTINGENCY	88	1	1	7	1	26	178	269	196	227	258	215	1467
SUB-TOTAL	677	6	11	55	11	197	1365	2062	1504	1738	1977	1647	11250
ESCALATION	141	1	2	15	3	58	414	648	490	585	710	611	3678
SUB-TOTAL	818	7	13	70	14	255	1,779	2,710	1,994	2,323	2,687	2,258	14928
CAPITALIZED EXPENSE	8	-	1	1	1	3	18	28	21	24	28	24	157
CASH FLOW	826	7	14	71	15	258	1,797	2,738	2,015	2,347	2,715	2,282	15,085
I.D.C.	37	43	43	44	45	47	60	87	116	143	174	206	1,045
TOTAL COST	863	50	57	115	60	305	1,857	2,825	2,131	2,490	2,889	2,488	16,130
ACCUMULATED CASH FLOW	3518	3525	3539	3610	3625	3883	5680	8418	10433	12780	15495	17777	

PREPARED BY J. J. CARNELL JJCarnell

APPROVED BY

PROJECT DESCRIPTION LAKE MICHEL HYDRO DEVELOPMENT

CAPITAL BUDGET PROPOSAL
CASH FLOW ESTIMATE
1985 FISCAL YEAR

PAGE 3 OF 4
DATE 82 06 03

ACCOUNT DESCRIPTION	JAN.	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
ENERGY STRUCTURES	37	-	-	-	-	-	624	819	755	840	541	292	3908
POWER STRUCTURES	1347	329	34	47	93	630	1314	1276	1135	1127	961	610	8903
PERMANENT & TEMPORARY SUPPORT	-	-	-	-	-	-	-	-	-	-	-	-	-
SUB-TOTAL DIRECT CONSTR.	1384	329	34	47	93	630	1938	2095	1890	1967	1502	902	12811
ENGINEERING & MANAGEMENT	187	44	12	6	20	85	269	283	255	267	217	123	1768
OWNER'S COST	10	10	10	10	10	10	10	10	10	10	10	20	130
SUB-TOTAL	1581	383	56	63	123	725	2217	2388	2155	2244	1729	1045	14709
CONTINGENCY	237	57	9	9	18	109	332	358	323	337	259	159	2207
SUB-TOTAL	1818	440	65	72	141	834	2549	2746	2478	2581	1988	1204	16916
ESCALATION	675	162	24	28	57	345	1087	1201	1113	1188	938	583	7401
SUB-TOTAL	2493	602	89	100	198	1179	3636	3947	3591	3769	2926	1787	24317
CAPITALIZED EXPENSE	27	8	3	4	5	14	39	43	39	42	34	23	281
CASH FLOW	2520	610	92	104	203	1193	3675	3990	3630	3811	2960	1810	24598
I.D.C.	229	249	256	260	265	276	306	353	401	447	491	523	5175
TOTAL COST	2749	859	348	364	468	1469	3981	4343	4031	4258	3451	2333	29773
ACCUMULATED CASH FLOW	20297	20907	20999	21103	21306	22499	26174	30164	33794	37605	40565	42375	

PREPARED BY J. J. CARNELL J. J. Carnell

APPROVED BY

PROJECT DESCRIPTION LAKE MICHEL HYDRO DEVELOPMENT

CAPITAL BUDGET PROPOSAL
CASH FLOW ESTIMATE
1986 FISCAL YEAR

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DATE 82 06 03

ACCOUNT DESCRIPTION	JAN.	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
ENERGY STRUCTURES	-											-	
POWER STRUCTURES	399											112	511
PERMANET & TEMPORARY SUPPORT	-											-	
SUB-TOTAL DIRECT CONSTR.	399											112	511
MANAGEMENT & ENGINEERING	100												100
OWNER'S COST	-												
SUB-TOTAL	499											112	611
CONTINGENCY	76											16	92
SUB-TOTAL	575											128	703
ESCALATION	260											58	318
SUB-TOTAL	835											186	1021
CAPITALIZED EXPENSE	14											2	16
CASH FLOW	849											188	1037
I.D.C.	0											0	0
TOTAL COST	849											188	1037
ACCUMULATED CASH FLOW	43224											43412	