WATER INVESTIGATIONS BRANCH
BRITISH COLUMBIA WATER RESOURCES SERVICE
DEPARTMENT OF LANDS, FORESTS AND WATER RESOURCES
PARLIAMENT BUILDINGS
VICTORIA, BRITISH COLUMBIA

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A PRELIMINARY GROUNDWATER INVESTIGATION OF THE PROPOSED DEASE LAKE TOWNSITE (104-I/5)

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SYNOPSIS

Groundwater is being considered as an alternative source of supply for the proposed Dease Lake Townsite, or as a possible initial source of supply for first stages of development of the Townsite.

This report considers the feasibility of developing a groundwater source in the immediate environs of the proposed townsite.

The surficial geology and sequence of latest glacial events is described briefly as a necessary prerequisite to a discussion of the possible distribution of aquifer materials and development of concepts of groundwater probability.

A programme of subsurface exploration is proposed to confirm the feasibility of the concepts developed together with estimated costs of exploration to provide a basis for management decision.

CONSIDERATIONS OF GROUNDWATER AS A SOURCE OF SUPPLY

Groundwater may be advantageous as a source of supply for the following reasons.

1. Groundwater temperatures are constant. Variations in temperture and freezing problems could be minimized.
2. Lower construction costs and maintenance costs could be realized because filtration is not necessary.
3. If suitably located, wells may reduce pipeline costs.
4. Groundwater wells may permit versatility of pumping rates and future expansion of capacities.

The major disadvantage of groundwater is the probably higher dissolved solids and hardness.

SURFICIAL GEOLOGY AND SEQUENCE OF GLACIAL EVENTS

The proposed Townsite is situated on a gently sloping, ice pitted plain bridging the Dease depression at the south end of Dease Lake.

The appended photomosaic (figure 1) shows the distribution of surficial geological materials in generalized form. For purposes of mapping and describing aquifer materials four major geological units have been recognized. These are:

1. Ground Moraine

This includes material deposited directly by ice. It is mainly till, a compact heterogeneous mixture of clay and stones with poor to nil porosity and permeability. It represents a sheet-like deposit, widespread over the area; its presence obscures underlying materials. Two morphological types were noted: hummocky and drumlinized ground moraine.

2. Ice Marginal Features

These represent materials deposited by water but in close association with ice. Although their mode of occurrence permits enough sorting to produce porosity, such materials commonly exhibit rapid facies changes which would permit only moderate permeabilities over any distance. The most prominent type noted is ice marginal (Kame) terracing at elevations 2750 and 2950. Several eskers are noted, none of which are sufficiently close to the townsite area to have immediate aquifer value.

3. Post Glacial Outwash Deposits

These materials were deposited in the early stages of deglaciation when meltwaters were heavily charged with debris and sufficient stagnating ice was present to block water courses causing aggraded deposits to accumulate. They are referred to as Tanzilla outwash materials.

4. Recent Alluvium

The main alluvial deposits referred to are flood plain materials adjacent to Tanzilla River. Minor alluvium is present at the mouths of meltwater channels; these are not considered significant for present purposes. Tanzilla alluvium ranges from coarse bouldery gravel to muck. Permeabilities may be highly variable in these deposits.

In summary, the sequence of latest glacial events as they affect groundwater probability appears to be as follows.

1. The most recent ice-advance traversed the region from south to north leaving a thick mantle of ground moraine in topograhically low areas. This has the effect of obscuring any previously deposited glacial materials which may exist in the lower areas.

2. The ice appears to have melted by stagnation and down-wasting rather than receding as an ice-front. This gave rise to several stages of meltwater channelling along the margins of the shrinking ice masses. As deglaciation progressed, isolated large masses of ice probably occupied the lower areas such as Dease depression and the lower Tanzilla valley tending to block natural watercourses and causing the heavily charged meltwaters to drop their load of sediment as aggraded terraces and outwash plains. Meltwaters in the ancestral Tanzilla drainage built one such plain in the townsite area. This sand and gravel plain has the morphology of a large fan with apex at the present bend of the Tanzilla

river and low gradients toward Dease Lake and downstream in the Tanzilla Valley. These materials are anticipated to have good porosity and permeability. This feature was thrown out rapidly covering ice-contact type of materials in which several smaller isolated blocks of ice were incorporated. The resulting kettled plain has a somewhat irregular surface. Collapse of the outwash materials around the perimeter of Kettles has presumably resulted in the bouldery armour which presently shows around the lake margins. From geological observations it is concluded that the outwash materials are relatively thin, in the order of 20 - 30 feet thick. The underlying ice contact materials can be anticipated to be heterogeneous with highly variable porosities and permeabilities but with only low to moderate permeabilities over any long distance.

3. As the glacial period ended and the present drainage pattern evolved, the existing base level was reached by dissecting previous deposits. It is interesting to note that in achieving its present base level the Tanzilla was unable to cut through the materials underlying the Townsite and has been deflected westward to join Pacific drainage. This deflection, referred to as the Tanzilla bend, also represents a marked decrease in gradient of the river. It is inferred that coarse material may have been deposited in the river alluvium at this point in response to the drop in gradient, making this area a primary objective for groundwater exploration.

GROUNDWATER DISCHARGE

The specific conductance of waters has been used as an indicator of groundwater contribution . Figure 3 summarizes field measurements made of various water sources in September 1972. Conductance ranges from 100 in the Tanzilla River to 370 in a shallow dug well near the airstrip. Increasing specific conductance may indicate greater distance from recharge. Figure 2 shows the locations of points of measurement.

Springs representing direct evidence of groundwater discharge were noted at several localities in the area. The Creek called Waterworks Creek which discharges onto the road north of the helicopter base presently occupies an abandoned meltwater channel on the west side of the townsite plain. An investigation of the source of this water indicated groundwater seeping from storage at about elevation 2700 feet. Its relatively high specific conductance of 320 micromhos reflects groundwater chemistry. Flow in the creek was estimated to be about 1 cfs in September. Catchment to this basin is small and groundwater storage is probably limited and local. The channel appears to be cut in poorly permeable morainal debris.

Springs issuing along the slope to the west of the airstrip probably arise by seepage through morainal debris. The water probably originates in the adjacent abandoned meltwater channel, the floor of which is saturated muskeg. These springs were not sampled or quantitavely assessed. They reenter the post glacial outwash and act to recharge locally perched aquifers. A shallow well dug near the airstrip encountered groundwater of this sort at eight or ten feet. The water has conductivity of 370 micromhos, the highest recorded in the area.

On the east side of the townsite plain the broader gently sloping surface permits more completely developed drainage channels. The largest of these is Hotel Creek. Ancillary drainage into this creek from catchment in abandoned meltwater channels probably occurs. The ephemeral nature of the meltwater channels makes this drainage system very complex. It would seem likely that groundwater is contributary in the upper reaches of this creek during low flow. This is substantiated by the relatively high conductance of 195 micromhos recorded in September.

The abandoned meltwater channels locally provide ponding such as Moose Lake immediately northeast of the townsite. This lake is margined with muskeg and supports a substantial growth of lily pads. It has a relatively low conductance of 115 micromhos. This might suggest that the source is precipitation directly rather than groundwater feeding.

The lake described as Beaver Lake immediately east of the townsite occupies a small kettle in ice-marginal terrace materials. The Kettle has been breached to provide the drainage into what is described as PGE Creek. It is presently controlled by a beaver dam. It seems likely that there is some degree of groundwater feeding to this system since the ice marginal terrace materials will probably have enough permeability to permit some infiltration. The conductance of 285 micromhos measured in this creek supports the premise that groundwater is being contributed to the system. Flow in the creek adjacent to the Railway camp was estimated at approximately 1 cfs in September. The creek disappears within a short distance of flowing onto the post glacial outwash materials and must contribute to the groundwater regime existing within and beneath the outwash.

Two warmer springs were noted as Prospector's and PGE springs. These issue at the base of the ice marginal terrace east of the Railway camp. They showed conductances of 310 at 19^{0}C and 300 at 17^{0}C respectively. The conductance is not remarkably high indicating that these are not mineral springs, however, the elevated temperatures suggest a deeper groundwater system probably associated with bedrock rather than percolation through the unconsolidated drift. The warm spring pools have a bluish purple cast to them possibly the result of a light tufa deposit in the bottom of the pool. The source of this water can only be speculated on. The bedrock geology on the east side of the townsite is evidently Mesozoic volcanics. A prominent major fault on the west side of the townsite trends east west about in line with the main road. This brings Permian? or Trassic? limestone on the north wall against Mesozoic volcanics on the south wall. An inspection of the limestone near the contact showed it to be vertically or near vertically fractured. This may represent an explanation of how groundwater could enter a bedrock system to provide elevating temperatures. Limestone would, however, possibly provide more dissolved solids to groundwater than the springs appear to contain.

GROUNDWATER RECHARGE

Groundwater recharge will ultimately come from precipitation, the sources of recharge available to aquifers near the townsite could be

1. Direct infiltration of precipitation in the local catchement area.
2. Influent recharge from the Tanzilla river drainage.
3. A deeper groundwater regime in or immediately above bedrock which is independent of near surface regimes.

Hydrogeological reasoning suggests that influent recharge from the Tanzilla will probably be more significant than direct infiltration of precipitation and there is evidence to suggest that a deeper groundwater regime may have less satisfactory water quality.

The large lakes (Allan and Allanby) probably represent expressions of the major water table. This surface relates reasonably to the Tanzilla river level and specific conductance appears to increase with greater distance from the river.

An additional indirect evidence of possible influent groundwater stored in Tanzilla alluvium is shown by figure 4. This figure represents the annual flow recorded in the Tanzilla at a gauging station approximately 20 miles downstream from the Townsite. The winter base-flow during the frozen months of February and March averages 80 - 90 cfs. There are no significant lake storages on the Tanzilla drainage and during the frozen months no surface waters are being contributed so that the base flow must probably be supported by groundwater moving from bank storage. This base flow represents approximately 40,000 US gpm and would indicate that useful quantities of groundwater may be stored in Tanzilla alluvium.

ANTICIPATED GROUNDWATER AQUIFERS

The primary groundwater objectives would appear to be:

1. Tanzilla Alluvium adjacent to the river at Tanzilla bend where geological reasoning suggests that coarse materials may be present with correspondingly higher permeabilities. This is considered Site 1.
2. Tanzilla Alluvium at the entrance to Allanby Lake where geological reasoning suggests that sufficient permeability may exist to provide Tanzilla river recharge to Allanby Lake. This is considered Site 2.
3. Sub-outwash aquifer materials may exist at depth beneath Tanzilla Point providing Tanzilla recharge to Allanby Lake. This is considered Site 3.
4. Sub-outwash aquifer materials may exist at depth beneath the Railway camp area providing infiltration recharge to Allanby Lake from the eastern catchement above the townsite. This is considered Site 4.

A deeper aquifer system appears to exist associated with bedrock as evidenced by the warm springs. This system would probably require considerable exploration to locate. Drilling adjacent to the springs would be a logical initial move, however, geological reasoning suggests that the profound fault on the west side of the townsite may be influential; drilling on this side may encounter groundwater nearer to recharge with somewhat improved water quality. At the present time this aquifer system is not considered a primary objective but might be kept in mind for possible future recreational or other special purpose usage.

A further consideration of groundwater aquifer materials relates to waste disposal. At the present time the means of waste disposal has not been resolved; the following points are mentioned with respect to this problem:

1. Individual septic tanks, if practical in this climate, will probably drain adequately into the outwash materials, however, as described previously the outwash is probably thin and significant quantities of effluent may eventually result in seepage from the base of the outwash around the perimeters of Allan Lake to contribute nutrients to the Lake. An attempt should be made to verify the thickness and basal configuration of the outwash materials to see whether probable flow channels might be delineated. Geophysical methods might be applicable to this purpose.

2. The elongate depression adjacent to the airstrip shows a floor elevation of 2580. There may be a reasonable chance that outwash materials have sloughed into this depression giving rise to highly permeable materials at the water table which should be around elevation 2540 in this area with gradient to the west or away from the townsite. This could represent a possibly effective effluent sink. If necessary this premise could be tested with one or two drilled holes which could subsequently be used to monitor effectiveness of the sink.

PROPOSED EXPLORATION PROGRAMME WITH ESTIMATED COSTS

The concepts outlined above could be tested adequately with a programme of 6 exploratory holes drilled by cable tool equipment. If water bearing materials are encountered the holes will be used for observation purposes to monitor rate of recharge to Allanby Lake. After the holes have been drilled, the most promising one could be converted to an intermediate yield well (in the order of 250 US gpm) and pump tested to estimate the hydraulic properties of the aquifer.

The sites are discussed below with estimated costs in 1972 dollars; locations of sites are shown on figure 2.

SITES 1 & 2

These locations require similar holes for testing, i.e. 50 feet deep, 8" diameter. It is recommended that two holes be considered at each site. At $15.00/foot each hole should cost $750.00

Total for four holes .... $ 3,000.00

The cost to convert one of these to a well and pump test it includes:

a) 10 feet of well screen & fittings =$750

b) development, 20 hrs. @ 25/hr. = 500

c) pump testing, 30 hrs. @ 25/hr. = 750

Total cost of well conversion .... $ 2,000.00

SITES 3 & 4

These locations require similar holes, i.e. 150 feet deep, 6" diameter. One hole required at each site to be used for observation purposes. If these sites are favourable they would reduce pipe line costs being nearer to the townsite. They should be regarded as pilot-observation holes only, with favourable indications a properly constructed production well could be positioned adjacent. At $13/ft each hole would cost $1950.00

Total for two holes .... $ 3,900.00

Additional costs would be:

a) Mobilization of drilling equipment into Dease Lake and out again .... $ 2,500.00

b) Moving between sites, access, construction etc. .... $ 1,500.00

The total cost of the programme of 6 holes is therefore estimated at $10,900, and including construction and testing of an intermediate production well is $12,900.00.

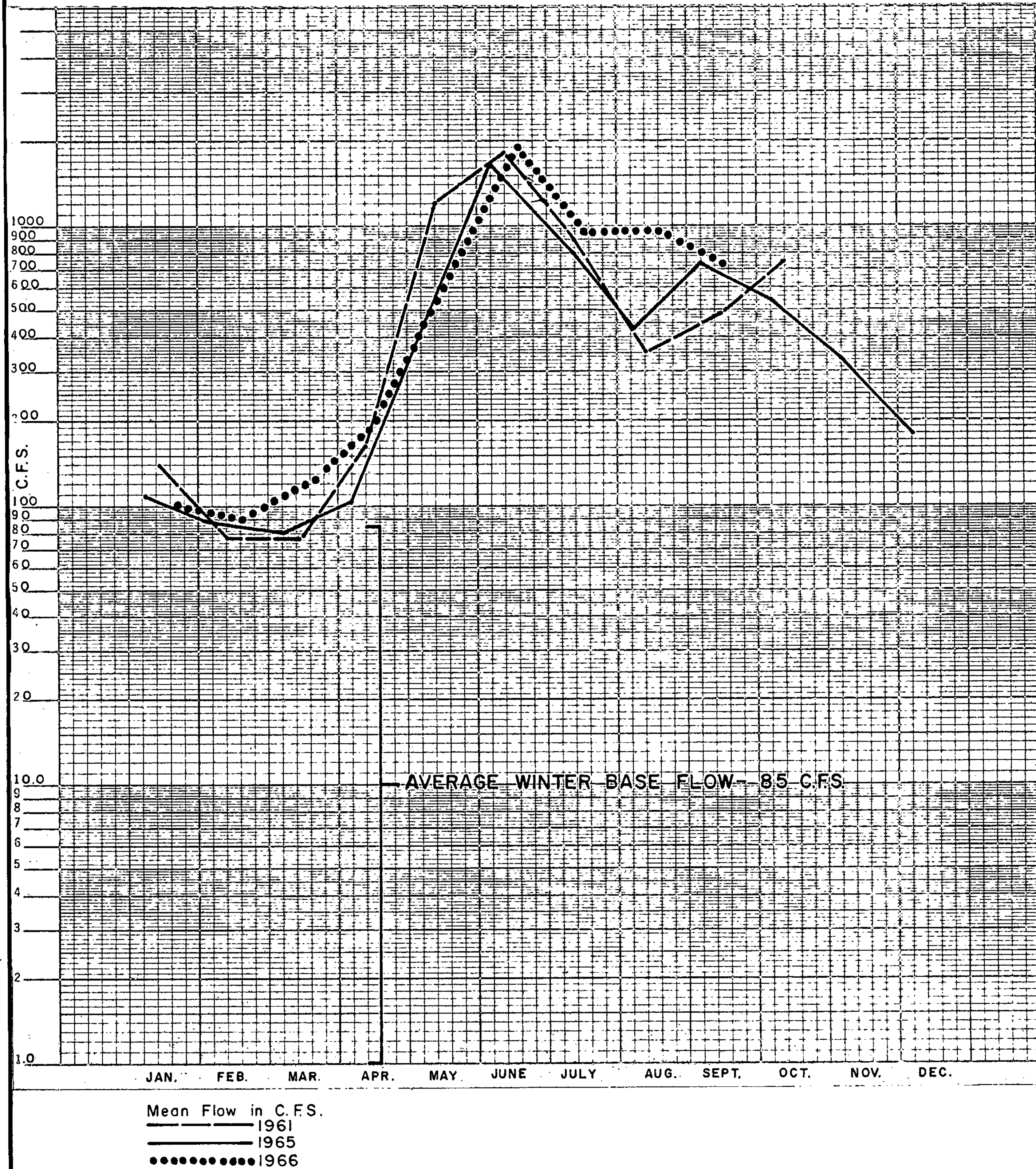
Higher yield production wells should cost approximately $25/ft. to drill and case and the fixed costs of well construction, development and testing would be approximately $4500.00 per well.

CONCLUSIONS AND RECOMMENDATIONS

1. The concepts of recharge to Allanby Lake require factual data which can only be determined by subsurface exploration.

2. A programme of exploration is recommended at a total estimated cost of approximately $11,000.00. With satisfactory indications an intermediate production well can be constructed and tested at an additional cost of approximately $2000.00.

3. Although not included in the terms of reference of the present investigation, it is recommended that geophysical exploration be considered to provide factual data for decisions on waste disposal methods and further drilling to test the feasibility of effluent sink concepts be also considered.



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WATER RESOURCES SERVICE
WATER INVESTIGATIONS BRANCH

TO ACCOMPANY REPORT ON

HYDROGRAPHS - TANZILLA RIVER

SCALE: VERT.

HOR.

DATE NOV. 1972

D. M. CALLAN ENGINEER

FILE No. 0239015 DWG. No. FIGURE 4

BCIL-3568A - W.R.B.

FIELD HYDROCHEMICAL MEASUREMENTS (SEPTEMBER 21, 1972)

Source Name	Temperature (°C)	Specific Conductance μ mhos	pH Units	Iron (Fe) ppm
Waterworks Creek	2.2°	320	8.25	0.1
Hotel Creek	2°	195	8.0	0.15
Highways Well	10°	235	7.5	0.2
Alan Lake	9.5°	220	6.85	0.05
Townsite Kettle	6.0°	110	7.6	0.15
P. G. E. Spring	16.8°	300	8.4	0.2
P. G. E. Creek	4.3°	285	8.35	0.05
Tanzilla River	2.2°	100	7.7	0.10
Forestry Kettle	10°	280	8.8	0.05
Moose Lake	3.8°	115	7.9	0.01
Dease Lake	8.0°	215	8.2	0.05
Prospector's Spring	19°	310	8.3	0.15
Tom's Well	5.6°	370	7.9	0.05
Alanby Lake	9.5°	160*	8.3*	0.04*

* Laboratory Determination (September 26, 1972)

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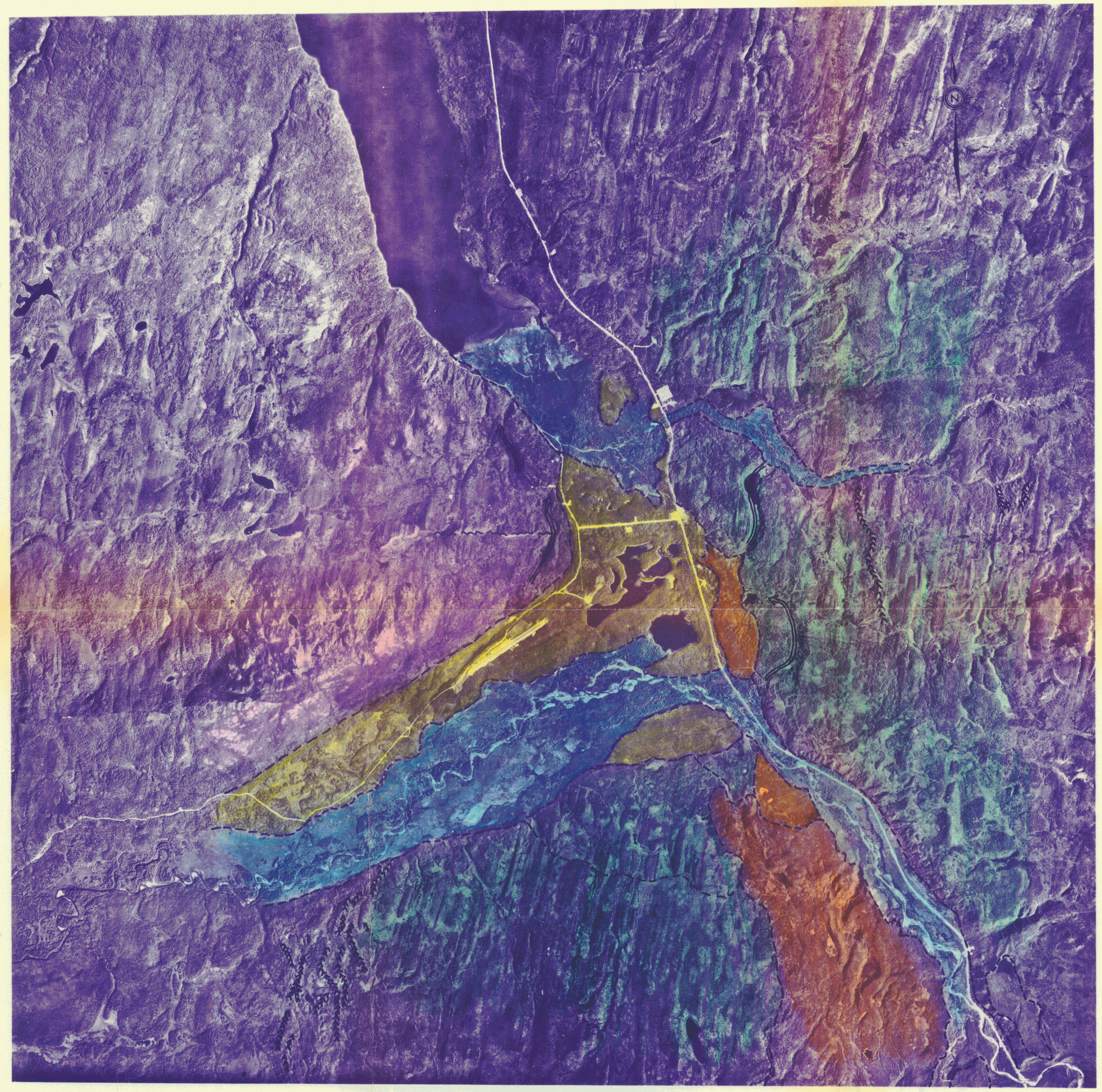
SCALE: VERT.
HOR.
DATE

D. M. CALLAN ENGINEER

FILE No. DWG. No. Figure 3

BCIL - 3500A - W.R.S.

GENERALIZED SURFICIAL GEOLOGY



LEGEND	
GROUND MORAINE	ESKER
ICE MARGINAL TERRACE STAGE 1	MELTWATER CHANNEL
ICE MARGINAL TERRACE STAGE 2	FAULT
POST GLACIAL OUTWASH	
FLOOD PLAIN ALLUVIUM	
BEDROCK	

COMPILATION A. QUIN
DATE
DESIGNED
DRAWN
TRACED W. McInnes
CHECKED
DATE

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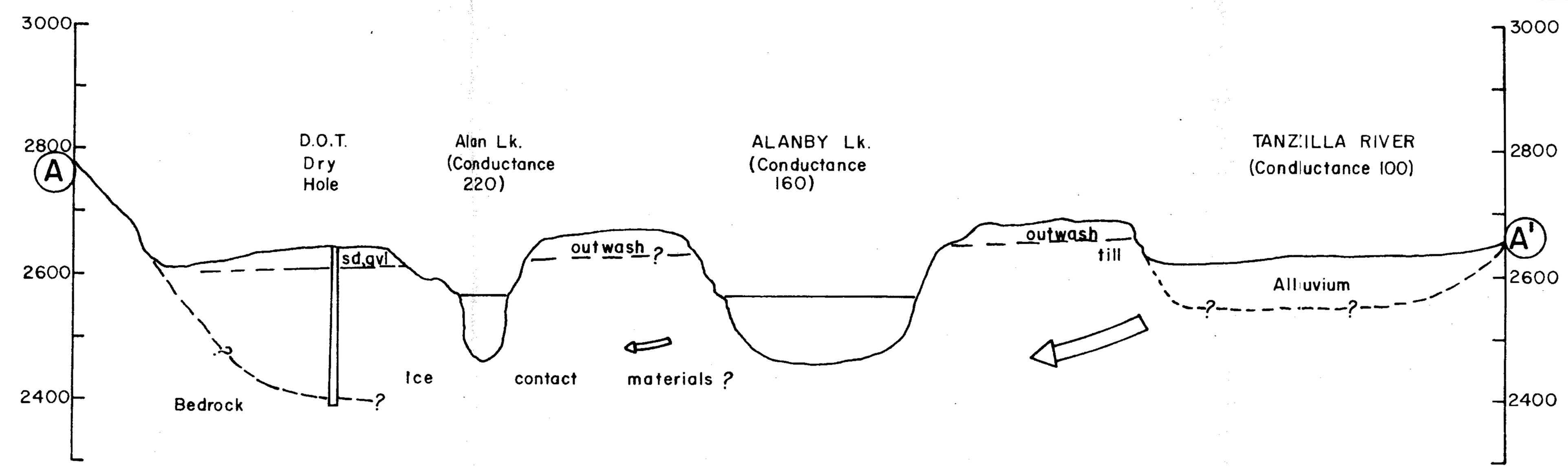
ENGINEER D. M. Callan
APPROVED DIV. CHIEF

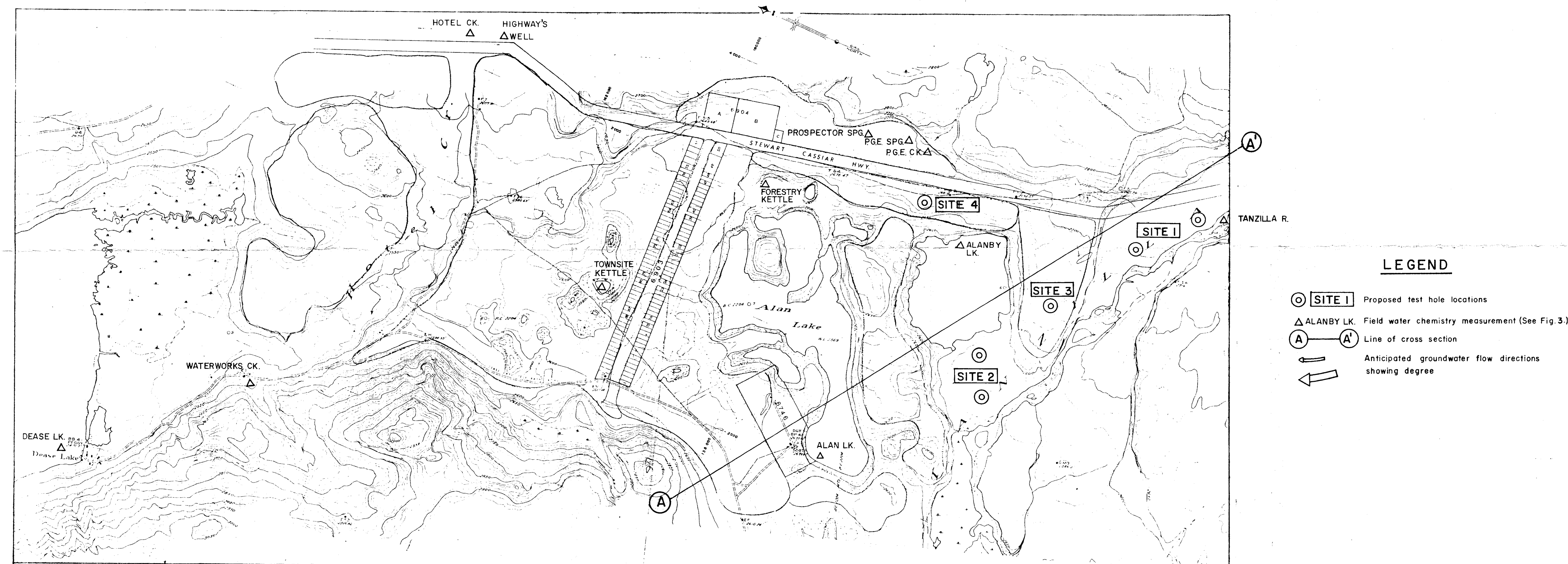
B.C.5382
AP4-6
68-70
FILE No. 0239015
SCALE 1" = 3600' APPROX.
PM56
FIGURE 1
SHEET OF

D



SCHEMATIC HYDROGEOLOGICAL SECTION

SCALE: Hor. 1" = 1000'
Vert. 1" = 2000'



LOCATION OF PROPOSED GROUNDWATER EXPLORATION HOLES

LEGEND

TRIANGULATION STATION	CONTOURS & ELEVATIONS
BENCH MARKS	CONTOURS INDEFINITE
GROUND CONTROL POINT	CLIFF
AIR PHOTO POINT	CUT
AIR PHOTO CENTRE & FL NO	FILL
ROAD MAIN — HARD TOP	FENCES
ROAD SECONDARY HARD TOP	GRAVEL PIT
ROAD OTHER	BUILDINGS
TRAIL	CULTIVATED
POWER LINE	ORCHARD
CREEK	WOODED AREA
CREEK INTERMITTENT	
CREEK INDEFINITE	
SWAMP	

NOTES

GRID ORIGIN - REFERRED TO 58°00' - 130°00'
DATUM OF ELEVATIONS - GEODETIC BM
CONTOUR INTERVAL 10'
A.B. PHOTOS - B C GOV'T. 1957
GROUND CONTROL BY :- G WABERSKI

COMPILED BY MULTIPLEX — CHECKED BY
TRACED BY — REVISED

BRITISH COLUMBIA
DEPARTMENT OF LANDS AND FORESTS
SURVEYS & MAPPING BRANCH
TOPOGRAPHIC DIVISION

DEASE RIVER DAM SITE PROJECT

Scale 1 Inch = 1000 Feet

DATE FEBRUARY 1960 — DRAWING NO. M-39

REFERENCES			REVISIONS		
DWG. No.	DESCRIPTION	DATE	No.	DESCRIPTION	DATE

SURVEYED
DATE
DESIGNED
DRAWN
TRACED W. Mc Innes
CHECKED
DATE

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FILE No. 0239015
SCALE 1" = 1000'
DWG. No. FIGURE 2
SHEET OF

D