No. 21

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
TOPICAL REPORT NO. 71

MACKENZIE RIVER DRAINAGE BASIN
DAM SITE INVESTIGATION

SITE NO. 8

FISH CREEK DAM SITE

(MAP AND PRELIMINARY REPORT)

BY
E. B. OWEN

OTTAWA
1963

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

TOPICAL REPORT NO. 71

MACKENZIE RIVER DRAINAGE BASIN

DAM SITE INVESTIGATION

Site No. 8

FISH CREEK DAM SITE

(Map and Preliminary Report)

by

E.B. Owen

OTTAWA

1963

CONTENTS

Illustrations

FISH CREEK DAM SITE

General Description

Fish Creek dam site is the farthest upstream of several potential power dams in a multiple stage power development proposed for the McDougall Pass area, Northwest Territories. The site is located about 6 miles east of Summit Lake which is situated at the head of the Pass close to the divide between Yukon River and Mackenzie River watersheds. A control dam proposed for the Summit Lake area is described in Topical Report No. 68.

At the present time a small, rapid-flowing stream known as Rat River flows easterly through McDougall Pass. The elevation of the Rat near the centre of Fish Creek site is about 945 feet above sea level. As at the other sites in the proposed development the reservoir at Fish Creek site will not be large. It will probably extend east as far as Summit Lake (El. 1029) and also, for short distances, into the narrow, steep-walled valleys of Fish and Sheep Creeks. These two streams drain most of the area surrounding the reservoir. An examination of aerial photographs indicated there is no possibility of large scale leakage around the perimeter of the reservoir.

At the site McDougall Pass consists of a relatively narrow valley, some 4,500 feet in width, trending in a northeast

direction. The walls of the valley consist of steep, irregular slopes in which it is planned to locate the abutments of the dam. Numerous bedrock exposures occur on both abutment slopes. The floor of the valley consists of a series of level terraces separated by low river-cut bluffs probably formed by Rat River when it was flowing at a higher elevation. One small lake and several former channels occur close to the Rat.

Bedrock exposed at the site consists of thin-bedded to massive sandstone with a few narrow interbeds of black, laminated shale. It is believed to be Mesozoic in age. Overburden covering both abutment slopes consists chiefly of talus. The valley floor is covered with alluvial deposits consisting of silt, sand and gravel. For the most part these materials are concealed by a thick, insulating cover of moss and decayed vegetation the lower part of which is usually frozen. Except along the various channels of Rat River they were only observed in the shot holes blasted during the seismic investigation.

Unconsolidated Deposits

Three types of unconsolidated deposits were identified in the Fish Creek site area. These are as follows:

1. Recent Alluvium: This material has been deposited by Rat River. It consists of silt, sand and gravel containing rounded

boulders up to 18 inches in diameter. Much of the material was probably carried down by Fish and Sheep Creeks during times of flood and deposited at their junctions with the Rat. In the site area extensive deposits of the material occur as elongated islands and bars separating the numerous channels of Rat River. It also constitutes much of the material covering that part of the valley floor adjacent to the river. About 90 per cent of the boulder-size rock fragments consist of quartzite and sandstone. Both these rocks are harder and more durable than bedrock exposed at the site.

2. Alluvium: This material consists of grey, clayey silt with minor quantities of fine-grained sand. It underlies the moss and decayed vegetation covering the floor of the valley above approximate elevation 960. The material is indistinctly stratified. It is believed to have been deposited by Rat River when that stream flowed at a higher elevation. Exposures of the clayey silt do not occur in the site area. It was observed only in the shot holes for the seismic line nearest the right abutment.

3. Talus: Talus is material resulting from the mechanical breakdown of adjacent bedrock. In the case of talus derived from sedimentary rocks the size and shape of the rock fragments depends in general on the thickness of the strata and the spacing between joint planes. At Fish Creek site talus occurs extensively on both abutment

slopes. The material on the right slope contains many large rock fragments derived from massive sandstone beds which range in thickness up to 8 feet. The talus in the left abutment area consists chiefly of small, platy fragments of sandstone mixed with a black, clayey, residual soil containing numerous small, angular fragments of shale. As at most of the dam sites located in McDougall Pass the talus contains a few rounded boulders of quartzite and sandstone which have slumped from deposits of glaciofluvial gravel located on the bluffs above the limits of the area mapped.

Bedrock

General Description

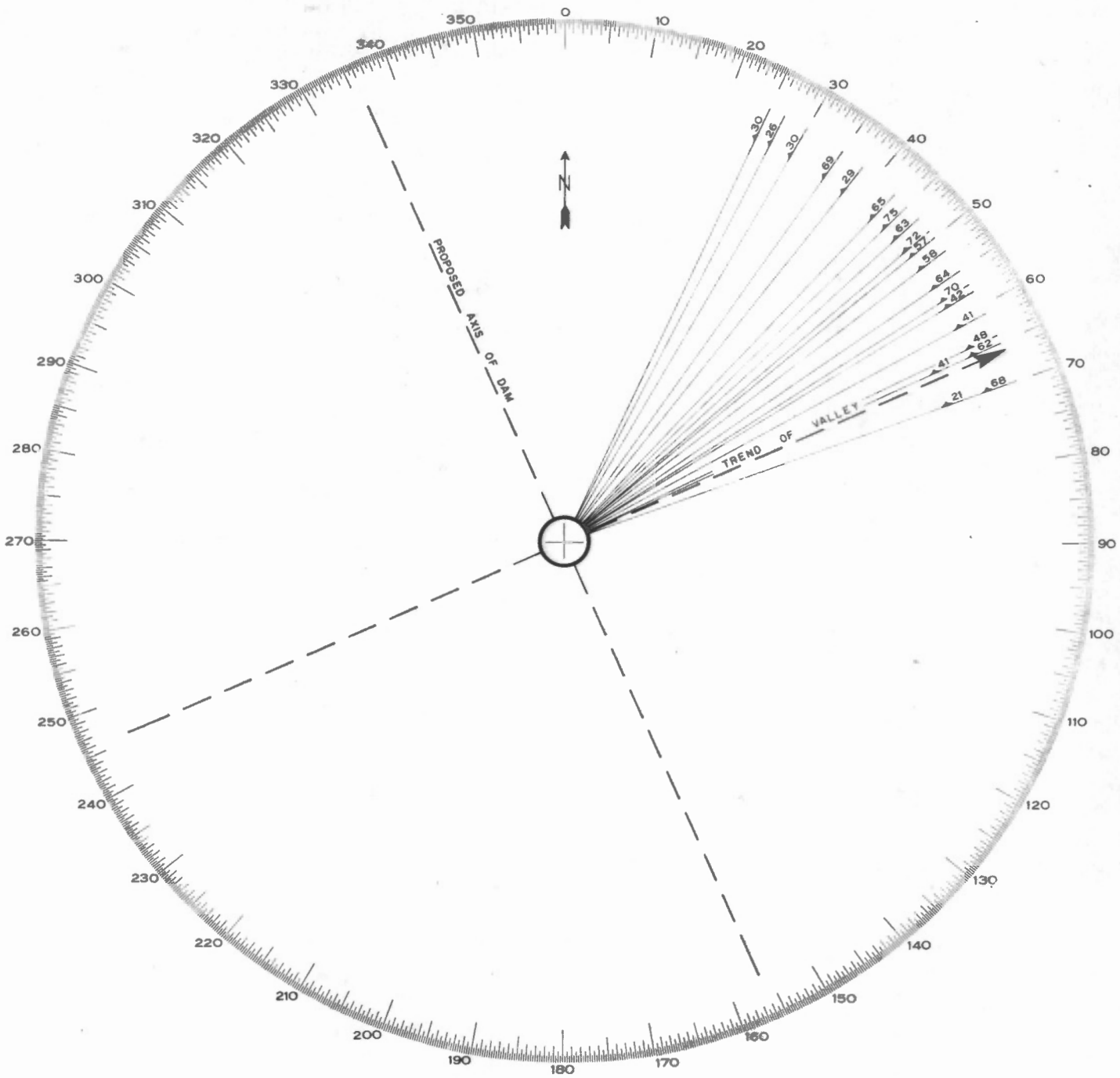
Bedrock exposed at Fish Creek site consists of fine-grained, grey, non-calcareous sandstone interbedded with black, silty shale. The sandstone varies from a massive, thick-bedded, competent rock which exists throughout the right abutment to a thin-bedded, argillareous sandstone which outcrops in the lower part of the bluff forming the left abutment. The shale is seldom exposed in the site area. In most places it is covered with black, clayey residual soil containing small, angular blocks of partially disentigrated shale. The thickness of the residual soil is usually only a few inches. Bedrock throughout the upper part of the left abutment consists of shale. It is also believed to underlie a large part of the valley between Rat River and the right abutment.

Bedrock Structures

Bedding and jointing are the two structures in bedrock exposed at the site which will exert any influence on the quality of the rock and its suitability as foundation or abutment material. The bedding intersects the valley at angles varying between 0 and 40 degrees and dips 26 to 75 degrees into the left abutment. The slope of the bedrock outcrops on the right abutment is similar to that of the strata. The thickness of the individual beds varies from a few inches to 8 feet. Beds 6 feet or more in thickness are common.

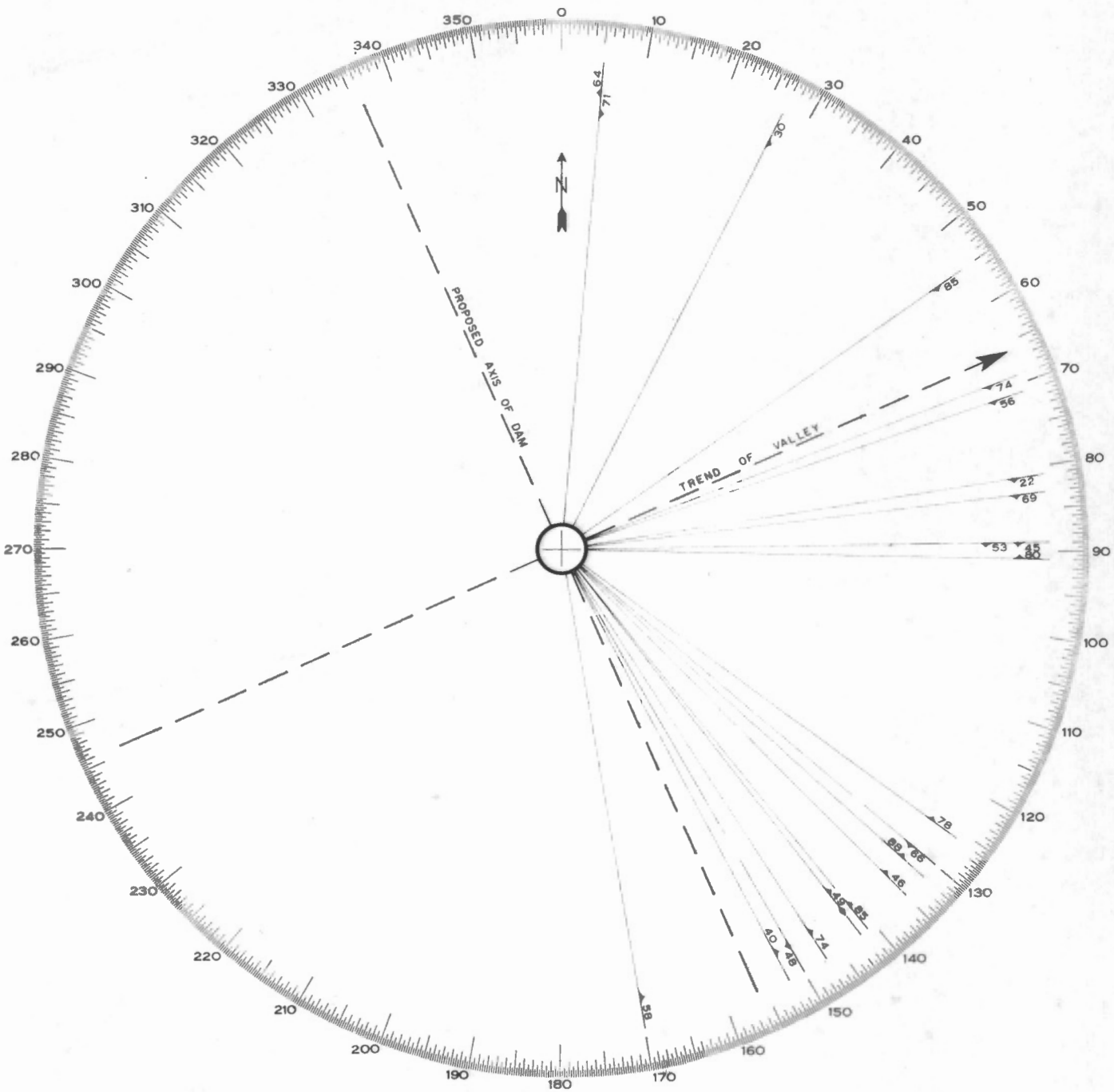
There are 2 principal joint sets at the site. Both have a considerable range of dip and strike. The most prominent intersects the valley at angles between 59 and 86 degrees and dips in general steeply downstream. The second set intersects the valley at 65 to 87 degrees and dips into the right abutment at angles varying from 22 degrees to almost vertical. The spacing of the jointing ranges from a few inches to several feet. Many joints are open fractures up to 6 inches in width and extending downwards 10 feet or more from bedrock surface.

Faulting was not observed in the area mapped. However, a large, north-trending fault is believed to occur along the east side of Sheep Creek Valley. This fault probably crosses McDougall Pass a few hundred feet west of the site and extends north along the valley



BEDDING ROSETTE

The above illustration presents diagrammatically the direction and dip of the bedding in bedrock exposed at Fish Creek dam site



JOINT ROSETTE

The above illustration presents diagrammatically the direction and dip of jointing in bedrock exposed at Fish Creek dam site

of Fish Creek. There is a possibility, however, it may pass through the left abutment area.

Quality of Bedrock

The sandstone exposed in the right abutment is a massive, competent rock and should provide satisfactory abutment material. The durability and specific gravity are relatively high. Consequently this rock should yield suitable riprap and artificial aggregate. The shale and thin-bedded sandstone in the left abutment area have little use as construction material. More information is required concerning the physical properties of these rocks before their suitability as abutment and foundation material can be assessed.

Engineering Considerations

Depth of Overburden

Overburden on both abutment slopes is believed to consist chiefly of a thin deposit of talus which is nowhere greater than 10 feet in thickness. On the upper part of the left abutment test pits put down into the residual soil derived from the shale encountered solid rock from 6 to 24 inches beneath ground surface.

There is no information concerning the depth of overburden on the floor of McDougall Pass at the site. During the investigation 4 refraction seismic profiles all approximately parallel to the Pass were shot between Rat River and the toe of the right abutment. The

locations of the profiles are indicated on the accompanying geological map. The deepest shot hole penetrated about 3 feet into the clayey silt covering the floor of the Pass. The data obtained from the seismic work was not available at the time this report was written.

The possible occurrence of soft, easily erodable shale beneath the valley floor suggests the elevation of bedrock surface may be low. There is also the chance bedrock surface may be exceedingly irregular consisting of ridges of more competent sandstone separated by valleys where shale may have existed. The trend of these undulations would be similar to the strike of bedding in bedrock exposed in the abutments, i.e. vary from being parallel to the valley to intersecting it at angles up to 40 degrees. The directions of the seismic profiles and the suggested undulations are about the same. Consequently, it is doubtful if their presence will be indicated by any one profile.

Abutments and Foundations

The massive sandstone exposed in the right abutment is the most competent rock occurring in the site area. It is suggested during preliminary design the main dam structures, such as diversion tunnels, spillway, etc. be located in or near the right abutment to take advantage of the better rock conditions. The interbedded shales and sandstones occurring in the left abutment and beneath the floor of the Pass should be avoided as much as possible.

Construction Materials

Aggregate

There are no deposits of natural aggregate in the site area with the exception of the Recent alluvial gravels occurring along Rat River. It is suggested a test-pitting program be conducted to determine the quantity and quality of this material. The deposits of glaciofluvial sand and gravel which occur above the site area on the bluffs forming the abutments are thin and irregular and are not considered important as a source of aggregate.

The fine-grained, grey, unweathered sandstone exposed in the right abutment could be crushed to provide suitable fine and coarse aggregate. However, because of the fine, even texture of this rock the resultant material may be lacking in some of the larger, sand-size fractions.

Impervious Material

The clayey silt which covers the floor of the Pass at the site is the only material present which might possibly be used as impervious material for the core of anearth or rock-fill dam. The material as at the other proposed sites is frozen but readily thaws and becomes fluid when the overlying moss has been stripped.

Pervious Material

There is little material suitable for the pervious shells, filters or drains of an earth dam available at the site. The Recent

alluvial gravels along Rat River could probably be processed to provide satisfactory material. However, these deposits are not large and it is doubtful if sufficient material is available.

Riprap and Rock Fill

Large quantities of material suitable for riprap or rock fill can be obtained in or near Fish Creek site area. The chief sources are exposures of massive sandstone, similar to that in the right abutment, which occur along the south side of the Pass between the site and Bear Creek site 3 miles east.

The sandstone is a durable rock with a relatively high specific gravity. The talus associated with it contains many large, roughly squared, flat-faced rock fragments which would make excellent riprap. The sandstone forms long, narrow ridges which project out into the valley parallel to the strike of the strata. The valleys between the ridges were occupied by shale which is less resistant and weathers more rapidly than the sandstone.

Groundwater

There is little information concerning groundwater conditions in the site area. Springs or seeps were not noted issuing from either abutment. The water in several small creeks which cross the valley floor to Rat River probably resulted from the thawing of the active layer and will disappear during the winter. At the time of the investigation there was considerable surface water present on the floor of

the Pass. This included one small lake. Most seismic shot holes rapidly filled with water after they had been blasted.

Frozen Ground

Frozen ground is believed to underlie the entire site area. It was encountered in all the shot holes for the 4 seismic lines and also in several shallow test pits put down in the black, clayey residual soil on the upper part of the left abutment. The depth of the frost line varies from 12 to 30 inches depending upon the thickness of the overlying moss and decayed vegetation.

Further Investigations - Conclusions

This geological investigation is a preliminary one designed to furnish the engineer with general geological information regarding the proposed dam site. The report is based upon a rapid field investigation of bedrock exposed on the abutment slopes and the soils exposed in the seismic shot holes and along the sides of Rat River. Available construction materials, such as earth, gravel and concrete aggregates were also investigated. The object of the investigation is to obtain sufficiently accurate information to permit office studies and cost estimates of the project to be made.

The results of the investigation indicate the site would be satisfactory for construction of a dam. It is believed to be a better site than the Bear Creek site located about 3 miles downstream.

However, more information is required concerning the competency of bedrock in the left abutment and beneath the floor of the Pass. All the major dam structures should be located close to the right abutment to take advantage of the better bedrock conditions. Test borings will be required to determine the quality of bedrock in the left abutment area and beneath the floor of the Pass. There is a strong possibility a large fault occurs in the left abutment.

Chemical Analyses of Rat River Water

During the 1962 field season samples of Rat River water were taken at Fish Creek dam site and at the point where Rat River leaves McDougall Pass and enters Mackenzie Delta. The samples were analysed for their chemical content by the Industrial Waters Section, Mines Branch, Department of Mines and Technical Surveys, Ottawa. The results of the analyses are included on the following page. The reported value of the turbidity should be considered only as indicative. Rat River is subject to flash floods which may cause a rapid increase in the sediment land. A proper sediment study requires regular sampling, often in the case of flash flooding, at hourly intervals. The quantity of dissolved salts in Rat River water is low. This is doubtless due largely to the frozen condition of the adjacent ground and the resultant small quantities of groundwater entering the stream. Groundwater ordinarily contains a higher proportion of dissolved constituents than surface water. The main

mineralization in Rat River water is bicarbonate salts of calcium and magnesium. There are no salts present in sufficient quantity to be harmful to the concrete or other parts of the dam structures which would be exposed to the water.

Chemical Analyses of Rat River Water
(parts per million)

Location	Date	River Discharge	pH	SiO_2	Ca	Mg	Na	K	Fe	CO_3	HCO_3	SO_4	Cl	F	NO_3	Turbidity	Hardness as $CaCO_3$
Fish Creek dam site	July 1, 1962	Medium	7.2	2.7	19.1	8.2	4.2	0.5	.2	0.0	40.6	52.5	3.2	.21	0.1	1.5	81.5
At point where Rat River enters Mac-Kenzie Delta	July 28, 1962	Medium	7.4	3.1	17.7	5.0	2.3	0.5	1.5	0.0	51.2	23.2	2.0	.13	0.2	70	64.9

Plate 1

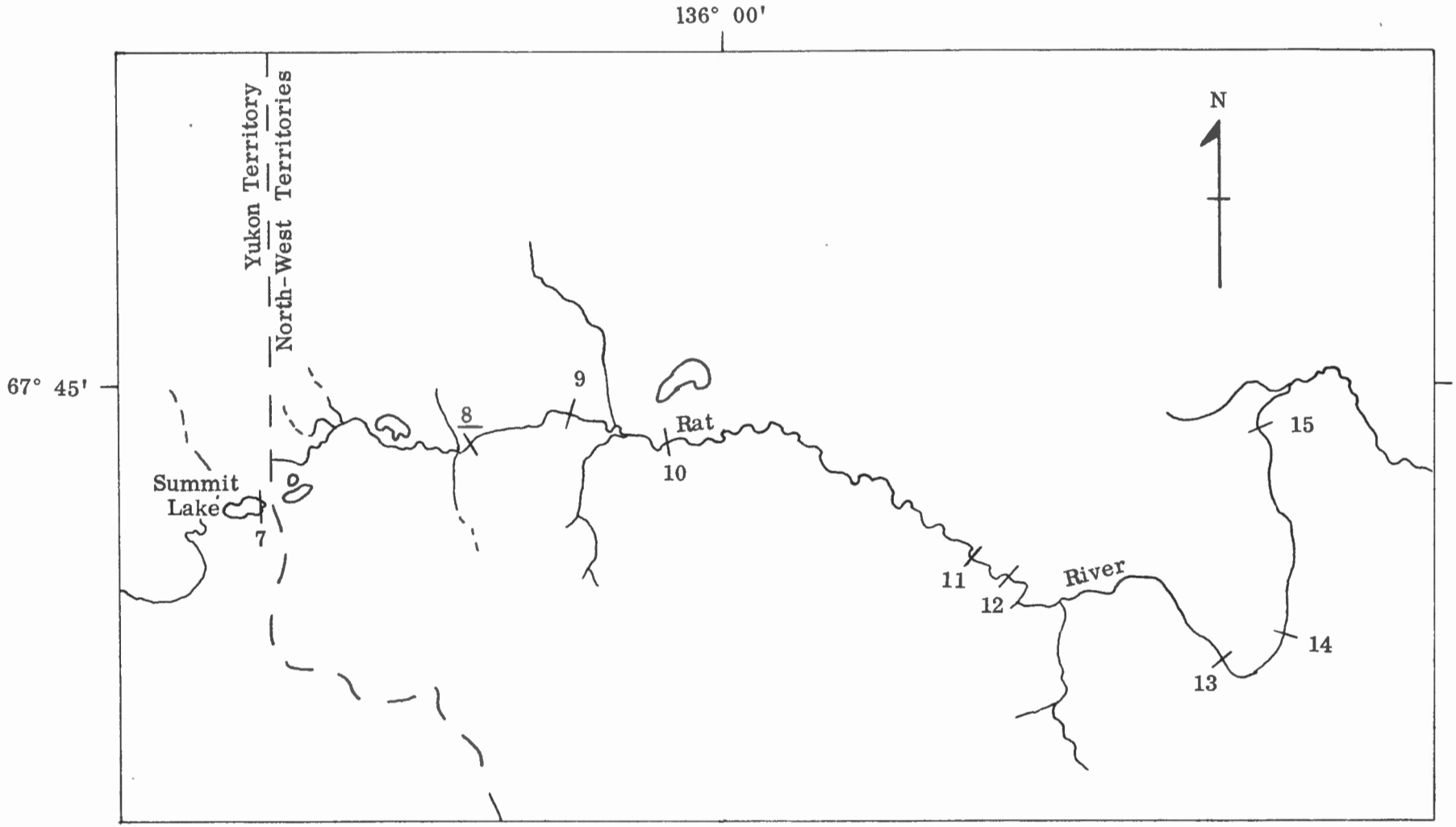
Talus covered right abutment slope.

G.S.C. 9-3-62

Plate 2

View north across site from right abutment;
Fish Creek Valley in left background.

G.S.C. 9-8-62



LOCATION OF PROPOSED DAM SITES
MACKENZIE RIVER DRAINAGE BASIN
Scale: 1 inch to 4 miles (approx.)

Site No.	Name	Site No.	Name	Site No.	Name
7 -	Summit Lake	10 -	Horn Lake	13 -	Barrier
8 -	Fish Creek	11 -	Rat Canyon (Upper)	14 -	Longstick
9 -	Bear Creek	12 -	Rat Canyon (Lower)	15 -	Delta