No. 34

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
TOPICAL REPORT NO. 99

YUKON RIVER DRAINAGE BASIN
DAM SITE INVESTIGATION

SITE No. 25

PORCUPINE DAM SITE

(MAP AND PRELIMINARY REPORT)

BY
E. B. OWEN

OTTAWA
1965

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

TOPICAL REPORT NO. 99

YUKON RIVER DRAINAGE BASIN

DAM SITE INVESTIGATION

Site No. 25

PORCUPINE DAM SITE

(Map and Preliminary Report)

by

E.B. Owen

OTTAWA

1965

CONTENTS

	Page
General description	1
Unconsolidated deposits	2
Bedrock	6
General description	6
Bedrock structures	6
Joint Rosette showing the relation of the jointing to the proposed axis of the dam	7
Gneissosity Rosette showing the relation of the gneissosity to the proposed axis of the dam	8
Quality of bedrock	9
Engineering considerations	9
Depth of overburden	9
Abutments and foundations	10
Construction materials	11
Aggregate	11
Impervious material	11
Pervious material	12
Riprap and rock fill	12
Groundwater	13
Frozen ground	13
Conclusions - Further Investigations	13
Chemical analyses of Stewart River water	14
Grain size analyses curves	14

Illustrations

Plate 1: View along proposed centre line from left abutment	15
2: View along proposed centre line from right abutment	16
Map of part of Yukon River drainage basin showing location of proposed dam sites	17
Map showing the geology of Porcupine dam site	(In pocket)

PORCUPINE DAM SITE

General Description

Porcupine dam site is situated on Stewart River about 33 miles upstream from the junction of the Stewart and Yukon Rivers. It is the furthest downstream of 3 fairly large sites proposed for Stewart River as part of the scheme to develop all the potential power in the Yukon River drainage basin. The other sites consist of Independence and Fraser Falls sites some 35 and 117 miles upstream respectively.

The centre line of the proposed dam is indicated on the accompanying geological map. It will consist of an earth-fill structure, 1,200 feet long, at its left end with the spillway and power house in its centre part. The right end of the dam is a concrete gravity structure. The total length of the dam is some 4,200 feet. Its height will be about 165 feet extending from the bottom of the river to a crest elevation of 1,385 feet.

At the site Stewart River is flowing in a southerly direction across a relatively narrow valley bounded by two parallel, southwest-trending bedrock bluffs. The average width of the valley is about 2,000 feet. In the upstream part of the site area the present channel of the river is along the right side but angles across and in the downstream part is located along the left side of the valley. In the parts where the river is not flowing against the rock bluffs it is bordered by low, level alluvium-covered bedrock terraces which extend from the edge of the river back to the bluffs. The earth-fill part of the dam would be located on the terrace along the left side of the river.

The reservoir will extend back to the tailwater of the Independence project; its maximum water-surface elevation will be about 1,370 feet. That part of Stewart River valley which will be inundated is steep-sided and rock-bordered; its width varies from one-half mile to 2 miles

except at the mouth of Lake Creek immediately downstream from Independence site where it exceeds 4 miles. Remnants of rock terraces covered with thick deposits of coarse-grained gravel occur at many levels along both sides of the valley. The thickness of these gravels exceeds 500 feet[1] along Rosebud Creek some 6 miles above the site. They are considered to be glacio-fluvial in origin. The area was not occupied by the last Pleistocene ice sheet and this, along with the belief the main discharge route for melt water from the last ice was by way of Australia Creek, may account for the relatively high degree of weathering of the gravel. The floor of the valley is covered chiefly with fine-grained alluvium similar to that on the terraces at the site. The course of the river is somewhat meandering as it flows against the rock bluff on one side of the valley and then moves across to flow against a similar bluff on the other side. It is usually located on the opposite side of the valley when it passes the mouth of one of its larger tributaries.

Unconsolidated Deposits

Six types of unconsolidated deposits occur at Porcupine dam site. They are as follows:

1. Recent Alluvium (silt, sand, gravel): This is material which has been deposited by Stewart River beneath and along the sides of its present channel. It occurs as flood plain deposits in the site area and, as well, is exposed in several bars in the river immediately upstream and downstream from the site. The material consists of silt, sand and gravel containing boulders up to 16 inches in diameter. The fine-grained material usually occurs on the flood plain whereas the river channel deposits as indicated by the material exposed on the bars consists chiefly of bouldery gravel. The flood plain deposits exist up to approximate elevation 1,250

---

[1] Bostock, H.S.: Ogilvie, Yukon Territory, Map 711A, Geol. Surv. Can., 1942.

which indicates the highest elevation to which Stewart River rises in the site area. The most extensive deposit of Recent alluvium at the site occurs along the right side of the river in the downstream part of the area. This is a flood plain deposit of silt and sand. The thickness of the deposit is not known although test pits put down to 4 feet encountered the same type of material. Frozen ground was not encountered in any of the pits.

2. Talus: Talus is material derived from the mechanical disintegration of adjacent bedrock. It occurs as an irregular, shallow deposit on the rock bluffs bordering the river and as a thin veneer overlying bedrock above the bluff along the left (west) side of the river. The rock fragments constituting the talus are usually platy and angular and are seldom greater than 24 inches in any dimension. They have usually broken off along joint and foliation planes. The close spacing of the former is the main reason for the platy character of the fragments. The undesirable shape of the fragments in the talus limits its use as a construction material. It is also an indication that suitable riprap or rock fill may not be obtained from bedrock as the shape of the rock fragments obtained by quarrying will be comparable to those in the talus.

3. Alluvium (silt, sand): This material consists of stratified silt and fine- to medium-grained sand which covers the level terraces along both sides of Stewart River between the upper limit of the flood plain of the river and the toes of the abutment shapes, i.e. between approximate elevations 1,250 and 1,260. The alluvium is believed to have been deposited by the present river when it was flowing at a higher elevation before it had cut down into its present channel. The most extensive area covered with alluvium occurs along the left (east) side of the river. Here it is covered with a thick layer of moss and decayed vegetation and is usually frozen. In places the frost line occurs in the organic material which prevented examination of the underlying alluvium. During the investigation the material was best examined

in the bottoms of the shot holes for seismic line No. 2 and in a few shallow test pits where the moss cover was thin. The thickness of the alluvium is not believed greater than 5 to 6 feet. It probably overlies more permeable gravel which in turn directly overlies bedrock. The alluvium has no potential as a construction material.

4. Glacio-lacustrine (clayey silt): This material consists of a thin layer of yellowish-brown, clayey silt which covers much of ground surface above the rock bluffs along both sides of the river. The maximum thickness of the deposit as determined by several test pits was about 30 inches. It overlies either a dense, clayey, silty till or highly weathered gravel. Stratification was not noted in the material and the dry strength is slight. The latter is an indication of its high silt content. The silt has been described as water-laid primarily because it is similar to the glacio-lacustrine silts which are exposed in high banks along Yukon River in the vicinity of Whitehorse and further downstream. Ground surface throughout much of Yukon Territory is covered with a thin veneer of silt similar to that at Porcupine site. It is possible these deposits are eolian, i.e. deposited by wind, in origin.

In some places at Porcupine site the silt contains small, angular, weathered rock fragments usually similar to the gneiss exposed at the site. The material has been identified on the accompanying geologic map as stony silt. The rock fragments are believed to have originated in the underlying till or bedrock from which they have probably worked upwards by frost action. The loose character of the stony silt distinguishes it from the more dense till.

The silt may have some potential as impervious material for an earth-fill dam; however, the deposit is thin and the quantity limited. The upper part of the silt as observed in the test pits contained considerable organic material. If an attempt was made to remove the contaminated material there would be little remaining suitable for construction purposes.

5. Glacio-fluvial (sand, gravel): This material consists essentially of a reddish-brown, highly weathered, sandy gravel which is exposed on both sides of the river usually directly overlying bedrock. The rock fragments consist chiefly of rounded cobbles and boulders of fine-grained, grey quartzite with minor quantities of grey, biotite gneiss, white quartz and black chert. The few granitic rocks present are usually highly weathered and disintegrate readily when struck with a hammer.

These gravels may be Tertiary in age. They are similar to the gravels on the high terraces along Yukon River between Dawson City and the Alaska-Yukon Territory boundary in that both materials are highly weathered and contain an abundance of black, chert pebbles.

The weathering in the gravel eliminates it as a source of natural aggregate. If sufficient quantities were available it could possibly be used as shell material for an earth dam. It is doubtful if any large volume of the material exists at the site but unlimited quantities occur near the mouth of Rosebud Creek about 6 miles upstream.

6. Till: Till was encountered at ground surface only in the downstream part of the left (west) abutment slope. It consists of a greyish-brown, dense, silty, clayey material containing many angular to subrounded pebbles and cobbles up to 6 inches in diameter. It is believed to directly overlie bedrock. The relatively high density of the till was evident when it was necessary to use a pick to penetrate the fresh material as a shovel was ineffective. The rock fragments in the till consist chiefly of fine-grained, grey quartzite with lesser quantities of white quartz, chert, gneiss and volcanic rocks. As in the glacio-fluvial gravel the few granitic rocks present are usually highly weathered and partially disintegrated.

The quantity of till present is unknown. It probably extends throughout most of the left abutment area as it was encountered in many test pits dug through the overlying silt. It may also occur beneath the silt

in the upper part of the right abutment although it was not encountered in several test pits put down to depths as much as 6 feet in this area. Test borings will be required to determine the quantity of till available. If sufficient volume is present it should be considered as potential blanket or lining material for an earth dam. Usually tills produce relatively impervious materials but removal of boulders, which in this case consist almost entirely of quartzite, will be necessary for the soil to be compacted properly.

Bedrock

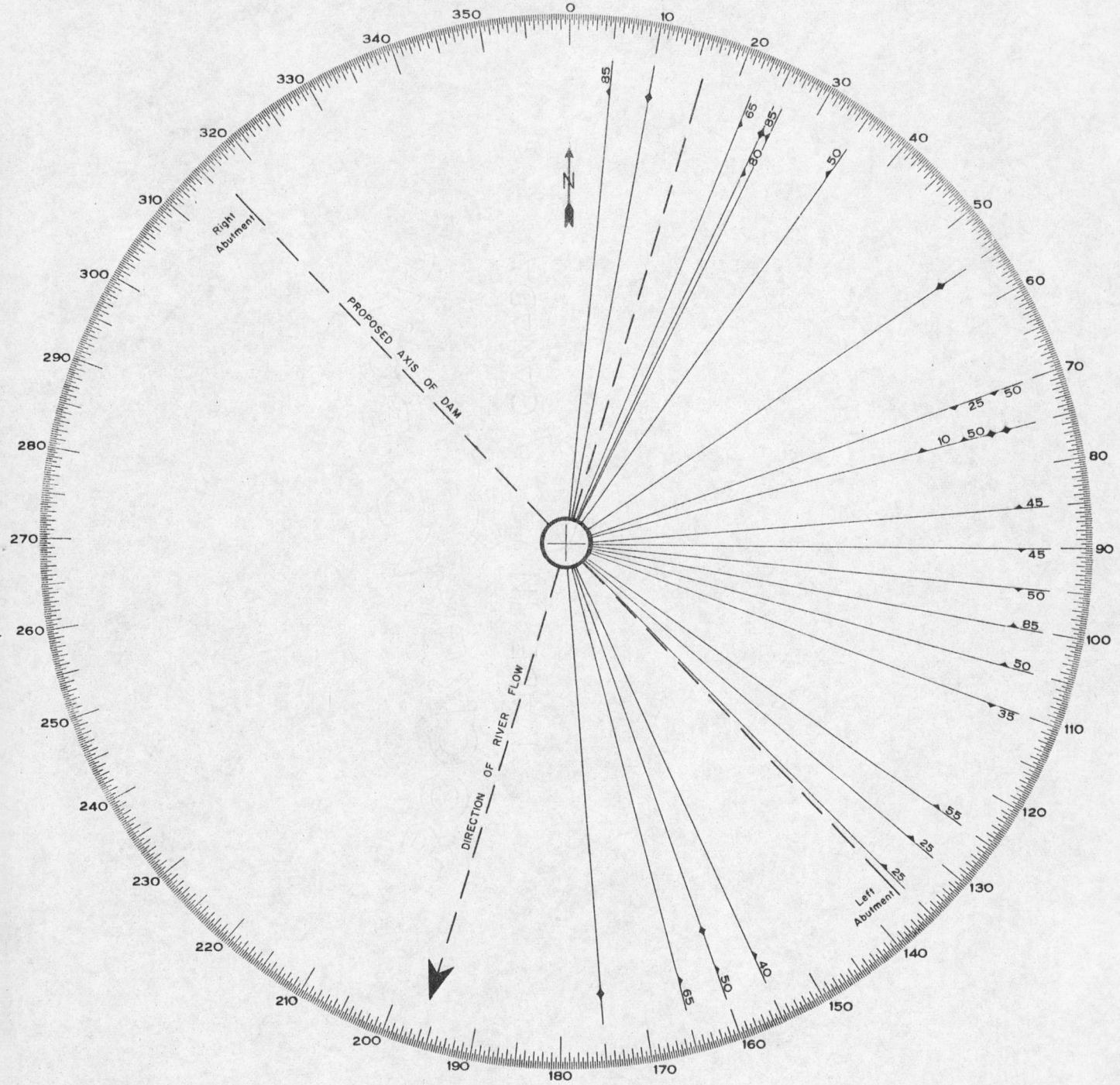
General Description

Bedrock exposed at Porcupine site consists essentially of a fine-grained, grey, biotite gneiss intruded by numerous irregular, white quartz veins which vary in width from a few inches to 2 feet. In places banding is quite distinct. The gneiss is similar to that exposed at the Ogilvie sites on Yukon River which were described in Topical Report Nos. 20 and 21 (sites Nos. 13 and 14). The chief difference is that at the Ogilvie sites a soft, easily weathered schist is interbedded with the gneiss whereas at Porcupine site very little schist is present. The schist which is very platy decreases the stability of the rock and, because of the high mica content, increases the danger of foundation sliding.

In many places especially along the left side of the river the surface of bedrock is badly broken and highly weathered. This is caused by the many closely spaced joint fractures which along with the intersecting gneissosity form planes of weakness along which the rock tends to break and consequently increase the amount of weathering.

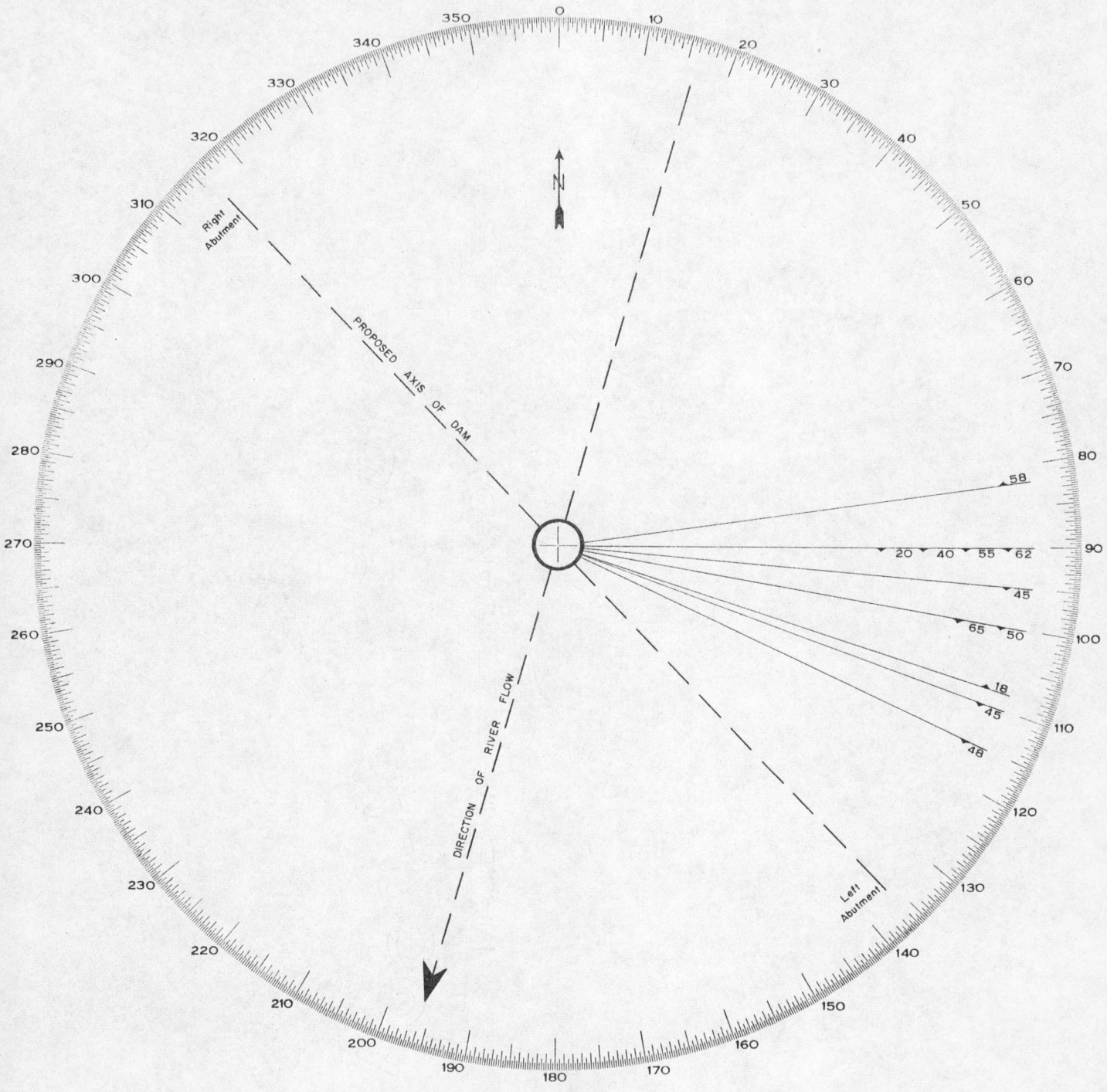
Bedrock Structures

Jointing and gneissosity are the two chief structures which could effect the competency of bedrock. The few small faults present lack the clayey gouge and broken rock zones usually associated with these



JOINT ROSETTE

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



GNEISSOSITY ROSETTE

The above illustration presents diagrammatically the direction and dip of gneissosity in bedrock exposed at Porcupine site

structures and consequently should have little influence upon the quality and permeability of the rock.

Jointing is common throughout bedrock. From the accompanying rosette it is apparent these structures are exceptionally irregular and that there are no prominent ~~sites~~ sets present. The spacing of the jointing is close varying from an inch to about 2 feet. On bedrock surface the joint fractures range up to 3 inches in width and can be traced for distances up to 50 feet. The presence of these fractures has greatly increased the amount of weathering. The effect of the gneissosity will be mainly to influence the manner in which the rock will break when blasted. The gneiss consists of dark grey bands in which biotite mica predominates alternated with light grey material consisting almost entirely of quartz. Most fracturing occurs in the darker micaceous rock.

Quality of Bedrock

Bedrock at Porcupine site is believed competent and should provide satisfactory foundation and abutment material for the proposed dam. Considerable broken, weathered rock will have to be removed before fresh, solid rock against which concrete or dike material can be placed will be exposed. The rock is insoluble and it is doubtful if any solution channels or caverns are present in it. Any leakage through bedrock will probably occur along the jointing, consequently it is suggested test borings be put down to determine if the jointing is tight at depth and at the same time to investigate the quality and permeability of the rock.

Engineering Considerations

Depth of Overburden

The results of seismic lines Nos. 1 and 4 located on the left and right abutment slopes respectively indicate the thickness of overburden in these areas varies from 17 to 25 feet. These figures are believed reasonable.

The material probably consists of a thin layer of silt overlying till which in turn directly overlies bedrock. The talus and glacio-fluvial deposits in the vicinity of the bedrock exposures are believed to be less than 10 feet in thickness. The depth of overburden beneath seismic line No. 3 located on a narrow flood plain along the left side of the river has been calculated to be about 40 feet. This indicates the elevation of bedrock surface here is slightly less than 1,210. It is suggested the lowest elevation of bedrock surface beneath the river at the proposed centre line would be about 1,200 or about 25 feet below the bottom of the river. The results of seismic line No. 2 located on the level alluvium-covered terrace east of the river indicate the depth of overburden varies from 9 to 12 feet. These figures may be accurate for this particular place but should not be considered true for the entire terrace. Bedrock surface probably slopes towards the river and there is also the possibility a buried stream channel filled with permeable material exists in bedrock beneath the terrace. Such a channel would probably be parallel to the seismic line and could easily have been missed.

Abutments and Foundations

Bedrock at the site consists almost entirely of gneiss intruded by numerous irregular quartz veins which should provide satisfactory abutment and foundation material. However to attain a crest elevation of 1,385 the ends of the dam will extend beyond the rock bluffs bordering the river and will be keyed into unconsolidated material. The dense, impervious till overlying bedrock on the left abutment slope should provide satisfactory abutment material. The right end, however, terminates in a coarse-grained, pervious gravel which may have to be removed and replaced with more impervious material. Till may occur in this area but it was not encountered in several test pits. A relatively large amount of weathered, broken rock will have to be removed before fresh, solid rock is exposed. Grouting will

be necessary to consolidate bedrock in both the abutments and foundations beneath the dam. In general the dip of the gneissosity is downstream or into the left abutment. There is little danger of downstream sliding of the dam along the gneissosity but because of the tendency of the rock to break along the more micaceous bands some difficulty due to overhang may be experienced in excavating bedrock in the left abutment.

Construction Materials

Aggregate

Satisfactory aggregate might be produced from the highly weathered gravels exposed in the terraces at the site and along the river downstream toward Yukon River. Most of the cobbles and boulders in this material consists of hard, fine-grained, grey quartzite. These rocks are relatively fresh. The material would have to be processed to eliminate the highly weathered granitic and other rocks. Similar gravel which is much less weathered is exposed along Stewart River commencing about 20 miles upstream. This material is described in the report on Independence dam site (Topical Report No. 100, site No. 24).

A large gravel bar in Stewart River immediately downstream from the site contains a minimum of 250,000 cubic yards of Recent alluvial gravel. About 10 per cent of this material consists of black chert pebbles. Satisfactory aggregate could probably be obtained by crushing bedrock exposed at the site.

Impervious Material

The till which occurs in the left abutment area may provide suitable impervious material for an earth dam. The material was frozen at the time of the investigation so that no samples were taken. However it is similar to the till sampled at Independence site which laboratory analyses indicated was satisfactory. In the site area the till is usually concealed by a

thin deposit of silt so that a program of test pitting or test borings will be required to determine the quantity available. Similar till is exposed in several places along Stewart River within a few miles of the site in both upstream and downstream directions. Consequently there should be no difficulty in obtaining a large volume of the material close to the site.

Pervious Material

The sand and gravel described under the aggregate heading could probably be processed to provide material suitable for the pervious shells, filters and drains of an earth dam. Fine material could also be produced by crushing bedrock.

Riprap and Rock Fill

The size and shape of the rock fragments in a talus is usually a good indication of the size and shape of the fragments obtained from the same rock by quarrying. If the freshly quarried rock is somewhat larger than the talus it will usually break down into smaller fragments in time. Most rock fragments in the talus at Porcupine site are small; only a few exceed 24 inches in diameter. The shape is frequently platy and angular and this along with the small size of the fragments indicates the rock will not produce satisfactory riprap. The physical characteristics of the gneiss should be determined by laboratory tests. It is believed to have sufficiently high strength and specific gravity but more information is required concerning its soundness and porosity. Large rock fragments were observed in a talus located on the right side of Stewart River about 20 miles downstream from the site. According to Bostock[1] the rock probably consists of granite or granodiorite. Similar rock occurs about 4 miles south of the site. These areas should be investigated as potential sources of riprap.

---

[1] Bostock, H.S.: Ogilvie, Yukon Territory, Map 711A, Geol. Surv. Can., 1942.

Groundwater

Little is known regarding groundwater conditions in the site area. In no place were seepages of groundwater observed. Thin deposits of brown carbonate probably deposited by groundwater frequently occur on the walls of open joint fractures. This is an indication these structures are potential aquifers. The weathered gravel overlying bedrock is also a potential aquifer. This material was usually loose and dry where seen, probably because it is located on slopes where drainage conditions are good. The silt overlying the gravel was more dry than the silt above till. The swamp conditions on the alluvium-covered terrace along the left side of the river are due to poor drainage. The accumulated water is probably a mixture of precipitation and water from the thawing of the underlying frozen ground. It is perched above the frozen material which prevents its downward percolation.

Frozen Ground

Frozen ground was encountered in most parts of the site area within 24 inches of ground surface (June 30, 1963). The frost line usually occurred in the soil but sometimes was located in the overlying organic material in areas where the moss cover was thick (12+ inches). Dry frozen ground which contains no ice as a cementing substance probably occurs in the gravels. There is no information regarding the occurrence of frozen ground beneath the river. It was encountered within 25 feet of the river on the terrace along its left side.

Conclusions - Further Investigations

It should be remembered this report is based upon a preliminary geological investigation designed to furnish the engineer with general geological information regarding the proposed dam site.

It is believed bedrock exposed at the site is sufficiently competent to provide suitable foundation and abutment material for the proposed dam

structures. However, test borings will be required to obtain information concerning the following:

1. To contour bedrock surface throughout the site area and to investigate the possibility of the existence of a buried stream channel beneath the terrace along the left side of the river.

2. To investigate the quality and permeability of the overburden and bedrock in the abutments and foundations for the dam. The presence of large boulders in the alluvium beneath the river should be noted as these may prevent the driving of steel sheet piling for the proposed coffer dams.

3. The extent of the till as it may have some use as impervious material if sufficient quantity is available.

4. The extent of frozen ground in the area.

Chemical Analyses of Stewart River Water

The results of chemical analyses of samples of Stewart River water taken at several places along the river are included in the report on Fraser Falls site (Topical Report No. 98, site No. 23). The analyses were made by the Industrial Waters Section, Mines Branch, Department of Mines and Technical Surveys, Ottawa.

Grain Size Analyses Curves

Soil samples were not taken at Porcupine site. Previously, similar materials had been sampled upstream at Independence site and it was thought, considering the preliminary character of the investigation, the results of the analyses of these materials would be sufficient. Descriptions and grain size analyses curves of the sampled materials are included in the report on Independence site (Topical Report No. 100, site No. 24).

Plate 1

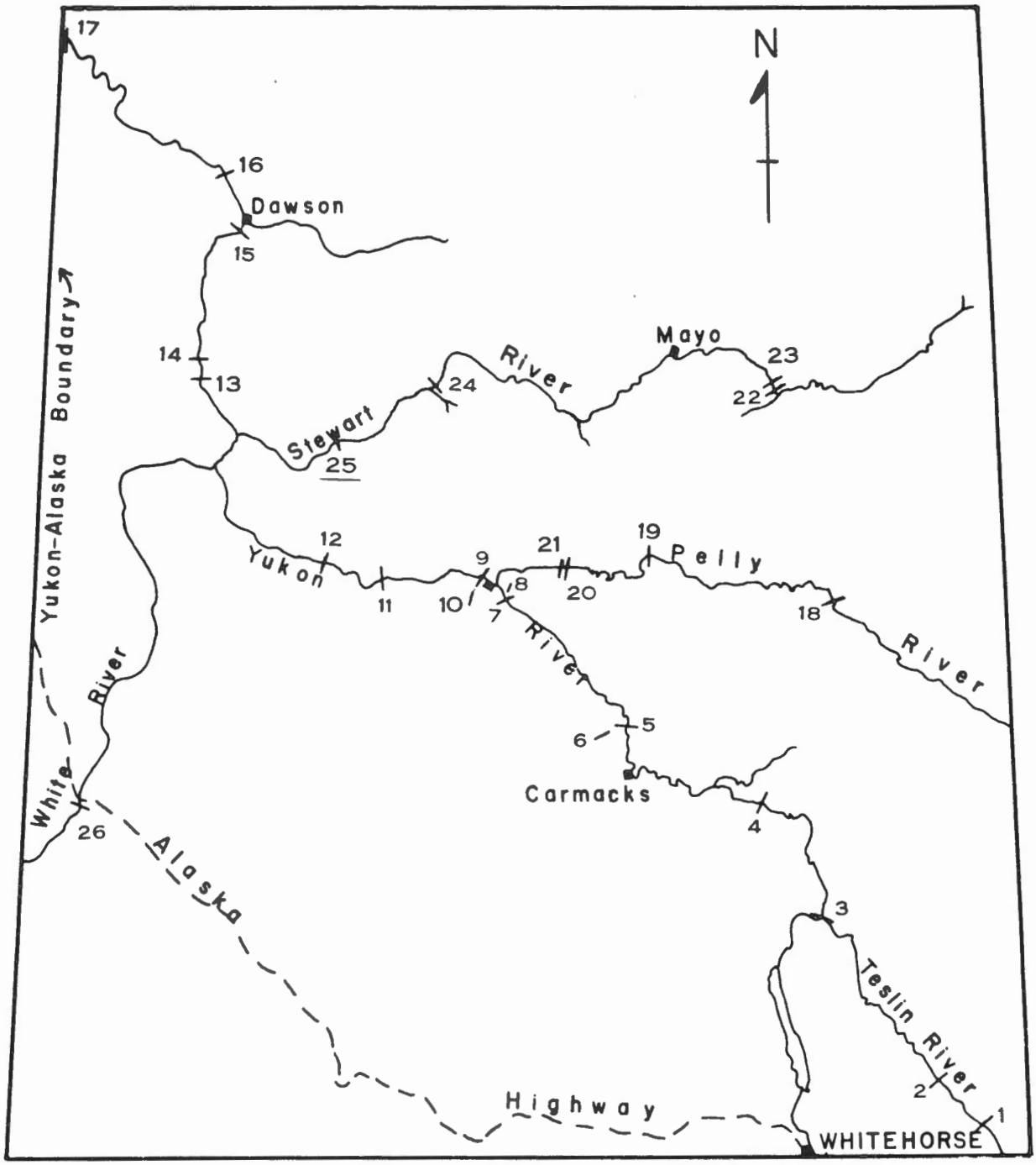
View along proposed centre line of Porcupine dam site from left abutment toward right abutment.

G.S.C. 1-6-63

Plate 2

View along proposed centre line of Porcupine dam site from right abutment toward left abutment.

G.S.C. 2-5-63



LOCATION OF PROPOSED DAM SITES
YUKON RIVER DRAINAGE BASIN
Scale: 1 inch = 40 miles

Site No.	Name	Site No.	Name	Site No.	Name
1	Swift River	10	Fort Selkirk Draw	19	Granite Canyon
2	Northwest Power	11	Selwyn	20	Gerc
3	Hootalinqua	12	Britannia	21	Bradens Canyon
4	Big Salmon	13	Ogilvie no. 1	22	Five Mile Rapids
5	Five Finger Rapids	14	Ogilvie no. 2	23	Fraser Falls
6	Five Finger Draw	15	Upper Dawson	24	Independence
7	Wolverine	16	Lower Dawson	25	Porcupine
8	Wolverine Draw	17	Boundary	26	Lower Canyon
9	Fort Selkirk	18	Detour		