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CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

TOPICAL REPORT NO. 13

YUKON RIVER DRAINAGE BASIN
DAM SITE INVESTIGATION

SITE NO. 7

WOLVERINE DAM SITE

(MAP AND PRELIMINARY REPORT)

BY

E. B. OWEN

OTTAWA
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WOLVERINE DAM SITE

General Description

The main Wolverine dam site at which it is proposed to develop hydro-electric power is located on Yukon River immediately downstream from the mouth of Wolverine Creek and about 5 miles upstream from the junction of Pelly and Yukon Rivers.

A secondary site known as the Wolverine Draw Section is situated in a valley about 3 miles north of the main power dam. The purpose of the Section is to contain the water impounded by the main dam. The Wolverine Draw Section is described in topical report no. 14, site no. 8.

At the main power site the river is flowing in a northwesterly direction between outcrops of intrusive rocks. On the left side a knob of intrusive rock, 500 feet in width, rises some 70 feet above the river (approximate elevation 1,435) and then drops down to a level terrace with an average elevation some 20 feet above the river. The terrace extends westerly for about 1,500 feet to the first of several steep bluffs of soft, volcanic rock paralleling the river.

Bedrock is fairly deep beneath the terrace. The results of three seismic lines on the terrace indicate the overburden is thickest near the river and along the base of the volcanic rock bluffs some 2,100 feet west of the river.

It is possible a shallow valley exists in bedrock surface adjacent to the bluffs. Such a depression would have been eroded out of the relatively soft volcanic rocks prior to the last glaciation.

Subsequently the Yukon River Valley was filled with glacial materials, chiefly glacio-fluvial sand and gravel, and covered with a veneer of silty-sandy alluvium. Further subsurface investigations are required on the terrace to determine the thickness of overburden.

On the right side, intrusive rocks are abundantly exposed along the river bank and for a distance of about 1,500 feet east. The outcrop area rises gradually from the river to a terrace some 700 feet in width and 200 feet above the level of the river. The terrace is slightly depressed in its centre and parallels the present channel of the river. A few outcrops of intrusive rock occur on the terrace. East of the terrace, the topography rises gradually through an area of volcanic rock outcrops to another wider terrace, about 100 feet higher in elevation, which extends easterly beyond the limits of the area mapped.

On the right side, overburden consists of a thin mantle of silt and fine sand of post-glacial origin. The distribution of the numerous rock outcrops and the topography suggests the overburden is shallow and probably less than 10 feet in depth throughout most of the area. These two features indicate a major depression in bedrock surface is unlikely to occur on this side of the river. Although 32- and 85-foot depths to bedrock were indicated by seismic line no. 4, numerous outcrops occur near the line and bedrock is actually exposed in three shot holes on the downstream side of the centre point.

Unconsolidated Deposits

Four types of unconsolidated deposits have been identified in the area adjacent to the proposed dam site at Wolverine. These are as follows:

1. Recent Alluvium: This material varies from a soft, silty clay to masses of cobbles and boulders up to 12 inches in diameter. The alluvial plain of Wolverine Creek is covered with a thin deposit of silty clay. This material was frozen in one locality where it was covered with twelve inches of moss and decayed vegetation.

2. Post-Lacustrine Alluvium(fine-grained sand,in part clayey): This is a soft, stratified material consisting chiefly of fine-grained sand with numerous, irregular lenses of clay. It is a thin deposit occurring extensively in the northwest part of the area mapped. In some places where it was overlaid with 12 to 18 inches of moss and decayed vegetation the material was frozen. The locations of the frozen material have been indicated on the accompanying map. There is not sufficient clay present to warrant considering it as a source of impervious material for the core of the proposed earth dam.

3. Post-Lacustrine Alluvium(silt and fine sand): This material consists of a very fine, medium dense, silty sand. It occurs as a thin deposit overlying both the glacio-fluvial sandy gravel and bedrock in thicknesses varying from a few inches to four feet or more. It is thought to have been deposited during the early formation of the Yukon River. It is an unimportant deposit and could be easily stripped if a borrow pit into the underlying material was opened.

4. Glacio-fluvial: This material consists of a loose, graded, sandy gravel containing numerous boulders up to 12 inches. It is almost silt-free. In the upper two to three feet boulders of the coarser-grained intrusive rocks are frequently weathered and crumble when disturbed. This material constitutes most of the overburden in the terrace immediately west of the river. It is usually overlain by a thin deposit of alluvium but is exposed in a ten-foot bluff along the west bank of the river downstream from a high knob of intrusive rock. It probably underlies the extensive flood plain of Wolverine Creek.

Bedrock

General Description

Three different rock types have been identified in the area near the proposed dam site.

1. Diorite: This is a dark green, fine- to coarse-grained, intrusive rock outcropping on both sides of the river. On the left bank it occurs as a single knob, some 800 feet long and 500 feet wide, which rises to a height of about 70 feet above the river. Numerous outcrops of diorite occur on the right side of the river. On this side it underlies the entire area where construction will take place. Small masses of magnetite occur throughout the diorite in sufficient quantity to affect a compass.

2. Granite: This is a medium-grained, buff to grey rock which intrudes the diorite as narrow stringers and irregular masses up to 50 feet in width. Because of their irregular occurrence few granite exposures have been plotted on the accompanying geological map. The intrusion of the granite does not appear to have affected the structural strength of the diorite. All contacts between the two rocks are firmly cemented.

3. Volcanic Rocks: These rocks are predominately fine-grained, dark grey to black lavas which in places are highly vesicular. They are exposed in the bluff forming the left abutment and also as scattered outcrops on both sides of the river. At the site, they unconformably overlie the intrusive rocks.

Quality of Bedrock:

The quality of bedrock exposed at the site varies considerably. The diorite and granite are massive, durable rocks which should make excellent foundation and abutment material. Weathering in these rocks is negligible and very little rock will have to be removed to obtain a fresh, solid surface against which concrete or dyke material could be placed. The volcanic rocks are relatively soft and less durable. Their porosity is undoubtedly high especially in the zones where large numbers of vesicles occur. Outcrops of the volcanic rocks are usually accompanied by a large talus consisting of small rock fragments up to six inches in diameter. Volcanic rocks overlying about 200 feet of unconsolidated sand and gravel are exposed in a high bluff on the east side of the river about one mile downstream from the proposed dam site. Test borings should be put down in these rocks where they are exposed at the site to determine their quality and permeability and to investigate the possibility they are underlain by similar unconsolidated material. An examination of the volcanic rocks exposed in the valley of Wolverine Creek two to three miles upstream from the Yukon River failed to disclose any underlying unconsolidated material.

Bedrock Structures:

The intrusive rocks, i.e. diorite and granite, are massive and primary structures such as divisional planes characteristic of sedimentary rocks are lacking. Jointing is the only feature in these rocks which could adversely affect the dam. One strong joint set in the diorite strikes about 25 degrees to the river and dips steeply in a westerly direction. It is possible the jointing could permit leakage through the foundations and abutments.

Vertical jointing is very common in the volcanic rocks and it is thought these structures along with the scoriaceous contact zones and vesicular structures could transmit water through the rock.

Engineering Considerations

Depth of Overburden

Except for the data obtained from the five seismic lines no information is available regarding the thickness of overburden in the vicinity of the site. However, as indicated on the accompanying map there are large areas on both sides of the river where the overburden is thought to be ten feet or less in thickness. The results of the three seismic lines put down on the wide terrace immediately west of the river indicate overburden is thickest beneath the west bank of the river. It becomes more shallow beneath the centre part of the terrace and then increases in thickness again along the toe of the bluff on the west side of the terrace. The average depth of overburden over most of the terrace is thought to be about fifty feet. As it is planned to extend the impervious core of the earth dam to bedrock beneath the terrace it is suggested test borings be put down here to determine the elevation of bedrock surface along the centre line and also the quality and quantity of terrace material which would have to be excavated. Much of the area mapped on the right side is covered by less than ten feet of overburden and consequently the greater part of the material excavated for the auxiliary spillway channel will be bedrock.

The results of seismic line no. 5 (121-125 feet to bedrock) located on the left bank some 900 feet below the proposed centre line are the only indications of the thickness of overburden beneath the river channel. These results are not necessarily an indication of the depth to bedrock along the centre line where it crosses the river. Here the proposed spillway and intake dams are located between two diorite outcrops, one on each river bank. The thickness of overburden in this area could be much less. Test borings should be put down to determine the elevations of bedrock surface and to investigate the feasibility of driving steel sheet piling for cofferdam construction.

Abutments and Foundations

Diorite forms most of the abutment and foundation material. This rock should make a satisfactory foundation for the power intake, spillway and non-overflow dams and for the powerhouse structure. The diorite shows little weathering and despite one pronounced joint system is probably water tight. The rock exposed opposite the slough in the southeast part of the map-area as well as the rock outcropping between that point and seismic line no. 4 is finer-grained and more open-jointed than the rest of the diorite. It is also more weathered and in some places exhibits slight shearing. This type of diorite will likely be encountered in the upper half of the spillway channel above the auxiliary spillway dam. It should not be encountered elsewhere.

There is not sufficient evidence available at present to indicate the suitability of the volcanic rocks, exposed on the left abutment area west of the river, as foundation or abutment material. This rock is relatively soft compared to the diorite. It is less durable and contains structures such as open jointing, scoreaceous contact zones and numerous vesicles which could transmit water. There is also the possibility it is underlain by unconsolidated sands and gravels. Test borings should be put down in this rock to determine its quality and permeability and to determine if it could be satisfactorily grouted. Similar volcanic rocks on the right side occur above and beyond the areas affected by the heavy construction.

Construction Materials

Aggregate

The deposits of glacio-fluvial sandy gravel underlying the terrace immediately west of the river are the only potential source of natural aggregate in the area mapped. The quantity is large. A program of test pitting and sampling would be necessary to determine the quality of the material. It will probably be necessary also to screen and reblend the sandy gravel to obtain a satisfactory aggregate. The silt content is low. In some places on the terrace it will be necessary to strip several feet of alluvial silt and fine sand and about 3 feet of weathered material before fresh gravel is exposed. Similar material occurs in a high bluff on the ~~(left)~~ right side of Wolverine Creek about one mile from its mouth. Aggregate could be obtained by crushing the diorite from the spillway channel excavation. This, however, would be a relatively expensive method and should only be considered as a last resort. The volcanic rocks are not a source of suitable aggregate.

Impervious Material

The nearest deposit of impervious material encountered during the investigation is in the area about the Fort Selkirk Saddle dam site. The material is a clayey, silty sand and is described in the geological report for the Fort Selkirk Saddle dam site (topical report no. 16, site no. 10). The deposit is located about eight miles downstream. It is easily accessible.

Pervious Material

Material for the pervious shell of the earth dam can be readily obtained from the extensive deposits of sandy gravel underlying the wide terrace immediately west of the river.

Riprap

The diorite outcropping on both sides of the river at the site is an excellent source of riprap. It is an extremely durable rock with a relatively high specific gravity. Considerable quantities of this rock will be excavated during construction of the auxiliary spillway channel and other dam structures. The larger fragments of blasted rock could be stock-piled until required as riprap or rock fill.

The talus along the bluff forming the left abutment is derived from porous volcanic rocks of low durability. It would not be a source of suitable riprap or rock fill.

Ground Water

Little is known regarding the ground-water table in the vicinity of the proposed site. It is thought to be low throughout the area mapped. This would increase the danger of leakage, especially through the volcanic rocks in the left abutment, following construction of the dam. Accurate information regarding the water table can only be obtained by an expensive test boring program involving the installation of many ground-water observation holes.

Frozen Ground

Frozen material was encountered in three different localities between the river and the rock bluff which forms the left abutment. Frozen, silty clay exists beneath twelve inches of moss about 200 feet west of the diorite knob situated on the left edge of the river. The frozen material is located almost on the centre line of the proposed earth dam. It is probably alluvium deposited by Wolverine Creek. In the northwest corner of the area mapped frozen fine sand with some clay underlies from twelve to eighteen inches of moss. Considerable ice occurs in the foot of a talus directly below the rock bluff which forms the left abutment. This is the probable result of permafrost moving up into the talus from the underlying frozen ground. Areas where frozen material was encountered have been identified on the accompanying geological map. It is suggested a small island of permafrost underlies the low, swampy area along the base of the bluff downstream from the left abutment. This is the most southerly area of frozen ground encountered along the Yukon River during this dam site investigation.

Further Investigations

It should be remembered the present geological investigation of the proposed dam site at Wolverine is a preliminary one designed to furnish the engineers with as much information as possible before money is spent on an expensive subsurface investigation. If it is decided more information is required, the following test borings are suggested as part of the program:

	Location	Approximate Elevation	Depth	Remarks
1.	Intersection of centre line of auxiliary spillway dam and centre line of spillway channel.	1,635 feet	15 feet below grade of spillway channel excavation.	Soil samples taken every 5 feet or where there is a change in material, permeability tests conducted, ground-water table noted.
2.	Centre line of spillway channel, 600 feet upstream from spillway dam.	1,620 feet	"	"
3.	Centre line of spillway channel, 1,200 feet upstream from spillway dam.	1,600 feet	"	"
4.	Centre line of intake dam, 150 feet from east bank of river.	1,440 feet (water)	15 feet into bedrock.	"
5.	Centre line of intake dam, 350 feet from east bank of river.	1,440 feet (water)	"	"
6.	Centre line of spillway dam, 220 feet from west bank of river.	1,440 feet (water)	"	"
7.	Centre line of earth dam, 1,100 feet west of river.	1,450 feet	"	"
8.	Centre line of earth dam, 1,900 feet west of river.	1,450 feet	"	"
9.	Centre line of earth dam, 2,700 feet west of river.	1,630 feet	15 feet below elevation of bedrock surface in hole no. 8.	", also ground-water observation hole installed.

	Location	Approximate Elevation	Depth	Remarks
10.	2,300 feet west of river, 400 feet south of centre line of earth dam.	1,540 feet	15 feet below elevation of bedrock surface in hole no. 8.	Soil samples taken every 5 feet or where there is a change in material, permeability tests conducted, ground-water table noted, ground-water observation hole installed.
11.	2,050 feet west of river, 825 feet south of centre line of earth dam.	1,515 feet	"	"