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CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
TOPICAL REPORT NO. 15

YUKON RIVER DRAINAGE BASIN
DAM SITE INVESTIGATION

SITE NO. 9

FORT SELKIRK DAM SITE

(MAP AND PRELIMINARY REPORT)

BY

E. B. OWEN

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FORT SELKIRK DAM SITE

General Description

The Fort Selkirk dam site is situated on the Yukon River about two miles downstream from the community of Selkirk. The junction of the Pelly and Yukon Rivers is about a mile above Selkirk. At the site, the river is flowing in a northwesterly direction between outcrops of volcanic rocks (basalts, andesites, agglomerates) exposed on both sides. On the left side a high ridge of rocks of the Mount Nansen Group rises abruptly some 800 feet above the river (approximate elevation 1398). On the right side a steep cliff some 300 to 350 feet high and consisting chiefly of volcanic rocks extends along the river's edge from the Pelly River downstream to a point several miles below the site. Above the cliff a wide, level terrace extends for a considerable distance north and east of the site area. The lower part of the cliff consists of agglomerate and andesite lava flows of the Mount Nansen Group. The upper half consists of flat lying, recently deposited lava flows belonging to the Selkirk series. Part of the slope is covered with talus.

The results of seismic line No. 1. (111 to 143 feet to rock) located on an island crossed by the proposed dam axis indicates bedrock is fairly deep beneath the present river channel. There is a possibility the river is now flowing over a former channel eroded in the Mount Nansen volcanic rocks prior to the advent of the Selkirk lava flows and subsequently filled with glacial materials. The present channel of the river has been eroded principally through Selkirk rocks which at one time completely filled the former Yukon River valley.

Overburden on the two abutments consists of talus in part covered with vegetation. Recent alluvium covers the islands in the area mapped as well as some low lying sections along the right bank of the river.

The Fort Selkirk site is believed to be located outside the limits of the last glaciation. It is characterized by an abundance of bedrock exposures and a lack of glacial materials.

Unconsolidated Deposits

Three types of unconsolidated materials were encountered in the area about the proposed dam site at Fort Selkirk. These are as follows:

1. Pre-Selkirk silt, sand and gravel: These unconsolidated deposits are exposed beneath Selkirk volcanic rocks in the bluff along the right side of the river. In places they directly overlie the Mount Nansen rocks. They apparently formed the overburden prior to the advent of the Selkirk lava flows and were buried during the formation of these rocks. They consist of interbeds of coarse bouldery gravel, medium to coarse grained sand and fine silt. In most instances they have a gentle northeasterly dip of about ten degrees. The upper part of these deposits has been semi-indurated by the heat of the volcanic rocks. Quantities of charred wood are visible in a silt bed a few feet below the contact with the Selkirk rocks. About 1,000 feet downstream from the dam axis a small exposure of till was noted between the gravel and underlying Mount Nansen rocks.

2. Talus: Considerable talus occurs on both sides of the river. The material ranges from silt size particles to rock fragments six feet in length. On the right side the bulk of the talus material is derived from the Selkirk volcanics. Fragments of Mount Nansen andesites occur near the bottom of these talus slopes. On the left side the talus consists entirely of fragments of Mount Nansen rocks. Most of the talus on both sides of the river is covered with considerable vegetation.

3. Recent Alluvium: This material consists of fine grained, silty sand with some interbedded clay and fine gravel. It is a deposit of the present river occurring on the islands in the map-area as well as on low lying ground along the right bank. It is not an important deposit.

Bedrock

General Description:

Three different rock types have been identified in the area about the proposed dam site:

1. Agglomerate and Andesite: These volcanic rocks belong to the Mount Nansen Group as mapped by Bostock[1]. They constitute all the rocks on the left abutment as well as the rocks exposed in the lower part (to elevation 1560) of the bluff on the right side. On the left abutment these rocks are chiefly a fine grained, dark green andesite containing numerous block phenocrysts of hornblende or pyroxene up to 1/8 inch in length. On the right side the rock is predominantly a fine grained, light green andesite spotted with small feldspar phenocrysts. The lower part of the Mount Nansen rocks exposed on the right bank consists of a fine grained, greenish agglomerate containing subangular to rounded inclusions from one-half to eight inches in diameter. A similar agglomerate occurs on the left side downstream from the proposed centre line near the edge of the area mapped.

2. Siliceous Dyke: A small exposure of light brown, siliceous rock intrudes the Mount Nansen andesite on the right side of the river about 900 feet

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[1] Bostock, H. S.: "Carmacks District, Yukon"; Geol. Surv., Canada, Mem. 189, p. 29, 1956.

upstream from the proposed centre line. Similar dykes also intruding Mount Nansen rocks occur on the left side of the river immediately upstream from the area mapped. The contacts between the two rocks are firmly cemented. The structural strength of the volcanic rocks does not appear to have been affected.

3. Recent Volcanics: These rocks have been mapped by Bostock as Selkirk volcanics. They do not occur in the left side of the river but are exposed in the upper 150 to 200 feet of the bluff along the right side and probably underlie the wide, flat plain which extends westerly from the site. They vary from a massive, fine grained, brown to black basalt to a vesicular, brecciated rock. The more massive rock possesses columnar jointing and as a consequence tends to break off into elongated, angular blocks. These rocks are relatively soft and weather rapidly. Considerable talus is usually associated with them. In the dam site area the Selkirk volcanic rocks unconformably overlie the Mount Nansen group and in some places overlie unconsolidated silts, sands and gravels.

Quality of Bedrock:

The Mount Nansen andesite and agglomerate are massive, durable rocks. They should make excellent abutment and foundation material for the proposed dam structures. Weathering has penetrated these rocks only slightly and it is thought very little weathered or broken rock would have to be removed to obtain a fresh, solid surface against which concrete could be poured or dyke material placed. The rocks of the overlying Selkirk Series are relatively more soft and less durable than those of the Mount Nansen. Outcrops of these rocks are frequently accompanied by a large talus consisting of rock fragments up to six feet in length. Numerous vesicles in some zones in the Selkirk rocks would make them porous and decrease their durability. The presence of unconsolidated sand and gravel

beneath the Selkirk rocks is important. The permeability of these materials is high and their structural strength is low. Test borings should be put down into the Selkirk rocks to determine their quality and permeability and the lateral extent of the underlying sands and gravels exposed in the bluff along the right side of the river.

Bedrock Structures:

The Mount Nansen volcanic rocks exposed on the left side of the river and in the lower part of the bluff on the right side are massive rocks with few structural weaknesses. Jointing is the only structure present which could adversely affect the dam. On the left side there are two sets of joints. The strongest set intersects the proposed dam axis at an angle of 45 degrees and dips steeply upstream. The other set intersects the axis at 30 degrees and dips steeply downstream. The rock knobs projecting out of the steep slope along the left side of the river are the probable result of jointing. The sides of the knobs are parallel to the two main joint planes. Jointing on the right side of the river is more irregular and not as pronounced as that on the left side. Here three sets of joints occur. Two are parallel with those on the left side and the third approximately parallels the river and dips to the east. All joint planes in the Mount Nansen rocks should be considered as a potential cause of leakage through the foundations and abutments of the proposed dam. If necessary these rocks could be grouted.

Minor faulting and shearing occurs in the Mount Nansen rocks. There is no indication of circulating ground water in these structures and consequently it is thought they are tight and would not carry water into the excavation during construction or act as aquifers following completion of the proposed dam.

The Selkirk volcanics overlying the Mount Nansen rocks are soft, porous and open jointed. The jointing is columnar and the more massive rock tends to break down into elongated rock fragments. The porosity of these rocks is relatively high. The permeability could only be ascertained by test borings and accompanying tests.

Engineering Considerations

Depth of Overburden

Extensive exposures of bedrock occur on both sides of the river. The overburden separating the outcrops consists chiefly of talus partly covered with vegetation. No attempt has been made to estimate the thickness of overburden between the outcrops although in most areas, especially on the left side, it is thought to be less than 10 feet. The depths to bedrock indicated by seismic lines 1 and 2 suggest the present Yukon River may be flowing over a former channel the lower part of which could be filled with permeable glacial fluvial sands and gravels. The thickness of overburden beneath the river is probably too great to contemplate founding any dam structure located in the river entirely on bedrock. Test borings should be put down to determine the quality and permeability of the material underlying the river and to determine the elevation of bedrock surface along the proposed dam axis. At the present time there is not sufficient sub-surface information to produce a geological section for the area.

Abutments and Foundations

The rocks which will form most of the abutment and foundation material are the Mount Nansen volcanics. They constitute all the rock on the left side of

the river and up to elevation 1560 on the right side. The Mount Nansen rocks should make satisfactory foundations for the dam structures. They exhibit little weathering and despite two pronounced joint systems and some minor faulting and shearing are probably fairly water tight. Grouting may be necessary to prevent leakage through some joint planes. The Selkirk volcanic rocks exposed in the upper half of the face in the bluff along the right side contain structures such as open jointing, scoraceous contact zones and numerous vesicles all of which could transmit water through the rock. These rocks also are relatively soft and have a low durability. It is not thought they would make satisfactory abutment or foundation material unless considerable remedial work, such as consolidation grouting, was carried out in them.

Irregular deposits of unconsolidated silt, sand and gravel underlying the Selkirk lava flows in the bluff along the right side present a problem at the Selkirk Dame site not commonly encountered. The lateral extent of these deposits is not known although they are exposed about seven miles upstream in a bluff along the right side of the river. At the Selkirk site their extent and apparent permeability should be investigated by test borings put down in the terrace above the bluff. The lowest elevation at which these materials were encountered in the area mapped was 1428 or about 30 feet above the level of the river.

Construction Materials

Aggregate

The nearest source of material aggregate underlies the area about the community of Fort Selkirk and the adjacent airport where it is exposed along the river bank and in several small excavations. The material is a loose, well

graded gravel with cobbles up to 8 inches in diameter. Many weathered pebbles and cobbles occur in the upper two feet but below this the material is fresh with little deleterious material. The proportion of rock types among the cobbles and pebbles is as follows:

(1) Intrusive Igneous (granite, etc.) = 50 per cent

(2) Extrusive Igneous (andesites, etc.) = 40 per cent

(3) Sedimentary (sandstones, etc.) = 10 per cent

Chert comprises from 3 to 5 per cent of the material.

Concrete in which this aggregate was used can be seen in the foundations of two partly completed buildings at Fort Selkirk. Satisfactory coarse aggregate could be obtained by crushing the Mount Nansen volcanic rocks. However, rocks of the Selkirk Series should not be considered a source of aggregate.

Impervious Material

It is doubtful if a sufficient supply of suitable impervious material occurs in the area adjacent to the proposed dam site. A deposit of fine grained, silty sand with some clay occurs on ground surface in the Saddle dam site area about two and a half miles to the west. Test borings would be necessary here to determine the quantity of material available. The supply for the main dam would be limited by the requirements of the adjacent Saddle dam and the fact that to maintain an impervious blanket upstream from the Saddle dam no impervious material could be taken from that area.

Pervious Material

Material for the pervious shell of the earth dam can be readily obtained from the extensive deposits of gravel underlying the area about the community of Fort Selkirk.

Rip-Rap

The Mount Nansen volcanic rocks outcropping on both sides of the river are an excellent source of rip-rap. They are durable rocks with a relatively high specific gravity.

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 through the unconsolidated sands and gravels and the Selkirk lava flows exposed in the right abutment. Accurate information regarding the water table can only be obtained by an expensive drilling program involving the installation of many ground-water observation holes.

Further Investigations

It should be remembered the present geological investigation of the proposed Fort Selkirk dam site is a preliminary one designed to furnish the engineers with as much information as possible before any money is spent on an expensive subsurface investigation. If it is decided more information is required at the Fort Selkirk site it is suggested test borings be put down in the following localities as part of the test boring program.

1. Along the centre line of the proposed dam site where it crosses the present river channel to determine the quality and permeability of the materials underlying the river and the elevation of the bedrock surface.

2. On the terrace above the bedrock bluff on the right side to determine the quality and permeability of the Selkirk volcanic rocks and the extent and permeability of the underlying unconsolidated sands and gravels exposed in the right abutment.

Comparison with Wolverine Site

As a result of these preliminary surveys the following comparisons can be made between the proposed sites and Wolverine and Fort Selkirk:

1. Depth of Overburden

More subsurface information is required at both sites to determine the quality of overburden and the elevation of bedrock surface along the centre lines.

2. Abutments and Foundations

The diorite and Mount Nansen volcanic rocks underlying the Wolverine and Fort Selkirk sites respectively should make satisfactory foundations for the dam site structures. Bedrock exposed in the left abutment at Fort Selkirk consists of massive, volcanic rocks which should be satisfactory whereas soft, porous Selkirk lavas form the left abutment at Wolverine. The right abutment at Wolverine consists of massive diorite while that at Fort Selkirk consists chiefly of soft, porous volcanic rocks overlying unconsolidated silts, sands and gravels. None of these materials will make a satisfactory abutment.

3. Aggregate

Large quantities of suitable natural aggregate are available at both sites.

4. Impervious Material

No impervious material was encountered in the area about the Wolverine site whereas a large area covered with clayey, silty sand exists in and near the Saddle dam site area at Fort Selkirk. Test pitting will be necessary to determine the quantity and quality of clayey material available.

5. Pervious Material

Large quantities of satisfactory pervious material is available at both sites.

6. Rip-Rap

Large quantities of rock suitable for rip-rap are available at each site.

7. Draw Sections

At Fort Selkirk the material underlying the Saddle dam site consists chiefly of relatively impervious clayey, silty sand whereas at Wolverine the material is a permeable, medium grained, graded sand. Consequently there will be less leakage through the Fort Selkirk site than at Wolverine. Material for an upstream impervious blanket at Wolverine could be obtained from the Fort Selkirk area some eight miles to the west. Permafrost exists in the left abutment of the Fort Selkirk Saddle dam whereas no permafrost occurs at the Wolverine site.

8. Silt Content

It is suggested consideration be given to the relative silt content of the Pelly and Yukon rivers. An examination of aerial photographs showing the junction of the two rivers indicates the silt content of the Pelly is appreciably higher than that of the Yukon. As water from the Pelly would be held back by a dam at Fort Selkirk but not by a dam at Wolverine the higher silt content of the Pelly may be important.

It is difficult to say at this stage in the investigation which of the two dam sites is the better. More subsurface information is required before a decision can be made. From the information available the Wolverine site appears to be the best. This opinion is based almost entirely upon the knowledge the materials exposed in the upper part of the right abutment at the main Fort Selkirk site are extremely unsatisfactory.