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CANADA  
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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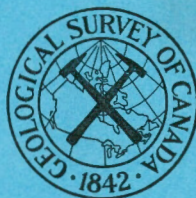
GEOLOGICAL SURVEY OF CANADA  
TOPICAL REPORT NO. 81

18  
MACKENZIE RIVER DRAINAGE BASIN  
DAM SITE INVESTIGATION

SITE NO. 15

DELTA DAM SITE  
(MAP AND PRELIMINARY REPORT)

BY  
E. B. OWEN



OTTAWA  
1963

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## DELTA DAM SITE

### General Description

Delta dam site is the farthest downstream along Rat River of the dam sites in the proposed power development for McDougall Pass. The site is about a mile from the east end of the Pass and 4 miles downstream from Longstick site. The topography and geology at Delta site is similar to that at Longstick. Consequently the descriptions of the soils and bedrock in the reports on the two sites are much the same. Delta is the more important site because of the possibility a large power house will be erected here if the proposed scheme to construct a power canal from Upper Rat Canyon site to Delta site materializes. In this case Barrier and Longstick sites, both located between Upper Rat Canyon and Delta sites, would be by-passed.

At Delta site McDougall Pass consists of a broad valley some 2,700 feet in width. Here, Rat River is flowing in a northerly direction along the right (east) side of the valley against the base of a steep bluff which rises more than 300 feet above the river. The left side of the valley consists of a more gentle slope. It ascends more than 400 feet to the same undulating terrace which exists above the abutments of Longstick, Barrier River and the Rat Canyon sites. It is across this terrace the proposed power canal would be constructed. The power house would be located on the left (west) side of the valley floor at the toe of the slope. The length of the power canal would be about 6 and a half miles. The terrace has a gentle slope to the east between Rat Canyon and Delta sites

which has resulted in a difference in elevation between its ends of about 400 feet. Local relief across the terrace is about 75 feet. It is dotted with numerous small lakes which have resulted, in part, from poor surface drainage and from the proximity of the frost line to ground surface.

At Delta site the flood plain of Rat River extends across most of the valley floor. Numerous, narrow, irregular channels are present. Some of these channels are abandoned but others are intermittent being filled with water at times of flood. Consequently most of the overburden exposed on the valley floor consists of Recent alluvium. The only exception is along the west side of the valley where the material consists of clayey silt and is not believed to be Recent. This material exists between approximate elevation 80 and the toe of the slope.

#### Unconsolidated Deposits

Overburden at Delta site has been divided into 3 types. Two of these are water-laid deposits located on the valley floor and the other, which occurs on the sides of the valley, consists of a mixture of several materials. Bedrock surface is believed to be about 240 feet above the floor of the valley. A deposit of coarse-grained, glacio-fluvial gravel directly overlies the rock. This in turn is overlaid by glacio-lacustrine sandy silt. The latter two materials are not included in the accompanying geological map because the map does not extend sufficiently far up the sides of the valley.

1. Recent alluvium (silt, sand, gravel): This is material which

has been deposited by the present Rat River. It consists of gravel containing a few rounded boulders up to 24 inches in diameter which is exposed chiefly along Rat River and in the channels on the valley floor. The areas between the channels are covered with silt and sand. The Recent alluvium is an extensive deposit but its thickness is not great. It is not believed to have any use as a construction material.

2. Alluvium (silt, minor clay): This material is believed to have been deposited by Rat River when it flowed at a somewhat higher elevation. It differs from the Recent alluvium in that it contains no sand or gravel. It is similar to materials existing at other sites which are considered to be alluvial in origin. The extent of this material at Delta site is small although it may underlie the Recent alluvium on the left (west) side of the valley floor.

3. The third material consists of fine- to medium-grained sand resulting from the weathering of sandstone bedrock mixed with small, angular fragments of sandstone. The material also contains considerable silt, sand and gravel which have slumped from deposits of this material located higher on the slopes. The material is exposed in several slide scars on the steep bluff along the east side of the valley. The more gentle slope along the west side is almost completely covered with vegetation. Here the material was encountered in several shallow test pits.

## Bedrock

### General Description

Bedrock is exposed only in a few slide scars on the steep, right abutment about 200 feet above the floor of the valley. In most places on the sides of the valley it is concealed by materials resulting from the weathering of bedrock mixed with silt, sand and gravel slumped from above.

The rock consists of fine-grained, dense, dark grey, calcareous sandstone. Most of the sand grains are quartz but considerable mica is also present. Interbeds of soft, brown shale and siltstone up to 6 inches in thickness are common. As at the other sites in the eastern part of McDougall Pass the surface of the sandstone has been highly weathered to a soft, porous rock.

### Bedrock Structures

The limited extent of the bedrock exposures restricted the examination of bedrock structures and the number of attitudes taken. The thickness of the sandstone beds exposed varies from a few inches to about 2 feet. As at Longstick site further upstream the bedding is horizontal.

There are two prominent joint sets in bedrock. One is parallel to the valley and the other intersects it at about 65 degrees. The dip is steeply upstream or into the right abutment. The spacing of the jointing is extremely variable ranging from a few inches to more than 2 feet.

## Quality of Bedrock

The results of laboratory tests made on samples of fresh sandstone taken from 4 dam sites located in the east part of McDougall Pass are included on the following page. The rocks from the Rat Canyon sites belong to a different geological period than those from the other 2 sites. In the field, however, all the rocks appeared similar. The samples taken were believed to be representative of the rock at the site. The percentage of mica, which has a higher specific gravity than quartz, varies considerably throughout the sandstone. It is extremely variable even in the individual beds. Consequently the unit weights obtained should not be considered true for all the rock at the site. The sample from Delta site contains a much larger proportion of mica than those from the other sites and as a consequence the reported unit weight of this rock is higher than for the others.

The compressive strengths, which are the stresses required to break a loaded sample unconfined at the sides, of the samples from the Rat Canyon sites are low. One reason for this is that, while in place, these rocks have passed through numerous freeze-thaw cycles. This would result in a decrease in soundness and in compressive strength.

The permeability of the sandstone from Upper Rat Canyon site is sufficiently low for foundation and abutment material. However, the presence of joint fractures, many of which are parallel to the river, would increase the permeability of the rock mass. The permeability of the sandstone from the Lower site is comparable to that of fine-grained sand. The unit weight of this latter rock is low and the absorption is relatively high.



Results of Laboratory Tests on Representative Samples of Fresh Sandstone

	Upper Rat Canyon Site	Lower Rat Canyon Site	Longstick Site	Delta Site
Compressive strength	11,700 psi.	7,250 psi.	-	-
Permeability	$1 \times 10^{-8}$ cm/s. ( $5.25 \times 10^{-3}$ ft/yr.)	$2 \times 10^{-4}$ cm/s. (105 ft./yr.)	-	-
Unit Weight	157.4 pcf.	134.3 pcf.	161.0 pcf.	168.3 pcf.
Absorption	1.3%	3.7%	1.3%	0.6%
Accelerated freeze-thaw	No apparent effect	No apparent effect	-	-
Specific gravity	2.64	2.64	2.65	2.68
Particle size	-	Uniform fine sand 99% - 0.6 to 0.7 mm	-	-
Sodium sulphate soundness	Loss 0.91%	-	-	-

Figures for the porosity of this rock are not available but are probably high. The results of the accelerated freeze-thaw and sodium sulphate soundness tests on sandstone from both Upper and Lower Rat Canyon sites indicate these rocks, in general, would be suitable for rock fill and riprap.

The results of the tests on the rock from the areas where the proposed diversion dam and the power house (Upper Rat Canyon site and Delta site respectively) would be located indicate these rocks would provide suitable foundation and abutment material. It is believed suitable sizes can be obtained to provide satisfactory riprap and rock fill.

#### Engineering Considerations

##### Depth of Overburden

The thickness of the mixture of talus, residual soil and slumped silt and gravel on the sides of the Pass is believed to be generally less than 10 feet. Local accumulations of this material especially along the toes of the slopes will probably exceed this figure. The thickness of the glacio-fluvial sand and gravel directly overlying bedrock at the site varies from 30 to 40 feet. The gravel in turn is overlaid by 20 to 40 feet of glacio-lacustrine sandy silt. The results of one seismic profile located in the east side of the valley near the main channel of Rat River indicated the depth of overburden is greater than 150 feet. At the downstream (north) end of the profile and within 250 feet of the toe of the steep bluff forming the east side of the valley the depth of overburden was greater than 175 feet. If this information is correct the bluff must continue downward beneath

Rat River at approximately its same slope. The thickness of the overburden beneath the centre and west side of the valley will probably be somewhat less than that beneath the seismic line.

#### Proposed Location of Power House

One result of this investigation indicated there is no specific place in or near Delta dam site which would be more favorable in locating the proposed power house.

In the site area the northerly slope of bedrock surface beneath the valley is believed to be steeper than the gradient of the valley floor. Consequently the thickness of overburden in the valley should be less upstream from the site. It is suggested the power house be located as far upstream from the area mapped as is possible without sacrificing any hydrostatic head. In order to connect with the power canal the power house would have to be located on or at the base of the slope forming the west side of the valley. The quantity of overburden that would have to be excavated to found the power house on bedrock would depend upon the location of the structure relative to the slope. Overburden on the slope is similar throughout the area. This mixture of sandy residual soil, small bedrock fragments, silt and gravel is unstable with the result slides frequently occur. To protect the power house the overburden on the slope in the proximity of the structure would have to be removed.

## Construction Materials

### Aggregate

The most probable source of aggregate are the extensive deposits of glacio-fluvial sand and gravel which occur throughout the east end of McDougall Pass. At Delta site the maximum thickness of the deposit is about 40 feet. A description of similar material is included in the report on Longstick site (Topical Report No. 79). The results of laboratory tests indicate a fairly high percentage of thin, flaky, elongated particles is obtained when bedrock is crushed. Bedrock should be investigated further to determine if this condition would occur in the field using full size processing equipment.

### Impervious Material

The glacio-lacustrine sandy silt which covers the undulating terrace west of McDougall Pass is a potential source of impervious material for an earth dam. A description of similar material is included in the report on Longstick site.

### Pervious Material

Materials suitable for the shells, filters and drains of an earth dam may be obtained from the granular deposits described under the aggregate heading. The quantity available is unlimited.

### Riprap and Rock Fill

Sandstone at the site is believed, in general, to be suitable for riprap or rock fill. The limited extent of the bedrock exposures

prevented any estimate of the quantity available. Ideally the sandstone should be thick-bedded and contain a high percentage of mica. This type of rock would provide large, angular fragments with a relatively high unit weight. Vertical test borings located along the top of the bluffs would be the most satisfactory method of determining the quality of bedrock at the site. These borings would provide little information concerning the spacing of the jointing the dip of which is close to vertical. The spacing is important because it controls to a great extent the size and shape of the rock fragments resulting from blasting. This could probably be best determined by stripping the overburden from the steep bluff east of the river and examining the bedrock surface thus exposed.

#### Groundwater

There is little information regarding groundwater conditions in the site area. Springs or seeps were not observed in any place. As a result of thawing of frozen ground during warm weather small quantities of groundwater issue from the gravel overlying bedrock. This water evidently percolates down the slope along bedrock surface and is a major cause of the numerous slides that frequently occur along the bluffs.

#### Frozen Ground

Frozen ground was encountered in several test pits put down on the terrace above the steep bluff along the east side of the valley and on the more gently sloping bluff along the west side (August 1, 1962). It was not noted in any of the shot holes for the seismic line which penetrated to

depths up to 3 feet. In most places the frost line occurred within 18 inches of ground surface. Invariably it was covered with a thick layer of moss and decayed vegetation. The depth to the frost line beneath the valley floor is uncertain. In all other sites it was encountered in the seismic shot holes. Delta site is the only site where the flood plain of Rat River extends across the entire floor of the valley. This may be the reason for the absence of frozen ground in this area.

#### Further Investigations - Conclusions

As at the other sites in the multiple stage power development proposed for McDougall Pass this report is based upon a rapid field examination of the soils and bedrock exposed in and adjacent to the site. It is believed the information contained in this report is sufficiently precise to permit office studies and obtain general cost estimates.

It is believed the fresh sandstone in the site area would provide suitable foundation and abutment material and could also be used as riprap and rock fill and as a source of aggregate.

The site is the most favourable in this part of McDougall Pass for a dam constructed across the valley. Considerably more subsurface information will be required, however, before the site can be properly assessed. The data provided by the one seismic profile indicates the depth of overburden here is greater than at any other site in the Pass. Test borings will be required to determine the elevations of bedrock surface and also the quantity of weathered surface rock present throughout the site. The presence of frozen ground beneath the valley floor should be investigated.



Samples of the overburden on the valley floor should be taken at 5 foot intervals or where there is a change in material. Permeability tests should be made both in the overburden and bedrock.

If the proposed power canal from Upper Rat Canyon site to Delta site is constructed it is suggested the power house be located as far upstream as possible to take advantage of the probable decrease in the thickness of overburden. Test borings will be required to determine the final location of the structure.

#### Chemical Analyses of Rat River Water

During the 1962 field season samples of Rat River water were taken at Fish Creek dam site and from a point about 2 miles downstream from Delta site. The samples were analysed for their mineral content by the Industrial Waters Section, Mines Branch, Department of Mines and Technical Surveys, Ottawa. The results of the analyses are included in the report on Fish Creek dam site (Topical Report No. 71, site No. 8).



Plate 1

Steep, right abutment, Delta dam site;  
bedrock exposed about 200 feet above  
the valley floor.

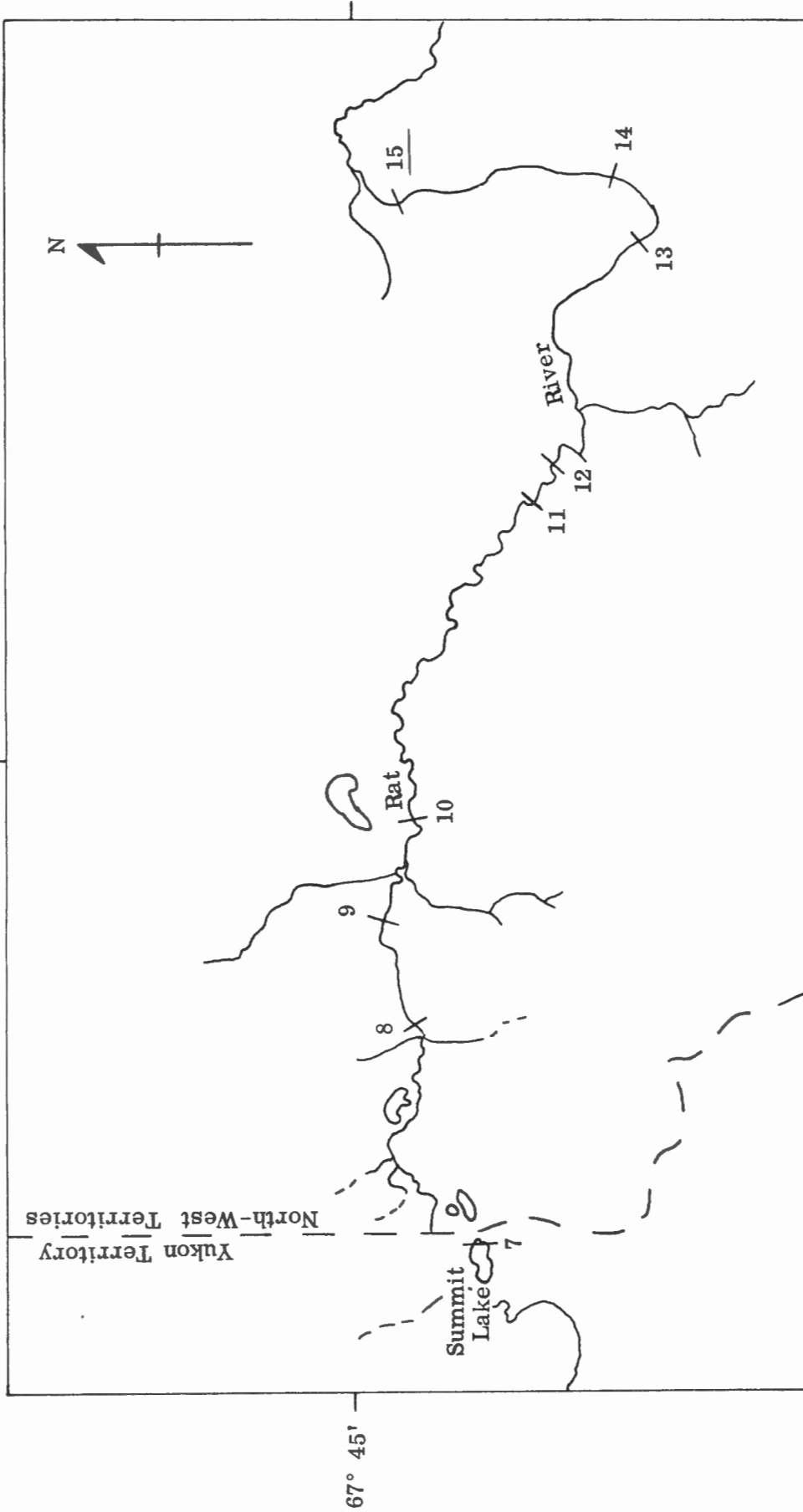
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Plate 2

View across wooded valley floor toward  
left abutment, Delta dam site.

G.S.C. 33-5-62



**LOCATION OF PROPOSED DAM SITES  
MACKENZIE RIVER DRAINAGE BASIN**

Scale: 1 inch to 4 miles (approx.)

<u>Site No.</u>	<u>Name</u>	<u>Site No.</u>	<u>Name</u>	<u>Site No.</u>	<u>Name</u>
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