No. 2

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
TOPICAL REPORT NO. 40

MACKENZIE RIVER DRAINAGE BASIN
DAM SITE INVESTIGATION

SITE NO. 2

FALSE CANYON DAM SITE

(MAP AND PRELIMINARY REPORT)

BY
E. B. OWEN

OTTAWA
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FALSE CANYON DAM SITE

General Description

False Canyon dam site is located on Frances River about 16 miles upstream from the bridge on the road joining the communities of Watson Lake and Ross River. The bridge is about 32 miles north of Watson Lake. A second bridge on the road leading into Canada Tungsten Mines crosses Frances River about 18 miles above the site. The site is easily accessible by small boat from either bridge.

At the site, Frances River is flowing in a southwest direction between two rocky cliffs which rise abruptly from the edges of the river to heights of about 40 feet. The average width of the river is about 300 feet. The water at the site is relatively clear compared to that in other rivers in Yukon Territory. Consequently, the river bottom beneath 3 to 4 feet of water is plainly visible. The temperature of the water about 12 inches below the surface was 60 degrees Fahrenheit on August 9, 1961.

Bedrock is exposed on both sides of the river. It consists of Palaeozoic sedimentary rocks which have been briefly described by Dawson[1]. Alluvial silt, sand and gravel constitute the greater part of overburden at the site. Minor quantities of talus occur at the base of the bluff some 700 feet northwest of the site.

A low, swampy valley, through which Frances River probably flowed when it was at a higher elevation, exists about 250 feet northwest of the right side of the river. This valley varies in width from 300 to 700 feet.

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[1]Dawson, G.M.: "Report on an Exploration in the Yukon District, N.W.T. and adjacent northern portion of British Columbia", Geol. Surv., Canada, 1898, p. 103.

Test pits put down to depths as great as 9 feet in the floor of the valley encountered alluvial sand and gravel overlying bedrock. The permeabilities of these materials, computed in the field, ranged from 10^{-2} to 10^{-4} cm. per second.

It will be necessary to construct a dyke across this valley to contain the water in the reservoir imponded behind the proposed power dam on the river. The high permeabilities of the materials filling the valley indicate a cut-off wall to bedrock surface will have to be constructed beneath the dyke to prevent piping and to control seepage.

The thickness of the overburden filling the valley is believed to be generally less than 10 feet. However, the possible presence of a buried stream channel eroded into the surface of underlying bedrock should be considered. It is suggested a minimum of two seismic lines similar to those put down by Water Resources Branch at many of the sites in the Yukon River drainage basin are required for this area. One line should extend south from P.B.H-9 to the large outcrop area and the second line, parallel to the first, should be located about 600 feet east.

There is a decided lack of construction materials in the area adjacent to the site. Frozen ground was encountered in only one locality. This has been indicated on the accompanying geological map.

Unconsolidated Deposits

Three types of unconsolidated deposits were identified in the area about the proposed False Canyon dam site. These are as follows:

1. Recent Alluvium (silt, sand, gravel): This is material which has been deposited by the present river. It consists chiefly of silt and sand with small quantities of sandy gravel. The steep, rock walls of the canyon, which in many places rise vertically from the river, have prevented the

formation of extensive Recent alluvial deposits. Consequently, this material occurs only in small, scattered areas along the edges of the river. The limited quantity available prevents it from becoming a source of construction material.

2. Talus: Talus consists of spalled material derived from adjacent bedrock. At False Canyon site it occurs only as a thin deposit along the lower part of the rocky slope which forms the northwest boundary of the draw valley. The talus consists of rock fragments ranging from sand size to boulders 12 inches in diameter. Many of the larger boulders are roughly squared and flat faced. They consist chiefly of hard, insoluble argillite. The deposits of talus in the site area are not sufficiently large to provide adequate quantities of riprap and rock fill for the dam. The size and shape of the rock fragments indicate, however, suitable material could be quarried from bedrock exposed at the site.

3. Alluvium (silty sand): This material constitutes most of the fill in the draw valley northwest of the river. It consists chiefly of stratified, poorly graded, silty sand. Crossbedding is common. The arrangement of the beds indicates the water which deposited the sand was flowing in the same direction as the present river. In some test pits a bed of sandy gravel, 12 inches in thickness, was encountered beneath the sand and directly overlying bedrock. The permeability of the gravel, as computed in the field, was in the order of 10^{-2} cm. per second. Representative samples (Nos. 39 and 40) of the silty sand and the gravel were sent to the Soils Laboratory of the Water Resources Branch in Vancouver for grain size analyses. The resultant curves are included at the end of this report.

Bedrock

General Description

Bedrock in the area consists of fairly massive, dark green to black argillite with occasional thin interbeds of medium-grained, grey quartzite. The argillite is hard and thinly-bedded but shows little tendency to split along the laminae. Both rock types are insoluble and are believed to be relatively impermeable.

Bedrock exposed at False Canyon site is not as altered or shattered as that occurring at the other potential dam sites (Lower Canyon, Upper Canyon) on Frances River and consequently is believed to be more competent. A few, irregular quartz veins, up to 2 inches in width, occur throughout the rock. They were too small to be included on the accompanying geological map.

Bedrock Structures

Jointing is common and usually closely spaced. It intersects the proposed centre line of the dam at angles varying from zero to 69 degrees and dips steeply downstream or into the right abutment. The most prominent set intersects the centre line at angles from 42 to 69 degrees. The set would undoubtedly exert considerable influence on the manner bedrock would break during blasting.

Considerable faulting occurs in the rock exposed along the left side of the river 100 to 200 feet upstream from the proposed centre line. Here bedrock is badly broken adjacent to several, irregular faults, many of which are potential aquifers. The average strike is approximately north and the dip steeply downstream.

Several other faults were observed in the bluffs upstream from the proposed centre line. In most instances the strike is generally

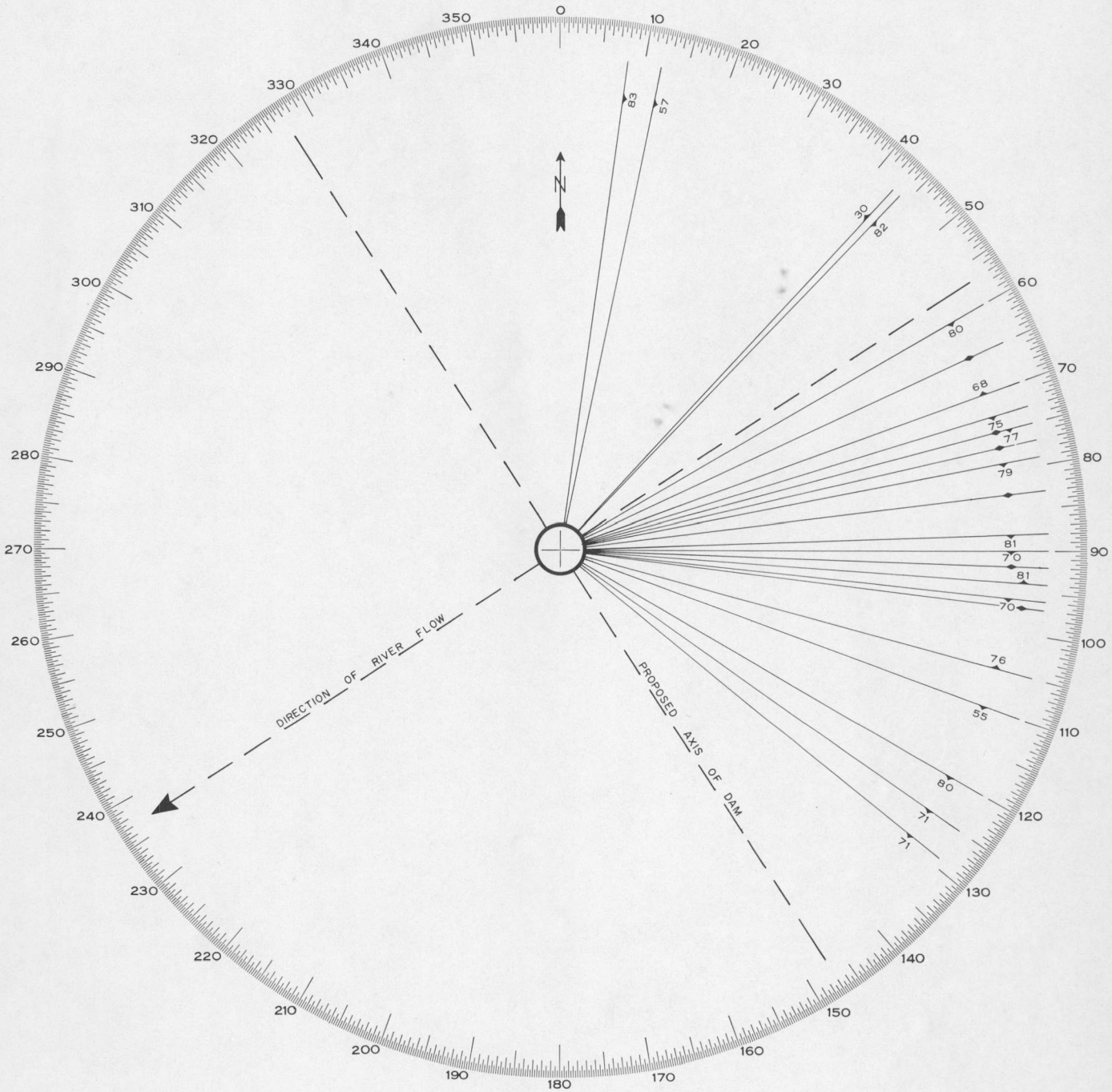
north. They intersect the river at about 45 degrees and dip steeply downstream. The gouge zone usually varies in thickness from 1 to 2 inches and consists of a grey, sandy clay. Bedding faults whose attitudes are parallel to the dip and strike of the strata occur throughout bedrock exposed at the site. They consist of narrow zones of shattered rock mixed with clayey gouge. In some places the dips may steepen and the faults cut across the beds or pass from one bedding surface to another.

The strike of the bedding varies between north and north 40 degrees east and the dip between 10 and 40 degrees northwest. Minor folding, however, has caused some deviation in these figures. In general, the bedding intersects the proposed centre line at angles varying from 26 to 66 degrees and dips into the right abutment.

Narrow zones of greenish, silvery schist occur in bedrock exposed on the right side of Frances River near the upstream end of the area mapped. The planes of schistosity parallel the river and dip toward the left side at about 65 degrees.

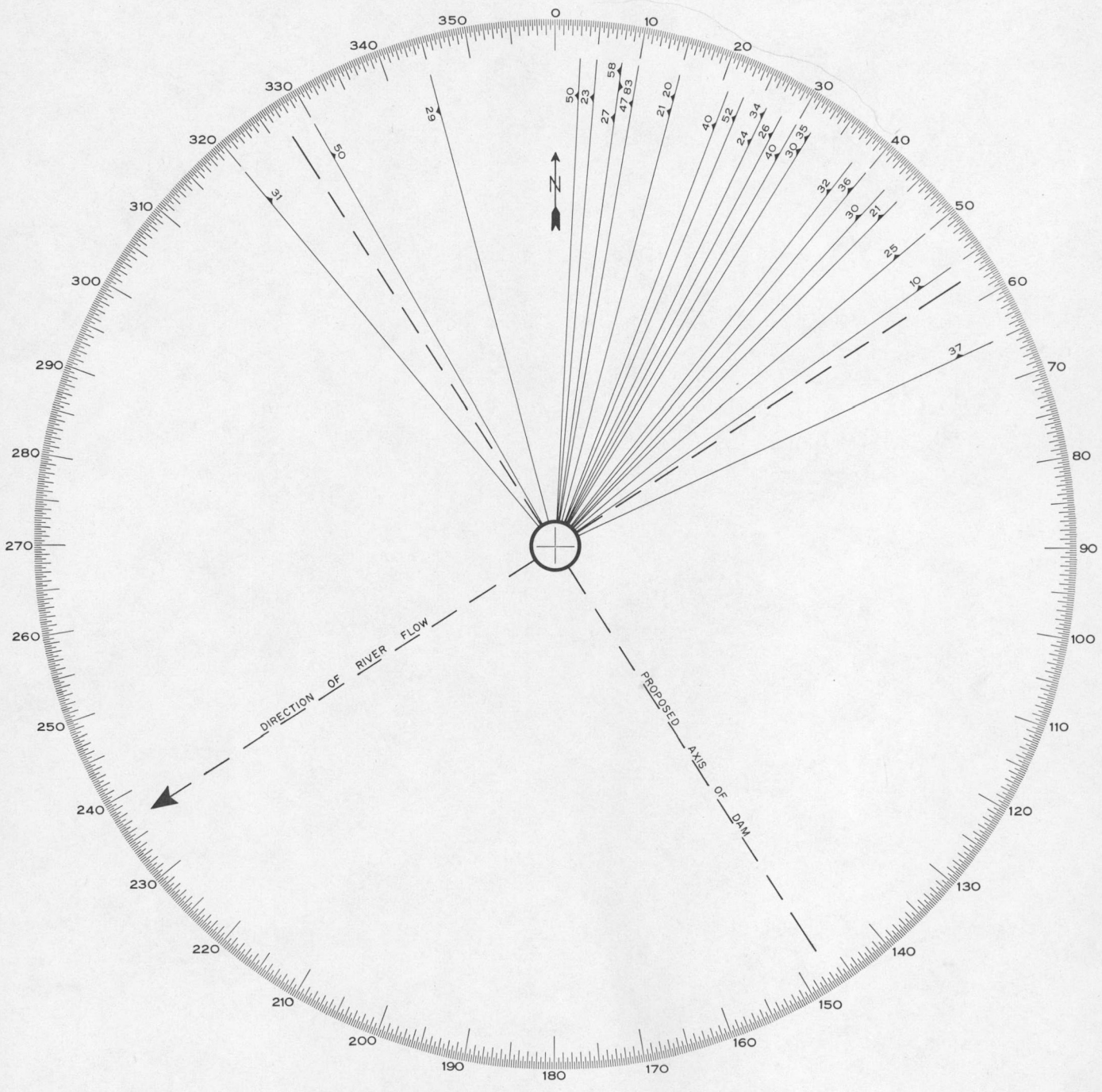
Quality of Bedrock

The argillite exposed at False Canyon dam site is a hard, strong, insoluble rock which is well suited for a dam foundation or abutments. The wide zones of badly shattered rock associated with the faulting should be thoroughly investigated to determine if they can be grouted or would have to be excavated during construction. Bedrock, except for the fault zones, is believed to be relatively impermeable.



JOINT ROSETTE

The above illustration presents diagrammatically the direction and dip of the jointing in bedrock exposed at False Canyon dam site, Frances River



BEDDING ROSETTE

The above illustration presents diagrammatically the direction and dip of the bedding in bedrock exposed at False Canyon dam site, Frances River

Engineering Considerations

Depth of Overburden

Overburden in the area consists of alluvial silt, sand and gravel with thin deposits of talus scattered along the base of the slope in the extreme northwest part of the area mapped. Bedrock is exposed in all the area investigated along the left (southeast) side of the river. On the right side the rock bluff which rises abruptly from the edge of the river drops off sharply about 250 feet northwest of the river into a low, swampy, draw valley. The width of the valley varies from 300 to 700 feet. Several test pits located in it encountered bedrock within 10 feet of ground surface.

The possibility of a buried stream channel, eroded into bedrock, beneath the valley should be investigated. Such a depression would probably be filled with permeable sandy gravel similar to that encountered underlying the more silty alluvium in some of the test pits. Bedrock is exposed on a small island in the centre of the river immediately downstream from the site. The location of this outcropping suggests the thickness of overburden beneath the river at the site is relatively small; perhaps in the order of 25 feet. Bedrock can also be seen to extend out beneath the river from both walls of the canyon.

Abutments and Foundations

The argillite exposed at False Canyon dam site is a competent rock and should provide satisfactory abutment and foundation material. The rock is essentially the same in both canyon walls. The presence of open joint fractures and zones of shattered rock suggests that, in some places, weathering may have penetrated the rock to a considerable depth. The clayey gouge associated with the numerous bedding faults may be important since sliding may be caused by the thrust of the dam.

Test borings should be put down to determine the depth of weathering in the argillite, the permeability of the rock and the possibility it can be grouted. It is doubtful if it will be necessary to construct a diversion tunnel through one of the abutments. A canal sufficiently large to carry all the water in Frances River could more easily be constructed in the draw valley northwest of the site.

Construction Materials

Aggregate

There is a lack of natural aggregate in the area about False Canyon dam site. There is a shortage of similar material along the Watson Lake - Ross River road which passes some 4 miles to the west between the site and Simpson Lake. Much of the overburden encountered along the road consists of fine-grained, silty sand similar to that in samples 45 and 46. The gravel deposits nearest the site are located on the road into Canada Tungsten Mine west of the bridge over Frances River. Bedrock at the site could not be crushed to produce suitable aggregate.

Impervious Material

The permeability of the fine-grained, silty sand which is the only unconsolidated material occurring in large quantities near the site ranges from semipervious to impervious. It could probably be used satisfactorily in construction of a low-head dyke but not for the type of dam required at the site. Field descriptions of this material along with grain size analyses curves from 2 representative samples (Nos. 45 and 46) are included at the end of this report.

Pervious Material

There is a shortage of material suitable for the pervious shells of an earth-fill dam in the site area. Satisfactory material may be obtained by processing the fine-grained, silty sand described under Impervious Material.

Riprap and Rock Fill

It is believed that material suitable for riprap or for a rock-fill dam could be quarried from bedrock exposed at the site. Bedrock is the same on both sides of the river. Consequently, the location of the quarry would depend upon the plan for construction of the dam. Possibly the best place for the quarry would be downstream from the site on the extension of the bluff northwest of the draw valley. However, if a diversion canal were constructed in the valley a bridge would have to be built across the canal to haul the material to the site.

Groundwater

The groundwater table in the area about False Canyon dam site is believed to be relatively high. Groundwater was encountered within 4 feet of surface in several test pits put down in the draw valley northwest of Frances River. Seepages of groundwater do not occur in the bedrock exposed in the walls of the canyon. However, many of the rock fragments in the fault zones have a brown coating of iron-bearing carbonate probably deposited by circulating groundwater. The fault zones should be considered as potential aquifers capable of carrying reservoir water through the abutments and foundations. Accurate information concerning the water table can be obtained by installing groundwater observation holes and reading them at regular intervals.

Frozen Ground

Frozen ground was encountered in one place during the investigation (August 8, 1961). The occurrence was in alluvial, silty sand underlying 8 inches of moss and decayed organic material. The frost line was about 24 inches beneath ground surface. The location, which is in the downstream part of the draw valley, has been indicated on the accompanying geological map.

Proposed Location of the Dam

A centre line for the dam has been indicated on the accompanying geological map by a line of proposed bore holes. This location was chosen because bedrock exposed in the two abutments is fairly massive and the visible faulting is of a minor nature. Most of the faulting occurs upstream from this line. An alternate site occurs about 200 feet downstream. Here bedrock is of similar quality but the rock bluffs forming the abutments are somewhat lower.

Conclusions

Bedrock exposed at False Canyon site is a competent rock and should provide satisfactory abutments and foundations for a power dam. In the upper part of the canyon there are several fault zones containing large quantities of shattered rock. These should be avoided if possible. Bedrock is exposed in both of the proposed abutments. Here, little surface rock will have to be removed before fresh, solid material against which concrete can be placed will be obtained. The thickness of the alluvium beneath the river is believed to be about 25 feet. The lack of construction materials and the necessity of constructing a dyke across the draw valley northwest from the right abutment are the two major defects of this site. The site should not be dismissed until an extensive investigation for granular materials has been conducted throughout the region.

Further Investigations

It should be remembered 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 on a rapid examination of the soils and bedrock exposed at the site. The maximum depth to which the test pits were put down was about 10 feet. If it is decided more information is required at the site the following test borings are suggested as part of the program. It is assumed the centre line of the proposed dam would be located approximately as indicated by the line of proposed test borings on the accompanying geological map.

Hole No.	Location
1	Left abutment, 150 feet southeast from edge of river.
2	On centre line, at left edge of river.
3	On centre line, centre of river.
4	On centre line, at right edge of river.
5	Right abutment, 150 feet northwest from edge of river.
6	Southeast side of draw valley, 300 feet northwest of edge of river.
7	Draw valley, 450 feet northwest of right edge of river.
8	Draw valley, 600 feet northwest of right edge of river.
9	Northwest side of draw valley, 750 feet northwest from right edge of river.

All borings should penetrate at least 15 feet below the lowest elevation of bedrock surface encountered; soil samples should be taken every 5 feet or where there is a change in material; permeability tests

should be conducted and the elevations of the groundwater table noted.

Faults visible in the canyon walls are usually vertical or steeply dipping. Consequently, they will seldom be intersected by vertical borings. It is suggested boring No. 2 be drilled north 81 degrees east and at an angle of 45 degrees. This boring is designed to intersect a strong fault exposed in the face of the bluff about 75 feet upstream. A second boring could be drilled from the same location in the opposite direction and with the same vertical angle. This boring should intersect another strong fault which probably crosses the proposed centre line near the centre of the river. The remaining borings should be drilled vertically.

Chemical Analyses of Frances River Water

Chemical analyses of Frances River water are included in the report on Lower Canyon site (Topical Report No. 41, site No. 3).

Grain Size Analyses Curves

The grain size analyses curves included in this report were prepared in the Soils Laboratory of the Water Resources Branch in Vancouver. The permeabilities were computed in the field using a Soiltest Permeameter, Model K-620.

The results of the analyses indicate the fine-grained, silty sand, which is the only soil type occurring in large quantities near the site, would not be desirable material for a rolled earth dam. It could probably be used satisfactorily in the low-head dyke suggested for the draw valley.

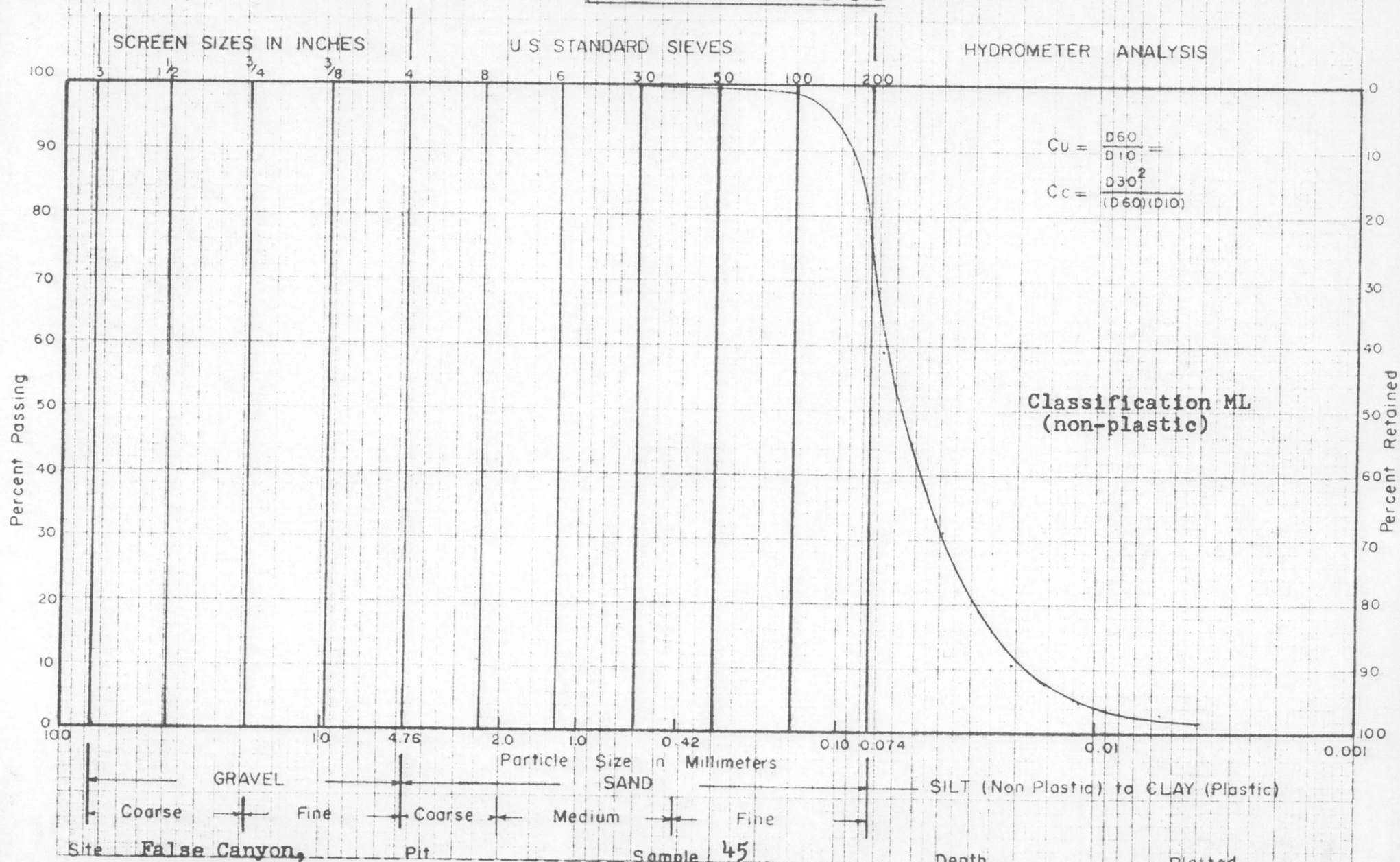
Description of Potential Impervious Material for the following Grain Size Analyses Curves

Sample Number	Location	Field Description of Material	Field Description of Overburden	Thickness of Deposit	Areal Extent (Estimated)	Permeability* (cm./sec.)
45	Steep bluff on north side of a tributary valley joining the east side of Frances River valley about 2 miles upstream from site; sample taken about 1/2 mile east of river and 10 feet below top of bluff	Fine-grained, silty sand; thinly-bedded; no pebbles; no weathering	None	250 feet	Unlimited; extends along both sides of the tributary valley for at least one mile	10^{-4}
46	Steep bluff 1/4 mile east of Frances River and 1/2 mile downstream from site; 20 feet below top of bluff and 4 feet beneath ground surface	Fine-grained, silty sand; no bedding; no pebbles; minor weathering	None	85 feet	Unlimited	10^{-4}

* Permeabilities computed in the field using a Soiltest Permeameter, Model K-620.

WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS

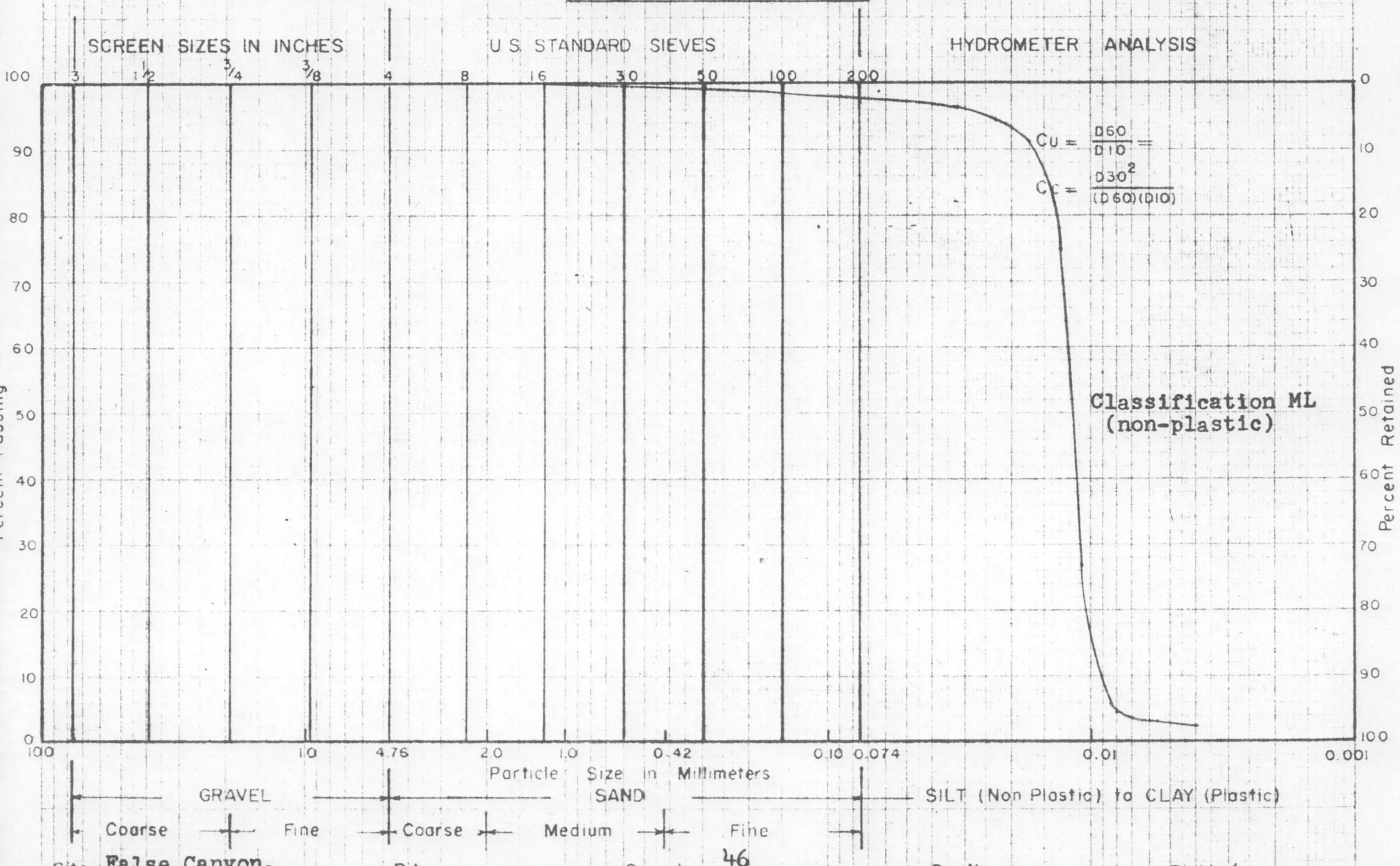


Site False Canyon, Francis River Pit Sample 45 Depth Plotted

PLAN

WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS



Site False Canyon, Francis River Pit Sample 46 Depth Plotted

PLAN

Description of Potential Pervious Material for the following Grain Size Analyses Curves

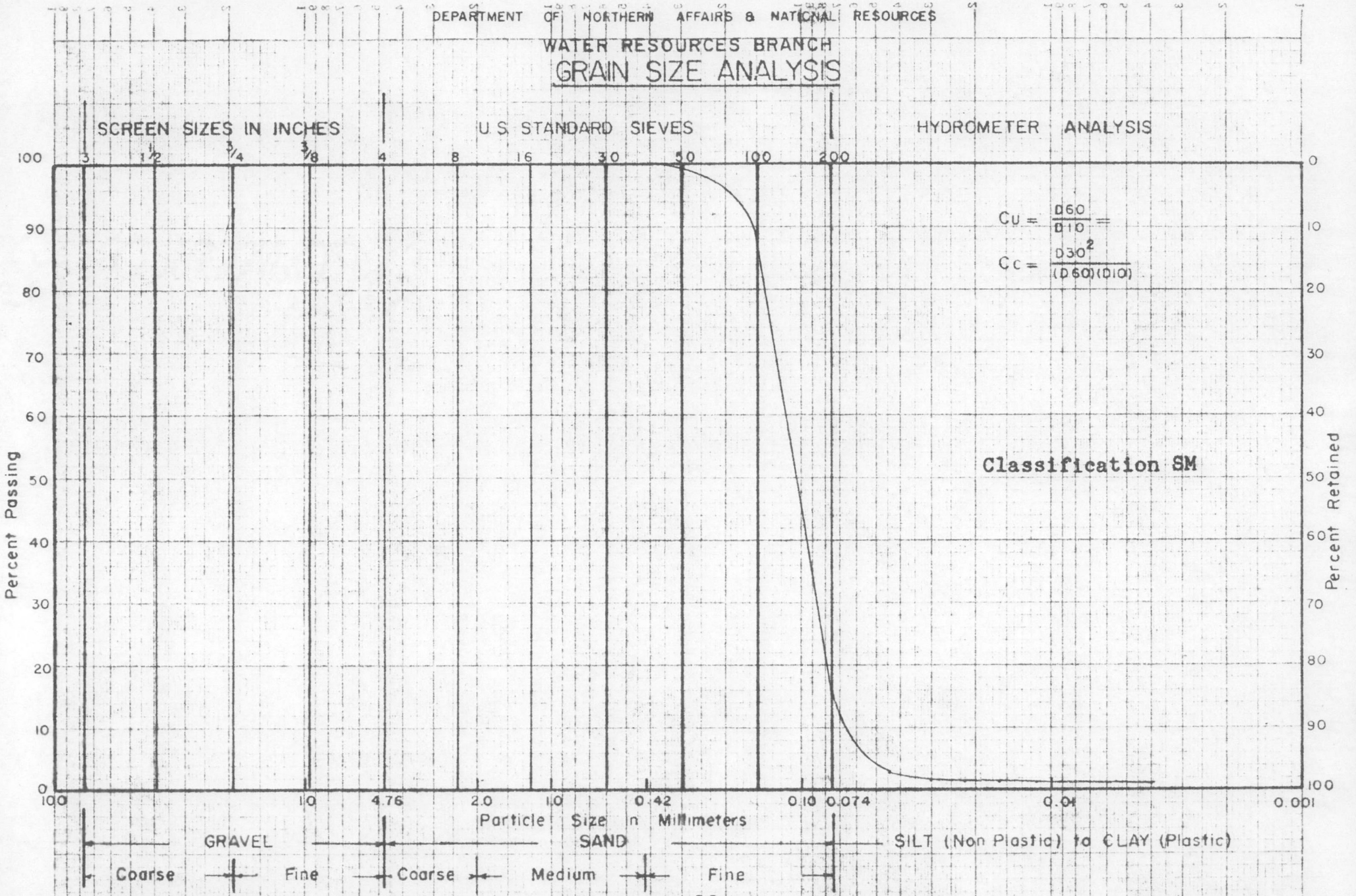
Sample Number	Location	Field Description of Material	Field Description of Overburden	Thickness of Deposit	Permeability* cm./sec.	Remarks
39	100 feet south of P.B.H.-7; 5 1/2 feet beneath ground surface	Fine-grained, brown, silty sand; poorly graded; unstratified; no pebbles	None	6+ feet	10^{-4}	Material is alluvium filling valley 250 feet northwest of site; leakage of reservoir water is an important problem here
40	200 feet west of P.B.H.-9; 7 1/2 feet beneath ground surface	Poorly graded, sandy gravel; argillite pebbles up to 3 inches in diameter; no cobbles or boulders	7 feet of sand	12 inches	10^{-2}	A 12-inch bed of permeable gravel directly overlying bedrock and underlying sand as in sample No. 39

*Permeabilities computed in the field using a Soiltest Permeameter, Model K-620.

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES

WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS



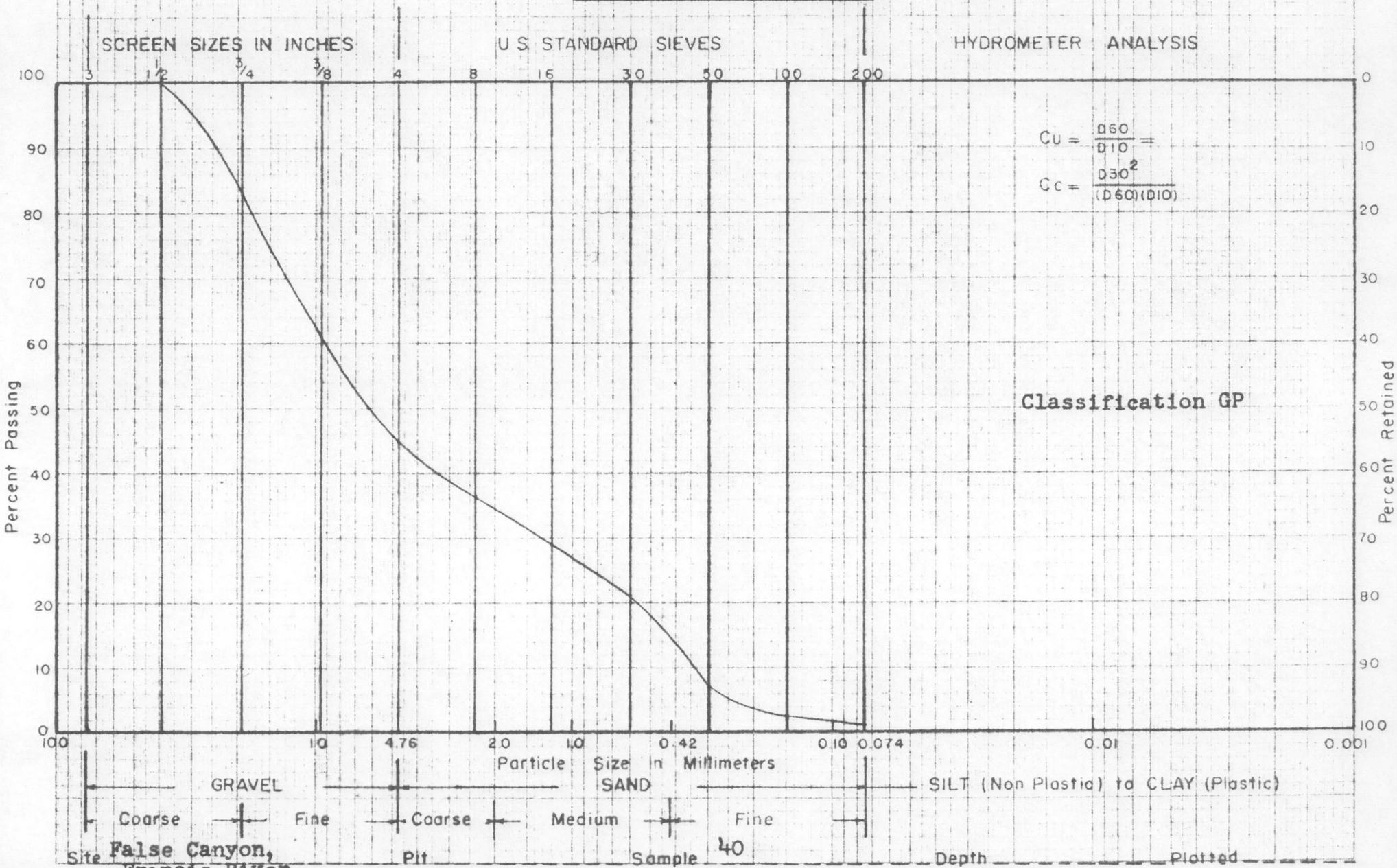
Site False Canyon, Francis River Pit Sample 39 Depth Plotted

PLAN

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES

WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS



Site False Canyon, Francis River Pit Sample 40 Depth Plotted

PLAN

Plate 1

False Canyon looking upstream from the centre of Frances River.

G.S.C. 7-2-61

Plate 2

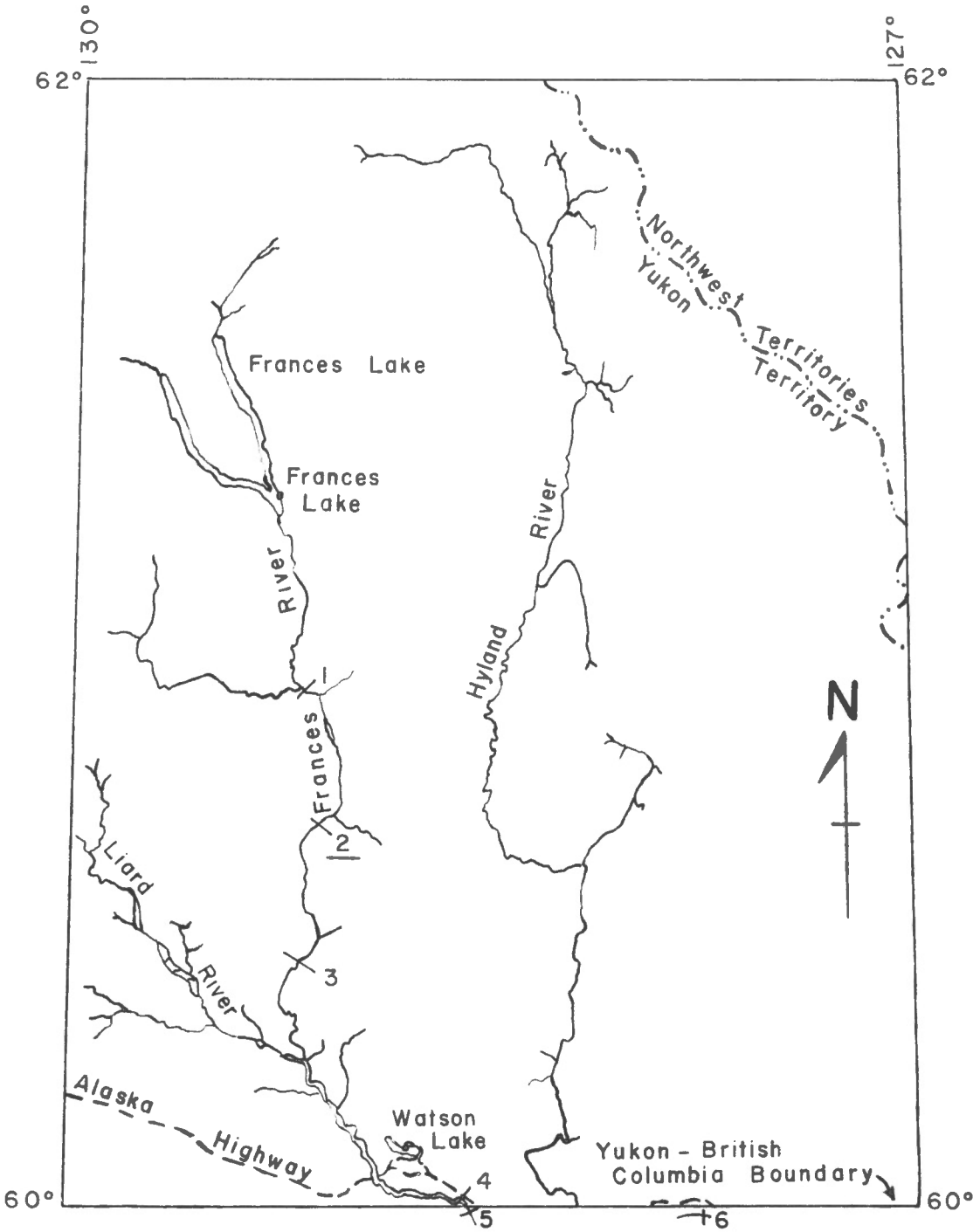
Right abutment rising about 40 feet above Frances River.

G.S.C. 7-3-61

Plate 3

Left abutment rising about 40 feet above Frances River.

G.S.C. 7-4-61



LOCATION OF PROPOSED DAM SITES
MACKENZIE RIVER DRAINAGE BASIN
Scale 1 inch = 20 miles

Site No.	Name	River
1 —	Upper Canyon	Frances
2 —	False Canyon	Frances
3 —	Lower Canyon	Frances
4 —	Liard Canyon(upper)	Liard
5 —	Liard Canyon(lower)	Liard
6 —	Contact Creek	Liard