No. 1

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

TOPICAL REPORT NO. 26

YUKON RIVER DRAINAGE BASIN
DAM SITE INVESTIGATION

SITE NO. 21

BRADEN'S CANYON DAM SITE

(MAP AND PRELIMINARY REPORT)

BY

E. B. OWEN

OTTAWA
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BRADEN'S CANYON DAM SITE

General Description

Braden's Canyon dam site is located on Pelly River about 14 miles downstream from the community of Pelly Crossing at which point the Whitehorse-Dawson highway crosses Pelly River. An alternative site called "Gerc" is located about one-half mile upstream from the Braden's Canyon site. The Gerc site is described in Topical Report No. 25, site no. 20.

At the site, the River is flowing in a westerly direction between high outcrops of metamorphic rocks of the Yukon Group described by Bostock[1] as Precambrian and Later. It is proposed to utilize these rocks as abutments and foundations for a concrete, power dam and a smaller earth-fill saddle dam. The crest of the power dam would at elevation 1,645 feet above sea level and the elevation of the normal full pool would be 1,630. The elevation of the water surface of Pelly River at the proposed site is usually slightly less than 1,460 feet.

At the site there is no wide, drift-filled valley such as occurs along Teslin River and Yukon River above its junction with the Pelly. In the left abutment area a bedrock bluff, more than 250 feet in height, rises abruptly from the River's edge. This bluff which forms the left abutment at the power dam site, continues downstream from the site for a considerable distance. A similar bluff forms the left abutment at the Gerc site.

On the right side two rock knobs rise to a height of more than 200 feet above the River. A third knob is located about 300 feet north of the first two and is separated from them by a draw flanked by steep rock walls.

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[1] Bostock, H.S.: "Carmacks District, Yukon"; Geol. Surv., Canada, Memoir 189, 1936.

Pelly River doubtless passed through this draw when it was at a higher elevation. The floor of the draw is approximately 110 feet above Pelly River.

The thickness of overburden underlying the River and the draw is not known but is believed to be relatively shallow. Test borings would be required to accurately determine the elevations of bedrock surface. It has been suggested by Bostock that Pelly River has flowed through Braden's Canyon only in post-glacial time and the former River Channel is located in a wide, drift-filled valley about one mile north of the site.

Three terraces are located along the right side of Pelly River immediately upstream from the rock knobs forming the right abutment. The elevation of the lowest terrace is about 12 feet higher than the present river (June 16, 1960). It extends back a distance of about 750 feet from the River's edge to the toe of a steep, 40-foot bluff. Above the bluff a level terrace, 300 feet in width and with an elevation of about 1,530 feet, extends back to a gently sloping bluff which ascends upwards to a third terrace with an elevation of about 1,705 feet. The upper terrace is about 1,400 feet north of the River. The middle terrace is continuous with the floor of the draw immediately north of the right abutment of the power dam suggesting it was formed when part of Pelly River was flowing through the draw. The upper terrace at one time occurred extensively throughout the area. Remnants of it are present on the left side of the River about 1,000 feet downstream from the abutment and on the right side of the River about one mile below the site. In the northwest part of the map-area it is continuous with a bedrock terrace. It also extends for several miles along the right side of Pelly River upstream from Gerc site.

A series of barometric elevations were taken along the floor of the valley about one mile north of Braden's Canyon site. The purpose was to

determine if any surface leakage would occur from the reservoir through this former drainage channel. The elevations were taken from a point on Pelly River about one mile above Gerc site to about 3 miles downstream from Braden's Canyon site. The floor of the valley was found to be fairly level with an average height above Pelly River of about 370 feet. In some places the valley floor rose to a height of 425 feet above the River. These results indicate there will be no surface drainage through the valley, however, permeable sands and gravels were encountered in several test pits put down in the valley floor suggesting the possibility of subsurface leakage.

Unconsolidated Deposits

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

1. Recent Alluvium: This material varies from a soft, silty sand to masses of cobbles and boulders up to 12 inches in diameter. It is a shallow, relatively unimportant deposit occurring along both sides of the River.

2. Alluvium (fine- to medium-grained sand, silty in part): This material consists of a medium-dense, graded sand with varying quantities of silt. The sand is usually fine- to medium-grained with a few isolated pockets of coarser material. It overlies the glacio-fluvial, sandy gravel and bedrock which constitute the main mass of the terraces north of the River and varies in thickness from a few inches to six feet or more. It is believed to have been deposited early in the history of Pelly River. It is an unimportant deposit and could easily be stripped if a borrow pit or quarry into

the underlying material were opened.

3. Glacio-fluvial (sandy gravel): This material consists of a loose, graded, sandy gravel containing numerous boulders up to 10 inches. The silt content appears to be low. In the upper 3 to 4 feet boulders of the coarser-grained, intrusive rocks are badly weathered. This material which constitutes most of the overburden in the area is usually overlain by a thin deposit of silty, sandy alluvium. It is exposed along the bluffs below the two upper terraces north of the River and in the remnants of a terrace on the left side of the River about 1,000 feet downstream from the proposed centre line.

4. Talus: This material covers much of the lower part of the bedrock ridge in which the left abutment is located. It consists of fragments of bedrock ranging from sand-size particles to large boulders several feet in diameter. Intermixed with this material are small quantities of alluvial silt and sand and glacio-fluvial sand and gravel. The talus is frequently covered with vegetation. Except in the deep, incised valleys between the rock outcrops its thickness is believed to be less than 10 feet.

Bedrock

General Description

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

1. Gneiss: This is the most common rock occurring at the site. It is a dark grey, fine- to medium-grained rock composed of quartz, feldspar, biotite and hornblende. It frequently exhibits distinct banding. Schistosity is well developed in some places.

2. Limestone: Considerable limestone occurs in the two rock knobs

forming the right abutment of the power dam. It is a light grey to white, soft, crystalline rock interbedded with the gneiss and schist as lenses varying in thickness from 12 inches to 30 feet. The strike of the limestone beds is such that they intersect the River at 30 degrees. However, the beds are sufficiently parallel to the River to prevent them from extending to the left side of the River within the area mapped.

3. Quartzite: About 36 inches of thinly-bedded quartzites are visible beneath a 12-inch limestone bed exposed on the right abutment. Both rocks are interbedded with the gneiss. The quartzite is light grey in color, hard and in beds up to 3 inches in thicknesses.

4. Conglomerate: A small, irregular outcrop of conglomerate occurs on the left side of the River about 1,000 feet downstream from the proposed dam axis. The rock consists chiefly of rounded, white, quartz pebbles up to 3 inches in diameter imbedded in a friable, quartz sandstone. A bed of similar sandstone, a few inches thick, is visible above the conglomerate.

Bedrock Structures

Bedrock exposed in the area about the proposed dam site consists chiefly of metamorphic rocks of sedimentary and volcanic origin. The original structure of these rocks has been completely altered and only the limestones and quartzites show distinctly the original bedding planes. The strike of the sedimentary rocks exposed in the right abutment is northwest and the dip is about 50 degrees northeast. They intersect the proposed centre line of the dam at about 30 degrees with a downstream dip.

The gneissic banding and schistosity are parallel to the interbedded quartzite and limestone. Local deformations, due to minor folding,

in these rocks are indicated on the accompanying geological map by strikes at variance with the general trend of the strata. Distorted gneissic banding is visible in the lower part of the left abutment slope near the centre line.

Minor jointing is common with one joint set striking at right angles to the River and dipping upstream. A second set intersects the River at 45 degrees and dips steeply upstream. The considerable jointing present will probably necessitate pressure grouting in both abutments. There are no visible structures in bedrock exposed at the site that would prevent the construction of a dam. There is no evidence of major faulting. Test borings should be put down, however, in each abutment to investigate the quality and permeability of the rock.

Quality of Bedrock

The gneiss which constitutes the greater part of the rock exposed at the site is massive and durable. It should make satisfactory foundation and abutment material. Weathering in the abutment areas is negligible and very little rock will have to be removed to obtain a fresh, solid face against which concrete or dyke material could be placed. The quartzite and limestone occurring in the right abutment appear to be massive, competent rocks and should not present any problem during construction. Solution cavities were not observed in the exposed sections of the limestone at this site but do occur in the limestone on the right abutment of Gerc site. It is believed the limestone is the soluble type and the absence of visible solution cavities in the rock is due, in part, to the lack of circulating ground water.

Engineering Considerations

Depth of Overburden

Except for the data obtained from the two seismic lines, little

information is available concerning the thickness of overburden at the site. However, as indicated on the accompanying geological map there are areas, usually adjacent to bedrock exposures, where overburden is believed to be less than 10 feet in thickness.

There are two localities in the dam site area where accurate information regarding the thickness of overburden is definitely required. The first is beneath Pelly River between the two abutments for the proposed power dam. The second is beneath the draw immediately north of the right abutment for the power dam across which it will be necessary to construct an earth-fill saddle dam to contain the water in the reservoir. The geological history of the area is such as to suggest a relatively small quantity of overburden beneath both the draw and the present River channel. However, test borings should be put down in each locality to ascertain the quality of overburden and to accurately determine the elevation of bedrock surface.

Abutments and Foundations

Bedrock exposed at the site should provide satisfactory foundation and abutment conditions for the proposed spillway and powerhouse structures and for the earth-fill saddle dam. The limestone exposed in the right abutment slope may cause trouble during construction of the two diversion tunnels planned for the right side of the River. The presence of soft, schistose rock may also cause trouble during tunnel construction. It is suggested test borings be put down along the lines of the two tunnels to investigate the character of the rock and to conduct permeability tests. To obtain better core recovery it is further suggested the borings be put down at 40 degrees and drilled at right angles to the strata, i.e. in a southerly direction. The present construction plan calls for the spillway and powerhouse structures to

be constructed in the dry between two earth-fill cofferdams. It should be pointed out that the material upon which the cofferdams will be built is highly permeable alluvium capable of carrying large quantities of water into the excavation.

Construction Materials

Aggregate

The deposits of sandy gravel underlying the two upper terraces, 750 and 1,400 feet north of the River, are the only potential sources of aggregate in the area covered by the accompanying geological map. The quantity of material available is not known. The deposits do not extend far downstream from the centre line of the dam as the lower terrace leads into the draw immediately north of the right abutment of the power dam, and the upper merges into a bedrock terrace about 1,000 feet downstream. In the opposite direction both terraces end at the rock ridge forming the right abutment of the Gerc site. Probably the best area to prospect for natural aggregate would be in the upper terrace directly north of the site. In some places it will be necessary to strip several feet of alluvial silt and sand and about 3 feet of weathered gravel before fresh material is exposed. A program of test pitting and sampling would be necessary to determine the quality of the material. It will probably be necessary to screen and reblend the sandy gravel to obtain a satisfactory aggregate. The gravel occurring along the sides of the former drainage valley one mile north of the site is a potential source of aggregate. The floor of the valley is very dry and there would be no difficulty in constructing access roads if it is decided to utilize these deposits.

Artificial aggregate might be obtained by crushing the rock produced during construction of the diversion tunnels. This, however, would be a relatively expensive method and should only be considered as a last resort.

Impervious Material

There is a shortage of impervious material in the site area. Six samples were taken of the more silty phases of the sandy alluvium which covers the glacio-fluvial gravel and bedrock in the north part of the area mapped. The samples were sent to the Soils Laboratory of the Water Resources Branch in Vancouver in the hope that they would prove to be satisfactory material for the impervious core of the earth-fill saddle dam. The grain size analyses curves are included in the back of this report along with permeabilities computed in the field.

More suitable material is located in the upper part of the bluff which occurs along the right bank of Pelly River about one mile upstream from the Gerc site. The material consists of a compact, fine-grained, silty sand interbedded with a dense, silty, sandy till. Similar material is exposed about 1,500 feet north of Pelly River in a high bluff on the east side of a steep-walled valley located about two miles below Braden's Canyon site. Grain size analyses curves for this material are included in the report for Gerc site.

Pervious Material

Material for the pervious shells of the earth-fill saddle dam can be obtained from the gravel deposits described under the "aggregate" heading.

Rip-rap and Rock Fill

The specific gravity and durability of gneiss is higher than that of most rocks. Consequently, part of the bedrock derived from the construction of the two diversion tunnels should make excellent rip-rap and rock fill providing the rock fragments are sufficiently large. The considerable jointing visible in the gneiss exposed on ground surface suggests this rock will break into relatively small fragments when blasted. The talus along the left side of the River would not be a source of suitable rip-rap or rock fill.

Ground Water

Little is known regarding the ground-water table in the vicinity of the proposed dam site. It is believed to be low throughout the area mapped. This would increase the danger of leakage especially through the permeable sandy gravels forming the terraces north of the site. Accurate information concerning the water table can only be obtained by a test-boring program involving the installation of many ground-water observation holes.

Frozen Ground

Evidences of permafrost were not encountered in the area about the proposed dam site.

Further Investigations

It should be remembered the present geological investigation of the proposed dam site at Braden's Canyon 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:

Hole No.	Location	Approximate Elevation	Depth	Remarks
1	Left abutment, on centre line, 150 feet from south bank of River.	1,645 feet	15 feet below grade of spillway channel excavation	Permeability tests conducted
2	Left abutment, on centre line, 10 feet from south bank of River.	1,530 feet	15 feet below grade of spillway channel excavation	Permeability tests conducted
3	Centre line of spillway dam, 188 feet north of south bank of River.	1,460 feet (water)		"
4	Centre line of powerhouse dam, 188 feet north of north bank of River.		15 feet below grade of powerhouse excavation	"
5	Right abutment on centre line, 10 feet from north bank of River.	1,530 feet		"
6	Centre line of south diversion tunnel, 240 feet upstream from dam centre line.	1,590 feet	15 feet below floor of tunnel	"
7	Intersection of dam centre line and south diversion tunnel centre line.	1,620 feet		"

Hole No.	Location	Approximate Elevation	Depth	Remarks
8	Centre line of south diversion tunnel 240 feet downstream from dam centre line	1,620 feet	15 feet below floor of tunnel	Permeability tests conducted
9	Centre line of south diversion tunnel, 480 feet downstream from dam centre line	1,650 feet	"	"
10	Centre line of north diversion tunnel, 240 feet upstream from dam centre line	1,560 feet	"	"
11	Intersection of dam centre line and north diversion tunnel centre line	1,675 feet	"	"
12	Centre line of north diversion tunnel 240 feet downstream from dam centre line	1,675 feet	"	"
13	Centre line of north diversion tunnel, 480 feet downstream from dam centre line	1,630 feet	"	"
14	Centre line, Saddle Dam, 44 feet south of bedrock bluff on southside of draw	1,670 feet	To same elevation as bottom of hole no. 17	Soil sample taken every five feet or where there is change in material, permeability tests conducted, ground-water table noted
15	Centre line, Saddle Dam, 76 feet north of bedrock bluff on south side of draw	1,620 feet	"	

Hole No.	Location	Approximate Elevation	Depth	Remarks
16	Centre line, saddle dam, 148 feet north of bedrock bluff on south side of draw	1,600 feet	To same elevation as bottom of hole no. 17	Soil sample taken every five feet or where there is change in material, permeability tests conducted, ground-water table noted
17	Centre line, saddle dam, 240 feet north of bedrock bluff on south side of draw	1,570 feet	15 feet into bedrock	"
18	Centre line, saddle dam, 360 feet north of bedrock bluff on south side of draw	1,640 feet	To same elevation as bottom of hole no. 17	"

Comparison between Braden's Canyon Site and Gerc Site

Gerc site is an alternative to Braden's Canyon site. A comparison between the two sites is included in the report on the Gerc site (Topical Report no. 25, site no. 20).

Chemical Analyses of Pelly River Water

Chemical Analyses of Pelly River water are included in the report on the Gerc site.

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 indicate that none of the materials tested could

be used for the impervious core of the saddle dam. It is suggested further investigations be made in the same area as it is possible finer material does exist.

Potential Impervious Material - Braden's Canyon Dam Site

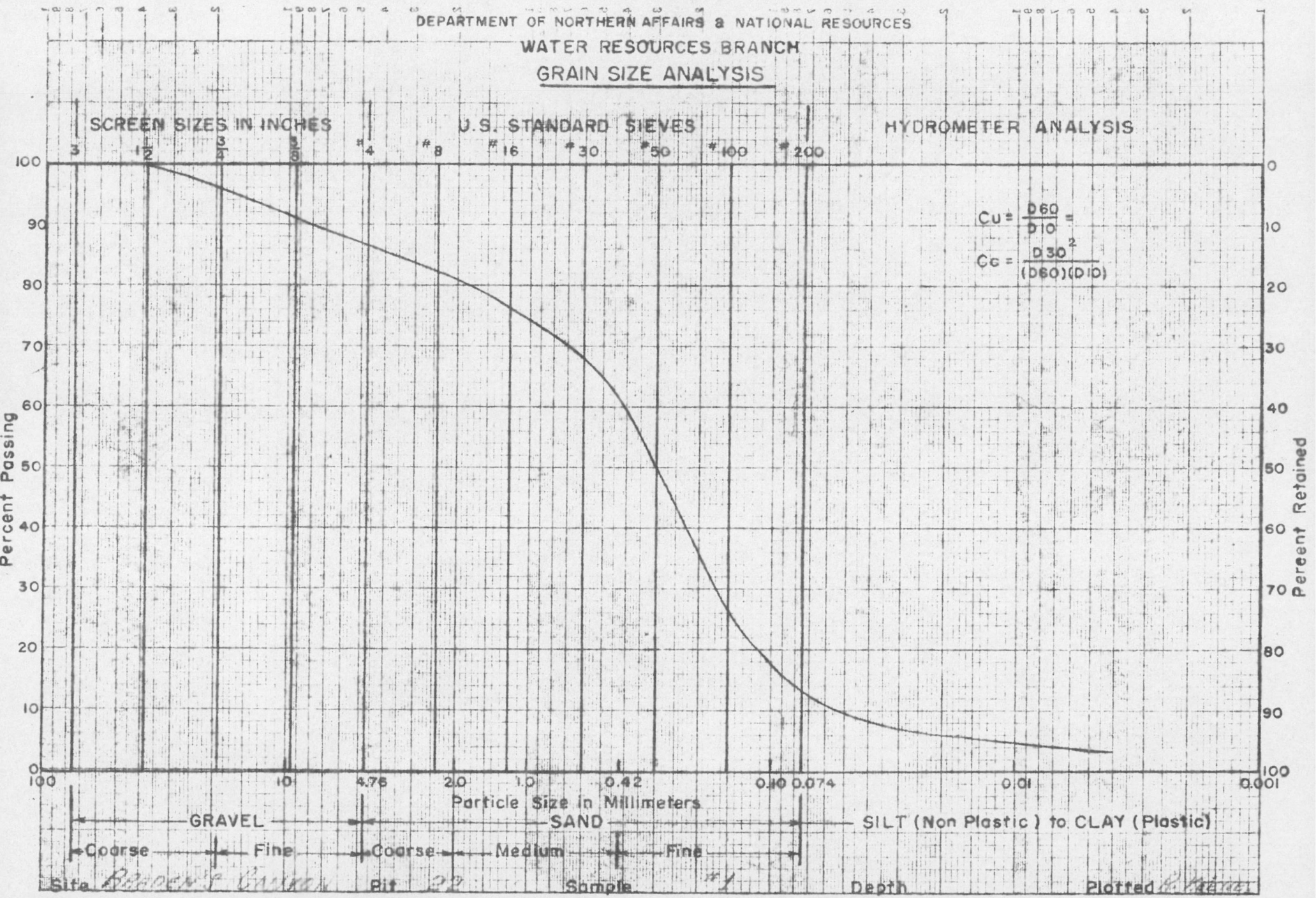
Sample Number	Location	Field Description of Material	Field Description of Overburden	Thickness of Deposit	Areal Extent (Estimated)	Permeability* (cm./sec.)
1	West end of seismic line no. 2, 6 feet below ground surface	Fine to medium sand, silty in part	none	1-6 feet	Large	10^{-5}
2	Centre of seismic line no. 2, 4 feet below ground surface	"	"	"	"	10^{-4}
3	East end of seismic line no. 2, 6 feet below ground surface	"	"	"	"	10^{-4}
4	West end of seismic line no. 1, 6 feet below ground surface	Fine, sandy gravel, some silt	"	Unknown	$\frac{1}{2}$ mile long, $\frac{1}{4}$ mile wide	
5	Centre of seismic line no. 1, 5 feet below ground surface	Fine, sandy, gravel, some silt	"	Unknown	$\frac{1}{2}$ mile long, $\frac{1}{4}$ mile wide	
6	East end of seismic line no. 1, 6 feet below ground surface	Fine to medium sand, silty in part	"	1-6 feet	Large	10^{-6}

* Permeabilities computed in the field using a Soiltest permeameter, model K-620

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES

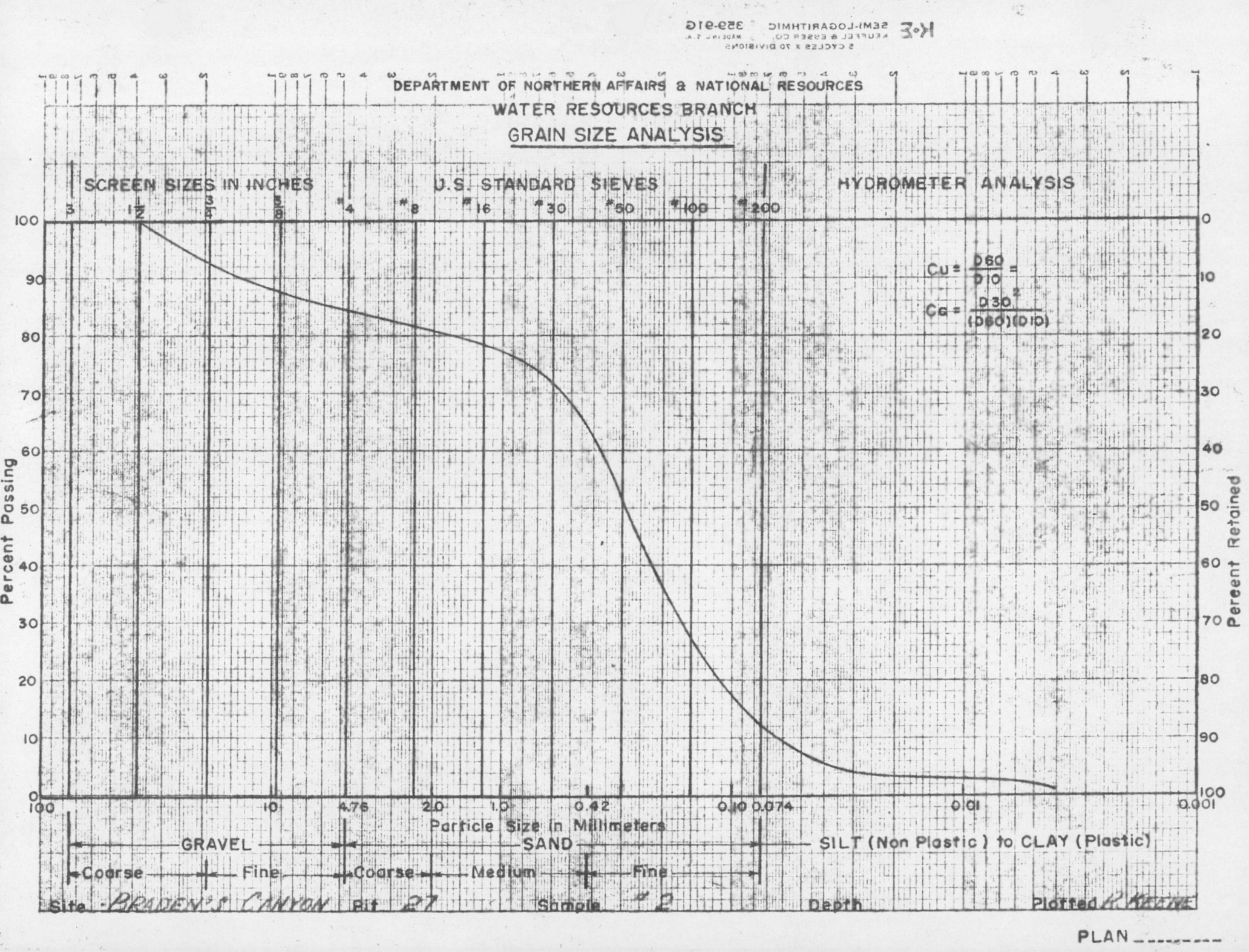
WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS



Site Beaver Creek Pit 22 Sample #1 Depth Plotted

PLAN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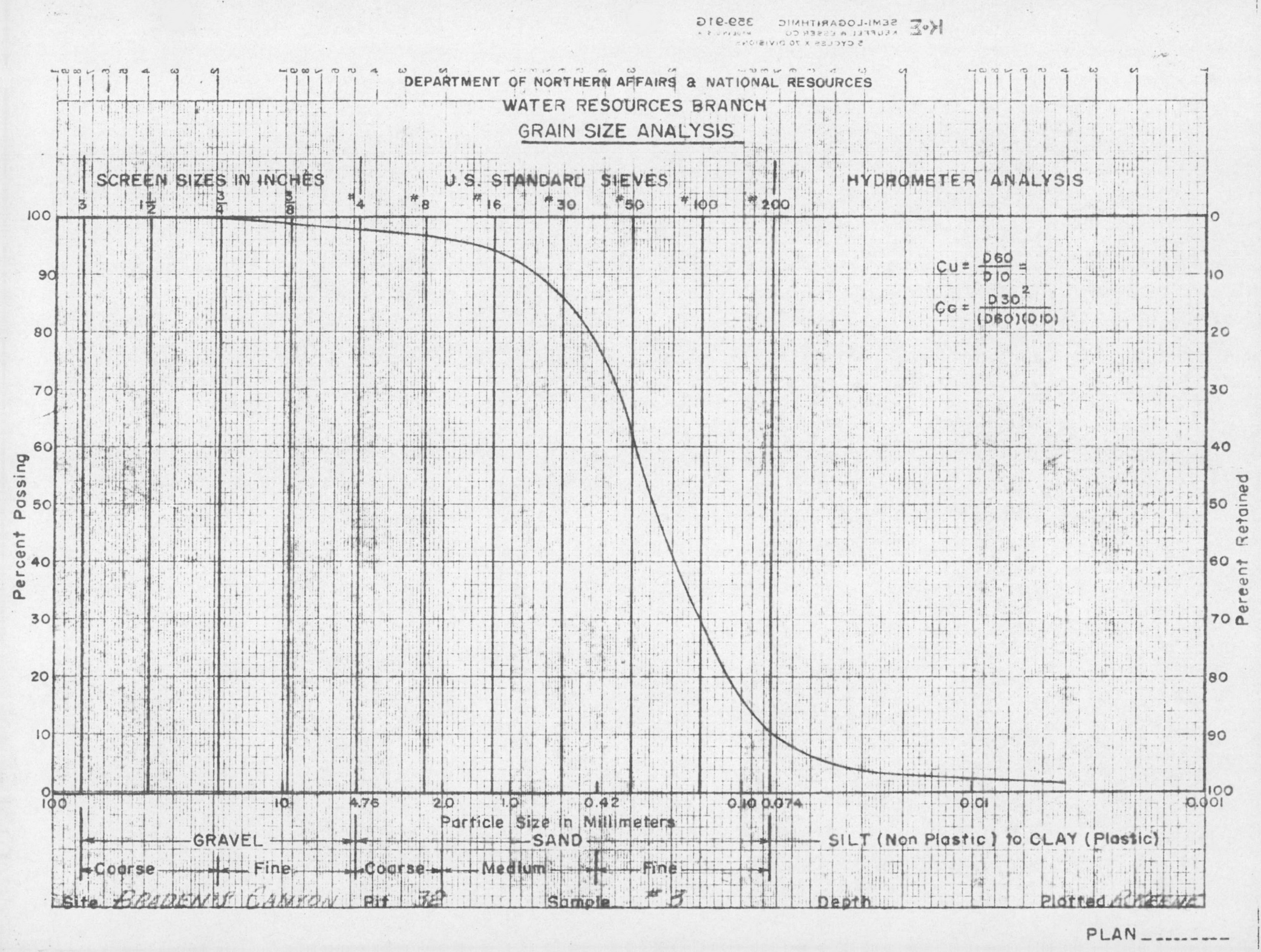
WATER RESOURCES BRANCH
GRAIN SIZE ANALYSIS
SCREEN SIZES IN INCHES
U.S. STANDARD SIEVES
HYDROMETER ANALYSIS
3
1 1/2
3/4
3/8
#4
#8
#16
#30
#50
#100
#200
Cu = D60/D10 =
Cc = D30²/(D60)(D10)
Percent Passing
Percent Retained
100
90
80
70
60
50
40
30
20
10
0
100
10
4.76
2.0
1.0
0.42
0.10
0.074
0.01
0.001
Particle Size in Millimeters
GRAVEL
SAND
SILT (Non Plastic) to CLAY (Plastic)
Coarse
Fine
Coarse
Medium
Fine
Site Braden's Canyon
Pit 27
Sample #2
Depth
Plotted
PLAN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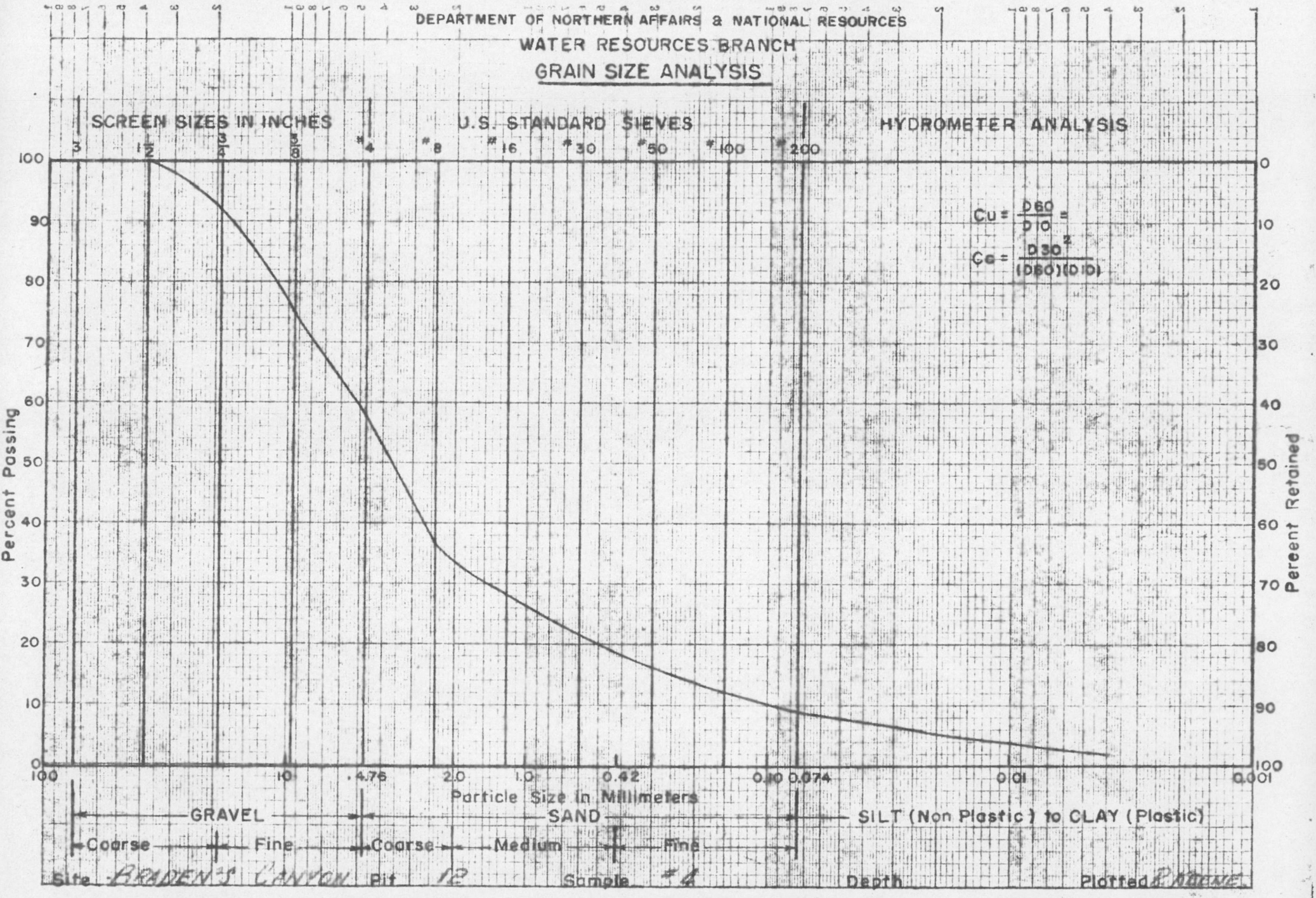
WATER RESOURCES BRANCH
GRAIN SIZE ANALYSIS
SCREEN SIZES IN INCHES
U.S. STANDARD SIEVES
HYDROMETER ANALYSIS
3
1 1/2
3/4
3/8
#4
#8
#16
#30
#50
#100
#200
Cu = D60 / D10 =
Cc = D30² / (D60)(D10)
Percent Passing
Percent Retained
100
90
80
70
60
50
40
30
20
10
0
100
10
4.76
2.0
1.0
0.42
0.10
0.074
0.01
0.001
Particle Size in Millimeters
GRAVEL
SAND
SILT (Non Plastic) to CLAY (Plastic)
Coarse
Fine
Coarse
Medium
Fine
Site Browns Canyon
Pit 32
Sample #3
Depth
Plotted
PLAN



PLAN

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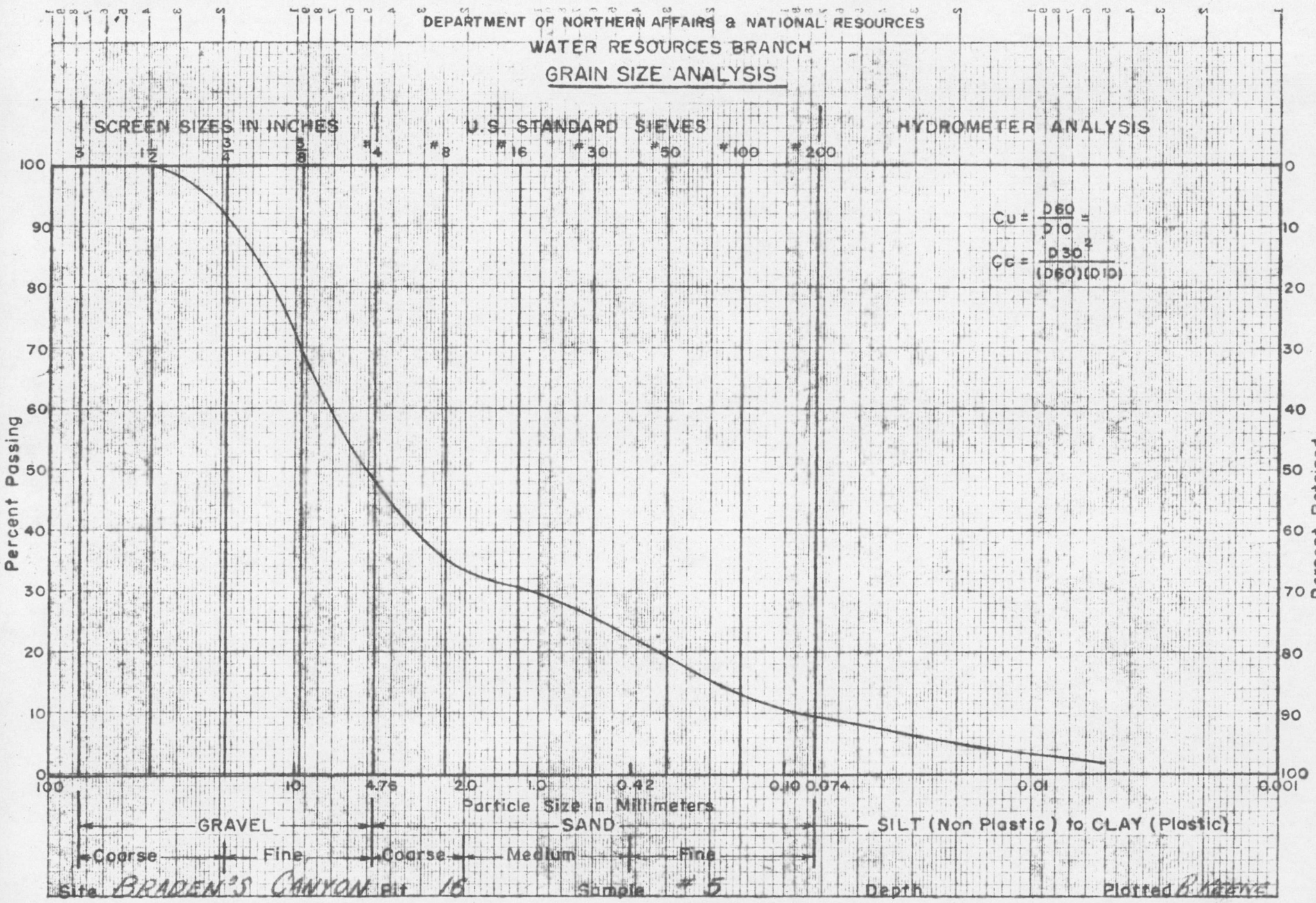
WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS



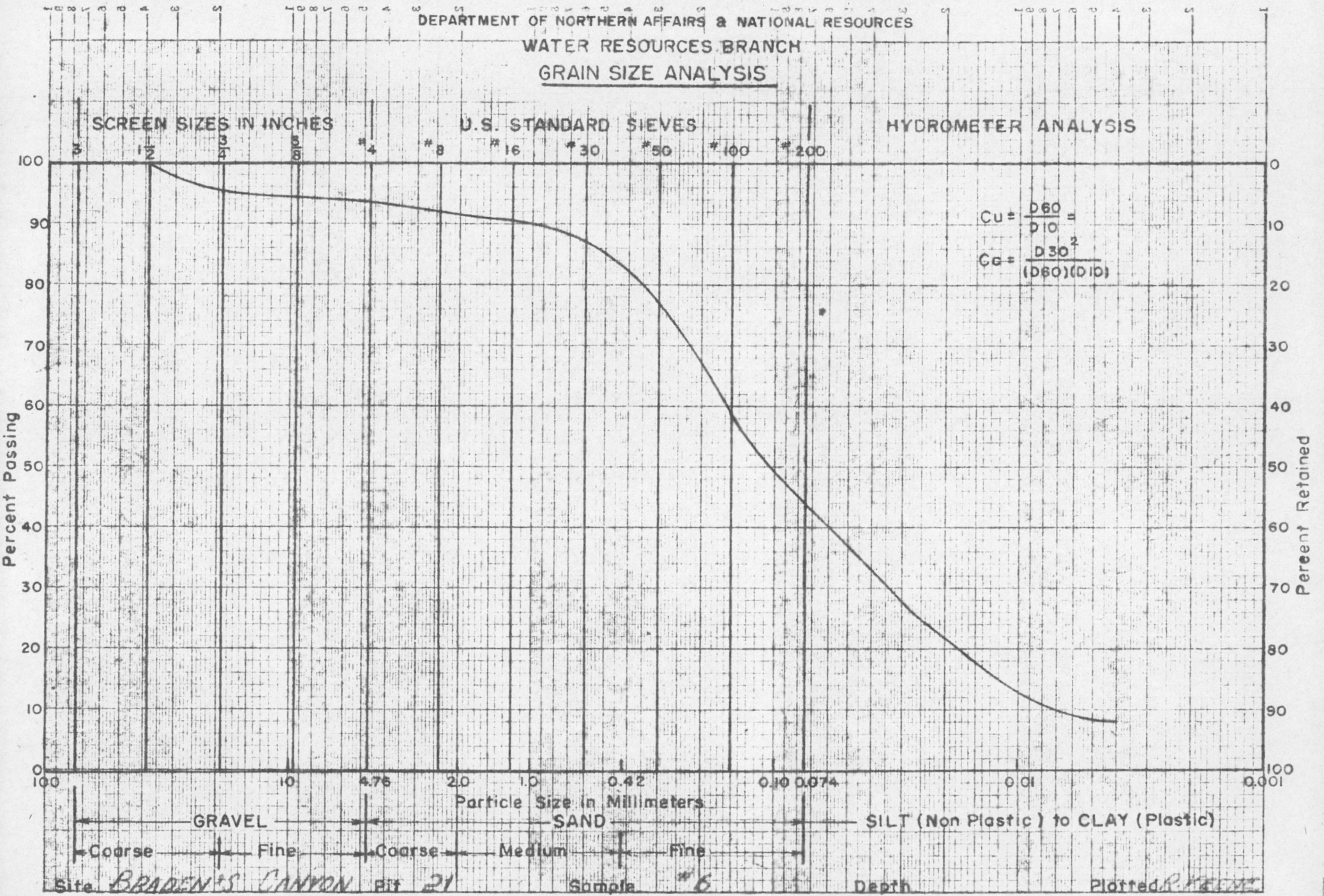
Site BRADEN'S CANYON Pit 16 Sample # 5 Depth Plotted B. Greene

PLAN

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES

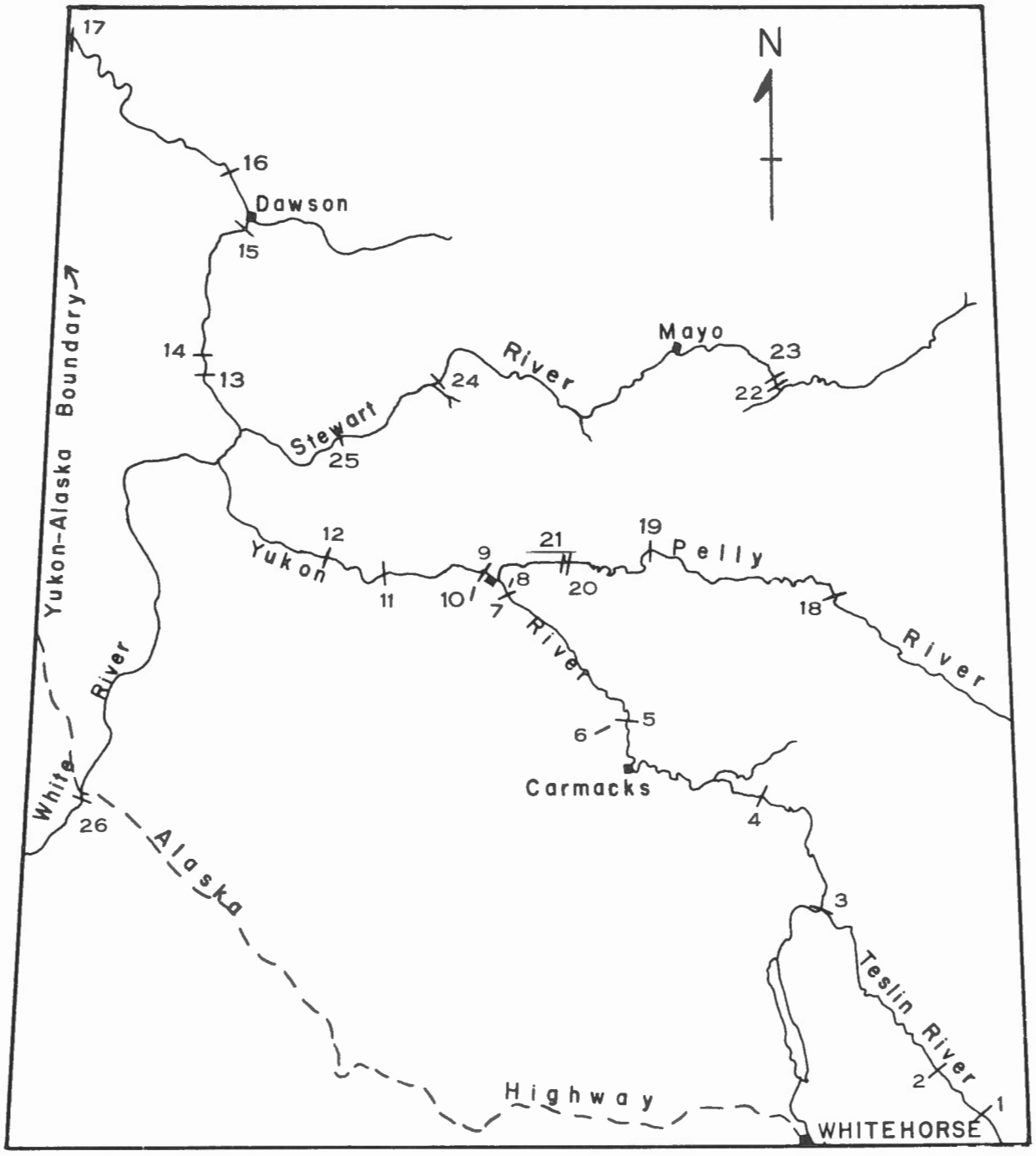
WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS



Site BRADEN'S CANYON Pit 21 Sample #6 Depth Plotted R. [illegible]

PLAN _____



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		