No. 2

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

TOPICAL REPORT NO. 35

YUKON RIVER DRAINAGE BASIN
DAM SITE INVESTIGATION

SITE NO. 26

LOWER CANYON DAM SITE

(MAP AND PRELIMINARY REPORT)

BY

E. B. OWEN

OTTAWA

1961

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

TOPICAL REPORT NO. 35

YUKON RIVER DRAINAGE SYSTEM

DAM SITE INVESTIGATION

Site No. 26

LOWER CANYON DAM SITE

(Map and Preliminary Report)

by

E.B. Owen

OTTAWA

1961

CONTENTS

Illustrations

LOWER CANYON DAM SITE

General Description

Lower Canyon dam site is located on White River immediately upstream from the Alaska Highway bridge which crosses the river at mile 1169.2

At the site the river is flowing in a northerly direction along the east side of a relatively narrow, steep-walled valley about 500 feet wide and 1,500 feet in length. The average width of the river is 200 feet. A short distance downstream from the site the valley widens into a flood plain, some 2 miles across, through which the river flows in several, narrow, unnavigable channels separated by extensive sand and gravel bars. The flood plain can be seen looking downstream from the Alaska Highway bridge.

The right abutment consists of a steep, rock bluff which rises abruptly from the edge of the river to a height slightly in excess of 200 feet. Bedrock is exposed on about 30 per cent of the right abutment slope. The remainder is covered with a thin layer of talus. Above the slope a fairly level terrace (approximate elevation 2,510 feet), covered with a thin layer of sandy gravel, extends eastward beyond the limit of the map-area.

On the left (west) side of the river a level terrace covered with sandy alluvium extends 500 feet to the toe of a steep, drift-covered bluff which rises several hundred feet above the river. The elevation of the terrace is about 2,300 feet above sea-level. Much of it is undoubtedly inundated during high water stages of White River. The results of seismic line No. 1 indicate the depth of overburden beneath the terrace varies between 81 and 99 feet. The thickness of this material, which probably consists of glacio-fluvial and later alluvial sand and gravel, is doubtless

greater beneath the present river .

The results of seismic line No. 2 indicate the thickness of overburden on the lower part of the bluff immediately west of the terrace varies between 33 and 40 feet. Bedrock is exposed higher on the bluff in which area much of the overburden is believed to be less than 10 feet in thickness.

Materials suitable for construction purposes are readily accessible. Frozen ground was encountered in many test pits put down on both sides of the river (June 17, 1961). In most instances the frozen material was covered with a 6- to 10-inch layer of moss.

Unconsolidated Deposits

Three types of unconsolidated deposits were encountered in the area about Lower Canyon dam site. These are as follows:

1. Recent Alluvium: This material has been laid down by the present river. It consists chiefly of silt, sand and gravel containing boulders up to 12 inches in diameter. The low terrace which extends along the left (west) side of the river is covered with fine- to medium-grained, alluvial sand in that part adjacent to the abutment slope and with silt, sand and gravel mixed with fine talus in the part nearest the river. Any alluvial material which might occur at the base of the steep, rock bluff along the right side of the river was covered by water at the time of the investigation. The thickness of the alluvium occurring at Lower Canyon site is not known. About 10 feet of the material is exposed in a pit located on the left side of White River about one mile downstream from the site. The permeability of the alluvium is probably high. Large boulders capable of causing refusal of steel sheet piling were not noted in the material.

2. Talus: Talus consists of spalled material derived from adjacent bedrock. At Lower Canyon site it occurs on both abutment slopes.

On the right (east) side the talus consists of weathered bedrock fragments up to 18 inches in diameter together with small quantities of greenish-black, residual soil which resulted from weathering of bedrock containing large quantities of chlorite. Much of the talus on the left side originated on the mountain west of the site. The material moved down along a narrow canyon and spread out as a fan-shaped deposit as it reached the floor of the valley. A thickness of about 10 feet of talus is exposed along the left edge of the river near the south limit of the area mapped. The material is relatively fine with few rock fragments greater than 10 inches in diameter. Talus at Lower Canyon site is not believed to be potential construction material. The rock fragments present are not sufficiently large to form satisfactory riprap or rock fill.

3. Glacio-fluvial (sand and gravel): This material consists of sandy gravel containing minor quantities of silt. In the area mapped it occurs only as a shallow deposit overlying bedrock on the terrace east of the right abutment. Similar material is exposed in the upper part of the road cut along the west side of Alaska Highway immediately north of the bridge over White River.

Bedrock

General Description

Bedrock exposed at the site consists of weathered, badly broken, altered, basic lavas. In some places schistose structures have developed, the weathering of which has produced a greenish-black, residual soil. According to Muller[1] the shattered condition of the rock may be due to the proximity of Shakwak fault which is believed to parallel the river a

---

[1] Muller, J.E.: "Kluane Lake Map-area, Yukon Territory"; Geol. Surv., Canada, Paper 58-9, p. 3, 1958.

short distance east of the right abutment. The extreme fracturing has resulted in considerable weathering which in places may have deeply penetrated bedrock. A siliceous dyke associated with a strong shear zone occurs in the right abutment. It was not possible to obtain an attitude on the dyke but it appears to strike approximately at right angles to the river and to be almost vertical. Numerous, irregular quartz veins occur throughout bedrock exposures at the site but are too small to be included on the accompanying geological map.

Bedrock Structures

The broken condition of bedrock exposed at the site has masked the jointing and consequently few attitudes were taken of these important structures. The most prominent visible joint set strikes almost parallel to the river and dips fairly steeply west into the left abutment. A second set intersects the river at about 70 degrees and dips steeply downstream.

Faulting is common. The locations of several of the more prominent faults are indicated on the accompanying geological map. One wide fault zone is located at the edge of the river about 50 feet upstream from the siliceous dyke. Bedrock associated with the fault is badly shattered and consequently a small valley, 10 feet wide and 8 feet deep, has been eroded into the face of the bluff. A second similar fault is believed to occur beneath the talus about 20 feet downstream. Several irregular faults occur in the lower part of the bluff about 500 feet downstream from the siliceous dyke. Bedrock in the vicinity is badly broken. Shattered, highly weathered rock also exists at the north end of the outcrop about 175 feet upstream from the bridge. All the fault zones observed are believed to be potential aquifers and capable of carrying large quantities of water through bedrock forming the abutments and foundations of the dam structures.

Many fragments of weathered, chlorite schist occur in the talus on the right abutment slope but attitudes on the schistosity were obtained only in the extreme upstream part. Here the schist intersects the river at approximately 80 degrees and dips steeply upstream.

Quality of Bedrock

Bedrock exposed at Lower Canyon dam site is badly shattered and highly weathered. The broken condition of the rock may be due to the proximity of Shakwak fault. The extreme weathering may be due to the considerable fracturing. It is possible the broken condition of bedrock extends throughout the right abutment and consequently it is suggested bedrock in this area be thoroughly investigated before a decision is reached regarding its competency. Test borings should be put down to determine the quality of the rock at depth. Permeability tests should be conducted in each boring.

Engineering Considerations

Depth of Overburden

Overburden in the right abutment slope consists of relatively fine talus with minor quantities of residual soil and is everywhere believed to be less than 10 feet in thickness. Information from the 2 seismic lines located west of the river indicate the elevation of bedrock surface decreases 235 feet between the small outcrop in the west limit of the map-area and seismic line No. 1, a distance of about 500 feet. It is believed the thickness of overburden beneath the present river is at least 100 feet.

Abutments and Foundations

Bedrock exposed on the right abutment slope is highly weathered and badly shattered. Considerable rock will have to be removed before fresh, solid material, against which concrete or dyke material can be placed, will

be obtained. There is not sufficient information available concerning the foliation and jointing to determine if these structures would be detrimental to dam construction. The large number of faults present in the right abutment would decrease the competency of bedrock and increase the danger of leakage. It is believed bedrock constituting the left abutment is similar to that in the right and comparable construction problems will be encountered in this area.

Overburden underlying the river probably consists of permeable sand and gravel. Test borings should be put down into this material to investigate its permeability and to ascertain if boulders sufficiently large to refuse steel sheet piling are present. At the same time the elevation of bedrock surface should be determined.

Construction Materials

Aggregate

The quantity of natural aggregate available within the area mapped about the proposed site is limited. Consequently several gravel deposits exposed in small borrow pits along the Alaska Highway were examined and representative samples taken. The samples were forwarded to the Soils Laboratory of the Water Resources Branch in Vancouver for grain size analyses. Field descriptions of the materials and grain size analyses curves are included at the end of this report. Suitable natural aggregate is believed to occur in a large borrow pit located on the left side of White River about a mile downstream from the site. A good access road into the pit branches off the Alaska Highway at mile 1171.4. The material is alluvium deposited by White River. It consists of well graded, sandy gravel with few boulders over 12 inches in diameter. The silt content is low. The deposit was used as a source of aggregate for the piers

and abutment of the White River bridge and also for the counter-weights at the microwave tower near mile 1173.8. The pit-run gravel was first passed through a 3-inch screen and the material passing was used as aggregate without further processing.

Impervious Material

Material suitable for the impervious core of an earth-fill dam was not found in the area about Lower Canyon site. A deposit of potential impervious material occurs on the northeast side of the Alaska Highway at mile 1159.2. Here a dense, grey, silty till, overlaid by about 18 inches of silt, is exposed in a small borrow pit. The till appears to be well graded, ranging from clay-size particles up to boulders 18 inches in diameter. The quantity available is believed to be large and easily accessible. A representative sample (No. 17) of the till was forwarded to the Soils Laboratory of the Water Resources Branch for a grain size analysis.

Silty, sandy gravel is exposed in a fifty-foot bluff along the left side of White River about three-quarters of a mile downstream from the White River bridge at mile 1169.2. The material is medium dense and till-like in appearance. The boulders are usually rounded but there is a large proportion of angular rock fragments. It is suggested this gravel be investigated further as a potential source of impervious material.

Pervious Material

Material suitable for the pervious shells of an earth-fill dam can be obtained from the gravel deposits described under the aggregate heading. In most instances the gravel will have to be processed by washing and screening before acceptable material is obtained.

Riprap and Rock Fill

It is not believed bedrock exposed at the site will provide satisfactory riprap or rock fill. A source of suitable material is the talus

associated with a large exposure of massive, grey granodiorite on the south end of Horse Camp Hill about 3,000 feet northeast of mile 1172.3 on the Alaska Highway. The talus contains many enormous rock fragments several cubic yards in size. Use of this material would involve construction of a road from the highway to the base of the hill and a total haul of about 3 and one half miles to the site of the proposed dam.

Similar rock is exposed in a small quarry on the north side of the Alaska Highway at mile 1160.2. Here the jointing is closer and smaller rock fragments should be expected when the rock is blasted.

A small quarry in fairly massive limestone of the Yukon Group of Precambrian rocks is located on the north side of the highway at mile 1155. The material has been crushed to approximate one-inch size and used in highway maintenance. The density and durability of the limestone is less than that of the granodiorite. Consequently it is believed the granodiorite will provide more satisfactory riprap or rock fill. The limestone should be considered as a potential source of large aggregate if tests on the natural aggregates in the area indicate they are not satisfactory.

Ground Water

There is little information concerning ground-water conditions in the area about the proposed dam site. Seepages of ground water were not observed on either abutment slope although many of the faults observed on the right abutment are believed to be potential aquifers. The swamp conditions prevailing on parts of the low terrace immediately west of the river are the result of the frozen conditions of the underlying alluvium and not to outcropping of the water table.

Frozen Ground

Frozen ground was encountered in several test pits put down in both abutment areas (June 17, 1961). It was usually overlain by 4 to

12 inches of moss.

Further Investigations

It should be remembered that this geological investigation is a preliminary one and is based entirely upon an examination of surface exposures in the immediate area of the proposed dam site. It is designed to furnish the engineers with as much information as possible before any money is spent on expensive engineering investigations both in the field and in the laboratory. Test pits put down in the field seldom penetrated to depths greater than 4 feet. If it is decided more information is required at Lower Canyon site the following test borings are suggested as part of the program:

1. Axis of the Dam: Three parallel lines of test borings at approximate 200-foot centres, should be put down across the river valley between the abutments. Soil samples should be taken every 5 feet or where there is a change in material; large boulders encountered in the overburden should be noted; bedrock should be penetrated until fresh, solid material is encountered; permeability tests should be conducted.

2. Abutments: The quality of bedrock in both abutments should be thoroughly investigated by test borings. Permeability tests should be conducted and the elevation of the ground-water table noted.

Chemical Analysis of White River Water

During the investigation a sample of White River water was taken from the right side of the river at a point directly beneath the bridge at mile 1169.2 on the Alaska Highway. The sample was analysed for its mineral content by the Industrial Waters Section, Mines Branch, Department of Mines and Technical Surveys, Ottawa. The results of the analysis are included on the following page. The reported value of the turbidity should be considered only as indicative. A proper sediment study requires regular sampling, often at hourly intervals.

Chemical Analysis of White River Water

(parts per million)

Location	Date	River Discharge	pH	SiO_2	Ca	Mg	Na	K	Fe	CO_3	HCO_3	SO_4	Cl	F	Turbidity	Total Hardness as $CaCO_3$
Right side of river below bridge at mile 1169.2 on the Alaska Highway	June 19, 1961	High	7.8	8.7	29.0	11.2	7.3	2.2	36	0.0	134	19.8	3.2	0.08	1,600	118

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. Each grain size sheet for potential aggregate shows the following information:

(a) Limits of coarse and fine aggregate based upon a 6-inch maximum size.

(b) A cumulative grain size curve for each sample.

(c) Curves showing the individual percentages of the coarse and fine fraction retained on each screen or sieve size. For these purposes the sample is divided at the No. 4 sieve into coarse and fine fractions.

Samples Nos. 17 and 22 were analysed as potential impervious material; the remaining samples (Nos. 15, 16, 18, 19, 20 and 21) as potential aggregate.

Description of Potential Aggregate for the following Grain Size Analyses Curves

Sample Number	Location	Field Description of Material	Field Description of Overburden	Thickness of Deposit	Areal Extent (Estimated)	Remarks
15	Large pit on northeast side of Alaska Highway at mile 1155; 15 feet below ground surface	Well graded, stratified gravel; minor silt; boulders up to 24 inches consisting of rounded volcanic rocks and angular schists and shales; minor weathering Pebble Lithology Igneous (granite, volcanics) - 20% Sedimentary (arkose, greywacke) - 10% Metamorphic (schists, etc.) - 30% Shale - 40%	None	30+ feet	Unlimited	Material is crushed and used for highway maintenance; high percentage of shale
16	Large pit on northeast side of Alaska Highway at mile 1118; 5 feet below ground surface	Well graded, stratified gravel; very little silt or clay-size particles; boulders up to 10 inches in diameter; minor weathering Pebble Lithology Igneous (granite, volcanics) - 75% Sedimentary (arkose, greywacke) - 20% Metamorphic (gneiss) - 5%	4 feet of silt and fine-grained sand	10+ feet	Unlimited	Material used for highway maintenance

Description of Potential Aggregate for the following Grain Size Analyses Curves

Sample Number	Location	Field Description of Material	Field Description of Overburden	Thickness of Deposit	Areal Extent (Estimated)	Remarks
18	Shallow pit on southwest side of Alaska Highway at mile 1170.6; 18 inches below ground surface	Well graded, alluvial gravel; considerable sand; about 10% silt and clay-size particles; boulders up to 24 inches in diameter; no chert but considerable shale; no weathering Pebble Lithology Igneous (volcanics, granite) - 70% Sedimentary (shale, greywacke) - 30%	6 inches to several feet of silt	5+ feet	Unlimited	Similar deposits occur north along west side of Shakwak Trench; material used for highway maintenance
19	Pit on northeast side of Alaska Highway at mile 1173.8; 600 feet from highway; 3 feet below ground surface	Well graded, sandy gravel; no silt; cobbles up to 7 inches in diameter; minor weathering; considerable white carbonate on cobbles near ground surface; no chert Pebble Lithology Igneous (volcanics, granite) - 85% Sedimentary (shale, greywacke) - 10% Metamorphic (schist, gneiss) - 5%	12 inches of silt	10+ feet	Large	Material used for fill and road construction at C.N.T. relay station at mile 1173.8; similar material is exposed in a large pit 0.6 miles north

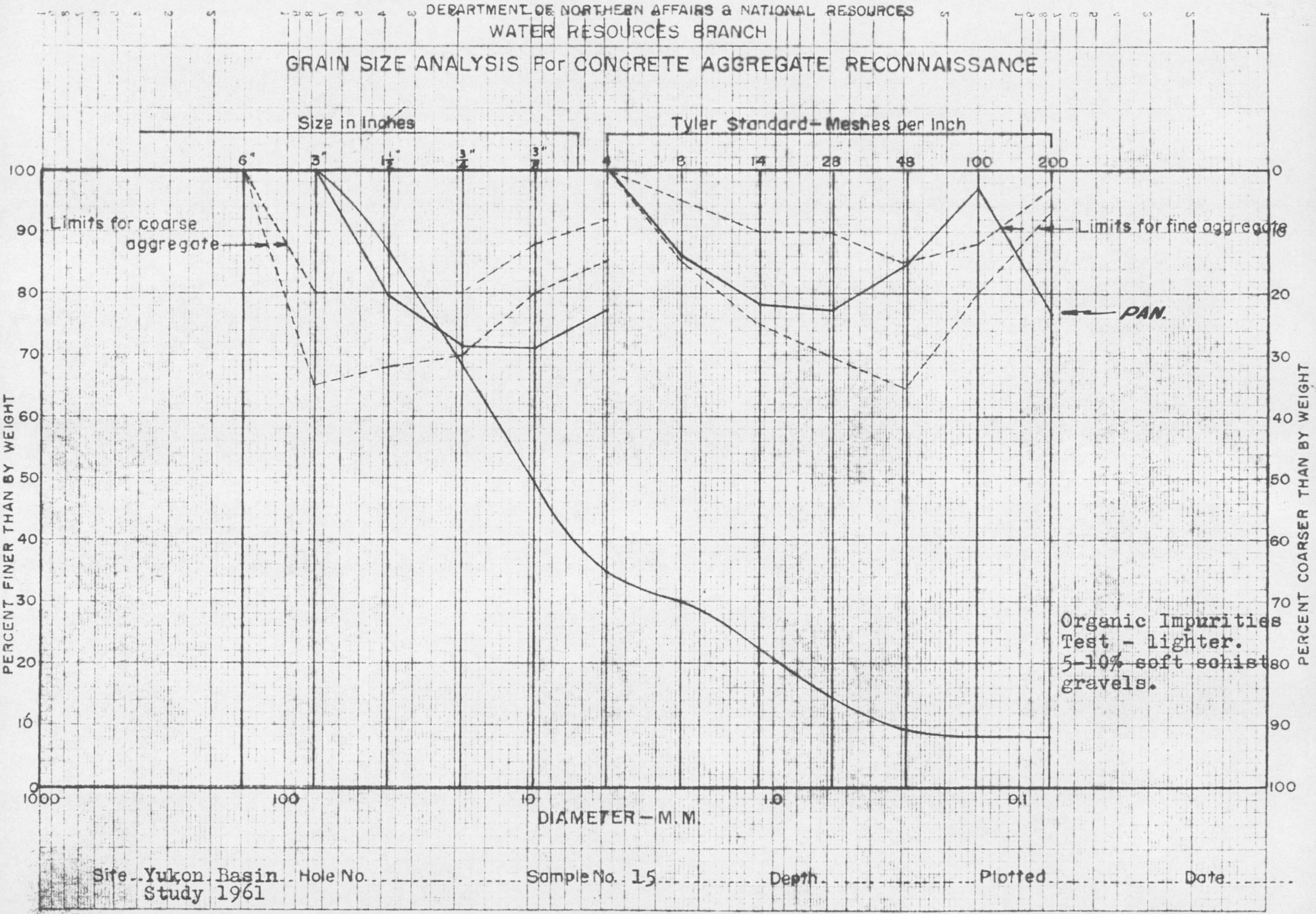
Description of Potential Aggregate for the following Grain Size Analyses Curves

Sample Number	Location	Field Description of Material	Field Description of Overburden	Thickness of Deposit	Areal Extent (Estimated)	Remarks
20	Cut on north-east side of Alaska Highway at mile 1172.3; 4 feet below ground surface	Well graded, sandy gravel; no silt; rounded to subrounded boulders up to 18 inches in diameter; minor weathering Pebble Lithology Igneous (granite, volcanics) - 50% Sedimentary (greywacke, arkose, shale) - 45% Metamorphic (gneiss, schist) - 5%	1+ feet of silt	30+ feet	Large	Extensive glacio-fluvial deposit near centre of Shakwak Trench
21	Large pit 2,100 feet west of mile 1171 on Alaska Highway; 5 feet below ground surface	Alluvial, sandy gravel; low silt content; large percentage of flattened pebbles of hard, durable rocks; gravel is fairly well graded with rounded boulders up to 12 inches in diameter; no weathering; no shale; no chert Boulder Lithology Igneous (granite, volcanics) - 70% Sedimentary (greywacke, arkose) - 20% Metamorphic (gneiss) - 10%	None	10+ feet	Large	Material passing a 3-inch screen was used as aggregate for piers and abutments for Alaska Highway bridge and at C.N.T. relay station at mile 1173.8; a flood plain deposit of White River; water table at 10 feet

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES

WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE



Organic Impurities Test - lighter. 5-10% soft schist gravels.

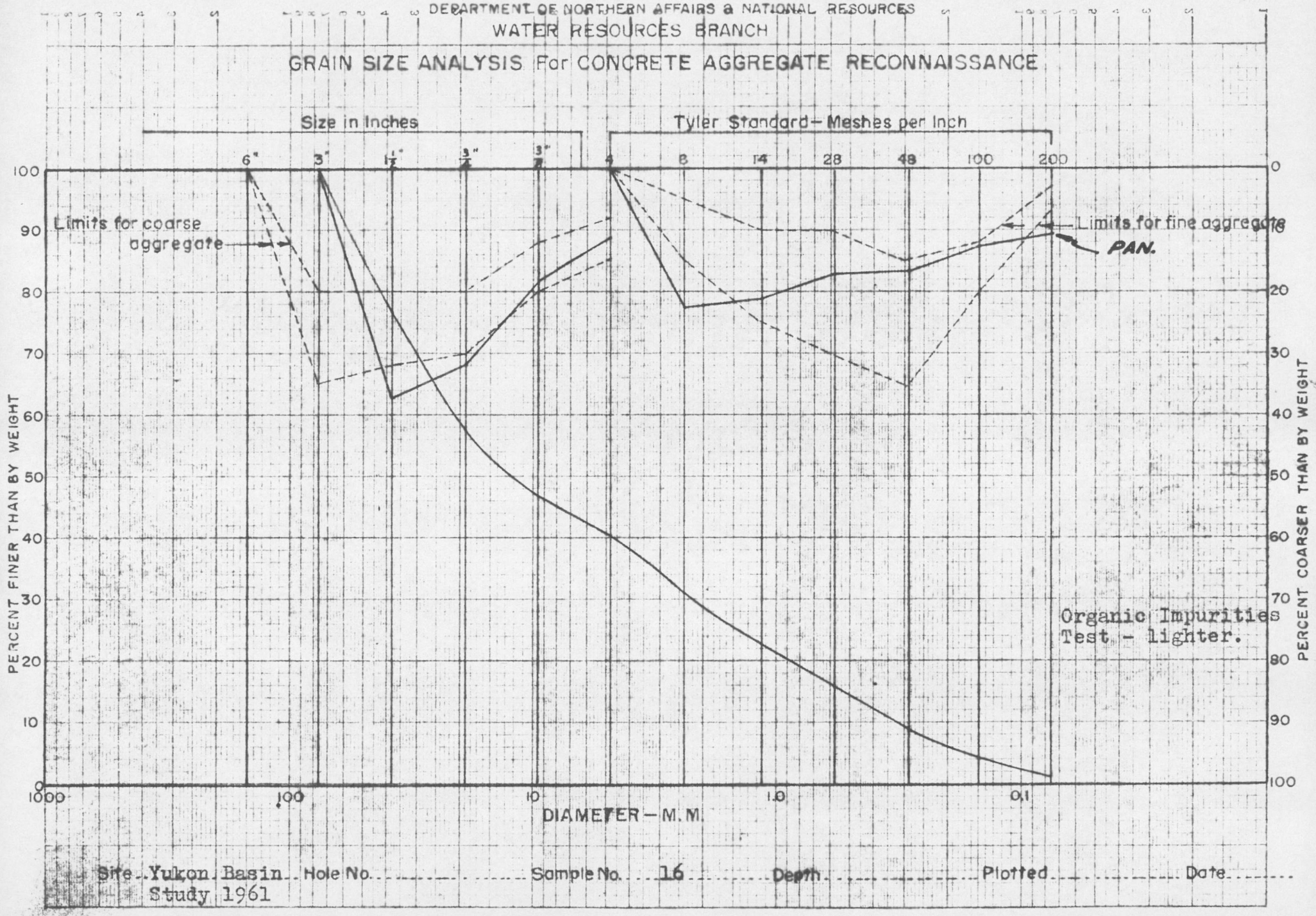
Site Yukon Basin Study 1961 Hole No. Sample No. 15 Depth Plotted Date

PLAN No. 100 – 13

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES

WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE



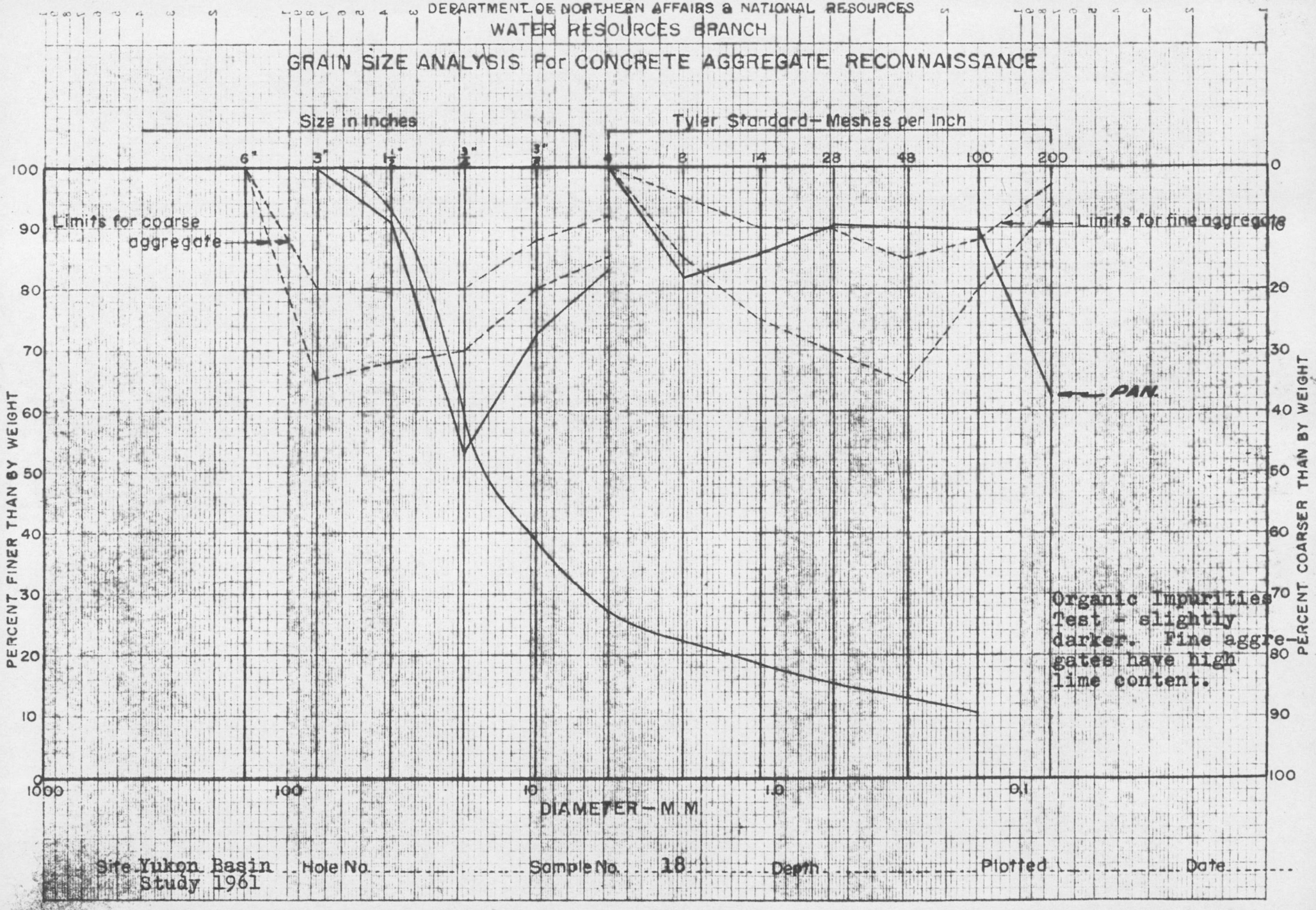
Site Yukon Basin Study 1961 Hole No. Sample No. 16 Depth Plotted Date

PLAN No. 100 – 13

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES

WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE



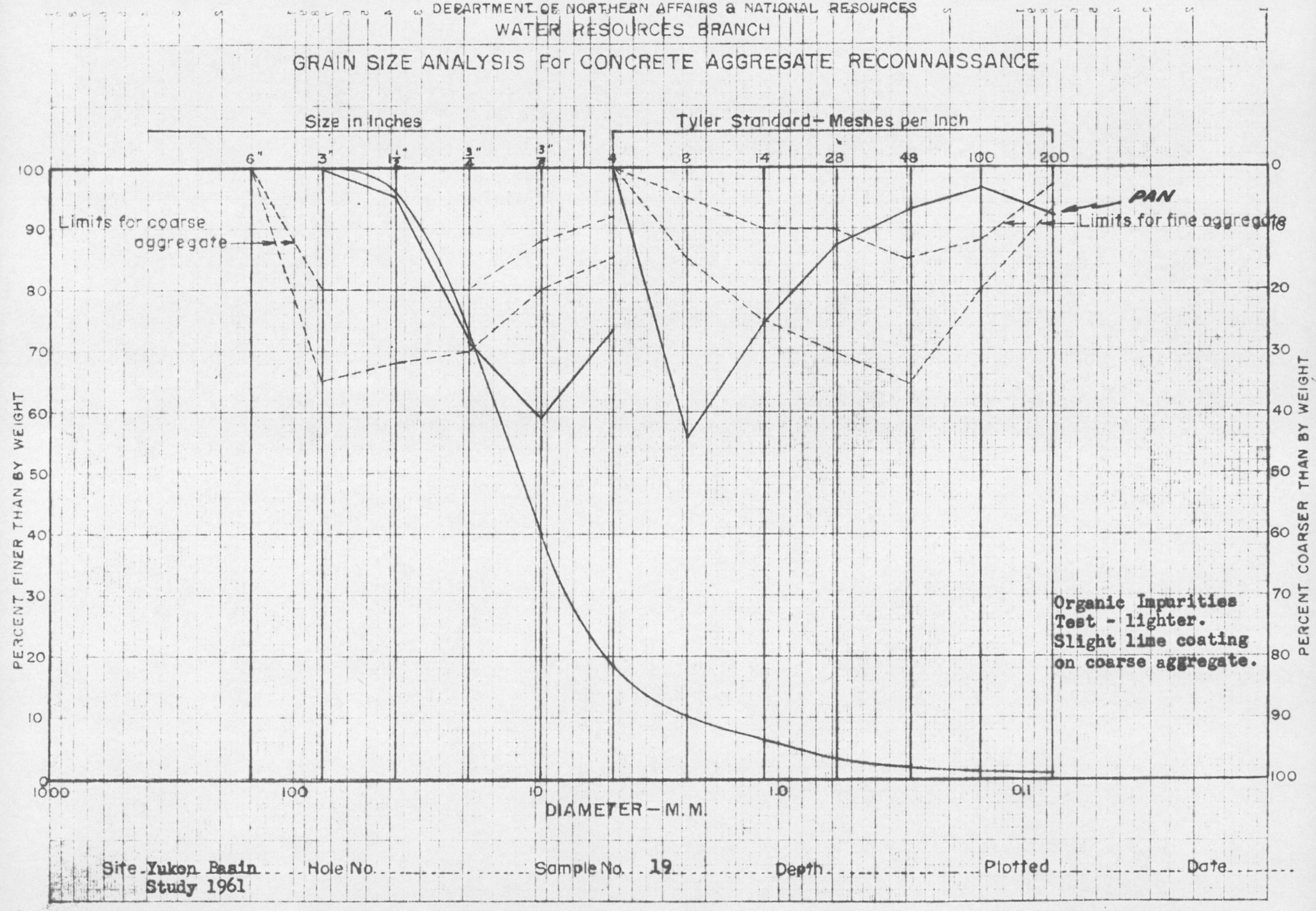
Site Yukon Basin Study 1961 Hole No. Sample No. 18 Depth Plotted Date

PLAN No. 100 – 13

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES

WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE



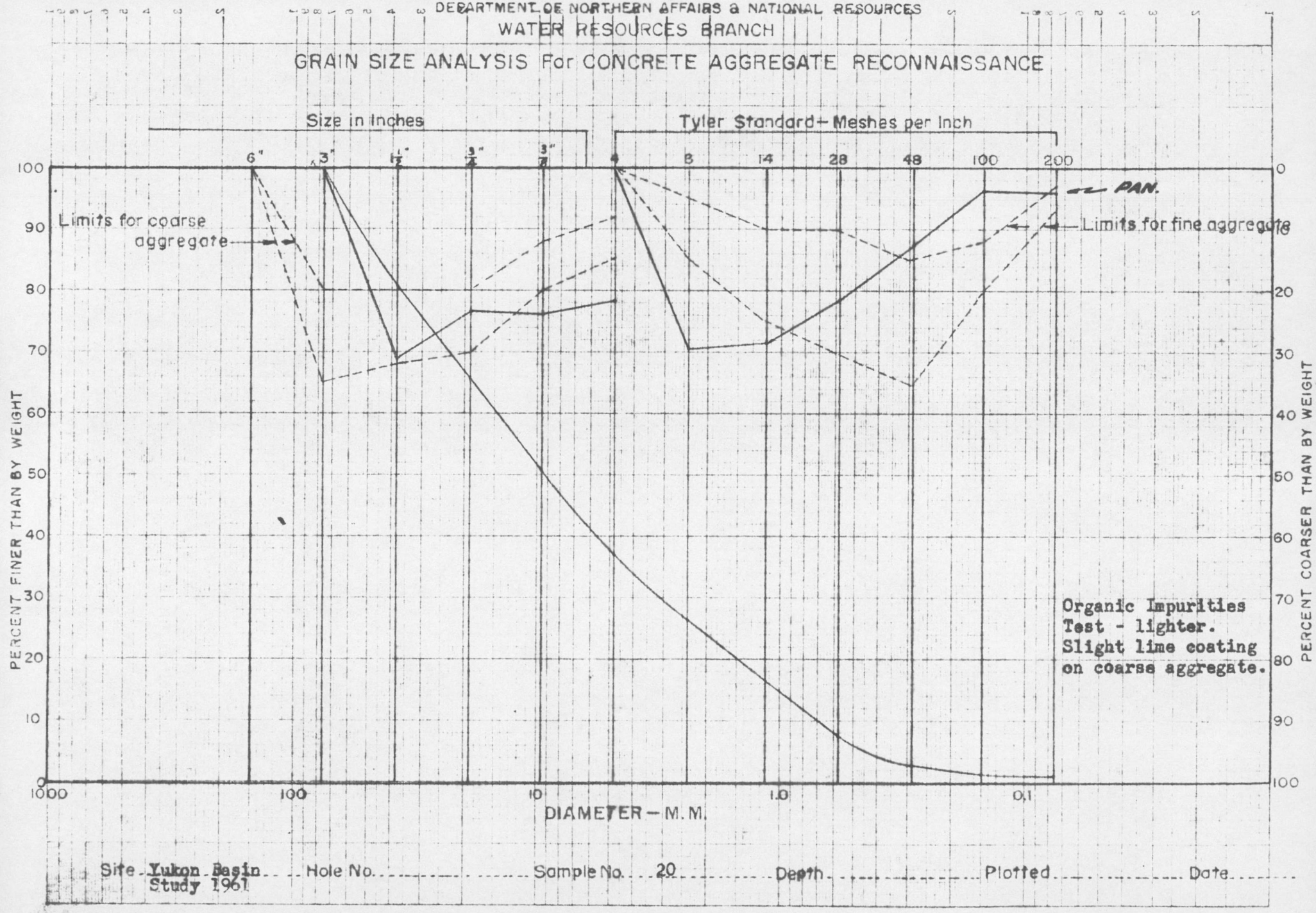
Site Yukon Basin Study 1961 Hole No. Sample No. 19 Depth Plotted Date

PLAN No. 100 – 13

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES

WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE



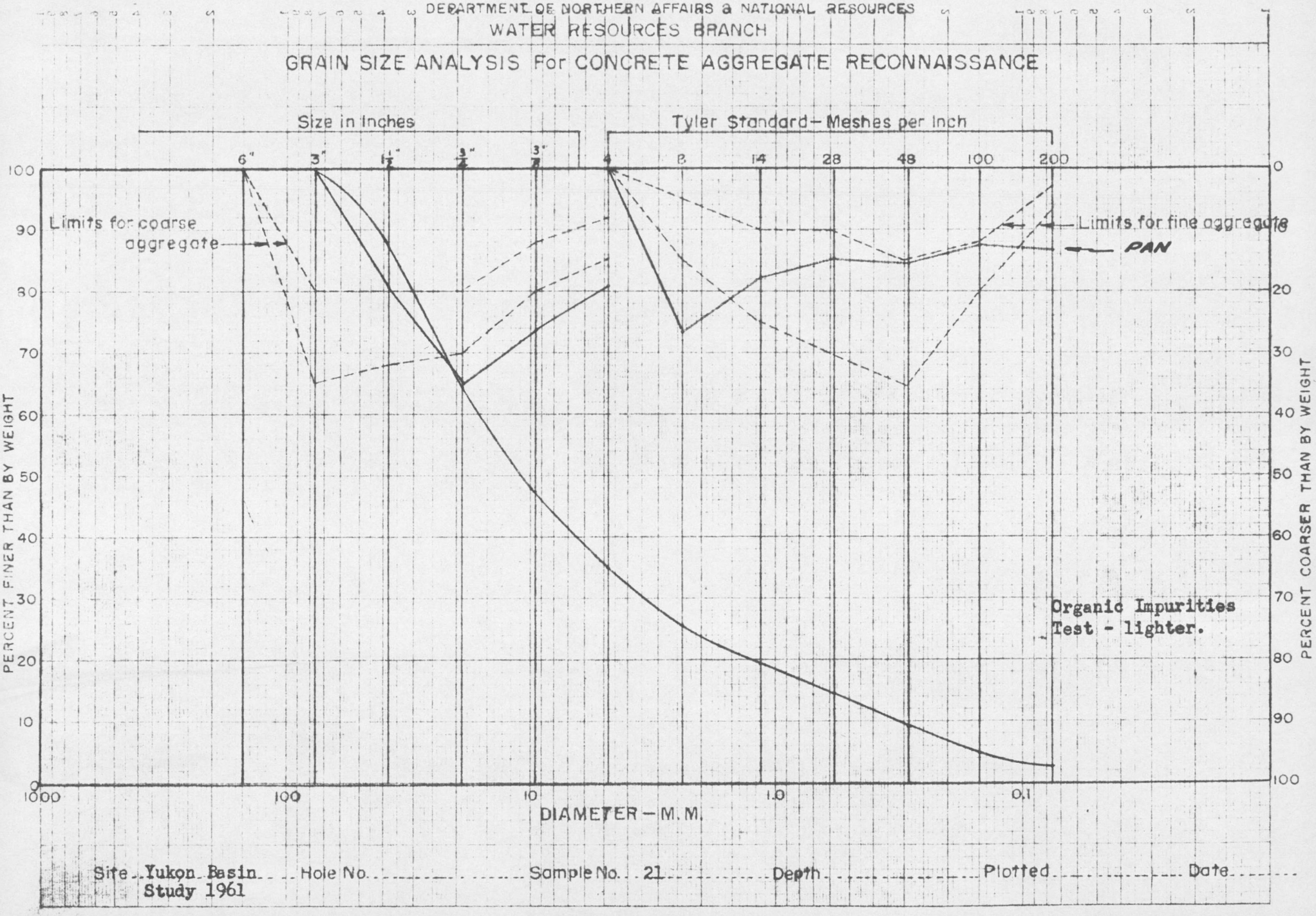
Site Yukon Basin Study 1961 Hole No. Sample No. 20 Depth Plotted Date

PLAN No. 100 – 13

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES

WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE



Site Yukon Basin Study 1961 Hole No. Sample No. 21 Depth Plotted Date

PLAN No. 100 – 13

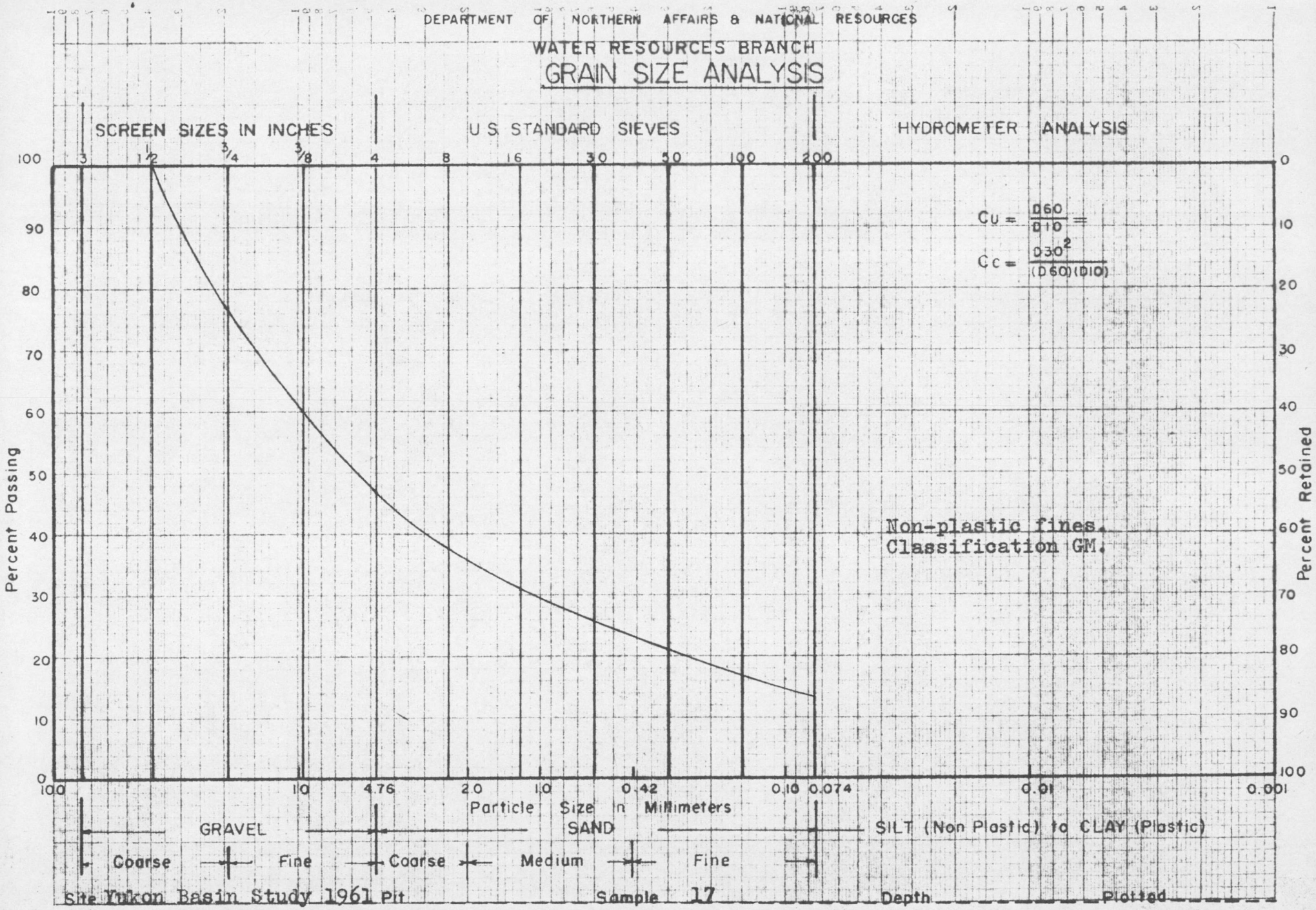
Description of Potential Impervious Material for the following Grain Size Analyses Curves

Sample Number	Location	Field Description of Material	Field Description of Overburden	Thickness of Deposit	Areal Extent (Estimated)	Remarks
17	Small pit on northeast side of Alaska Highway at mile 1159.2; 10 feet below ground surface	Well graded till; about 15 per cent of material is silt or clay; a few boulders up to 18 inches in diameter; minor weathering, chiefly in the shale and schist pebbles	18 inches of silt	12+ feet	Unlimited	Material used for highway maintenance
22	Large pit on left side of White River about one mile downstream from Alaska Highway bridge at mile 1169.2; sample taken in the face of a 50-foot bluff; 20 feet below ground surface; about 1/2 mile upstream from sample No. 21	Well graded, silty, sandy gravel (till); about 10 per cent of material is silt or clay; a few sub-angular boulders up to 10 inches in diameter; minor weathering	None	50+ feet	Unlimited	Pit is easily accessible from Alaska Highway; material used for highway maintenance

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES

WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS



Site Yukon Basin Study 1961 Pit Sample 17 Depth Plotted

PLAN

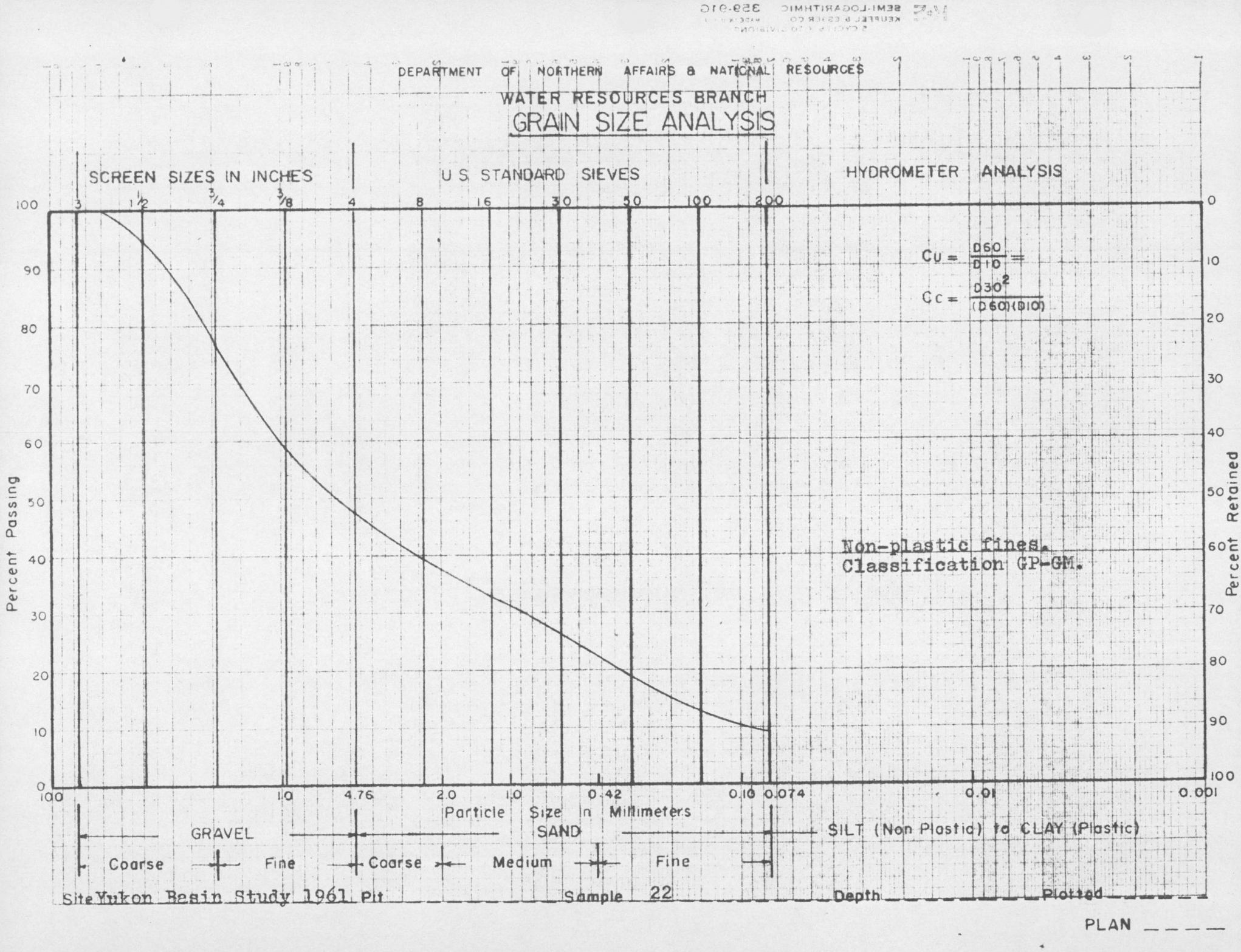

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES
WATER RESOURCES BRANCH
GRAIN SIZE ANALYSIS
SCREEN SIZES IN INCHES
U.S. STANDARD SIEVES
HYDROMETER ANALYSIS
3
1 1/2
3/4
3/8
4
8
16
30
50
100
200
Cu = D60/D10 =
Cc = D30²/(D60)(D10)
Non-plastic fines.
Classification GP-GM.
Percent Passing
Percent Retained
100
90
80
70
60
50
40
30
20
10
0
100
1.0
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 Yukon Basin Study 1961 Pit
Sample 22
Depth
Plotted
PLAN

Plate 1

Bridge over White River at mile 1169.2, Alaska Highway; right abutment in background.

G.S.C. 2-7-61

Plate 2

Bare flood plain of White River immediately downstream from Lower Canyon dam site; a potential source of natural aggregate.

G.S.C. 2-2-61

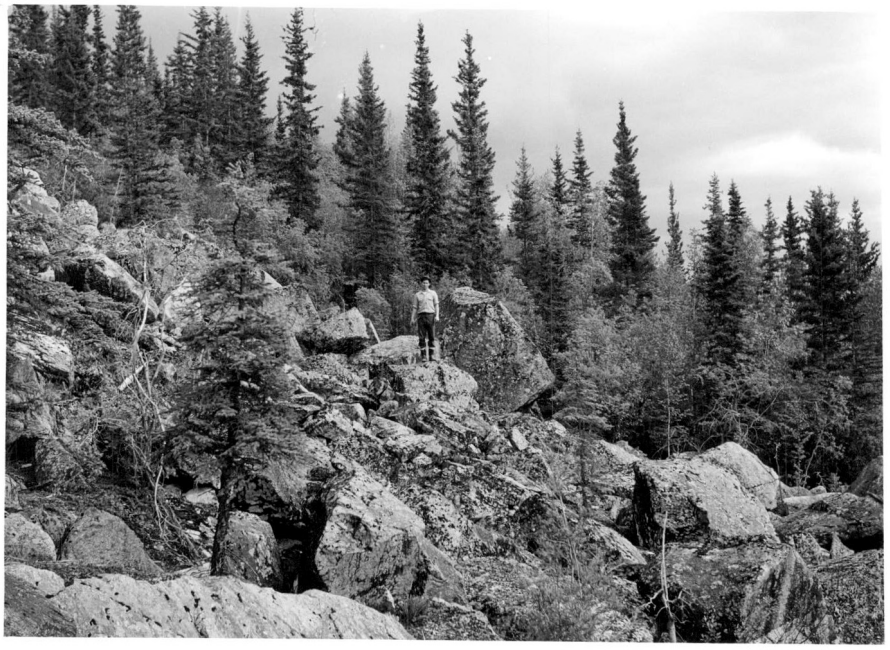
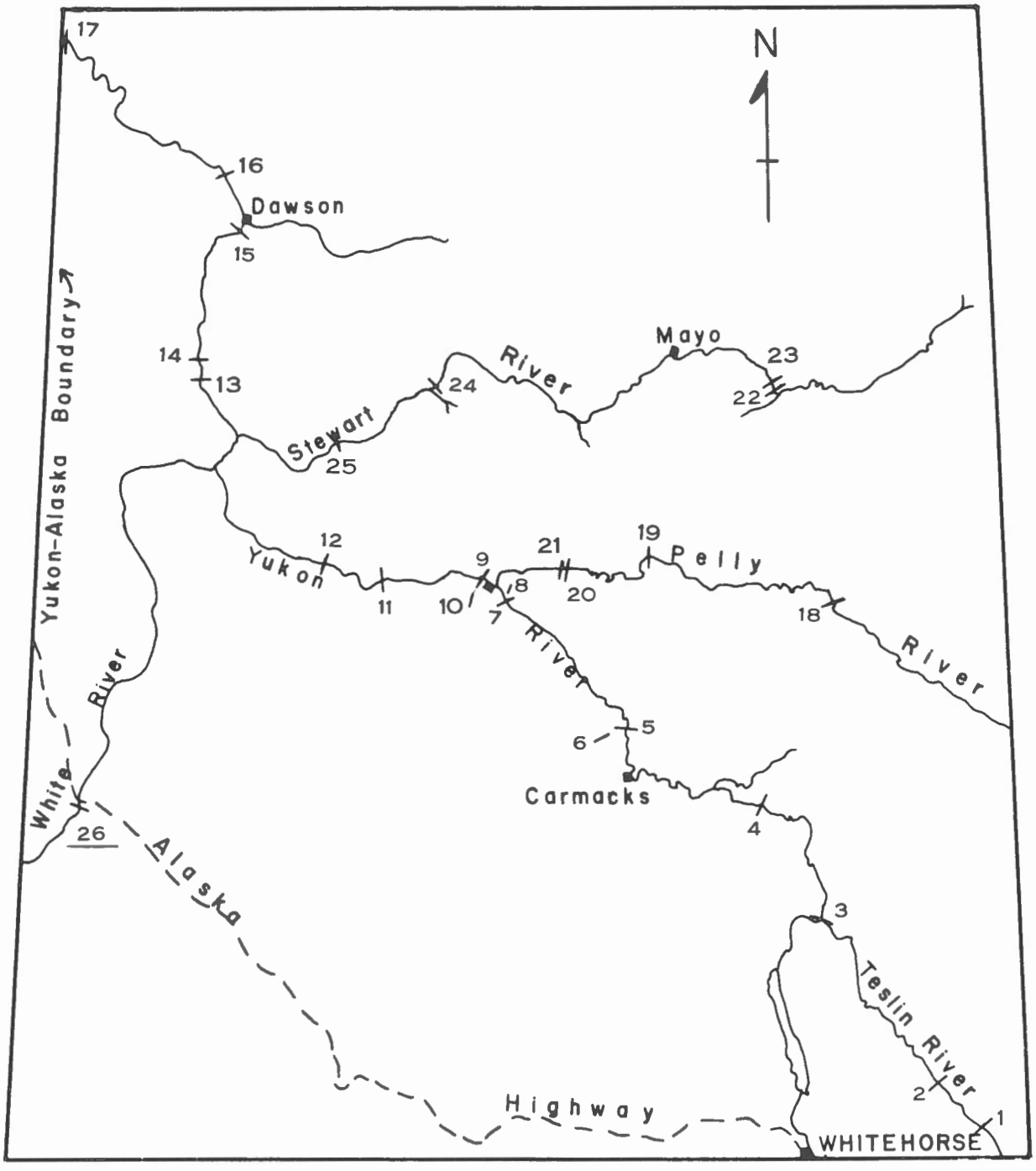


Plate 3

Talus consisting of large fragments of granodiorite; south end of Horse Camp Hill; potential riprap.

G.S.C. 2-6-61



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		