GROUND WATER DIVISION
WATER INVESTIGATIONS BRANCH
B. C. WATER RESOURCES SERVICE
DEPT. OF LANDS, FORESTS & WATER RESOURCES
VICTORIA, B.C.

17th January, 1966

File No. 0239016

# NOTES ON THE NO. 1 ROTARY DRILLING PROGRAM AND THE PROPOSED NO. 2 ROTARY DRILLING PROGRAM NICOMEKL-SERPENTINE BASIN DRAINAGE APPRAISAL - ARDA PROJECT NO. 10032

## INTRODUCTION

During the months of July-September, six test holes were drilled by rotary drill equipment in the Nicomekl-Serpentine Basin area (see Fig. 1) as part of an investigation of sources of irrigation water to supply the area proposed to be drained in an ARDA scheme. Old logs of wash-bored wells in the area showed that down to about 400 feet, the area was underlain by silt and some sand under artesian pressure. It was felt that coarser beds underlying these silty sediments could serve as high capacity aquifers which could be utilized for irrigation purposes. The test holes did not reach to the desired depths due to squeezing conditions, repeated loss of circulation, and in two test holes because of stuck pipe conditions in thick silty sections. I recommended to Mr. Livingston, Chief, Ground-water Division, that the project be terminated in the sixth hole, after the contractor, Pacific Water Wells Ltd., had lost a third set of drilling rods due to stuck pipe conditions. I further recommended that an additional program of test drilling should be undertaken in the area with heavier drilling equipment at a later date, in order to obtain further information at greater depths than was possible under the first program.

Mr. Livingston sent inquiries to a number of drilling mud manufacturers and suppliers for advice on the problem of stuck pipe or "differential sticking" as it is usually called. The replies seemed to be unanimous in stating that proper mud can overcome the differential sticking problem to a large extent. A new contract was subsequently awarded (December 21st, 1965) to Pacific Water Wells Ltd. for the proposed No. 2 Rotary Drilling program, which is now scheduled to commence in January, 1966. Further details of the No. 2 Program are given in the last section of these notes (see also Fig. 1).

## No. 1 ROTARY DRILLING PROGRAM

### General

Brief details of the cost of this drilling program are as follows:

| | |
|---|---|
| Footage | 3,597 feet |
| Cost | $11,873.51 |
| Unit Cost per Foot | $ 3.30 |

Selection of sites for the above program was carried out during July by myself and Mr. Gulliver after consultation with Mr. Livingston. The first three test hole sites Nos. 1 to 3 (see Fig. 1) were considered to be the most suitable on the limited surface and subsurface information available. These three sites were located away from the sides of valleys to avoid possible thinning or pinching out of materials, and one test hole was located in each of three main areas making up the Nicomekl-Serpentine Basin. In all, 15 sites were selected in the field prior to the commencement of the drilling program. All 15 drill sites were selected on road allowances within Surrey Municipality and permission to drill on these sites was obtained from the Municipality. Sites were selected near to water where possible and close to drainage ditches in case an artesian flow should be encountered during drilling. All sites were readily accessible for a truck-mounted drilling rig. A trailer was rented for use as a field laboratory, for the drying, and logging of samples. It was also necessary to have a small sheet metal oven made to fit over the propane stove in the trailer in order to dry out the samples.

Sampling and logging

The techniques used for sampling and logging during the No. 1 rotary drilling program are briefly as follows:

1) Careful drilling by the contractor and the recording of a good "driller's log", including penetration rates of the drill, careful sampling of the cuttings.
2) Logging of the cuttings at the site by the geologist.
3) Comparison of cuttings with occasional tube samples.
4) Electric log - resistivity and fluid potential graphs.

This information is combined into a summarized "composite log". In general, the techniques used are based on those perfected by the Research Council of Saskatchewan and outlined by Mr. Livingston in his memo of July 9th, 1965, file no. 0242686.

Comparisons were made in Test Holes Nos. 3 and 4 between washed cutting samples taken from the testhole during drilling and mud samples taken at the same time from the mud pit. These samples were subjected to hydrometer and sieve size analyses at the Department of Highway's Laboratory and the results plotted on the grading curves on Sheets 1-7 attached.

Sheets Nos. 1, 2 and 3 show mud samples taken from Test Hole No. 4 at 236 feet, 240 feet and 256-7 feet respectively. The grading curves are very similar to those obtained from samples taken at the same time from the mud pit.

This similarity between mud samples taken from the hole and mud samples taken from the pit at the same time, could indicate that the mud pits we have been using are not big enough, and that the mud has insufficient time to enable the material brought up from the test hole to settle out before recirculation takes place.

A drive sample taken at 254-5 feet in Test Hole No. 4 (Curve No. 3 in Sheet No. 4) contains over 50% of grain sizes larger than silt. Mud samples from the test hole, taken one foot below the drive sample show how small a fraction of this greater than silt size material is transported with the mud sample to the surface.

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A washed cutting sample taken at 230 feet in Test Hole No. 4 (Sheet No. 5) shows none of the sand sizes that are present in either the mud sample taken at 236 feet or the drive sample at 235 feet. The washed sample consists of clasts of clay and silt sizes only - the coarser sand fractions must therefor tend to be broken up to a greater extent into individual grains. This would indicate then that a description of a formation based just on samples of clasts alone would exclude possibly an important percentage of the sand portions from the formation descriptions. This would again appear to be the case in Sheet No. 6 where three washed samples of clasts in the 490-492 range show less percentages of sand sizes than a drive sample taken at this depth.

An exception to this is however found on Sheet No. 4 where a drive sample from 254-5 feet contains a smaller percentage of sand than washed cuttings collected from 245 feet to 257 feet. I think this can be explained by the heterogeneous nature of the sediments here. Conceivably the coarser fractions of the cuttings came from thin coarse lenses of material which may have been present above and below the section obtained in the drive sample. Nevertheless, it is possibly premature to make too many assumptions on the limited evidence available here. A comparison of our sampling methods should preferably be made in a known homogeneous formation. The above discussion however does point out the need for a larger and longer mud pit to allow time for settling out of the cuttings. It would also appear from these results that some caution is necessary in describing any section of a test hole on the basis of clasts alone, as this may exclude coarser size fractions from the log description

Discussion of results

Generally speaking, the six test holes drilled in the No. 1 Rotary Drilling Program can be correlated to some extent. Current pollen studies, and size analyses from tube samples may throw further light on the problem. From ground surface to about 20 feet, the material generally encountered in all holes is a light grey clay, and silt, with peat and shells. Below this to about 215 feet is a light grey clay, silty clay, clay silt, silt and very fine sand, all with shells. From about this depth to the bottom of Holes Nos. 1, 2, 3 and 5, the material is similar except that it contains scattered stones; probably glacio-marine sediments. In Test Hole No. 6, occasional stones start from 125 feet. All these holes are all under slight artesian pressures. Test Hole No. 4 is similar to the other holes down to 310 feet. Below 310 feet to 491 feet, there is a light grey silt with occasional pebbles. From 491 to 509 is probably a till, 509 to 523 is a stony, silty sand and gravel, possibly with some till. This zone is probably an aquifer in part as the mud circulation was lost at times. From 523 to 680, the hole may be in a till or stony glacio-marine sediments; at 680 feet, the drill rods broke, partly because of poor drilling techniques.

The geology, except for the upper part of these holes tends to be somewhat confusing. The presence of the gravel in Hole A4 is encouraging and shows that there is a reasonable chance of finding aquifers below the silt in this area. Mr. Livingston suggests that some sort of combined rotary-cable tool well construction technique should probably be used to keep down the costs of well construction in deeper holes.

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In Test Holes Nos, 2 and 3, there is also a possible aquifer at 298-300 feet and 330-340 feet respectively. Other well records in this area show an aquifer to be present at this general level.

In Test Hole No. 5, possible aquifer zones may be present between 206 and 220 and also 587-597 in fine sand. In Test Hole No. 6, a section at 124-131 feet may be water-bearing. It is unfortunate that an electric log could not be obtained on either of these two holes.

Sections have been drawn on a scale of 1000 feet to one inch, and these sections show details of the subsurface information as along the section line XY as shown in Fig. 1. A geological map of the test hole area showing available information has also been compiled on the same scale. Details on the drilling difficulties experienced in the six test holes, together with a composite log of each hole, are included in Appendix I. The composite logs are based on all available information from the drilling records, electric log, cutting samples, etc.

## NO. 2 PROPOSED ROTARY DRILLING PROGRAM

### General

A new contract has been awarded to Pacific Water Wells Ltd. (December 21, 1965) for the proposed number 2 rotary drilling program scheduled to commence the last week in January. Initially, six sites have been selected, see Fig. 1, mainly along the section line XY (shown on Fig.1). These holes are to provide stratigraphic information at depth (to 1200 feet) and may be followed by a series of shallower holes to investigate possible aquifers found in the first holes and from other well records. After the test holes are completed, one or more water wells could be constructed in the most likely aquifer zones. If an aquifer is found under thick silts, Mr. Livingston considers it may be advantageous to use a 12-inch diameter rotary hole through the silts which could be cased with light 10-inch casing. The aquifer sections could then be completed using conventional cable tool methods.

In order to successfully accomplish a test hole to 1200 feet in the adverse drilling conditions known to exist in the Nicomekl-Serpentine area, many improvements in technique must be included into the new number 2 drilling program. The contractors, Pacific Water Wells Ltd., have acquired a mud program from Milchem Canada Ltd., who will have a technical advisor on the first hole. The company will require a mud pit 40 feet long, ten feet wide and five feet deep. The advantages of a big mud pit have already been discussed. Cost of mud per hole may be $1,200.00. As the success of this program may well lie in correct mud techniques, this additional cost may well be worthwhile. Milchem Canada Ltd. feel confident they can overcome the problem of differential sticking and also offer a better recovery of satisfactory samples with the mud program they recommend.

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In reply to a letter of enquiry by Mr. Livingston, Milchem Canada Ltd. think the problems encountered in the number 1 program arose from two things and the following is an extract from their letter (file 0242686, October 27th, 1965).

1. Mud Rings

"which involves the incorporation of the soft silt, sand, clay into the drilling fluid, and thus, makes it very viscous and causes high pump pressures, and in some cases will not rise to the surface through the drill pipe annulus. This may eventually cause stuck pipe or the breaking down of the formation around the bit. This could result in serious loss of circulation".

2. Differential Sticking

"This results when you have a situation where the hydrostatic head of the fluid in the hole is higher than the formation pressure. If the formation is finely permeable, the hydrostatic pressure of the mud column forces the water out of the mud into the formation, and deposits the solid phase of the mud onto the wall of the hole. If the drilling fluid does not have low water loss characteristics, this process builds a thick, mushy filter cake, and when the drill pipe is static, it is forced into this cake and held there by the differential pressure".

Milchem Canada Ltd. consider the mud ring problem can be cured by using a dispersing and inhibiting chemical in the mud system. The differential sticking can be solved by lower mud weight (less than 9.4 #/gal.), lower water loss (less than 4 cc's), the addition of oil (5 - 8% emulsified), the addition of fine mud, etc. to seal off permeability, the addition of a surfactant to provide lubricity between pipe and wall.

The problem of squeezing clays encountered in some of the last holes may, in fact, be due to the mud ring problem, however, it will be interesting to note what precautions Milchem Canada Ltd. will take to overcome this problem on the first test hole.

Other improvements to be incorporated in this program include a Geolograph or equivalent penetration rate recorder. Binocular microscope and lamp for logging samples. A larger drilling rig - a Mayhew 1000 is to be used on this job, and it would be advantageous if the mud pump system can be powered independently of the drilling machine, to avoid loss of circulation if the drill machine should stall.

As on the number 1 program, all deep test holes will have about 100 feet of inexpensive casing at the top of the hole and placed using cement grout to afford some control in case artesian conditions are encountered.

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Tube samples will be taken during the first 100 feet for pollen studies at the University of British Columbia. Additional cutting samples will also be taken for this study. Deeper tube samples may also be taken on later holes for pollen studies and possibly may also be used for the investigation of the salinity concentrations existing in the water content of silts and fine sands found deep in these holes.

Temperature logs will also be run in the test holes after the completion of the electric logging, and after mud circulation has been stopped for some time.

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17th. Jan., 1966 FILE No. 0239016

# APPENDIX I

## GENERAL NOTES AND COMPOSITE LOGS FOR TEST HOLES NO'S 1 - 6, NO. 1 ROTARY DRILLING PROGRAMME

The test holes in the Nicomekl-Serpentine Rivers area were drilled with a Failing 1000 machine, using Failing drill rods, and drilling a 3 7/8 inch hole. Drag bits were used in clay, silt and sand sections, and tricone bits in harder compact sections. The contractor, Pacific Water Wells Limited, used a mud with additives and in some holes the water used was brackish. (Water from a well near No. 5 hole was definitely brackish when tested with the Hach field kit).

At times, the mud pressures became quite high, and the possible explanations for this are discussed under the No. 2 proposed rotary drilling programme. The problem of stuck pipe conditions has been discussed both in the 'Introduction', and also in the No. 2 proposed rotary drilling programme.

Test holes were grouted after completion to prevent leakage from artesian pressures.

### Test Hole No. 1 Well N° 8, S.E. 1/4, Sec. 3, Tp. 2

Location: See Figure 1. Site is located at end of 48th Avenue, just west of Johnston Road (152 St.) at Serpentine River.

Elevation of collar: 4 feet approximately

General Notes: This hole was terminated at 307 feet in a chalky calcareous siltstone. Bedrock was not expected at this depth.

Composite Log in Feet:

| | |
|---|---|
| 0 - 20 | Light grey silt, peat and shell fragments. These deposits probably related to present sea level fluctuations (Salish Deposits?). |
| 20 - 95 | Mostly silt grading to coarser silt and fine sand near base, abundant thick-walled shells, mica flakes, some lenses of sandy silt. |
| 95 - 210 | Clay-silt to silt clay with shell fragments. The drilling mud used in this hole appears to be saline. A sample showed the resistivity of the mud at 22°C to be 0.574 ohm meters. This makes any interpretation difficult as the salinity of the formation itself relative to the drilling mud is not known. |
| 210 - 267 | Clay silt with pieces of chalky calcareous silt with coarse sands and pebble sizes. Some shell fragments. From 195 feet onward there is an increase in the resistivity and an increase in the potential, which could indicate an increase in porosity |

210 - 267 of the formations, or an alteration in the mud consistency, or change in the salinity, or possibly even an increase in the amount of hard chalky calcareous material found lower in the hole. The electric log probe was only able to penetrate to a depth of 237 feet, however, it is conceivable that due to cable slippage the true depth of the electric log may be over 240 feet. Harder drilling was encountered at 247 feet.

267 - 307 Chalky calcareous siltstone. (?Pliocene)

Test Hole No. 2 Well No. 17 N.W. ¼ Sec. 19, Tp. 7

Location: See Figure 1. Site is located at the end of Pratt Road (180 St.) south of Mud Bay Road (40th Avenue)

Elevation of collar: 9 feet approximately

General Notes: Squeezing conditions were encountered in this test hole. As only a day shift was operating, considerable time was lost each day with pulling rods and reaming out the hole, due to squeezing conditions. Hole terminated at 841 feet, when time spent on the above became excessive.

Composite Log in Feet:

0 - 20 Light grey clay, silt, peat and some shell fragments

20 - 50 Light grey clay, silt with some shell fragments

50 - 216 Light grey clay silt, sandy silt, very fine sand with mica flakes, shell fragments, ? wood pieces - may be contamination from peat layer above 20 feet. (Electric log shows small zones of increased porosity possibly representing more sandy members. Porosity would appear low from 182-214 feet. Note resistivity of drilling mud at 22°C is 7.826 ohm meters indicating a fresh water drilling mud).

216 - 297 Light grey clay silt, silt and very fine sand, shell fragments associated with some coarse sand and grains to pebble size. (Electric log indicates small increased in porosity probably associated with thin sand lenses).

297 - 323 As above but there is a marked increase in the resistivity log corresponding with slower drilling rates. Possible aquifer at 298-300 feet? (see electric log)

323 - 340 Stony silt, some clay and sand, gravel, shell fragments. (Electric log shows marked increase in resistivity in compact silty sand and gravel from 322-328 feet followed by a sharp drop in porosities from 330-340, indicating possibly a more impermeable layer of hard clay).

340 - 398 Stony silt, with some clay and sand, shell fragments.

398 - 483 Stony "clay"-silt, silt, some clay, sand and shell fragments (Electric log and drillers log indicates softer clay silts in layers as at 398-400, 438 feet.) (Electric log indicates lower resistivity values to those immediately above).

483 - 642 Stony clay-silt, silt, some clay, sand and shell fragments. (Electric log indicates possible change here - increased resistance and less amplitude changes on potential side - samples appear coarser and could be better sorted and more permeable. The drilling is easier in this section).

642 - 718 Clay silts to silts - badly sorted with grains up to pebble size. Plant remains collected in bit sample, possibly isolated lenses only? Drilling definitely harder in this section. (Electric log shows an increase in potential indicating an increase of porosity or salinity?)

718 - 841 Friable poorly sorted silt to sandy silt containing grains from coarse sand up to pebble sizes.

Test Hole No. 3

Location: See Figure 1. Site is located at end of Livingstone Road off Harvie Road, on a road allowance which is an extension of 180 St.

Elevation of Collar: 4 feet approximately

General Notes: Same as for Test Hole No. 2 - squeezing conditions. Hole terminated at 630 feet, when time spent on pulling rods and reaming out hole became excessive.

Composite Log in Feet:

0 - 15 Light grey clay, silt and peat beds.

15 - 120 Light grey clay to clay silt, plastic when wet, friable chalky when dry, shell fragments at 39 feet onwards. Plant remains possibly from contamination above?

120 - 140 Silt to very fine sandy silt. Some mud loss at 132-133 feet. (No electric log above this section).

140 - 229 Silty clay, clayey silt, silt, some disseminated mica, shell fragments. (Electric log for this hole is poor and results suspect - machine sent in for repairs at this point. Resistivity of drilling mud at 22°C is 6.957 ohm meters).

229 - 330 Silty clay, clayey silt, silt, some disseminated mica, shell fragments, associated with some sand and grains to pebble size. (Electric log shows marked changes in resistivity possibly coinciding with thin porous sandy beds between finer silts and clays).

330 - 340 Stony silt and some sand, gravel and shell fragments. Drill log indicates an aquifer here. (Electric log shows a porous aquifer at this point, possibly with brackish water? Electric log ends here).

340 - 440 Stony silt, clay and sand, shell fragments. Drive sample at 354-355 feet (see grading curve Sheet No. 9) shows about 40% in silts and clays, and the remainder nearly all in sand size. Drive sample contained some stones up to 2.4 inches. Slower drilling rates.

440 - 600 Mainly sand with minor silt and clay and stones of assorted sizes. (see grading curve Sheet No. 9) Drive sample at 441.5 - 442 feet mainly medium to coarse sand. Drive sample at 490-490.5 feet mainly sand with 20% silt and clay.

600 - 636 As above but softer drilling.

Test Hole No. 4 Well No. 12, S.W. 1/4 Sec. 1, Tp. Tp. 2

Location: See Figure 1. Site is located at end of Cameron Road (50th Avenue) West of 168 St. and east of Serpentine River.

Elevation of Collar: 4 feet approximately

General Notes: Adverse drilling conditions were encountered in this hole. The circulation was lost at times, and very hard drilling was experienced in sections of till. At a depth of 680 feet, the drill rods broke probably due in part to poor drilling technique. This prevented an electric log from being run in this hole.

Composite Log in Feet:

0 - 80 Silt to fine sandy silt, peat to 40 feet (maximum) shell fragments and plant fragments may be recirculated in part by mud.

80 - 202 Silty clay to clay silt, many thick walled shell fragments, 130 feet - thin walled shell fragments in clay.

202 - 235 Same as above but associated with some sand and grains to pebble size.

235 - 310 Clay, silty clay, clayey silt, and silt with minor sand and some pebbles to 2.6 inches (at 235 feet) (see grading curve Sheet No. 3 for drive sample analysis from 235 feet. Drive sample from 254-255 feet very poorly sorted, contains considerable clay, silt, sand and gravel sizes). Harder drilling. Stone 1 foot in diameter at 309 feet.

310 - 491 Light grey silt, a little sand, minor shell fragments, an occasional pebble (small).

491 - 509 Till? Stony sandy clay, silt, shell fragments possibly from re-circulation? Hard drilling (14 min. at 1000 psi for 1 foot)

509 - 512 Stony silty sand? Gravel? Lost circulation. Water bearing horizon.

512 - 520 Till? Stony sandy clay silt

520 - 523 Stony silty sand? Loose gravel? Water bearing horizon

523 - 680 Till? Stony sandy clay, silt. Hard drilling (20 min at 1000 psi for 1 foot).

Test Hole No. 5 Well #93, N.W.¼ Sec. 36, Tp. 1

Location: See Figure 1. Site is located at south end of Boothroyd Road (160 St.) between Serpentine and Nicomekl Rivers.

Elevation of Collar: 4 feet approximately

General Notes: Circulation was lost repeatedly near bottom of this hole (587-597 feet). A length of casing was lowered into the hole as a last resort to restore circulation, but this became bent and stuck at 160 feet and the hole was abandoned. The electric log probe could not therefore be run down this hole.

Composite Log in Feet:

0 - 20 Silt (loamy appearance) with peat and disseminated mica flakes

20 - 60 Silt, shell fragments usually showing ribbed pattern, disseminated mica flakes.

60 - 206 Light grey clay silt, silt with some sand grains in the matrix also small shell fragments.

206 - 220 As above but associated with some coarse sand and some grains up to pebble size.

220 - 280 Light grey clay silt, silt, with minor grains to 3 mm. in matrix, also small shell fragments.

280 - 520 Light olive grey silts with some sand grains in the matrix, driller reported stones encountered at 294, 337, 412, 413, 447, and 453. Harder drilling at 289-290 feet, and 379-380 feet. ( 3 min. at 1000 psi for 1 ft.) A few thick walled shell fragments at 430 ft. Shells elsewhere may be recirculated in mud?

520 - 587 Light olive grey silt to very fine sandy silt with shell fragments. Soft drilling. (At 549-550, 6 secs. with weight of rods only for 1 foot).

587 - 593 Fine sand (gravel) - possibly saturated with brackish water. Lost circulation - rods dropped under their own weight to 593 feet. Cemented this section.

593 - 597 Drilled ahead and lost circulation again at 597 feet. This may be due to mud loss at 587 - 593 feet level or loss at 597 feet.

Test Hole No. 6 [illegible], S.W. 1/4, Sec. 36, T. [illegible]

Location: See Figure 1. Site is located north of the Mud Bay Road (40th Avenue) at the Nicomekl River on a right-of-way extension of Boothroyd Road (160 St.) Access is by way of private land only.

Elevation of collar: 4 feet approximately

General Notes: The drill rods became stuck 10 feet from the bottom of this hole (540 feet) while mud was being mixed. A second hole drilled down along side the stuck rods was also unsuccessful, the rods also becoming stuck at 520 feet. I recommended at this point to Mr. Livingston, Chief, Ground Water Division that the drilling project be terminated at this point. I further recommended an additional program of test drilling be undertaken with larger equipment to enable us to reach greater depth than had been possible (see also test hole program No. 2).

Composite Log in Feet:

0 - 10 Light olive grey silt, some disseminated mica flakes, shell fragments, (thin walled) and peat lenses.

10 - 124 Light olive grey to light grey silt with minor sand, fairly friable, some disseminated mica flakes, shell fragments - thin and thick walled.

124 - 131 Light oliver grey silt with some sand grains (and up to 3 min.) in matrix. Drilling firmer here ( 3 minutes for 1 foot at 300 psi). Circulation maintained but could be water bearing? Driller reports stones in this section.

131 - 240 Light grey silt with a little fine sand and fine grit. Stones encountered at 140 and 153 feet. A few shell fragments.

240 – 540 Light olive grey to light grey silty clay to silt with some sand grains (and sizes up to 3 min) in the matrix. Plant remains and pieces of shell. Stones found at 307-312, 351? Thin gravel seam, 364, 441, 455, 465-66. Drilling is firm here (varies between 30 secs. and 3 1/3 mins for 1 foot under rod weight only).

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## GRADING CURVES

(3) Curve No. 1 — — — —

(4) Curve No. 2 — · — · —

Curve No. 3

Curve No. 4

# NICOMEKL - SERPENTINE

## ROTARY DRILLING

## PROJECT No. 1

## Test Hole No. 4

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VICTORIA, B. C.

DATE J. C. Foweraker Jan 11, 1966

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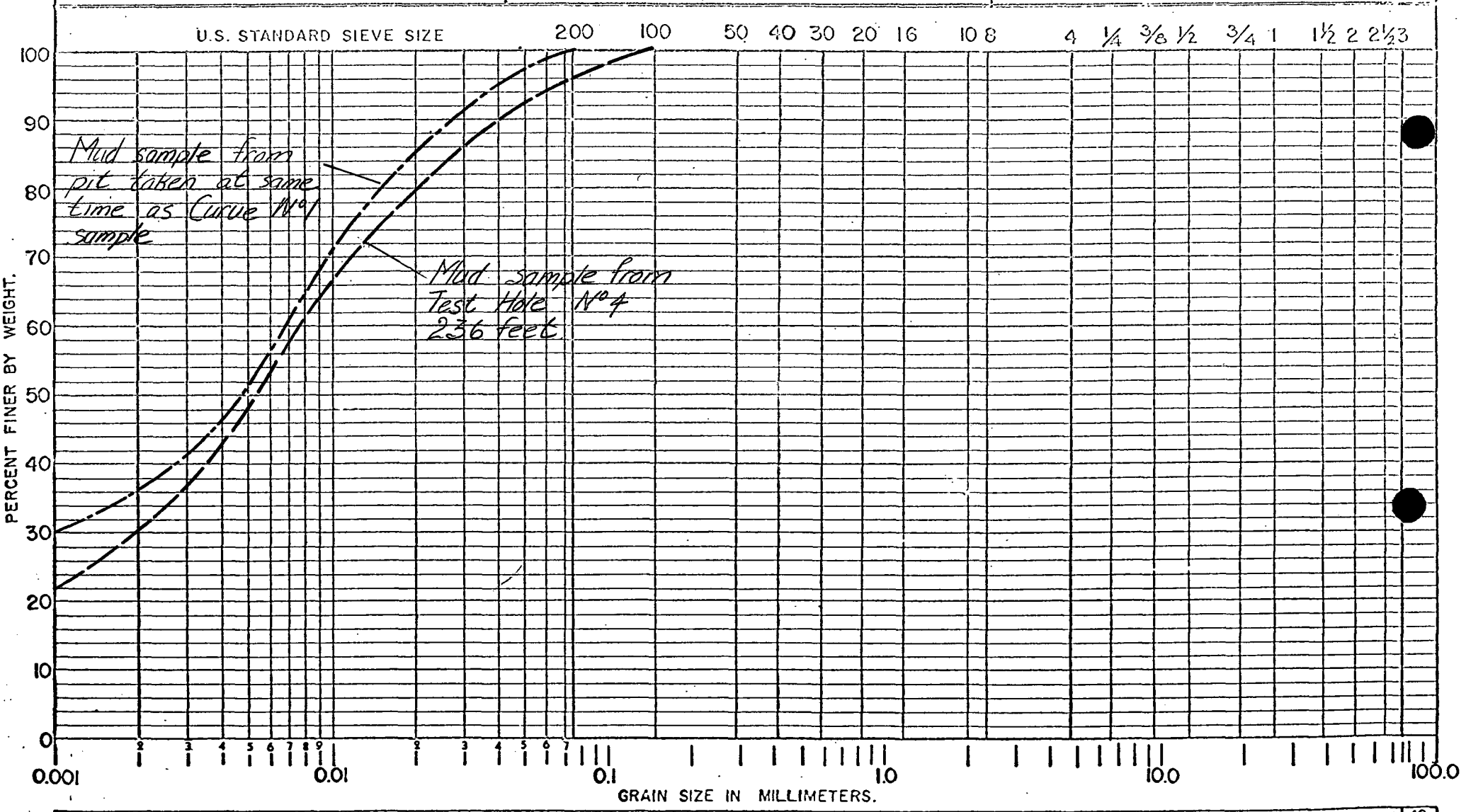


| CLAY | SILT | SAND | | | GRAVEL | | COBS |
|---|---|---|---|---|---|---|---|
| | | Fine | Medium | Coarse | Fine | Coarse | |

## GRADING CURVES

(1) Curve No 1 ———

(2) Curve No 2 — - — - —

Curve No 3 . . . . . .

Curve No 4 - - - - - -

# NICOMEKL - SERPENTINE

## ROTARY DRILLING

## PROJECT No 1

*Test Hole No 4*

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DATE *J C Fowler Jan 11, 1966*

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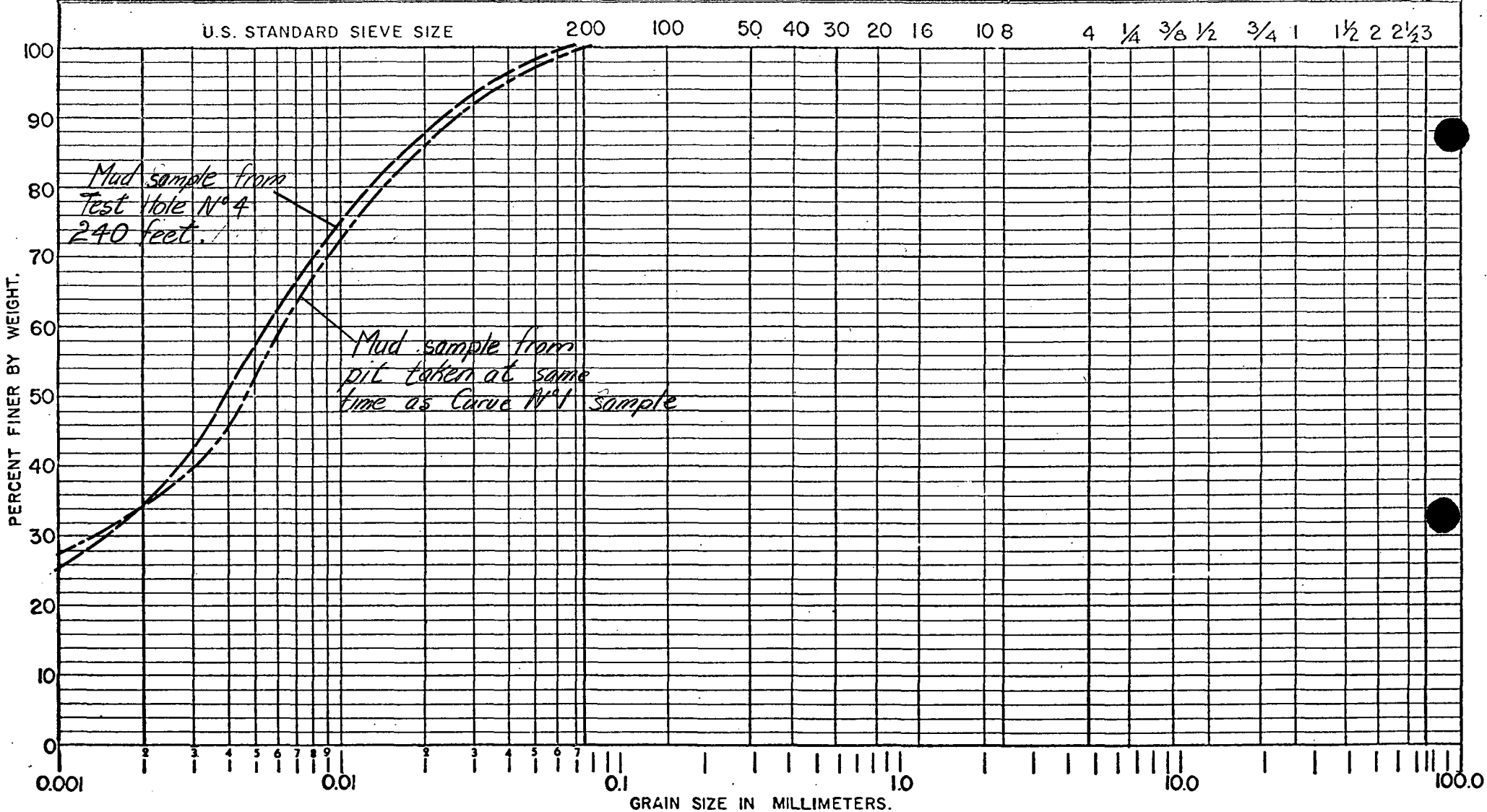


| CLAY | SILT | SAND | | | GRAVEL | | COBS |
|---|---|---|---|---|---|---|---|
| | | Fine | Medium | Coarse | Fine | Coarse | |

## GRADING CURVES

(7) Curve No 1 — — — —

(6) Curve No 2 — · — · —

Curve No 3 . . . . . .

Curve No 4 . . . . . .

# NICOMEKL - SERPENTINE

## ROTARY DRILLING

## PROJECT No 1

## Test Hole No 4

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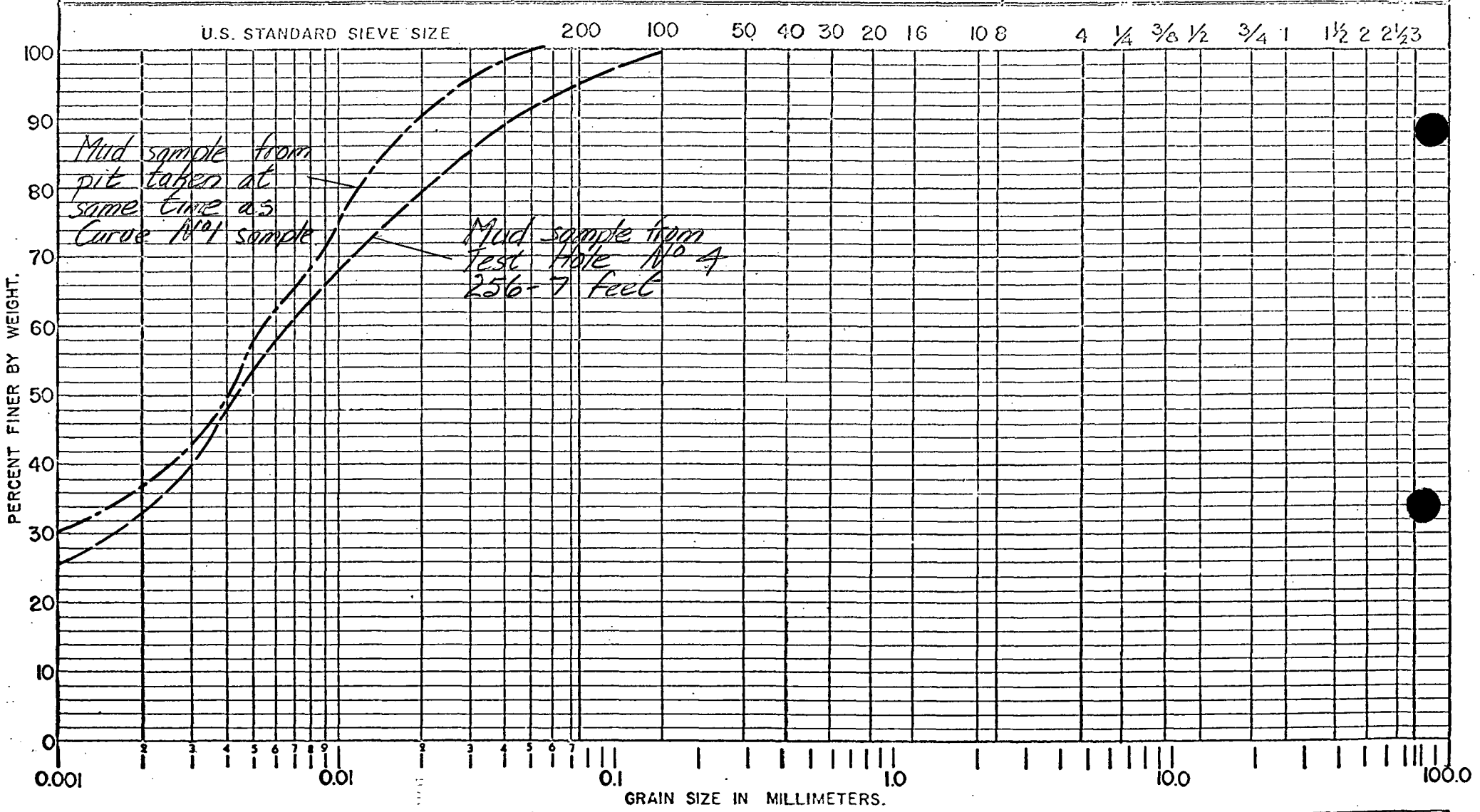


| CLAY | SILT | SAND | | | GRAVEL | | COBS |
|---|---|---|---|---|---|---|---|
| | | Fine | Medium | Coarse | Fine | Coarse | |

## GRADING CURVES

(7) Curve No 1 ——————

(8) Curve No 2 —·—·—·—

(11) Curve No 3 - - - - - - - -

(18) Curve No 4 ——·——·——

# NICOMEKL - SERPENTINE

## ROTARY DRILLING

## PROJECT No 1

*Test Hole N° 4*

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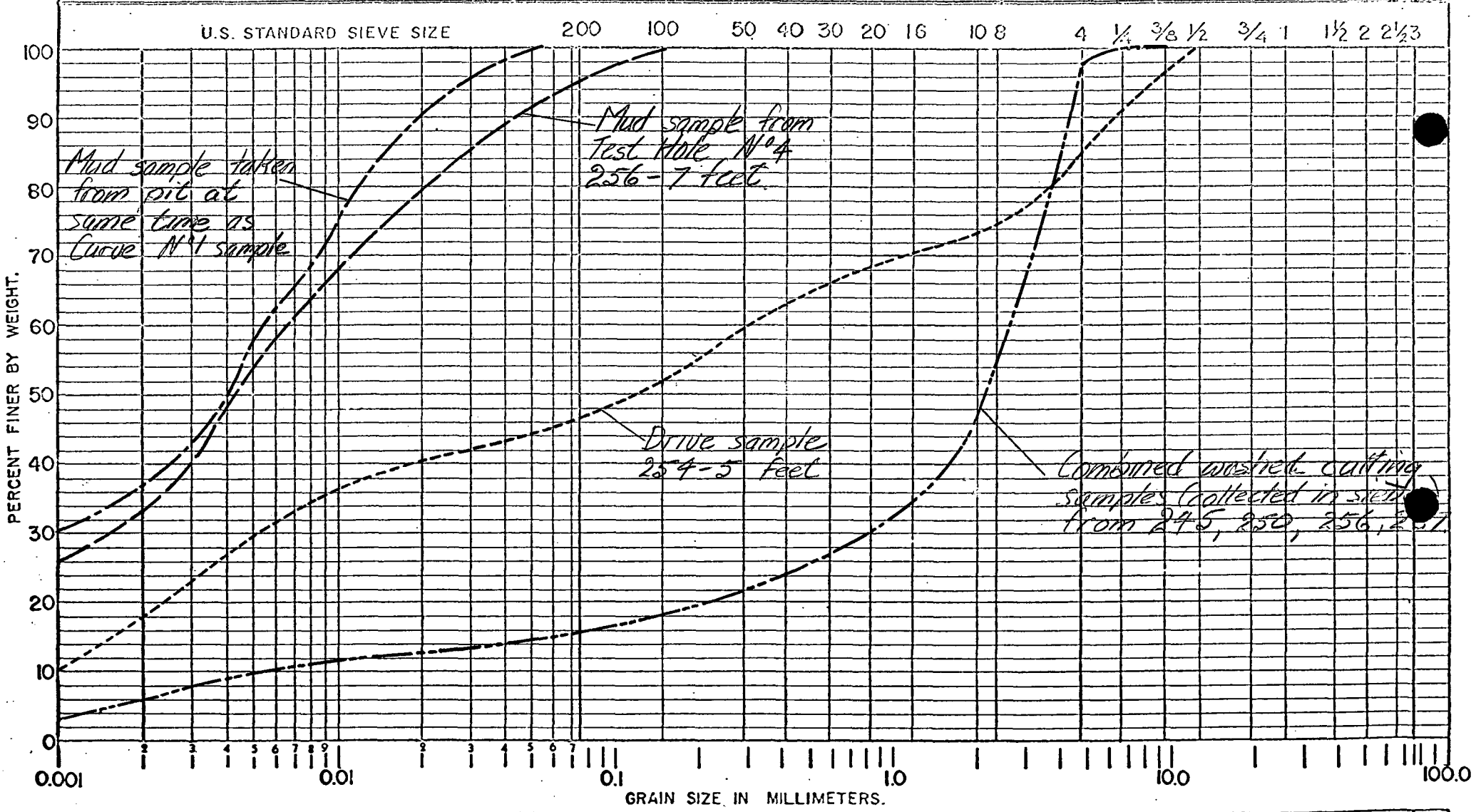


| CLAY | SILT | SAND | | | GRAVEL | | COBS |
|---|---|---|---|---|---|---|---|
| | | Fine | Medium | Coarse | Fine | Coarse | |

## GRADING CURVES

(3) Curve No 1 ——————

(6) Curve No 2 —·—·—·—

(2) Curve No 3 - - - - - -

(5) Curve No 4 ——··——··——

# NICOMEKL - SERPENTINE

## ROTARY DRILLING

## PROJECT No 1

## Test Hole No 4

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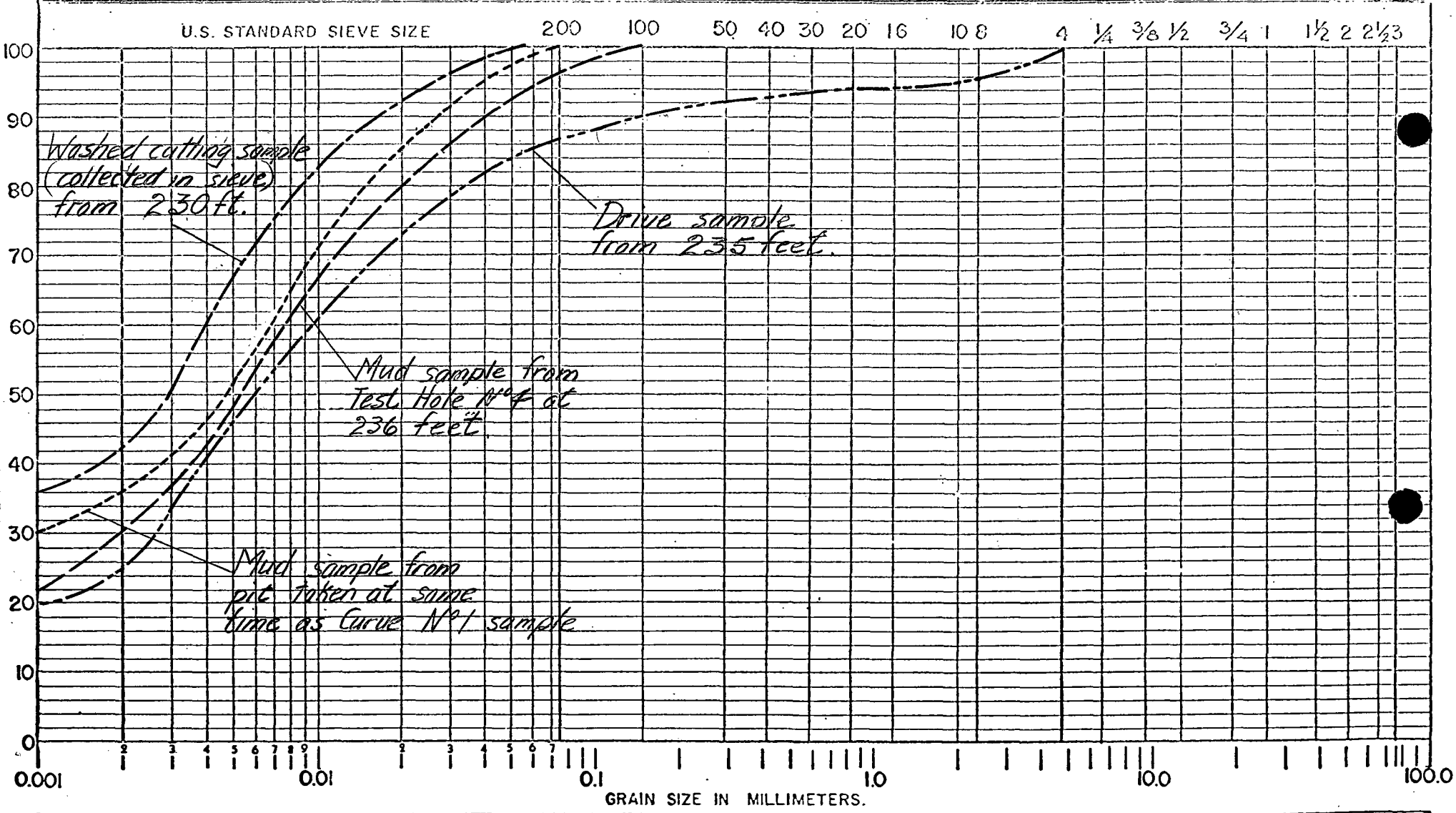
DATE J C Fawcett Jan 11, 1966

File No 0239016




| CLAY | SILT | SAND | | | GRAVEL | | COBS |
|---|---|---|---|---|---|---|---|
| | | Fine | Medium | Coarse | Fine | Coarse | |

## GRADING CURVES

(16) Curve No 1 ———

(17) Curve No 2 — — — —

(19) Curve No 3 - - - - - -

(12) Curve No 4 ———

# NICOMEKL - SERPENTINE

## ROTARY DRILLING

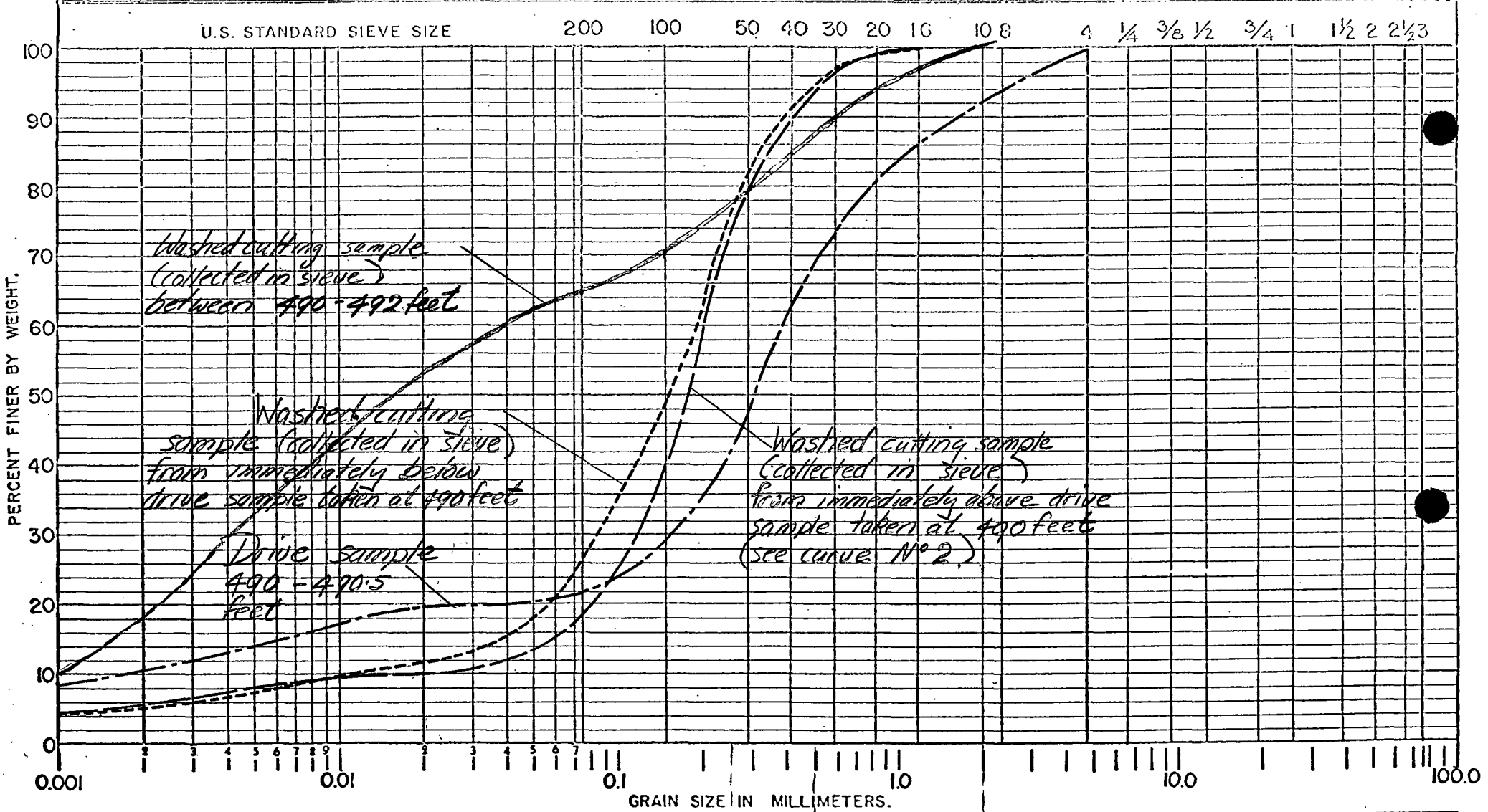
## PROJECT No 1

## Test Hole No 3

WATER INVESTIGATIONS BRANCH
WATER RESOURCES SERVICE
DEPT. OF LANDS, FORESTS AND WATER RESOURCES
VICTORIA, B. C.

DATE J C Fawcett Jun 11, 1966

File No 0239016



## GRADING CURVES

(13) Curve N° 1 — — — —
(17) Curve N° 2 — - — - — -
(20) Curve N° 3 — - - - - - -
(5) Curve N° 4 — - - — - - —

# Nicomekl - Serpentine
## Rotary Drilling
## Project N° 1

WATER INVESTIGATIONS BRANCH
WATER RESOURCES SERVICE
DEPT. OF LANDS, FORESTS AND WATER RESOURCES
VICTORIA, B.C.

DATE 9 Novembre Jan 14, 1966

File N°. 023.9016