
**AN INTERIM WATER SUPPLY
FOR THE OAKES AQUIFER TEST AREA
OF THE GARRISON DIVERSION UNIT:
EVALUATION AND SELECTION
OF WELL-FIELD SITES
AND WELL-FIELD DESIGN**

By Robert B. Shaver

**Water Resources Investigation No.15
North Dakota State Water Commission**



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North Dakota State Water Commission

NORTH DAKOTA STATE WATER COMMISSION
WATER-RESOURCE INVESTIGATION NO. 15

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INTRODUCTION

The International Joint Commission recommended that the United States Bureau of Reclamation develop and monitor a prototype irrigation test area in the James River Basin (U.S. House of Representatives, 1978). The purpose of the test area is to verify and evaluate many of the impacts on the soil, water, plants, and animals predicted from developing the Garrison Diversion Unit. Testing would be accomplished without Missouri River water entering the Canadian drainage basin.

The Bureau of Reclamation selected a 5,000-acre test plot in the West Oakes irrigation area, southeastern Dickey County (U.S. Bureau of Reclamation, 1980). Water from Jamestown Reservoir would be used on an interim basis to service the irrigation test area.

The Bureau of Reclamation began irrigating 890 acres in the 5,000-acre test plot in 1988 using water from Jamestown Reservoir. The drought of 1988 and 1989 demonstrated that Jamestown Reservoir alone cannot supply enough water to irrigate the 5,000-acre test plot on a long-term basis. As a result of the water shortage during 1988 and 1989, the Bureau of Reclamation proposed development of a supplemental water supply using ground water from the Oakes aquifer that underlies the 5,000-acre test plot. Wells would be installed within the test plot near the existing distribution canal (lateral 0-2.0). Ground water would be pumped from wells into the canal and then distributed to selected irrigation

tracts in the 5,000-acre test plot. About 1,064 acres of land were targeted for irrigation in the test plot during 1990, using ground water diverted from the proposed well fields.

There are a number of irrigation appropriations approved by the State Engineer in and around the 5,000-acre test plot that divert ground water from the Oakes aquifer. Additional ground-water withdrawals for the proposed interim water supply in the test plot may dewater the aquifer locally thereby reducing well yields for some existing appropriators. To mitigate these potential adverse effects, the Bureau of Reclamation will divert water from the James River, during peak spring runoff periods, to surface-spreading recharge sites near the proposed well fields. During the spring of 1989 and 1990, the Bureau of Reclamation successfully recharged 2,400 acre-feet and 850 acre-feet of water, respectively by surface spreading to the Oakes aquifer at selected sites in the 5,000-acre test plot.

In December 1989, the North Dakota State Water Commission entered into a cooperative agreement with the U.S. Bureau of Reclamation (agreement #O-FC-60-01480) to develop an interim ground-water supply from the Oakes aquifer for the purpose of irrigation in the 5,000-acre test plot. Field work was initiated in October, 1989 and completed in March 1990.

PURPOSE AND SCOPE

The purpose of this investigation is to develop an interim ground-water supply from the Oakes aquifer to irrigate selected tracts of land in the 5,000-acre test plot. Specific objectives of this investigation are:

- 1) Assemble and evaluate existing data on the Oakes aquifer in the 5,000-acre test plot for locating wells and well fields.
- 2) Initiate a test drilling and aquifer testing program in areas most feasible for locating well fields.
- 3) Design well fields.
- 4) Prepare specifications for a well-installation contract (under separate cover).

LOCATION-NUMBERING SYSTEM

The location-numbering system used in this report is based on the public land classification system used by the U.S. Bureau of Land Management. The system is illustrated in figure 1. The first number denotes the township north of a base line, the second number denotes the range west of the fifth principal meridian, and the third number denotes the section in which the well or test hole is located. The letters A, B, C, and D designate, respectively, the northeast, northwest, southwest, and southeast quarter section, quarter-quarter section, and quarter-quarter-quarter section (10-acre tract). For example, well 130-059-15DAA is located in the NE1/4 NE1/4 SE1/4 Section 15, Township 130 North, Range 59 West. Consecutive terminal numerals are

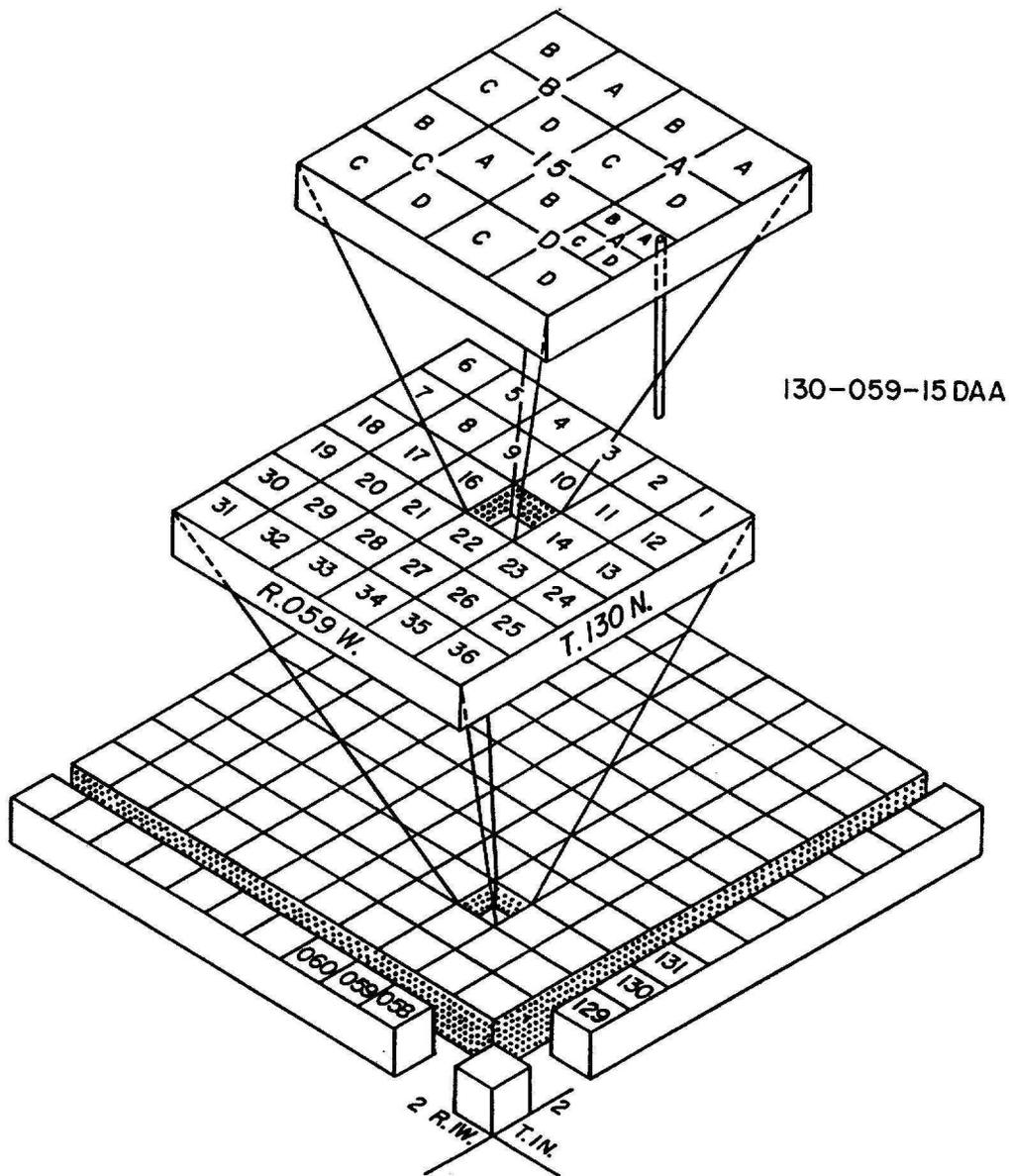


Figure 1.-- Location-numbering system

added if more than one well or test hole is located within a 10-acre tract.

FIELD AND LABORATORY METHODS

Test-drilling data used in this report were provided by the North Dakota State Water Commission, the U.S. Bureau of Reclamation, and a commercial well-drilling firm. The North Dakota State Water Commission and the commercial well drilling firm used a forward mud rotary rig to drill test holes and production wells. The U.S. Bureau of Reclamation used a truck-mounted, solid-stem spiral power auger to drill test holes.

The North Dakota State Water Commission constructed observation wells at selected sites to monitor water levels and to determine water quality. The observation wells were constructed using 20-foot lengths of 1.5-inch diameter polyvinyl-chloride (PVC) plastic casing. Each well was completed using a 5-foot length of 0.018 slot, PVC screen. A check valve was attached to the bottom of each screen. The plastic casing, well screen, and check valve were assembled prior to insertion into the drill hole. After insertion, the hole was backwashed through the screen to clean the formation. After backwashing, the hole was blown with compressed air to collapse the formation around the screen. The remaining annular space was sealed with a mixture of drill cuttings and bentonite grout.

Geologic logs of all test holes completed by the North Dakota State Water Commission are prepared by a site geologist. The geologist reports 1) texture (grain size), 2) sorting, 3) roundness, 4) mineralogy, 5) color, 6) cohesiveness, and 7) drilling characteristics (bit chatter, relative rate of bit penetration, drill fluid loss). Textural classification is based on the Wentworth (1922) scale.

Geologic logs of all test holes completed by the U.S. Bureau of Reclamation also are prepared by a site geologist. The geologist reports the same basic information as described above. Textural classification is based on the U.S. Department of Agriculture system (1947).

All observation wells were developed using an air-lift pump. Development pumping time ranged from 3 to 6 hours. After development, the observation wells were sampled using a PVC point-source bailer that was inserted to the bottom of the well. Specific conductance, pH, and temperature were measured at land surface for all water samples collected.

Four samples were collected from each well: 1) a 500-mL raw sample, 2) a 500-mL filtered sample, 3) a 500-mL filtered sample that was acidified with 2-mL nitric acid, and 4) a 500-mL filtered sample that was acidified with 2-mL nitric acid and placed in an acid rinsed bottle. A 0.45-micron filter was used to remove suspended matter. Concentrations of bicarbonate, carbonate, and laboratory determinations of pH and specific conductance were measured on the 500-mL raw

sample. Concentrations of sulfate, chloride, fluoride, boron, nitrate, silica, and total dissolved solids were determined on the 500-mL filtered sample. Concentrations of calcium, magnesium, sodium, potassium, iron, and manganese were determined on the filtered and acidified 500-mL sample. Trace element concentrations (selenium, arsenic, lead, lithium, mercury, molybdenum, and strontium) were determined on the filtered and acidified 500-mL sample placed in acid-rinsed bottles.

Concentrations of the major cations were determined using a Perkin-Elmer Model 4000 atomic absorption spectrophotometer. Concentrations of bicarbonate, carbonate, and chloride were determined using a Fisher Model 741 titralyzer; and the concentration of sulfate was determined by gravimetric methods. The North Dakota State Water Commission laboratory participates in quality-assurance programs with the U.S. Geological Survey.

Gradation analyses were performed on selected saturated zone samples using a Bureau of Reclamation procedure (USBR, 1986). Sieve sizes used for gradation analysis are shown in Table 1.

Table 1 -- U.S.A. standard sieves used in gradation analysis

<u>U.S.A. Standard Sieve No.</u>	<u>Screen Diameter, in millimeters.</u>
1/2 inch	38.1
3/4 inch	19.0
3/8 inch	9.5
# 4	4.75
# 6	3.33
# 8	2.38
# 10	1.65
# 14	1.17
# 20	0.84
# 28	0.58
# 35	0.41
# 50	0.295
# 65	0.20
#100	0.15
#200	0.075

DESCRIPTION OF THE STUDY AREA

Physiography and Climate

The study area is located in the Central Lowland Physiographic Province in southeastern North Dakota (fig. 2). The study area occupies a flat lake plain. Relief generally is less than 10 feet per mile. Locally, the topography is hummocky because of scattered sand dunes and blowouts. Runoff from the lake plain is minor as indicated by the lack of surface drainage.

Climate of the study area is semiarid to subhumid. Mean annual precipitation at Oakes from 1931 through 1974 is 19.21 inches. About 70 percent of the precipitation generally falls from April through August. Mean annual temperature at Oakes from 1951 through 1980 is 40.9°F.

Geology

In descending order throughout most of the study area, the stratigraphic section consists of sand or sand and gravel, silt and clay, till, and bedrock shale (fig. 3). The Oakes aquifer consists predominantly of sand or sand and gravel deposits of the Pleistocene Coleharbor Group (Bluemle, 1979).

Near Oakes, stratified sand and gravel deposits form a deltaic complex up to about 80 feet thick (fig. 4). The deltaic deposits grade into lacustrine sand south of Oakes. Medium sand predominates in the central part of the lake plain. South of Ludden, the medium sand grades into fine to

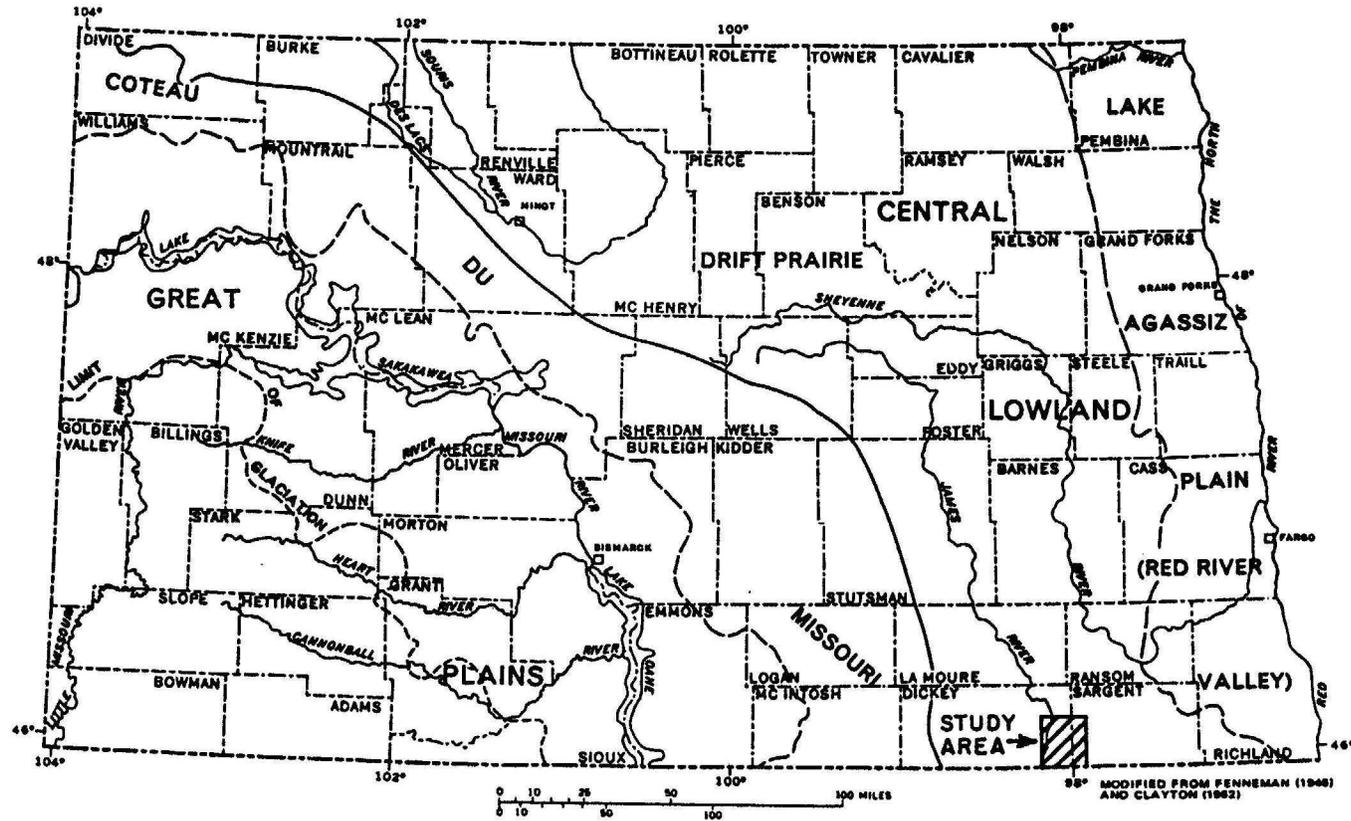
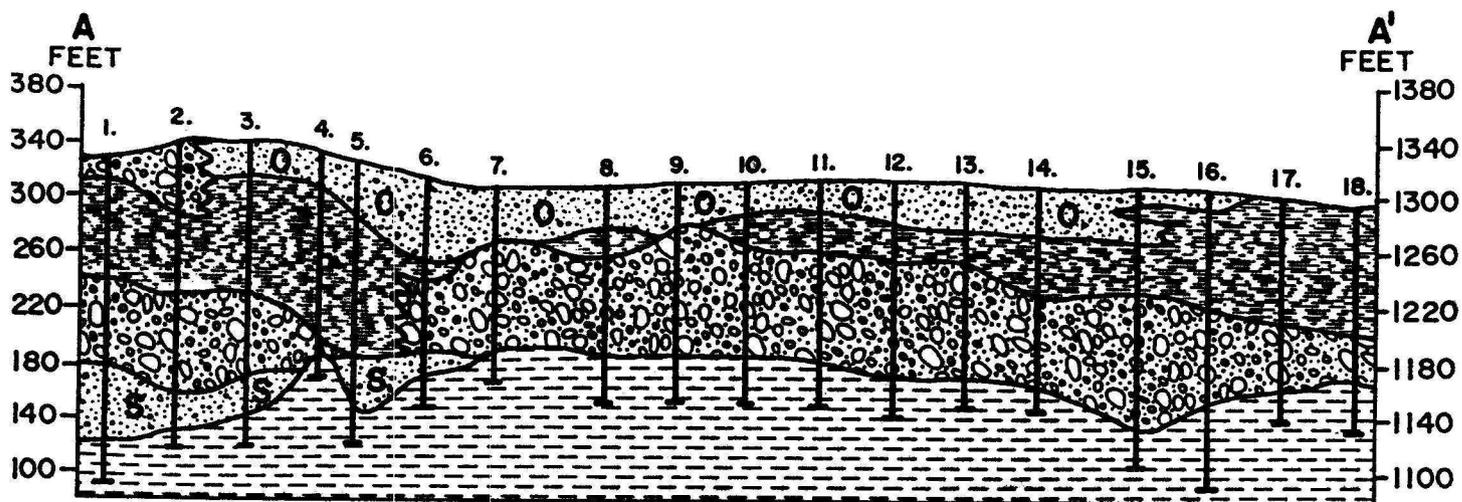


Figure 2.-- Physiographic divisions in North Dakota and location of study area



0 8,000 16,000 FEET
 0 2,000 4,000 METERS
 SCALE
 VERTICAL EXAGGERATION - 100 X

EXPLANATION

-  - SAND OR SAND AND GRAVEL
-  - SILT AND CLAY
-  - TILL
-  - BEDROCK SHALE

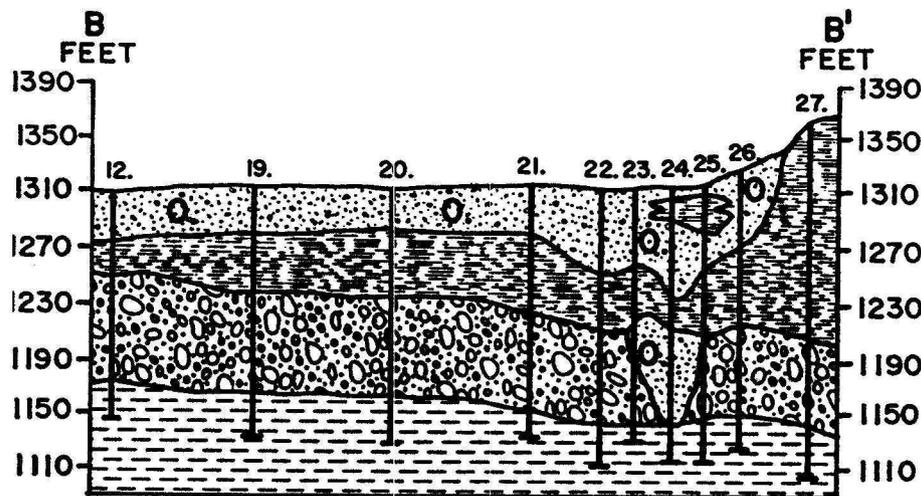
12. - TEST HOLE NUMBER

 - TOTAL DEPTH OF TEST HOLE

 - TRACE OF SECTIONS SHOWN ON FIGURE 4.

O. - OAKES AQUIFER

S. - SPIRITWOOD AQUIFER



0 4,000 8,000 FEET
 0 1,000 2,000 METERS
 SCALE
 VERTICAL EXAGGERATION - 50 X

Figure 3.-- Geologic sections A-A¹ and B-B¹ showing the Oakes aquifer

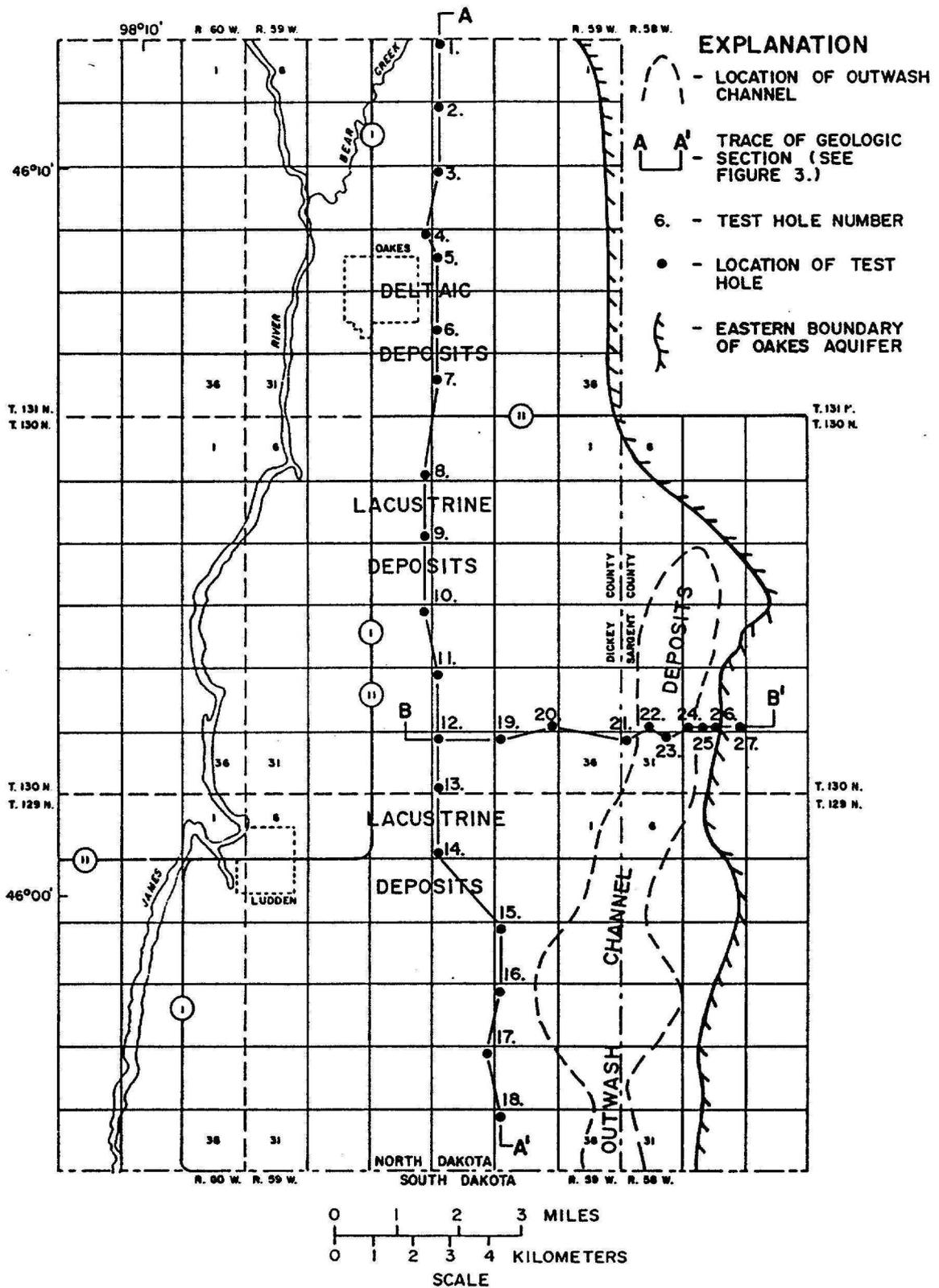


Figure 4.-- Distribution of depositional facies in the Oakes aquifer and location of geologic sections A-A¹ and B-B¹

very fine silty sand, clayey silt, and silty clay. Average thickness of the lacustrine deposits is about 35 feet.

Channel-fill deposits consisting of stratified very fine sand to coarse cobbly gravel up to 197 feet thick occur in an outwash channel along the eastern margin of the lake plain (fig. 4). A surface to near-surface fluvial silt and clay deposit overlies the northern and central parts of the outwash channel (fig. 5). The deltaic, lacustrine, and channel-fill deposits which comprise the Oakes aquifer are composed of quartz, shale, carbonates, Canadian Shield silicates and lignite fragments.

GROUND-WATER HYDROLOGY OF THE OAKES AQUIFER

Occurrence and Movement of Ground Water

For the most part, the Oakes aquifer is unconfined. Water occurs under leaky confined conditions where fluvial silt and clay sequences overlie the lacustrine and channel-fill deposits (fig. 5).

In general, regional ground-water flow in the Oakes aquifer is from east to west toward the James River valley (fig. 6). Recent James River valley flood-plain deposits that consist of sandy silty clay truncate the western flank of the Oakes aquifer. As a result, ground-water flow from the Oakes aquifer westward to the James River is negligible.

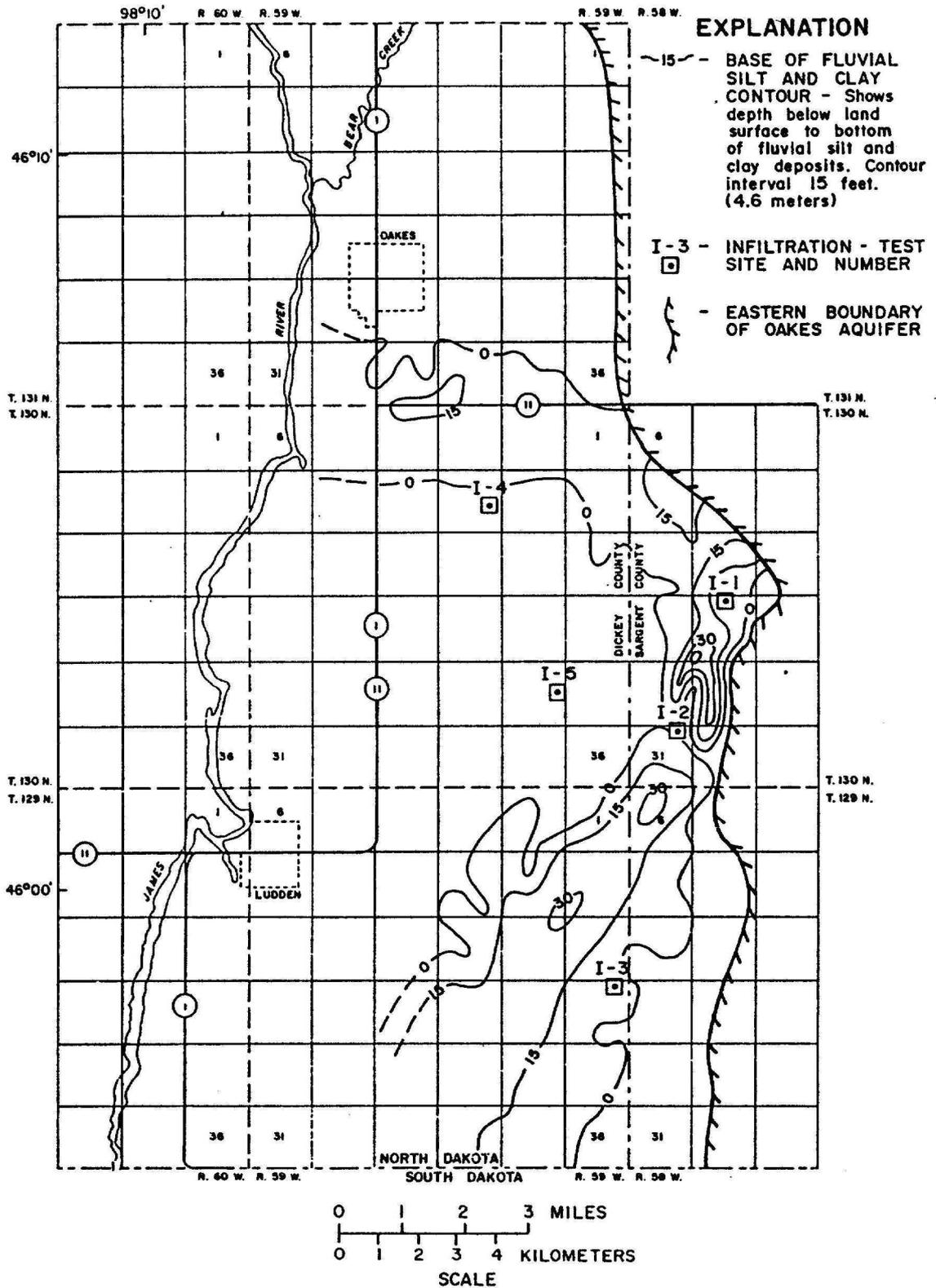


Figure 5.-- Depth below land surface to bottom of fluvial silt and clay deposits

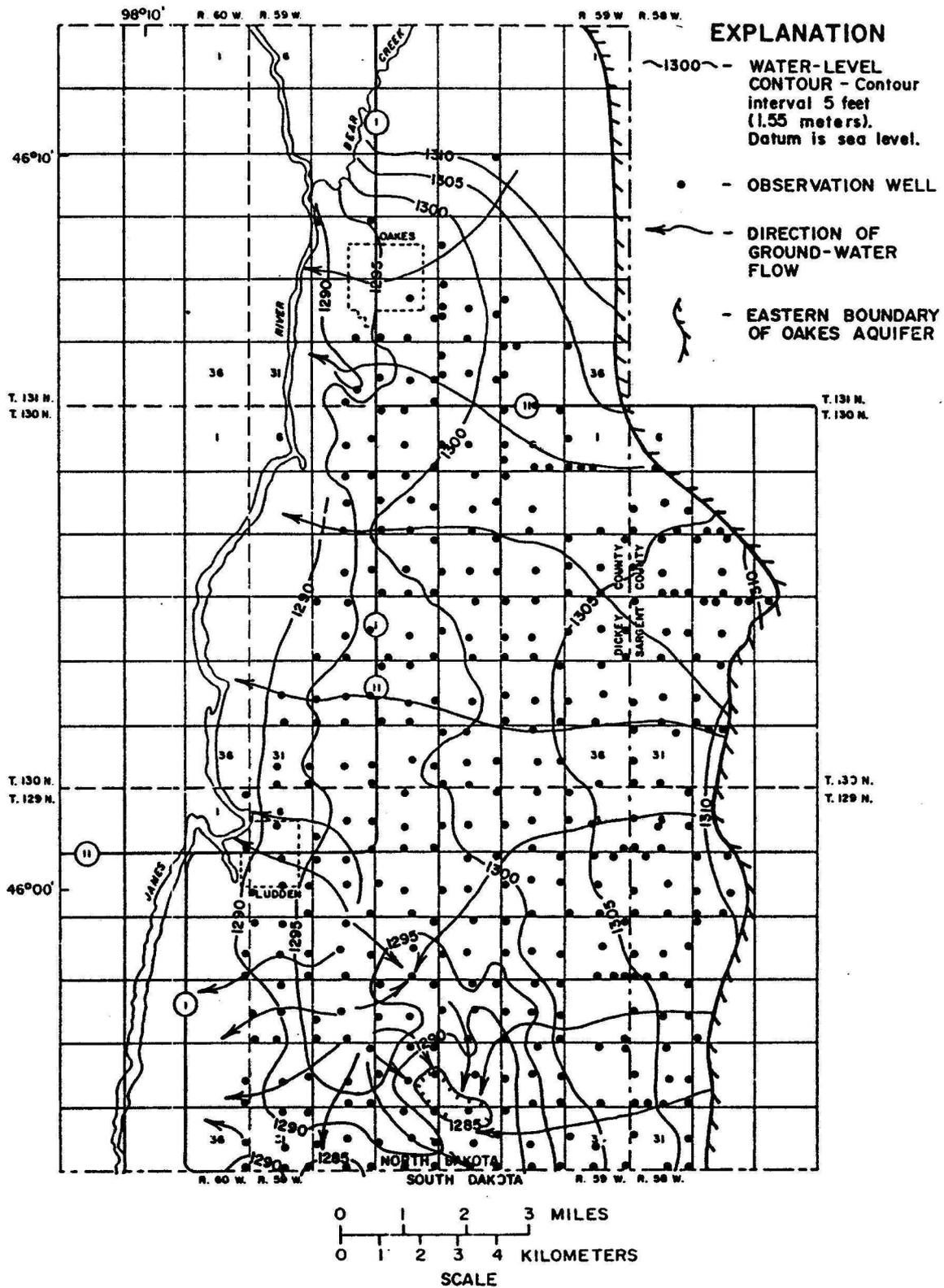


Figure 6.-- Altitude of water table in the Oakes aquifer, April 1988

Ground-Water Recharge and Discharge

Depth to the water table in the Oakes aquifer generally is less than 8 feet below land surface. Scattered sand dunes and blowouts cause a hummocky land-surface topography. Therefore, the Oakes aquifer consists of numerous localized flow systems. Within each local flow system, recharge is from direct infiltration of precipitation and local runoff that primarily occurs during the spring. Discharge primarily is from evapotranspiration that occurs during the summer. Estimating recharge and natural discharge in the Oakes aquifer is virtually impossible because of the inability to describe spatial variation in precipitation, land-surface topography, soil physical properties, and the evapotranspiration process.

Aquifer Transmissivity and Well Yield

There are two large-transmissivity areas of the Oakes aquifer that can accommodate individual well yields of greater than 500 gallons per minute (Shaver and Schuh, 1990). These areas are 1) the northern part of the study area near Oakes (deltaic sand and gravel deposits); and 2) the eastern flank of the lake plain (channel-fill sand and gravel deposits) (fig. 7). As compared to the deltaic deposits, the channel-fill deposits have the largest transmissivity at 94,000 feet squared per day and will provide well yields of up to about 3,000 gallons per minute.

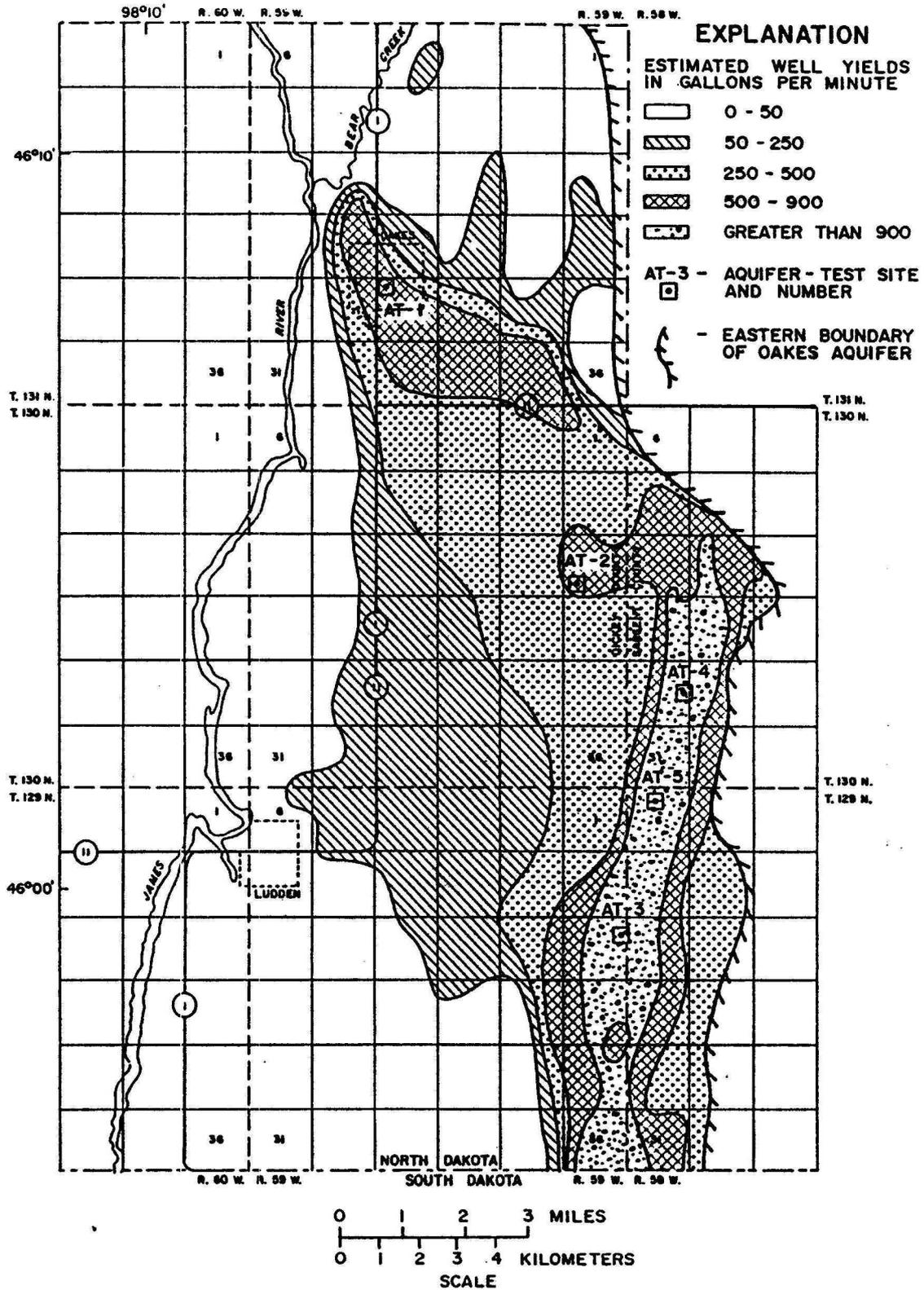


Figure 7.-- Estimated well yields in the Oakes aquifer

Surface Infiltration Rates

Surface and shallow pit infiltration tests conducted at 5 sites overlying the Oakes aquifer indicate initial infiltration rates ranging from 2.5 to 67 feet per day (Shaver and Schuh, 1990). The locations of the infiltration-test sites are shown in figure 5. Buried A soil horizons that contain up to about 14 percent clay and surficial fluvial silt and clay sequences (fig. 5) overlie parts of the lacustrine and outwash channel deposits. In these areas, surface infiltration rates are estimated to be significantly less than one foot per day.

Water Quality

Water quality in the Oakes aquifer is variable. Dissolved-solids concentrations range from less than 300 to more than 20,000 mg/L (fig. 8). Ground water with small (less than 650 mg/L) dissolved-solids concentrations is a calcium-magnesium bicarbonate type (fig. 9). The small dissolved solids calcium-magnesium bicarbonate type predominates in the Oakes aquifer and poses no limitations for irrigation use. Ground water with dissolved-solids concentrations greater than 2,000 mg/L is a sodium-magnesium sulfate or magnesium-sulfate type and occurs beneath closed land-surface depressions that represent net discharge areas. In these limited areas, ground water poses salinity, sodium, or boron hazards for irrigation use.

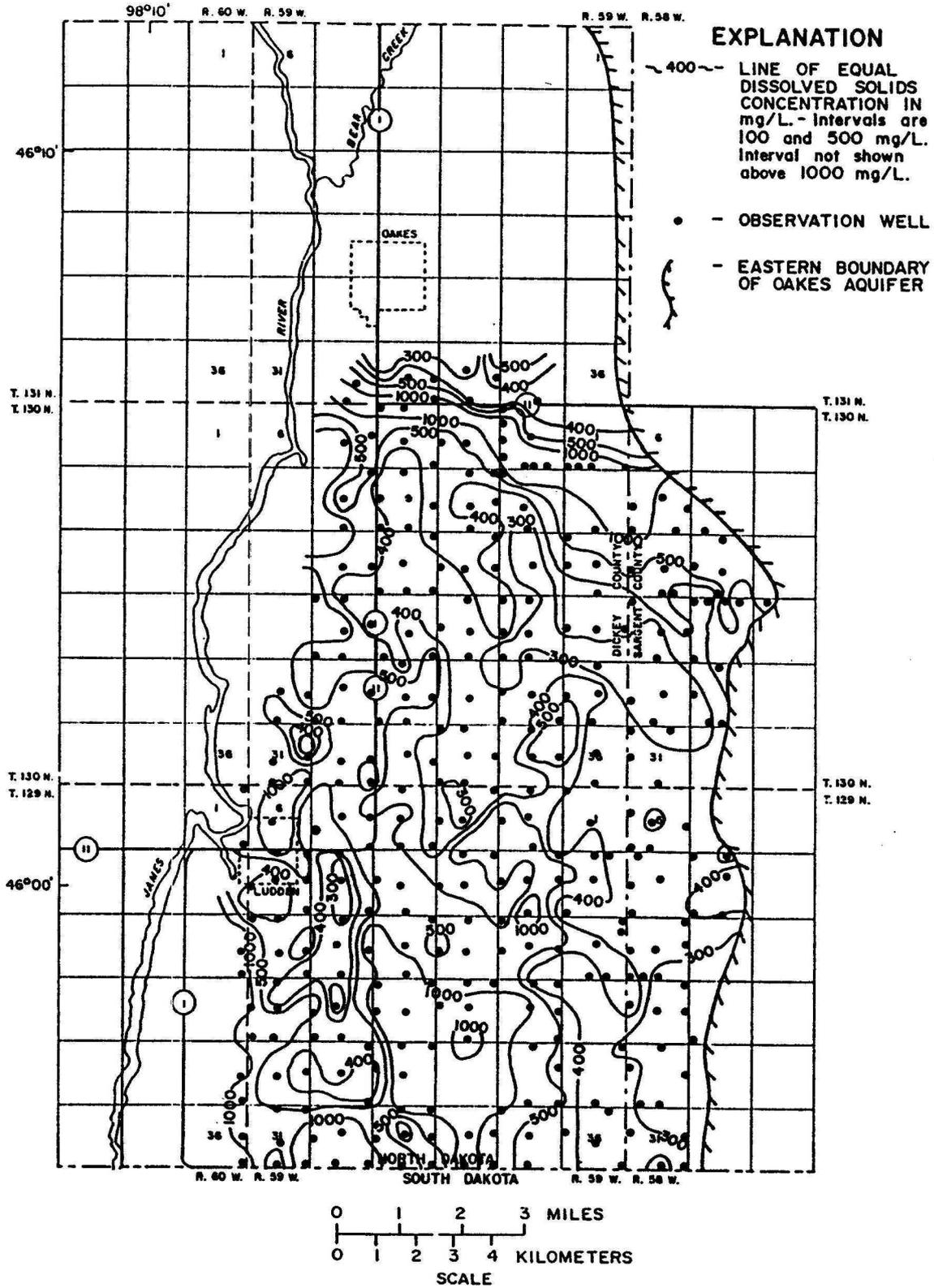


Figure 8.-- Dissolved-solids concentrations of ground water in the Oakes aquifer

EXPLANATION

Total Dissolved Solids
Concentration (In Milligrams
Per Liter)

- — Less Than 400
- — 400 To 2000
- △ — 2000 To 8000
- + — Greater Than 8000

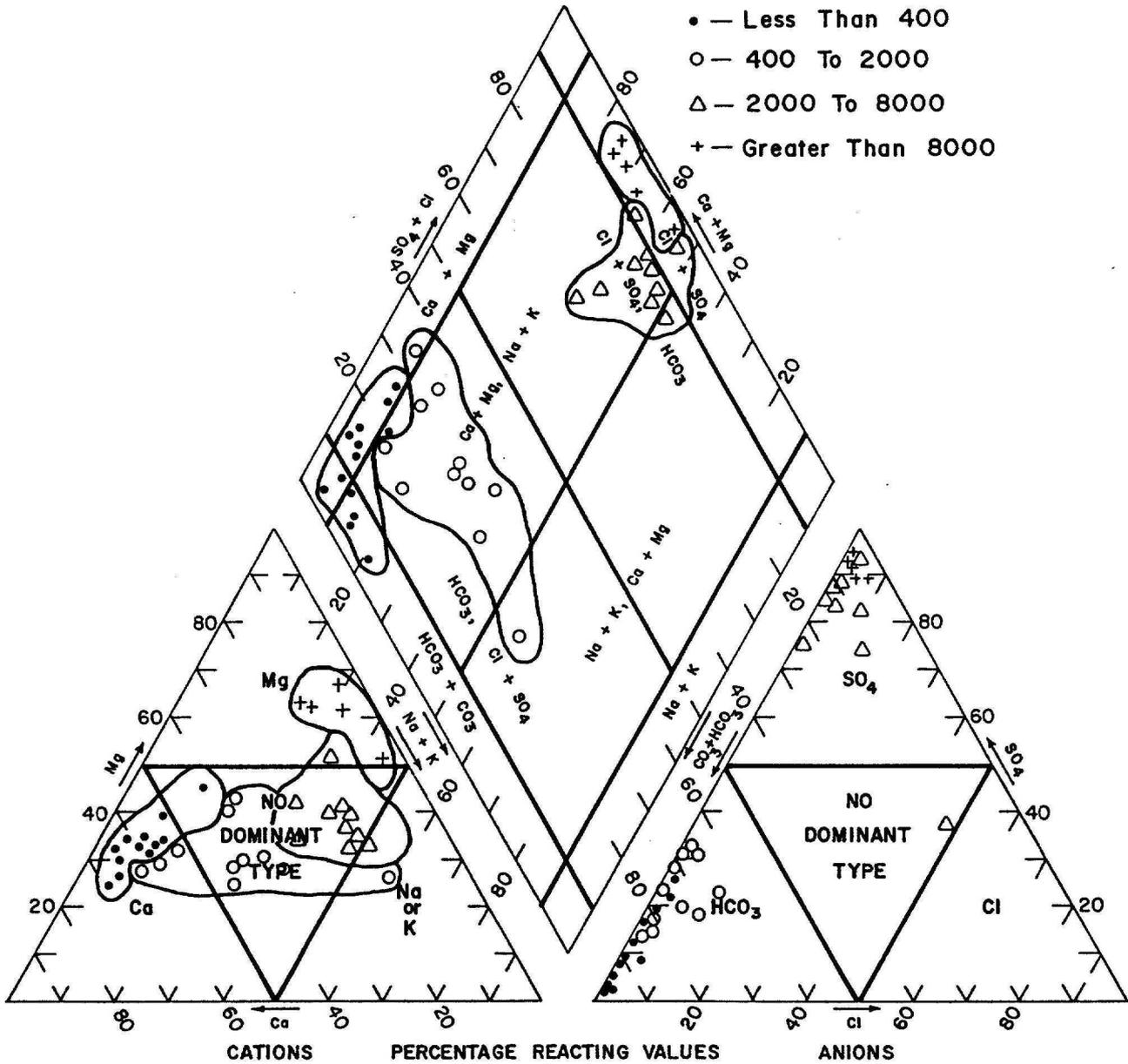


Figure 9.-- Hydrochemical facies of ground water in the Oakes aquifer

EVALUATION AND SELECTION OF WELL FIELD SITES

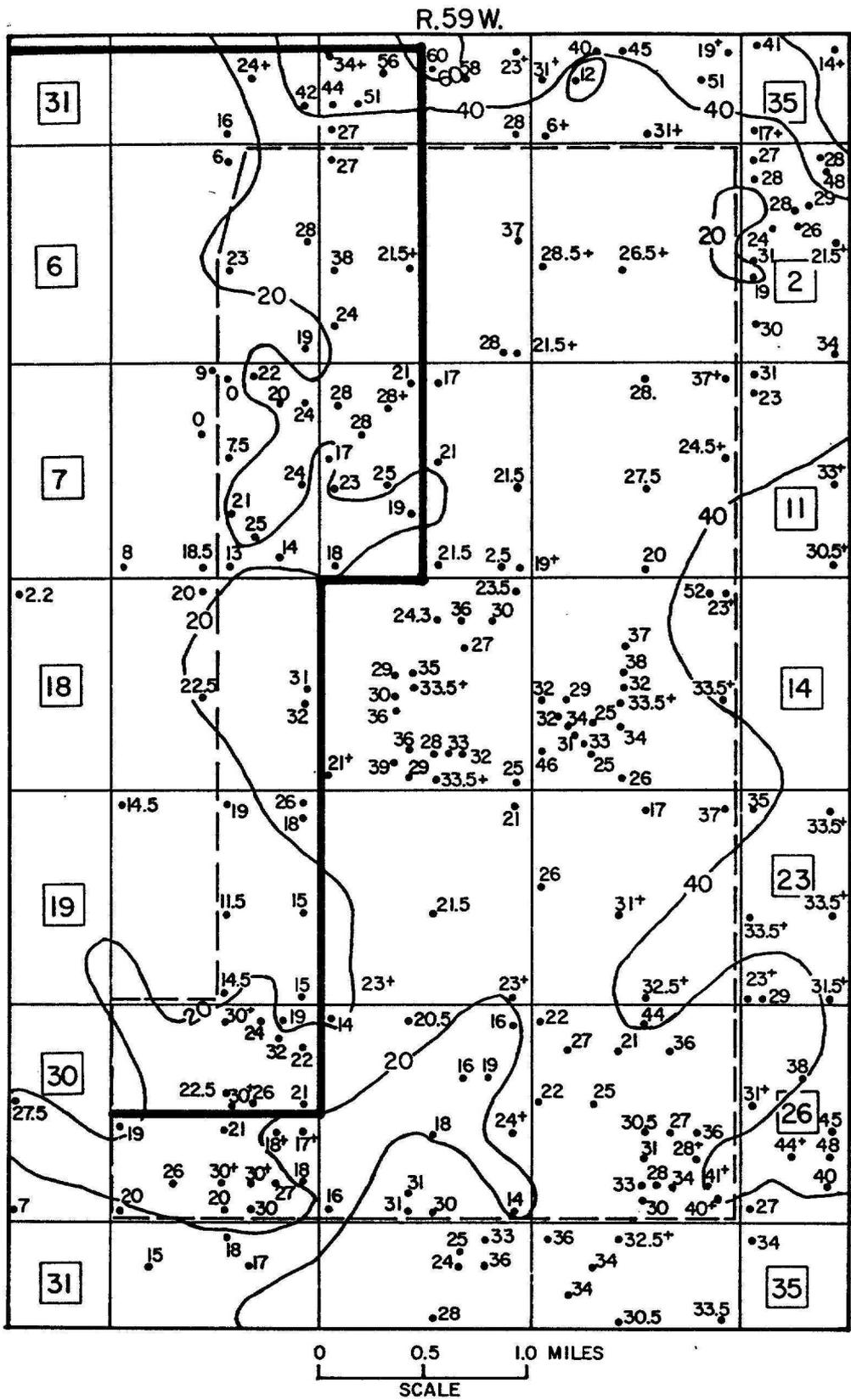
Preliminary selection of well field sites in the 5,000-acre test plot primarily was based upon data from the aquifer thickness map (fig. 10) and well yield map (fig. 7) of the Oakes aquifer. Requirements for selecting a well field site included:

- 1) The site should be within one mile of the distribution canal (lateral 0-2.0) shown in figure 10 to minimize ground-water conveyance facilities and reduce costs.
- 2) Saturated thickness of the Oakes aquifer should be at least 20 feet.
- 3) Estimated individual well yields should be greater than 75 gallons per minute.

Based on the above criteria, Sections 3, 4, and 16, all in Township 130 North, Range 59 West were selected as potential areas to locate well fields. These areas were targeted for additional test drilling, aquifer testing, and water sampling programs.

Section 4, Township 130 North, Range 59 West

Eighty-five test holes were drilled in Section 4, Township 130 North, Range 59 West (fig. 11). Geologic logs of the test holes are found in Appendix I. Twenty-one observation wells (5 at aquifer test site 38+27) were completed at selected test drilling sites. Water samples were collected from 16 observation wells for chemical analysis (Table 2). At 46 drilling sites, saturated zone samples were collected and sent to the U.S. Bureau of Reclamation Laboratory in Harvey, North Dakota, for gradation



T. 131 N.
T. 130 N.

EXPLANATION

- WELL OR TEST HOLE
- 22 • THICKNESS OF SAND AND/OR GRAVEL IN FEET. Plus Sign indicates full thickness of aquifer not penetrated.
- 40- LINE OF EQUAL SAND AND/OR GRAVEL THICKNESS. Interval is 20 feet.
- OAKES IRRIGATION 5,000 ACRE TEST AREA
- ┌ WATER DISTRIBUTION CANAL (LATERAL 0-2.0)
- 18 SECTION NUMBER

Figure 10.-- Thickness of sand and gravel deposits that comprise the Oakes aquifer

TOWNSHIP 130 NORTH, RANGE 59 WEST, SECTION 4

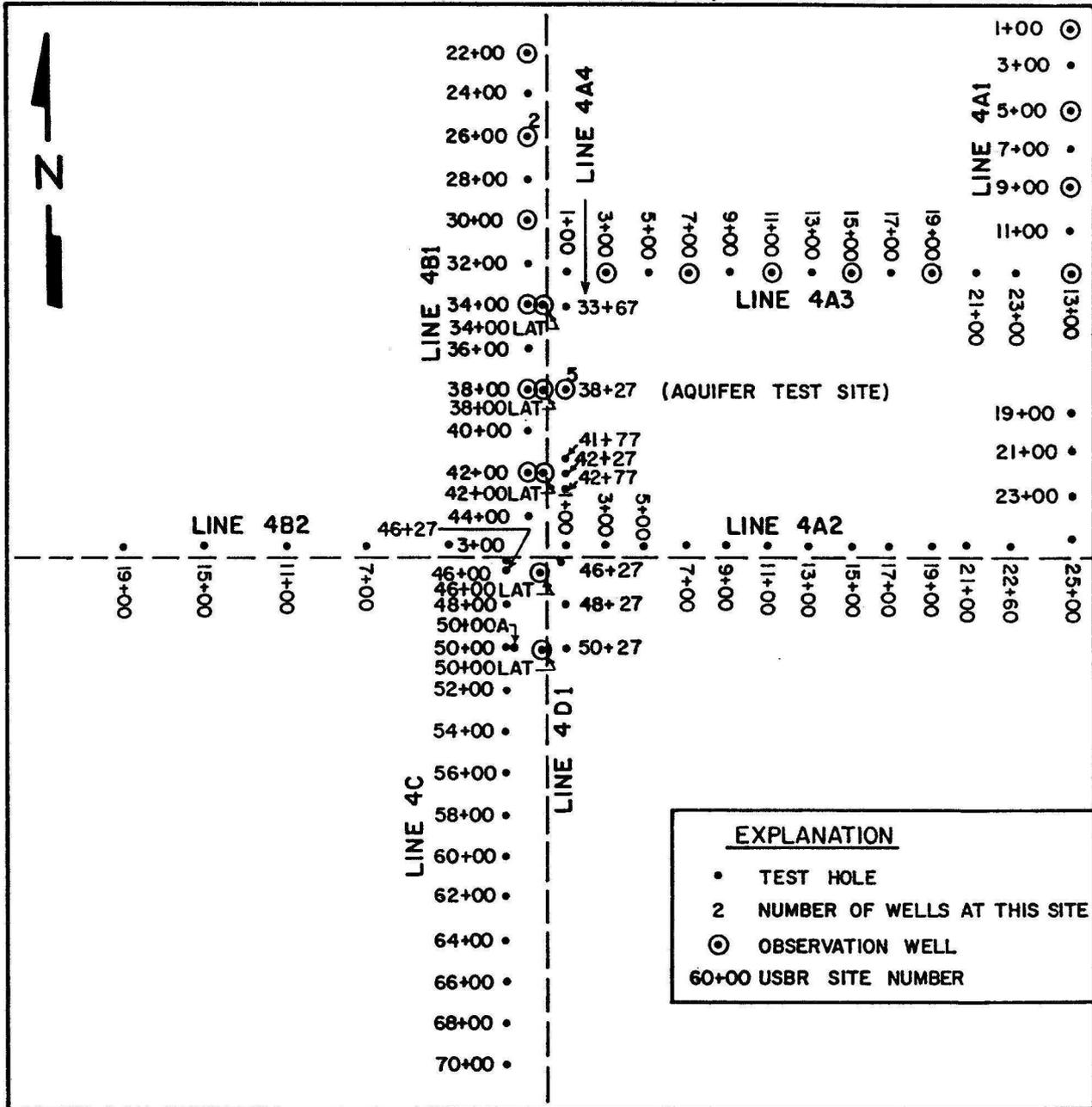


Figure 11.-- Location of test-drilling sites in Section 4, Township 130 North, Range 59 West

Table 2.-- Water chemistry analyses from 16 observation wells completed in Section 4, Township 130 North, Range 59 West

LOCATION	SCREENED INTERVAL (FT)	DATE SAMPLED	------(MILLIGRAMS PER LITER)-----														Hardness as		SAR	Spec Cond (umho)	Temp (°C)	pH		
			SiO ₂	FE	MN	CA	MG	NA	K	HCO ₃	CO ₃	SO ₄	CL	F	NO ₃	B	TDS	CaCO ₃					NCH	
130-059-04AAA1	35-40	12-05-89	29	7.3	1.7	390	130	120	16	572	0	1300	40	0.1	1	0.16	2320	1500	1000	15	1.3	2800	7.7	7.7
130-059-04AAA3	43-48	12-05-89	29	4.8	1.7	340	100	180	17	616	0	1000	37	0.3	1	0.15	2010	1300	760	23	2.2	2580	7.8	7.7
130-059-04AAD4	40-45	12-05-89	29	2.0	0.56	95	54	200	12	504	0	340	67	0.3	1	0.22	1090	460	0	48	4.1	1624	7.8	8.0
130-059-04AAD6	38-43	12-05-89	28	0.06	0.39	77	59	250	12	597	0	350	99	0.4	1	0.41	1170	430	0	55	5.3	1784	8.3	8.0
130-059-04ABC2	33-38	12-04-89	31	1.8	0.36	100	33	54	6	462	0	130	18	0.2	1	0.13	604	390	7	23	1.2	962	8.9	7.2
130-059-04ABD1	44-49	12-04-89	31	2.0	0.25	78	37	87	7	470	0	140	16	0.2	1	0.18	631	350	0	35	2.0	982	8.8	7.4
130-059-04ABD3	42-47	12-04-89	29	2.4	0.32	100	46	150	9	585	0	310	20	0.3	1	0.18	956	440	0	42	3.1	1446	8.6	7.5
130-059-04AAC1	38-43	12-04-89	29	2.4	0.43	120	44	120	8	556	0	270	17	0.2	1	0.16	886	480	25	35	2.4	1306	8.0	7.1
130-059-04AAC3	46-51	12-05-89	28	2.4	0.67	120	61	160	9	600	0	360	34	0.2	1	0.2	1070	550	59	38	3.0	1566	7.6	8.0
130-059-04BAA4	38-43	12-05-89	32	1.2	0.35	56	38	110	8	462	0	150	15	0.2	1	0.16	640	300	0	44	2.8	973	8.8	8.0
130-059-04BAA1	38-43	12-05-89	32	1.7	0.33	60	39	91	8	437	0	150	15	0.2	1	0.15	613	310	0	38	2.2	999	7.7	8.0
130-059-04BAA2	20-25	12-05-89	32	2.0	0.32	52	35	110	8	418	0	170	13	0.3	1	0.13	630	270	0	46	2.9	971	7.6	8.1
130-059-04BAD2	31-36	12-05-89	32	2.4	0.53	110	53	200	9	400	0	580	18	0.2	1	0.1	1200	490	160	46	3.9	1690	7.7	7.9
130-059-04BDA3	32-37	12-12-89	29	1.4	0.45	91	38	55	6	444	0	110	12	0.2	1	0.08	555	350	0	25	1.3	872	7.7	7.3
130-059-04BDA1	35-40	12-12-89	29	1.5	0.49	92	29	60	6	430	0	130	11	0.2	1	0.08	572	350	0	27	1.4	889	7.7	8.0
130-059-04BDD3	30-35	12-12-89	30	0.17	0.63	100	32	44	7	434	0	130	10	0.2	1	0.07	571	380	26	20	1.0	878	8.2	7.0

-----Micrograms Per Liter-----

	Selenium	Lead	Mercury	Strontium	Arsenic	Lithium	Molybdenum
130-059-04 AAA1	0	0	0	1,700	16	160	2
130-059-04 AAA3	0	0	0	1,500	16	180	2
130-059-04 AAD4	1	1	0	610	1	140	7
130-059-04 AAD6	1	1	0	510	2	140	7
130-059-04 ABC2	0	1	0.1	480	3	50	5
130-059-04 ABD1	0	1	0	430	5	80	6
130-059-04 ABD3	0	1	0	560	1	140	5
130-059-04 AAC1	0	1	0	560	4	110	4
130-059-04 AAC3	0	1	0	580	1	140	4
130-059-04 BAA4	0	0	0	380	7	90	5
130-059-04 BAA1	0	0	0	380	7	70	5
130-059-04 BAA2	0	0	0	330	6	80	5
130-059-04 BAD2	0	0	0	520	3	90	4
130-059-04 BDA3	0	0	0	430	12	50	4
130-059-04 BDA1	0	0	0	440	12	50	4
130-059-04 BDD3	0	0	0	460	7	40	5

analysis. Graphs for each sample gradation analysis, showing percent passing versus grain-size diameter are found in Appendix II.

Saturated Thickness

The saturated thickness of the Oakes aquifer in Section 4 ranges from 5 to 44 feet (fig. 12). The largest saturated thickness occurs along the center and SE1/4 of the NE1/4 of Section 4. To the south in Section 4, the Oakes aquifer is thinner and is finer textured.

In the N1/2 N1/2 of Section 4, the Oakes aquifer also is thinner because the aquifer is overlain by a fluvial silt and clay layer up to 30 feet thick. In this area the Oakes aquifer is confined. The confining silt and clay layer is the northwest part of the surface to near surface fluvial silt and clay deposits shown in figure 5.

Water Quality

Based on texture and saturated thickness, the best potential for a well field is along an east-west line in the center of the NE1/4 of Section 4 (line 4A3, fig. 11). This line of test holes, however, is close to the southern flank of a subtle land-surface topographic low area underlain with ground-water characterized by large dissolved-solids concentrations. (fig. 13). Field electrical conductivity, which is directly proportional to dissolved-solids concentration, was measured at 43 test hole and observation

TOWNSHIP 130 NORTH, RANGE 59 WEST, SECTION 4

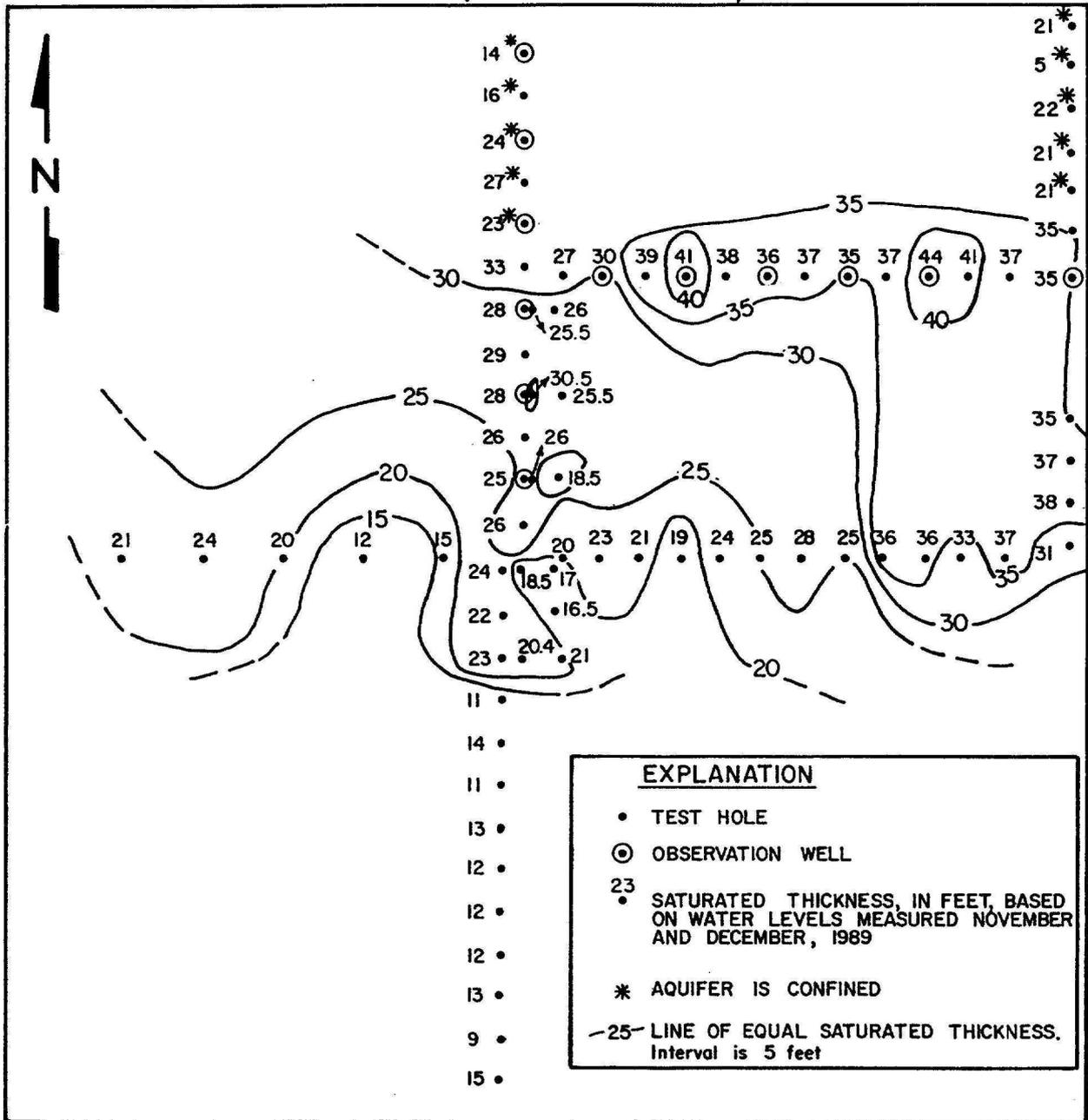
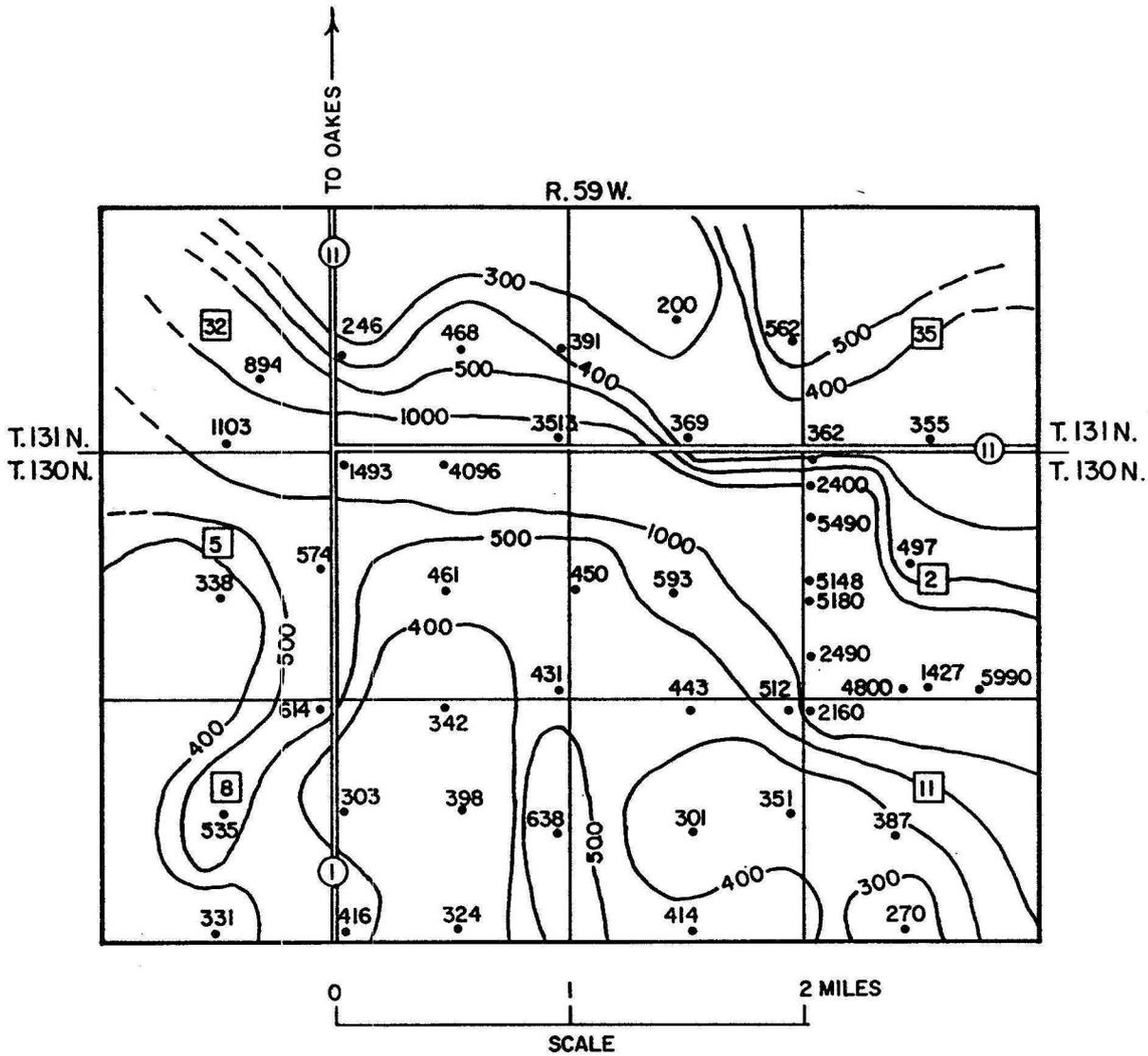


Figure 12.-- Saturated thickness of the Oakes aquifer in Section 4, Township 130 North, Range 59 West



EXPLANATION

- 461 DISSOLVED SOLIDS (CALCULATED)
- OBSERVATION WELL
- 400 - LINE OF EQUAL DISSOLVED-SOLIDS CONCENTRATION IN MILLIGRAMS PER LITER. Intervals 100 and 500 mg/L. No interval shown for concentrations in excess of 1000 mg/L.
- 35 SECTION NUMBER

Figure 13.-- Distribution of dissolved solids for ground water in and near Section 4, Township 130 North, Range 59 West

well sites (fig. 14). Temporary observation wells were installed at U.S. Bureau of Reclamation test-hole sites to measure electrical conductivity. The large electrical-conductivity values are associated with the southern flank of the land-surface topographic low area.

Chemical analyses were performed on samples collected from the 16 observation wells shown in figure 14. The ground water is a mixed cation type with anionic composition ranging between a bicarbonate and sulfate type (fig. 15). In general, absolute and relative sulfate concentration increase with increased dissolved solids.

Sodium adsorption ratio and field conductance measured from samples collected from the above 16 observation wells were plotted on a U.S. Department of Agriculture irrigation classification diagram (fig. 16, U.S. Department of Agriculture, 1954). The ground water poses a low sodium hazard and a high to very high salinity hazard. The soils to be irrigated in the 5,000-acre test plot consist predominantly of Hecla, Ulen, and Arveson soil series. These are well-drained, light-textured soils. With proper management practices, application of ground water with dissolved-solids concentrations of less than 2,000 mg/L should not pose a salinity problem in these soils. To avoid capturing significant quantities of relatively high salinity, (>2,000 mg/L dissolved solids) ground water located in the N1/2 NE1/4 of Section 4, the well field should be located

TOWNSHIP 130 NORTH, RANGE 59 WEST, SECTION 4

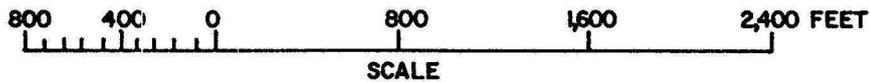
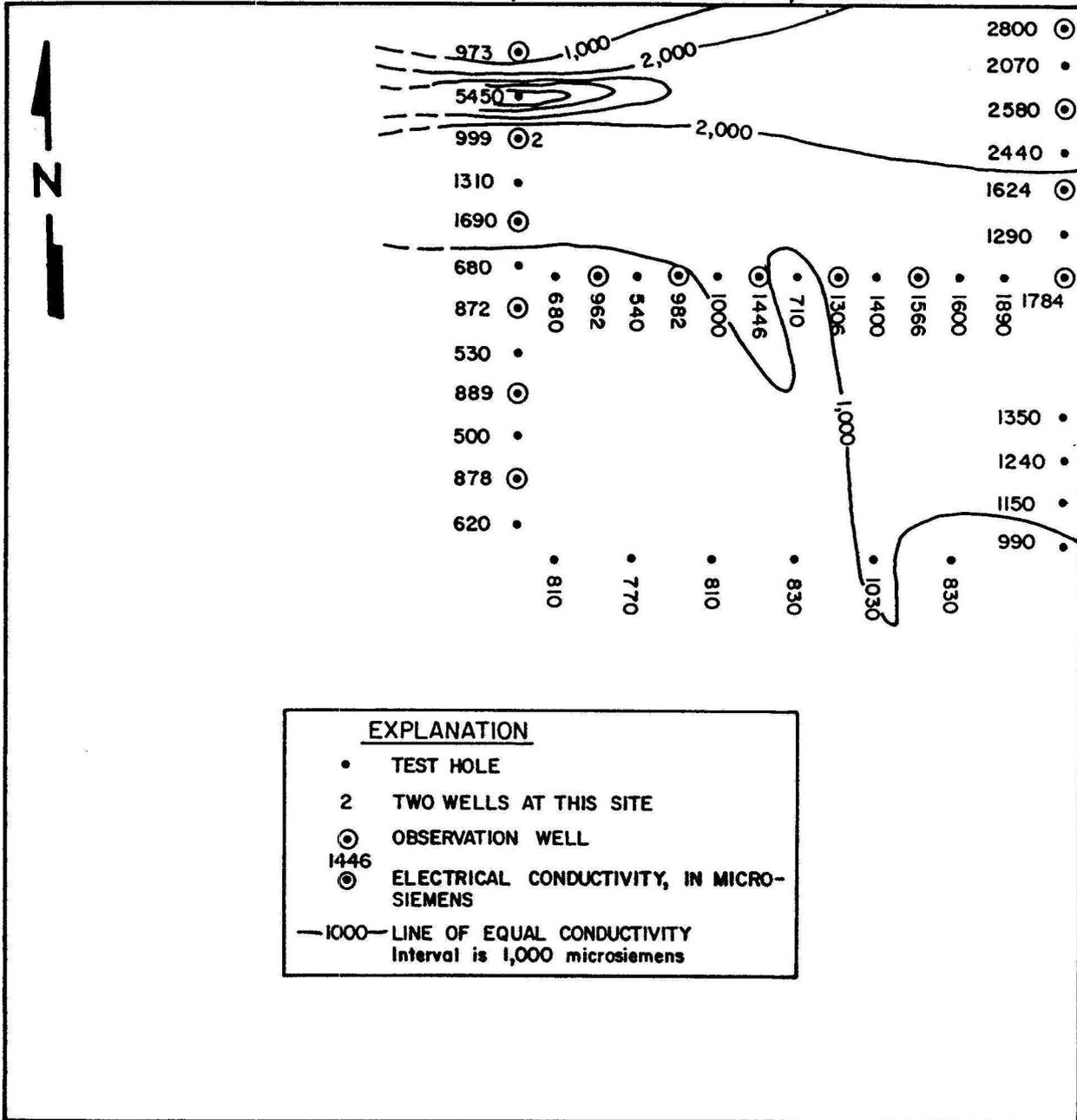


Figure 14.-- Distribution of ground-water electrical conductivity in the NE1/4 of Section 4, Township 130 North, Range 59 West

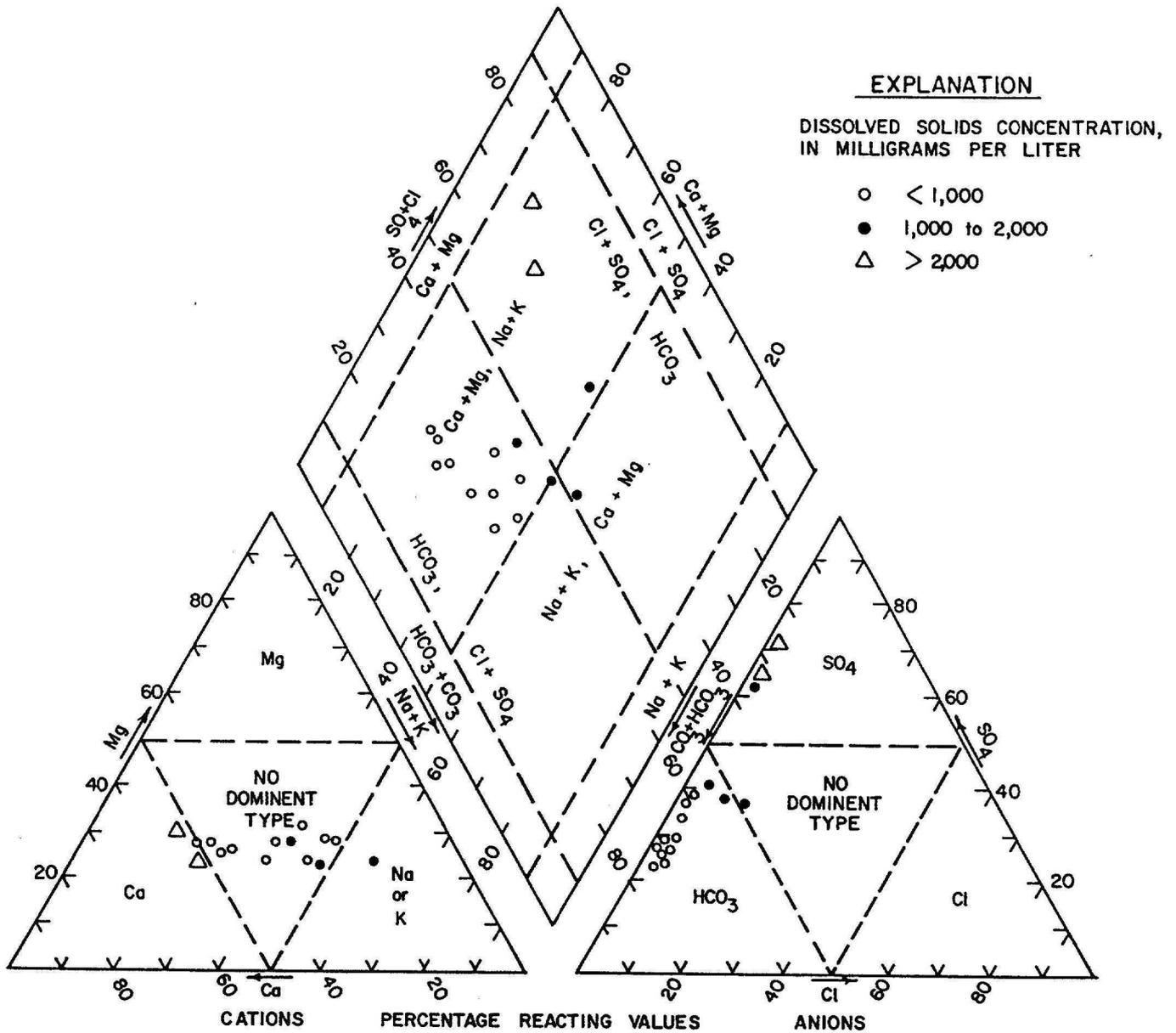


Figure 15.-- Hydrochemical facies of ground water in the NE1/4 of Section 4, Township 130 North, Range 59 West

IRRIGATION CLASSIFICATION

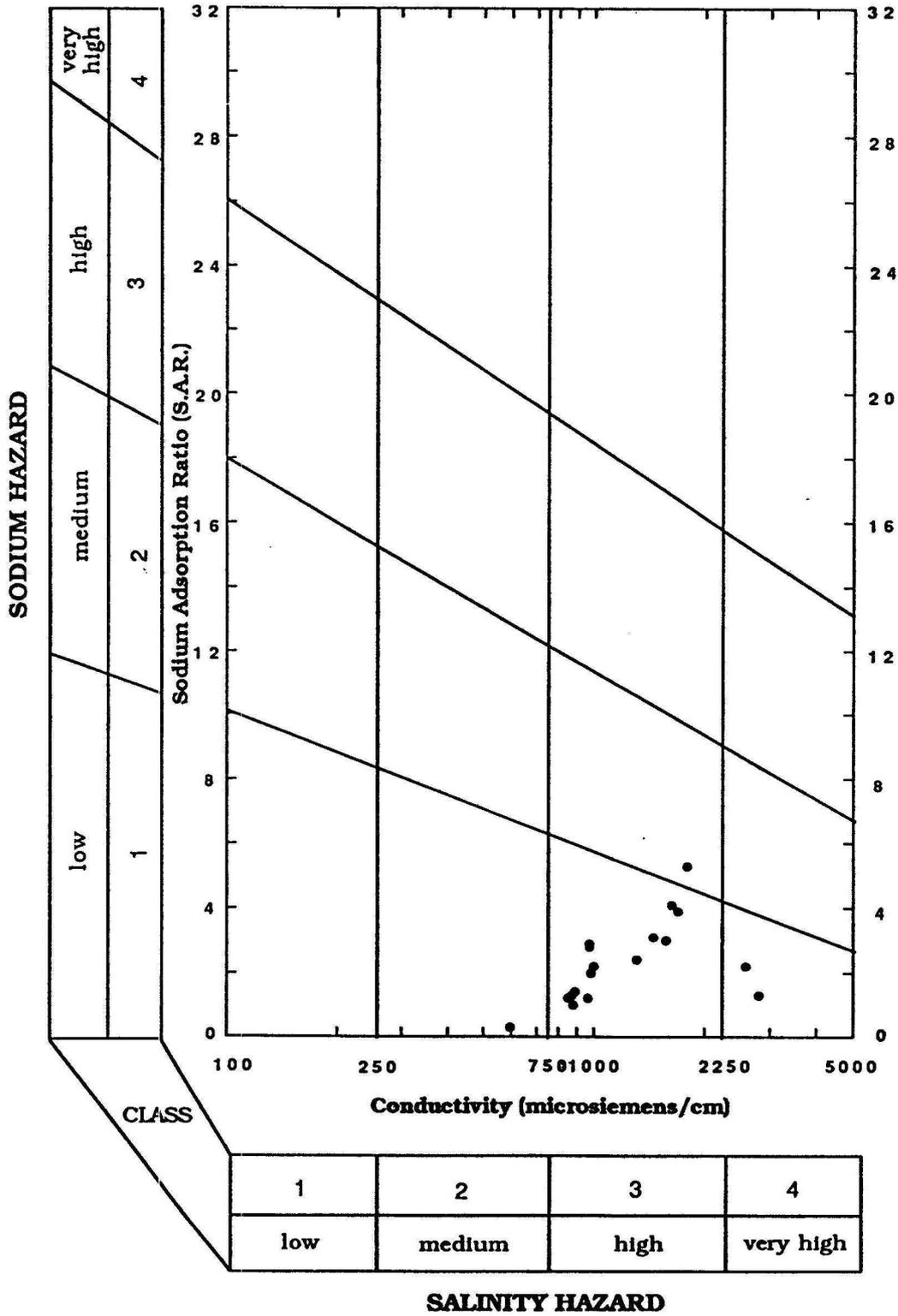


Figure 16.-- Salinity and sodium hazard for ground water in the NE1/4 of Section 4, Township 130 North, Range 59 West

further south along lines 4A2, 4B1 and the north part of line 4C (fig. 11).

Hydraulic Properties - Aquifer Test Site 38+27

Based on test drilling data along lines 4C and 4B1, an aquifer test site was selected at 38+00 (fig. 11), west of the distribution canal (lateral 0-2.0). The Bureau of Reclamation was unable to obtain an easement at this site and as a result the test site was moved about 150 feet to the east on the east side of the distribution canal (fig. 11, line 4A4, site #38+27). The locations of the production well and observation wells are shown in figure 17. A geohydrologic section showing the production well and the five closest observation wells is shown in figure 18. At this test site, the Oakes aquifer is unconfined with an average saturated thickness of about 28 feet. The aquifer is comprised of sand and gravel underlain by greenish-gray silty clay.

Nine feet of 8-inch diameter, pipe size, stainless steel, High Q, Johnson screen was installed in the production well from 30.5 to 39.5 feet below land surface. Number 45 slot (0.045 inch) was set from 30.5 to 35.5 feet and number 25 slot (0.025 inch) was set from 35.5 to 39.5 feet. The well casing was 8-inch diameter PVC.

The production well was pumped continuously at a fairly constant rate of 300 gallons per minute for 3,000 minutes (50 hours) from 9:00 a.m. December 5 to 11:00 a.m. December 7, 1989. Production-well discharge was measured continuously

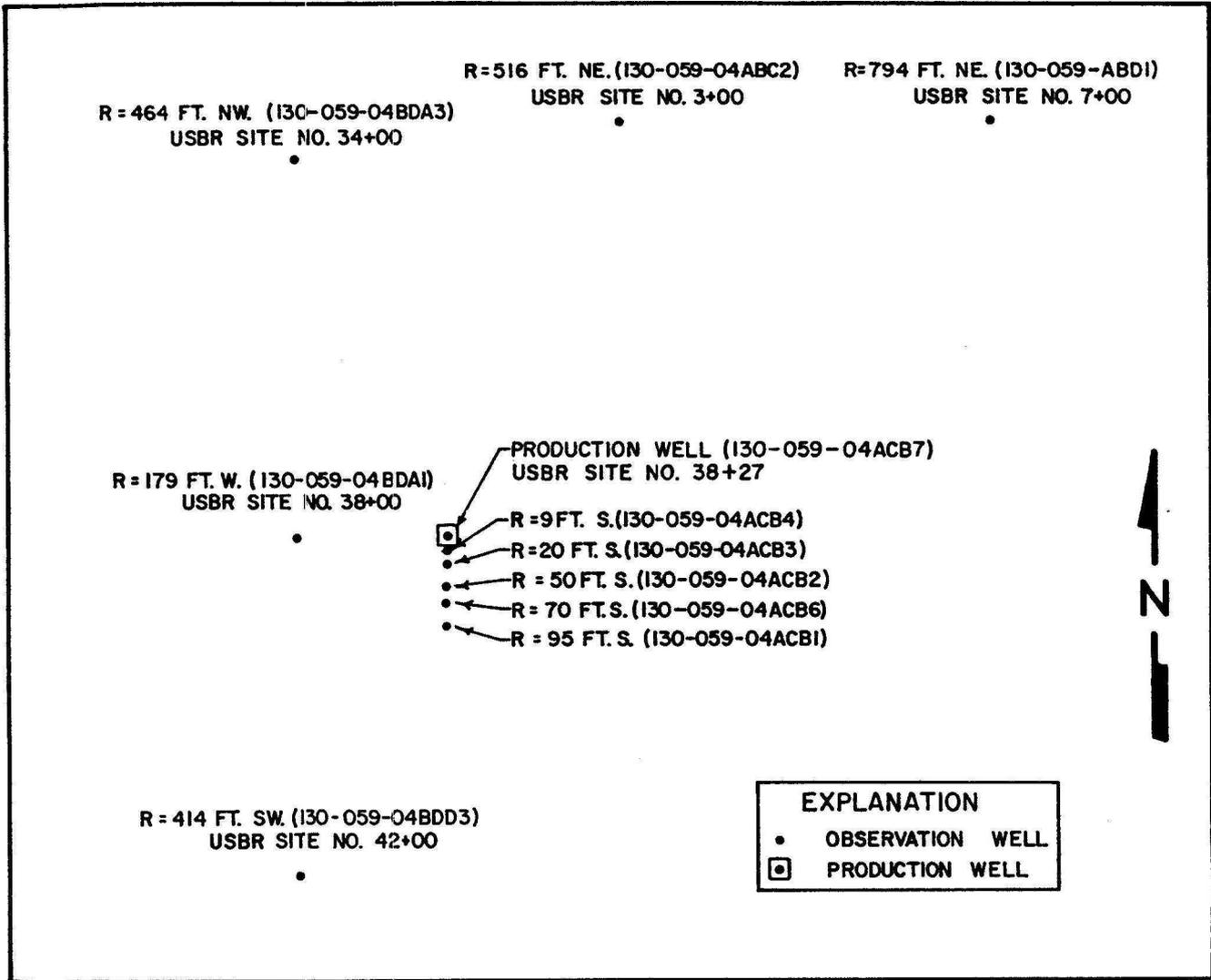


Figure 17.-- Location of production well and observation wells at aquifer-test site No. 38+27

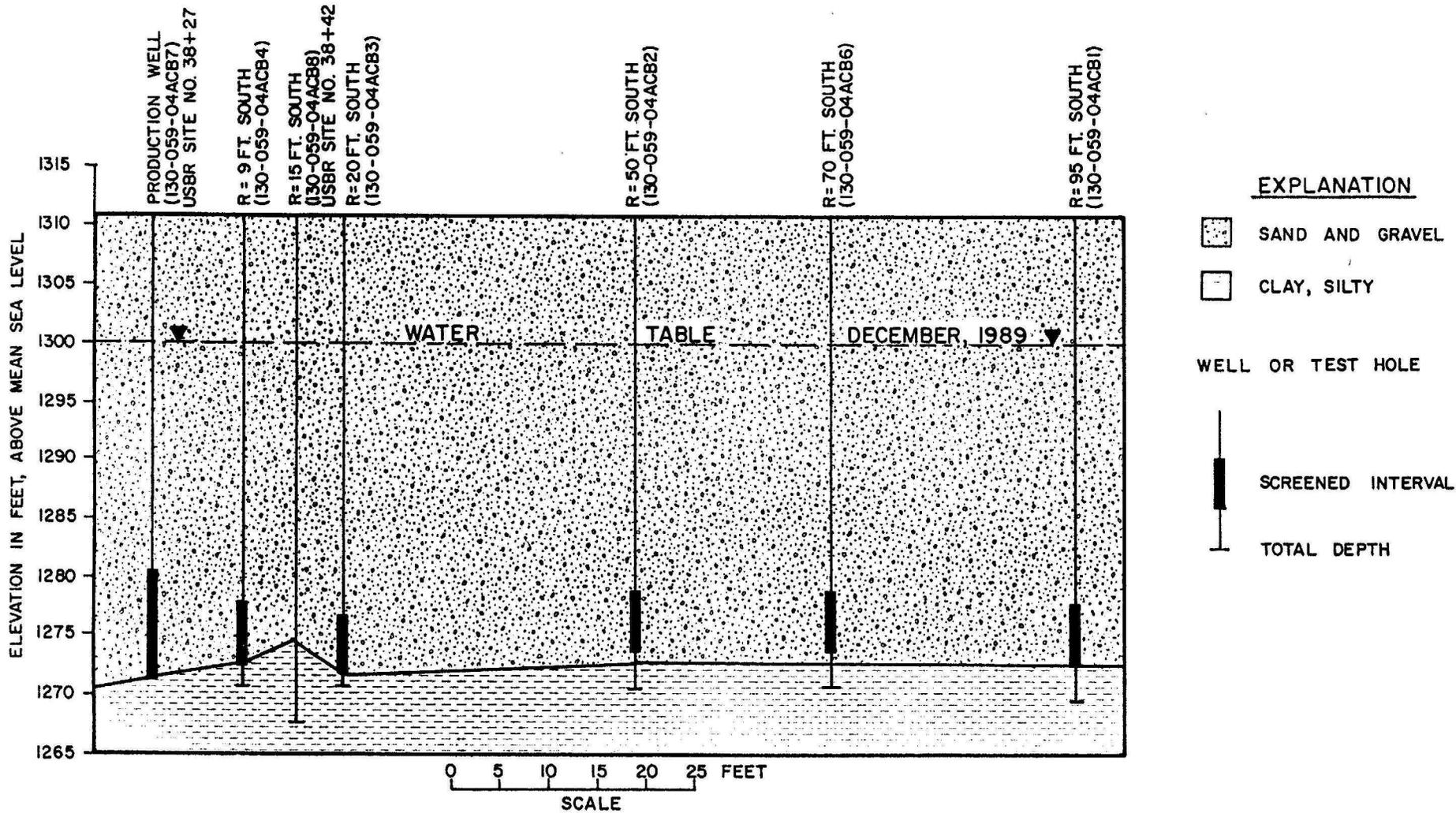


Figure 18.-- Geohydrologic section showing the Oakes aquifer at aquifer-test site No. 38+27

using a Panametrics Model 6069 ultra-sonic flowmeter (± 2 percent accuracy). The semi-log time versus drawdown plot of the production well indicates a fluctuating pumping rate for a short time at about 110 minutes and near the end of the test (fig. 19). The pumping rate fluctuated near the end of the test because the pumping level in the well approached the pump intake. As a result, the test was terminated after 50 hours of pumping. The specific capacity of the production well after 3,000 minutes of pumping was 13.2 gallons per minute per foot.

Water levels in the production well and 10 observation wells were monitored during the aquifer test using chalked steel tapes and a Keck water level sensor coupled to a Stevens Type F water level recorder. Drawdown data for each well were corrected using the method of Jacob (1963), to account for aquifer dewatering (decreasing transmissivity with time).

The drawdown data from observation wells at radii of 9, 20, 50, 70, 95, and 179 feet were plotted on a log time divided by radius squared (t/r^2) versus log drawdown graph (fig. 20). The composite t/r^2 versus drawdown graph shows a typical response of an unconfined aquifer. During early time, the individual data curves are separated and are characterized by relatively small slopes. This is caused by delayed yield from gravity drainage. At later times, some data curves ($r = 50, 70, \text{ and } 95 \text{ ft.}$) begin to merge indicating the affects of delayed yield from gravity drainage

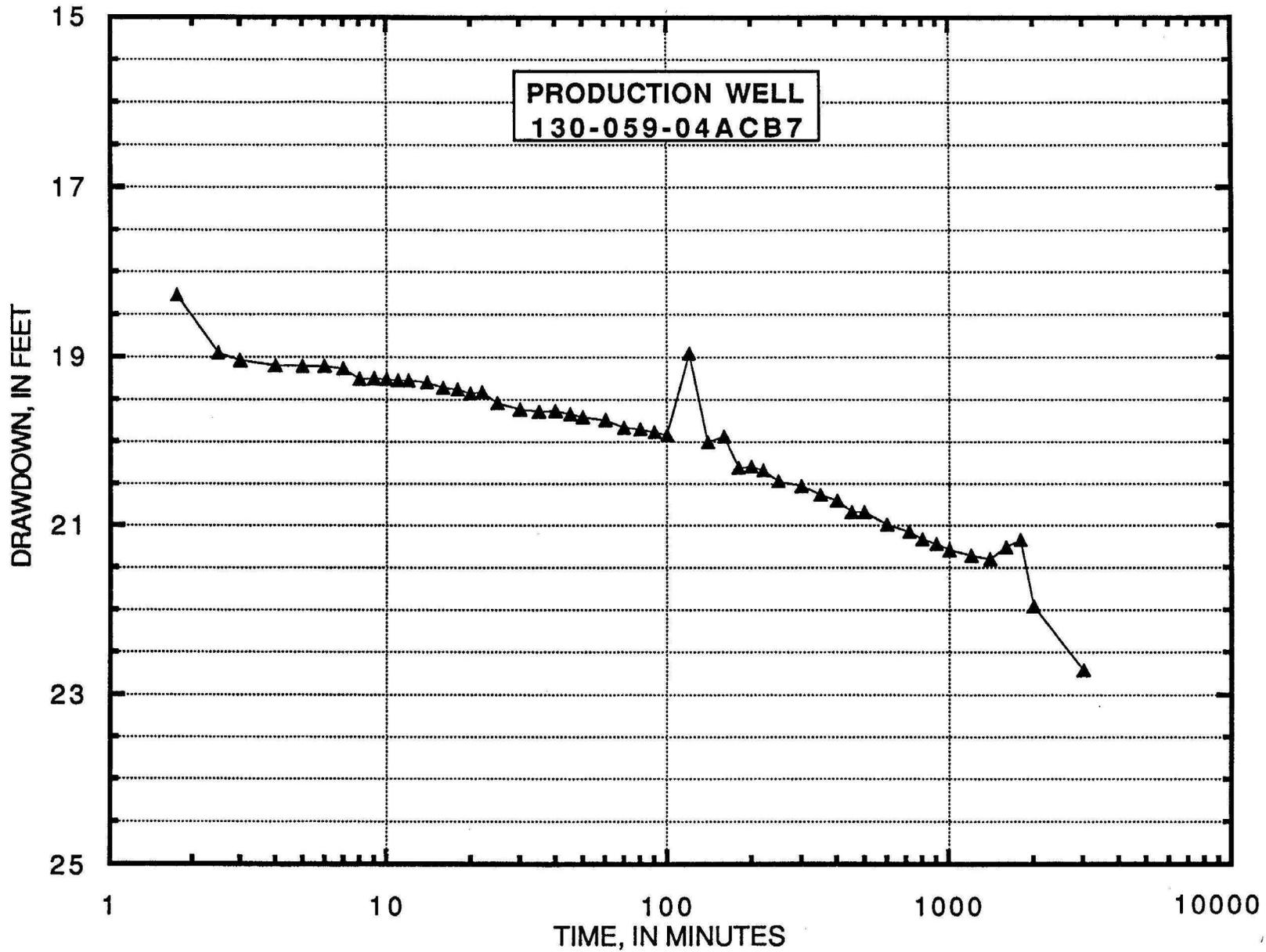


Figure 19.-- Logarithmic time versus arithmetic drawdown for production well at aquifer-test site No. 38+27

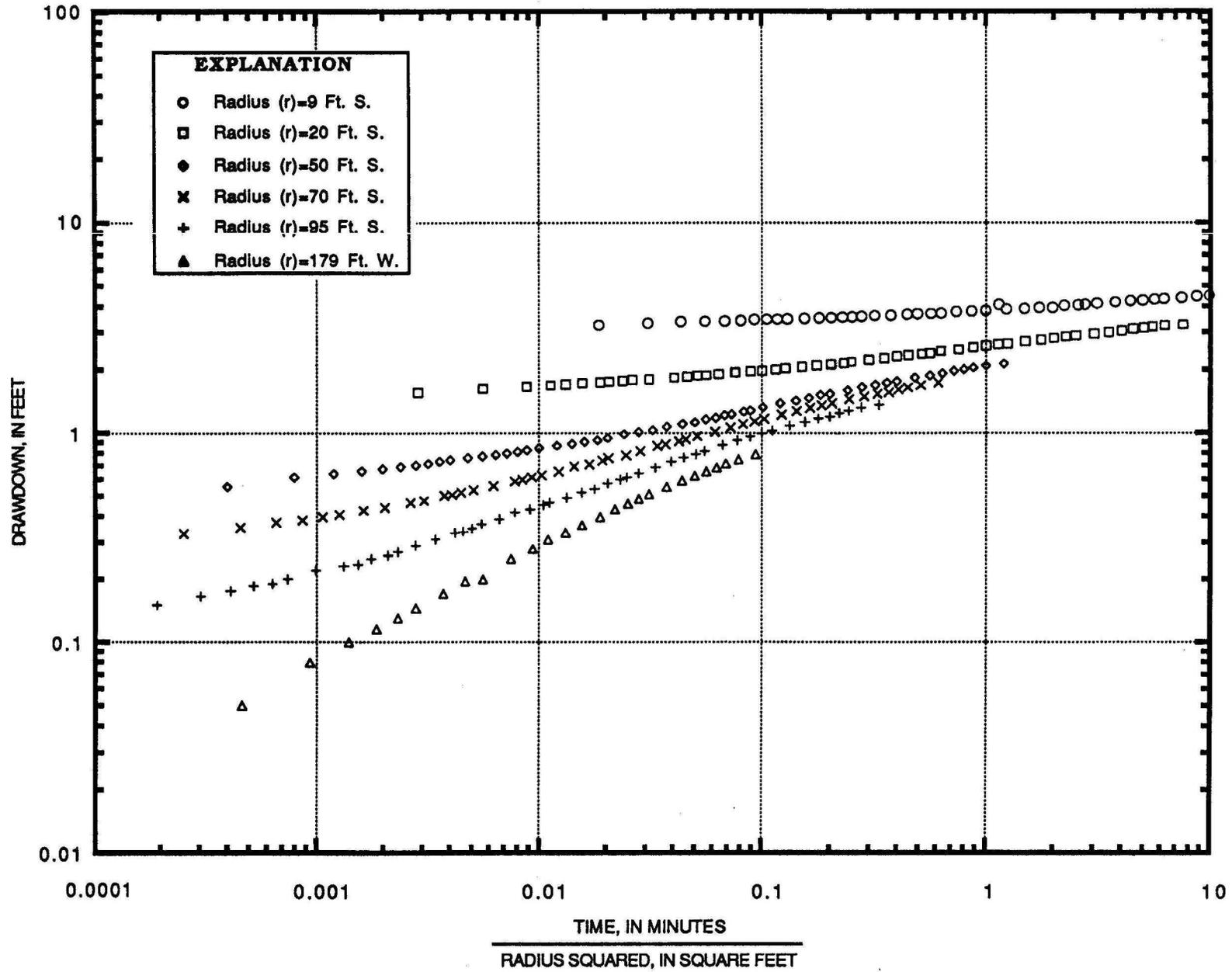


Figure 20.-- Logarithmic composite t/r^2 versus drawdown plot at aquifer-test site 38+27

are negligible and the Theis assumptions are valid. The data curves from observation wells at radii of 9 and 20 feet do not merge with the other data curves because of the affects of partial penetration.

The methods of Theis and Jacob (both in Lohman, 1972) using time versus drawdown analysis were not used to calculate aquifer coefficients because the test was not run for a sufficient length of time after the effects of delayed yield had dissipated. The Theis log distance versus log drawdown graphical analytical method was selected to calculate aquifer coefficients (fig. 21). A transmissivity of 8,360 feet squared per day and an apparent specific yield of 0.34 were calculated using this method. Based on an average saturated thickness of about 28 feet, an average hydraulic conductivity of 300 feet per day was calculated. An apparent specific yield of 0.34 is large particularly for a relatively short duration test in which the water table fluctuated in a very fine to fine sand. For design purposes, an apparent specific yield of 0.25 is deemed more appropriate.

Section 16, Township 130 North, Range 59 West

Sixty-one test holes were drilled in Section 16, Township 130 North, Range 59 West (fig. 22). Geologic logs of these test holes are found in Appendix I. Four observation wells were completed at aquifer test site 229+00. At 39 drilling sites, saturated zone samples were collected and sent to the U.S. Bureau of Reclamation Laboratory in

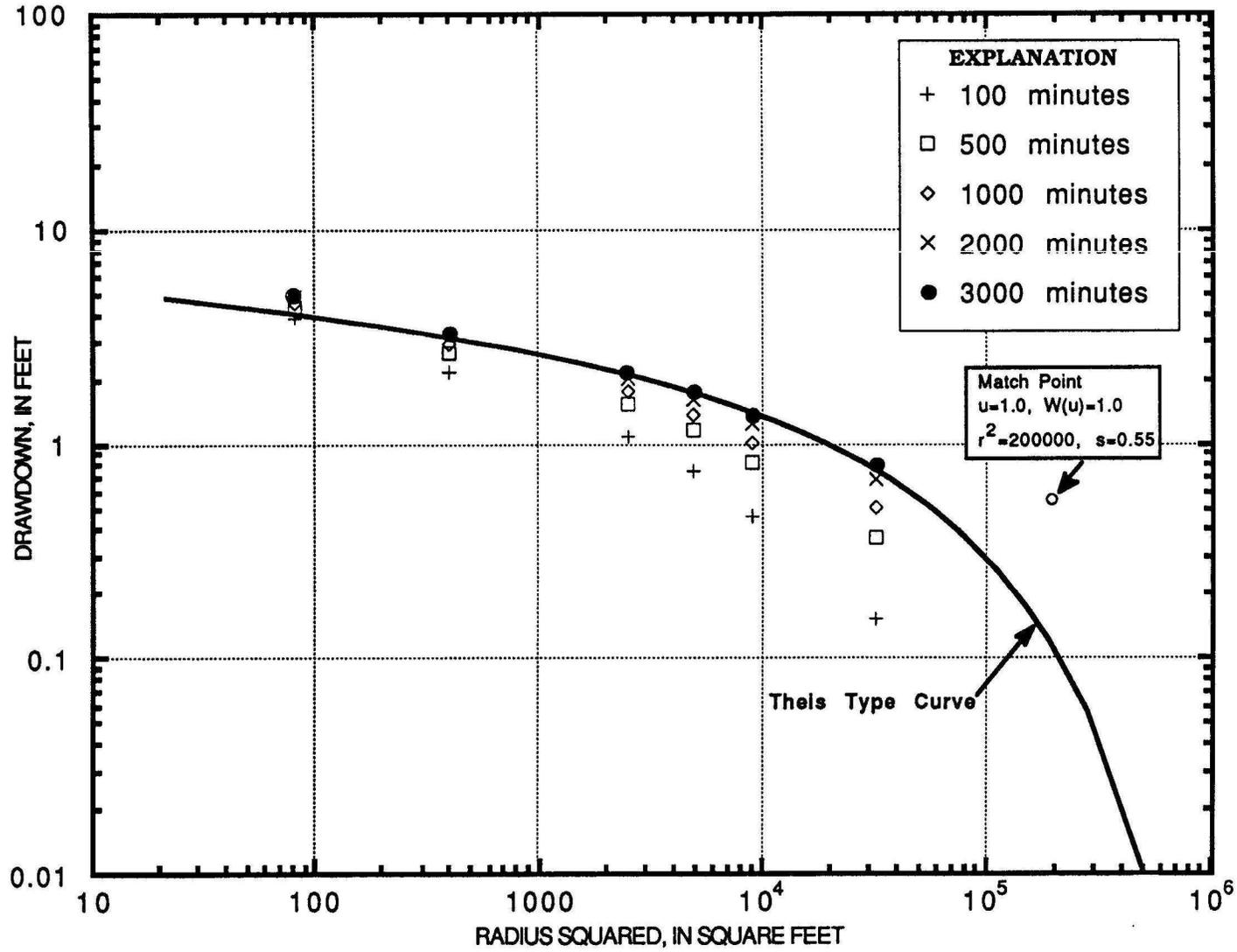


Figure 21.-- Logarithmic distance squared versus drawdown plot at aquifer-test site 38+27

TOWNSHIP 130 NORTH, RANGE 59 WEST, SECTION 16

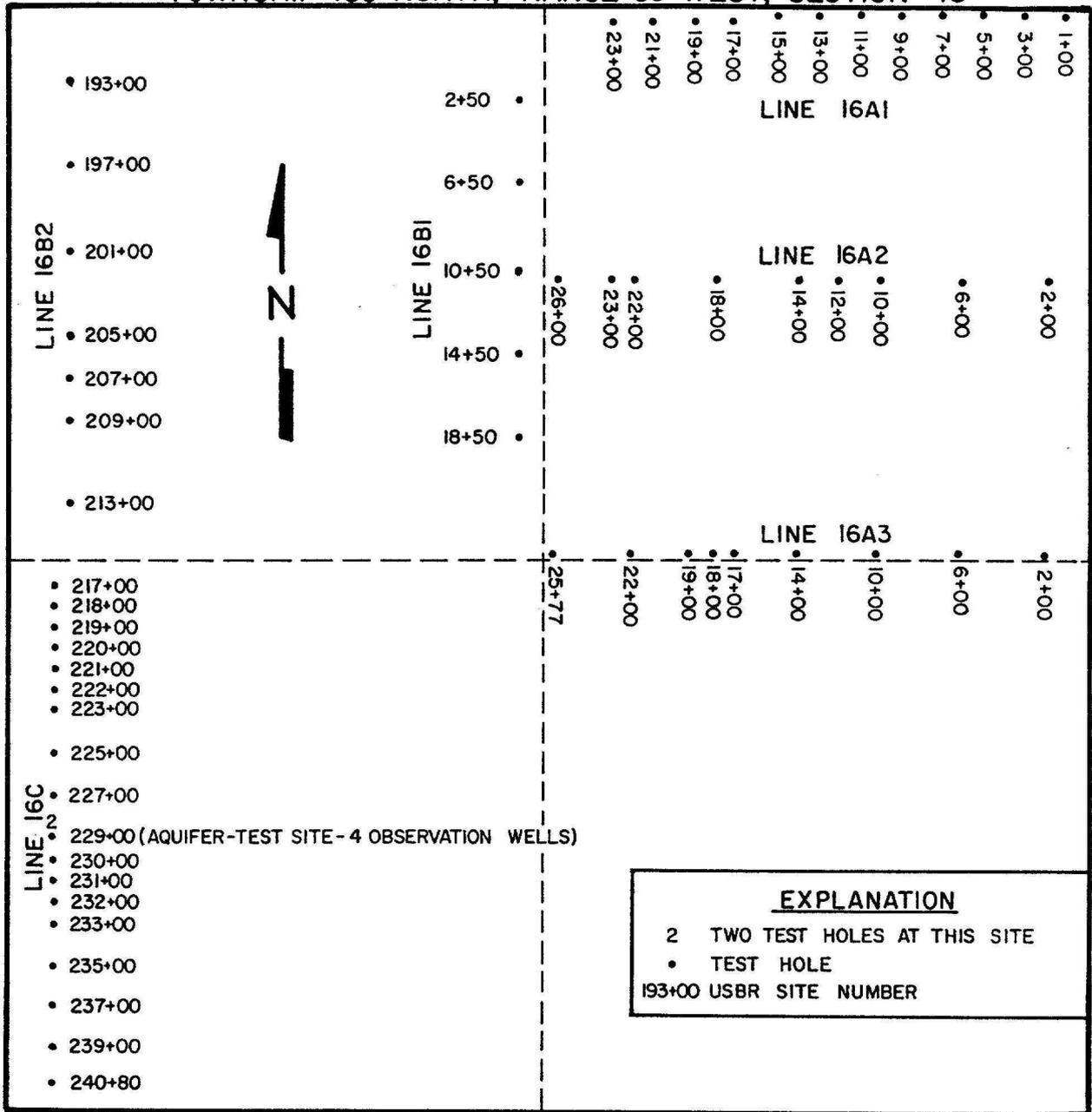


Figure 22.-- Location of test-drilling sites in Section 16, Township 130 North, Range 59 West

Harvey, North Dakota for gradation analysis. Graphs for each sample gradation analysis showing percent passing versus grain-size diameter are found in Appendix II.

Saturated Thickness

The saturated thickness of the Oakes aquifer in Section 16 ranges from 8 to 26 feet (fig. 23). Saturated thicknesses greater than 20 feet occur along drilling lines 16A1, 16A2, 16A3, and 16C. At test hole sites with a saturated thickness greater than 20 feet along line 16A1, the basal aquifer lithologies are comprised of very fine to fine silty sand. The increased saturated thickness in this area is offset by the fine texture (low transmissivity) of the basal lithologies thereby reducing individual well yields.

Initially, test holes were drilled using a 400-foot spacing along line 16C. Preliminary evaluation indicated two areas along line 16C, near sites 219+00 and 229+00 with potential for individual well yields of at least 100 gallons per minute.

Water Quality

Except for aquifer-test site 229+00, no observation wells were completed at test-drilling sites in Section 16. The U.S. Bureau of Reclamation has completed numerous observation wells in and near Section 16. Water samples for chemical analysis have been collected periodically by the U.S. Bureau of Reclamation. The water quality in and near Section 16 is relatively uniform with dissolved-solids concentrations ranging between 300 and 599 mg/L (fig. 8).

TOWNSHIP 130 NORTH, RANGE 59 WEST, SECTION 16

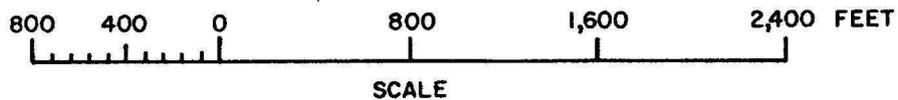
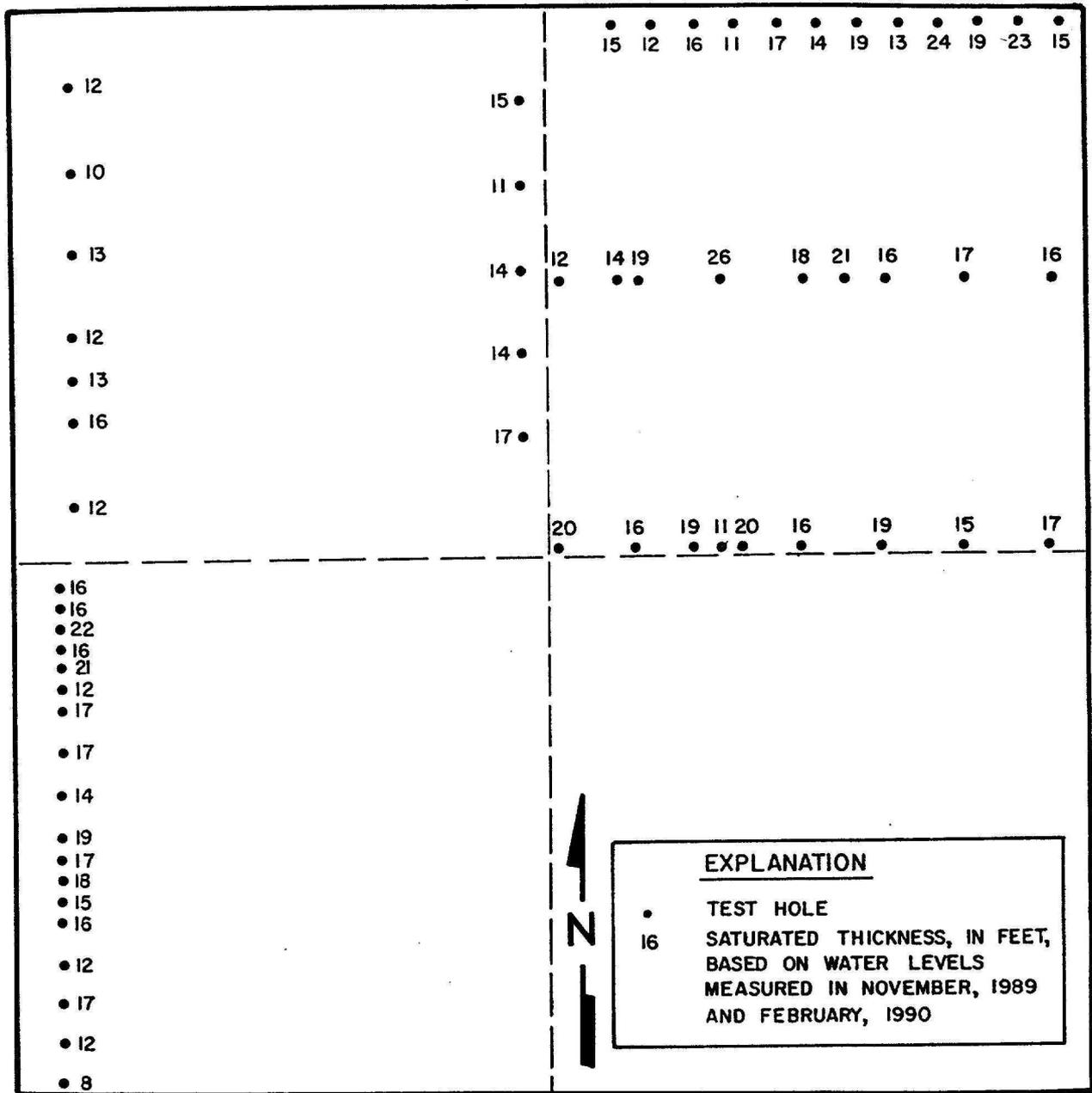


Figure 23.-- Saturated thickness of the Oakes aquifer in Section 16, Township 130 North, Range 59 West

The water is a calcium-magnesium-bicarbonate type and does not pose a boron, sodium or salinity hazard for irrigation applications.

Hydraulic Properties - Aquifer Test Site 229+00

An aquifer test site was selected at 229+00 (fig. 22). The locations of the production well and observation wells are shown in figure 24. A geohydrologic section showing the production well, four observation wells, and two test holes is shown in figure 25. At this test site, the Oakes aquifer is unconfined with an average saturated thickness of about 19 feet. The aquifer is comprised of slightly gravelly sand underlain by till.

Nine feet of 8-inch diameter, pipe size, stainless steel, High Q, Johnson screen was installed in the production well from 26 to 35 feet below land surface. Number 20 slot (0.020 inch) was set from 26 to 30 feet and number 12 slot (0.012 inch) was set from 30 to 35 feet. The well casing was 8-inch diameter PVC.

The production well was pumped continuously at a constant rate of 50 gallons per minute for 2,360 minutes (39.3 hours) from 9:00 a.m., December 1, 1989 to 12:20 a.m., December 3, 1989. Production-well discharge was measured continuously using a Panametrics Model 6068 ultra-sonic flowmeter (± 2 percent accuracy). A fan belt broke on the generator engine used to power the submersible pump, thereby terminating the test at 12:20 A.M. on December 3, 1989. The

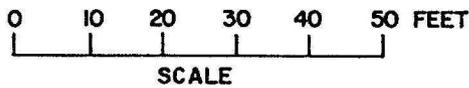
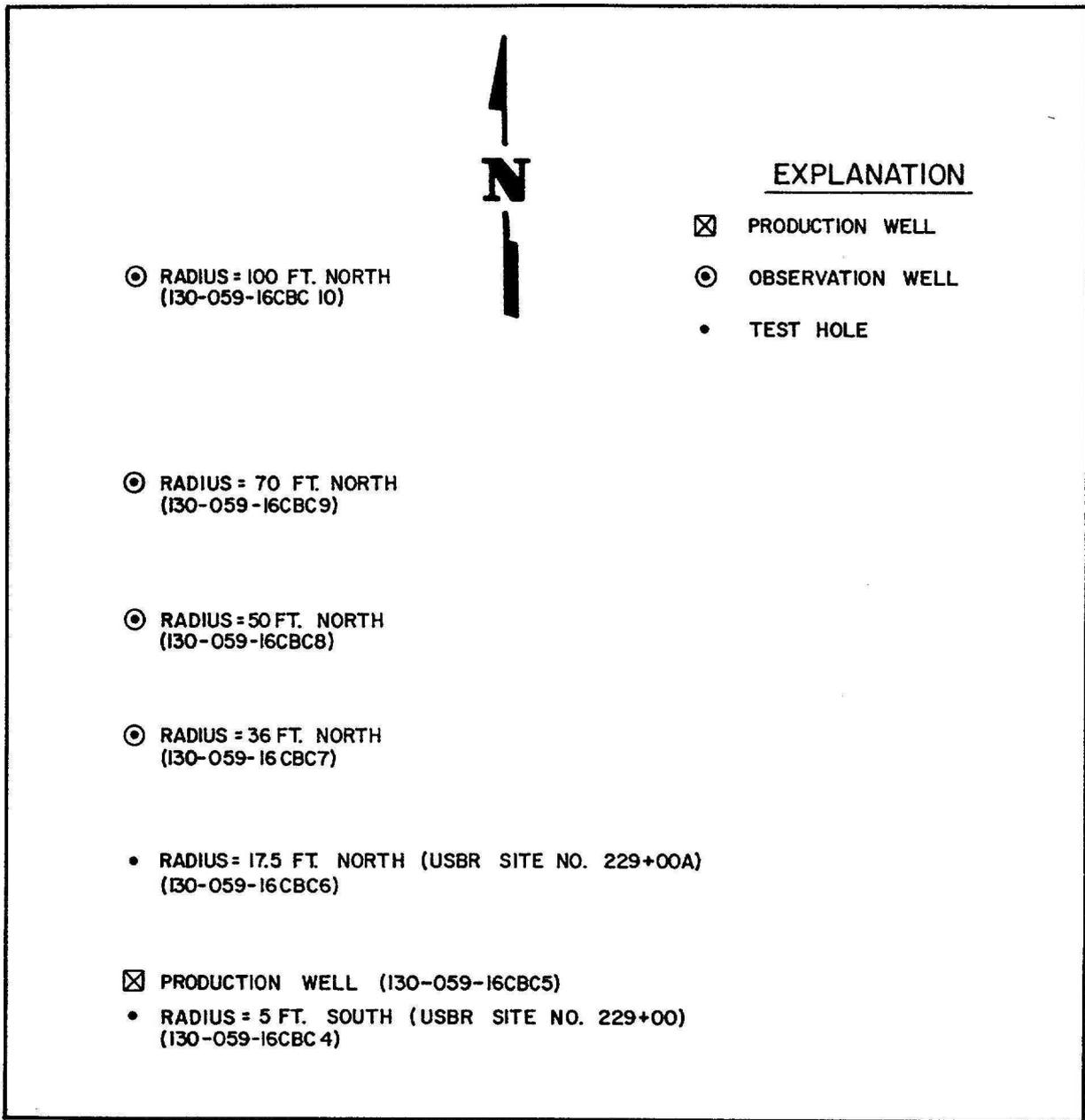


Figure 24.-- Location of production well and observation wells at aquifer-test site No. 229+00

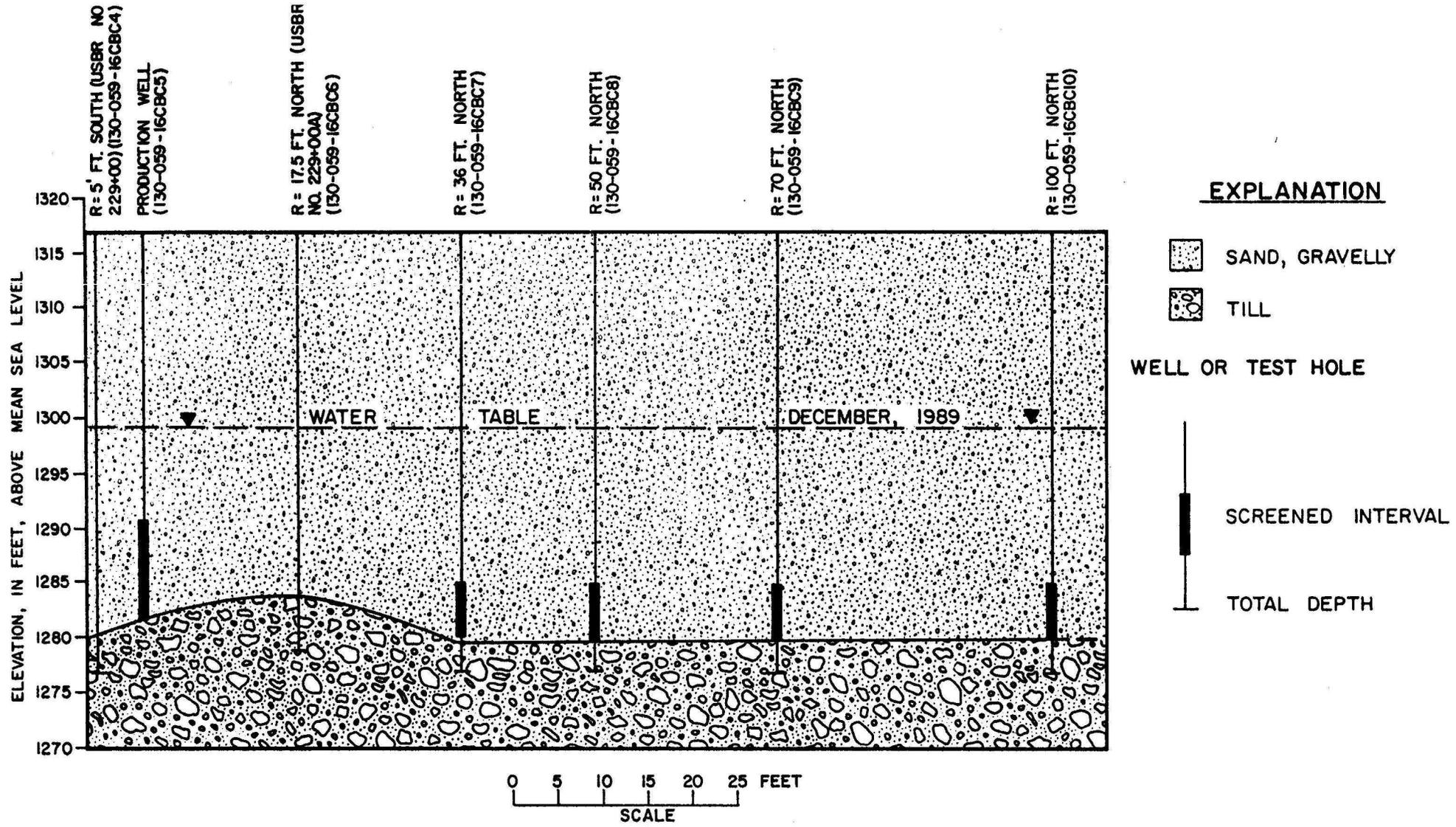


Figure 25.-- Geohydrologic section showing the Oakes aquifer at aquifer-test site 229+00

specific capacity of the production well after 2,200 minutes of pumping was 4.5 gallons per minute per foot.

Water levels in the production well and four observation wells were monitored during the aquifer test using chalked steel tapes and a Keck water level sensor coupled to a Stevens Type F water-level recorder. Drawdown data for each well were corrected using the method of Jacob (1963), to account for aquifer dewatering (decreasing transmissivity with time).

The drawdown data from the four observation wells was plotted on a log time divided by radius squared (t/r^2) versus log drawdown graph (fig. 26). The composite t/r^2 versus drawdown graph shows a typical response of an unconfined aquifer. During early time, the individual data curves are separated and are characterized by relatively small slopes. This is caused by delayed yield from gravity drainage. At later times, as gravity drainage becomes negligible, the individual data curves should merge into a single curve if the Theis assumptions are valid. For this test, during late time, the individual data curves do not merge. The drawdown distribution is irregular with the $r=70$ feet data curve plotting above the $r=50$ feet data curve, and the $r=50$ feet data curve plotting above the $r=36$ feet data curve.

The methods of Theis and Jacob (both in Lohman, 1972) using time versus drawdown analysis were not used to calculate aquifer coefficients because the test was not run for a sufficient length of time after the affects of delayed

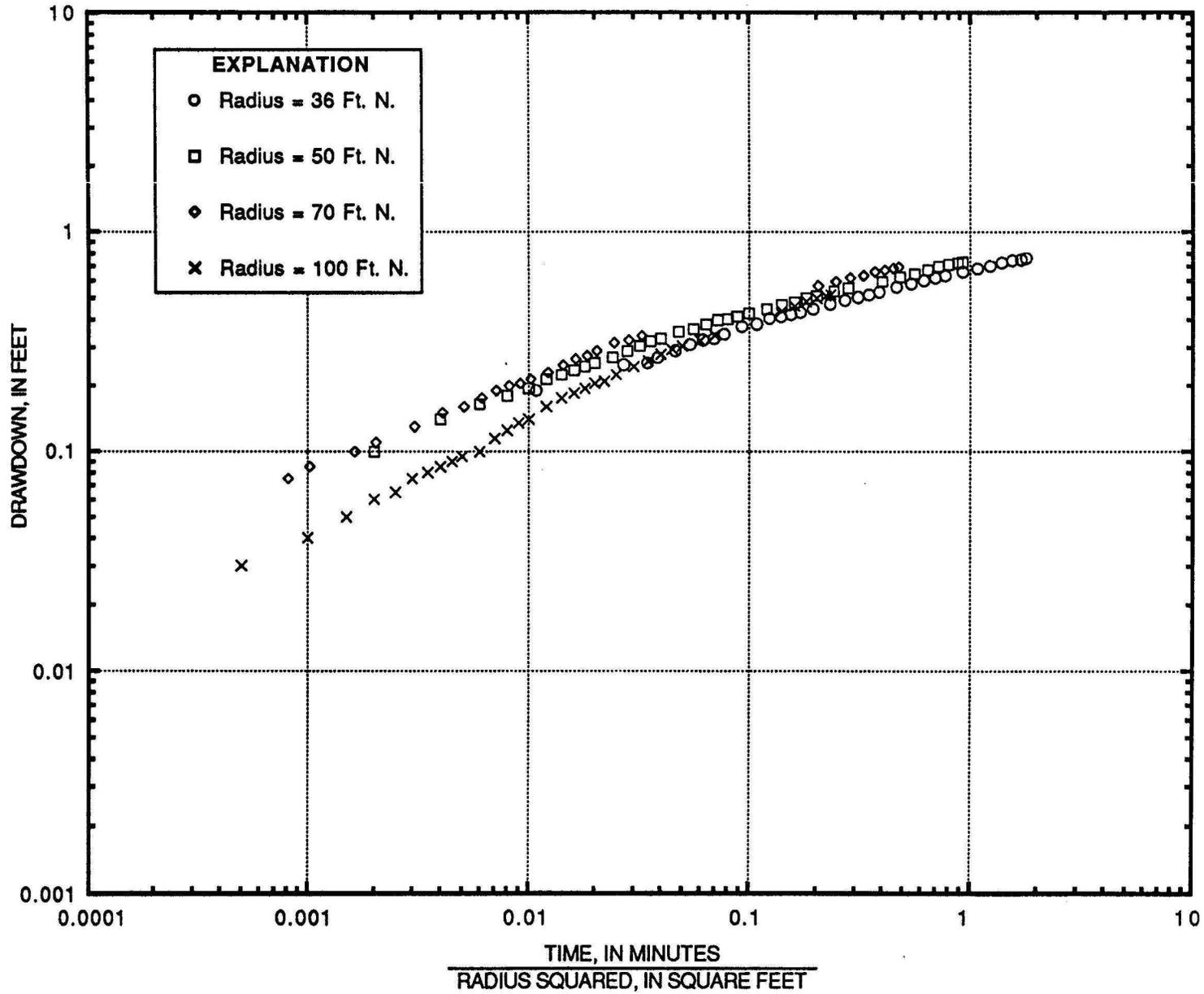


Figure 26.-- Logarithmic composite t/r^2 versus drawdown plot at aquifer-test site No. 229+00

yield had dissipated. The Theis log distance versus log drawdown graphical-analytical method was not applicable for this test at late times because of the irregular drawdown distribution shown in figure 26.

Consideration was given to initiating a second aquifer test at this site and running the test for a sufficient length of time after the effects of delayed yield dissipated. However, the irregular drawdown distribution problem could still preclude accurate calculation of aquifer parameters using graphical-analytical techniques. It was hypothesized that a significant decrease in transmissivity between the production well and the four observation wells could cause the irregular drawdown distribution shown in figure 26. The Bureau of Reclamation augered a test hole 17.5 feet north of the production well (fig. 25). At this test hole site, the saturated thickness of the aquifer decreases about four feet. In addition, the basal aquifer lithology at this site consists of seven feet of fine sand as compared to a predominantly medium to coarse sand at the other observation well sites to the north. Thus, a zone of low transmissivity occurs between the production well and the four observation wells.

A two-dimensional finite-difference computer model (McDonald and Harbaugh, 1984) was developed to test the effect on drawdown distribution caused by a zone of lower transmissivity occurring perpendicular to and between a

production well and a line of five observation wells (Cline, personal communication).

The variably spaced finite-difference grid consisted of 100 blocks (x-direction) by 50 blocks (y-direction). The length of the smallest block was 0.5 feet at the production well. Block dimensions outward from the production well block were increased using a multiplier of 1.2. The largest block was 4550.2 feet, located 25,023.5 feet on either side of the production well in the x-direction.

The aquifer was modelled as unconfined with a uniform transmissivity of 2,000 feet squared per day. Transmissivity was based on a hydraulic conductivity of 100 feet per day and a saturated thickness of 20 feet both of which approximate the aquifer-test site. A 9-foot wide low transmissivity zone was simulated along a line perpendicular to a line formed by the production and observation wells at a distance between 17.7 and 26.7 feet from the production well. A transmissivity of 200 feet squared per day was selected for this zone. This transmissivity was based on a hydraulic conductivity of 10 feet per day and a saturated thickness of 20 feet. A hydraulic conductivity of 10 feet per day is a reasonable estimate for the fine sand that occurs between the production well and observation wells at the aquifer-test site.

The production well was located at block $x(51)$, $y(1)$. Because radial flow is assumed, one plane of symmetry exists along the x-axis. The low-transmissivity zone was placed

perpendicular to the x-axis, between 17.7 and 26.7 feet from the production well. The above spatial relationships allow for modelling one-half of the flow field by halving the pumping rate. The actual pumping rate for the aquifer test was 50 gallons per minute and, therefore, the pumping rate used in the model was 25 gallons per minute. The initial time step in the model was 0.06 days and subsequent time steps were increased using a multiplier of 1.1 to the end of the simulation at 10 days.

Output from the model is shown graphically by the composite logarithmic time divided by radius squared (t/r^2) versus logarithmic drawdown plot in figure 27. The pattern of drawdown response in figure 27 is similar to the pattern of drawdown response in figure 26. At later times, the individual data curves do not merge and the data curves corresponding to observation wells farthest from the production well plot above the data curves corresponding to observation wells closer to the production well. It was concluded from the modelling effort that local inhomogeneities preclude analysis of the aquifer-test data using graphical-analytical methods and as a result, aquifer parameters can not be calculated. Therefore, a second aquifer test, at site number 229+00, was not initiated.

Based on the results of this aquifer test, individual well yields of about 50 to 75 gallons per minute were estimated along line 16C. Although line 16C is close to the

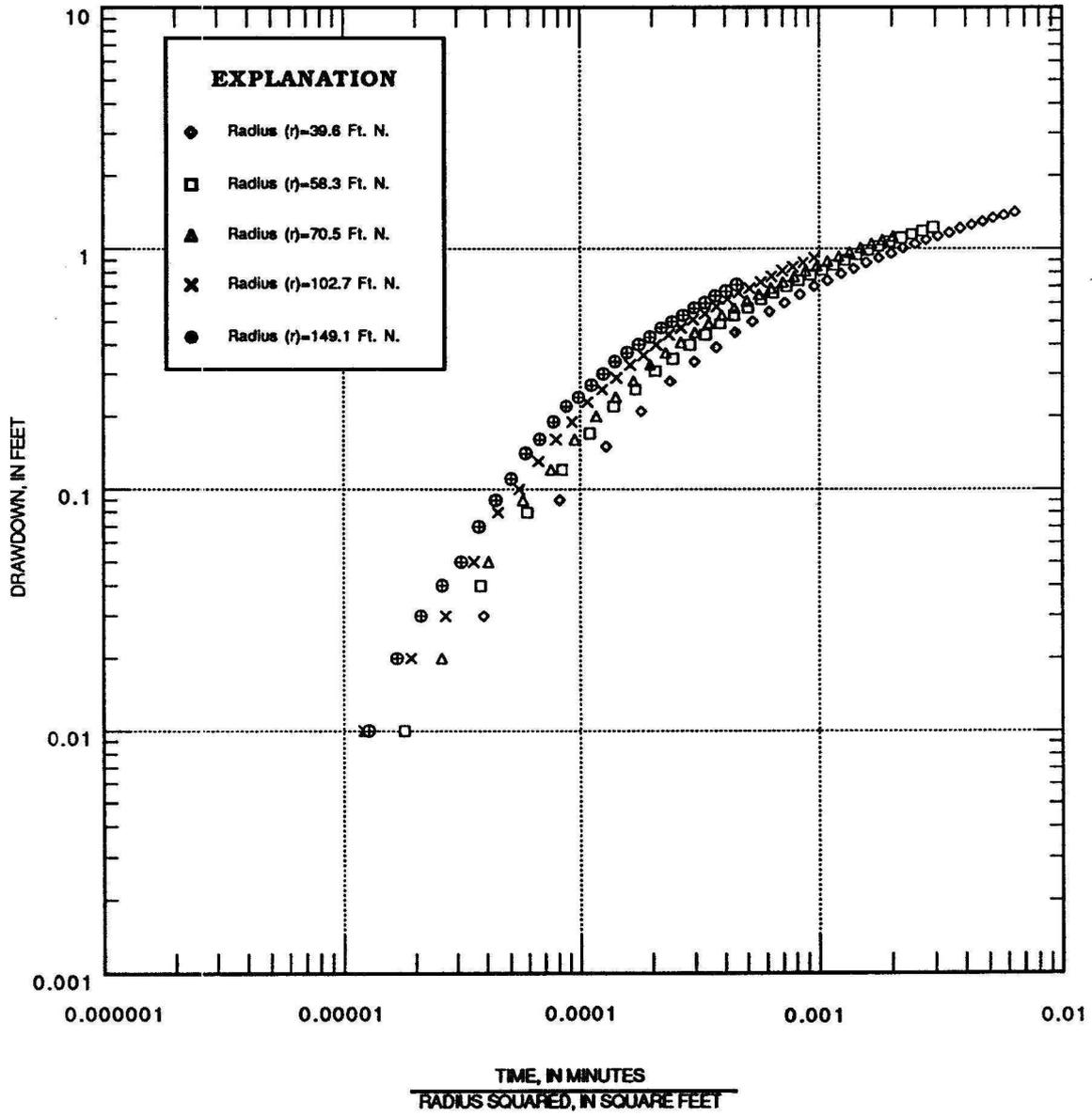


Figure 27.-- Computer-simulated logarithmic composite t/r^2 versus drawdown plot at aquifer-test site No. 229+00

distribution canal (lateral 0-2.0) small individual well yields precluded this area for locating a well field.

Available commercial well drilling data indicated potential for locating well fields in the E 1/2 of Section 16. As a result, additional test holes were drilled along lines 16A2 and 16A3 (fig. 22). The average saturated thickness along lines 16A2 and 16A3 is about the same as the average saturated thickness along lines 16C and 16A1 (fig. 23). However, the basal lithologies along lines 16A2 and 16A3 are for the most part more coarse textured as compared to the basal lithologies along lines 16C and 16A1.

Based on the above, individual well yields in excess of 75 gallons per minute were considered attainable along lines 16A2 and 16A3. Therefore, lines 16A2 and 16A3 were selected as locations for well fields.

SW1/4 Section 3, Township 130 North, Range 59 West

Thirty-three test holes were drilled in the SW1/4 of Section 3, Township 130 North, Range 59 West (fig. 28). Geologic logs of the test holes are found in Appendix I. At each drilling site, saturated zone samples were collected and sent to the U.S. Bureau of Reclamation Laboratory in Harvey, North Dakota, for gradation analysis. Graphs for each sample gradation analysis, showing percent passing versus grain-size diameter are found in Appendix II.

Saturated Thickness

The saturated thickness of the Oakes aquifer in the SW1/4 of Section 3 ranges from 13.9 to 33.6 feet (fig. 29).

TOWNSHIP 130 NORTH, RANGE 59 WEST, SW 1/4 SECTION 3

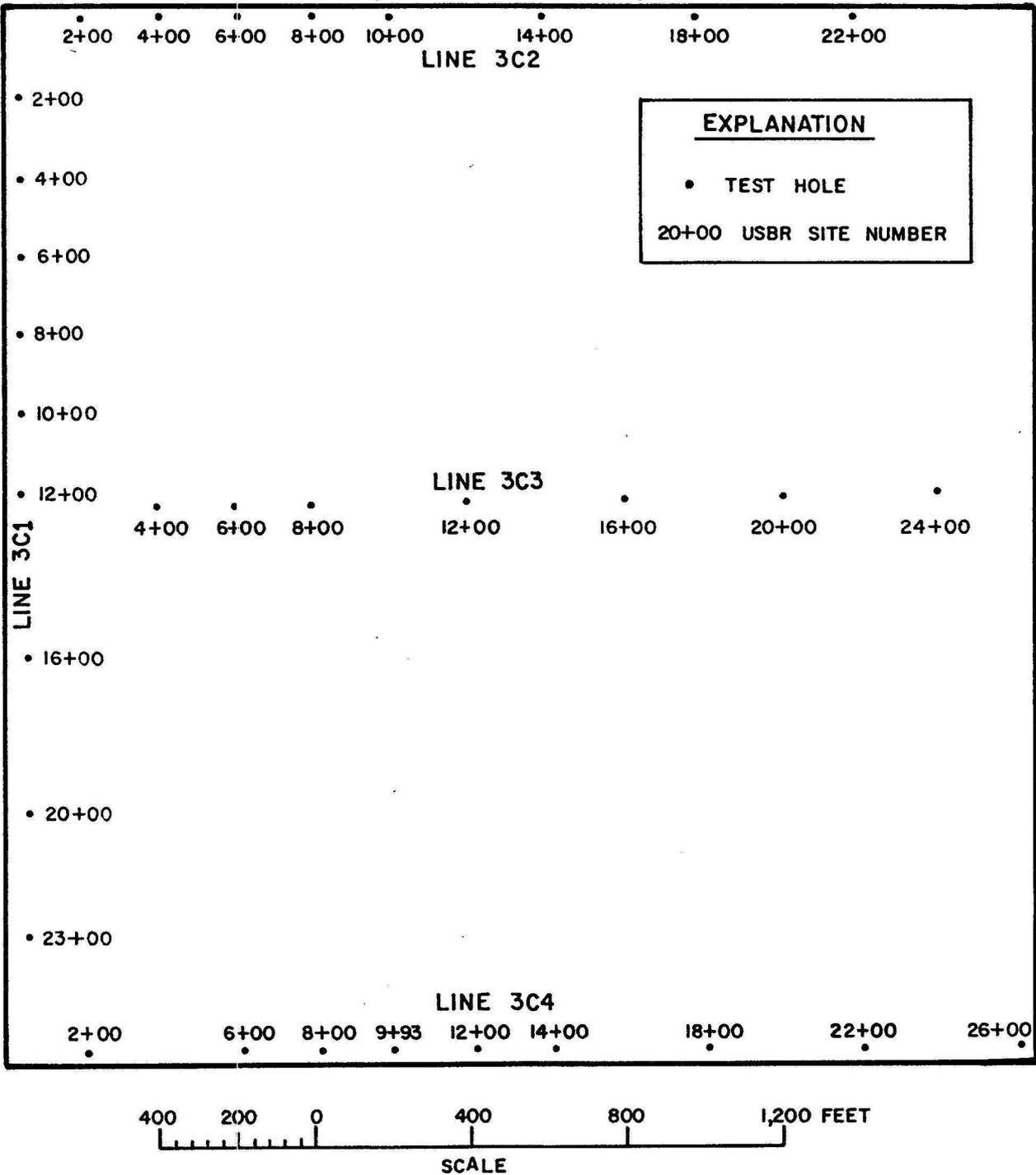


Figure 28.-- Location of test-drilling sites in the SW1/4 of Section 3, Township 130 North, Range 59 West

TOWNSHIP 130 NORTH, RANGE 59 WEST, SW 1/4 SECTION 3

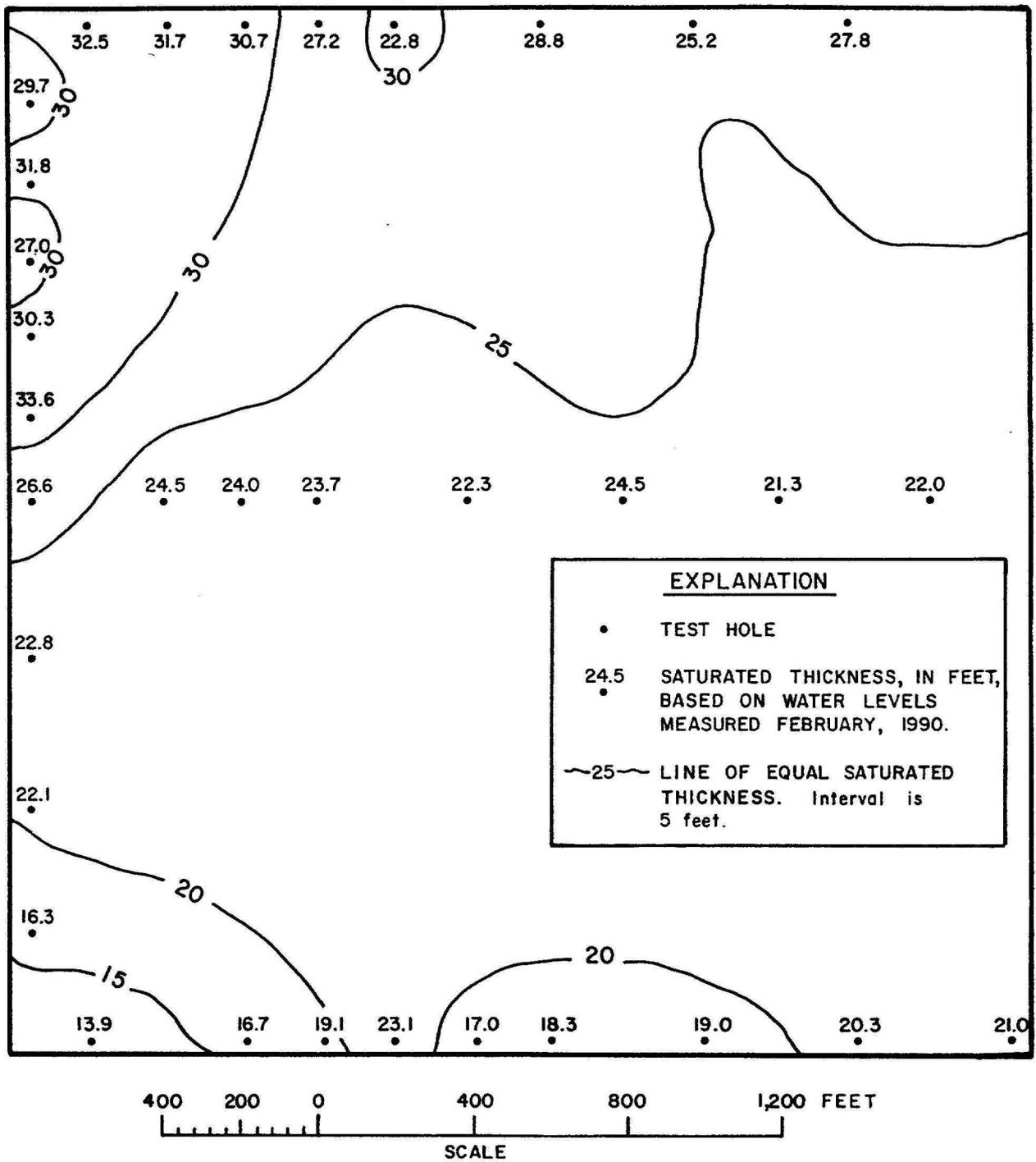


Figure 29.-- Saturated thickness of the Oakes aquifer in the SW1/4 of Section 3, Township 130 North, Range 59 West

The largest saturated thickness occurs in the N1/2 SW1/4 of Section 3. In the S1/2 SW1/4 of Section 3, the Oakes aquifer is thinner and finer textured.

Based on texture and saturated thickness, all four lines of test holes (3C1, 3C2, 3C3, and 3C4) are potential sites for production wells with estimated individual well yields greater than 100 gallons per minute. Largest individual well yields are associated with the test holes along line 3C2. This line of test holes, however, is close to the southern flank of a subtle land-surface topographic low area characterized by relatively high ground-water salinity (fig. 13).

Water Quality

Field electrical conductivity, which is directly proportional to dissolved-solids concentration of ground water was measured in temporary observation wells completed at each test-hole site (fig. 30). In general, dissolved-solids concentrations are higher in the north and east part of the SW1/4 of Section 3. To avoid capturing significant quantities of relatively high salinity (>2,000 mg/L dissolved solids) ground water located in the N1/2 of Section 3, the well fields should be located to the south along lines 3C1, 3C3, and 3C4.

Hydraulic Properties

No aquifer or slug tests were performed to measure hydraulic properties in the SW1/4 of Section 3. The lithologies reported on geologic logs of test holes completed

TOWNSHIP 130 NORTH, RANGE 59 WEST, SW 1/4 SECTION 3

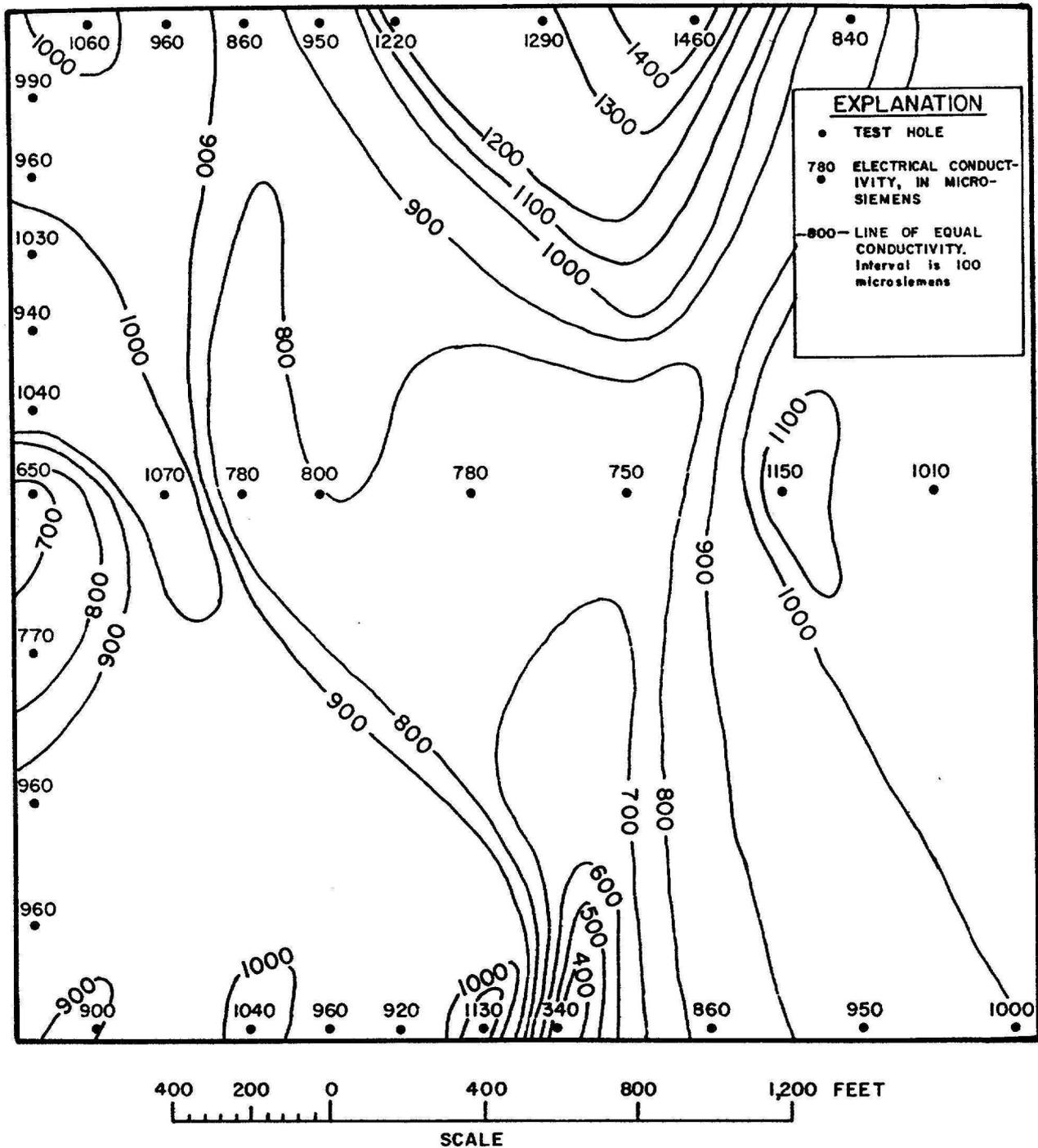


Figure 30.-- Distribution of ground-water electrical conductivity in the SW1/4 of Section 3, Township 130 North, Range 59 West

in the SW1/4 of Section 3 are similar to the lithologies reported on geologic logs of test holes completed in the NE1/4 of Section 4, Township 130 North, Range 59 West. Therefore, estimates of hydraulic properties at proposed production-well sites in the SW1/4 of Section 3 were based on the method used to estimate hydraulic properties at proposed production-well sites in Section 4. This method is described in the next section of the report.

LOCATION AND DESIGN OF WELL FIELDS

Section 4, Township 130 North, Range 59 West

The best potential for locating well fields in Section 4 is along lines 4A2, 4B1, and the north part of line 4C (fig. 11). The U.S. Bureau of Reclamation was unable to obtain easements to construct production wells on privately owned land in Section 4. As a result, the production wells can only be installed along the distribution canal (lateral 0-2.0) right-of-way about 50 feet east of lines 4B1 and 4C.

Well Spacing and Estimated Pumping Rates

The location of the proposed production wells along the distribution canal right-of-way in Section 4 are shown in figure 31. Well spacing and pumping rate were determined using the Theis analytical method (In Lohman, 1972) modified by the method of Jacob (1963) to account for aquifer dewatering.

A transmissivity of 8,360 ft²/day was calculated from the aquifer-test data obtained at site 38+27. Mathison

TOWNSHIP 130 NORTH, RANGE 59 WEST, SECTION 4

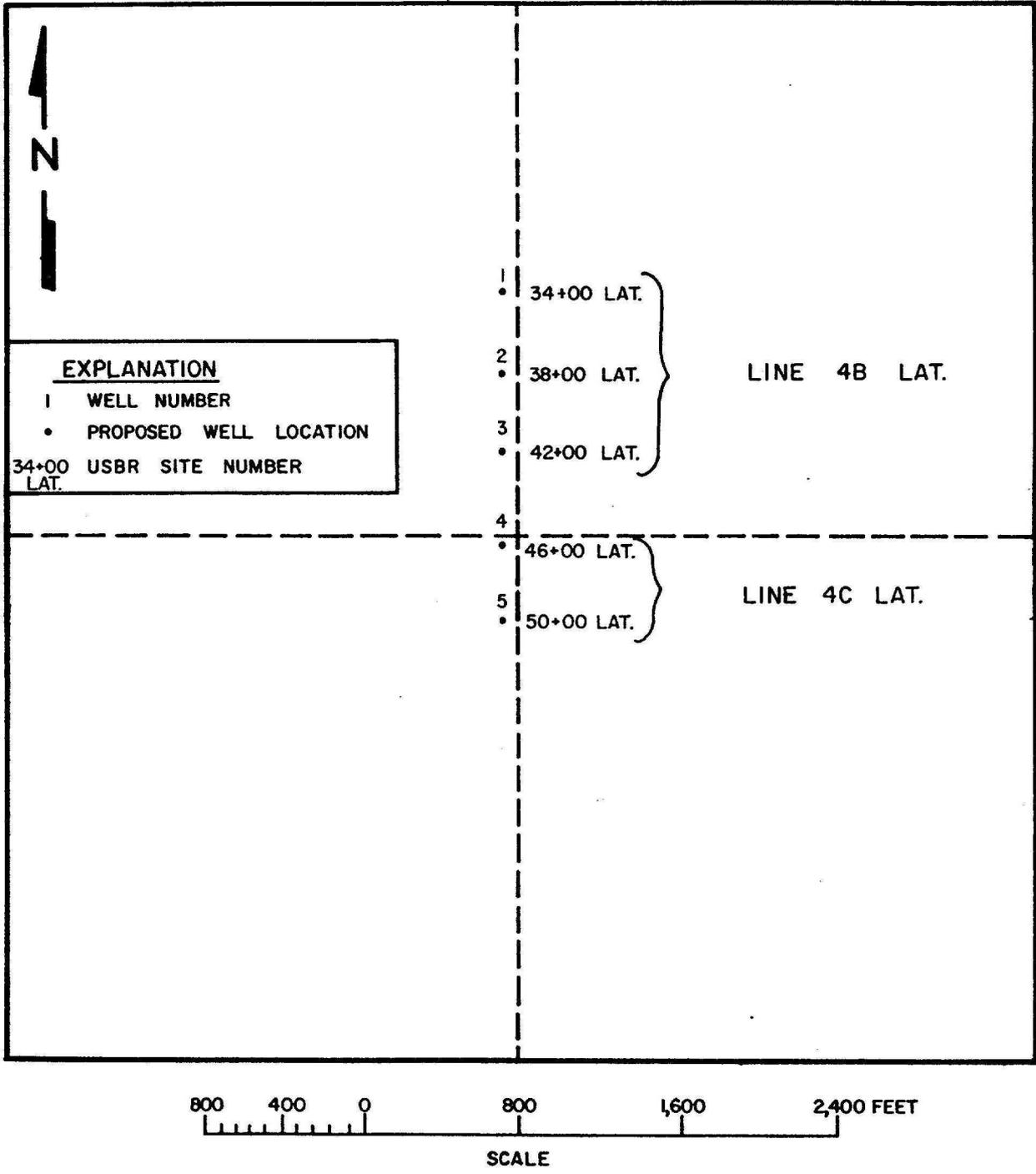


Figure 31.-- Location of proposed production wells in Section 4, Township 130 North, Range 59 West

(unpublished table) developed a table relating texture and hydraulic conductivity for unconsolidated sediments in the Oakes aquifer (Table 3). A transmissivity at site 38+27 of 1,415 ft²/day was calculated using table 3 in conjunction with the lithologies reported on the test hole log. This transmissivity is about six times less than the transmissivity calculated analytically using the aquifer-test data.

The sand and gravel deposits in this area of the Oakes aquifer are well stratified. As a result, the aquifer is anisotropic. A ratio of horizontal to vertical hydraulic conductivity of 10 to 1 is plausible in this area of the Oakes aquifer.

Based on the above, aquifer transmissivity at each of the proposed production well sites in Section 4 was estimated at five times the transmissivity calculated using table 3 in conjunction with texture reported in the geologic log of each test hole. An apparent specific yield of 0.25 was estimated at each of the proposed well sites.

The first step in the analytical process was to calculate total well interference (Theis assumptions) at each proposed well site after pumping continuously for 40 days at a specified pumping rate (drawdown component A). A well spacing of 400 feet was selected based on hydraulic considerations and on the spatial distribution of existing multiple-well capture systems in the Oakes aquifer project area. Transmissivity at each production well site was

Table 3.-- Estimated hydraulic conductivities of selected classes (from Mathison, U.S. Bureau of Reclamation)

Texture	Hydraulic conductivity, in feet per day
Coarse sand and gravel	100
Medium sand and gravel	70
Fine sand and gravel	40
Coarse sand	70
Medium sand	50
Fine sand	40
Very fine sand	20
Loamy sand	12
Loamy fine sand	12
Loamy very fine sand	10
Sandy loam	4
Fine sandy loam	4
Very fine sandy loam	3.6
Silt loam	1.0
Loam	1.0
Silty clay	<.4
Silty clay loam	<.4
Clay loam	<.4
Clay	<.4

decreased by the amount corresponding to the total well interference calculated after 40 days of pumping. The adjusted transmissivity was then applied in the Theis formula, modified by the method of Jacob (1963), to calculate production-well drawdown (drawdown component B). A 20 percent well loss factor was applied to the above drawdown (drawdown component C). Total drawdown in each production well after pumping continuously for 40 days was estimated as the sum of drawdown components A, B, and C. Individual pumping rates were adjusted to maintain production well drawdown (after 40 days of pumping) at two-thirds of the available head above the top of the screen (assuming the bottom one-third of the aquifer is screened) plus three feet of saturated thickness to account for natural water-table decline during the summer. Using the above analytical method, estimated maximum pumping rates at each of the five proposed wells in Section 4 are shown in table 4.

Well Design

The principal objectives of good well design should ensure the following (Driscoll, 1986):

- 1) The highest yield with minimum drawdown consistent with aquifer capability.
- 2) Good quality water with proper protection from contamination.
- 3) Water that remains sand free.
- 4) A well that has a long life (25 years).
- 5) Reasonable short-term and long-term costs.

Table 4 -- Estimated pumping rates for proposed production wells in Section 4, Township 130 N, Range 59 W

<u>Well Number</u>	<u>U.S.B.R. Line and Site Number</u>	<u>Pumping Rate, in gallons per minute</u>
1	4B Lat 34+00	250
2	4B Lat 38+00	250
3	4B Lat 42+00	200
4	4C Lat 46+00	100
5	4C Lat 50+00	150

There are three basic components of a water well:

- 1) Casing
- 2) Intake area (screen)
- 3) Pump

Casing design elements include diameter, wall thickness, type of material, and length. Well-screen design elements include diameter, length, slot size, open area, and type of material. Pump design elements include type, size, and power supply requirements.

Casing Design

Past experience with private ground-water irrigation development in the project area indicates that 12-inch diameter production wells are not cost effective in relation

to well yield. As a result, 8-inch diameter production wells were selected for this project.

The maximum depth of the production wells for this project is 45 feet. To reduce costs and still maintain strength and durability requirements, 8-inch diameter, SDR21, polyvinyl-chloride (PVC) casing will be used in all wells.

Well-screen Design

For non-homogeneous unconfined aquifers less than 150 feet thick, screen lengths should vary in length between one-third and one-half the saturated thickness of the aquifer. Because the saturated thickness of the aquifer in the project area is less than 30 feet, screen lengths for all wells were based on one-third of the saturated thickness.

Screen slot size was determined using gradation analyses from solid-stem spiral auger samples collected by the U.S. Bureau of Reclamation at each potential well site. The slot size was selected based on the grain-size diameter at which 40 percent of the sample was retained. Because the aquifer is thin, and non-homogeneous and because screen lengths are small, transmitting capacity must be maximized. Therefore, Johnson, V-slot, High Q, pipe size, well screen (or equivalent) is recommended.

At many of the production-well sites, the lithologies opposite the screened intervals consist of fine-grained sediments overlying coarse-grained sediments. To reduce the potential of fine-grained sediment moving downward and through the larger screen slots opposite coarse-grained

sediments, the following screen design criteria were applied:

(Driscoll, 1986):

- 1) Extend three feet of screen designed for the overlying fine lithology into the coarser lithology below.
- 2) The slot size for the screen section installed in the coarse layer three feet beneath the formation contact will not be more than double the slot size for the overlying finer material. Doubling of the slot size will be done over screen increments of two feet or more.

At some well sites, samples were not collected for gradation analysis every five feet. If, for instance, the basal lithology appeared to have a consistent texture over 13 feet, one composite sample was collected for gradation analysis. For these cases a more conservative (smaller) screen slot size was selected as compared to the slot size based on the 40 percent retained diameter from the single gradation analysis.

Three factors govern the choice of material used to fabricate well screen (Driscoll, 1986). These are: (1) water quality, (2) potential presence of iron bacteria, and (3) strength requirements of the well screen. Both corrosion and incrustation can result in well-screen failure. Corrosion can cause enlargement of screen openings allowing sediment to enter the well. Incrustation can reduce screen openings causing a reduction in well yield. As with well casing, the potential for corrosion and incrustation of well screen can be estimated by analyzing selected chemical parameters and constituents.

The potential for corrosion can be assessed by the following chemical parameters and constituents (Driscoll, 1986).

- 1) pH - If the pH is less than 7, the water is acidic and corrosion is indicated.
- 2) Dissolved oxygen - If dissolved oxygen exceeds 2 mg/L, corrosive water is indicated.
- 3) Hydrogen sulfide - Hydrogen sulfide in ground water can be detected by its characteristic rotten-egg odor. Less than 1 mg/L can cause severe corrosion, and this amount can be detected by odor and taste.
- 4) Total dissolved solids - If total dissolved solids exceed 1,000 mg/L, electrical conductivity of the water is great enough to cause serious electrolyte corrosion.
- 5) Carbon dioxide - If the amount of this gas exceeds 50 mg/L, corrosive water is indicated.
- 6) Chlorides - If the chloride content of the water exceeds 500 mg/L, corrosion can be expected.

The range and mean of the above chemical parameters and constituents (less dissolved oxygen and CO₂ gas) for ground water in Section 4 are shown in table 5. Total dissolved solids is the only parameter indicting corrosive potential.

**Table 5 -- Chemical parameters and constituents used to
assess the potential for corrosion
in the project area**

	CHEMICAL PARAMETER OR CONSTITUENT			
	pH	Total Dissolved Solids (mg/L)	Chloride (mg/L)	Hydrogen Sulfide mg/L
Sum of values (Σ)	123.83	15,518	442	*
Mean (\bar{X})	7.74	970	28	*
Maximum value	8.15	2,320	99	*
Minimum value	7.03	555	10	*

*No odor detected during sample collection, therefore H₂S assumed negligible

Explanation

\bar{X} = arithmetic mean

Σ = sum of values

N = number of samples = 16

For the most part, however, the location of the wells are in areas where total dissolved solids concentrations are less than 1,000 mg/L. Thus, corrosion does not appear to be a significant problem in the project area.

Indicators of incrusting ground water are (Driscoll, 1986):

- 1) pH - If the pH value is above 7.5, the water will tend to be incrusting.
- 2) Carbonate hardness - If carbonate hardness of the ground water exceeds 300 mg/L, incrustation of calcium carbonate (lime scale) is likely.

- 3) Iron - If the iron content of the water exceeds 0.5 mg/L, precipitation of iron is likely, although some precipitation may begin at concentrations as low as 0.25 mg/L.
- 4) Manganese - If the manganese content of the water exceeds 0.2 mg/L and the pH value is high, precipitation of manganese is likely if oxygen is present.

The range and mean values of the above chemical parameters and constituents for ground water in Section 4 are shown in table 6. Based on the above, ground water in Section 4 is incrusting. Mineral deposits from incrusting-type ground water can often be removed from well screens by acidizing techniques. In incrusting environments, the well screen should consist of a non-corrosive material to withstand the corrosive effect of acid treatment.

Table 6 -- Chemical parameters and constituents used to assess the potential for incrustation in the project area

	CHEMICAL PARAMETER OR CONSTITUENT			
	pH	Carbonate Hardness (mg/L)	Iron (mg/L)	Manganese (mg/L)
Sum of values (Σ)	123.82	8,322	35.73	9.48
Mean (\bar{X})	7.74	520	2.23	0.59
Maximum value	8.15	1,509	7.3	1.70
Minimum value	7.03	274	0.06	0.25

Explanation

\bar{X} = arithmetic mean
 Σ = sum of values
 N = number of samples = 16

Iron bacteria form gelatinous masses that block well-screen openings thereby reducing well yield. Remedial techniques include chemical treatment (chlorination) or pasteurization (steam injection). These techniques are corrosive and, therefore, non-corrosive well screen should be used in aquifers where iron-bacteria growth is anticipated.

The Bureau of Reclamation reports iron-bacteria growth in the drain complex within the 5,000-acre test plot south of Oakes (Mathison, verbal communication). The author is also aware of iron bacteria reported in domestic and stock wells completed in the Oakes aquifer. Because of the potential for both incrustation and iron-bacteria growth in wells completed in the Oakes aquifer project area, production wells should be constructed with a non-corrosive, stainless-steel type well screen.

The final design requirement for well screen is strength. The Johnson High Q, type screen (or equivalent) recommended to maximize transmitting capacity, is not as strong in terms of load capacity and collapse strength as conventional continuous-slot well screen. However, because the maximum well depth is 45 feet and PVC casing will be used for all wells, the Johnson High Q screen (or equivalent) will have sufficient strength.

The design specifications for the five production wells, located along the distribution canal (lateral 0-2.0) right-of-way are summarized in table 7. Schematic diagrams for these wells are found in Appendix III.

Table 7. - - Selected specifications for five production wells located
in Section 4, Township 130 North, Range 59 West

WELL NUMBER	USBR LINE AND SITE NUMBER	DEPTH OF WELL, IN FEET	LENGTH OF CASING ¹ ., IN FEET	LENGTH OF WELL SCREEN, IN FEET	SCREENED INTERVAL, IN FEET	SCREEN SLOT SIZE, IN INCHES	ESTIMATED PUMPING RATE, IN G.P.M.
1	4B LAT 34+00	36	28	9	27-33 33-36	0.019 (#19 Slot) 0.040 (#40 Slot)	250
2	4B LAT 38+00	42.5	33.5	10	32.5-42.5	0.040 (#40 Slot)	250
3	4B LAT 42+00	36	28	9	27-30 30-32 32-36	0.020 (#20 Slot) 0.040 (#40 Slot) 0.050 (#50 Slot)	200
4	4C LAT 46+00	30	24	7	23-26 26-30	0.020 (#20 Slot) 0.040 (#40 Slot)	100
5	4C LAT 50+00	32	26	7	25-29 29-32	0.020 (#20 Slot) 0.040 (#40 Slot)	150

1. Based on 1 foot of casing above ground level

Pump Selection

Personnel from the U.S. Bureau of Reclamation calculated pump horsepower requirements for each of the five proposed production wells in Section 4 based on estimated pumping rate, pump lift, and friction in the distribution pipe. Estimated pumping rate and lift data were supplied by the North Dakota State Water Commission. Friction head loss was calculated using the Hazen-Williams formula (Fair and others, 1966, p. 12-7). Plastic (PVC) pipe was selected for the distribution system in Section 4. A Hazen-Williams coefficient (C) of 150, applicable to plastic conduit, was applied in the Hazen-Williams formula. Pump design specifications for the five proposed production wells in Section 4 are summarized in table 8.

SW1/4 of Section 3, Township 130 North, Range 59 West

Based on estimated transmissivity and well yield, production wells can be located along all four lines of test holes (3C1, 3C2, 3C3, and 3C4) in the SW1/4 of Section 3 (fig. 28). Test hole line 3C2 is located along the southern flank of a subtle land-surface topographic low area characterized by relatively high ground-water salinity (fig. 13). To avoid capturing significant quantities of relatively high salinity, ground water (>2,000 mg/L dissolved solids) located in the N1/2 of Section 3, the well fields should be located further south along lines 3C1, 3C3, and 3C4.

Table 8. - - Selected pump specifications for five production wells located
in Section 4, Township 130 North, Range 59 West

WELL NUMBER	USBR LINE AND SITE NUMBER	PUMP SIZE, IN INCHES	PUMPING HEAD, IN FEET	ESTIMATED PUMPING RATE, IN G.P.M.	PUMP HORSE- POWER	LENGTH OF DROP PIPE, IN FEET	DIAMETER OF DROP PIPE, IN INCHES
1	4B LAT 34+00	6	36	250	5	28	4
2	4B LAT 38+00	6	40	250	5	34	4
3	4B LAT 42+00	6	33	200	3	28	4
4	4C LAT 46+00	4	23	100	1.5	24	2
5	4C LAT 50+00	6	28	150	2	26	3

Well Spacing and Estimated Pumping Rates

The locations of the proposed production wells in the SW1/4 of Section 3 are shown in figure 32.

Well spacing and pumping rate were determined using the same analytical methods described previously for the proposed wells in Section 4, Township 130 North, Range 59 West.

Well Design

Casing and Well-Screen Design

The methods for designing the production wells in the SW1/4 of Section 3 are the same as those used to design the production wells in Section 4. The well casing will consist of 8-inch diameter PVC. Except for well sites 4+00C1 and 8+00C1, that have limited transmitting capacity (finer texture) the bottom one-third of the aquifer will be screened. To increase transmitting capacity at sites 4+00C1 and 8+00C1, screen lengths were increased to about 40 percent of the initial saturated thickness. Screen slot size was determined using methods previously described for proposed production wells in Section 4. Also, to maximize transmitting capacity at all well sites, Johnson High Q (or equivalent) pipe size screen will be used.

The potential for well screen incrustation in the SW1/4 of Section 3 is similar to that measured in Section 4. Therefore, stainless-steel well screen will be used. The design specifications for the 14 proposed production wells located in the SW1/4 of Section 3 are summarized in table 9. Schematic diagrams for these wells are found in Appendix III.

TOWNSHIP 130 NORTH, RANGE 59 WEST, SECTION 3

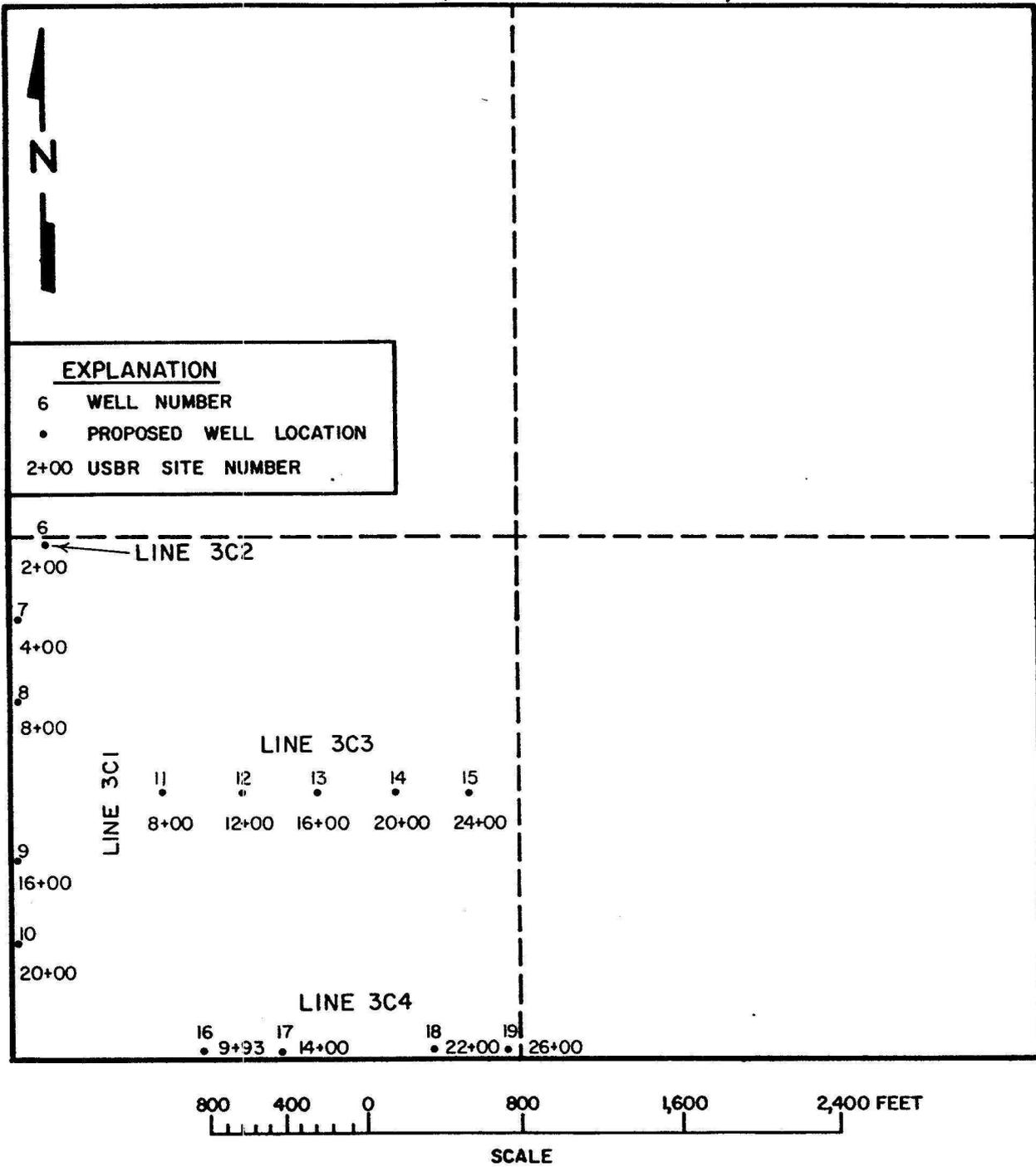


Figure 32.-- Location of proposed production wells in the SW1/4 of Section 3, Township 130 North, Range 59 West

Table 9. - - Selected specifications for 14 production wells located in the SW1/4 Section 3, Township 130 North, Range 59 West

WELL NUMBER	USBR LINE AND SITE NUMBER	DEPTH OF WELL, IN FEET	LENGTH OF CASING ¹ , IN FEET	LENGTH OF WELL SCREEN, IN FEET	SCREENED INTERVAL, IN FEET	SCREEN SLOT SIZE, IN INCHES	ESTIMATED PUMPING RATE, IN G.P.M.
6	3C2 2+00	43	33	11	32-37 37-39 39-41 41-43	0.015 (#15 Slot) 0.030 (#30 Slot) 0.060 (#60 Slot) 0.100 (#100 Slot)	250
7	3C1 4+00	40.5	26.5	15	25.5-38.5 38.5-39.5 39.5-40.5	0.008 (#8 Slot) 0.016 (#16 Slot) 0.030 (#30 Slot)	150
8	3C1 8+00	41	28	14	27.0-36.5 36.5-38.0 38.0-41.0	0.007 (#7 Slot) 0.014 (#14 Slot) 0.023 (#23 Slot)	150
9	3C1 16+00	34	27	8	26-29 29-34	0.025 (#25 Slot) 0.050 (#50 Slot)	150
10	3C1 20+00	31	24	8	23-26.5 26.5-31	0.019 (#19 Slot) 0.040 (#40 Slot)	100
11	3C3 8+00	34	27	8	26-34	0.017 (#17 Slot)	150
12	3C3 12+00	33	26	8	25-31 31-33	0.016 (#16 Slot) 0.019 (#19 Slot)	100

¹. Based on 1 foot of casing above ground level

Table 9. (Cont.)

WELL NUMBER	USBR LINE AND SITE NUMBER	DEPTH OF WELL, IN FEET	LENGTH OF CASING ¹ , IN FEET	LENGTH OF WELL SCREEN, IN FEET	SCREENED INTERVAL, IN FEET	SCREEN SLOT SIZE, IN INCHES	ESTIMATED PUMPING RATE, IN G.P.M.
13	3C3 16+00	35	28	8	27-29 29-35	0.010 (#10 Slot) 0.017 (#17 Slot)	150
14	3C3 20+00	32	26	7	25-32	0.015 (#15 Slot)	100
15	3C3 24+00	33	26	8	25-33	0.019 (#19 Slot)	150
16	3C4 9+93	36	29	8	28-36	0.023 (#23 Slot)	200
17	3C4 14+00	26	21	6	20-26	0.023 (#23 Slot)	100
18	3C4 22+00	32	26	7	25-30 30-32	0.013 (#13 Slot) 0.026 (#26 Slot)	100
19	3C4 26+00	35	29	7	28-33 33-35	0.019 (#19 Slot) 0.026 (#26 Slot)	150

¹. Based on 1 foot of casing above ground level

Pump Selection

Pump design criteria and methods for the proposed production well and distribution system in Section 4 were applied to the proposed production well and distribution system in the SW1/4 of Section 3. Pump design specifications for the 14 proposed production wells in the SW1/4 of Section 3, are summarized in table 10.

NE1/4 Section 16. Township 130 North. Range 59 West

The best potential for locating well fields in the NE1/4 of Section 16 is along lines 16A2 and 16A3 (fig. 22). In contrast to the previous well field sites in Sections 3 and 4, the location of well field sites in the NE1/4 of Section 16 will not be restricted to avoid capturing highly saline ground water (>2,000 mg/L dissolved solids). Available water quality data in this area of the aquifer does not pose sodium, salinity, or other irrigation hazards. Thus, location of the well field will be entirely based on hydraulic parameters.

Well Spacing and Estimated Pumping Rate

There are five abandoned irrigation wells located in the NE1/4 of Section 16. Three of the wells are 12 inches in diameter, one well is 8 inches in diameter, and one well is 6 inches in diameter. The three, 12-inch diameter wells were installed in 1976 and 1977. Specific capacity was measured on the well installed in 1977. After pumping 150 gallons per minute for two hours the specific capacity was 12.5 gallons per minute per foot, and after pumping 200 gallons per minute

Table 10. - - Selected pump specifications for 14 production wells located in the SW1/4 of Section 3, Township 130 North, Range 59 West

<u>WELL NUMBER</u>	<u>USBR LINE AND SITE NUMBER</u>	<u>PUMP SIZE, IN INCHES</u>	<u>PUMPING HEAD, IN FEET</u>	<u>ESTIMATED PUMPING RATE, IN G.P.M.</u>	<u>PUMP HORSE-POWER</u>	<u>LENGTH OF DROP PIPE, IN FEET</u>	<u>DIAMETER OF DROP PIPE, IN INCHES</u>
6	3C2 2+00	6	70	250	7.5	37	4
7	3C1 4+00	6	58	150	5	31	4
8	3C1 8+00	6	58	150	5	28	4
9	3C1 16+00	6	51	150	5	27	4
10	3C1 20+00	6	52	100	3	24	3
11	3C3 8+00	6	57	150	5	27	4
12	3C3 12+00	6	59	100	3	26	3
13	3C3 16+00	6	62	150	5	28	3
14	3C3 20+00	6	62	100	5	26	3
15	3C3 24+00	6	63	150	5	26	3
16	3C4 9+93	6	56	200	5	29	4
17	3C4 14+00	6	49	100	3	21	3
18	3C4 22+00	6	59	100	3	26	3
19	3C4 26+00	6	63	150	5	29	3

for two hours, the specific capacity was 10 gallons per minute per foot. Two of the three wells were pulled, the screens repaired and re-installed along an east-west line, east of the center pivot. The combined pumping rate of the three 12-inch diameter and one 6-inch diameter wells was estimated at about 550 to 600 gallons per minute in the spring, 1984 (Joe Wucetich, verbal communication).

A 6-inch and 8-inch diameter well were installed in the NE1/4 of Section 16 in 1984 (Joe Wucetich, verbal communication). No logs for these wells are available. The 6-inch well is located about 100 feet southwest of the center pivot and is 26 feet deep. The screened interval is from 16 to 26 feet below land surface. The well was test pumped after completion in 1984. The specific capacity after pumping 70 gallons per minute for one hour was 32.48 gallons per minute per foot. The well was test pumped again in March, 1990 and the specific capacity after pumping 82 gallons per minute for 1 1/2 hours was 27.2 gallons per minute per foot.

The 8-inch diameter well is located near the center of the NE1/4. This well was test pumped in March, 1990 and the specific capacity after pumping 78 gallons per minute for two hours was 10.5 gallons per minute per foot.

The aquifer matrix in the NE1/4 of Section 16 is finer textured and appears less stratified than the aquifer matrix in Sections 3 and 4. As a result, the aquifer in the NE1/4 of Section 16 probably is less anisotropic. Therefore, the

method of estimating transmissivity using the hydraulic conductivity table of Mathison (Table 3) with a multiplication factor of five in conjunction with the lithologic log of each test hole, is not considered applicable in the NE1/4 of Section 16.

Individual well yields in the NE1/4 of Section 16 were estimated using specific capacity data from the previously described commercial irrigation wells. As with the previous proposed wells, the bottom one-third of the aquifer will be screened for proposed production wells in the NE1/4 of Section 16. Based on using two-thirds of the available head above the top of the screen, plus three feet of saturated thickness, to account for a natural water-table decline during the summer, and a specific capacity of 10 gallons per minute per foot of drawdown, individual well yields are estimated at between 75 and 100 gallons per minute. A well spacing of 400 feet is recommended. The locations of the 13 proposed production wells in the NE1/4 of Section 16 are shown in figure 33.

Well Design

Casing and Well-Screen Design

For all wells located in the NE1/4 of Section 16, the casing will consist of 8-inch diameter PVC. The bottom one-third of the aquifer will be screened. Screen slot size was determined using methods previously described for proposed production wells in Sections 3 and 4.

TOWNSHIP 130 NORTH, RANGE 59 WEST, SECTION 16

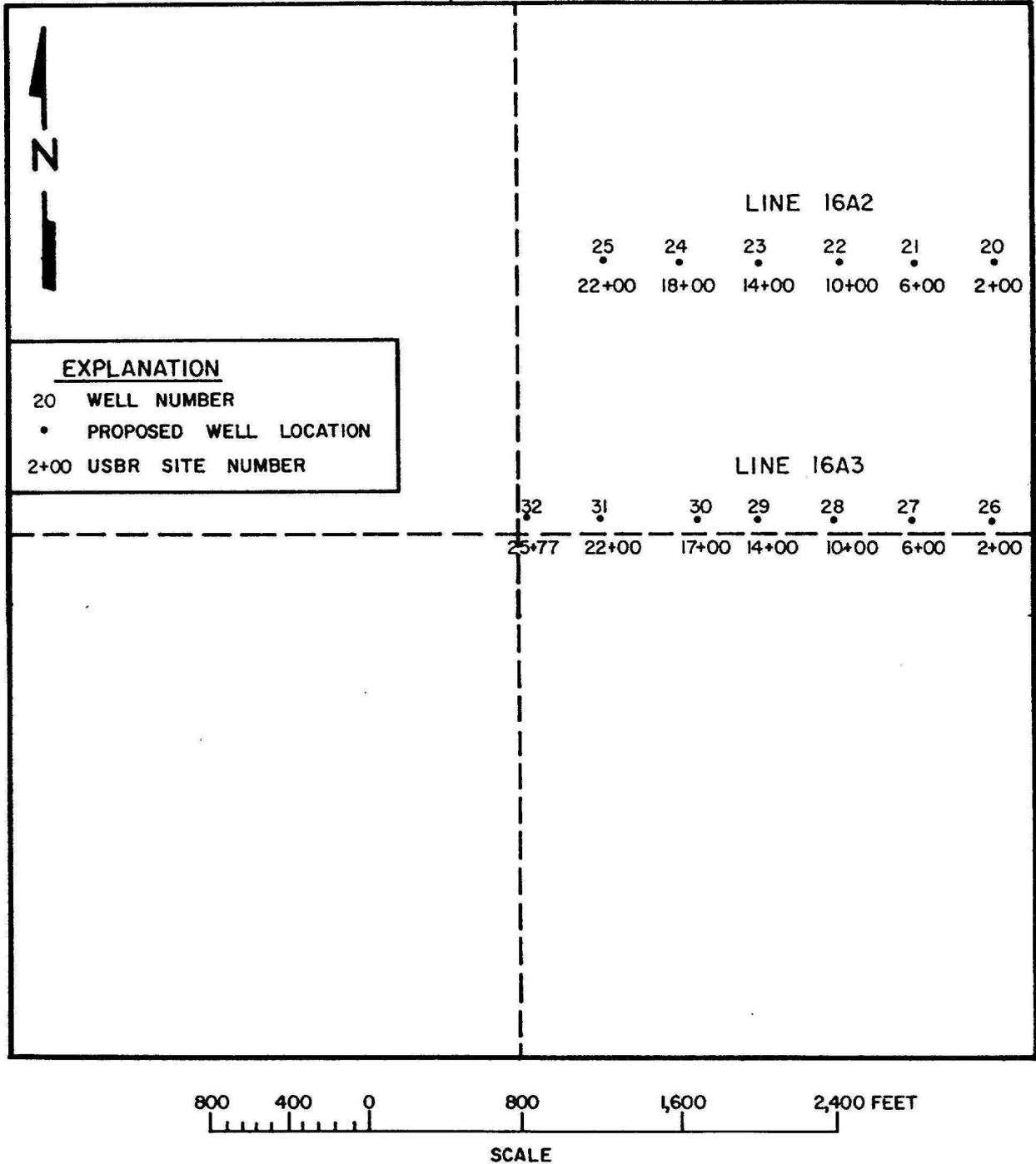


Figure 33.-- Location of proposed production wells in the NE1/4 of Section 16, Township 130 North, Range 59 West

The potential for well screen incrustation in the NE1/4 of Section 16 is similar to that measured in Section 4. Therefore, stainless-steel well screen will be used. The design specifications for the 13 proposed production wells in the NE1/4 of Section 16 are summarized in table 11. Schematic diagrams for these wells are found in Appendix III.

Pump Selection

Pump design methodology used for the proposed production well and distribution system in Sections 3 and 4 was applied to the proposed production well and distribution system in the NE1/4 of Section 16. The distribution system in the NE1/4 of Section 16 consists of 2,600 feet of 12-inch diameter aluminum pipe, 1,677 feet of 8-inch diameter plastic pipe, and 3,100 feet of 6-inch diameter plastic pipe. A Hazen-Williams coefficient of 120 was applied in the Hazen-Williams formula to calculate friction head loss in the 12-inch diameter aluminum pipe. A Hazen-Williams coefficient of 150 was applied in the Hazen-Williams formula to calculate friction head loss in the 8- and 6-inch diameter plastic pipe. Pump design specifications for the 13 proposed production wells located in the NE1/4 of Section 16 are summarized in table 12.

RECOMMENDATIONS

Based on data evaluated for this cooperative study between the North Dakota State Water Commission and the U.S. Bureau of Reclamation, three areas are selected for the

Table 11. - - Selected specifications for 13 production wells located in the
NE1/4 Section 16, Township 130 North, Range 59 West

<u>WELL NUMBER</u>	<u>USBR LINE AND SITE NUMBER</u>	<u>DEPTH OF WELL, IN FEET</u>	<u>LENGTH OF CASING¹, IN FEET</u>	<u>LENGTH OF WELL SCREEN, IN FEET</u>	<u>SCREENED INTERVAL, IN FEET</u>	<u>SCREEN SLOT SIZE, IN INCHES</u> (#24 Slot)	<u>ESTIMATED PUMPING RATE, IN G.P.M.</u> 75-100
20	16A2 2+00	28	23	6	22-28	0.024 (#24 Slot)	75-100
21	16A2 6+00	29	24	6	23-29	0.025 (#25 Slot)	75-100
22	16A2 10+00	28	23	6	22-28	0.010 (#10 Slot)	75-100
23	16A2 14+00	30	24	7	23-30	0.007 (#7 Slot)	75-100
24	16A2 18+00	37	29	9	28-37	0.013 (#13 Slot)	125-150
25	16A2 22+00	31	25	7	24-31	0.025 (#25 Slot)	75-100
26	16A3 2+00	30	25	6	24-30	0.022 (#22 Slot)	75-100
27	16A3 6+00	29	25	5	24-29	0.023 (#23 Slot)	75-100
28	16A3 10+00	32	26	7	25-32	0.021 (#21 Slot)	75-100
29	16A3 14+00	29	24	6	23-29	0.010 (#10 Slot)	75-100
30	16A3 17+00	36	30	7	29-36	0.019 (#19 Slot)	75-100
31	16A3 22+00	33.5	28.5	6	27.5-33.5	0.016 (#16 Slot)	75-100
32	16A3 25+77	33	27	7	26-33	0.020 (#20 Slot)	75-100

1. Based on 1 foot of casing above ground level

Table 12. - - Selected pump specifications for 13 production wells located in the NE1/4 Section 16, Township 130 North, Range 59 West

WELL NUMBER	USBR LINE AND SITE NUMBER	PUMP SIZE, IN INCHES	PUMPING HEAD, IN FEET	ESTIMATED PUMPING RATE, IN G.P.M. *	PUMP HORSE-POWER	LENGTH OF DROP PIPE, IN FEET	DIAMETER OF DROP PIPE, IN INCHES
20	16A2 2+00	6	44	100	2	23	3
21	16A2 6+00	6	44	100	2	24	3
22	16A2 10+00	6	42	100	2	23	3
23	16A2 14+00	6	41	100	2	24	3
24	16A2 18+00	6	42	150	3	29	4
25	16A2 22+00	6	36	100	2	25	3
26	16A3 2+00	6	46	100	2	25	3
27	16A3 6+00	6	46	100	2	25	3
28	16A3 10+00	6	46	100	2	26	3
29	16A3 14+00	6	41	100	2	24	3
30	16A3 17+00	6	44	100	2	30	3
31	16A3 22+00	6	41	100	2	29	3
32	16A3 25+77	6	37	100	2	27	3

*The maximum estimated pumping rate shown in Table 1 was selected to estimate maximum horsepower requirements.

location of well fields to provide a supplemental water supply for irrigation in the 5,000-acre test plot of the West Oakes irrigation area. The first area is located along the eastern perimeter of the W1/2 of Section 4, Township 130 North, Range 59 West. Five production wells will be located along a north-south line, spaced 400 feet apart adjacent to and west of the distribution canal (lateral 0-2.0). The maximum estimated total pumping rate of the five wells is 950 gallons per minute. The maximum annual appropriation from these wells will be 240 acre-feet.

The second area selected for the location of production wells is in the SW1/4 of Section 3, Township 130 North, Range 59 West. Fourteen production wells will be located on (1) a north-south line along the western perimeter of the SW1/4 of Section 3 (five wells), (2) an east-west line along the center of the SW1/4 of Section 3 (five wells), and (3) an east-west line along the southern perimeter of the SW1/4 of Section 3 (four wells). For the most part, the wells will be spaced 400 feet apart. The maximum estimated total pumping rate of the 14 production wells is 2,000 gallons per minute. The maximum annual appropriation from these 14 wells will be 505 acre-feet.

The third area selected for location of production wells is in the NE1/4 of Section 16, Township 130 North, Range 59 West. Thirteen wells will be located on (1) an east-west line along the center of the NE1/4 of Section 16 (six wells) and (2) an east-west line along the southern perimeter of the

NE1/4 of Section 16 (seven wells). For the most part, the wells will be spaced 400 feet apart. The estimated total pumping rate of the 13 wells is between 975 and 1,350 gallons per minute (75 to 100 gallons per minute per well). The maximum annual appropriation from these 13 wells will be 340 acre-feet.

The saturated thickness of the Oakes aquifer in the study area generally is less than 25 feet. There are other ground water irrigation appropriators within the estimated area of influence of the proposed well fields. The yield capabilities of some existing capture systems may be significantly reduced by interference from these well fields. To mitigate potential adverse effects, the U.S. Bureau of Reclamation will artificially recharge the Oakes aquifer near the proposed well fields by diverting spring runoff from the James River. Pumping from the well fields may be reduced or suspended in years when artificial recharge cannot be accomplished. Observation wells throughout the Oakes aquifer study area will be monitored to measure water-table response to ground-water withdrawals and recharge. Analysis of this data will provide the basis for the North Dakota State Engineer to allocate a specific amount of ground water from the proposed well fields. The State Engineer will evaluate the allocation of ground water annually by requiring the U.S. Bureau of Reclamation to submit a temporary water permit application.

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APPENDIX 1

Geologic Logs of Test Holes

130-059-04AAA1

USBR hole number: 1+00
Date completed: 11/29/89
Depth drilled: 45 ft.
Screened interval: 35-40 ft.
Casing Size: 1 1/4 in.

NDSWC hole number: 12514
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1307.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
CLAY, silty, very slightly sandy, soft, dark brown	0-2
CLAY, silty, light gray, with red-yellow stringers, soft, oxidized	2-10
CLAY, silty, greenish gray, soft, sticky, unoxidized	10-19
SAND, very fine to very coarse, predominantly medium, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, #15-#20 slot screen	19-25
SAND, very fine to very coarse, predominantly medium to coarse, less than 5% gravel, composition as above, takes lots of water, mixed 2 bags of mud, #25-#35 slot screen	25-40
CLAY, silty, sandy, pebbly, olive gray (Till)	40-45

130-059-04AAA2

USBR hole number: 3+00
Date completed: 12/05/89
Depth drilled: 36
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1306.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-0.5
LOAM, sandy, fine, moderate lime, brown	0.5-1.5
LOAM, sandy, very fine, moderate lime, pale brown	1.5-3.0
LOAM, sandy, very fine, brown	3.0-6.0
LOAM, silty, iron stains, olive brown	6.0-11.0
LOAM, silty, gray	11.0-19.0
CLAY, silty, gray	19.0-26.0
SAND, coarse, poor recovery, gray	26.0-31.0
CLAY, silty, gray	31.0-36.0

Water Level = 8.7 feet below land surface
Electrical Conductivity = 2070 microsiemens

130-059-04AAA3

USBR hole number: 5+00
Date completed: 11/29/89
Depth drilled: 50 ft.
Screened interval: 43-48 ft.
Casing Size: 1 1/4 in.

NDSWC hole number: 12515
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1307.9

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
CLAY, silty, dark brown	0-2
CLAY, silty, light gray, soft, with red-yellow stringers, oxidized	2-12
CLAY, silty, greenish gray, soft, sticky	12-26
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, takes lots of water, mixed 1 bag of mud, @ 40-48 feet lots of shale and detrital lignite	26-48
CLAY, silty, greenish gray, soft, slightly sticky	48-50

130-059-04AAD3

USBR hole number: 7+00
Date completed: 12/05/89
Depth drilled: 50 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1307.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, moderate lime, black	0-2.0
LOAM, sandy, very fine, pale brown	2.0-5.0
LOAM, sandy, very fine, iron stains, olive brown	5.0-10.0
LOAM, silty, gray	10.0-14.0
LOAM, clayey, dense, gray	14.0-28.0
SAND, coarse, gray	28.0-41.0
SAND, medium, graded, 25% shale, 10% lignite	41.0-43.0
SAND (50%), very coarse, and gravel, 5% shale, 5% lignite	43.0-49.0
CLAY, silty, dark gray	49.0-50.0

Water Level = 10.1 feet below land surface
Electrical Conductivity = 2440 microsiemens

130-059-04AAD4

USBR hole number: 9+00
Date completed: 11/29/89
Depth drilled: 50 ft.
Screened interval: 40-45 ft.
Casing Size: 1 1/4 in.

NDSWC hole number: 12516
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1307.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
CLAY, silty, soft, dark brown	0-2
CLAY, silty, light gray, with red-yellow stringers, soft, sticky, oxidized	2-12
CLAY, silty, greenish gray, soft, sticky	12-24
SAND, very fine to very coarse, predominantly medium to coarse, takes lots of water, mixed 1 bag of mud, poor sample returns for grain size estimate, @ 31 feet slight bit chatter due to lignite fragments	24-41
GRAVEL (70-80%), fine to medium, and sand, poor recovery for grain size estimate, light to moderate bit chatter	41-45
CLAY, silty, sandy, pebbly, olive gray (Till)	45-50

130-059-04AAD5

USBR hole number: 11+00
Date completed: 12/06/89
Depth drilled: 48 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1307.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.5
LOAM, sandy, fine, brown	1.5-4.5
SAND, medium, dirty, graded, brown	4.5-8.5
SAND, fine, dirty, uniform, gray	8.5-18.0
SAND, fine, clean, gray	18.0-28.0
SAND, very fine, clean, uniform, gray	28.0-31.5
SAND, (50%), very coarse, and gravel, clean, gray	31.5-44.0
LOAM, silty, dark gray	44.0-48.0

Water Level = 9.0 feet below land surface
Electrical conductivity = 1290 microsiemens

130-059-04AAD6

USBR hole number: 13+00 Date completed: 11/30/89 Depth drilled: 50 ft. Screened interval: 38-43 Casing Size: 1 1/4 in.	NDSWC hole number: 12517 Purpose: obs. well Source of data: SWC Principal aquifer: Oakes Land surface altitude: 1308.1
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LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, very slightly clayey, dark brown	0-2
CLAY, light gray, yellow stringers, oxidized	2-3
SAND, very fine to very coarse, predominantly fine to medium, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	3-5
SAND, very fine to fine, silty, oxidized to 9-10 feet	5-13
SAND, very fine to very coarse, predominantly medium, composition as above, takes water, mixed 1 bag mud @ 20 feet, #18-#20 slot screen	13-25
SAND, very fine to very coarse, predominantly medium to coarse, composition as above, #20-#25 slot screen	25-35
SAND, very fine to very coarse, predominantly coarse to very coarse, 5 to 10% fine gravel, light bit chatter, takes water, mixed 1 bag of mud @ 35 feet, and 1 bag of mud @ 40 feet	35-44
CLAY, silty, sandy, pebbly, olive gray (Till)	44-50

130-059-04ADA1

USBR hole number: 19+00
Date completed: 12/07/89
Depth drilled: 50 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, fine, lime zone, pale brown	1.0-3.5
SAND, medium, dirty, iron stains	3.5-11.5
SAND, medium, very dirty, lignitic, oxidized, dark brown	11.5-14.0
SAND, medium, graded, gray brown	14.0-17.0
SAND, fine, uniform, gray	17.0-38.0
SAND, medium, slightly gravelly, graded, 5% shale, lignitic, gray	38.0-41.5
SAND (50%), coarse, and gravel, shaly, lignitic @	41.5-46.0
LOAM, silty, dark gray	46.0-50.0

Water Level = 10.6 feet below land surface
Electrical Conductivity = 1350 microsiemens

130-059-04ADD3

USBR hole number: 21+00
Date completed: 12/07/89
Depth drilled: 53 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, black	0-1.5
LOAM, sandy, fine, heavy lime zone @ 2.5-3.0 feet, pale brown	1.5-3.0
SAND, loamy, light lime, pale brown	3.0-5.5
SAND, medium, slightly gravelly, iron stains	5.5-10.5
SAND, fine, uniform, brown	10.5-13.0
LOAM, sandy, very fine, olive gray	13.0-14.0
SAND, very fine, uniform, olive brown	14.0-16.5
SAND, medium, dirty, graded, shaly, lignitic, gray	16.5-22.0
SAND, fine, uniform, clean, gray	22.0-34.0
SAND, medium, graded, 20% shale chips, gray	34.0-41.5
SAND (50%), very coarse, and gravel, gray	41.5-48.0
LOAM, silty, dark gray	48.0-53.0

Water Level = 10.6 feet below land surface
Electrical Conductivity = 1240 microsiemens

130-059-04ADD4

USBR hole number: 23+00
Date completed: 12/07/89
Depth drilled: 53 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, lime zone, black	0-1.5
LOAM, sandy, fine, olive brown	1.5-3.0
LOAM, silty, iron stains, olive brown	3.0-8.5
SAND, loamy, coarse, brown	8.5-11.0
SAND, loamy, gray brown	11.0-14.5
SAND, medium, 5% shale, gray	14.5-21.0
SAND, fine, clean, 5% shale, gray	21.0-28.0
SAND, medium, clean 5% shale, gray	28.0-41.5
SAND, (50%) very coarse, and gravel, gray	41.5-48.0
TILL, loamy, dark gray	48.0-53.0

Water Level = 10.6 feet below land surface
Electrical Conductivity = 1150 microsiemens

130-059-04ADD5

USBR hole number: 25+00
Date completed: 12/06/89
Depth drilled: 53 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.9

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.8
LOAM, sandy, fine, light lime, pale brown	1.8-4.0
LOAM, silty, olive brown	4.0-8.0
LOAM, silty, iron stains, red brown	8.0-9.5
SAND, coarse, dirty, graded, 5% shale, gray brown	9.5-16.0
SAND, fine, clean, uniform, gray	16.0-29.0
SAND, medium, clean, graded, 5% shale, gray	29.0-35.0
SAND, coarse, gray	35.0-40.0
SAND (50%), coarse, and gravel, few rocks, gray	40.0-43.0
TILL, loamy, dark gray	43.0-48.0
LOAM, silty, dark gray	48.0-53.0

Water Level = 11.8 feet below land surface
Electrical Conductivity = 990 microsiemens

130-059-04ACC1

USBR hole number: 1+00
Date completed: 12/08/89
Depth drilled: 38
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.0

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, fine, sandy	0-3.5
LOAM, silt	3.5-6.5
SAND, medium, graded, dirty, iron stains throughout	6.5-9.0
SAND, coarse, graded	9.0-11.5
SAND, fine, 20% shale, 5% lignite, graded	11.5-14.5
SAND, coarse, uniform, with larger lignite chips	14.5-20.0
SAND, coarse, and gravel, 15% shale, 50% gravel	20.0-31.0
CLAY, silty, dense	31.0-38.0

Water Level = 11.2 feet below land surface
Electrical Conductivity = 810 microsiemens

130-059-04ACC2

USBR hole number: 3+00 Date completed: 11/21/89 Depth drilled: 40 Screened interval: none Casing Size: n/a	NDSWC hole number: 12497 Purpose: test hole Source of data: SWC Principal aquifer: Oakes Land surface altitude: 1309.9
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LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, very slightly clayey, dark brown	0-2
CLAY, light gray, with red-yellow stringers, oxidized	2-7
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, yellow stained, oxidized	7-14
SAND, as above, gray, unoxidized	14-15
SAND, very fine to very coarse, predominantly medium, very slightly gravelly, lots of quartz, and detrital shale, #20 slot screen	15-20
SAND, very fine to very coarse, predominantly medium to coarse, composition as above, #20-#25 slot screen	20-27
SAND, coarse to very coarse, and gravel, fine to medium, composition as above, moderate bit chatter, takes water, mixed two bags of mud at 30 feet	27-34
CLAY, silty, greenish gray, soft	34-40

130-059-04ACC3

USBR hole number: 5+00
Date completed: 12/12/89
Depth drilled: 38
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.4

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, fine, sandy	0-2.5
SAND, very fine , loamy	2.5-4.0
LOAM, silty	4.0-8.0
SAND, coarse, dirty, graded	8.0-12.5
SAND, fine, uniform	12.5-18.0
SAND, medium, graded, 5% shale, some lignite	18.0-20.0
SAND, coarse, graded, 15% shale	20.0-23.0
SAND, medium, uniform, clean	23.0-28.5
SAND, very coarse, and gravel, 60%, 5% shale	28.5-32.5
LOAM, silty, clayey	32.5-38.0

Water Level = 11.6 feet below land surface
Electrical conductivity = 770 microsiemens

130-059-04ACD1

USBR hole number: 7+00
Date completed: 11/21/89
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12498
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1311.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, very slightly clayey, dark brown	0-3
CLAY, light gray, with red-yellow stringers, oxidized	3-7
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	7-14
SAND, as above, gray, unoxidized, #20-#25 slot screen	14-31
CLAY, silty, very slightly sandy, occasional pebble, olive gray, (Till)	31-40

130-059-04ACD2

USBR hole number: 9+00
Date completed: 12/12/89
Depth drilled: 38
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1311.4

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine	0-2
SAND, very fine, loamy	2.0-4.5
LOAM, silty	4.5-8.0
SAND, medium, dirty, graded	8.0-9.5
SAND, loamy	9.5-10.5
SAND, coarse, dirty, graded	10.5-13.5
SAND, fine	13.5-15.0
SAND, medium, clean, graded, less than 5% shale	15.0-22.5
SAND, coarse, graded, clean, less than 10% shale	22.5-28.0
SAND, medium, dirty, graded, 20% shale	28.0-31.0
SAND, very coarse, and gravel (60%), 5% shale	31.0-36.0
LOAM, silty, dark gray	36.0-38.0

Water Level = 12.4 feet below land surface
Electrical Conductivity = 810 microsiemens

130-059-04ACD3

USBR hole number: 11+00
Date completed: 11/22/89
Depth drilled: 50
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12499
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1311.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, very silty, slightly clayey, dark brown	0-3
CLAY, slightly silty, light gray, with red-yellow stringers, oxidized	3-8
SAND, very fine to very coarse, predominantly coarse, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	8-14
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, composition as above, gray, unoxidized, #20-#25 slot screen	14-20
SAND, very fine to coarse, predominantly fine to medium, composition as above, takes water, mixed two bags of mud at 30 feet, #12-#18 slot screen	20-30
SAND, and gravel, moderate bit chatter, very viscous drilling fluid, fine to medium gravel, estimate #50 slot screen or greater	30-37
CLAY, silty, sandy, pebbly, olive gray (Till)	37-50

130-059-04ACD4

USBR hole number: 13+00
Date completed: 12/14/89
Depth drilled: 43
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.8

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-2.0
LOAM, sandy, fine, brown	2.0-3.5
LOAM, silty, olive brown	3.5-8.0
SAND, medium, dirty, graded, brown	8.0-10.0
SAND, coarse, dirty, graded, brown	10.0-13.0
SAND, medium, clean, graded, gray	13.0-26.0
SAND, medium, slightly gravelly, graded, gray, 40% shale	26.0-29.5
SAND, very coarse, and gravel, 50% gravel, 5% shale, gray	29.5-39.5
LOAM, silty, dense, dark gray	39.5-43.0

Water Level = 11.6 feet below land surface
Electrical Conductivity = 830 microsiemens

130-059-04ADC1

USBR hole number: 15+00	NDSWC hole number: 12500
Date completed: 11/22/89	Purpose: test hole
Depth drilled: 40	Source of data: SWC
Screened interval: none	Principal aquifer: Oakes
Casing Size: n/a	Land surface altitude: 1309.8

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, slightly clayey, dark brown	0-3
CLAY, light gray, with red-yellow stringers, oxidized	3-8
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	8-13
SAND, very fine to very coarse, predominantly medium, @ 15-20 feet more shaly, very slightly gravelly, composition as above, gray unoxidized, #15-#20 slot screen	13-27
SAND, and gravel, takes lots of water, mixed two bags of mud, moderate bit chatter, composition as above, fine to medium gravel, estimate screen slot size greater than #50 slot	27-36
CLAY, silty to silt, clayey, poor recovery, drilled smooth	36-40

130-059-04ADC2

USBR hole number: 17+00
Date completed: 01/03/90
Depth drilled: 53
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.9

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.2
LOAM, sandy, fine, gray brown	1.2-2.5
LOAM, sandy, very fine, pale brown, moderate lime	2.5-4.0
LOAM, silty, olive brown	4.0-8.5
SAND, loamy, slightly gravelly, gray	8.5-10.5
SAND, medium, graded, less than 5% shale, gray	10.5-21.0
SAND, fine, uniform, clean, less than 5% shale, gray	21.0-28.5
SAND, coarse, graded, 5% shale, gray	28.5-32.5
SAND, coarse, graded, 15% shale, 5% lignite chips, gray	32.5-38.5
SAND, fine, loamy, cohesive, 10% shale, gray	38.5-41.0
SAND, fine, clean, 10% fine shale	41.0-42.0
SAND, medium, dirty, lignite fragments at 45-46 feet, gray	42.0-47.0
LOAM, silty, dense, dark gray	47.0-53.0

Water Level = 11.5 feet below land surface
Electrical Conductivity = 1030 microsiemens

130-059-04ADC3

USBR hole number: 19+00 Date completed: 11/22/89 Depth drilled: 50 Screened interval: none Casing Size: n/a	NDSWC hole number: 12501 Purpose: test hole Source of data: SWC Principal aquifer: Oakes Land surface altitude: 1309.9
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LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, slightly clayey, dark brown	0-2
CLAY, silty, light gray, with red-yellow stringers, oxidized	2-10
SAND, very fine to very coarse, predominantly medium, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	10-13
SAND, as above, gray, unoxidized	13-15
SAND, very fine to very coarse, predominantly coarse, composition as above, #20-#30 slot screen	15-21
SAND, very fine to fine, silty, #5-#8 slot screen	21-25
SAND, very fine to very coarse, predominantly medium to coarse, composition as above, #20-#25 slot screen	25-35
SAND, very fine to very coarse, predominantly medium, composition as above, #15-#20 slot screen	35-40
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, composition as above, slight bit chatter from 45-47 feet, #20-#25 slot screen	40-47
CLAY, silty, sandy, pebbly, olive gray (Till)	47-50

130-059-04ADD1

USBR hole number: 21+00
Date completed: 01/04/90
Depth drilled: 53
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine black	0-1.0
LOAM, sandy, fine, gray brown	1.0-3.5
LOAM, silty, olive brown	3.5-9.0
LOAM, clayey, olive brown	9.0-13.5
SAND, coarse, dirty, graded, brown	13.5-15.5
SAND, fine, dirty, 40% shale, lignitic, dark gray	15.5-29.0
SAND, medium, clean, graded, 10% shale, lignitic, gray	29.0-35.0
SAND, medium, dirty, graded, 40% shale, dark gray	35.0-37.5
SAND, coarse, and gravel, (15%), 10% shale, large lignite chips, dark gray	37.5-44.5
TILL, dark gray	44.5-53.0

Water Level = 11.4 feet below land surface
Electrical Conductivity = 830 microsiemens

130-059-04ADD2

USBR hole number: 22+60 Date completed: 11/22/89 Depth drilled: 60 Screened interval: none Casing Size: n/a	NDSWC hole number: 12502 Purpose: test hole Source of data: SWC Principal aquifer: Oakes Land surface altitude: 1310.7
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LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, very slightly clayey, dark brown	0-4
CLAY, silty, light gray, with red-yellow stringers, oxidized	4-8
SAND, very fine to very coarse, predominantly coarse, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, yellow stained, oxidized	8-10
SAND, as above, gray, unoxidized, #25-#30 slot screen	10-15
SAND, very fine to coarse, predominantly fine to medium, #10-#12 slot screen	15-20
SAND, very fine to fine silty, as above, #5-#8 slot screen	20-30
SAND, very fine to very coarse, predominantly fine to medium, composition as above, #12-#18 slot screen	30-40
SAND, very fine to very coarse, predominantly medium, composed predominantly of well rounded shale grains	40-48
CLAY, silty, sandy, pebbly, olive gray, (Till)	48-60

130-059-04ABC1

USBR hole number: 1+00
Date completed: 11/30/89
Depth drilled: 45 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1308.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.8
LOAM, sandy, fine, gray brown	1.8-3.0
LOAM, sandy, very fine	3.0-5.5
SAND, medium, dirty, iron stained, brown	5.5-9.0
SAND, medium, dirty, lignite chips, brown	9.0-11.5
SAND, medium, dirty, graded, gray brown	11.5-19.0
SAND, coarse, dirty, graded, 5% shale, gray	19.0-23.0
SAND, coarse, clean, uniform, gray	23.0-30.0
SAND, coarse, dirty, graded, 10% shale chips	30.0-33.0
SAND (50%), coarse, and gravel, dirty, graded, 10% shale, lignitic, gray	33.0-37.0
CLAY, silty, dark gray	37.0-40.0
TILL, loamy, dark gray	40.0-45.0

Water Level = 9.6 feet below land surface
Electrical Conductivity = 680 microsiemens

130-059-04ABC2

USBR hole number: 3+00
Date completed: 12/01/89
Depth drilled: 45 ft.
Screened interval: 33-38 ft.
Casing Size: 1 1/4 in.

NDSWC hole number: 12522
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1308.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, slightly clayey, dark brown	0-3
CLAY, light gray, yellow stained, oxidized	3-4
SAND, very fine to very coarse, predominantly medium, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, yellow stained, oxidized	4-13
SAND, very fine to very coarse, predominantly medium, slightly gravelly, composition as above, gray, unoxidized, lots of detrital lignite fragments, takes water, mixed 1 bag of mud at 20 feet, #15-#20 slot screen	13-33
SAND, (70-80%), very fine to very coarse, predominantly coarse to very coarse, and gravel, fine to medium, moderate bit chatter, takes water, mixed 1 bag of mud at 40 feet, greater than #50 slot screen	33-40
CLAY, silty, sandy, pebbly, olive gray, (Till)	

130-059-04ABC3

USBR hole number: 5+00
Date completed: 11/30/89
Depth drilled: 53
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1308.3

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, lime zone, black	0-2.5
SAND, very fine, loamy, brown	2.5-4.3
SAND, coarse, dirty, iron stained, 5% shale, brown	4.3-8.0
SAND, medium, graded, iron stained, brown	8.0-13.0
SAND, coarse, clean, graded, 5% shale, gray	13.0-32.5
SAND, coarse, and gravel, (30%), graded, 5% shale, gray	32.5-35.0
SAND, coarse, and gravel gravel sized lignite chips, 20% shale chips, gray	35.0-40.0
SAND, very coarse, clean, 20% shale, lignitic, gray	40.0-45.0
SAND, coarse, clean, 20% shale, gray	45.0-49.0
LOAM, sandy, very fine, dense, dark gray	49.0-52.0
TILL, loamy, dark gray	52.0-53.0

Water Level = 9.8 feet below land surface
Electrical Conductivity = 540 microsiemens

130-059-04ABD1

USBR hole number: 7+00	NDSWC hole number: 12521
Date completed: 11/30/89	Purpose: obs. well
Depth drilled: 55 ft.	Source of data: SWC
Screened interval: 44-49 ft.	Principal aquifer: Oakes
Casing Size: 1 1/4 in.	Land surface altitude: 1309.0

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-3
CLAY, light gray, yellow stained, oxidized	3-4
SAND, very fine to very coarse, predominantly medium, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	4-15
SAND, very fine to very coarse, predominantly medium to coarse, composition as above, unoxidized between 15-20 feet, #20-#25 slot screen	15-20
SAND, very fine to very coarse, predominantly medium, composition as above, mixed 1 bag of mud, takes water, #18-#20 slot screen	20-40
SAND, very fine to very coarse, predominantly coarse, slightly gravelly, composition as above, #20-#25 slot screen	40-49
GRAVEL, rocky, hard drilling, strong bit chatter	49-51
CLAY, silty, sandy, pebbly, olive gray, some silty clay to clayey silt recovery	51-55

130-059-04ABD2

USBR hole number: 9+00
Date completed: 11/30/89
Depth drilled: 58
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.2
LOAM, sandy, moderate lime, gray brown	1.2-2.5
SAND, coarse, loamy, pale brown	2.5-5.0
SAND, coarse, dirty, iron stained, 5% shale, brown	5.0-8.0
SAND, medium, graded, shaly, lignitic, some iron stains	8.0-20.0
SAND, coarse, graded, 5% shale, gray	20.0-25.0
SAND, medium, clean, uniform, gray	25.0-33.0
SAND, fine, layers of lignite chips, gray	33.0-35.0
SAND, coarse, graded, 10% shale, gray	35.0-38.5
SAND, very coarse, and gravel (50%), graded, 10% shale, gray	38.5-48.0
TILL, loamy, dark gray	48.0-58.0

Water Level = 10.7 feet below land surface
Electrical Conductivity = 1000 microsiemens

130-059-04ABD3

USBR hole number: 11+00	NDSWC hole number: 12520
Date completed: 11/30/89	Purpose: obs. well
Depth drilled: 55	Source of data: SWC
Screened interval: 42-47 ft.	Principal aquifer: Oakes
Casing Size: 1 1/4 in.	Land surface altitude: 1309.4

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-3
CLAY, light gray, yellow stained, oxidized	3-4
SAND, very fine to very coarse, slightly gravelly, predominantly fine to medium sand, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	4-6
SAND, very fine to medium, silty, predominantly fine to very fine, composition as above	6-15
SAND, very fine to very coarse, predominantly coarse, slightly gravelly, composition as above, #25-#30 slot screen	15-30
SAND, very fine to very coarse, predominantly medium, composition as above, #15-#20 slot screen	30-35
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, slightly coarser than above, composition as above, #20-#25 slot screen	35-47
CLAY, silty, sandy, pebbly, olive gray, (Till)	47-55

130-059-04ABD4

USBR hole number: 13+00
Date completed: 12/01/89
Depth drilled: 53 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.0

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-2.2
LOAM, sandy, fine, light lime, brown	2.2-3.0
SAND, fine, uniform, iron stains, light brown	3.0-8.0
SAND, medium, dirty, graded, 5% shale, brown	8.0-10.5
SAND, medium, graded, dirty, coarser than above, 5% shale, gray brown	10.5-15.0
SAND, coarse, graded, dirty, 20% shale, gray	15.0-17.5
SAND, fine, some lignite, gray	17.5-24.5
SAND, medium, clean, uniform, less than 5% shale, gray	24.5-33.0
SAND, coarse, clean, 10% shale, gray	33.0-46.5
SAND, very coarse, and gravel, graded, gravel to 1 inch in diameter	46.5-47.5
LOAM, silty, dark gray	47.5-53.0

Water Level = 10.4 feet below land surface
Electrical Conductivity = 710 microsiemens

130-059-04AAC1

USBR hole number: 15+00 Date completed: 11/30/89 Depth drilled: 55 ft. Screened interval: 38-43 ft. Casing Size: 1 1/4 in.	NDSWC hole number: 12519 Purpose: obs. well Source of data: SWC Principal aquifer: Oakes Land surface altitude: 1310.2
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LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-3
CLAY, light gray, yellow stringers, oxidized	3-4
SAND, very fine to very coarse, predominantly medium, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized somewhere between 10 and 15 feet, gray, unoxidized	4-15
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, composition as above, gray, unoxidized	15-22
SAND, very fine to medium, predominantly very fine to fine, silty, composition as above, #6-#12 slot screen	22-28
SAND, very fine to very coarse, predominantly medium, composition as above, #15-#20 slot screen	28-35
SAND, very fine to very coarse, predominantly medium to coarse, very shaly, lignitic, #20-#25 slot screen	35-44
SAND, gravel and rocks, strong bit chatter	44-46
CLAY, silty, sandy, pebbly, olive gray, (Till)	46-55

130-059-04AAC2

USBR hole number: 17+00
Date completed: 12/04/89
Depth drilled: 53 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-2.0
LOAM, sandy, light lime, gray brown	2.0-2.5
SAND, medium, iron stains, graded, brown	2.5-8.5
SAND, medium, dirty, graded, brown	8.5-10.5
SAND, coarse, brown	10.5-14.5
SAND, coarse, clean, gray	14.5-25.5
SAND, coarse, clean, 10% shale, lignitic, gray	25.5-30.0
SAND, medium, 10% shale, gray	30.0-33.0
SAND, medium, clean, graded, 5% shale	33.0-38.0
SAND, medium, dirty, graded, 20% shale, gray	38.0-43.0
GRAVEL(70%), and sand, coarse, 10% rocks to 1.5 inch diameter	43.0-48.0
TILL, loamy, dark gray	48.0-53.0

Water Level = 11.5 feet below land surface
Electrical Conductivity =- 1400 microsiemens

130-059-04AAC3

USBR hole number: 19+00
Date completed: 11/30/89
Depth drilled: 60 ft.
Screened interval: 46-51 ft.
Casing Size: 1 1/4 in.

NDSWC hole number: 12518
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1310.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-3
SAND, very fine to very coarse, predominantly fine, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	3-7
SAND, very fine to fine, silty, composition as above, yellow stained, oxidized	7-10
SAND, very fine to very coarse, predominantly medium, very slightly gravelly, composition as above, yellow stained, oxidized	10-17
SAND, very fine to very coarse, predominantly medium, slightly gravelly, composition as above, takes water, mixed 1 bag of mud @ 20 feet, #18-#20 slot screen	17-40
SAND, very fine to very coarse, predominantly fine to medium, composition as above, #12-#18 slot screen	40-46
SAND, very fine to very coarse, predominantly coarse to very coarse, 5% gravel, light bit chatter, takes water, mixed 1 bag of mud @ 50 feet, from 50-56 feet less bit chatter, probably finer section	46-56
CLAY, silty, sandy, pebbly, olive gray, (Till)	56-60

130-059-04AAD1

USBR hole number: 21+00
Date completed: 12/05/89
Depth drilled: 55 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.5
LOAM, sandy, light lime, gray brown	1.5-2.2
SAND, medium, iron stains, dirty, graded, brown	2.2-6.5
SAND, fine, some iron stains, brown	6.5-8.5
SAND, medium, graded, brown	8.5-13.0
SAND, medium, clean, graded, gray brown	13.0-18.5
SAND, very fine, clean, uniform, gray	18.5-24.0
SAND, medium, clean, graded, gray	24.0-34.5
SAND, coarse, slightly gravelly, graded, 5% shale	34.5-43.0
SAND (50%), very coarse, and gravel, gray	43.0-52.0
TILL, loamy, dark gray	52.0-55.0

Water Level = 11.2 feet below land surface
Electrical Conductivity = 1600 microsiemens

130-059-04AAD2

USBR hole number: 23+00
Date completed: 12/05/89
Depth drilled: 53 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.0

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-2.5
SAND, medium, dirty, graded, brown	2.5-4.0
SAND, fine, some iron stains, brown	4.0-12.5
SAND, medium, graded, brown	12.5-16.0
SAND, coarse, clean, uniform, 5% shale	16.0-20.0
SAND, medium, graded, 10% shale, gray	20.0-23.0
SAND, very fine, uniform, gray	23.0-30.0
SAND, medium, clean, uniform, gray	30.0-35.5
SAND, medium, graded, 5% shale, gray	35.5-41.5
GRAVEL (50%), and sand, coarse, 10-25% shale, gray	41.5-49.0
TILL, loamy, dark gray	49.0-53.0

Water Level = 11.7 feet below land surface
Electrical Conductivity = 1890 microsiemens

130-059-04ACC6

USBR hole number: 42+77
Date completed: 02/23/90
Depth drilled: 33 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1307.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, light lime, iron stains, pale olive brown	1.0-3.0
SAND, coarse, loamy, iron stains, shale chips, brown	3.0-8.0
SAND, coarse, graded, shale and lignite chips, gray	8.0-22.0
SAND, (60%), very coarse, and gravel, well graded, shale chips, gray	22.0-28.0
TILL, loamy, dark gray	28.0-33.0

Water Level = 9.5 feet below land surface

130-059-04ACC4

USBR hole number: 42+27
Date completed: 02/15/90
Depth drilled: 33 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1307.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
SAND, loamy, light iron stain, brown	1.0-4.0
SAND, coarse, loamy, iron stains, graded, brown	4.0-7.0
LOAM, sandy, lignite chips, dark brown	7.0-10.0
SAND, medium, clean, uniform, gray	10.0-23.0
SAND, coarse, well graded, clean, lignite and shale chips, gray	23.0-25.5
SAND, very coarse, and gravel (25%), well graded, clean, gray	25.5-28.0
TILL, loamy, dark gray	28.0-33.0

Water Level = 9.5 feet below land surface

130-059-04ACC5

USBR hole number: 41+77
Date completed: 02/23/90
Depth drilled: 33 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1307.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, light lime, iron stains, pale olive brown	1.0-3.0
SAND, coarse, loamy, heavy iron stains, shale chips, yellow brown	3.0-9.0
SAND, medium, dirty, graded, shale and lignite chips, gray	9.0-22.5
SAND, (50%), very coarse, and gravel, well graded, clean, shale chips, gray	22.5-30.0
TILL, loamy, dark gray	30.0-33.0

Water Level = 9 feet below land surface

130-059-04ACB1

USBR hole number: n/a
Date completed: 11/29/89
Depth drilled: 40 ft.
Screened interval: 32-37
Casing Size: 1 1/4 in.

NDSWC hole number: 12510
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1310.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-2
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	2-10
SAND, very fine to coarse, predominantly fine to medium, composition as above, gray, unoxidized, #12-#15 slot screen	10-14
SAND, very fine to medium, predominantly fine, composition as above, #10-#12 slot screen	14-20
SAND, very fine to very coarse, predominantly medium, composition as above, #15-#20 slot screen	20-29
SAND, very fine to very coarse, predominantly coarse to very coarse, 5% gravel, light to moderate bit chatter, takes water, mixed 1 bag of mud, #40-#50 slot screen	29-37
CLAY, silty, greenish gray, soft, poor recovery	37-40

Observation well located 95 feet south of test well

130-059-04ACB2

USBR hole number: n/a
Date completed: 11/29/89
Depth drilled: 40 ft.
Screened interval: 32-37
Casing Size: 1 1/4 in.

NDSWC hole number: 12511
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1310.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-2
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	2-10
SAND, very fine to very coarse, predominantly medium, predominantly shale and quartz, #15-#20 slot screen	10-14
SAND, very fine to very coarse, predominantly medium, composition as above, less shale, #15-#20 slot screen	14-20
SAND, very fine to very coarse, predominantly medium to coarse, composition as above, #20-#25 slot screen	20-29
SAND, very fine to very coarse, predominantly coarse to very coarse, composition as above, lignitic, light bit chatter, takes water, mixed 1 bag mud, greater than #50 slot screen	29-38
CLAY, silty, greenish, soft, sticky	38-40

Observation well located 50 feet south of test well

130-059-04ACB3

USBR hole number: n/a	NDSWC hole number: 12512
Date completed: 11/29/89	Purpose: obs. well
Depth drilled: 40 ft.	Source of data: SWC
Screened interval: 34-39 ft.	Principal aquifer: Oakes
Casing Size: 1 1/4 in.	Land surface altitude: 1310.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-2
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	2-10
SAND, very fine to very coarse, predominantly medium, composition as above, gray, unoxidized, #15-#18 slot screen	10-15
SAND, very fine to medium, predominantly fine to medium, composition as above, #12-#15 slot screen	15-20
SAND, very fine to very coarse, predominantly medium to coarse, composition as above, #20-#25 slot screen	20-30
SAND, very fine to very coarse, predominantly coarse to very coarse, 5-10% gravel, light to moderate bit chatter, takes water, mixed 1 bag of mud, greater than #50 slot screen	30-39
CLAY, silty, greenish gray, soft, sticky, good recovery	39-40

Observation well located 20 feet south of test well

130-059-04ACB4

USBR hole number: n/a
Date completed: 11/29/89
Depth drilled: 40 ft.
Screened interval: 33-38 ft.
Casing Size: 1 1/4 in.

NDSWC hole number: 12513
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1310.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-2
SAND, very fine to very coarse, predominantly medium, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	2-9
SAND, very fine to medium, predominantly fine to very fine, composition as above, gray, unoxidized, #8-#10 slot screen	9-18
SAND, very fine to very coarse, predominantly fine to medium, composition as above, #12-#18 slot screen	18-28
SAND, very fine to very coarse, 5-10% fine gravel, composition as above, takes lots of water, mixed 2 bags of mud, estimate greater than #50 slot screen	28-38
CLAY, silty, greenish gray, soft, sticky	38-40

Observation well located 9 feet south of test well

130-059-04ACB6

USBR hole number: n/a Date completed: 12/01/89 Depth drilled: 40 ft. Screened interval: 32-37 ft. Casing Size: 1/1/4 in.	NDSWC hole number: 12523 Purpose: obs. well Source of data: SWC Principal aquifer: Oakes Land surface altitude: 1310.7
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LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, very slightly clayey, dark brown	0-2
SAND, very fine to very coarse, predominantly medium, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	2-5
SAND, very fine to coarse, predominantly fine to medium, composition as above, yellow stained, oxidized	5-11
SAND, very fine to very coarse, predominantly fine to medium, composition as above, gray, unoxidized	11-15
SAND, very fine to medium, predominantly fine, composition as above, #10-#12 slot screen	15-20
SAND, very fine to very coarse, predominantly medium, composition as above, lignite fragments at 28 feet, #18-#20 slot screen	20-32
SAND, very fine to very coarse, predominantly coarse to very coarse, 5% gravel, greater than # 50 slot screen	32-38
CLAY, silty, sandy, pebbly, olive gray, (Till)	38-40

Observation well located 70 feet south of test well

130-059-04ACB7

USBR hole number: n/a
Date completed: 11/30/89
Depth drilled: 39.5 ft.
Screened interval: 30.5-39.5
Casing Size: 8 in. pvc

NDSWC hole number: n/a
Purpose: test well
Source of data: M&W Drilling
Principal aquifer: Oakes
Land surface altitude: 1310.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
TOPSOIL	0-2
SAND, brown	2-12
SAND, medium, gray	12-29.5
SAND, coarse, and gravel	29.5-34.5
SAND, fine to medium, gray	34.5-38.0
LIGNITE	38.0-38.2
SAND, fine gray	38.2-39.5

Well screen construction information:
8-inch pipe size, stainless steel screen
#45 slot from 30.5-35.5 feet
#25 slot from 35.5 39.5 feet

130-059-04ACB8

USBR hole number: 38+42
Date completed: 12/12/89
Depth drilled: 43 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.5
SAND, fine, dirty, brown	1.5-3.0
LOAM, sandy, olive brown	3.0-4.5
SAND, medium, dirty, iron stains, red brown	4.5-6.5
SAND, loamy, olive brown	6.5-8.0
SAND, fine, uniform, slight iron stains, brown	8.0-10.5
SAND, fine, olive brown	10.5-18.0
SAND, medium, graded, 5% shale, gray brown	18.0-20.0
SAND, coarse, graded, 20% shale chips, lignitic	20.0-22.0
SAND, medium, clean, with layers of up to 25% shale, gray	22.0-29.5
SAND,(50%), very coarse, and gravel, 5% shale chips, gray	29.5-33.0
SAND, medium, graded, 50% lignite chips between 34.5-36.0	33.0-36.0
LOAM, silty, clayey, dark gray	36.0-43.0

Water Level = 10.5 feet below land surface
Test hole located 15 feet south of test well

130-059-04ACB9

USBR hole number: 33+67
Date completed: 02/16/90
Depth drilled: 38 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1308.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, moderate lime, gray brown	1.0-3.0
LOAM, sandy, iron stains, light lime, brown	3.0-10.5
SAND, coarse, loamy, dirty, lots of lignite and shale, gray	10.5-18.0
SAND, coarse, graded, clean, some lignite and shale, gray	18.0-30.0
SAND, very coarse (50%), and gravel, well graded, clean, gray	30.0-35.0
TILL, loamy, dark gray	35.0-38.0

Water Level = 9.0 feet below land surface

130-059-04BAA4

USBR hole number: 22+00
Date completed: 11/28/89
Depth drilled: 50 ft.
Screened interval: 38-43 ft.
Casing Size: 1 1/4 in.

NDSWC hole number: 12509
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1306.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
CLAY, silty, very slightly sandy, dark brown	0-2
CLAY, silty, light gray, with red-yellow stringers, soft, sticky, oxidized	2-17
CLAY, silty, greenish gray, soft, sticky, unoxidized	17-30
SAND, very fine to very coarse, predominantly medium, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, #20 slot screen	30-40
SAND, very fine to very coarse, predominantly coarse, composition as above, slightly gravelly, #30-#35 slot screen	40-44
CLAY, silty, sandy, pebbly, olive gray (Till)	44-50

130-059-04BAA3

USBR hole number: 24+00
Date completed: 11/29/89
Depth drilled: 40 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1305.8

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.4
LOAM, sandy, fine, light lime, pale brown	1.4-5.0
LOAM, sandy, very fine, iron stains, olive brown	5.0-13.0
LOAM, silty, gray	13.0-22.0
CLAY, silty, very dense, gray	22.0-30.0
SAND, coarse, dirty, graded, 5% shale, gray	30.0-31.0
SAND, medium, dirty, 5% shale, gray	31.0-32.0
SAND, coarse, clean, 10% shale, gray	32.0-38.0
TILL, loamy, dark gray	38.0-40.0

Water Level = 7.9 feet below land surface
Electrical Conductivity = 5450 microsiemens

130-059-04BAA2

USBR hole number: n/a	NDSWC hole number: 12508
Date completed: 11/28/89	Purpose: obs.well
Depth drilled: 30 ft.	Source of data: SWC
Screened interval: 20-25 ft.	Principal aquifer: Oakes
Casing Size: 1 1/4 in.	Land surface altitude: 1306.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
CLAY, silty, sandy, dark brown	0-2
CLAY, slightly silty, light gray, with red-yellow stringers, oxidized	2-12
CLAY, slightly silty, greenish gray, soft, sticky	12-20
SAND, very fine to very coarse, predominantly medium to coarse, less than 5% gravel, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, gray, unoxidized, #20-#25 slot screen	20-25
SAND, very fine to very coarse, predominantly coarse, composition as above, #25-#30 slot screen	25-30

130-059-04BAA1

USBR hole number: 26+00
Date completed: 11/28/89
Depth drilled: 50 ft.
Screened interval: 38-43 ft.
Casing Size: 1 1/4 in.

NDSWC hole number: 12507
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1306.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
CLAY, silty, sandy, dark brown	0-2
CLAY, silty, light gray,with red-yellow stringers, soft, sticky, oxidized	2-12
CLAY, silty, greenish gray, soft, sticky, unoxidized	12-20
SAND, very fine to very coarse, predominantly medium to coarse, less than 5% gravel, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, #20-#25 slot screen	20-25
SAND, very fine to very coarse,predominantly coarse, composition as above, #25-#30 slot screen	25-30
SAND, very fine to very coarse, predominantly medium, composition as above, #15-#20 slot screen	30-35
SAND, very fine to very coarse, predominantly medium to coarse, composition as above, lignitic, #20-#25 slot screen	35-44
CLAY, silty, greenish gray, soft	44-47
CLAY,silty, sandy, pebbly,olive gray,soft, (Till)	47-50

130-059-04BAD3

USBR hole number: 28+00
Date completed: 11/29/89
Depth drilled: 53 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1307.3

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, lime zone from 1.5-2.0 feet, black	0-2.0
LOAM, sandy, very fine, pale brown	2.0-3.0
LOAM, silty, iron stains, olive brown	3.0-9.0
CLAY, silty, dark gray	9.0-13.5
SAND, coarse, loamy, graded, gray	13.5-16.0
SAND, coarse, dirty, gray	16.0-28.0
SAND, very coarse, and gravel (5%), 10% shale chips, gray	28.0-34.0
SAND, coarse, graded, dirty with gravel from 38-40 feet, gray	34.0-40.0
CLAY, silty, dark gray	40.0-43.0
TILL, loamy, dark gray	43.0-53.0

Water Level = 9.2 feet below land surface
Electrical Conductivity = 1310 microsiemens

130-059-04BAD2

USBR hole number: 30+00
Date completed: 11/21/89
Depth drilled: 50
Screened interval: 31-36 ft.
Casing Size: 1 1/4 in.

NDSWC hole number: 12491
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1307.0

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, silty, slightly clayey, dark brown	0-2
CLAY, slightly silty, sticky, soft, light gray to yellow brown, oxidized	2-10
CLAY, very slightly silty, soft, very sticky, greenish gray	10-17
SAND, very fine to very coarse, predominantly medium to coarse, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, #20-#25 slot screen	17-29
SAND, (70-80%), coarse to very coarse, and gravel, predominantly fine, composition as above, with lignite fragments, moderate bit chatter, takes water, greater than #50 slot screen	29-40
CLAY, slightly silty, soft, greenish gray	40-50

130-059-04BAD1

USBR hole number: 32+00	NDSWC hole number: n/a
Date completed: 11/29/89	Purpose: test hole
Depth drilled: 48 ft.	Source of data: USBR
Screened interval: none	Principal aquifer: Oakes
Casing Size: n/a	Land surface altitude: 1308.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-2.0
LOAM, sandy, fine, pale brown	2.0-3.0
LOAM, sandy, very fine, iron stains, olive brown	3.0-8.0
LOAM, silty, clayey, gray	8.0-10.0
SAND, loamy, gray	10.0-13.0
SAND, coarse, dirty, 5% shale, lignitic, gray	13.0-22.0
SAND, coarse, slightly dirty, 5% shale chips	22.0-29.5
SAND, very coarse, and gravel (50%), slightly dirty, gray	29.5-34.0
GRAVEL(80%), and very coarse sand, large lignite fragments, gray	34.0-43.0
CLAY, silty, dark gray	43.0-46.0
TILL, loamy, dark gray	46.0-48.0

Water Level = 10.0 feet below land surface
Electrical Conductivity = 680 microsiemens

130-059-04BDA3

USBR hole number: 34+00
Date completed: 11/21/89
Depth drilled: 50 ft.
Screened interval: 32-37 ft.
Casing Size: 1 1/4 in.

NDSWC hole number: 12490
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1308.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to medium, silty, slightly clayey, dark brown	0-3
CLAY, light gray to brown, soft, oxidized	3-5
SAND, very fine to very coarse, predominantly medium to coarse, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	5-11
SAND, as above, gray, unoxidized, from 10-15 feet lots of detrital shale and lignite, slight bit chatter, #20-#25 slot screen	11-34
SAND, and gravel, strong bit chatter, takes water, mixed 1 1/2 bags of mud at 30 and 35 feet, lots of carbonates, shale, shield silicates, gravel is fine to medium, greater than #50 slot screen	34-38
CLAY, silty, soft, greenish gray	38-50

130-059-04BDA2

USBR hole number: 36+00	NDSWC hole number: n/a
Date completed: 11/28/89	Purpose: test hole
Depth drilled: 43	Source of data: USBR
Screened interval: none	Principal aquifer: Oakes
Casing Size: n/a	Land surface altitude: 1310.3

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.5
SAND, loamy, light lime, pale brown	1.5-4.0
SAND, medium, graded, iron stains, brown	4.0-10.0
SAND, fine, uniform, iron stains, brown	10.0-22.5
SAND, coarse, 10% shale, some lignite, gray	22.5-33.5
GRAVEL (60%), and sand, very coarse, clean, graded, gray	33.5-36.5
SAND, coarse, graded, 10% shale, gray	36.5-41.0
LOAM, silty, dense, dark gray	41.0-43.0

Water Level = 11.8 feet below land surface
Electrical Conductivity = 530 microsiemens

130-059-04BDA1

USBR hole number: 38+00
Date completed: 11/20/89
Depth drilled: 50
Screened interval: 35-40
Casing Size: 1 1/4 in.

NDSWC hole number: 12489
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1311.3

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, silty, very slightly clayey, dark brown	0-2
CLAY, light gray, oxidized	2-3
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	3-13
SAND, very fine to medium, predominantly fine to very fine, silty, yellow stained, oxidized, composition as above	13-18
SAND, very fine to coarse, predominantly medium, yellow stained, oxidized, #15-#18 slot screen	18-20
SAND, very fine to very coarse, predominantly medium to coarse, very slightly gravelly, lots of detrital shale and quartz, #20-#25 slot screen	20-25
SAND, very fine to very coarse, predominantly medium, lots of quartz, #15-#20 slot screen	25-29
SAND, coarse to very coarse, and gravel, takes lots of water, mixed 1 bag of mud at 30 feet and 1 bag of mud at 40 feet, moderate bit chatter, greater than #50 slot screen	29-41
CLAY, silty to silt, clayey	41-50

130-059-04BDD4

USBR hole number: 40+00
Date completed: 11/28/89
Depth drilled: 38
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy,black	0-1.2
SAND, loamy, light lime, pale brown	1.2-3.0
SAND, medium, dirty, graded, 5% shale,brown	3.0-7.0
SAND, fine,uniform, some iron stains	7.0-10.5
SAND, medium, graded, iron stains, 5% shale, lignitic	10.5-15.0
SAND, coarse, clean 15% shale, gray	15.0-26.5
GRAVEL (80%), and very coarse sand, clean, graded, 5% shale, mostly 1/8-1/4 inch gravel, gray	26.5-36.5
LOAM, silty, clayey, dark gray	36.5-38.0

Water Level = 10.4 feet below land surface
Electrical Conductivity = 500 microsiemens

130-059-04BDD3

USBR hole number: 42+00
Date completed: 11/20/89
Depth drilled: 40
Screened interval: 30-35
Casing Size: 1 1/4 in.

NDSWC hole number: 12488
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1308.3

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
CLAY, silty, slightly sandy, dark brown	0-2
CLAY, silty, very slightly sandy, light gray, with red-yellow stringers, oxidized	2-4
SAND, very fine to very coarse, predominantly medium to coarse, very slightly gravelly, lots of quartz, carbonates, shale, minor shield silicates, subangular to well rounded, yellow stained, oxidized	4-13
SAND, very fine to fine, silty, composition as above, lignitic	13-20
SAND, very fine to very coarse, predominantly medium to coarse, composition as above, #20-#25 slot screen	20-26
SAND, very fine to very coarse, predominantly medium to coarse, slight bit chatter, slightly gravelly, takes lots of water, mixed two bags of mud, composition as above, #25-#30 slot screen	26-33
SAND, and gravel, very strong bit chatter, poor recovery to estimate grain size, lots of carbonates	33-35
CLAY, slightly silty, soft, greenish gray	35-40

130-059-04BDD1

USBR hole number: 44+00
Date completed: 11/28/89
Depth drilled: 38
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1308.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, black	0-1.2
LOAM, silty, iron stains, pale brown	1.2-4.5
SAND, medium, dirty, graded, 5% shale chips, brown	4.5-9.5
SAND, medium, very dirty, graded, 10% shale, 20% lignite chips, gray	9.5-16.0
SAND, coarse, graded, 5% shale, lignitic, gray	16.0-18.0
SAND, medium, 5% shale, gray	18.0-24.0
SAND, very coarse, clean, 15% shale, lignitic, gray	24.0-32.5
GRAVEL (80%), and sand, very coarse, few rocks to 1 inch in diameter, gray	32.5-35.5
LOAM, sandy, very fine, dark gray	35.5-38.0

Water level = 9.6 feet below land surface
Electrical Conductivity = 620 microsiemens

130-059-04BDD2

USBR hole number: 3+00
Date completed: 11/21/89
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12492
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1309

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, very silty, slightly clayey, dark brown	0-3
CLAY, light gray, soft, oxidized	3-4
SAND, very fine to very coarse, predominantly medium to coarse, less than 5% gravel, @ 8 feet slight bit chatter, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	4-13
SAND, as above, gray, unoxidized	13-15
SAND, very fine to coarse, predominantly fine to medium, from 20 to 25 feet mostly detrital shale, #10-#18 slot screen	15-25
SAND, (90%), very fine to very coarse, predominantly coarse to very coarse, and gravel (10%), fine, composition as above, moderate bit chatter	25-26
CLAY, silty, greenish gray, soft	26-38
CLAL, silty, sandy, pebbly, olive gray, (Till)	38-40

130-059-04BDC1

USBR hole number: 7+00 Date completed: 11/21/89 Depth drilled: 40 Screened interval: none Casing Size: n/a	NDSWC hole number: 12493 Purpose: test hole Source of data: SWC Principal aquifer: Oakes Land surface altitude: 1310
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LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, very silty, slightly clayey, dark brown	0-3
CLAY, silty, light gray	3-4
SAND, very fine to fine, very silty, yellow stained, oxidized	4-6
CLAY, silty, sandy, pebbly, yellow gray, oxidized, (Till block?)	6-8
SAND, very fine to very coarse, predominantly medium to coarse, very slightly gravelly, lots of shale, quartz, carbonates, minor shield silicates, subangular to well rounded, yellow stained oxidized	8-14
SAND, as above, lots of detrital shale, gray unoxidized, #20-#25 slot screen	14-22
SAND, predominantly coarse to very coarse, and gravel, fine to medium, predominantly carbonates	22-23
CLAY, silty, greenish gray, soft	23-24
CLAY, silty, sandy, pebbly, olive gray, (Till)	24-40

130-059-04BDC2

USBR hole number: 11+00
Date completed: 11/21/89
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12494
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1307

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, very silty, slightly clayey, dark brown	0-2
CLAY, slightly silty, light gray, with red-yellow stringers, oxidized	2-6
SAND, very fine to very coarse, predominantly medium to coarse, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, lignitic, subangular to well rounded, yellow stained, oxidized	6-11
SAND, as above, lots of shale and detrital lignite, gray, unoxidized, #20-#25 slot screen	11-20
SAND, very fine to very coarse, predominantly coarse, less than 5% gravel, composition as above, slight bit chatter, #30-#35 slot screen	20-25
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, composition as above, #20-#30 slot screen	25-30
SILT, very clayey to clay, very silty, greenish gray, varved?	30-40

130-059-04BCD

USBR hole number: 15+00
Date completed: 11/21/89
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12495
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1311

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, slightly clayey, dark brown	0-3
CLAY, silty, light gray, with red-yellow stringers, oxidized	3-9
SAND, very fine to very coarse, predominantly coarse, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	9-15
SAND, very fine to very coarse, predominantly medium to coarse, lots of shale and quartz, gray, unoxidized, #18-#20 slot screen	15-20
SAND, very fine to very coarse, predominantly medium to coarse, composition as above, #20-#25 slot screen	20-25
SAND, very fine to very coarse, predominantly coarse to very coarse, less than 5% gravel, lots of detrital shale, #25-#35 slot screen	25-30
SAND, very fine to very coarse, overall a little coarser than above, less detrital shale, #30-#45 slot screen	30-36
CLAY, silty, to silt, clayey, greenish gray, soft	36-40

130-059-04BCC

USBR hole number: 19+00
Date completed: 11/21/89
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12496
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1308

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
CLAY, silty, dark brown, sticky	0-2
CLAY, light gray, with red-yellow stringers, oxidized	2-6
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, lignitic, subangular to well rounded, yellow stained, oxidized	6-14
SAND, as above, gray, unoxidized, #20-#25 slot screen	14-28
ROCK	28-29
CLAY, silty, greenish gray, soft	29-40

130-059-04BDA4

USBR hole number: 34+00LAT
Date completed: 3/1/90
Depth drilled: 43 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1311.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, clayey, moderate lime at 2.0-3.0, gray brown	1.0-3.0
LOAM, sandy, light iron stains, moderate lime, gray brown	3.0-4.0
SAND, coarse, graded, heavy iron stains, yellow brown	4.0-9.5
SAND, coarse, loamy, lots of shale and lignite chips, gray	9.5-13.0
SAND, coarse, graded, clean, gray	13.0-30.0
SAND (60%), very coarse, and gravel, clean well graded, gravel up to 1.5 inch diameter, shale and lignite chips, gray	30.0-36.0
LOAM, silty, gray	36.0-43.0

Water Level = 10.5 feet below land surface

130-059-04BDA5

USBR hole number: 38+00LAT
Date completed: 3/1/90
Depth drilled: 43 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1311.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
SAND, coarse, clean, graded, iron stains, brown	1.0-8.0
SAND, medium, clean, uniform, iron stains, brown	8.0-17.0
SAND, coarse, clean, graded, shale chips, gray	17.0-27.0
SAND (70%), very coarse, and gravel, well graded, clean, shale chips, gravel up to 2 inches diameter, gray	27.0-42.5
TILL, loamy, gray	42.5-43.0

Water Level = 12.0 feet below land surface

130-059-04BDD5

USBR hole number: 42+00LAT
Date completed: 3/2/90
Depth drilled: 43 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1308.4

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-2.0
LOAM, clayey, light lime, olive brown	2.0-3.0
SAND, coarse, loamy, heavy iron stains, shale and lignite chips, yellow brown	3.0-8.0
SAND, medium, clean, uniform, gray	8.0-19.0
SAND, coarse, clean, graded, shale and lignite chips, gray	19.0-27.0
SAND, (60%), very coarse, and gravel up to 1 inch in diameter, well graded, clean, shale and lignite chips, gray	27.0-36.0
LOAM, silty, gray	36.0-43.0

Water Level = 10.0 feet below land surface

130-059-04CAA4

USBR hole number: 46+00
Date completed: 11/07/89
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12465
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1312.3

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, silty, very slightly clayey, noncohesive dark brown	0-2
SAND, very fine to medium, silty, predominantly fine to very fine, yellow brown, oxidized	2-5
CLAY, silty, slightly sandy, light gray, with red-yellow stringers, oxidized	5-9
SAND, very fine to very coarse, predominantly medium, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	9-15
SAND, as above, gray, unoxidized	15-17
SAND, very fine to very coarse, predominantly coarse, composition as above, gray, unoxidized	17-26
SAND (80%), very fine to very coarse, predominantly coarse to very coarse, and gravel (20%), lots of shale, quartz, detrital lignite fragments, carbonates, minor shield silicates, subangular to well rounded, @ 35 feet caving, added 1 bag of mud	26-36
CLAY, silty, sandy, pebbly, olive gray, poor recovery	36-40

130-059-04CAA5

USBR hole number: 46+27
Date completed: 3/1/90
Depth drilled: 33 ft
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1312.3

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-2.0
LOAM, sandy, light iron stains, light lime, brown	2.0-4.0
LOAM, silty, clayey, iron stains, olive brown	4.0-8.0
LOAM, sandy, coarse, heavy iron stains, shale chips, yellow brown	8.0-13.5
SAND, coarse, clean, graded, shale chips, gray	13.5-23.0
SAND (50%), very coarse, and gravel, clean, well graded, shale chips, gray	23.0-33.0

Water Level = 12.0 feet below land surface

130-059-04CAA3

USBR hole number: 48+00
Date completed: 11/08/89
Depth drilled: 35
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1311.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, dark brown	0-3.0
LOAM, sandy, fine, iron stains, brown	3.0-6.0
LOAM, silty, clayey, gray	6.0-8.5
LOAM, sandy, iron stains, brown	8.5-11.0
SAND, medium, graded, with shale chips	11.0-18.0
SAND, medium, uniform, with shale and lignite chips, gray	18.0-22.0
SAND, coarse, clean, graded, with shale and lignite chips	22.0-27.5
SAND, very coarse, and gravel (50%), clean, well graded, gray	27.5-33.5
TILL, loamy, gray	33.5-35.0

Water Level = 12.0 feet below land surface

130-059-04CAA7

USBR hole number: 50+00A
Date completed: 3/1/90
Depth drilled: 43 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.9

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-2.0
LOAM, sandy, iron stains, brown	2.0-4.5
LOAM, sandy, iron stains, pale olive	4.5-7.5
LOAM, silty, clayey, iron stains, olive brown	7.5-10.0
LOAM, sandy, coarse, graded, iron stains, shale chips, brown	10.0-13.0
SAND, coarse, loamy, graded, shale and lignite chips, gray	13.0-18.0
SAND, coarse, graded, shale and lignite chips, gray	18.0-30.0
SAND, very coarse, well graded, dirty, 25% gravel, gray	30.0-33.0
TILL, loamy, gray	33.0-43.0

Water Level = 10.5 feet below land surface

130-059-04CAA2

USBR hole number: 50+00
Date completed: 11/07/89
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12464
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1310.9

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, silty, very slightly clayey, noncohesive, dark brown	0-2
SAND, very fine to medium, predominantly fine to very fine, yellow brown, oxidized	2-4
CLAY, silty, very slightly sandy, sticky, light gray, with red-yellow stringers, oxidized	4-11
SAND, very fine to very coarse, predominantly medium to coarse, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	11-16
SAND, very fine to very coarse, predominantly coarse, very slightly gravelly, slight bit chatter, lignitic, composition as above	16-20
SAND, very fine to coarse, predominantly fine to medium, very slightly gravelly, composition as above	20-25
SAND, very fine to very coarse, predominantly medium to coarse, very slightly gravelly, composition as above	25-31
SAND, (80%), very fine to very coarse, predominantly coarse to very coarse, and gravel, (20%), lots of shale, quartz, carbonates, minor shield silicates, slight bit chatter, subangular to well rounded	31-35
CLAY, silty, sandy, pebbly, olive gray, (Till), with some silty clay to clayey silt	35-40

130-059-04CAA1

USBR hole number: 52+00
Date completed: 11/08/89
Depth drilled: 25
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.9

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy,black	0-2.0
LOAM, sandy, clayey, iron stains, yellow brown	2.0-3.0
LOAM, silty, clayey, some sand lenses, olive brown	3.0-8.0
LOAM, sandy, lots of detrital shale, iron stains, dark brown	8.0-10.0
SAND, coarse, clean, graded, shale chips, gray	10.0-21.0
SAND, coarse,loamy, and gravel (30%), graded, gray	21.0-22.0
TILL,loamy, dark gray	22.0-25.0

Water Level = 10.9 feet below land surface

130-059-04CAD3

USBR hole number: 54+00
Date completed: 11/07/89
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12463
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1308.3

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
CLAY, silty, sandy, dark brown, slightly cohesive	0-2
CLAY, silty, very slightly sandy, slightly sticky, with red-yellow stringers, oxidized	2-5
SAND, very fine to very coarse, predominantly medium to coarse, very slightly gravelly, lots of shale, quartz, carbonates, minor shield silicates, lignitic, subangular to well rounded, yellow stained, oxidized	5-11
SAND, very fine to very coarse, predominantly coarse, slightly gravelly, composition as above, @ 14 feet a little bit chatter, some gravel recovery, gray, unoxidized, #20-#25 slot screen	11-23
CLAY, silty, sandy, pebbly, olive gray, (Till), some silty clay to clayey silt recovery, @ 25-26 feet and 30-31 feet thin sand and gravel layers composed predominantly of carbonates	23-40

130-059-04CAD2

USBR hole number: 56+00
Date completed: 11/07/89
Depth drilled: 23
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1307.9

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, black	0-1.0
LOAM, silty, clayey, iron stains, olive brown	1.0-3.7
SAND, medium, iron stains, clean from 3.7-6.0, dirty from 6.0-8.5, brown	3.7-8.5
SAND, coarse, well graded, lots of shale chips, gray	8.5-14.0
SAND, very coarse, clean, well graded, lignite chips, gray	14.0-19.0
TILL, loamy, dark gray	19.0-23.0

Water Level = 8.0 feet below land surface

130-059-04CAD1

USBR hole number: 58+00
Date completed: 11/07/89
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12459
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1308.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
CLAY, silty, slightly sandy, slightly cohesive, dark brown	0-2
CLAY, silty, slightly sandy, cohesive, light gray, with red-yellow stringers, oxidized	2-5
SAND, very fine to very coarse, predominantly medium, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	5-8
SAND, very fine to very coarse, predominantly coarse to very coarse, slightly gravelly, composition as above, yellow stained, oxidized	8-11
SAND, very fine to very coarse, predominantly medium to coarse, very slightly gravelly, composition as above, unoxidized, #20-#25 slot screen	11-22
CLAY, silty, sandy, pebbly, olive gray, some intervals have less sand, more silty and brittle (Till)	22-40

130-059-04CDA3

USBR hole number: 60+00
Date completed: 11/07/89
Depth drilled: 23
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1308.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, black	0-0.8
LOAM, silty, clayey, moderate lime, olive	0.8-2.0
SAND, loamy, graded, iron stained, greater than 5% gravel	2.0-9.0
SAND, fine, uniform, iron stained, brown	9.0-9.5
SAND, fine, uniform, olive	9.5-13.0
SAND, medium, clean, uniform, gray	13.0-14.0
SAND, very coarse, clean, graded, shale chips, gray	14.0-21.0
TILL, loamy	21.0-23.0

Water level = 9.0 feet below land surface

130-059-04CDA2

USBR hole number: 62+00
Date completed: 11/06/89
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12458
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1310.0

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
CLAY, silty, sandy, slightly cohesive, dark brown	0-2
CLAY, silty, slightly sandy, very slightly cohesive, light gray with red-yellow stringers, oxidized	2-4
SAND, very fine to very coarse, predominantly coarse to very coarse, moderately gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	4-8
SAND, very fine to very coarse, predominantly coarse, more fines than above, slightly gravelly, composition as above, some detrital lignite fragments, subangular to well rounded, yellow stained, oxidized	8-11
SAND, very fine to very coarse, predominantly medium, more fines than above, composition as above, more shale, #20-#30 slot screen	11-22
CLAY, silty, sandy, pebbly, cohesive, olive gray, Till)	22-27
SAND, very fine to very coarse, predominantly coarse to very coarse, and gravel (20%), lots of carbonates and shale, minor shield silicates, caving, takes water, probably a lense in the till	27-36
CLAY, silty, sandy, pebbly, olive gray (Till)	36-40

130-059-04CDA1

USBR hole number: 64+00
Date completed: 11/07/89
Depth drilled: 23
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.0

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-0.7
LOAM, sandy, brown, iron stains	0.7-1.5
SAND, coarse, loamy, graded, iron stained, 10% gravel, brown	1.5-9.0
SAND, medium, graded, iron stained, brown	9.0-12.5
SAND, fine, clean, uniform, gray	12.5-15.0
SAND, coarse, well graded, with shale chips and lignite, gray	15.0-22.0
TILL, loamy, olive gray	22.0-23.0

Water Level = 10.5 feet below land surface

130-059-04CDD3

USBR hole number: 66+00
Date completed: 11/06/89
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12457
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1310.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SILT, clayey, slightly sandy, pebbly, dark brown	0-2
SAND, very fine to very coarse, predominantly coarse, moderately gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	2-10
SAND, as above, finer section, predominantly fine to medium, yellow stained, oxidized	10-13
SAND, very fine to very coarse, predominantly fine to medium, very slightly gravelly, composition as above, at 23 feet lots of detrital lignite and shale, #15-#20 slot screen	13-23
CLAY, silty, sandy, pebbly, olive gray, rock at 25 feet, becomes less sandy with depth	23-40

130-059-04CDD2

USBR hole number: 68+00
Date completed: 11/07/89
Depth drilled: 23
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, brown	1.0-2.0
LOAM, sandy, clayey, gray brown	2.0-3.0
SAND, coarse, loamy, iron stained, graded, brown	3.0-11.0
SAND, medium, clean, graded, gray	11.0-18.7
TILL, loamy, dark gray	18.7-23.0

Water Level = 9.5 feet below land surface

130-059-04CDD1

USBR hole number: 70+00
Date completed: 11/06/89
Depth drilled: 31
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12456
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1309.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SILT, clayey, sandy, dark brown	0-2
CLAY, silty, slightly sandy, light gray, with yellow stringers, oxidized	2-4
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	4-11
SAND, as above, predominantly medium, more fines than above, light gray, unoxidized, #20-#25 slot screen	11-23
CLAY, silty, sandy, pebbly, olive gray, (Till)	23-26
SILT, clayey to clay, silty, slightly brittle to sticky, greenish gray	26-31

130-059-04CAA6

USBR hole number: 46+00LAT
Date completed: 3/2/90
Depth drilled: 38 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-2.0
LOAM, sandy, light iron stains, brown	2.0-3.5
LOAM, silty, clayey, iron stains, sand layers at 8.0-9.5 feet, olive brown	3.5-9.5
SAND, coarse, loamy, heavy iron stains, graded, shale chips, yellow brown	9.5-14.0
SAND, coarse, clean, graded, shale chips, gray	14.0-23.0
SAND (60%), very coarse, and gravel up to 1 inch in diameter, well graded, shale chips, gray	23.0-30.0
TILL, loamy, dark gray	30.0-38.0

Water Level = 11.5 feet below land surface

130-059-04CAA8

USBR hole number: 50+00LAT
Date completed: 3/2/90
Depth drilled: 38 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1308.4

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-2.0
LOAM, sandy, light iron stains, brown	2.0-4.5
LOAM, silty, clayey, iron stains, olive brown	4.5-10.0
SAND, coarse, loamy, heavy iron stains, shale chips, yellow brown	10.0-13.0
SAND, coarse, clean, graded, shale and lignite chips, gray	13.0-26.0
SAND (60%), very coarse, and gravel, clean graded, shale chips, gray	26.0-32.0
LOAM, silty, dark gray	32.0-37.0
TILL, loamy, dark gray	37.0-38.0

Water Level = 11.6 feet below land surface

130-059-04DBB1

USBR hole number: 46+27
Date completed: 02/15/90
Depth drilled: 33 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.0

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, fine, light iron stains, brown	1.0-2.0
LOAM, silty, clayey, iron stains, mottled, olive brown	2.0-4.5
SAND, loamy, heavy iron stains, 10% gravel, yellow brown	4.5-9.0
LOAM, sandy, 20% gravel, heavy iron stains, yellow brown	9.0-11.0
SAND, medium, clean, shale and lignite chips, gray	11.0-19.5
SAND, coarse, well graded, clean, lignite and shale chips, gray	19.5-23.0
SAND, very coarse, well graded, clean, shale and lignite chips, gray	23.0-27.0
TILL, loamy, dark gray	27.0-33.0

Water Level = 10.0 feet below land surface

130-059-04DBB2

USBR hole number: 48+27
Date completed: 02/16/90
Depth drilled: 38 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, light iron stains, brown	1.0-3.0
LOAM, silty, clayey, iron mottled, sand lenses, pale olive	3.0-6.0
LOAM, sandy, heavy iron stains, yellow brown	6.0-12.0
SAND, medium, graded, shale and lignite chips, gray	12.0-20.0
SAND, very coarse, well graded, clean, shale and lignite chips, gray	20.0-27.0
TILL, loamy, dark gray	27.0-38.0

Water Level = 10.5 feet below land surface

130-059-04DBB3

USBR hole number: 50+27
Date completed: 02/16/90
Depth drilled: 33 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.0

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, medium lime, iron stains, gray brown	1.0-4.0
LOAM, silty, clayey, iron stains, mottled, olive brown	4.0-8.0
LOAM, sandy, coarse, heavy iron stains, yellow brown	8.0-13.0
SAND, coarse, loamy, dirty, graded, lignite and shale chips, gray	13.0-17.0
SAND, coarse, well graded, clean, shale and lignite chips, gray	17.0-23.0
SAND, very coarse, and gravel (20%), well graded, clean, few lignite chips, gray	23.0-30.0
LOAM, silty, clayey, dark gray	30.0-33.0

Water Level = 9.0 feet below land surface

130-059-16AAA1

USBR hole number: 1+00
Date completed: 11/16/89
Depth drilled: 28 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1311.4

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-4.0
SAND, loamy, moderate lime, pale brown	4.0-5.5
SAND, medium, dirty, iron stains, brown	5.5-6.5
SAND, medium, dirty, yellow brown	6.5-8.0
SAND, coarse, loamy, oxidized, lignitic, dark brown	8.0-10.0
SAND(50%), coarse, and gravel, 20% shale, 20% lignite chips, gray	10.0-14.0
SAND, coarse, and gravel(20%), graded, dirty, 20% shale, lignitic, gray	14.0-22.0
SAND, medium, 60% shale chips, gray	22.0-24.5
TILL, loamy, dark gray	24.5-28.0

Water Level = 9.4 feet below land surface

130-059-16AAA2

USBR hole number: 3+00
Date completed: 11/14/89
Depth drilled: 40 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12482
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1309.9

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-3
CLAY, light gray, soft, sticky	3-4
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	4-10
SAND, very fine to very coarse, predominantly medium to coarse, gray, unoxidized, light bit chatter, lots of gravel sized detrital shale chips, #20-#25 slot screen	10-15
SAND, very fine to very coarse, predominantly medium to coarse, moderate bit chatter, lignite chips and gravel, 5-10%, composition as above, #25-#35 slot screen	15-20
SAND, very fine to very coarse, predominantly fine to medium, lignitic, composition as above, #10-#18 slot screen	20-31
CLAY, silty, sandy, pebbly, olive gray, (Till)	31-40

130-059-16AAA3

USBR hole number: 5+00
Date completed: 11/16/89
Depth drilled: 28 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-2.2
LOAM, sandy, fine, pale brown	2.2-3.0
LOAM, sandy, light lime, gray brown	3.0-5.5
SAND, medium, graded, dirty, iron stained, yellow brown	5.5-9.0
SAND, coarse, uniform, pale brown	9.0-9.5
SAND, coarse, loamy, lignitic, gray brown	9.5-12.5
SAND, coarse, and 20% gravel, graded, 25% shale chips	12.5-18.0
SAND, very coarse, and gravel, graded, 20% shale, lignitic, gray	18.0-21.5
SAND, medium, dirty, 20% shale, gray	21.5-27.0
LOAM, silty, dark gray	27.0-28.0

Water Level = 8.6 feet below land surface

130-059-16AAB1

USBR hole number: 7+00 Date completed: 11/14/89 Depth drilled: 40 Screened interval: none Casing Size: n/a	NDSWC hole number: 12481 Purpose: test hole Source of data: SWC Principal aquifer: Oakes Land surface altitude: 1311.3
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LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-3
SAND, very fine to very coarse, predominantly fine to medium, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	3-7
CLAY, soft, sticky, light gray, oxidized	7-10
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, @ 17 feet slight bit chatter, @ 15-20 feet more shaly, composition as above, unoxidized at 13 feet, #20-#25 slot screen	10-20
SAND, very fine to very coarse, predominantly coarse to very coarse, 10% gravel, slight bit chatter, composition as above	20-30
SAND, very fine to coarse, predominantly fine, dark gray, very shaly, lignitic, #10-#15 slot screen	30-34
CLAY, silty, sandy, pebbly, olive gray, (Till)	34-40

130-059-16AAB2

USBR hole number: 9+00
Date completed: 11/16/89
Depth drilled: 33
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-2.0
LOAM, sandy, fine, light lime, pale brown	2.0-4.5
LOAM, sandy, light lime pale brown	4.5-6.5
SAND, coarse, dirty, graded, iron stained, yellow brown	6.5-10.0
SAND, very coarse, and 5% gravel, graded, gray	10.0-15.0
SAND, medium, graded, 20% shale chips	15.0-20.0
SAND, very coarse, and 20% gravel, graded, gray	20.0-21.0
LOAM, silty, dark gray	21.0-23.0
TILL, loamy, dark gray	23.0-33.0

Water level = 8.4 feet below land surface

130-059-16AAB3

USBR hole number: 11+00 Date completed: 11/14/89 Depth drilled: 40 ft. Screened interval: none Casing Size: n/a	NDSWC hole number: 12480 Purpose: test hole Source of data: USBR Principal aquifer: Oakes Land surface altitude: 1312.9
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LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-3
SAND, very fine to very coarse, predominantly fine to medium, very slightly gravelly, yellow stained, oxidized	3-5
SAND, very fine to very coarse, predominantly medium to coarse, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	5-12
SAND, as above, gray, unoxidized, #20-#25 slot screen	12-15
SAND, very fine to very coarse, predominantly coarse to very coarse, 10-20% gravel, moderate bit chatter, composition as above, greater than #50 slot screen	15-20
SAND, very fine to very coarse, predominantly medium to coarse, less than 5% gravel, composition as above, #20-#25 slot screen	20-25
SAND, very fine to very coarse, predominantly fine, very slightly gravelly, mostly shale, dark gray, #10-#15 slot screen	25-30
CLAY, silty, sandy, pebbly, olive gray, (Till)	30-40

130-059-16AAB4

USBR hole number: 13+00
Date completed: 11/14/89
Depth drilled: 28 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1313.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-2.0
SAND, fine, loamy, brown	2.0-4.5
LOAM, sandy, olive yellow	4.5-5.5
SAND, loamy, pale brown	5.5-7.0
SAND, medium, graded, iron stains	7.0-9.5
SAND, coarse, with lignite chips, yellow brown	9.5-11.0
SAND, coarse, dirty, graded, 10% shale, and 10% lignite, gray	11.0-13.0
SAND, coarse, 15% shale, gray	13.0-17.0
SAND, very coarse, 20% shale chips, gray	17.0-18.5
SAND, coarse, uniform, 20% shale chips	18.5-23.0
SAND, fine, uniform, gray	23.0-25.5
LOAM, silty, dark gray	25.5-27.5
TILL, loamy, dark gray	27.5-28.0

Water Level = 11.8 feet below land surface

130-059-16ABA1

USBR hole number: 15+00	NDSWC hole number: 12479
Date completed: 11/14/89	Purpose: test hole
Depth drilled: 40	Source of data: SWC
Screened interval: none	Principal aquifer: Oakes
Casing Size: n/a	Land surface altitude: 1312.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-3
SAND, very fine to very coarse, predominantly fine to medium, very slightly gravelly, yellow brown, oxidized	3-5
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	5-12
SAND, very fine to very coarse, predominantly coarse, slightly gravelly, slight bit chatter, composition as above, lignitic	12-16
SAND, very fine to very coarse, predominantly coarse to very coarse, 10-15% gravel, moderate bit chatter, composition as above	16-20
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, takes water, mixed 1/2 bag of mud, composition as above	20-28
CLAY, silty, sandy, pebbly, olive gray, soft, (Till)	28-40

130-059-16ABA2

USBR hole number: 17+00
Date completed: 11/14/89
Depth drilled: 28
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1311.3

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-0.7
LOAM, sandy, brown	0.7-2.9
SAND, coarse, dirty, graded, light iron stains, yellow brown	2.9-7.0
SAND, coarse, dirty, graded, iron stains, yellow brown	7.0-9.0
SAND, coarse, dirty, graded, 5% shale, brown	9.0-10.5
SAND, coarse, dirty, graded, slightly gravelly, 5% shale, lignitic, gray	10.5-13.5
SAND, (50%), very coarse, and gravel, gray	13.5-18.5
SAND, fine, with layers of coarse sand, gray	18.5-21.5
TILL, loamy, dark gray	21.5-28.0

Water Level = 10.1 feet below land surface

130-059-16ABA3

USBR hole number: 19+00	NDSWC hole number: 12478
Date completed: 11/13/89	Purpose: test hole
Depth drilled: 40	Source of data: SWC
Screened interval: none	Principal aquifer: Oakes
Casing Size: n/a	Land surface altitude: 1311.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-1
SAND, very fine to very coarse, predominantly fine to medium, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	1-4
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, composition as above	4-10
SAND, very fine to very coarse, predominantly coarse, 10-20% gravel, slight bit chatter, composition as above	10-20
SAND, very fine to very coarse, predominantly medium, mostly shale and quartz	20-27
CLAY, silty, sandy, pebbly, olive gray, (Till)	27-40

130-059-16ABB1

USBR hole number: 21+00
Date completed: 11/14/89
Depth drilled: 28
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1311.8

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-0.7
LOAM, sandy, brown	0.7-1.7
SAND, medium, slightly gravelly, iron stains	1.7-5.5
SAND, coarse, 5% gravel, graded, dirty, yellow brown	5.5-8.0
SAND, coarse, graded, dirty, some iron stains, 5% shale, brown	8.0-10.5
SAND, medium, brown	10.5-11.5
SAND (50%), very coarse, and gravel, 10% shale chips, gray	11.5-17.0
SAND, coarse, graded, dirty, gray	17.0-20.5
SAND, very coarse, 5% shale, gray	20.5-22.0
CLAY, silty, dense, dark gray	22.0-24.0
TILL, loamy, dark gray	24.0-28.0

Water Level = 9.8 feet below land surface

130-059-16ABB2

USBR hole number: 23+00
Date completed: 11/13/89
Depth drilled: 40 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12477
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1311.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to medium, silty, dark brown	0-1
SAND, very fine to very coarse, predominantly medium, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	1-5
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, composition as above	5-10
SAND, very fine to very coarse, predominantly coarse, 5-10% gravel, composition as above, unoxidized after about 11 feet, lignitic	10-15
SAND, very fine to very coarse, predominantly medium to coarse, very slightly gravelly, composition as above, lignitic	15-20
SAND, very fine to very coarse, predominantly fine to medium, very slightly gravelly, composition as above	20-25
CLAY, silty, sandy, pebbly, olive gray,(Till)	25-40

130-059-16AAD1

USBR hole number: 2+00A2
Date completed: 02/26/90
Depth drilled: 33
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1313.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, iron stains, brown	1.0-3.0
SAND, coarse, loamy, and gravel (5%), graded, iron stains, brown	3.0-8.0
SAND, coarse, graded, iron stains, gray	8.0-13.0
SAND, very coarse, well graded, shale and lignite chips, gray	13.0-28.0
LOAM, silty, gray	28.0-31.0
TILL, loamy, dark gray	31.0-33.0

Water Level = 12.0 feet below land surface

130-059-16AAD2

USBR hole number: 6+00A2
Date completed: 02/27/90
Depth drilled: 33
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1313.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, light lime, iron stains, brown	1.0-5.0
SAND, medium, loamy, iron stains, brown	5.0-10.0
SAND, medium, loamy, shale and lignite, gray	10.0-13.0
SAND, very coarse, well graded, clean, shale and lignite chips, gray	13.0-29.0
TILL, loamy, gray	29.0-33.0

Water Level = 12.3 feet below land surface

130-059-16AAC1

USBR hole number: 10+00A2
Date completed: 2/27/90
Depth drilled: 30
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1312.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, iron stains, brown	1.0-2.0
SAND, medium, loamy, iron stains, brown	2.0-8.0
SAND, medium, uniform, slightly dirty, iron stains, brown	8.0-12.0
SAND, medium, uniform, clean, gray	12.0-14.0
SAND, very coarse, well graded, clean, shale and lignite chips, gray	14.0-21.0
SAND, medium, dirty, shale and lignite chips, gray	21.0-28.0
TILL, loamy, gray	28.0-30.0

Water Level = 11.7 feet below land surface

130-059-16AAC2

USBR hole number: 12+00 A2
Date completed: 3/6/90
Depth drilled: 38ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1313.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, light lime and light iron stains, pale olive brown	1.0-5.0
SAND, coarse, loamy, graded, iron stained, brown	5.0-10.0
SAND, medium, iron stains, clean, uniform, yellow brown	10.0-13.0
SAND, medium, clean, shale chips, graded, gray	13.0-16.0
SAND, very coarse, graded, shale chips, gray	16.0-21.0
SAND, medium, slightly graded, shale and lignite chips, gray	21.0-31.0
SAND, very coarse, well graded, clean, gray	31.0-33.0
TILL, loamy, dark gray	33.0-38.0

Water Level = 11.4 feet below land surface

130-059-16ABD1

USBR hole number: 14+00A2
Date completed: 2/27/90
Depth drilled: 38
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1312.4

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, light lime, iron stains, brown	1.0-5.0
SAND, gravelly(less than 5%), dirty, graded, iron stains, yellow brown	5.0-11.0
SAND, coarse, graded, dirty, shale and lignite chips, gray	11.0-18.0
SAND, medium, clean, uniform, shale and lignite chips, gray	18.0-30.0
TILL, loamy, dark gray	30.0-38.0

Water Level = 11.7 feet below land surface

130-059-16ABD2

USBR hole number: 18+00A2
Date completed: 2/27/90
Depth drilled: 38
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1312.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-3.0
LOAM, silty, clayey, moderate lime, gray mottled, olive brown	3.0-7.0
LOAM, sandy, heavy iron stains, yellow brown	7.0-10.0
SAND, coarse, graded, clean, gray	10.0-13.0
SAND, very coarse, well graded, clean, shale and lignite chips, gray	13.0-24.0
SAND, coarse, graded, clean, shale and lignite chips, gray	24.0-37.0
TILL, loamy, dark gray	37.0-38.0

Water Level = 11.3 feet below land surface

130-059-16ABC1

USBR hole number: 22+00A2
Date completed: 2/28/90
Depth drilled: 38
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1312.4

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, light iron stains, brown	1.0-3.0
SAND, medium, graded, clean, iron stains, brown	3.0-8.0
SAND, coarse, loamy, well graded, shale and lignite chips, gray	8.0-12.0
SAND, very coarse, well graded, clean, shale chips, gray	12.0-31.0
TILL, loamy, dark gray	31.0-38.0

Water Level = 11.7 feet below land surface

130-059-16ABC3

USBR hole number: 23+00A2
Date completed: 3/5/90
Depth drilled: 33 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1312.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, light lime and light iron stains, brown	1.0-4.0
SAND, coarse, loamy, graded, iron stains, shale chips, pale olive brown	4.0-8.0
SAND, loamy, iron stains, shale chips, brown	8.0-12.5
SAND, very coarse, dirty, well graded, shale and lignite chips, gray	12.5-18.0
SAND, coarse, graded, dirty, shale and lignite chips, gray	18.0-26.0
TILL, loamy, dark gray	26.0-33.0

Water Level = 11.9 feet below land surface

130-059-16ABC2

USBH hole number: 26+00A2
Date completed: 2/28/90
Depth drilled: 33
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1313.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, light iron stains, brown	1.0-3.0
SAND, very coarse, loamy, and gravel (25%), graded, iron stains, brown	3.0-8.0
SAND, coarse, graded, iron stains, shale chips, brown	8.0-13.0
SAND, coarse, graded, shale and lignite chips, gray	13.0-25.0
TILL, loamy, dark gray	25.0-33.0

Water Level = 12.8 feet below land surface

130-059-16ADD2

USBR hole number: 2+00A3
Date completed: 3/6/90
Depth drilled: 38 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1314.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, iron stains, brown	1.0-6.0
SAND, medium, uniform, iron stains, brown	6.0-13.0
SAND, coarse, graded, shale and lignite chips, gray	13.0-18.0
SAND, very coarse, dirty, well graded, shale and lignite chips, gray	18.0-30.0
LOAM, silty, gray	30.0-36.5
TILL, loamy, gray	36.5-38.0

Water Level = 13.1 feet below land surface

130-059-16ADD1

USBR hole number: 6+00A3
Date completed: 3/6/90
Depth drilled: 33 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1315.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-2.0
SAND, medium, clean, uniform, iron stains, yellow brown	2.0-13.0
SAND, coarse, graded, iron stains, brown	13.0-19.0
SAND, very coarse, clean, well graded, lots of shale and lignite between 21.0-24.0 feet, gray	19.0-29.0
LOAM, silty, gray	29.0-33.0

Water Level = 14.2 feet below land surface

130-059-16ADC

USBR hole number: 10+00A3
Date completed: 3/6/90
Depth drilled: 38 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1314.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-2.0
LOAM, sandy, lime and iron stains, brown	2.0-5.0
SAND, medium, uniform, clean, heavy iron stains, yellow brown	5.0-11.0
SAND, coarse, graded, shale and lignite chips, gray	11.0-18.0
SAND, very coarse, and gravel (5%), to 1 inch diameter, clean, well graded, gray	18.0-32.0
TILL, loamy, gray	32.0-38.0

Water Level = 11.3 feet below land surface

130-059-16ACD2

USBR hole number: 14+00A3
Date completed: 3/7/90
Depth drilled: 33 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1314.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, light iron stains, brown	1.0-3.5
SAND, medium, graded, heavy iron stains, yellow brown	3.5-8.0
SAND, coarse, loamy, graded, iron stains, shale chips, brown	8.0-12.0
SAND, very coarse, graded, shale chips, gray	12.0-19.0
SAND, medium, uniform, clean, gray	19.0-29.0
TILL, loamy, dark gray	29.0-33.0

Water Level = 12.7 feet below land surface

130-059-16ACD1

USBR hole number: 17+00A3
Date completed: 3/9/90
Depth drilled: 38 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1317.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-3.0
LOAM, sandy, very fine, iron stains, yellow brown	3.0-5.0
SAND, medium, clean, graded, iron stains, brown	5.0-15.0
SAND, medium, clean, uniform, shale chips, gray	15.0-20.0
SAND, very coarse, graded, shale and lignite chips, gray	20.0-36.0
TILL, loamy, gray	36.0-38.0

Water Level = 16.0 feet below land surface

130-059-16ACD3

USBR hole number: 18+00A3
Date completed: 3/7/90
Depth drilled: 28 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1317.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, light iron stains, olive brown	1.0-3.5
SAND, medium, uniform, clean, iron stains, yellow brown	3.5-6.0
SAND, coarse, loamy, graded, iron stains, shale chips, yellow brown	6.0-15.0
SAND, very coarse, graded, lots of shale between 18.0-20.0 feet, gray	15.0-25.0
SAND, medium, clean, uniform, gray	25.0-27.5
TILL, loamy, gray	27.5-28.0

Water Level = 16.1 feet below land surface

130-059-16ACD4

USBR hole number: 19+00A3
Date completed: 3/9/90
Depth drilled: 38 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1317.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-0.5
LOAM, sandy, light iron stains, yellow brown	0.5-4.5
SAND, medium, clean, slightly graded, iron stains, brown	4.5-8.0
SAND, coarse, greater than 5% gravel, graded, iron stains, brown	8.0-15.0
SAND, very coarse, clean, graded, shale and lignite chips, gray	15.0-28.0
SAND, coarse, clean, graded, shale and lignite chips, gray	28.0-36.0
TILL, loamy, gray	36.0-38.0

Water Level = 16.9 feet below land surface

130-059-16ACC2

USBR hole number: 22+00A3
Date completed: 3/7/90
Depth drilled: 38 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1317.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-2.0
LOAM, sandy, fine, light iron stains, brown	2.0-3.0
LOAM, sandy, fine, iron stains, olive brown	3.0-7.5
SAND, medium, iron stains, yellow brown	7.5-9.5
SAND, very coarse, well graded, heavy iron stains, shale chips, yellow brown	9.5-15.0
SAND, very coarse, well graded, clean, shale chips, gray	15.0-22.0
SAND, coarse, graded, shale and lignite chips, gray	22.0-33.5
LOAM, silty, gray	33.5-38.0

Water Level = 16.6 feet below land surface

130-059-16ACC1

USBR hole number: 25+77A3
Date completed: 3/8/90
Depth drilled: 36 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1313.8

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-3.0
SAND, medium, iron stains, brown	3.0-4.0
LOAM, sandy, light lime, iron stains, olive brown	4.0-7.0
SAND, medium, graded, greater than 5% gravel, graded, iron stains, brown	7.0-10.5
LOAM, silty, iron stains, sand layers, olive brown	10.5-12.0
SAND, medium, loamy, heavy iron stains, graded, yellow brown	12.0-15.0
SAND, coarse, graded, clean, shale and lignite chips, gray	15.0-33.0
TILL, loamy, dark gray	33.0-38.0

Water Level = 13.0 feet below land surface

130-059-16BAA

USBR hole number: 2+50
Date completed: 11/14/89
Depth drilled: 40 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12487
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1309.9

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-2
SAND, very fine to medium, predominantly very fine to fine, yellow stained, oxidized	2-8
SAND, very fine to very coarse, predominantly medium to coarse, less than 5% gravel, lots of shale, quartz, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	8-12
SAND, very fine to very coarse, predominantly coarse to very coarse, 5 to 10% gravel, slight bit chatter, composition as above, gray, unoxidized, #25-#35 slot screen	12-16
SAND, very fine to very coarse, predominantly medium, slightly gravelly, no bit chatter, more shaly, lignitic	16-20
SAND, very fine to very coarse, predominantly medium to coarse, shaly, #20-#25 slot screen	20-24
CLAY, silty, sandy, pebbly, olive gray, (Till)	24-40

130-059-16BAD2

USBR hole number: 6+50
Date completed: 11/14/89
Depth drilled: 40 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12486
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1313.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-2
SAND, very fine to fine, silty, yellow stained, oxidized	2-5
SAND, very fine to very coarse, predominantly fine to medium, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	5-10
SAND, very fine to very coarse, predominantly medium to coarse, 5% gravel, light bit chatter, yellow stained, oxidized	10-13
SAND, as above, less than 5% gravel, composition as above, #20-#25 slot screen	13-20
SAND, as above, more fines, less coarse to very coarse sand, more shale and lignite, #15-#20 slot screen	20-24
CLAY, silty, sandy, pebbly, olive gray, (Till)	24-40

130-059-16BAD1

USBR hole number: 10+50
Date completed: 11/14/89
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12485
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1313.4

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-3
CLAY, light gray, soft, sticky	3-4
SAND, very fine to very coarse, predominantly coarse to very coarse, 10-15% gravel, bit chatter from 5-10 feet, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	4-11
SAND, very fine to very coarse, predominantly fine to medium, very slightly gravelly, gray, unoxidized, composition as above, lignitic, #10-#15 slot screen	11-21
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, lignite chips, #20-#25 slot screen	21-26
CLAY, silty, slightly sandy, soft, greenish gray	26-31
CLAY, silty, sandy, pebbly, olive gray, (Till)	31-40

130-059-16BDA2

USBR hole number: 14+50 Date completed: 11/14/89 Depth drilled: 40 ft. Screened interval: none Casing Size: n/a	NDSWC hole number: 12484 Purpose: test hole Source of data: SWC Principal aquifer: Oakes Land surface altitude: 1312.7
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LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-2
SAND, very fine to very coarse, predominantly medium, less than 5% gravel, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	2-11
SAND, very fine to very coarse, predominantly medium, after 15 feet becomes more shaly, lignitic, less coarse to very coarse sand, #15-#20 slot screen	11-20
SAND, very fine to very coarse, predominantly medium, more fines than above, #15-#18 slot screen	20-26
CLAY, silty, to silt, clayey, greenish gray, soft, smooth	26-31
CLAY, silty, sandy, pebbly, olive gray, (Till)	31-40

130-059-16BDA1

USBR hole number: 18+50
Date completed: 11/14/89
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12483
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1312.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, dark brown	0-2
SAND, very fine to very coarse, predominantly medium to coarse, less than 5% gravel, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	2-13
SAND, very fine to very coarse, predominantly fine to medium, mostly quartz, some shale and carbonate, very slightly gravelly, #15-#18 slot screen	13-20
SAND, very fine to very coarse, predominantly medium, more shale and lignite chips, #15-#20 slot screen	20-29
CLAY, silty, greenish gray, soft	29-31
CLAY, silty, sandy, pebbly, olive gray, (Till)	31-40

130-059-16BBB1

USBR hole number: 193+00
Date completed: 11/13/89
Depth drilled: 60 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12472
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1310.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
CLAY, silty, slightly sandy, dark brown	0-2
CLAY, slightly silty, sticky, light gray	2-3
GRAVEL, sandy, sand predominantly coarse to very coarse, lots of carbonates and shale, some shield silicates, yellow stained, oxidized	3-6
SAND (95%), very fine to very coarse, predominantly coarse to very coarse, and gravel, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	6-11
SAND, as above, gray, unoxidized	11-16
SAND, as above, finer section, predominantly medium to coarse sand, more detrital shale	16-22
CLAY, silty, sandy, pebbly, olive gray, (Till), interbedded with thin sand and gravel layers composed of shale and quartz	22-60

130-059-16BBC1

USBR hole number: 197+00
Date completed: 11/13/89
Depth drilled: 40 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12473
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1312.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, silty, clayey, dark brown	0-2
CLAY, very silty, light gray	2-3
SAND, very fine to very coarse, predominantly medium to coarse, less than 5% gravel, lots of quartz, shale, carbonates, yellow stained, oxidized	3-10
SAND, as above, predominantly coarse to very coarse, thin gravel layer accounts for 10-15% gravel recovery	10-15
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, very lignitic, composition as above	15-22
CLAY, silty, sandy, pebbly, olive gray, (Till)	22-40

130-059-16BBC2

USBR hole number: 201+00	NDSWC hole number: 12474
Date completed: 11/13/89	Purpose: test hole
Depth drilled: 40 ft.	Source of data: SWC
Screened interval: none	Principal aquifer: Oakes
Casing Size: n/a	Land surface altitude: 1312.9

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, silt, clay, dark brown	0-2
SAND, very fine to very coarse, predominantly fine to medium , slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded,	2-10
SAND, (85-90%), predominantly coarse to very coarse, and gravel(10-15%), slight bit chatter, yellow stained, oxidized	10-13
SAND, very fine to very coarse, predominantly medium, lots of quartz, shale, carbonates, lignitic ,minor shield silicates, slightly gravelly, gray, unoxidized	13-25
CLAY, silty,sandy, pebbly, olive gray (Till)	25-40

130-059-16BCB1

USBR hole number: 205+00
Date completed: 11/13/89
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12475
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1314.4

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, silt, clay, dark brown	0-2
SAND, very fine to very coarse, predominantly fine to medium, slightly gravelly, lots of shale, quartz, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	2-5
SAND, very fine to very coarse, predominantly medium to coarse, slightly gravelly, thin gravel layers between 5-10 feet, composition as above, oxidized	5-17
SAND, as above, gray, unoxidized	17-26
CLAY, silty, sandy, pebbly, olive gray (Till)	26-40

130-059-16BCB2

USBR hole number: 207+00
Date completed: 11/14/89
Depth drilled: 33 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1314.8

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-0.8
LOAM, sandy, brown	0.8-2.0
SAND, fine, uniform, brown	2.0-5.5
SAND, coarse, graded, iron stains, 5% shale, brown	5.5-12.5
SAND, coarse, dirty, graded, 5% shale, lignite layer at 13.0-13.5 feet, brown	12.5-15.5
SAND, coarse, clean, 5% shale, gray	15.5-21.0
SAND, coarse, 20% shale, gray	21.0-22.5
SAND, very coarse, 20% gravel, 20% shale, gray	22.5-28.0
LOAM, sandy, very fine, olive brown	28.0-28.5
TILL, loamy, dark gray	28.5-33.0

Water Level = 14.4 feet below land surface

130-059-16BCB3

USBR hole number: 209+00
Date completed: 11/13/89
Depth drilled: 40 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12476
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1315.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, silty, dark brown	0-1
SAND, very fine to very coarse, predominantly fine to medium, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	1-5
SAND, very fine to very coarse, predominantly medium to coarse, very slightly gravelly, composition as above, oxidized	5-17
SAND, gray, as above, unoxidized	17-25
SAND, very fine to very coarse, predominantly coarse to very coarse, 5% gravel, composition as above	25-32
CLAY, silty, sandy, pebbly, olive gray (Till), with thin shale and quartz medium sand layers	32-40

130-059-16BCC

USBR hole number: 213+00
Date completed: 11/14/89
Depth drilled: 43 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1315.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, brown	1.0-2.5
SAND, fine, loamy, pale brown	2.5-4.0
SAND, fine, graded, light yellow brown	4.0-5.0
SAND(50%), and gravel, light yellow brown	5.0-8.0
SAND, medium, dirty, iron stained, 20% gravel	8.0-11.5
SAND, coarse, slightly gravelly, dirty, 10% shale, lignitic, gray brown	11.5-15.0
SAND, medium, graded, 20% shale chips, lignitic, gray	15.0-20.5
SAND, coarse, graded, 20% shale chips, gray	20.5-28.0
TILL, loamy, dark gray	28.0-43.0

Water Level = 15.8 feet below land surface

130-059-16CBB1

USBR hole number: 217+00
Date completed: 11/07/89
Depth drilled: 80 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12466
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1315.9

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, silty, very slightly clayey, dark brown	0-3
CLAY, very silty, very slightly sandy, light gray, oxidized	3-4
SAND, very fine to very coarse, predominantly medium to coarse, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, yellow stained to about 18 feet, after 18 feet , gray, unoxidized, #20-#25 slot screen	4-32
CLAY, silty, sandy, pebbly, olive gray, (Till)	32-36
SAND, very fine to very coarse, predominantly coarse to very coarse, 95% shale, slightly gravelly, some carbonates, good recovery, ** probably a lenticular deposit**	36-50
CLAY, as above, (Till)	50-57
SAND, mostly shale, as above, bit slipped fast, good recovery	57-65
CLAY, as above, (Till)	65-72
SAND, shale, as above	72-76
CLAY, as above (Till)	76-80

130-059-16CBB2

USBR hole number: 218+00 Date completed: 01/10/90 Depth drilled: 38 ft. Screened interval: none Casing Size: n/a	NDSWC hole number: n/a Purpose: test hole Source of data: USBR Principal aquifer: Oakes Land surface altitude: 1315.2
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LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.5
LOAM, sandy, fine, brown	1.5-2.5
LOAM, silty, moderate lime, olive brown	2.5-4.5
SAND, medium, dirty, iron stains, red brown	4.5-10.0
SAND, fine, iron stains, red brown	10.0-11.5
SAND, medium, dirty, graded, some iron stains, red brown	11.5-15.0
SAND, medium, clean, uniform, brown	15.0-19.0
SAND, medium, clean, graded, lignitic, gray	19.0-25.0
SAND, fine, clean, uniform, gray	25.0-29.0
SAND, fine, graded, 40% shale chips, lignitic	29.0-31.5
SAND, medium, 20% shale chips, gray	31.5-32.0
LOAM, sandy, very fine, dense, olive gray	32.0-33.0
LOAM, silty, clayey, dark gray	33.0-36.0
TILL, loamy, dark gray	36.0-38.0

Water Level = 16.0 feet below land surface

130-059-16CBB3

USBR hole number: 219+00
Date completed: 11/07/89
Depth drilled: 38 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1314.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
SAND, fine, loamy, brown	1.0-3.0
LOAM, sandy, fine, light lime, pale brown	3.0-4.0
SAND, coarse, uniform, clean, iron stains, light yellow brown	4.0-11.5
SAND, medium, uniform, light iron stains, light yellow brown	11.5-14.0
SAND, loamy, pale brown	14.0-15.0
SAND, medium, uniform, 20% shale chips, lignitic, yellow brown	15.0-19.5
SAND, medium, 25% shale chips, clean, uniform, gray	19.5-25.5
SAND, coarse, 25% shale chips, lignitic, gray	25.5-37.0
TILL, loamy, dark gray	37-38

Water Level = 15.0 feet below land surface

130-059-16CBB4

USBR hole number: 220+00	NDSWC hole number: n/a
Date completed: 01/10/90	Purpose: test hole
Depth drilled: 38 ft.	Source of data: USBR
Screened interval: none	Principal aquifer: Oaks
Casing Size: n/a	Land surface altitude: 1314.3

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.5
LOAM, sandy, fine, brown	1.5-2.5
SAND, loamy, brown	2.5-5.5
SAND, medium, graded, dirty, iron stains, red brown	5.5-12.0
SAND, medium, graded, dirty, high lignite content, gray brown	12.0-14.0
SAND, medium, clean, uniform, brown	14.0-18.0
SAND, medium, clean, graded, gray	18.0-23.5
SAND, medium, graded, 5% shale, lignitic, gray	23.5-29.5
SAND, medium, cleaner than above, gray	29.5-32.0
LOAM, sandy, very fine, dark gray	32.0-38.0

Water Level = 15.1 feet below land surface

130-059-16CBB5

USBR hole number: 221+00
Date completed: 11/07/89
Depth drilled: 50 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12467
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1314.9

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, silty, very slightly clayey, dark brown	0-3
SAND, very fine to very coarse, predominantly medium to coarse, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	3-21
SAND, as above, gray, unoxidized, #20-#25 slot screen	21-37
CLAY, silty, sandy, pebbly, olive gray, soft, (Till)	37-50

130-059-16CBB6

USBR hole number: 222+00
Date completed: 01/09/90
Depth drilled: 38 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1315.8

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, fine, moderate lime, pale brown	1.0-3.5
SAND, fine, dirty, graded, some iron stains, brown	3.5-8.5
SAND, medium, iron stains, red brown	8.5-11.0
SAND, fine, uniform, red brown	11.0-15.0
SAND, fine, uniform, brown	15.0-17.5
SAND, medium, graded, dirty, less than 5% shale, lignitic, gray	17.5-29.0
LOAM, sandy, very fine, dense in places, dark gray	29.0-31.0
LOAM, silty, varved, very dark gray	31.0-36.0
TILL, loamy, very dark gray	36.0-38.0

Water Level = 17.7 feet below land surface

130-059-16CBC1

USBR hole number: 223+00
Date completed: 11/09/89
Depth drilled: 38 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1316.3

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.2
LOAM, sandy, fine, pale brown	1.2-3.2
SAND, medium, light iron stains, light yellow brown	3.2-12.0
SAND, very fine, uniform, light iron stains, pale brown	12.0-13.0
SAND, medium, uniform, iron stains, yellow brown	13.0-19.5
SAND, loamy, coarse, 10% shale chips, lignitic, brown	19.5-21.5
SAND, medium, uniform, iron stains, brown	21.5-24.5
SAND, coarse, uniform, gray	24.5-34.0
LOAM, sandy, very fine, dark gray	34.0-36.0
TILL, loamy, dark gray	36.0-38.0

Water Level = 17.3 feet below land surface

130-059-16CBC2

USBR hole number: 225+00	NDSWC hole number: 12468
Date completed: 11/07/89	Purpose: test hole
Depth drilled: 40 ft.	Source of data: SWC
Screened interval: none	Principal aquifer: Oakes
Casing Size: n/a	Land surface altitude: 1316.8

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, very slightly clayey, dark brown	0-2
SAND, very fine to very coarse, predominantly medium to coarse, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	2-18
SAND, as above, gray, unoxidized, from 30-35 feet ,predominantly medium sand, #20-#25 slot	18-35
CLAY, silty, sandy, pebbly, olive gray, (Till)	35-40

130-059-16CBC3

USBR hole number: 227+00
Date completed: 01/10/90
Depth drilled: 38 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1316.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-0.8
LOAM, sandy, slightly organic, dark brown	0.8-1.8
SAND, medium, dirty, pale brown	1.8-8.0
SAND, medium, light iron stains, yellow brown	8.0-16.0
SAND, medium, 5% shale chips, brown	16.0-18.0
SAND, fine, graded, gray	18.0-19.5
SAND, coarse, clean, uniform, gray	19.5-20.5
SAND, medium, graded, 10% shale chips, dirty, lignitic, gray	20.5-25.5
SAND, medium, graded, clean, 10% shale, lignitic, gray	25.5-29.5
SAND, very coarse, graded, 5% shale chips, lignitic, gray	29.5-32.5
TILL, loamy, dark gray	32.5-38.0

Water Level = 18.1 feet below land surface

130-059-16CBC4

USBR hole number: 229+00	NDSWC hole number: 12469
Date completed: 11/07/89	Purpose: test hole
Depth drilled: 40 ft.	Source of data: SWC
Screened interval: none	Principal aquifer: Oakes
Casing Size: n/a	Land surface altitude: 1316.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, slightly clayey, dark brown	0-1
SAND, silt, clay, light gray to yellow brown, oxidized	1-4
SAND, very fine to very coarse, predominantly medium, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	4-11
SAND, very fine to medium, predominantly fine, composition as above, #10-#15 slot screen	11-20
SAND, very fine to very coarse, predominantly medium to coarse, as above, #20-#25 slot screen	20-34
SAND, very fine to very coarse, predominantly medium, as above, #20-#25 slot screen	34-37
CLAY, silty, sandy, pebbly, olive gray, (Till)	37-40

130-059-16CBC5

USBR hole number: n/a
Date completed: 12/15/89
Depth drilled: 35 ft.
Screened interval: 26-35 ft.
Casing Size: 8 in. pvc

NDSWC hole number: n/a
Purpose: test well
Source of data: M&W Drilling
Principal aquifer: Oakes
Land surface altitude: n/a

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
TOPSOIL	0-1
SAND, medium, brown	1-13
SAND, medium, gray	13-20
SAND, medium to coarse, scattered gravels, gray	20-29
SAND, very fine to medium, predominantly very fine to fine, gray	29-35

Screen Construction Details :
8 -inch pipe size, stainless steel
#20 slot from 26-30 feet
#12 slot from 30-35 feet

130-059-16CBC6

USBR hole number: 229+00A
Date completed: 12/11/89
Depth drilled: 38 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: n/a

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, fine, light lime, olive brown	1.0-2.5
SAND, medium, some iron stains, red brown	2.5-8.0
SAND, fine, uniform, light iron stains, red brown	8.0-15.5
SAND, fine, graded, olive brown	15.5-17.5
SAND, coarse, clean, graded, 5% shale chips, gray	17.5-26.0
SAND, fine, clean, 5% shale, gray	26.0-33.0
TILL, loamy, dark gray	33.0-38.0

Water Level = 17.0 feet below land surface
Test hole located 17.5 feet north of test well

130-059-16CBC7

USBR hole number: n/a
Date completed: 11/28/89
Depth drilled: 40 ft.
Screened interval: 32-37 ft.
Casing Size: 1 1/4 in.

NDSWC hole number: 12503
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: n/a

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, very slightly clayey, dark brown	0-2
CLAY, light gray, with red-yellow stringers, oxidized	2-4
SAND, very fine to very coarse, predominantly medium, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow brown, oxidized	4-15
SAND, very fine to medium, predominantly fine, composition as above, gray, unoxidized	15-20
SAND, very fine to very coarse, predominantly medium to coarse, composition as above, takes water, mixed 1 bag of mud at 20 feet	20-37
CLAY, silty sandy, pebbly, olive gray, soft, (Till)	37-40

Observation well located 36 feet north of test well

130-059-16CBC8

USBR hole number: n/a	NDSWC hole number: 12504
Date completed: 11/28/89	Purpose: Obs. well
Depth drilled: 40 ft.	Source of data: SWC
Screened interval: 32-37 ft.	Principal aquifer: Oakes
Casing Size: 1 1/4 in.	Land surface altitude: n/a

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, very slightly clayey, dark brown	0-2
CLAY, silty, light gray, with red-yellow stringers, oxidized	2-4
SAND, very fine to very coarse, predominantly medium, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	4-12
SAND, very fine to medium, predominantly fine, composition as above, yellow stained, oxidized	12-15
SAND, very fine to medium, predominantly fine, composition as above, gray, unoxidized	15-18
SAND, very fine to very coarse, predominantly medium to coarse, very slightly gravelly, composition as above, after 25 feet very shaly, takes water, mixed 1 bag of mud at 20 feet	18-37
CLAY, silty, sandy, pebbly, olive gray, (Till)	37-40

Observation well located 50 feet north of test well

130-059-16CBC9

USBR hole number: n/a
Date completed: 11/28/89
Depth drilled: 40 ft.
Screened interval: 32-37 ft.
Casing Size: 1 1/4 in.

NDSWC hole number: 12505
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: n/a

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, very slightly clayey, dark brown	0-2
CLAY, silty, light gray, with red-yellow stringers, oxidized	2-4
SAND, very fine to very coarse, predominantly medium, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	4-13
SAND, very fine to medium, predominantly fine, composition as above, gray, unoxidized	13-20
SAND, very fine to very coarse, predominantly medium, composition as above, takes water, mixed 1 bag of mud at 20 feet, finer section from 32-37 feet	20-37
CLAY, silty, sandy, pebbly, olive gray, (Till)	37-40

Observation well located 70 feet north of test well

130-059-16CBC10

USBR hole number: n/a
Date completed: 11/28/89
Depth drilled: 40 ft.
Screened interval: 32-37 ft.
Casing Size: 1 1/4 in.

NDSWC hole number: 12506
Purpose: obs. well
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: n/a

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, very slightly clayey, dark brown	0-2
CLAY, slightly silty, light gray, with yellow stringers, oxidized	2-4
SAND, very fine to very coarse, predominantly medium, slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	4-15
SAND, very fine to medium, predominantly fine, composition as above, gray, unoxidized	15-25
SAND, very fine to very coarse, predominantly medium to coarse, composition as above, more shaly with depth	25-37
CLAY, silty, sandy, pebbly, olive gray, (Till)	37-40

Observation well located 100 feet north of test well

130-059-16CCB1

USBR hole number: 230+00
Date completed: 01/10/90
Depth drilled: 38 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1316.0

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, fine, moderate lime, olive brown	1.0-3.0
SAND, fine, slightly dirty, graded, some iron stains, brown	3.0-5.0
SAND, medium, graded, iron stains, red brown	5.0-10.0
SAND, fine, uniform, some iron stains, brown	10.0-16.0
SAND, fine, uniform, some very light iron stains, brown	16.0-20.0
SAND, fine, uniform, brown	20.0-22.5
SAND, coarse, clean, uniform, 5% shale, lignitic, gray	22.5-31.5
SAND, fine, uniform, dense in places, gray	31.5-33.0
SAND (85%), coarse, and gravel, dirty, 5% shale, lignite chips	33.0-34.5
TILL, loamy, dark gray	34.5-38.0

Water Level = 17.3 feet below land surface

130-059-16CCB2

USBR hole number: 231+00
Date completed: 11/13/89
Depth drilled: 36 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1315.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.5
LOAM, sandy, fine, brown	1.5-2.5
SAND, loamy, pale brown	2.5-4.0
SAND, medium, graded, yellow brown	4.0-8.0
SAND, fine, graded, some iron stains, yellow brown	8.0-14.5
SAND, fine, uniform, brown	14.5-16.5
SAND, very fine, uniform, gray	16.5-19.0
SAND, coarse, uniform, clean, gray	19.0-21.0
SAND, coarse, graded, dirty, 20% shale, lignitic, gray	21.0-26.5
SAND, coarse, graded, dirty, 50% shale chips, 10% lignite, gray	26.5-31.5
SAND, coarse, 20% shale chips, some lignite, gray	31.5-34.5
TILL, sandy, loamy, dark gray	34.5-36.0

Water Level = 16.2 feet below land surface

130-059-16CCB3

USBR hole number: 232+00
Date completed: 01/05/90
Depth drilled: 38 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1315.3

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, gray brown	1.0-2.5
SAND, loamy, pale brown	2.5-5.5
SAND, medium, graded, brown	5.5-8.5
SAND, fine, uniform, iron stains, red brown	8.5-14.0
SAND, fine, uniform, brown	14.0-22.0
SAND, coarse, graded, 10% shale, less than 5% lignite, gray	22.0-25.0
SAND, coarse, loamy, 30% shale, 10% lignite chips, graded, dark gray	25.0-29.0
SAND, (80%), very coarse, and gravel, gray	29.0-31.0
TILL, loamy, dark gray	31.0-38.0

Water Level = 16.4 feet below land surface

130-059-16CCB4

USBR hole number: 233+00	NDSWC hole number: 12470
Date completed: 11/07/89	Purpose: test hole
Depth drilled: 40 ft.	Source of data: SWC
Screened interval: none	Principal aquifer: Oakes
Casing Size: n/a	Land surface altitude: 1315.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, very slightly clayey, dark brown	0-3
CLAY, silty, sandy, light yellow gray	3-4
SAND, very fine to very coarse, predominantly coarse to very coarse, very slightly gravelly, lots of quartz, shale, carbonates, minor shield silicates, lignitic, subangular to well rounded, yellow stained, oxidized	4-7
SAND, very fine to very coarse, predominantly fine, as above, #10-#15 slot screen	7-20
SAND, very fine to very coarse, predominantly medium to coarse, composition as above, #20-#25 slot screen	20-32
CLAY, silty, sandy, pebbly, olive gray (Till)	32-40

130-059-16CCB5

USBR hole number: 235+00
Date completed: 11/09/89
Depth drilled: 30 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1313.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, fine, brown	1.0-2.5
LOAM, silty, light iron stains, pale olive	2.5-4.0
SAND, medium, iron stains, brown	4.0-6.0
SAND, fine, iron stains, brown	6.0-8.0
SAND, loamy, heavy iron stains, yellow brown	8.0-12.0
SAND, medium, clean, graded, shale chips, gray	12.0-16.0
SAND, coarse, well graded, lots of detrital shale, gray	16.0-26.5
TILL, loamy, dark gray	26.5-30.0

Water Level = 14.5 feet below land surface

130-059-16CCC1

USBR hole number: 237+00
Date completed: 11/07/89
Depth drilled: 40 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: 12471
Purpose: test hole
Source of data: SWC
Principal aquifer: Oakes
Land surface altitude: 1312.4

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
SAND, very fine to fine, silty, very slightly clayey, dark brown	0-3
CLAY, silty, sandy, yellow gray, oxidized	3-4
SAND, very fine to fine, yellow stained, oxidized	4-5
CLAY, silty, very slightly sandy, sticky, yellow gray, oxidized	5-7
SAND, very fine to very coarse, predominantly fine to medium, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized	7-15
SAND, very fine to very coarse, predominantly medium, as above, gray, unoxidized	15-20
SAND, very fine to very coarse, predominantly medium to coarse, composition as above, very lignitic, #20-#25 slot screen	20-32
CLAY, silty, slightly sticky, color changed in water, poor recovery	32-35
CLAY, silty, sandy, pebbly, olive gray, (Till)	35-40

130-059-16CCC2

USBR hole number: 239+00
Date completed: 11/08/89
Depth drilled: 37 ft.
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1311.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, dark brown	1.0-2.0
LOAM, silty, clayey, moderate lime, light iron stains, gray brown	2.0-3.5
SAND, loamy, iron stains, brown	3.5-8.0
SAND, medium, uniform, iron stains, brown	8.0-13.0
SAND, medium, clean, uniform, shale and lignite at 17-18 feet, gray	13.0-23.0
SAND, coarse, and gravel (20%), graded, gray	23.0-27.0
TILL, loamy, dark gray	27.0-37.0

Water Level = 15.0 feet below land surface

130-059-16CCC3

USBR hole number: 240+80	NDSWC hole number: 12471A
Date completed: 11/07/89	Purpose: test hole
Depth drilled: 40 ft.	Source of data: SWC
Screened interval: none	Principal aquifer: Oakes
Casing Size: n/a	Land surface altitude: 1311.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
CLAY, slightly silty, dark brown, soft	0-2
CLAY, slightly silty, very slightly sandy, yellow gray, oxidized	2-5
SAND, very fine to very coarse, predominantly medium, lots of quartz, shale, carbonates, minor shield silicates, subangular to well rounded, yellow stained, oxidized, # 15-#20 slot screen	5-14
SAND, as above, gray, unoxidized	14-24
CLAY, silty, sandy, pebbly, olive gray, (Till)	24-40

130-059-03CBB1

USBR hole number: 2+00C1
Date completed: 02/09/90
Depth drilled: 43
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1307.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, fine, brown	1.0-2.5
LOAM, silty, iron streaks, olive brown	2.5-6.0
SAND, coarse, dirty, graded, light brown	6.0-9.0
SAND, coarse, graded, dirty, 10% shale, gray	9.0-16.0
SAND, medium, graded, gray	16.0-20.0
SAND, fine, uniform, gray	20.0-25.5
SAND, medium, uniform, 10% shale, gray	25.5-28.0
SAND, fine, uniform, gray	28.0-32.0
SAND, coarse, graded, light gray	32.0-36.5
GRAVEL (60%), and sand, very coarse, few rocks, light gray	36.5-38.0
TILL, loamy, dark gray, dense	38.0-43.0

Water Level = 8.3 feet below land surface

130-059-03CBB2

USBR hole number: 4+00C1
Date completed: 02/06/90
Depth drilled: 43
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1308.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-2.0
LOAM, sandy, fine, very dark gray	2.0-3.5
LOAM, silty, iron streaks, olive brown	3.5-8.0
SAND, loamy, dark brown	8.0-10.0
SAND, fine, graded, slightly dirty, light brown	10.0-15.0
SAND, coarse, graded, gray	15.0-18.0
SAND, medium, graded, 10% shale chips, gray	18.0-20.5
SAND, fine, very uniform, gray	20.5-35.5
SAND, coarse, graded, slightly gravelly, gray	35.5-38.0
SAND (50%), very coarse, and gravel, gray	38.0-40.5
TILL, loamy, dark gray	40.5-43.0

Water Level = 8.7 feet below land surface

130-059-03CBB5

USBR hole number: 6+00C1
Date completed: 02/21/90
Depth drilled: 38
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.4

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, light lime, light iron stains, olive brown	1.0-3.0
LOAM, silty, clayey, iron stained, mottled, olive brown	3.0-9.0
SAND, coarse, loamy, graded, dirty, shale chips, gray	9.0-22.0
SAND, coarse, graded, shale and lignite chips, gray	22.0-33.0
SAND, very coarse, and gravel(25%), clean, gray	33.0-37.0
LOAM, silty, gray	37.0-38.0

Water Level = 10.0 feet below land surface

130-059-03CBC1

USBR hole number: 8+00C1	NDSWC hole number: n/a
Date completed: 02/06/90	Purpose: test hole
Depth drilled: 43	Source of data: USBR
Screened interval: none	Principal aquifer: Oakes
Casing Size: n/a	Land surface altitude: 1310.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, light lime, black	0-1.5
SAND, very fine, loamy, pale brown	1.5-3.5
LOAM, silty, iron streaks, olive brown	3.5-9.5
SAND, medium, graded, light brown	9.5-16.0
SAND, medium, graded, fairly clean, gray	16.0-22.0
SAND, coarse, graded, clean, 5% shale	22.0-27.0
SAND, fine, uniform, clean, gray	27.0-31.5
SAND, fine, loamy, 20% shale chips, dark gray	31.5-34.5
SAND, coarse, graded, 5% shale chips	34.5-39.0
SAND, very coarse, slightly gravelly, 20% shale chips, dark gray	39.0-41.0
LOAM, silty, very dark gray	41.0-43.0

Water Level = 10.7 feet below land surface

130-059-03CBC5

USBR hole number: 10+00C1
Date completed: 02/21/90
Depth drilled: 45
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.9

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, light lime, iron stains, pale olive brown	1.0-3.5
LOAM, silty, clayey, iron stains, mottled gray, olive brown	3.5-6.0
LOAM, sandy, heavy iron stains, yellow brown	6.0-11.0
SAND, coarse, graded, slightly dirty, shale and lignite chips, gray	11.0-33.0
SAND, loamy, graded, very dirty, lots of shale and lignite, gray	33.0-43.0
TILL, gray	43.0-45.0

Water Level = 9.4 feet below land surface

130-059-03CBC2

USBR hole number: 12+00C1
Date completed: 02/06/90
Depth drilled: 43
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, very fine, moderate lime, gray	1.0-2.5
LOAM, silty, iron streaks, olive brown	2.5-4.0
SAND, coarse, loamy, brown	4.0-9.5
SAND, medium, graded, gray	9.5-16.0
SAND, coarse, graded, clean, 5% shale	16.0-24.5
SAND, fine, uniform, clean, gray	24.5-27.5
SAND, coarse, loamy, 10% gravel sized shale chips, dark gray	27.5-31.5
SAND, coarse, graded, 20% shale, gray	31.5-37.0
CLAY, silty, dark gray	37.0-40.0
TILL, loamy, very dark gray	40.0-43.0

Water Level = 10.4 feet below land surface

130-059-03CCB1

USBR hole number: 16+00C1
Date completed: 02/06/90
Depth drilled: 38
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1311.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, fine, light lime, pale brown	1.0-2.5
SAND, fine, graded, iron stains, light red brown	2.5-8.5
SAND, medium, graded, light iron stains, red brown	8.5-11.0
SAND, coarse, graded, gray brown	11.0-14.0
SAND, medium, graded, gray	14.0-23.0
SAND, coarse, dirty, 40% shale chips, 5% gravel sized lignite, dark gray	23.0-26.0
SAND, very coarse, slightly gravelly, 15% shale, gray	26.0-34.0
CLAY, silty, dark gray	34.0-38.0

Water Level = 11.2 feet below land surface

130-059-03CCC1

USBR hole number: 20+00C1
Date completed: 02/12/90
Depth drilled: 33
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.0

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-0.8
LOAM, sandy, fine, slightly organic, gray brown	0.8-2.0
SAND, fine, loamy, brown	2.0-3.5
SAND, fine, uniform, pale yellow	3.5-6.5
LOAM, sandy, very fine, iron streaks, olive brown	6.5-9.5
SAND, coarse, graded, dirty, 5% shale, gray	9.5-23.5
SAND, very coarse (50%), and gravel, gray	23.5-31.0
TILL, loamy, very dark gray	31.0-32.0
LOAM, sandy, fine, dense, dark gray	32.0-33.0

Water Level = 8.9 feet below land surface

130-059-03CCC2

USBR hole number: 23+00C1
Date completed: 02/07/90
Depth drilled: 28
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.0

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, fine, moderate lime, gray brown	1.0-2.3
LOAM, silty, sand lenses, iron streaks, olive brown	2.3-6.0
SAND, medium, graded, heavy iron stains, yellow brown	6.0-10.5
SAND, fine, uniform, clean, gray	10.5-20.5
SAND, fine, loamy, 20% shale chips, gray	20.5-23.5
SAND, very coarse, gray	23.5-25.5
TILL, loamy, very dark gray	25.5-28.0

Water Level = 9.2 feet below land surface

130-059-03CBB3

USBR hole number: 2+00C2
Date completed: 02/06/90
Depth drilled: 48
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.0

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, light lime, iron stains, brown	1.0-3.5
LOAM, silty, clayey, moderate lime, iron stains, mottled, olive brown	3.5-7.0
SAND, coarse, loamy, graded, iron stains, yellow brown	7.0-10.0
SAND, coarse, loamy, graded, lots of shale chips, gray	10.0-21.0
SAND, medium, slightly graded, clean, shale chips, gray	21.0-34.0
GRAVEL, and sand, very coarse, well graded, up to 1 inch diameter, gray	34.0-43.0
TILL, loamy, dark gray	43.0-48.0

Water Level = 10.5 feet below land surface

130-059-03CBB6

USBR hole number: 4+00C2
Date completed: 02/21/90
Depth drilled: 43
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, silty, clayey, light lime, iron stains, mottled, olive brown	1.0-6.0
LOAM, sandy, heavy iron stains, yellow brown	6.0-11.0
SAND, coarse, graded, dirty, shale and lignite chips	11.0-36.0
SAND, (70%), very coarse, and gravel, well graded, clean, shale chips, gray	36.0-42.0
TILL, loamy, gray	42.0-43.0

Water Level = 10.3 feet below land surface

130-059-03CBB4

USBR hole number: 6+00C2
Date completed: 02/07/90
Depth drilled: 50
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-2.0
LOAM, sandy, fine, light lime, iron stains, yellow brown	2.0-3.0
LOAM, silty, clayey, iron stains, mottled, olive brown	3.0-7.0
SAND, loamy, heavy iron stains, yellow brown	7.0-8.0
SAND, coarse, graded, clean, shale chips, gray	8.0-31.5
SAND, very coarse, well graded, shale chips, gray	31.5-41.0
LOAM, silty, very dense, gray	41.0-42.0
TILL, loamy, dark gray	42.0-50.0

Water Level = 10.3 feet below land surface

130-059-03CBA1

USBR hole number: 8+00C2
Date completed: 02/21/90
Depth drilled: 43
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, black	0-1.0
LOAM, sandy, iron stains, light lime, olive brown	1.0-3.0
LOAM, silty, clayey, iron stains, mottled, olive brown	3.0-8.0
LOAM, clayey, sandy, heavy iron stains, sand layers, yellow brown	8.0-9.0
SAND, coarse, clean, graded, shale chips, gray	9.0-33.0
SAND, very coarse, well graded, clean, shale chips, gray	33.0-38.0
LOAM, silty, gray	38.0-43.0

Water Level = 10.8 feet below land surface

130-059-03CBA

USBR hole number: 10+00C2
Date completed: 02/07/90
Depth drilled: 43
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-2.0
LOAM, silty, clayey, iron stained, mottled, sand lenses, olive brown	2.0-6.5
SAND, loamy, heavy iron stains, yellow brown	6.5-7.5
LOAM, silty, clayey, gray	7.5-8.0
SAND, coarse, graded, clean, shale chips, gray	8.0-23.0
SAND, medium, clean, shale chips, gray	23.0-28.0
SAND, coarse, graded, clean, shale chips, gray	28.0-33.5
LOAM, sandy, very fine, gray	33.5-36.0
LOAM, silty, gray	36.0-43.0

Water Level = 10.7 feet below land surface

130-059-03CAB1

USBR hole number: 14+00C2
Date completed: 02/07/90
Depth drilled: 38
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.0

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, light lime, light iron stains, pale olive	1.0-2.0
LOAM, silty, clayey, iron stains, mottled, few sand lenses, olive brown	2.0-8.0
CLAY, few sand lenses, dark brownish gray	8.0-11.0
SAND, medium, clean, uniform, shale chips, gray	11.0-18.0
SAND, coarse, clean, graded, shale chips, gray	18.0-28.0
SAND, very coarse, clean, well graded, gravel up to 1 inch in diameter, gray	28.0-37.5
TILL, loamy, dark gray	37.5-38.0

Water Level = 8.7 feet below land surface

130-059-03CAB2

USBR hole number: 18+00C2
Date completed: 02/08/90
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.3

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, fine, light lime, gray brown	1.0-2.0
LOAM, silty, clayey, iron stains, mottled, olive brown	2.0-8.0
CLAY, silty, varved, dark gray	8.0-13.0
SAND, medium, slightly graded, shale chips, gray	13.0-23.0
SAND, coarse, graded, shale chips, gray	23.0-32.0
SAND, coarse, loamy, dirty, shale chips, gray	32.0-36.0
TILL, loamy, dark gray	36.0-40.0

Water Level = 10.8 feet below land surface

130-059-03CAA

USBR hole number: 22+00C2
Date completed: 02/08/90
Depth drilled: 38
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.4

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, fine, light lime, gray brown	1.0-2.0
LOAM, sandy, fine, light lime, light iron stains, brown	2.0-3.0
LOAM, silty, clayey, moderate lime, iron stains, olive brown	3.0-4.5
LOAM, sandy, fine, heavy iron stains, yellow brown	4.5-8.0
CLAY, silty, dense, dark gray	8.0-11.0
SAND, medium, clean, shale chips, gray	11.0-35.0
SAND, coarse, clean, graded, few shale chips, gray	35.0-37.0
TILL, loamy, dark gray	37.0-38.0

Water Level = 9.2 feet below land surface

130-059-03CBC3

USBR hole number: 4+00C3
Date completed: 02/07/90
Depth drilled: 43
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, dark black	0-1.0
LOAM, silty, light lime, olive brown	1.0-3.0
SAND, medium, graded, iron stained, yellow brown	3.0-8.5
SAND, medium, uniform, gray	8.5-17.0
SAND, medium, 15% shale chips, 5% lignite, dark gray	17.0-24.0
SAND, fine, dirty, graded, 15% shale, dark gray	24.0-32.0
SAND, fine, graded, slightly gravelly, 25% shale, 5% lignite, dark gray	32.0-34.5
SAND, very fine, loamy, dark gray	34.5-37.0
TILL, loamy, dark gray	37.0-43.0

Water level = 10.0 feet below land surface

130-059-03CBC4

USBR hole number: 6+00C3
Date completed: 02/13/90
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, fine, light lime, gray brown	1.0-2.0
LOAM, silty, olive brown	2.0-3.0
SAND, loamy, light iron stains, red brown	3.0-5.5
SAND, fine, dirty, yellow brown	5.5-8.5
SAND, medium, dirty, graded, 5% shale, red brown	8.5-12.0
SAND, medium, gray	12.0-18.0
SAND, fine, uniform, gray	18.0-22.5
SAND, medium, clean, gray	22.5-26.5
SAND, coarse, graded, dirty, 5% shale, less than 5% lignite, gray	26.5-30.5
SAND, fine, loamy, dark gray	30.5-35.0
TILL, loamy, dark gray	35.0-40.0

Water Level = 11.0 feet below land surface

130-059-03CBD1

USBR hole number: 8+00C3
Date completed: 02/07/90
Depth drilled: 40
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, very fine, olive brown	1.0-3.5
SAND, medium, graded, dirty, iron stains, red brown	3.5-11.0
SAND, coarse, graded, clean, 10% shale, some lignite, gray	11.0-16.0
SAND, fine, graded, dirty, 30% shale, dark gray	16.0-18.5
SAND, coarse, graded, dirty, 10% shale, gray	18.5-23.0
SAND, coarse, graded, clean, 10% shale, light gray	23.0-34.0
TILL, loamy, dark gray	34.0-40.0

Water Level = 10.3 feet below land surface

130-059-03CBD2

USBR hole number: 12+00C3
Date completed: 02/07/90
Depth drilled: 38
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, fine, moderate lime, pale brown	1.0-3.0
SAND, medium, dirty, graded, iron stains, red brown	3.0-12.0
SAND, medium, graded, dirty, gray	12.0-17.0
SAND, coarse, graded, 10% shale chips, lignitic, gray	17.0-24.5
SAND, fine, graded, dirty, 10% shale, lignitic, dark gray	24.5-26.0
SAND, medium, graded, 20% shale chips, dark gray	26.0-29.5
SAND, medium, 25% shale, dark gray	29.5-31.0
SAND, coarse, graded, clean, 2 -inch thick gravel layer above till, gray	31.0-33.0
TILL, loamy, dense, dark gray	33.0-38.0

Water Level = 10.7 feet below land surface

130-059-03CAC1

USBR hole number: 16+00C3
Date completed: 02/08/90
Depth drilled: 38
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.5
LOAM, sandy, fine, light lime, brown	1.5-4.0
SAND, medium, dirty, graded, iron stains, light brown	4.0-11.0
SAND, medium, graded, 10% shale, gray	11.0-23.0
SAND, fine, uniform, clean, gray	23.0-26.0
SAND, coarse, uniform, clean, gray	26.0-35.0
TILL, loamy, dark gray	35.0-38.0

Water Level = 10.5 feet below land surface

130-059-03CAD1

USBR hole number: 20+00C3
Date completed: 02/08/90
Depth drilled: 35
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.9

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.5
LOAM, sandy, very fine, brown	1.5-3.0
LOAM, silty, clayey, moderate lime, gray brown	3.0-4.5
LOAM, silty, iron streaks, olive brown	4.5-5.0
SAND, medium, dirty, graded, iron stains, light brown	5.0-12.0
SAND, medium, graded, dirty, 15% shale, 10% lignite, gray	12.0-19.0
SAND, medium, graded, clean, gray	19.0-32.0
TILL, loamy, dark gray	32.0-35.0

Water Level = 10.7 feet below land surface

130-059-03CAD2

USBR hole number: 24+00C3
Date completed: 02/08/90
Depth drilled: 35
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1311.0

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, fine, heavy lime zone at 5.5-6.0 feet, brown	1.0-6.0
SAND, medium, dirty, graded, gray brown	6.0-10.0
SAND, medium, graded, iron stains, red brown	10.0-12.0
SAND, medium, graded, 5% shale, gray	12.0-17.0
SAND, fine, dark gray	17.0-18.0
SAND, medium, uniform, gray	18.0-21.0
SAND, coarse, graded, 5% shale, gray	21.0-27.0
SAND, coarse, very graded, dirty, 10% shale, dark gray	27.0-28.5
SAND, medium, graded, dirty, 15% shale, dark gray	28.5-31.0
SAND(60%), medium, and gravel, dirty, rocks, dark gray	31.0-33.0
TILL, loamy, dark gray	33.0-35.0

Water Level = 11.0 feet below land surface

130-059-03CCC3

USBR hole number: 2+00C4
Date completed: 02/13/90
Depth drilled: 28
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1309.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-2.5
SAND, loamy, heavy iron stains, yellow brown	2.5-5.5
CLAY, silty, iron stains, mottled, sand lenses, olive brown	5.5-8.0
SAND, medium, uniform, clean, shale chips, gray	8.0-20.0
SAND, very coarse, well graded, clean, lots of shale and lignite chips, gray	20.0-23.0
TILL, loamy, dark gray	23.0-28.0

Water Level = 8.8 feet below land surface

130-059-03CCC4

USBR hole number: 6+00C4	NDSWC hole number: n/a
Date completed: 02/13/90	Purpose: test hole
Depth drilled: 28	Source of data: USBR
Screened interval: none	Principal aquifer: Oakes
Casing Size: n/a	Land surface altitude: 1311.2

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.5
SAND, loamy, light iron stains, brown	1.5-3.0
SAND, medium, iron stains, pale olive brown	3.0-5.5
LOAM, silty, clayey, iron stains, mottled, yellow brown	5.5-8.0
SAND, loamy, heavy iron stains, gray	8.0-10.5
SAND, medium, graded, shale chips, gray	10.5-18.0
SAND, very coarse, well graded, clean, lignite chips, gray	18.0-27.0
TILL, loamy, dark gray	27.0-28.0

Water Level = 10.3 feet below land surface

130-059-03CCD2

USBR hole number: 8+00C4
Date completed: 02/22/90
Depth drilled: 33
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1310.999999

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, fine, iron stains, brown	1.0-2.0
SAND, loamy, iron stains, yellow brown	2.0-4.0
LOAM, silty, clayey, iron stains, mottled, sand lenses, olive brown	4.0-8.0
LOAM, sandy, heavy iron stains, yellow brown	8.0-10.5
SAND, medium, dirty, shale, chips, gray	10.5-20.0
SAND, coarse, graded, shale and lignite chips, gray	20.0-27.0
SAND, coarse, well graded, clean, shale and lignite chips, gray	27.0-29.0
TILL, loamy, gray	29.0-33.0

Water Level = 9.9 feet below land surface

130-059-03CCD1

USBR hole number: 9+93C4
Date completed: 02/18/90
Depth drilled: 38
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1313.5

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
SAND, loamy, light lime, light iron stains, brown	1.0-4.5
LOAM, silty, light lime, light iron mottled and iron stains, olive brown	4.5-6.0
SAND, loamy, iron stains, brown	6.0-9.0
SAND, coarse, graded, shale and lignite chips, gray	9.0-23.0
SAND, very coarse, and gravel, well graded, clean, shale and lignite chips, gray	23.0-36.0
TILL, loamy, gray	36.0-38.0

Water Level = 12.9 feet below land surface

130-059-03CCD3

USBR hole number: 12+00C4
Date completed: 02/22/90
Depth drilled: 33
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1311.6

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.0
LOAM, sandy, iron stains, brown	1.0-3.0
LOAM, silty, clayey, iron stains, mottled, brown	3.0-4.5
SAND, medium, dirty, uniform, heavy iron stains, yellow brown	4.5-11.0
SAND, coarse, graded, clean, shale and lignite chips, gray	11.0-22.0
SAND, very coarse, well graded, clean, lignite and shale chips, gray	22.0-28.0
TILL, loamy, gray	28.0-33.0

Water Level = 11.0 feet below land surface

130-059-03CDC1

USBR hole number: 14+00C4
Date completed: 02/13/90
Depth drilled: 33
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1308.9

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.5
LOAM, silty, olive brown	1.5-4.0
SAND, medium, dirty, graded, red brown	4.0-8.5
SAND, fine, graded, dirty, 15% shale, gray	8.5-16.5
SAND, coarse, clean, graded, gray	16.5-20.0
SAND, coarse, clean, 5% shale, gray	20.0-22.0
SAND, coarse, and gravel (10%), graded, 10% shale, gray	22.0-24.5
SAND, coarse, graded, dirty, 15% shale, some lignite, gray	24.5-26.0
TILL, loamy, dense, dark gray	26.0-33.0

Water Level = 7.7 feet below land surface

130-059-03CDC2

USBR hole number: 18+00C4
Date completed: 02/14/90
Depth drilled: 30
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1311.0

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-1.5
LOAM, sandy, fine, olive brown	1.5-2.5
LOAM, silty, clayey, light lime, gray brown	2.5-3.5
SAND, medium, dirty, brown	3.5-11.5
SAND, loamy, olive brown	11.5-13.5
SAND, medium, graded, dirty, 40% shale chips, gray	13.5-17.5
SAND, medium, graded, dirty, 15% shale chips, less than 5% lignite, gray	17.5-22.0
SAND, fine, uniform, 20% shale chips, gray	22.0-25.5
SAND, coarse, graded, clean, less than 5% shale chips, from 28-29 feet 10% rocks and gravel	25.5-29.0
TILL, loamy, dark gray	29.0-30.0

Water Level = 10.0 feet below land surface

130-059-03CDD1

USBR hole number: 22+00C4
Date completed: 02/14/90
Depth drilled: 33
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1312.7

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-2.0
LOAM, sandy, fine, brown	2.0-3.5
LOAM, silty, iron streaks, olive brown	3.5-5.8
SAND, fine, heavy iron stains, yellow brown	5.8-8.5
SAND, fine loamy, olive brown	8.5-11.5
SAND, medium, dirty, graded, brown	11.5-14.0
SAND, medium, uniform, clean, 10% shale chips, gray	14.0-27.0
SAND, coarse, slightly gravelly, clean, gray	27.0-29.5
SAND (60%), and gravel, gray	29.5-32.0
TILL, loamy, dark gray	32.0-33.0

Water Level = 11.7 feet below land surface

130-059-03CDD2

USBR hole number: 26+00C4
Date completed: 02/14/90
Depth drilled: 38
Screened interval: none
Casing Size: n/a

NDSWC hole number: n/a
Purpose: test hole
Source of data: USBR
Principal aquifer: Oakes
Land surface altitude: 1315.1

LITHOLOGIC LOG

<u>Unit description</u>	<u>Depth (ft)</u>
LOAM, sandy, fine, black	0-3.0
SAND, loamy, iron stains, brown	3.0-6.0
LOAM, silty, clayey, iron mottled and iron stained, olive brown	6.0-10.5
SAND, loamy, heavy iron stains, yellow brown	10.5-13.0
SAND, medium, clean, graded, shale and lignite chips, gray	13.0-23.0
SAND, coarse, well graded, clean, shale, chips, gray	23.0-30.0
SAND, very coarse, well graded, shale chips, gray	30.0-35.0
TILL, loamy, dark gray	35.0-38.0

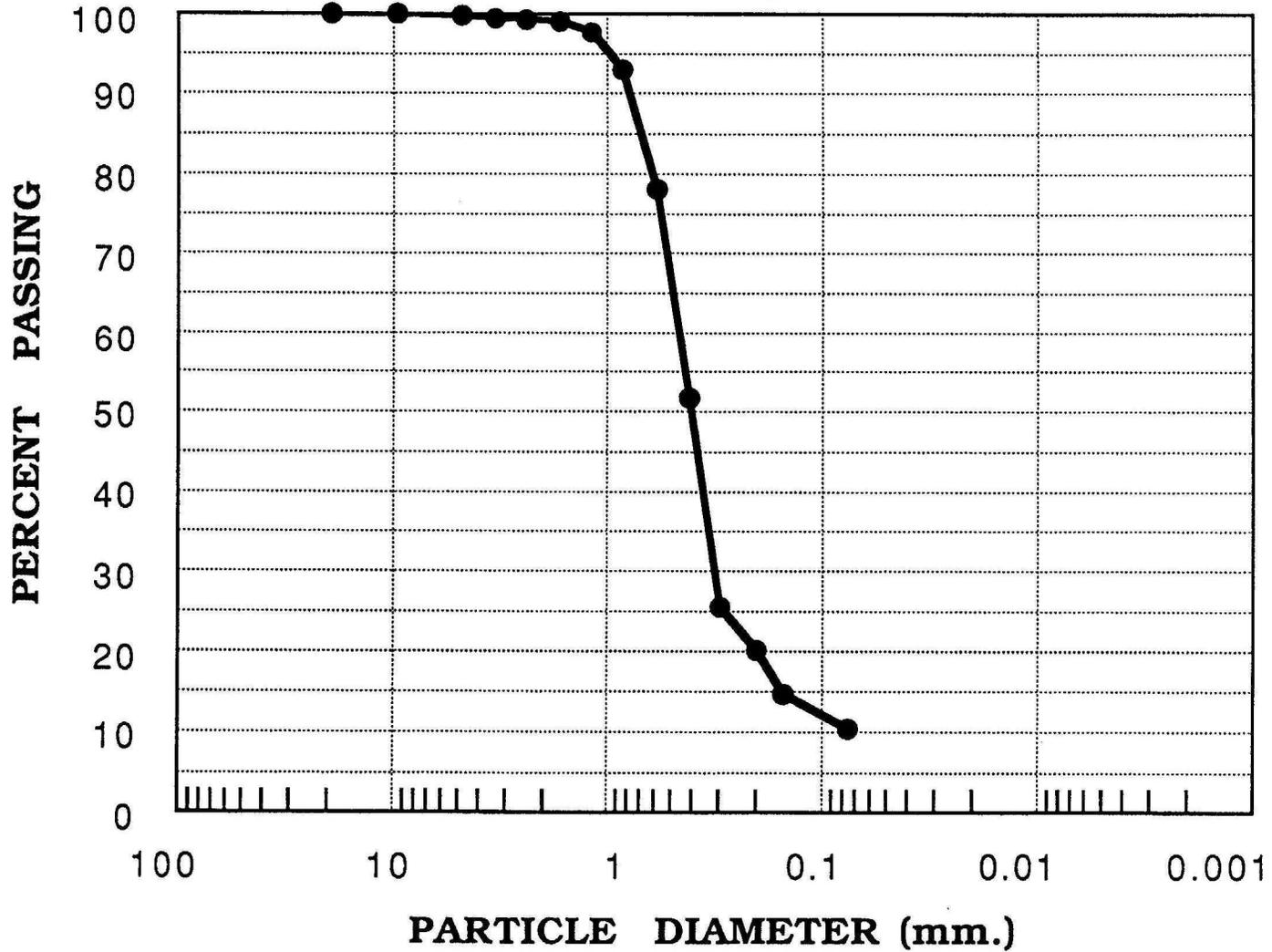
Water Level = 14.0 feet below land surface

APPENDIX 2

**Gradation Analysis Graphs Showing
Percent Passing Versus Grain-Size Diameter**

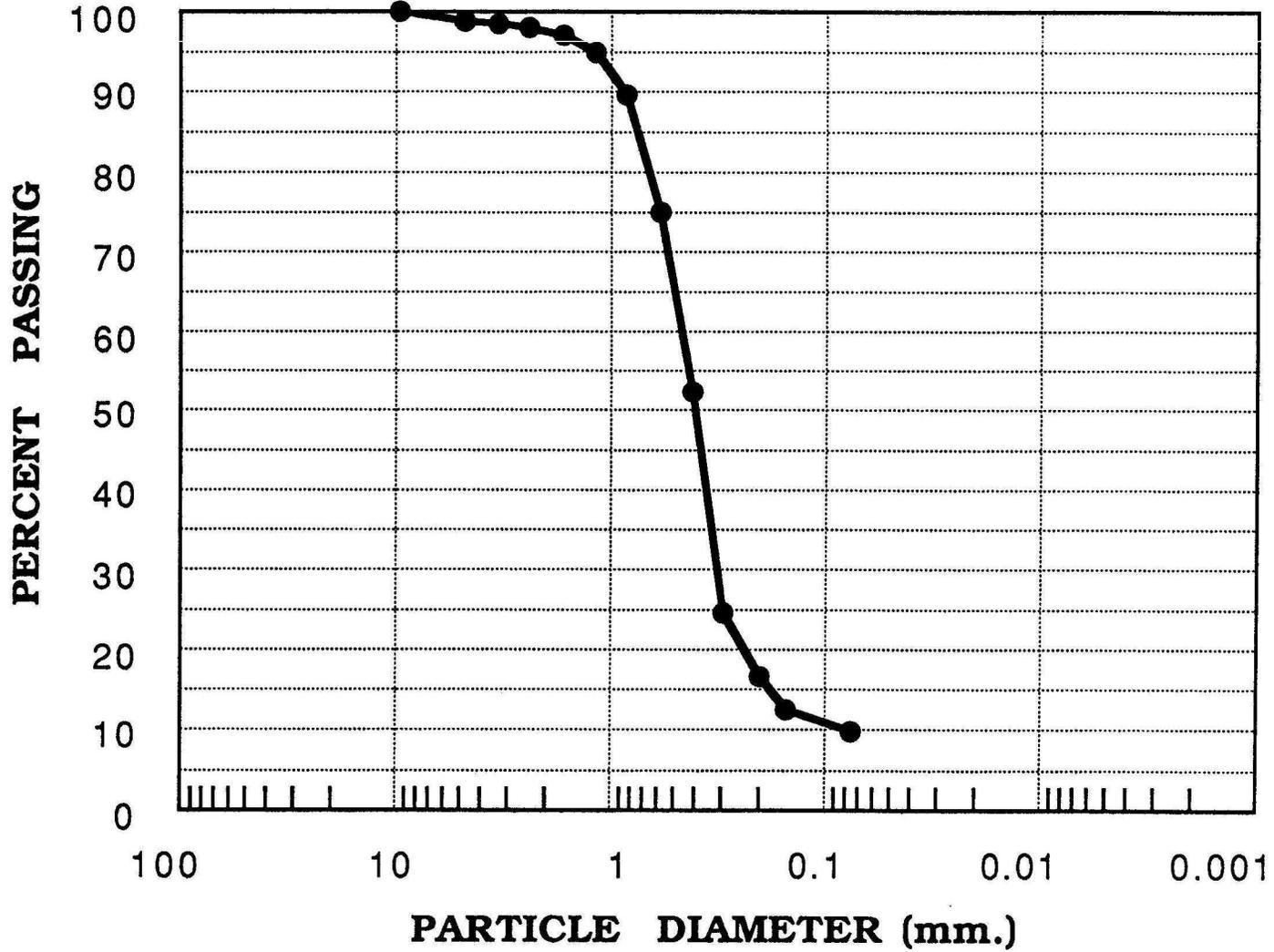
LINE # 4A1 N-S
USBR SITE # 7+00
SAMPLING DEPTH (ft.) 28-38

Particle Diameter @ 60% Passing = 0.46 mm.(0.018 in.)



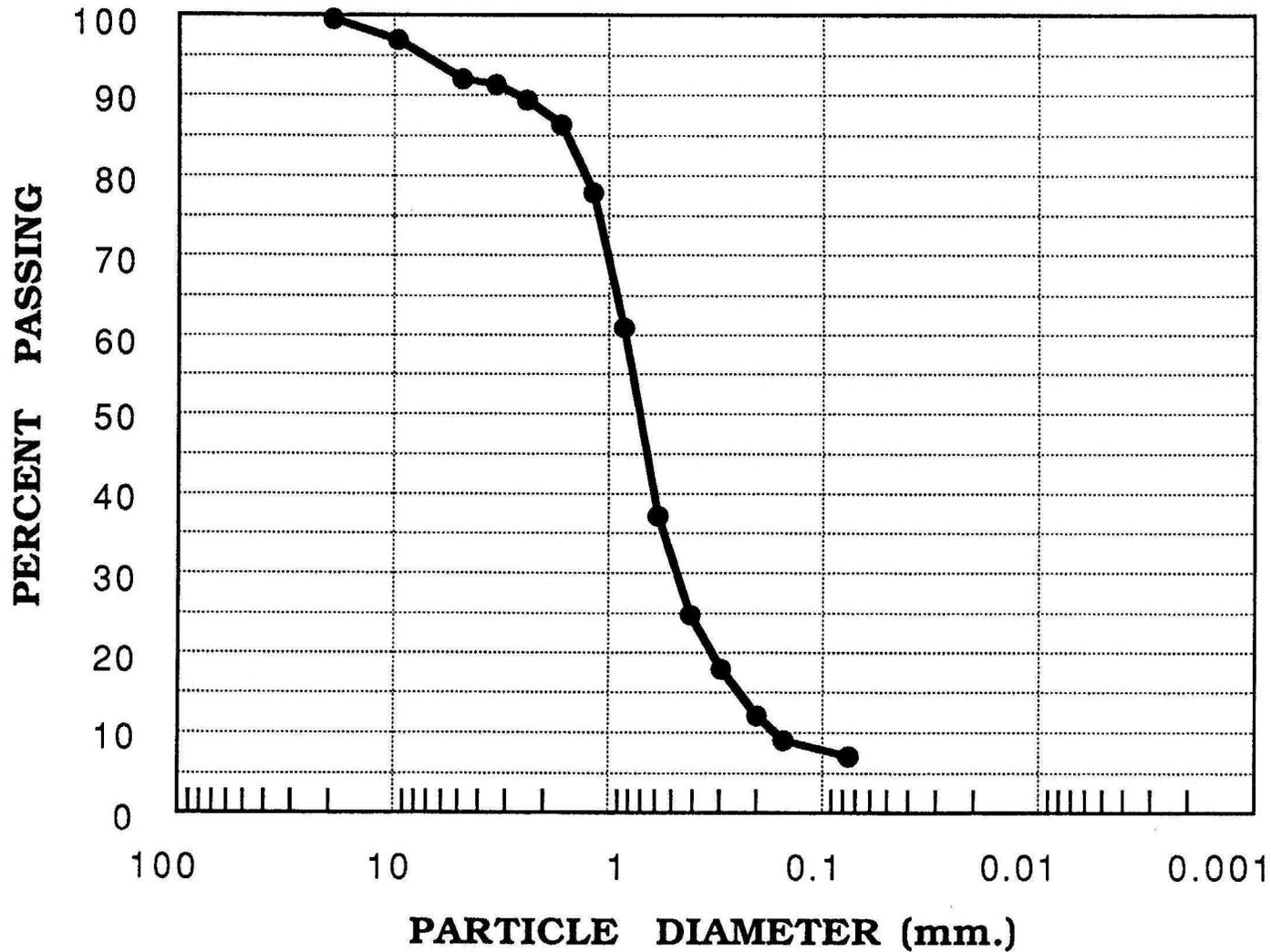
LINE # 4A1 N-S
USBR SITE # 7+00
SAMPLING DEPTH (ft.) 38-43

Particle Diameter @ 60% Passing = 0.44 mm.(0.017 in.)



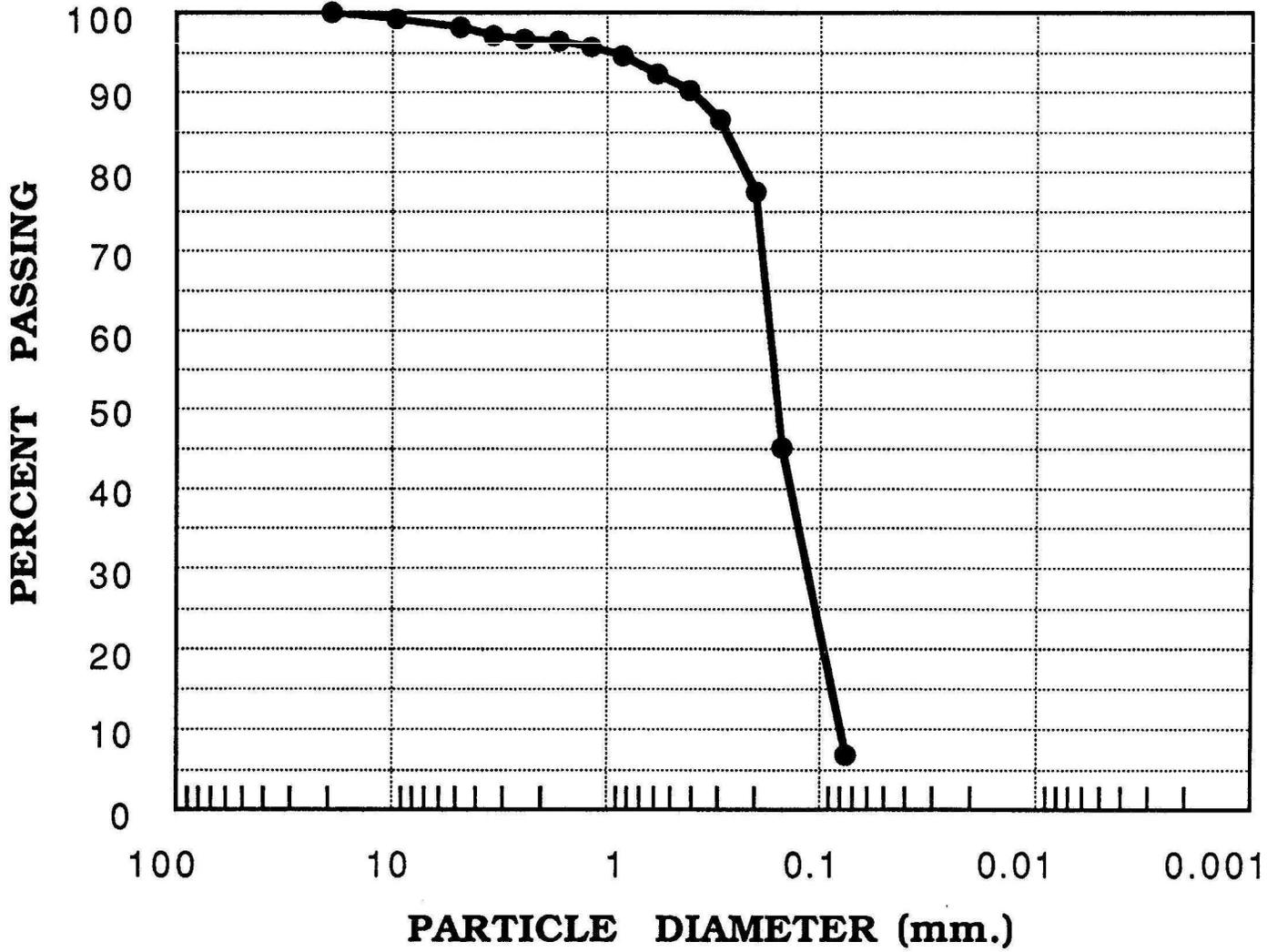
LINE # 4A1 N-S
USBR SITE # 7+00
SAMPLING DEPTH (ft.) 43-49

Particle Diameter @ 60% Passing = 0.83 mm.(0.033 in.)



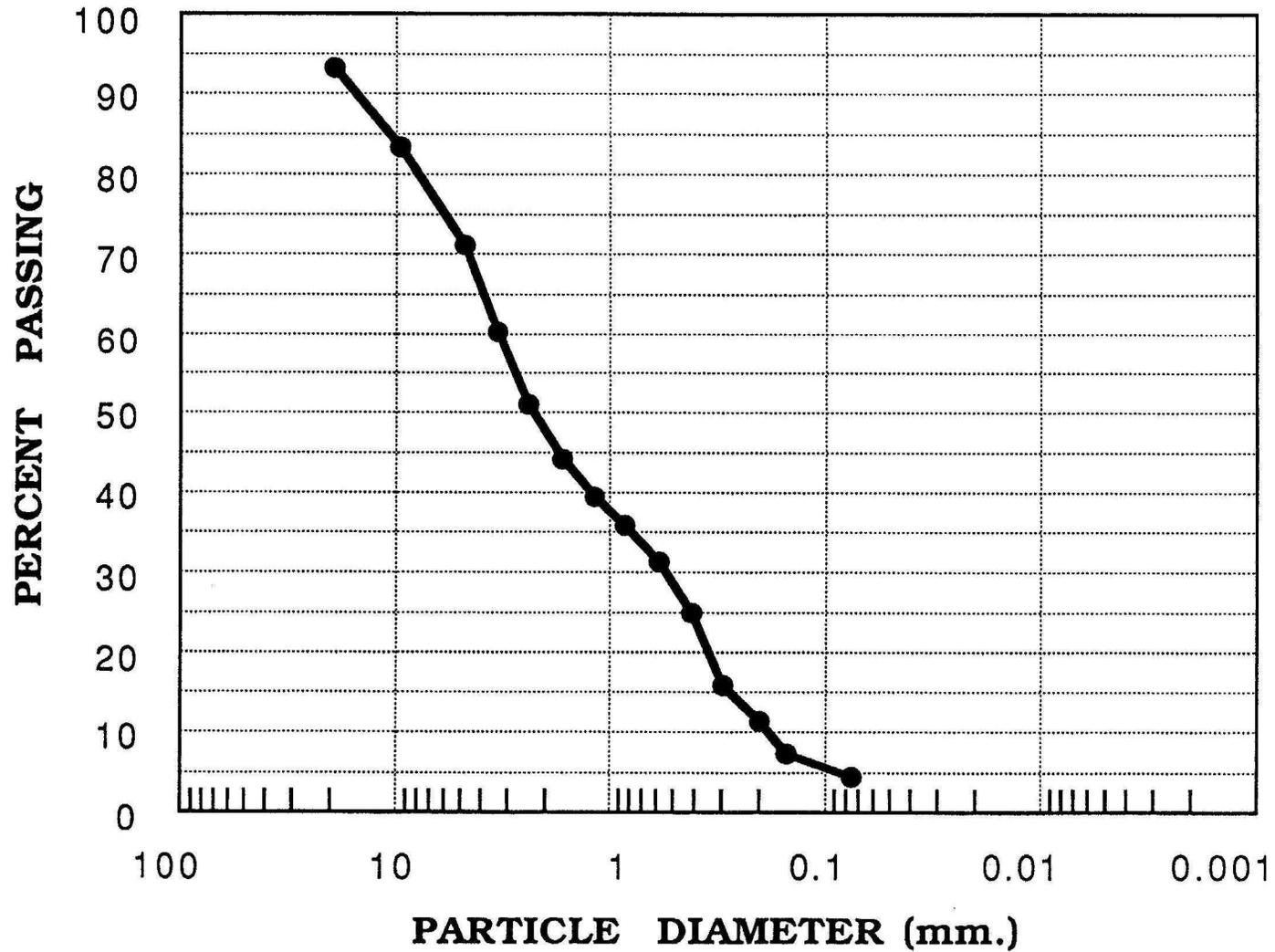
LINE # 4A1 N-S
USBR SITE # 11+00
SAMPLING DEPTH (ft.) 28-31.5

Particle Diameter @ 60% Passing = 0.17 mm.(0.007 in.)



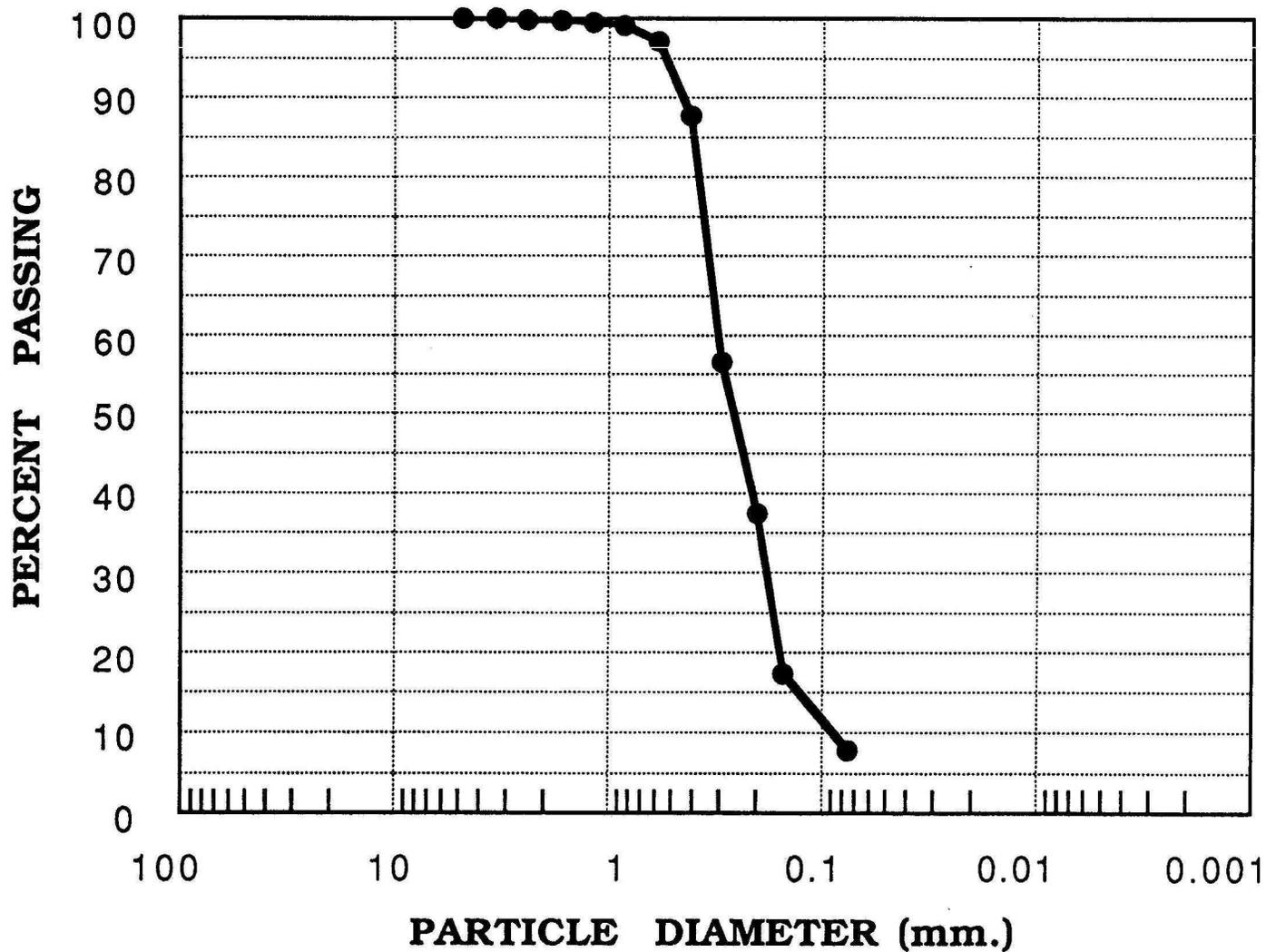
LINE # 4A1 N-S
USBR SITE # 11+00
SAMPLING DEPTH (ft.) 31.5-44

Particle Diameter @ 60% Passing = 3.28 mm.(0.129 in.)



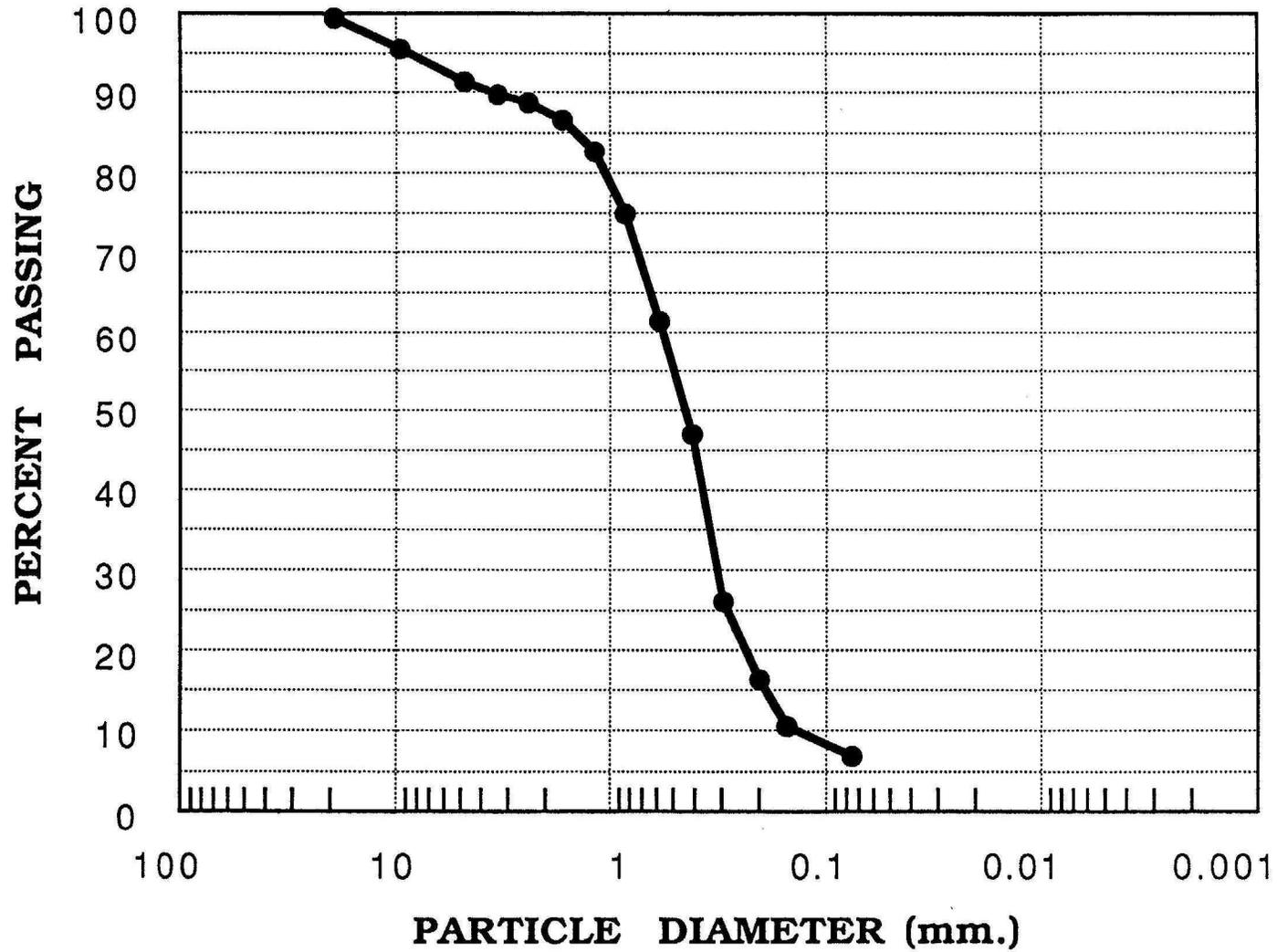
LINE # 4A1 N-S
USBR SITE # 19+00
SAMPLING DEPTH (ft.) 28-38

Particle Diameter @ 60% Passing = 0.30 mm.(0.012 in.)



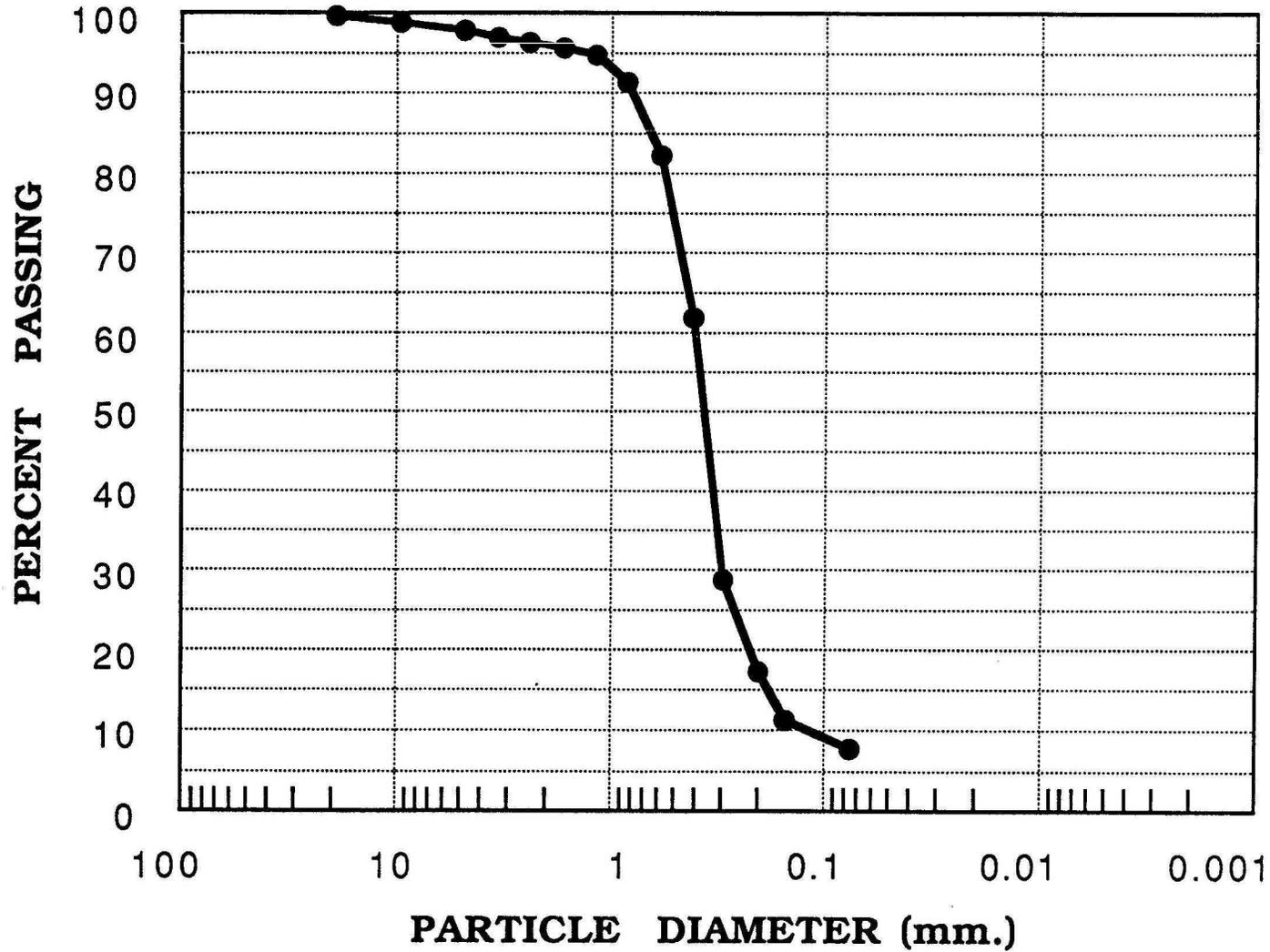
**LINE # 4A1 N-S
USBR SITE # 19+00
SAMPLING DEPTH (ft.) 38-46**

Particle Diameter @ 60% Passing = 0.58 mm.(0.023 in.)



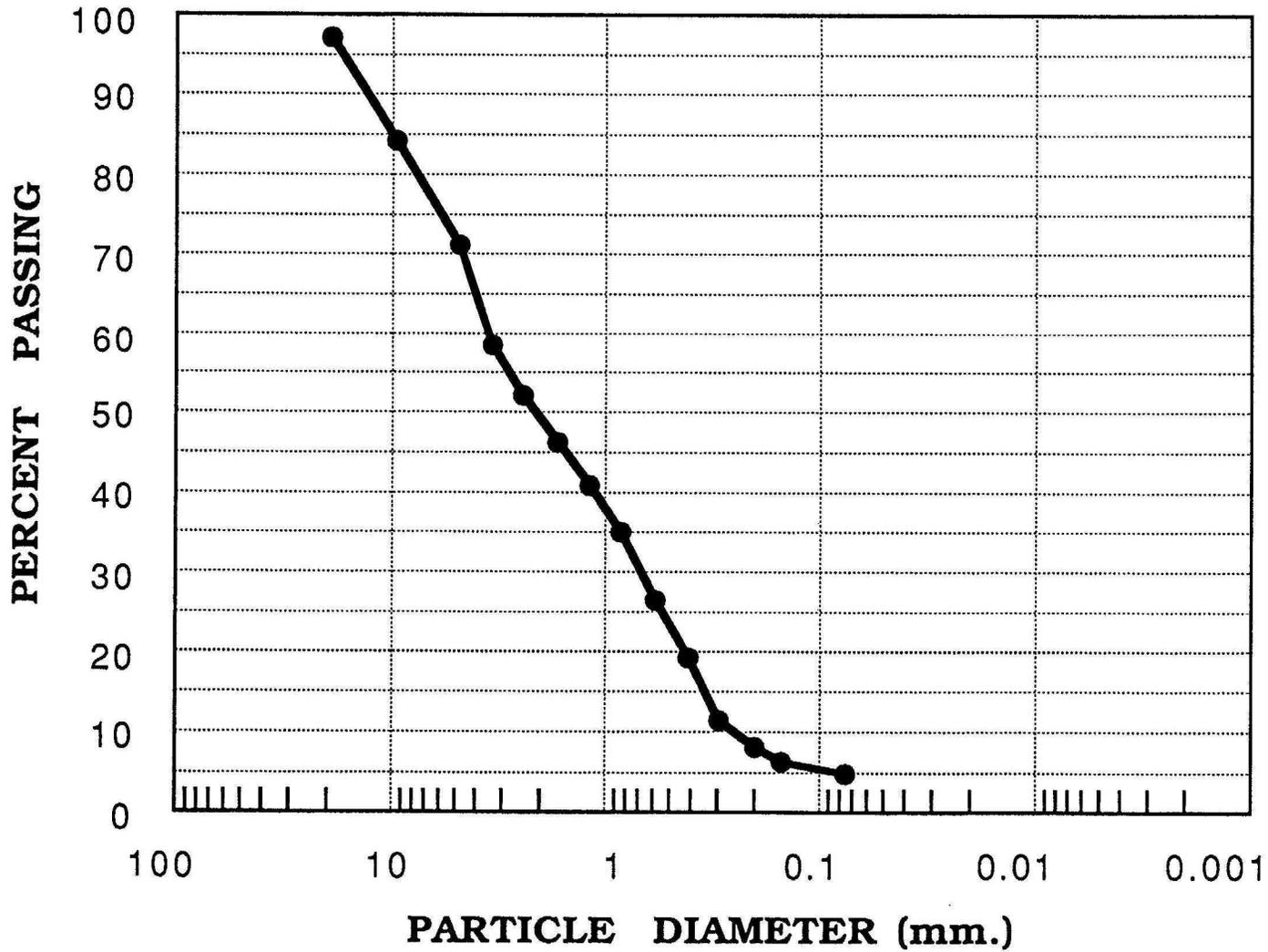
LINE # 4A1 N-S
USBR SITE # 21+00
SAMPLING DEPTH (ft.) 34-41.5

Particle Diameter @ 60% Passing = 0.40 mm.(0.016 in.)



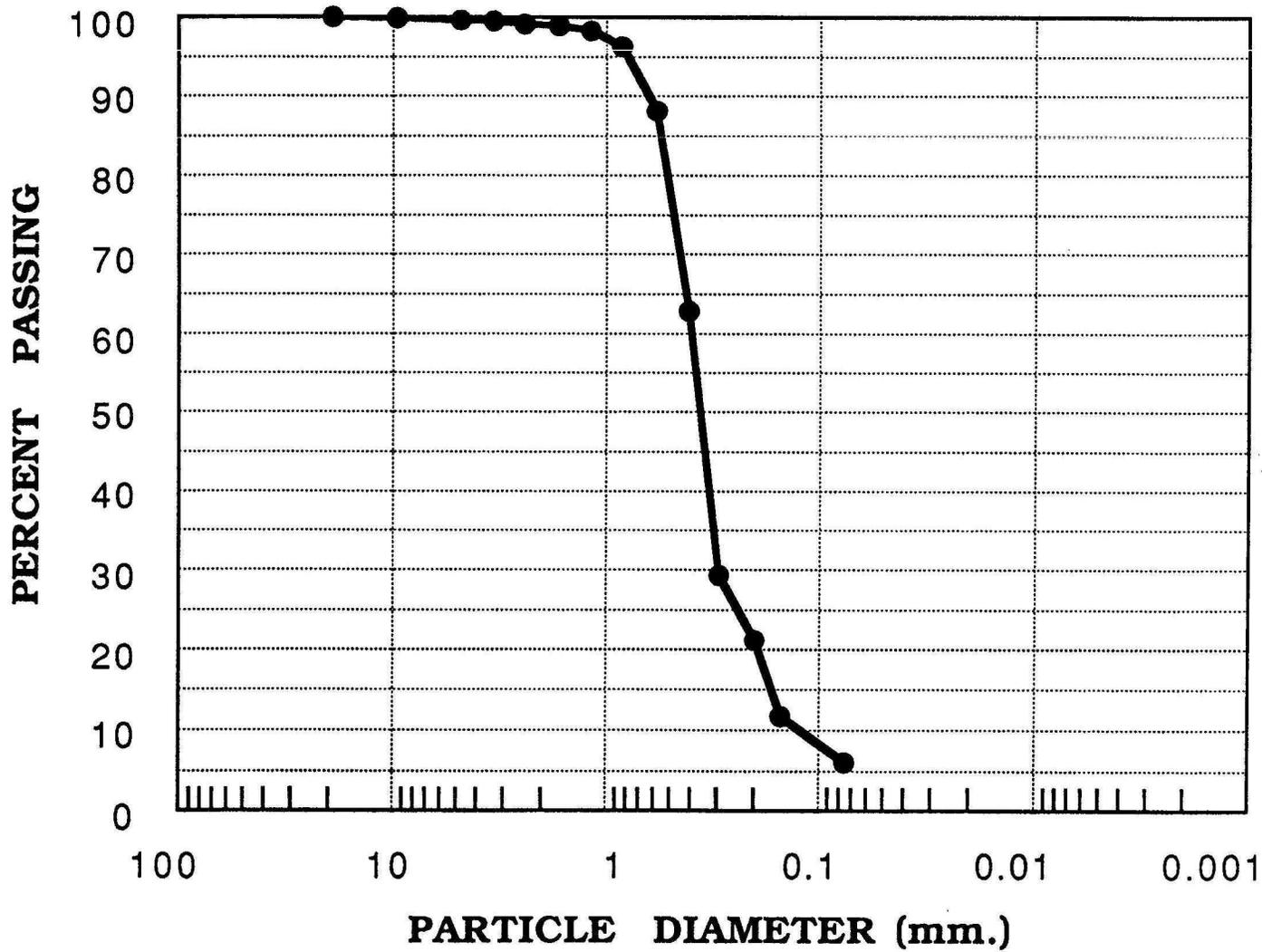
LINE # 4A1 N-S
USBR SITE # 21+00
SAMPLING DEPTH (ft.) 41.5-48

Particle Diameter @ 60% Passing = 3.44 mm.(0.135 in.)



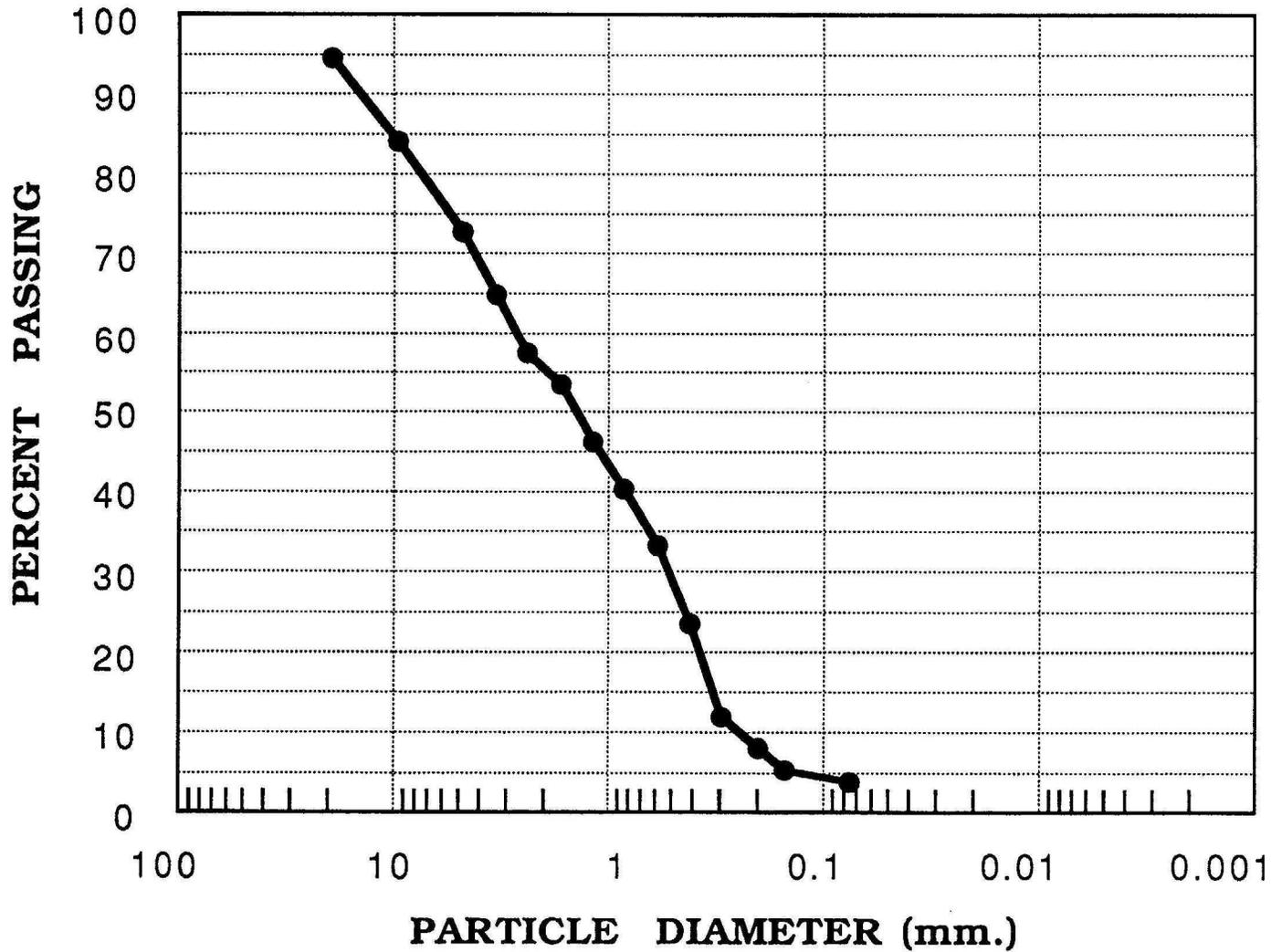
LINE # 4A1 N-S
USBR SITE # 23+00
SAMPLING DEPTH (ft.) 28-41.5

Particle Diameter @ 60% Passing = 0.40 mm.(0.016 in.)



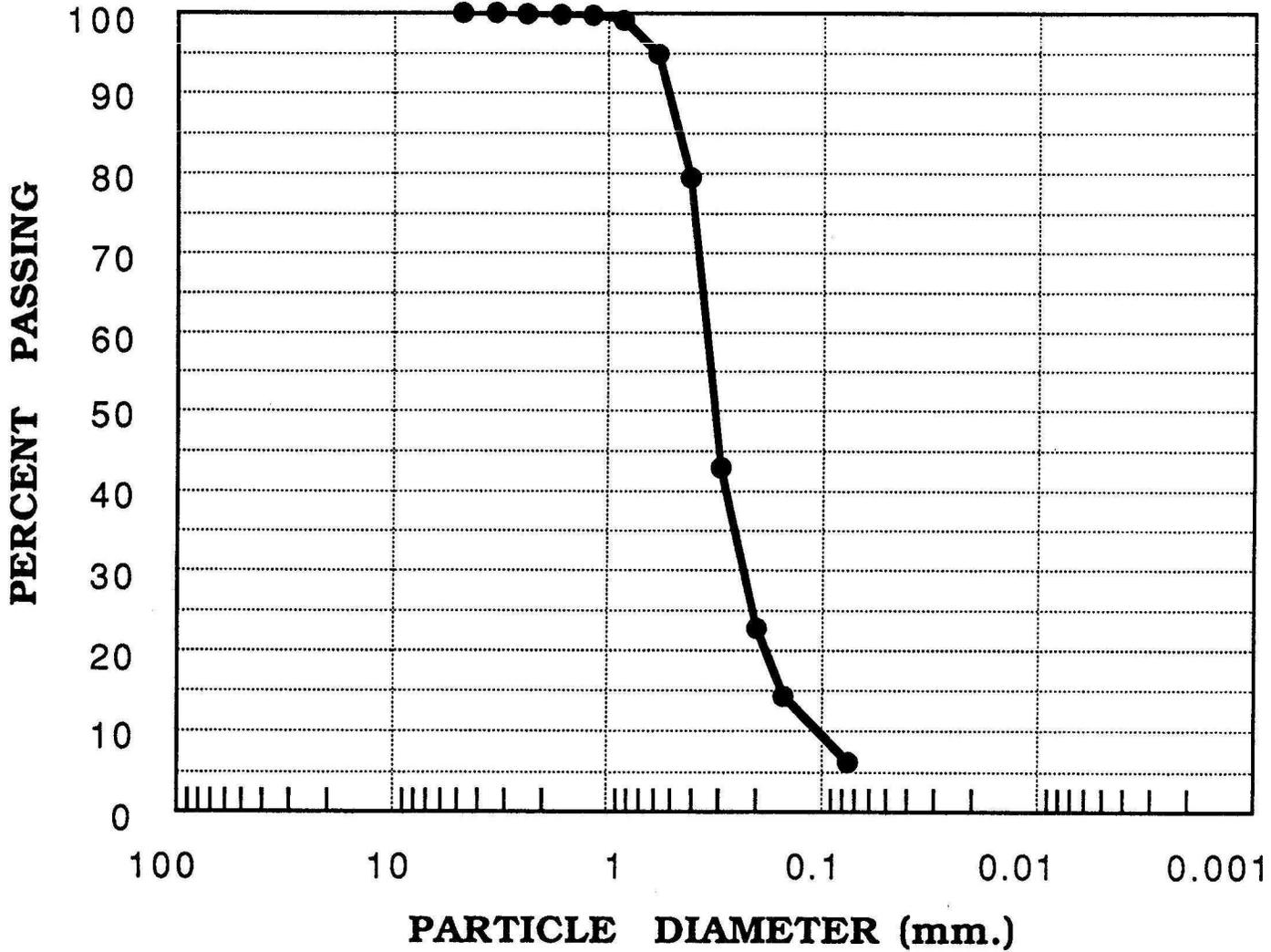
LINE # 4A1 N-S
USBR SITE # 23+00
SAMPLING DEPTH (ft.) 41.5-48

Particle Diameter @ 60% Passing = 2.61 mm.(0.103 in.)



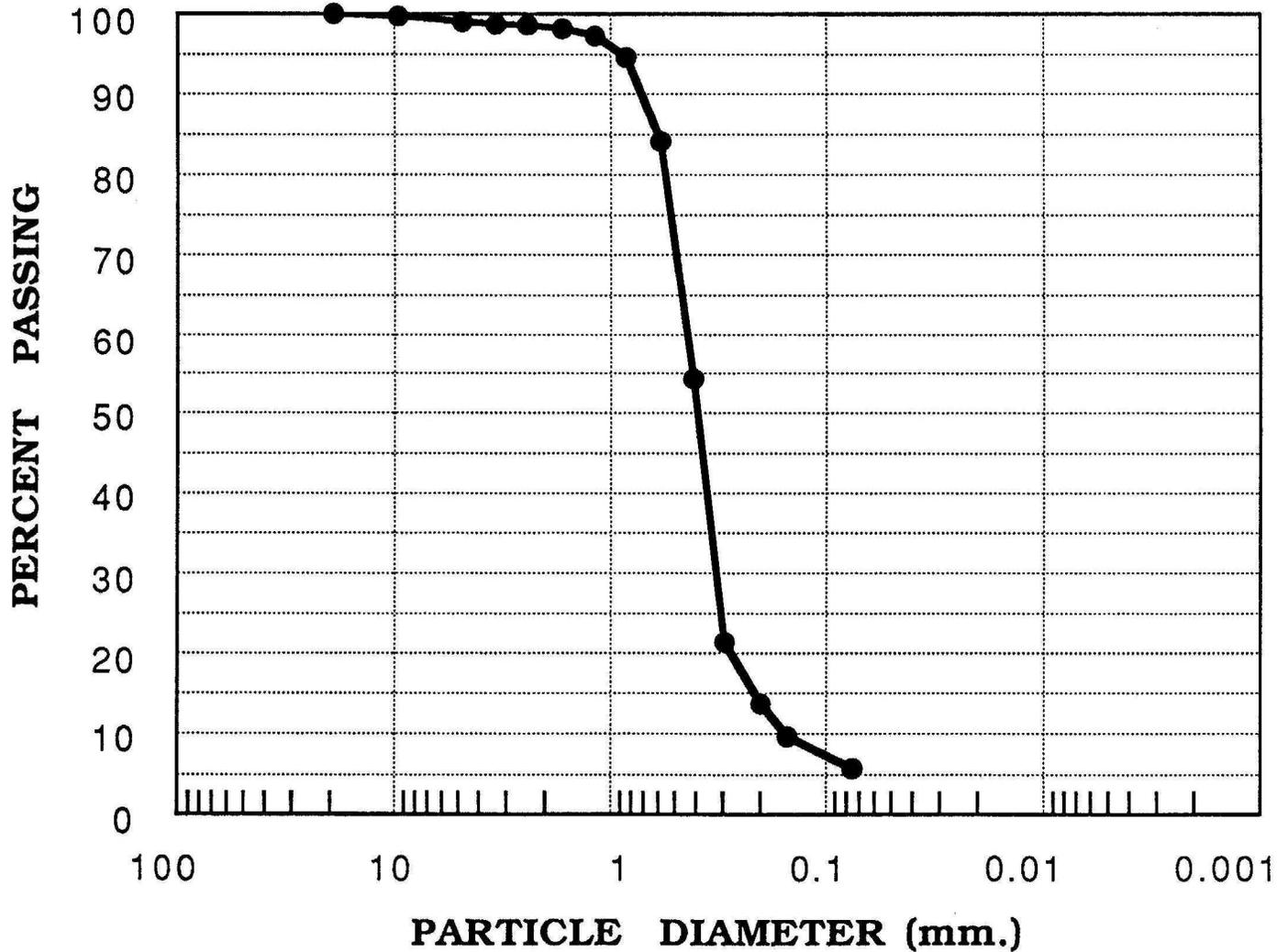
LINE # 4A1 N-S
USBR SITE # 25+00
SAMPLING DEPTH (ft.) 29-35

Particle Diameter @ 60% Passing = 0.33 mm.(0.013 in.)



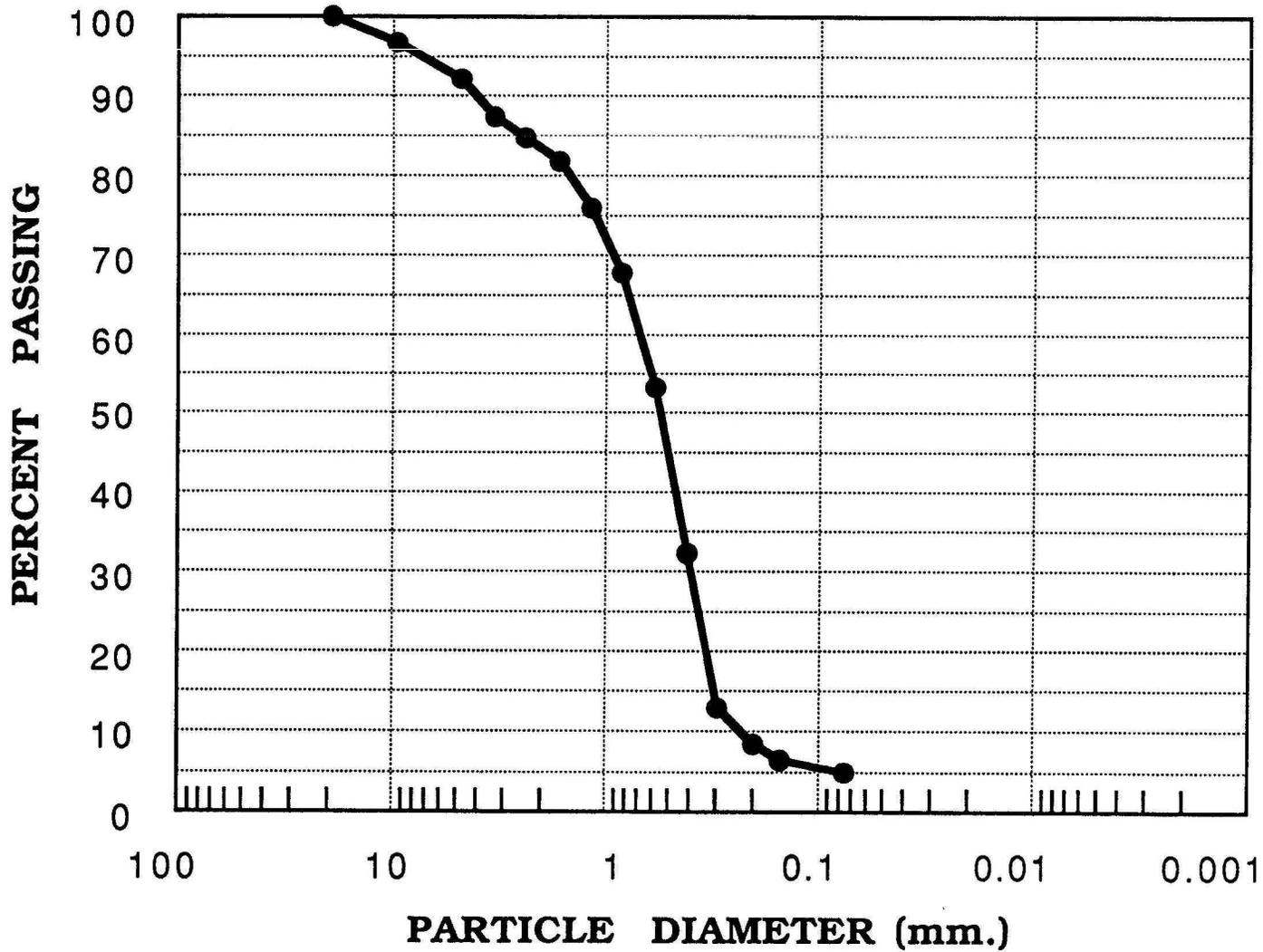
LINE # 4A1 N-S
USBR SITE # 25+00
SAMPLING DEPTH (ft.) 35-40

Particle Diameter @ 60% Passing = 0.44 mm.(0.017 in.)



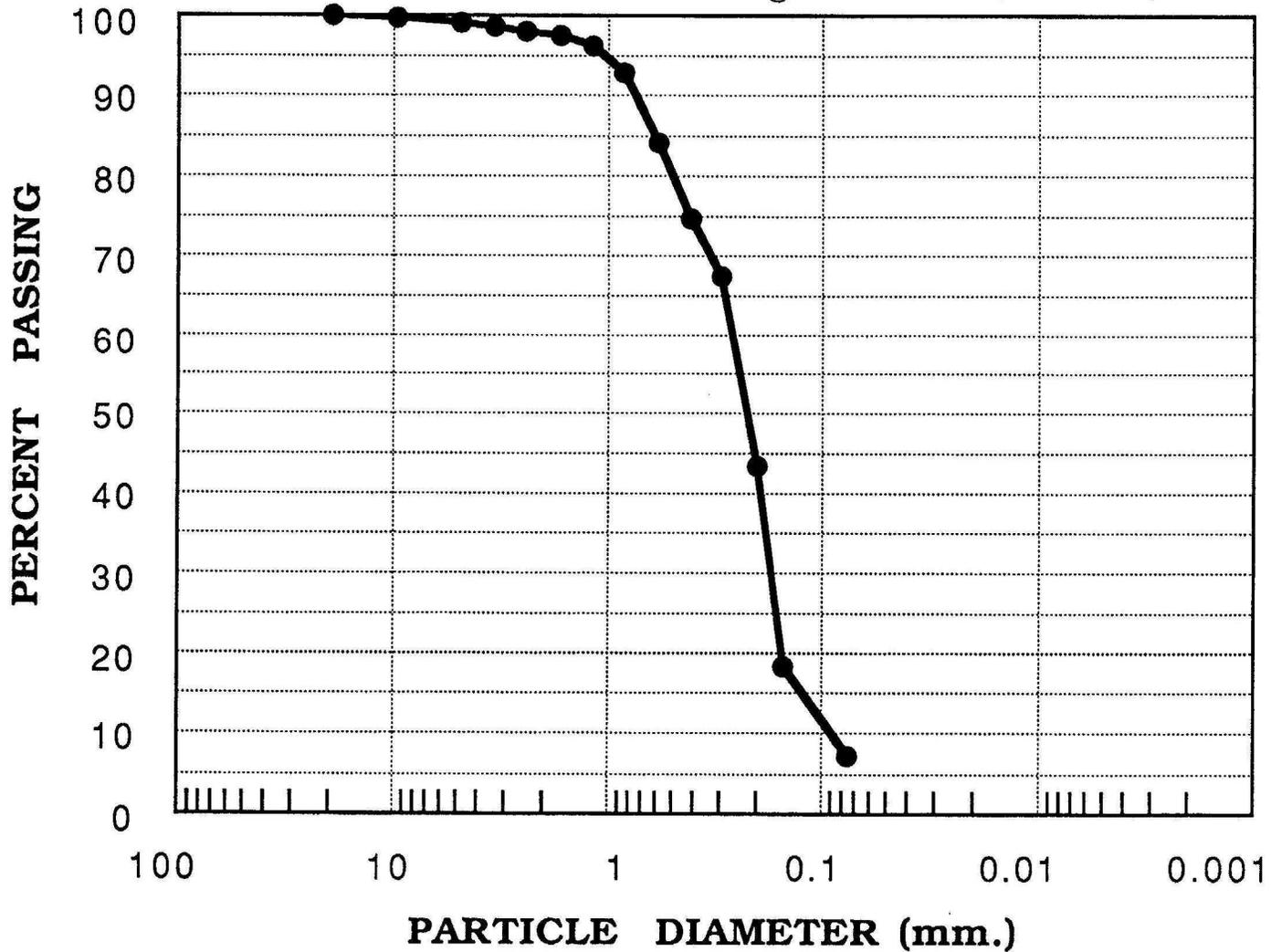
LINE # 4A1 N-S
USBR SITE # 25+00
SAMPLING DEPTH (ft.) 40-43

Particle Diameter @ 60% Passing = 0.66 mm.(0.026 in.)



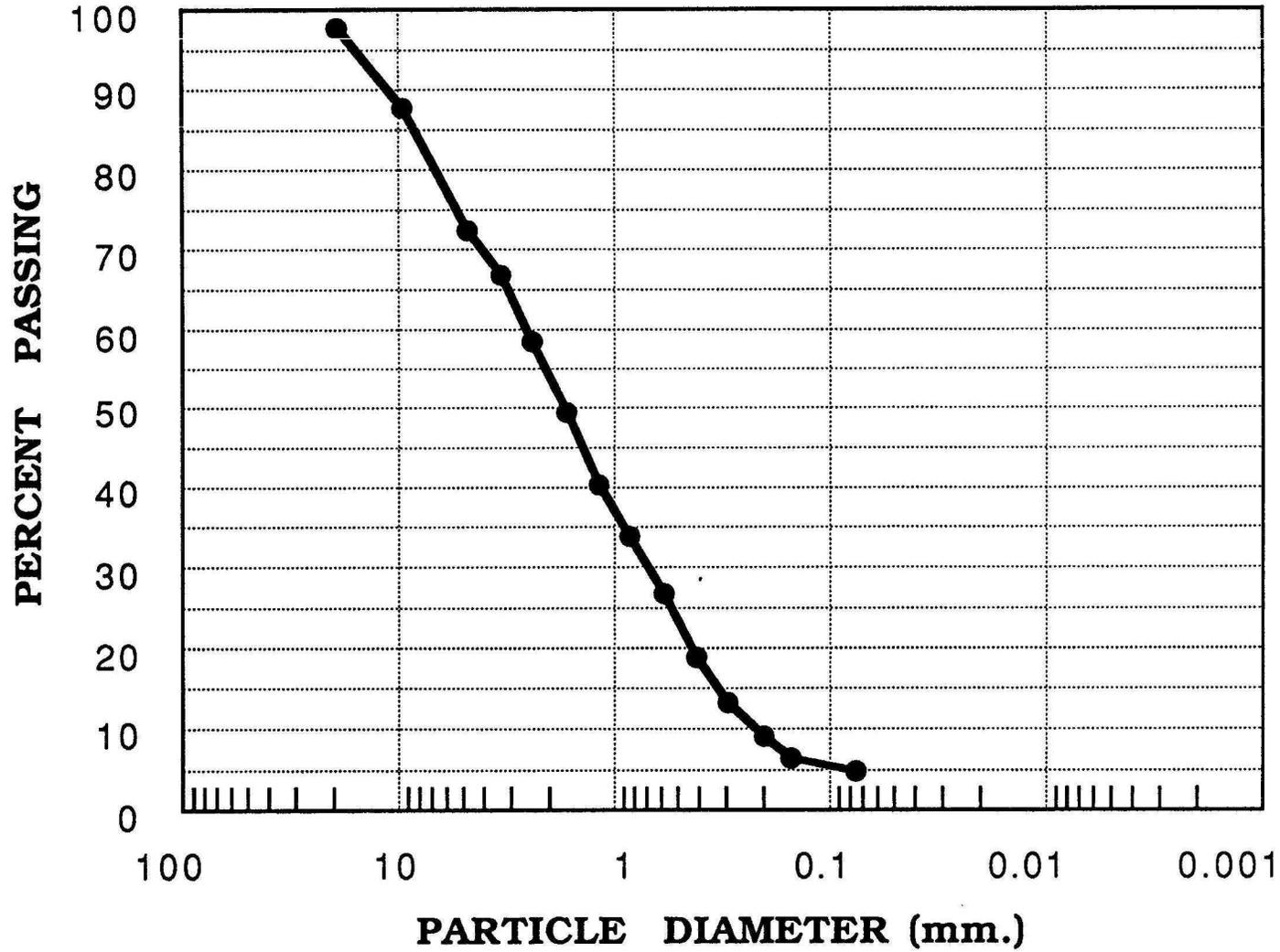
LINE # 4A2 W-E
USBR SITE # 1+00
SAMPLING DEPTH (ft.) 17-22.5

Particle Diameter @ 60% Passing = 0.26 mm.(0.010 in.)



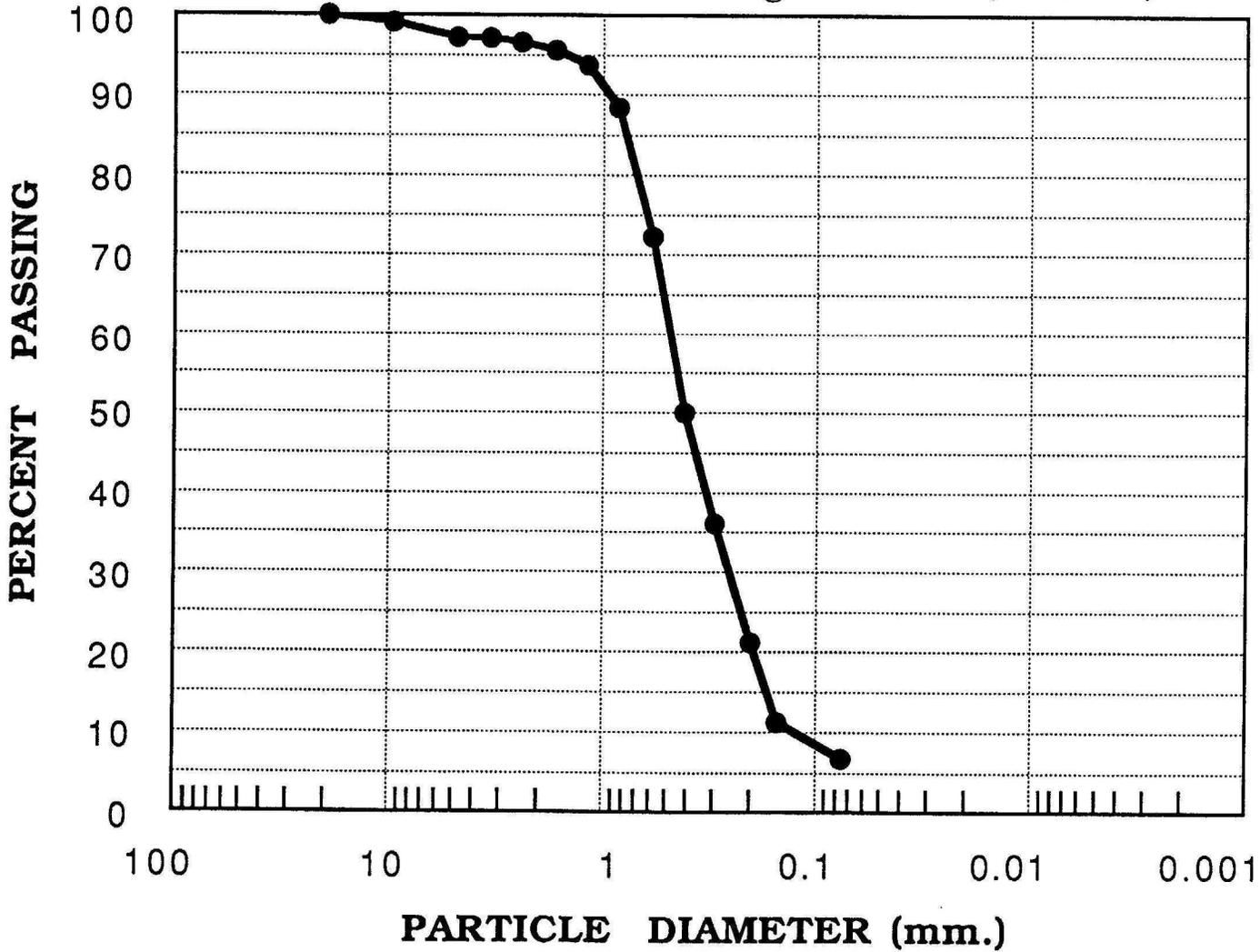
LINE # 4A2 W-E
USBR SITE # 1+00
SAMPLING DEPTH (ft.) 22.5-31

Particle Diameter @ 60% Passing = 2.49 mm.(0.098 in.)



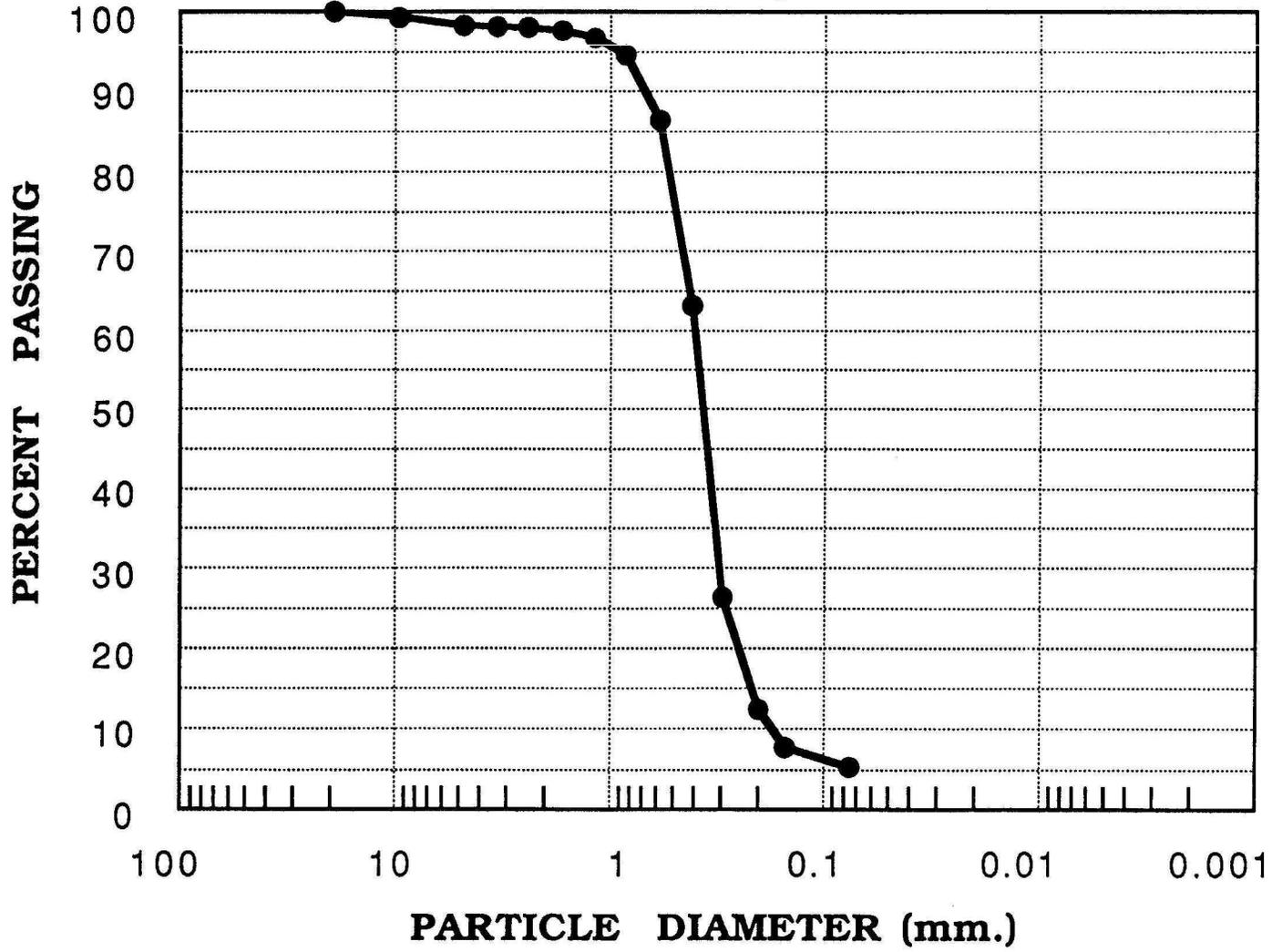
LINE # 4A2 W-E
USBR SITE # 3+00
SAMPLING DEPTH (ft.) 18-23

Particle Diameter @ 60% Passing = 0.48 mm.(0.019 in.)



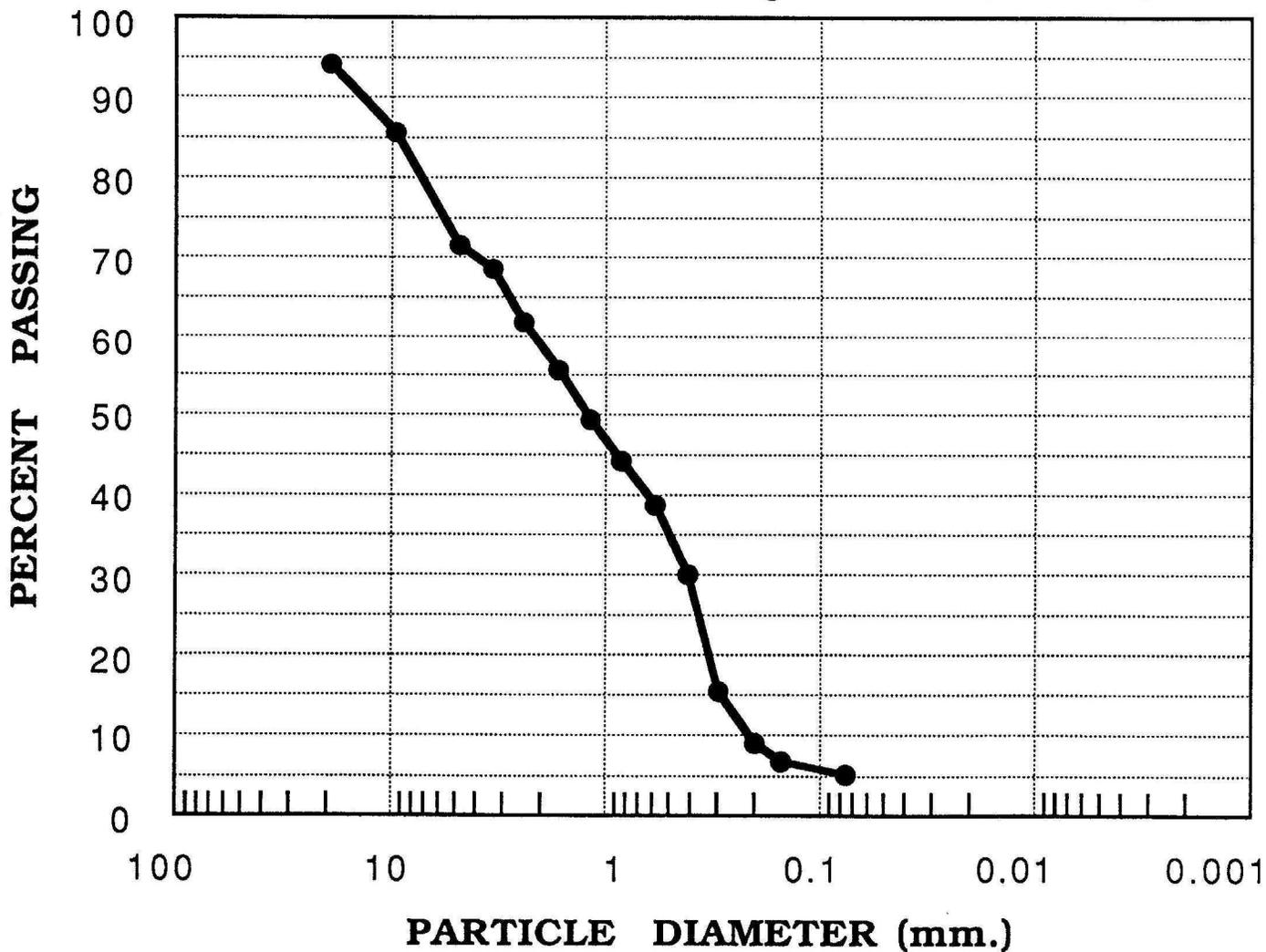
LINE # 4A2 W-E
USBR SITE # 5+00
SAMPLING DEPTH (ft.) 23-28.5

Particle Diameter @ 60% Passing = 0.38 mm.(0.015 in.)



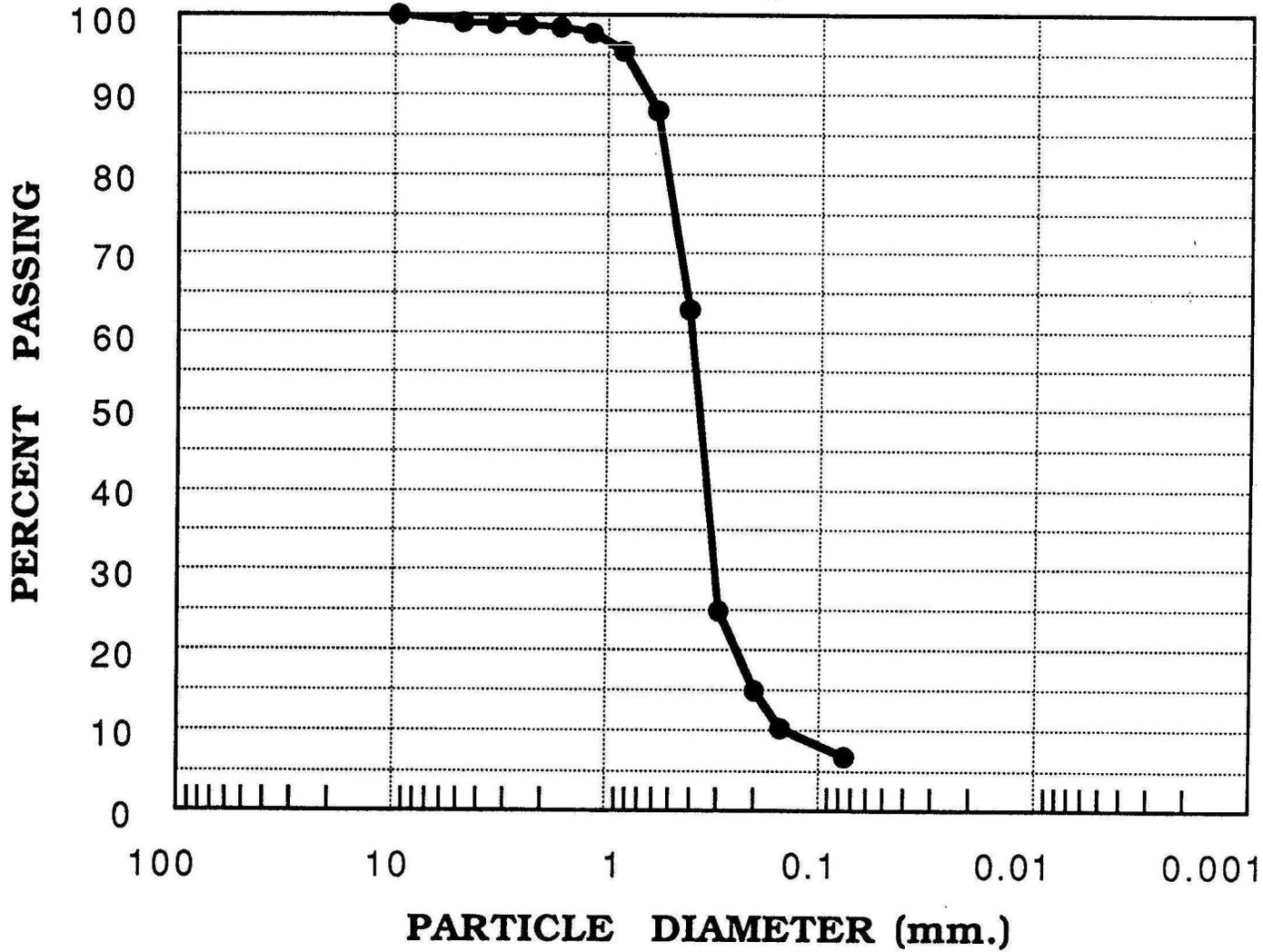
LINE # 4A2 W-E
USBR SITE # 5+00
SAMPLING DEPTH (ft.) 28.5-32.5

Particle Diameter @ 60% Passing = 2.17 mm.(0.085 in.)



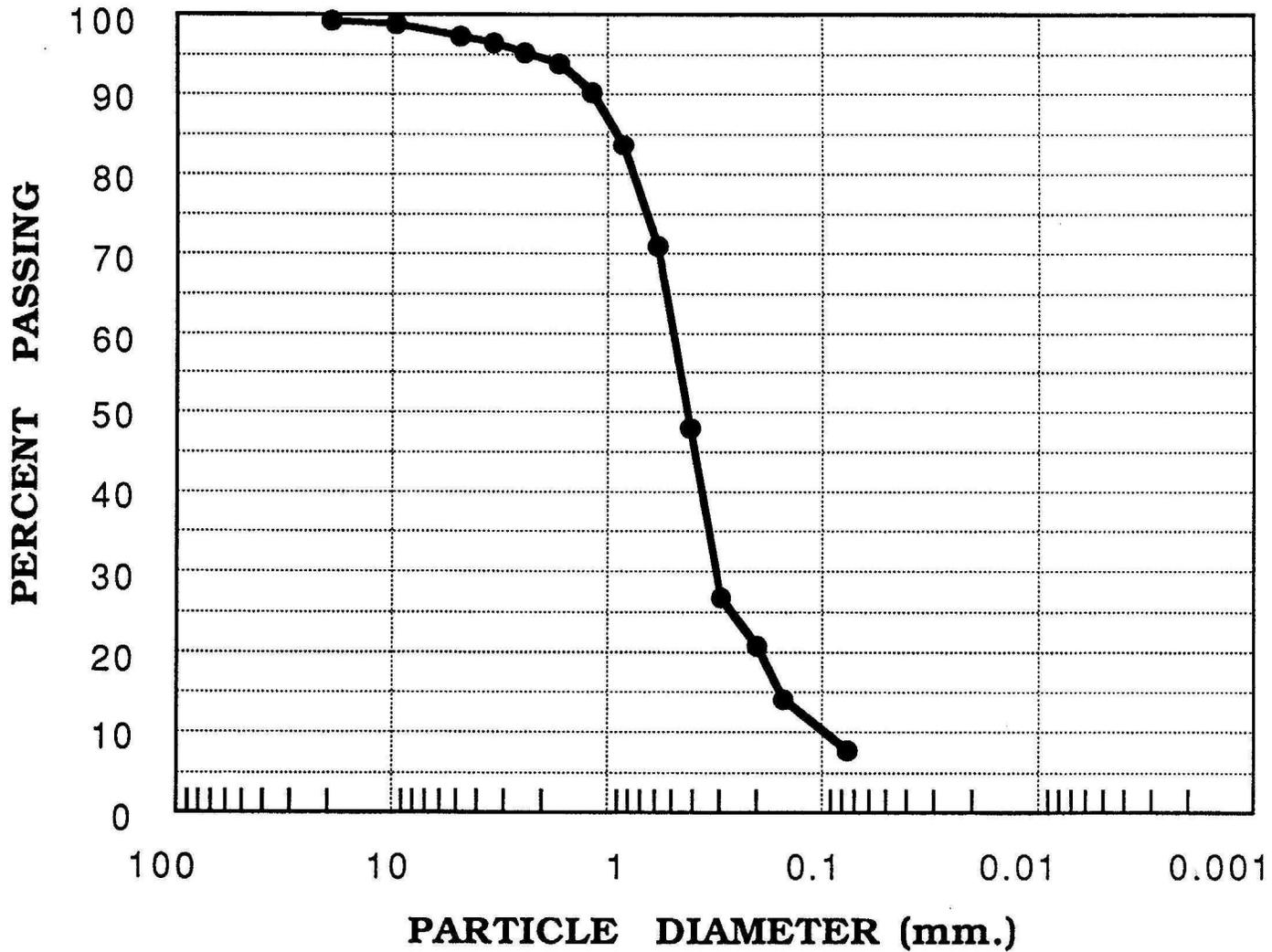
LINE # 4A2 W-E
USBR SITE # 9+00
SAMPLING DEPTH (ft.) 22.5-28

Particle Diameter @ 60% Passing = 0.40 mm.(0.016 in.)



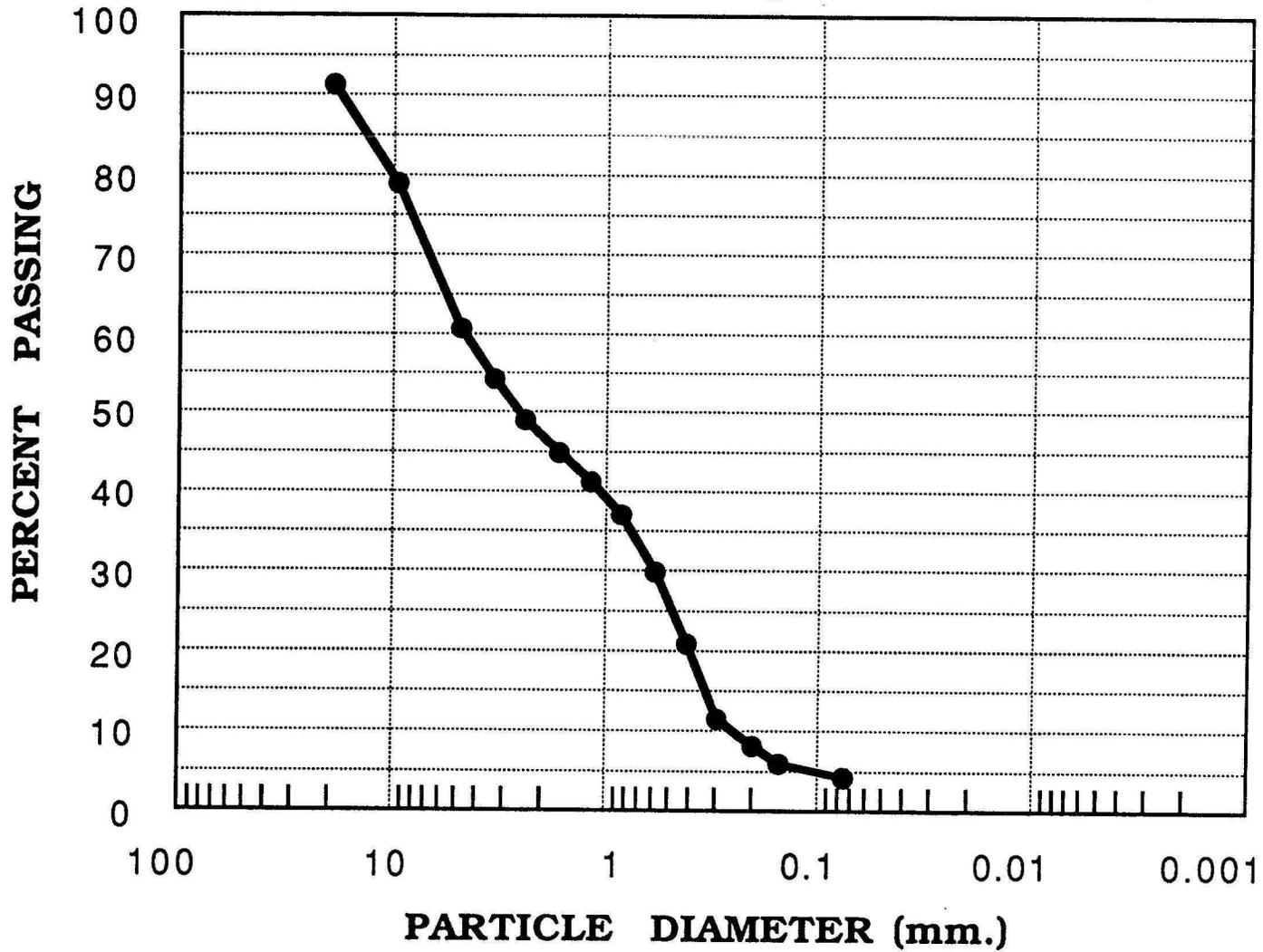
LINE # 4A2 W-E
USBR SITE # 9+00
SAMPLING DEPTH (ft.) 28-31

Particle Diameter @ 60% Passing = 0.48 mm.(0.019 in.)



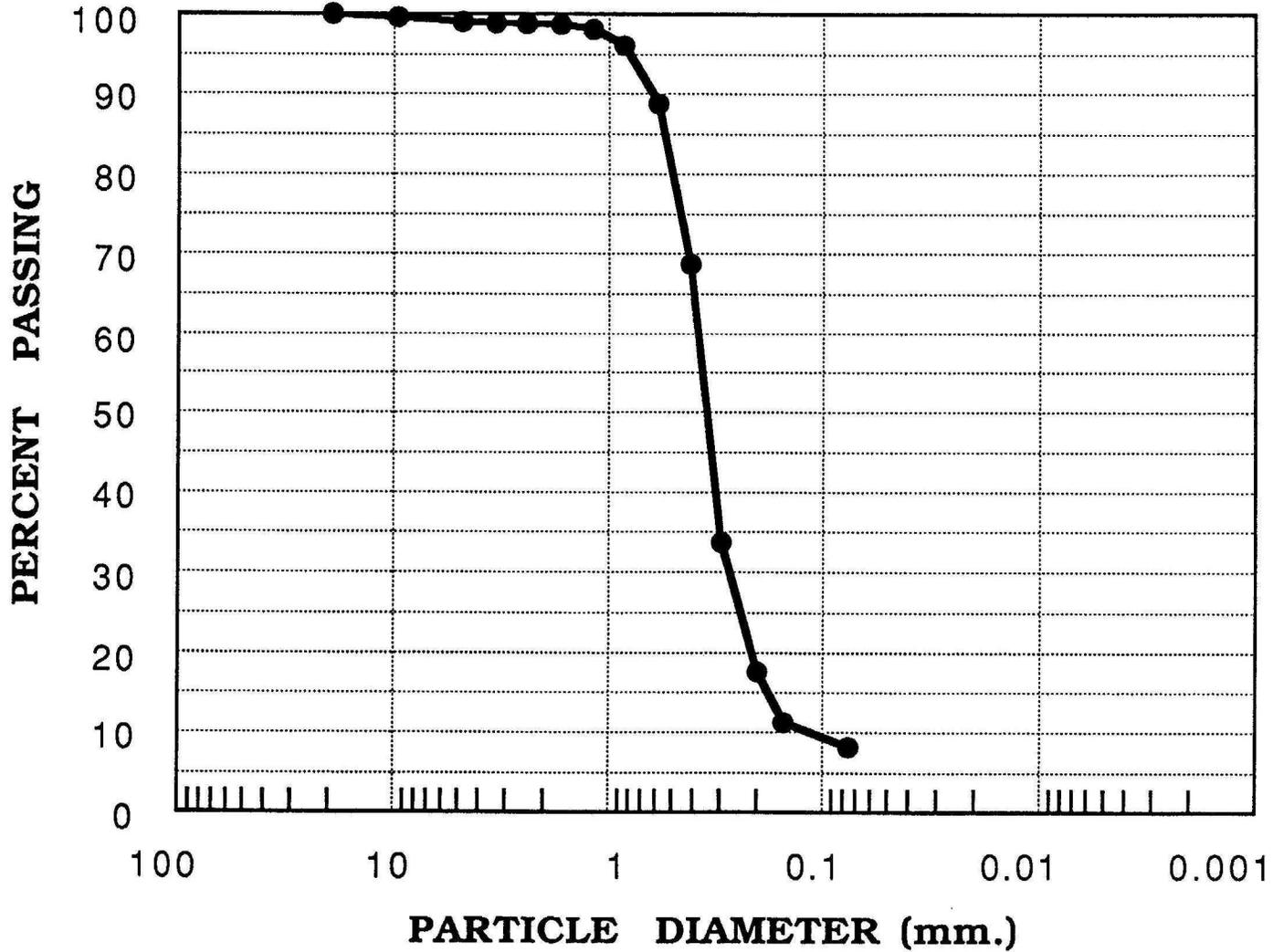
LINE # 4A2 W-E
USBR SITE # 9+00
SAMPLING DEPTH (ft.) 31-36

Particle Diameter @ 60% Passing = 4.52 mm.(0.178 in.)



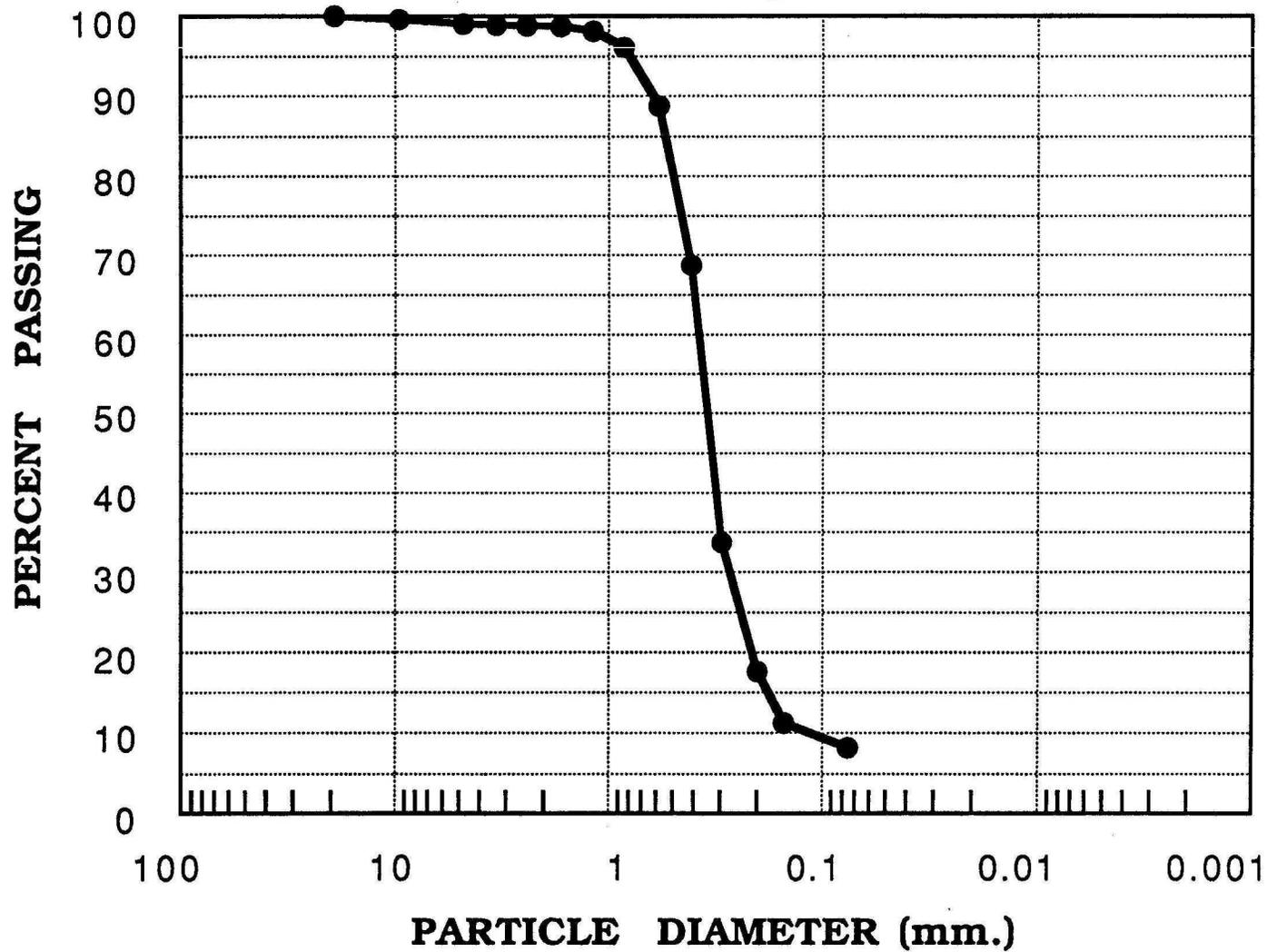
LINE # 4A2 W-E
USBR SITE # 13+00
SAMPLING DEPTH (ft.) 24-27.5

Particle Diameter @ 60% Passing = 0.66 mm.(0.014 in.)



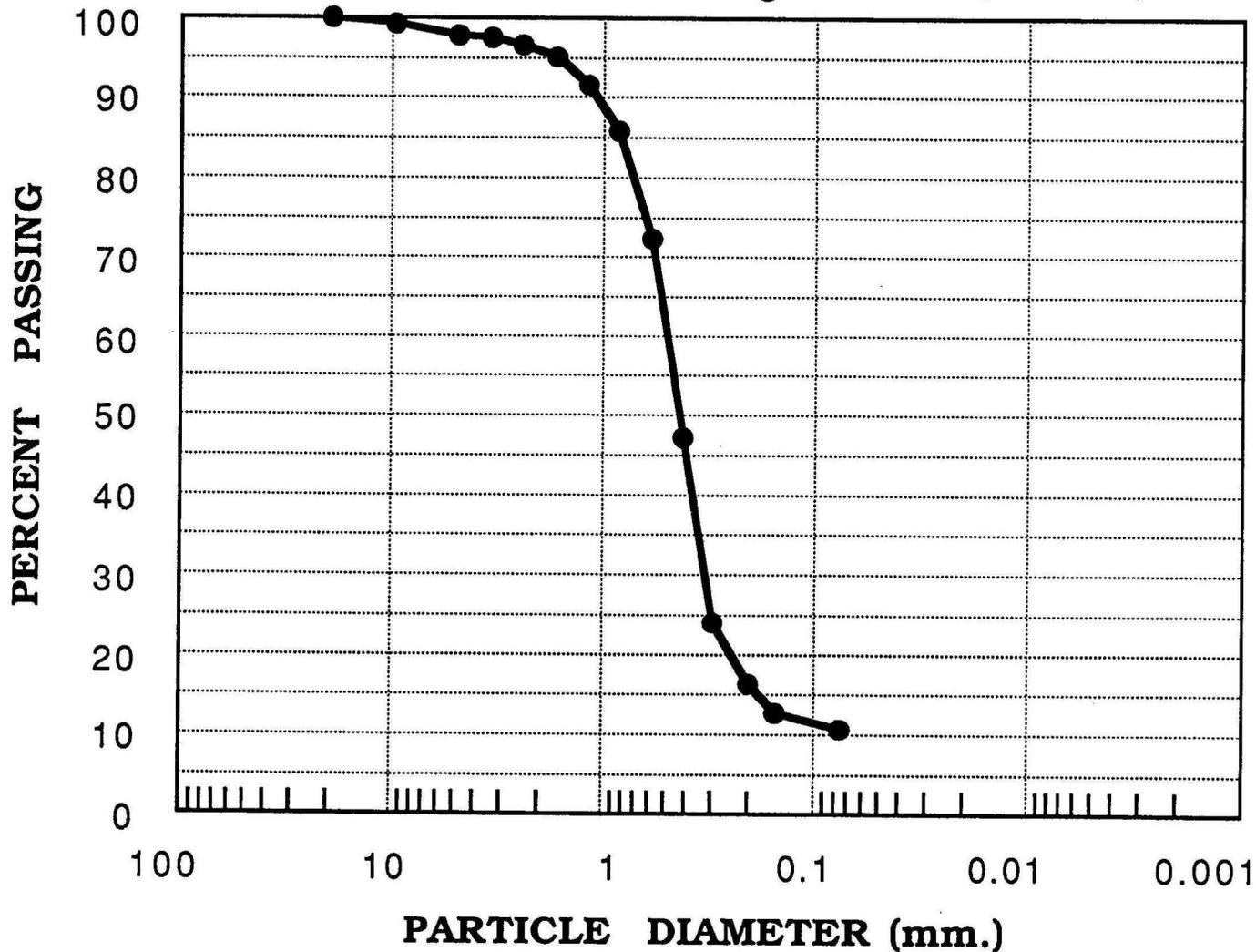
LINE # 4A2 W-E
USBR SITE # 13+00
SAMPLING DEPTH (ft.) 29.5-39.5

Particle Diameter @ 60% Passing = 0.36 mm.(0.014 in.)



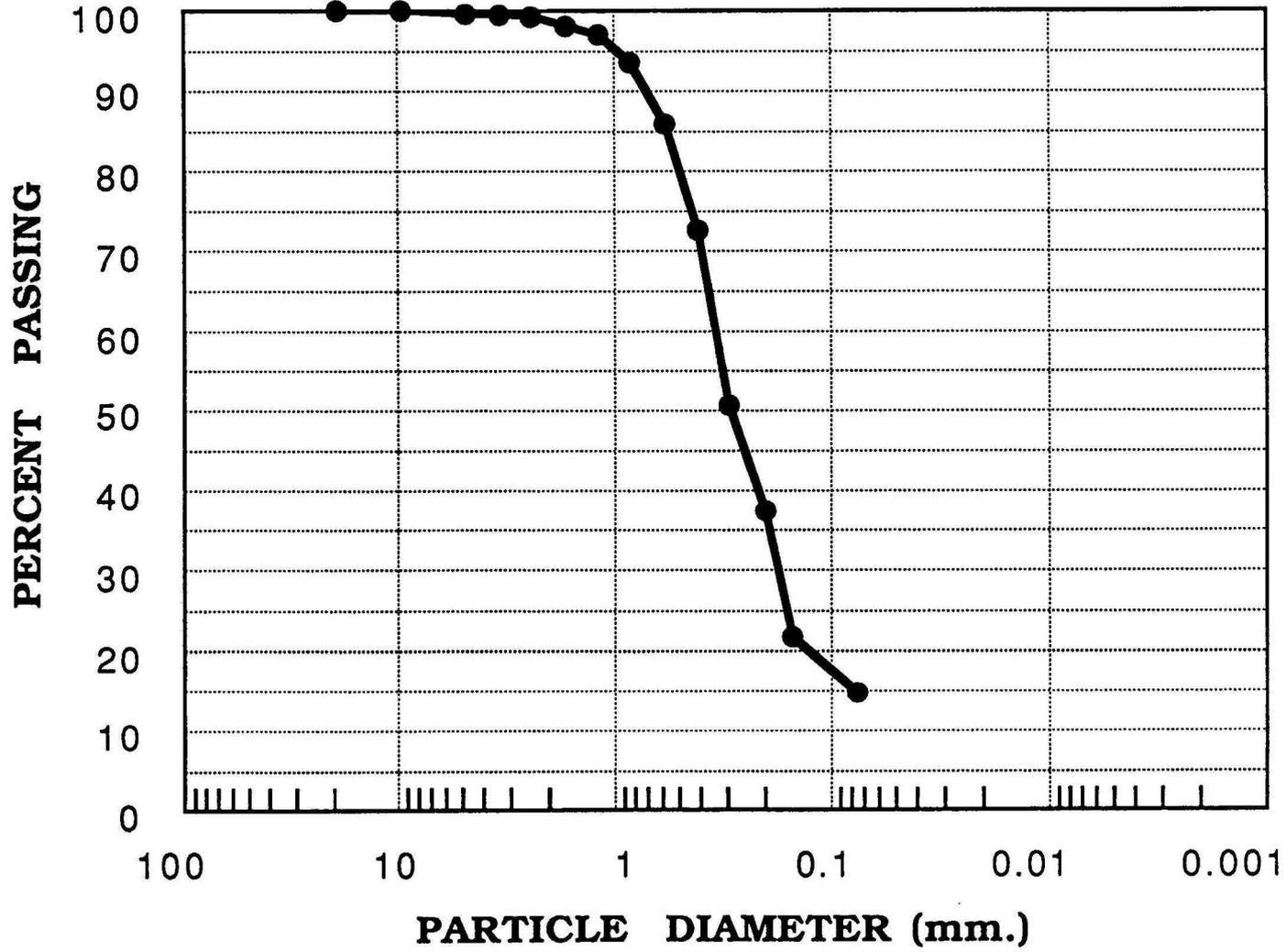
LINE # 4A2 W-E
USBR SITE # 17+00
SAMPLING DEPTH (ft.) 32.5-38.5

Particle Diameter @ 60% Passing = 0.48 mm.(0.019 in.)



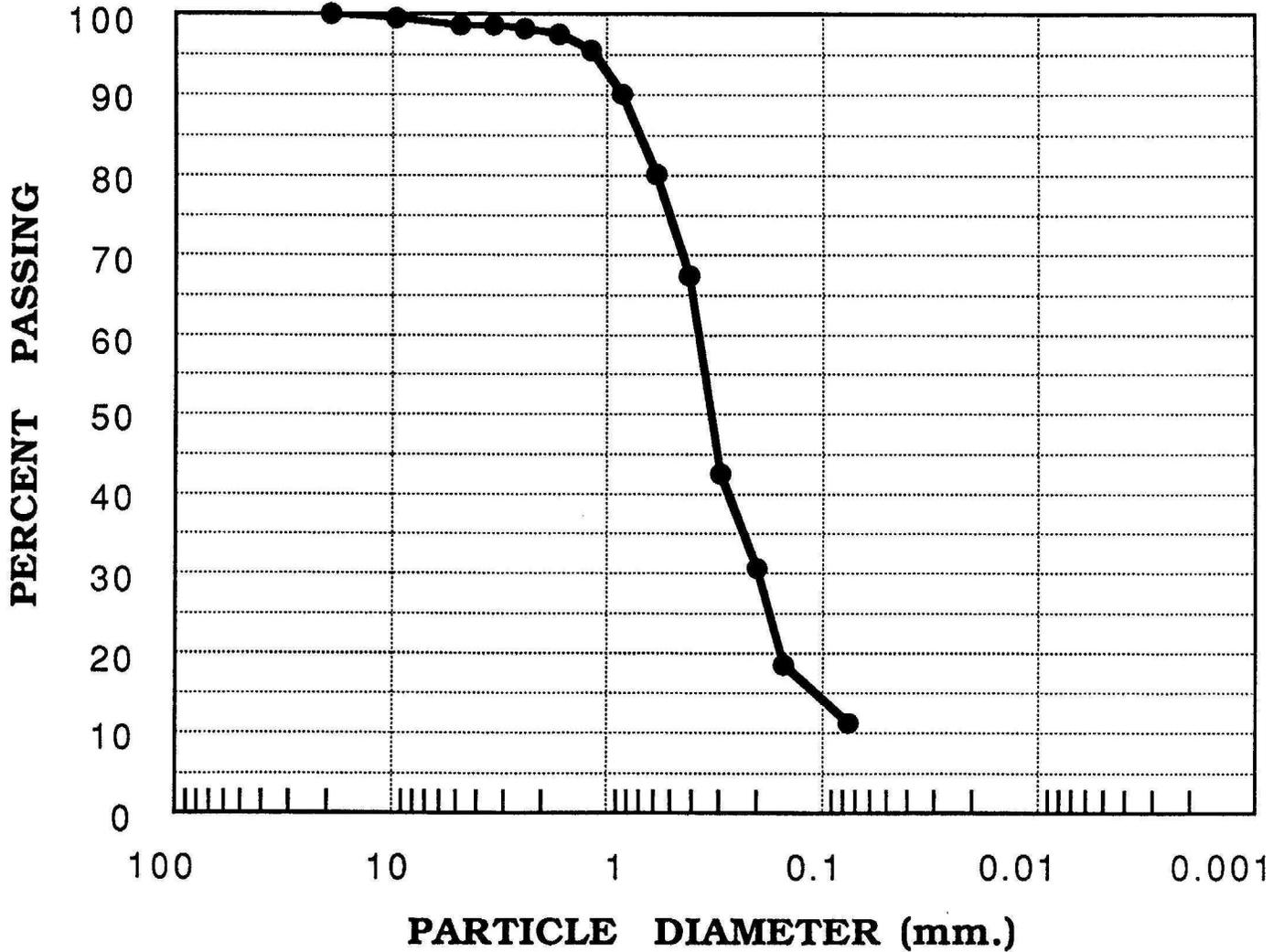
LINE # 4A2 W-E
USBR SITE # 17+00
SAMPLING DEPTH (ft.) 38.5-42

Particle Diameter @ 60% Passing = 0.35 mm.(0.014 in.)



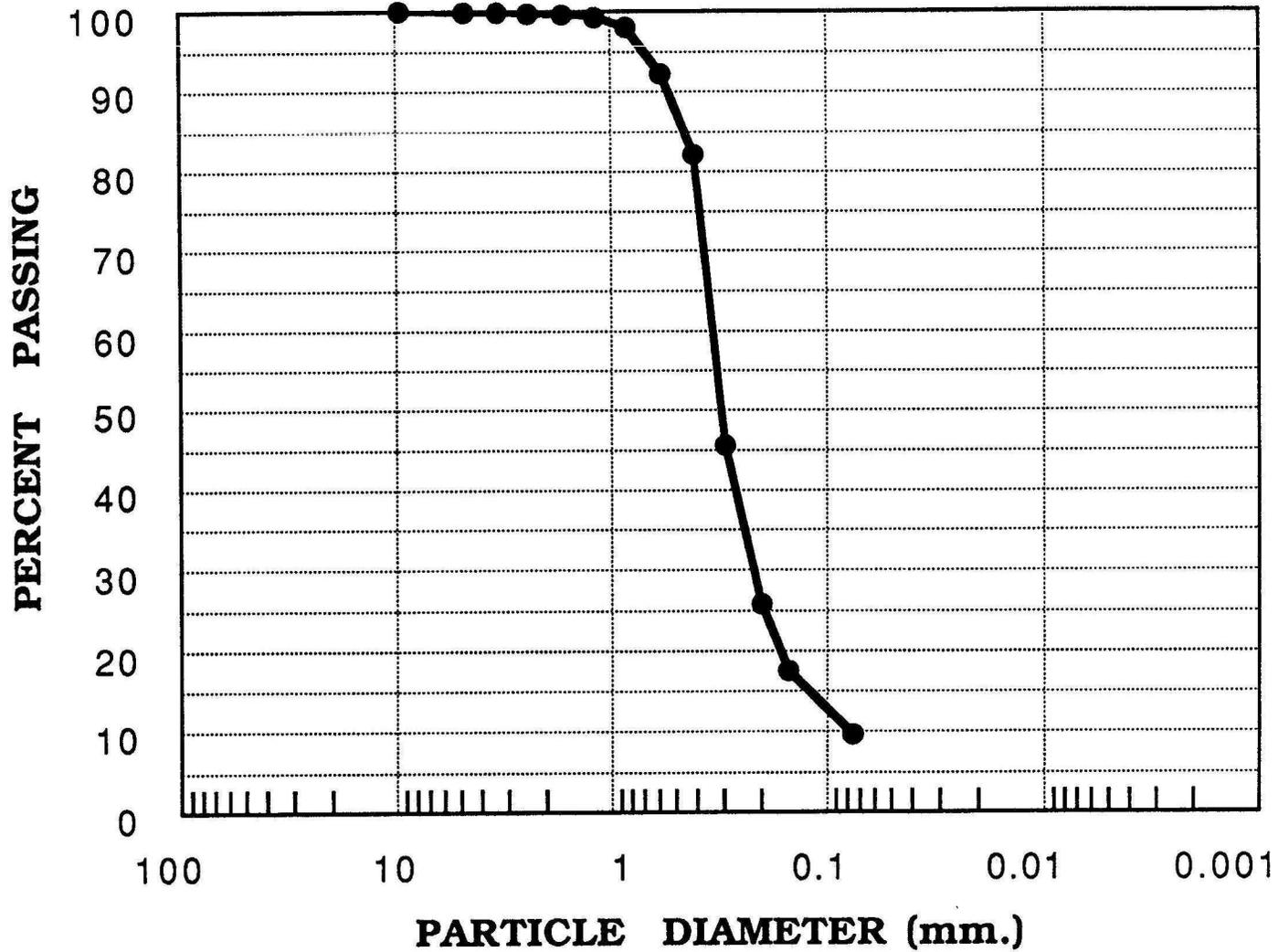
LINE # 4A2 W-E
USBR SITE # 17+00
SAMPLING DEPTH (ft.) 42-47

Particle Diameter @ 60% Passing = 0.36 mm.(0.014 in.)



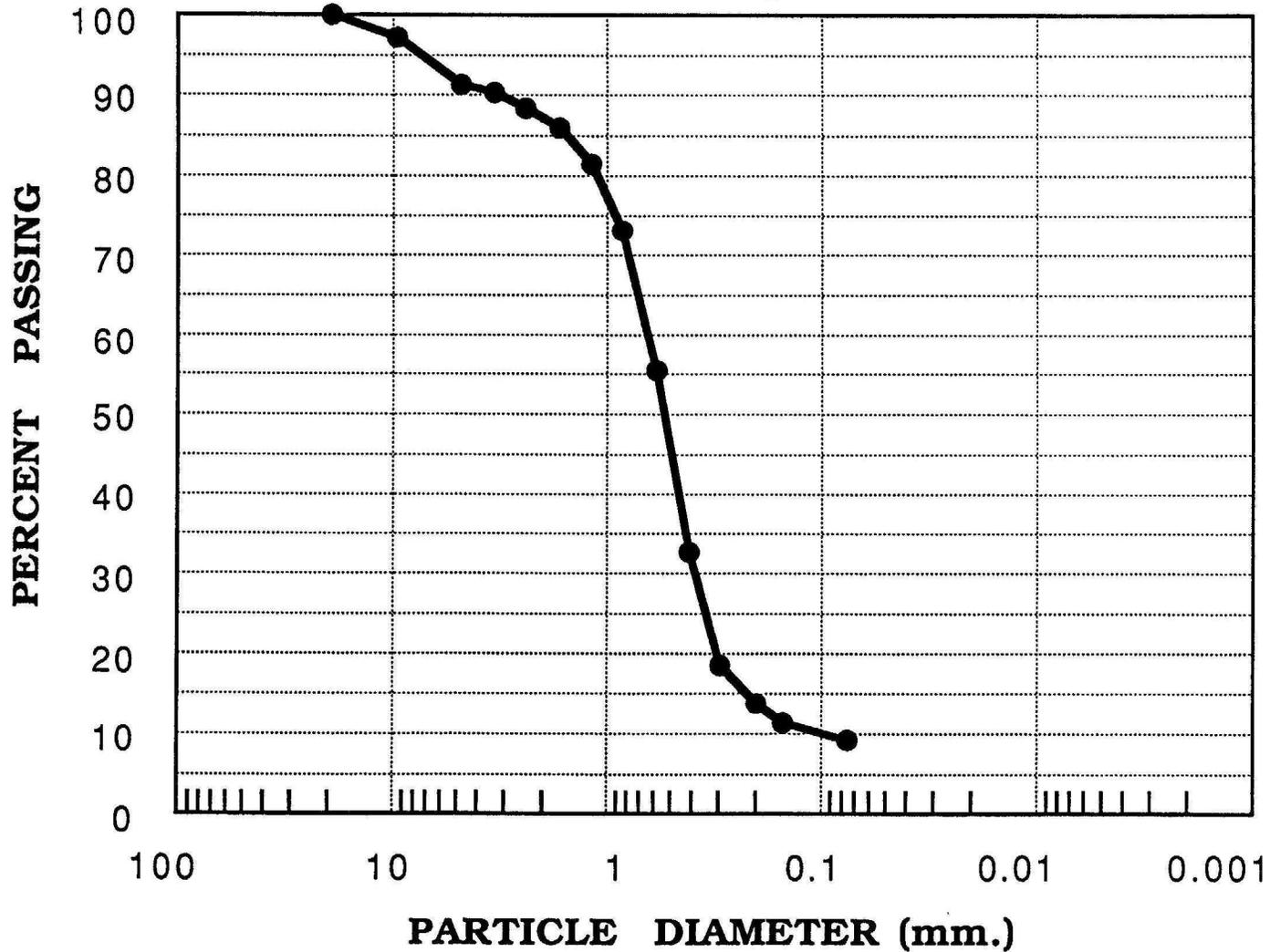
LINE # 4A2 W-E
USBR SITE # 21+00
SAMPLING DEPTH (ft.) 29-37.5

Particle Diameter @ 60% Passing = 0.33 mm.(0.013 in.)



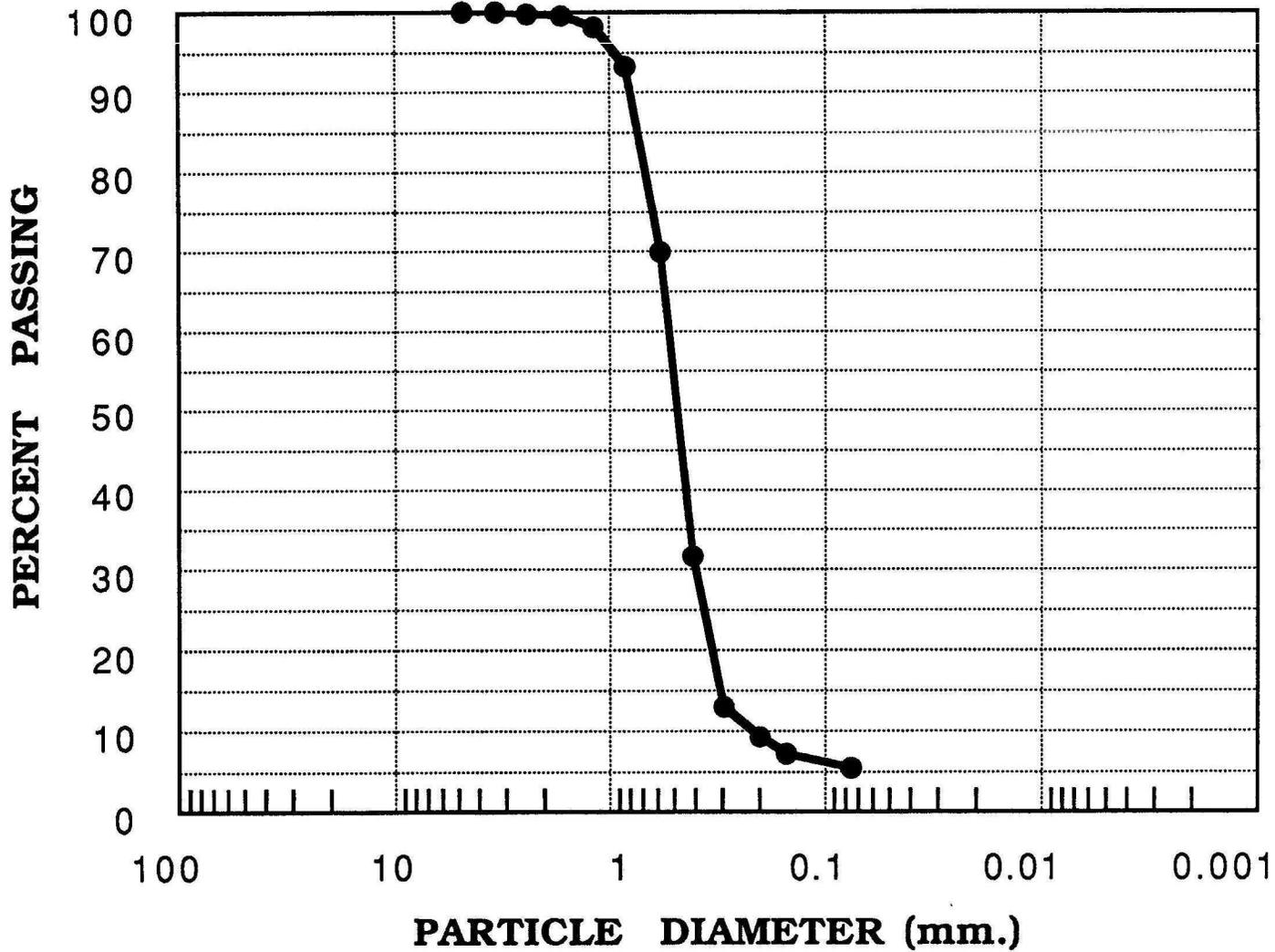
LINE # 4A2 W-E
USBR SITE # 21+00
SAMPLING DEPTH (ft.) 37.5-44.5

Particle Diameter @ 60% Passing = 0.63 mm.(0.025 in.)



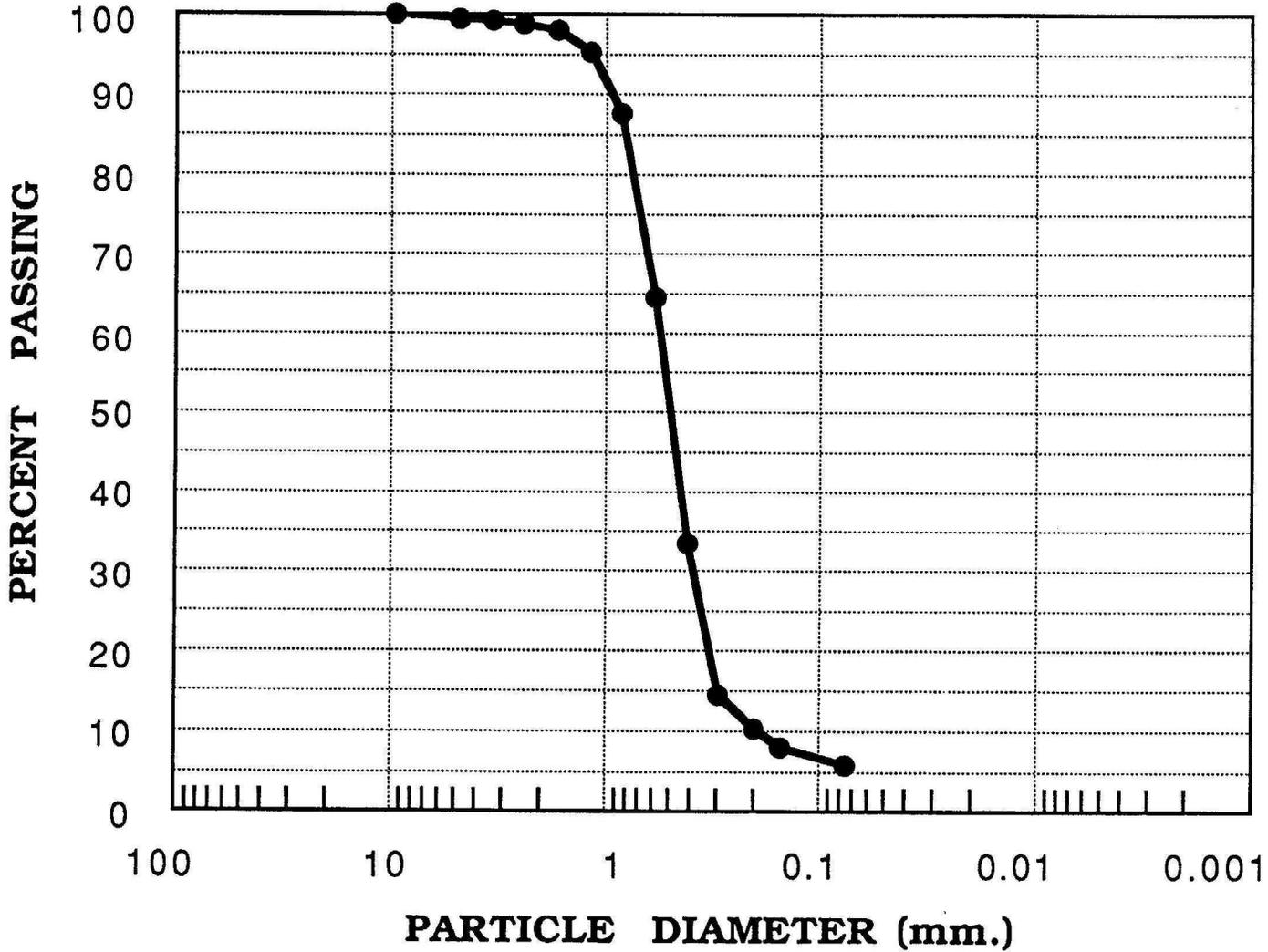
LINE # 4A3 E-W
USBR SITE # 1+00
SAMPLING DEPTH (ft.) 23-28

Particle Diameter @ 60% Passing = 0.53 mm.(0.021 in.)



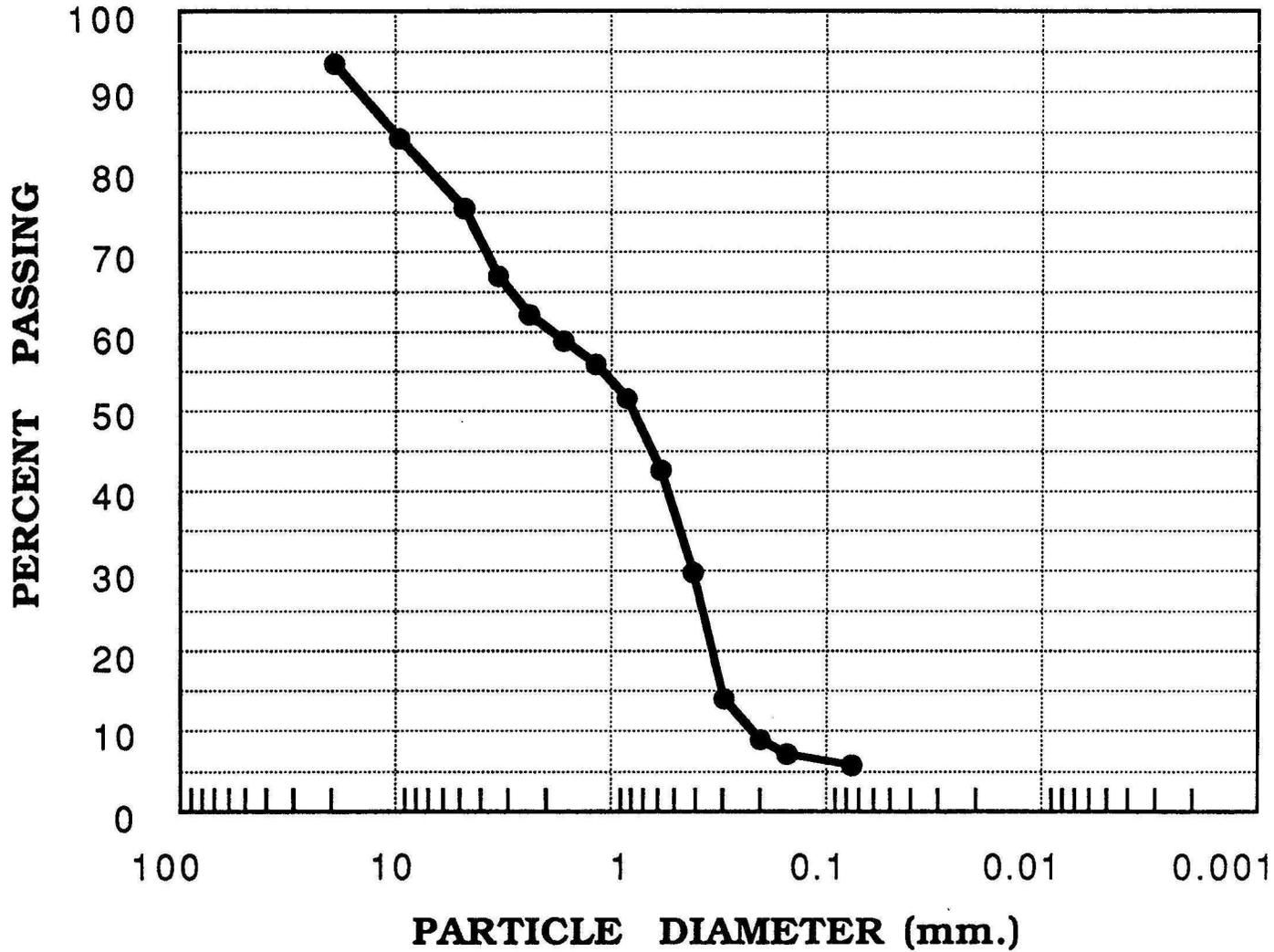
LINE # 4A3 E-W
USBR SITE # 1+00
SAMPLING DEPTH (ft.) 28-33

Particle Diameter @ 60% Passing = 0.55 mm.(0.022 in.)



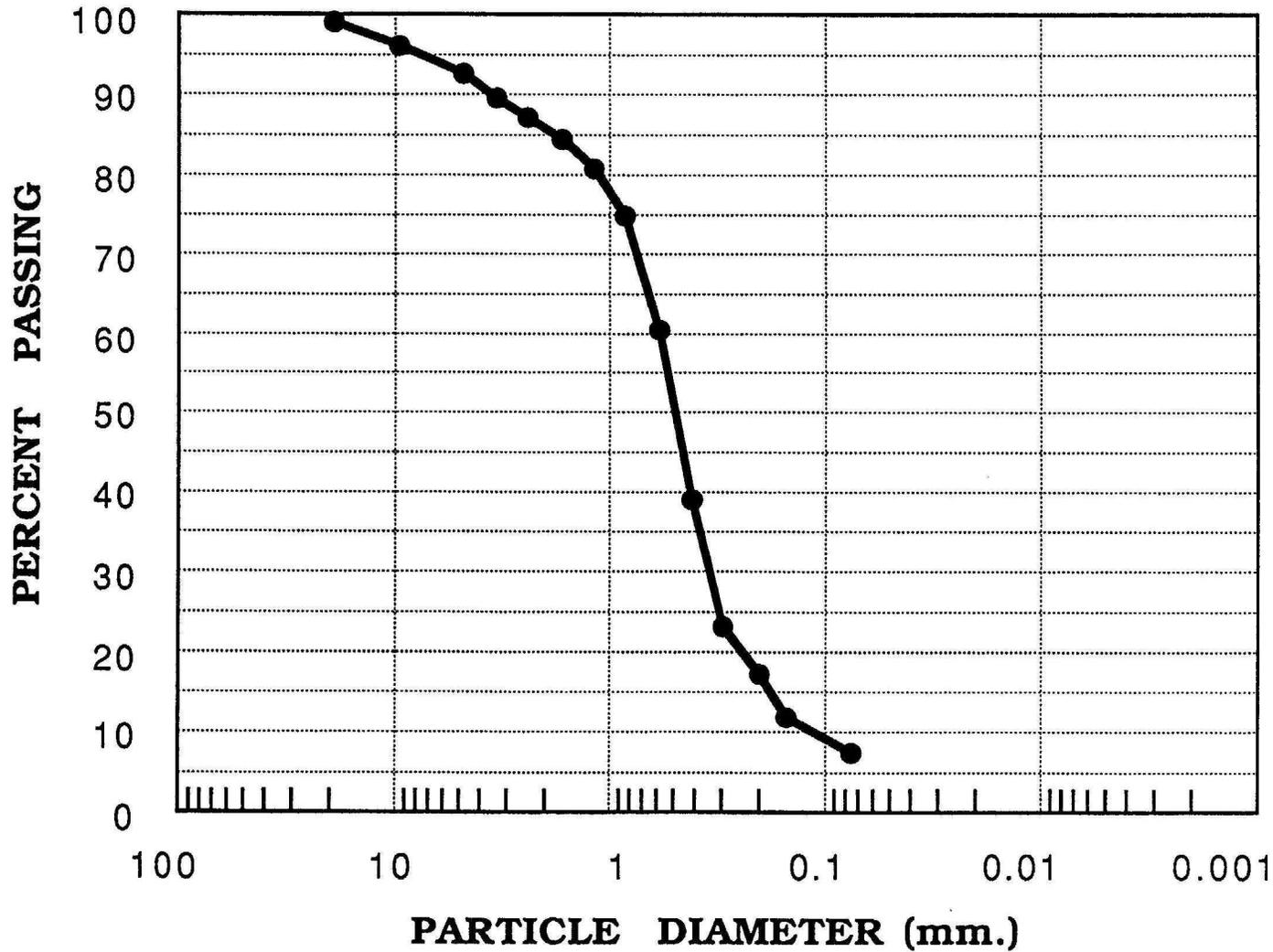
LINE # 4A3 E-W
USBR SITE # 1+00
SAMPLING DEPTH (ft.) 33-37

Particle Diameter @ 60% Passing = 1.90 mm.(0.075 in.)



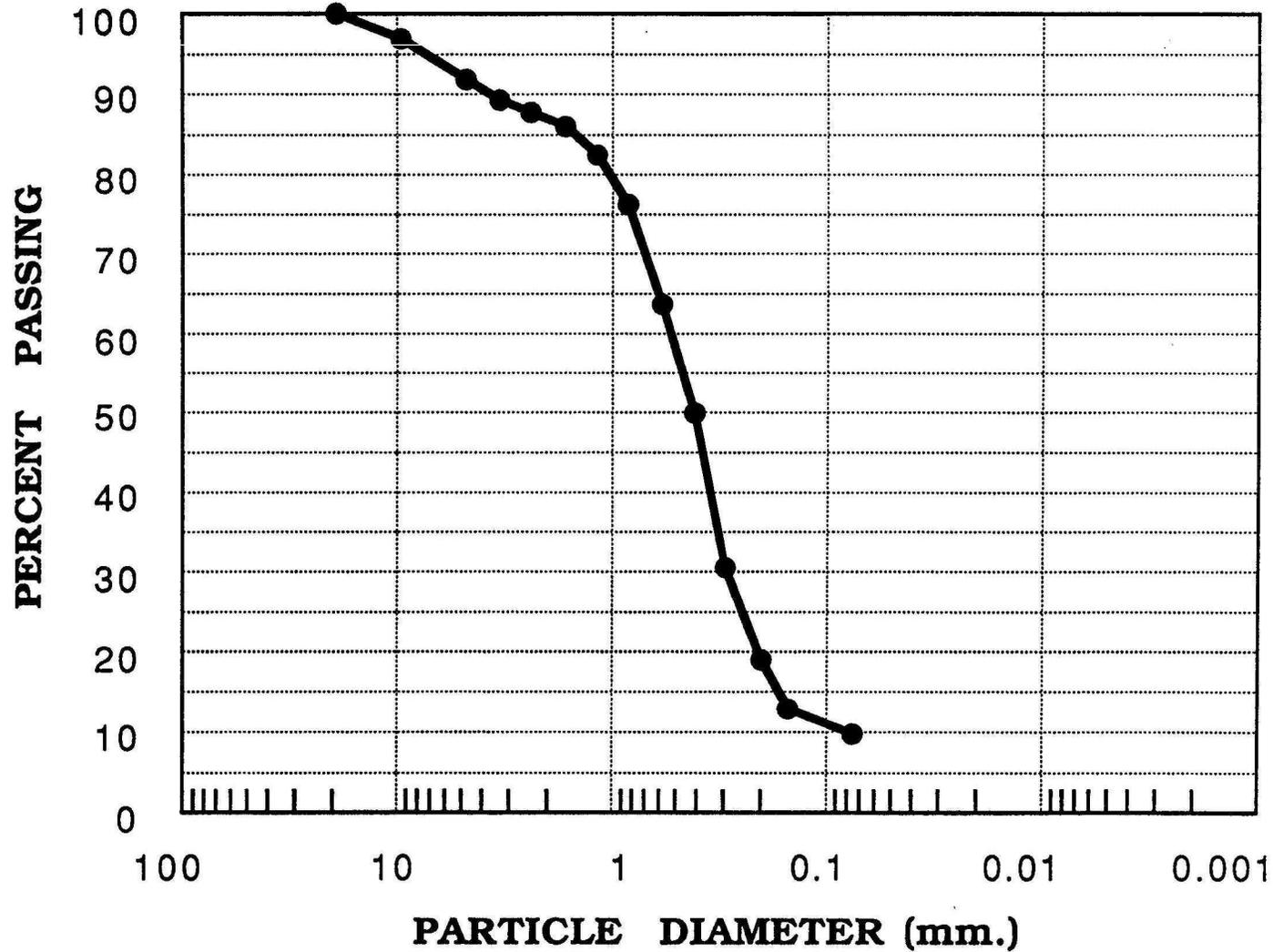
LINE # 4A3 E-W
USBR SITE # 5+00
SAMPLING DEPTH (ft.) 30-35

Particle Diameter @ 60% Passing = 0.60 mm.(0.024 in.)



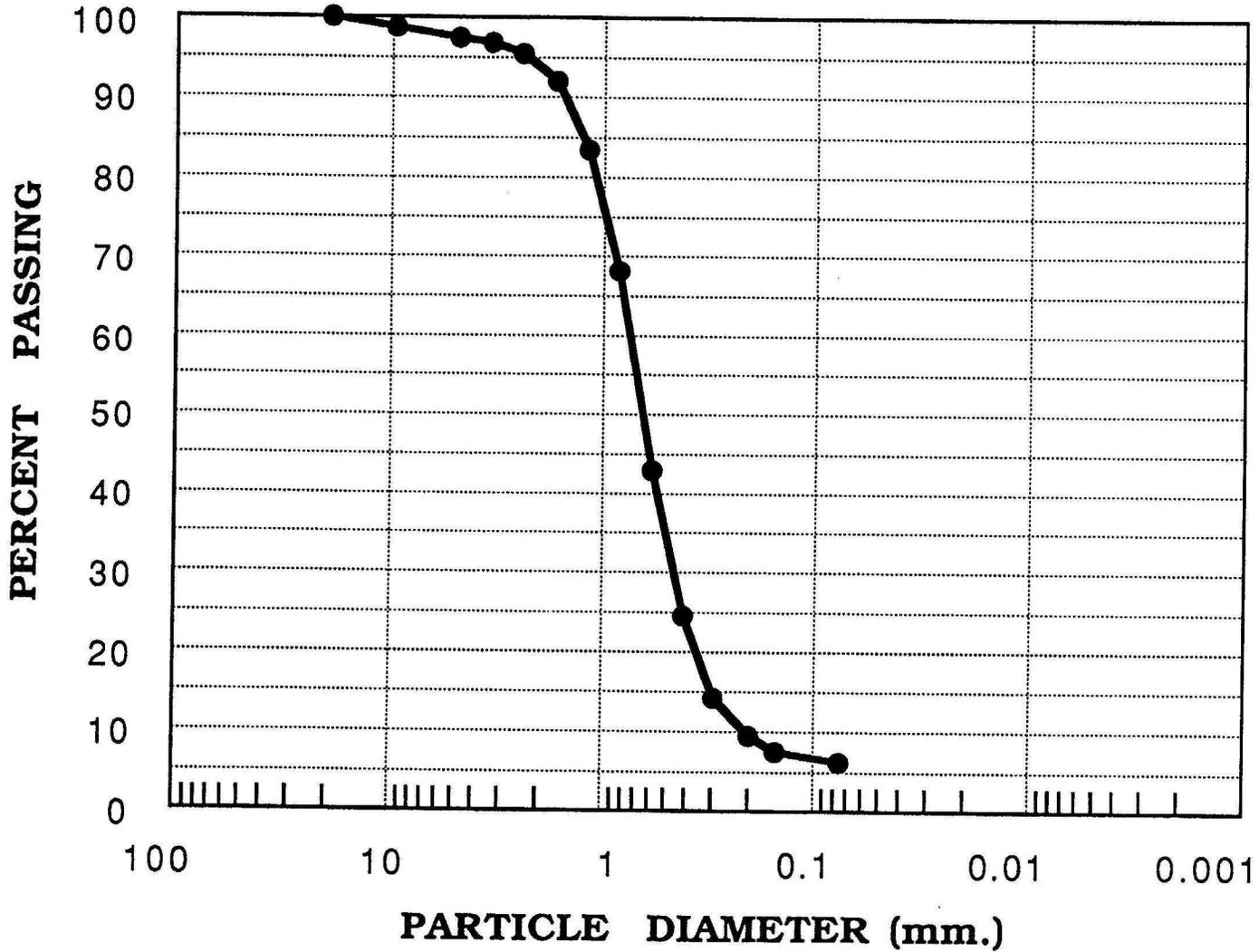
LINE # 4A3 E-W
USBR SITE # 5+00
SAMPLING DEPTH (ft.) 35-40

Particle Diameter @ 60% Passing = 0.53 mm.(0.021 in.)



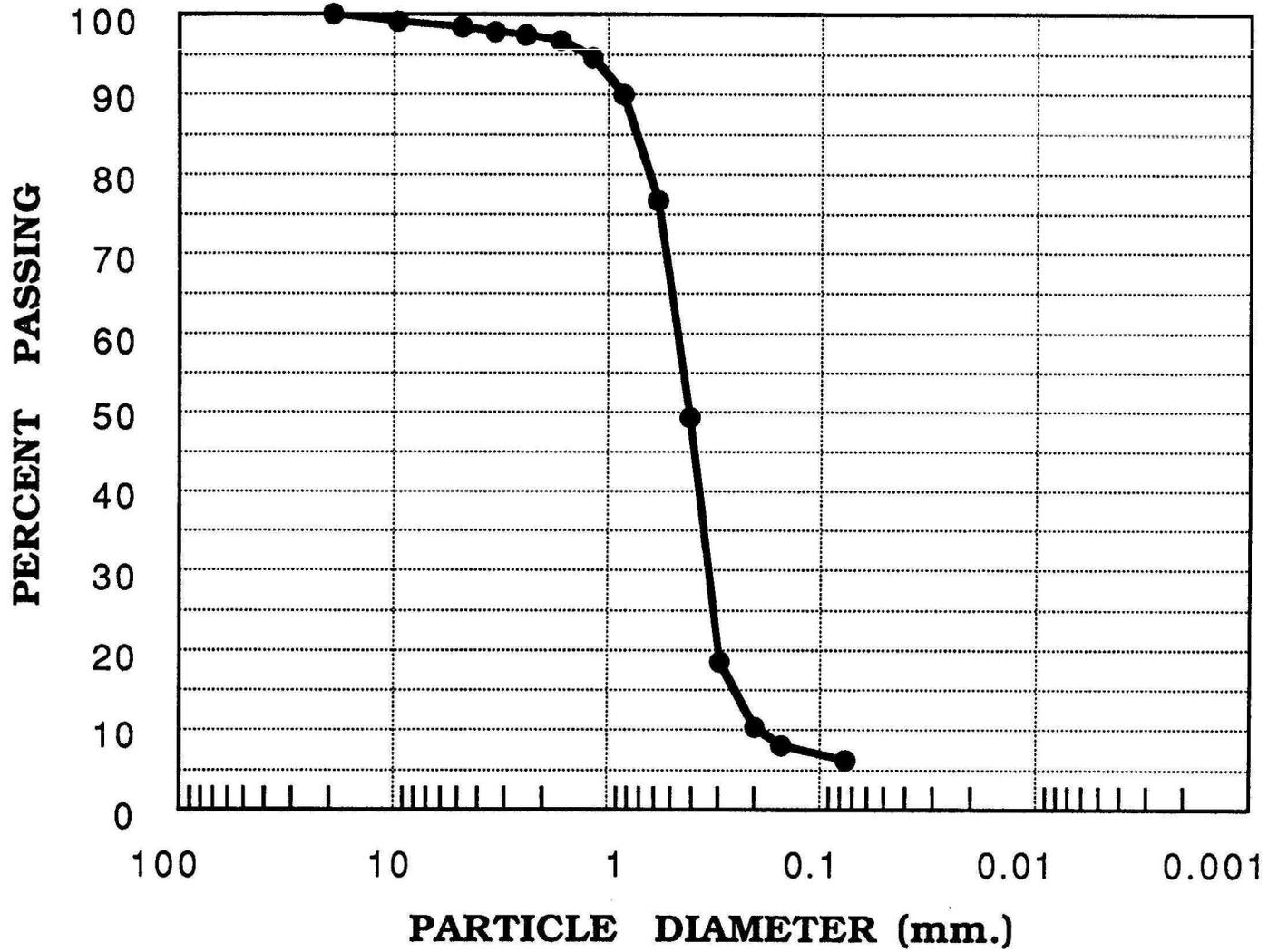
LINE # 4A3 E-W
USBR SITE # 5+00
SAMPLING DEPTH (ft.) 40-45

Particle Diameter @ 60% Passing = 0.76 mm.(0.030 in.)



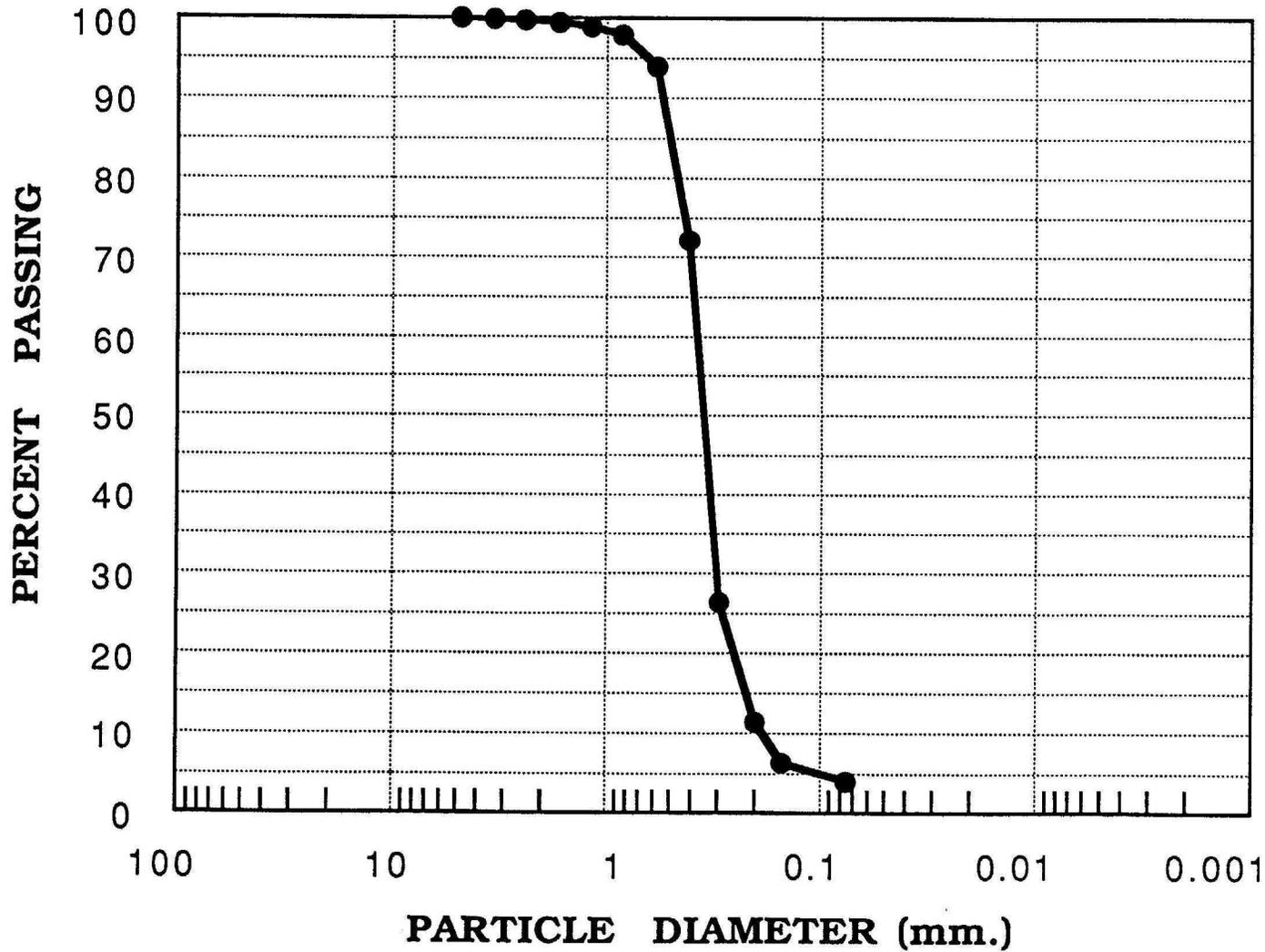
LINE # 4A3 E-W
USBR SITE # 5+00
SAMPLING DEPTH (ft.) 45-49

Particle Diameter @ 60% Passing = 0.48 mm.(0.019 in.)



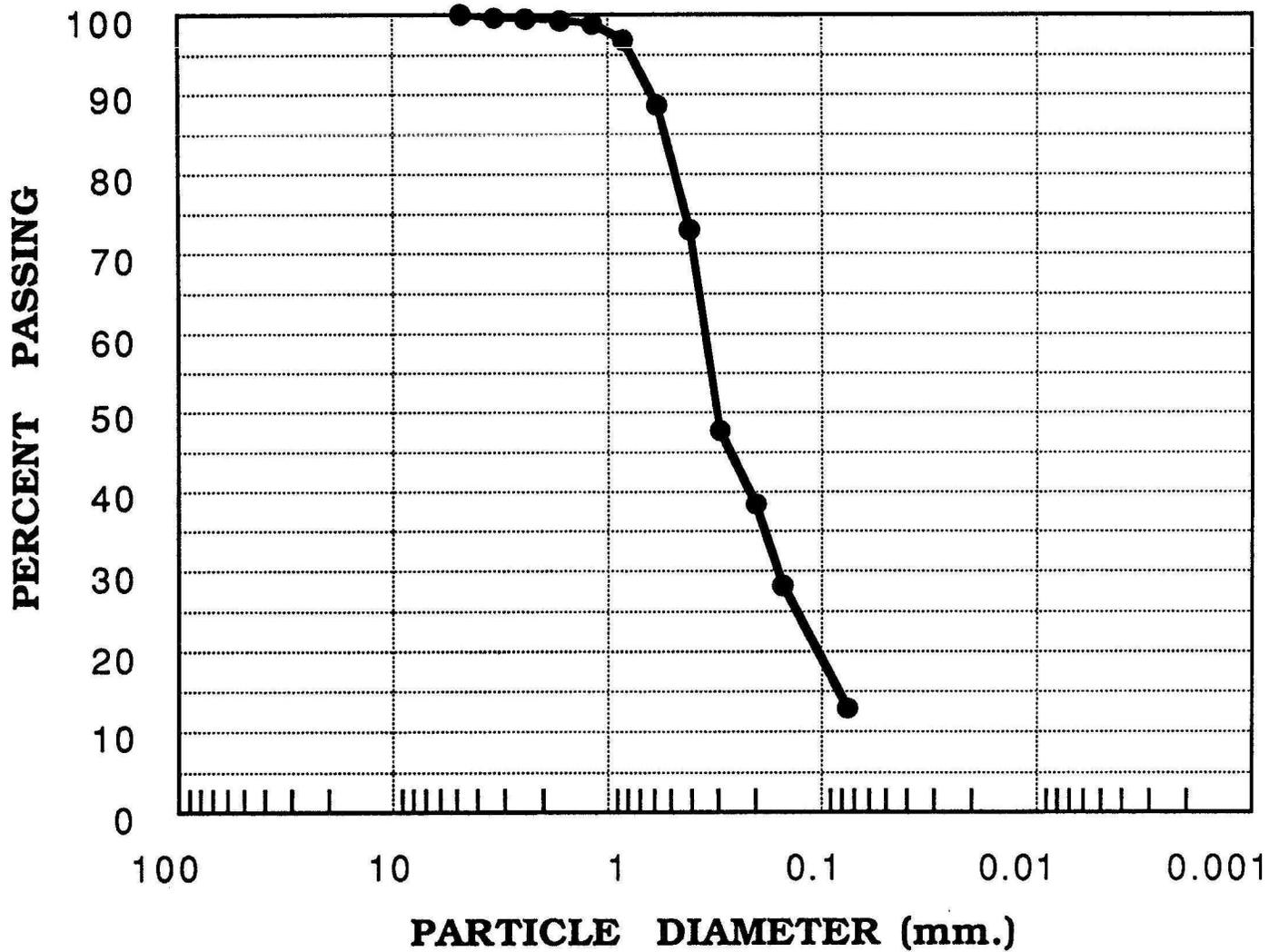
LINE # 4A3 E-W
USBR SITE # 9+00
SAMPLING DEPTH (ft.) 28-33

Particle Diameter @ 60% Passing = 0.36 mm.(0.014 in.)



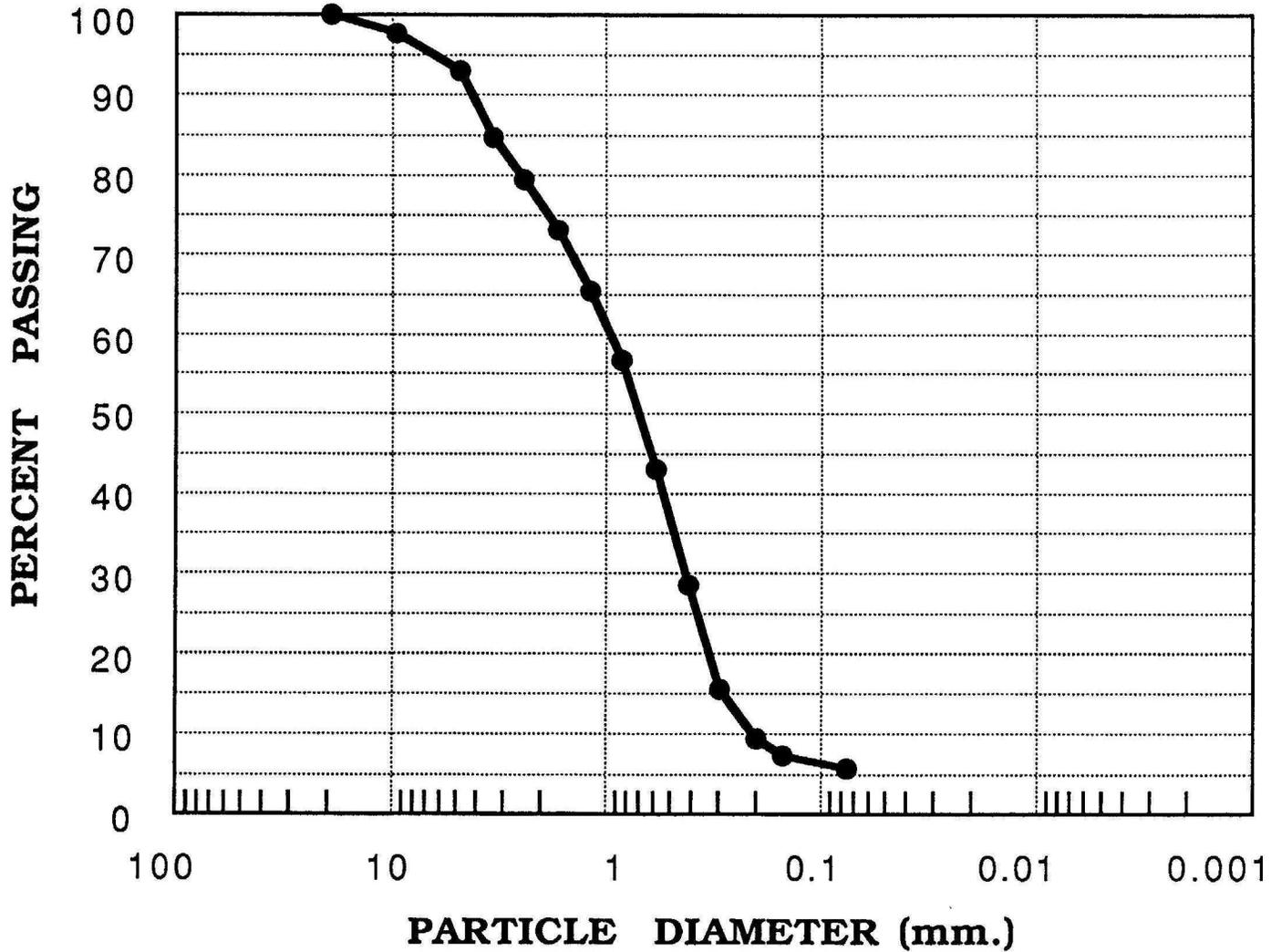
LINE # 4A3 E-W
USBR SITE # 9+00
SAMPLING DEPTH (ft.) 33-38.5

Particle Diameter @ 60% Passing = 0.35 mm.(0.014 in.)



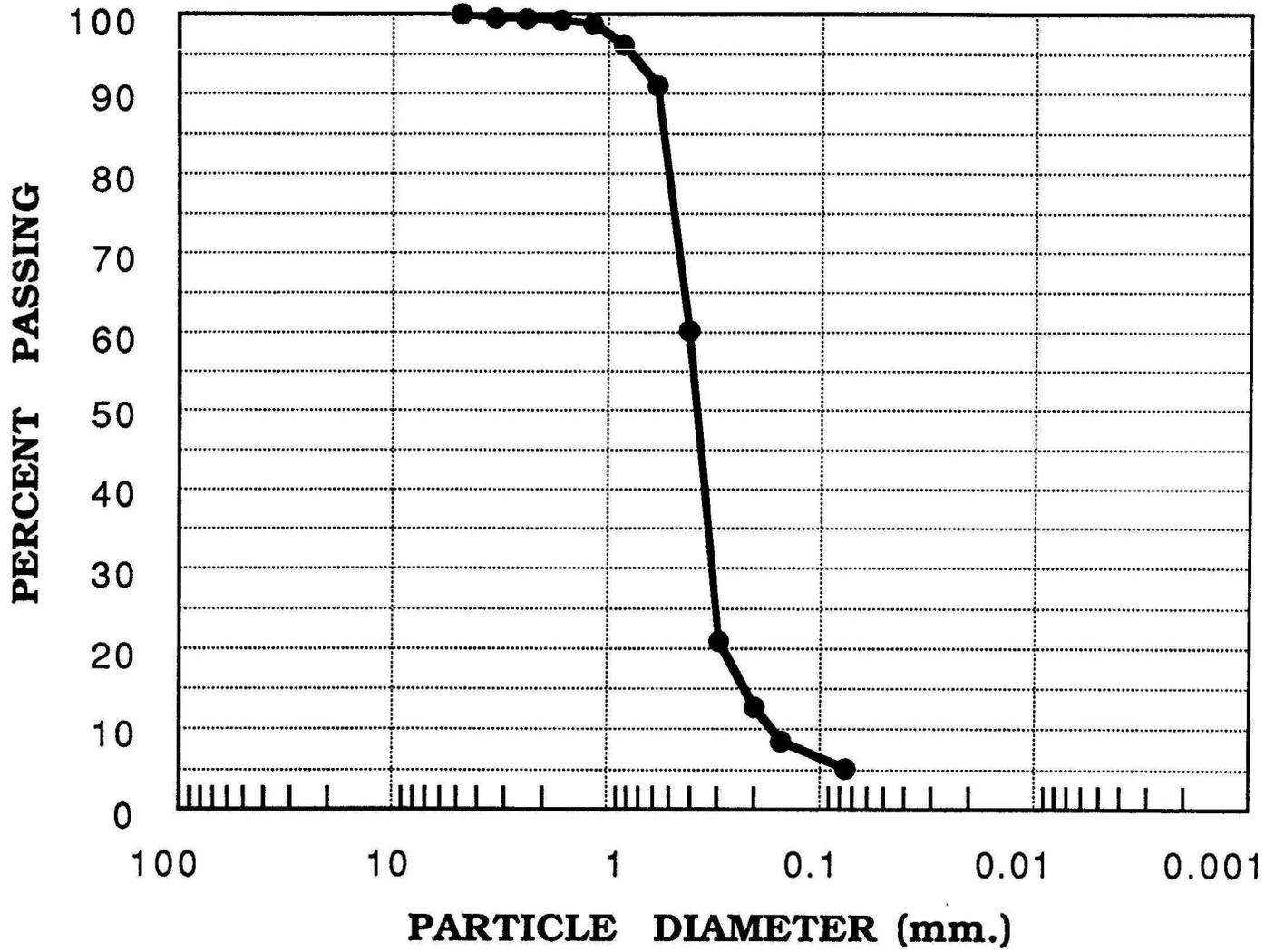
LINE # 4A3 E-W
USBR SITE # 9+00
SAMPLING DEPTH (ft.) 38.5-48

Particle Diameter @ 60% Passing = 0.95 mm.(0.037 in.)



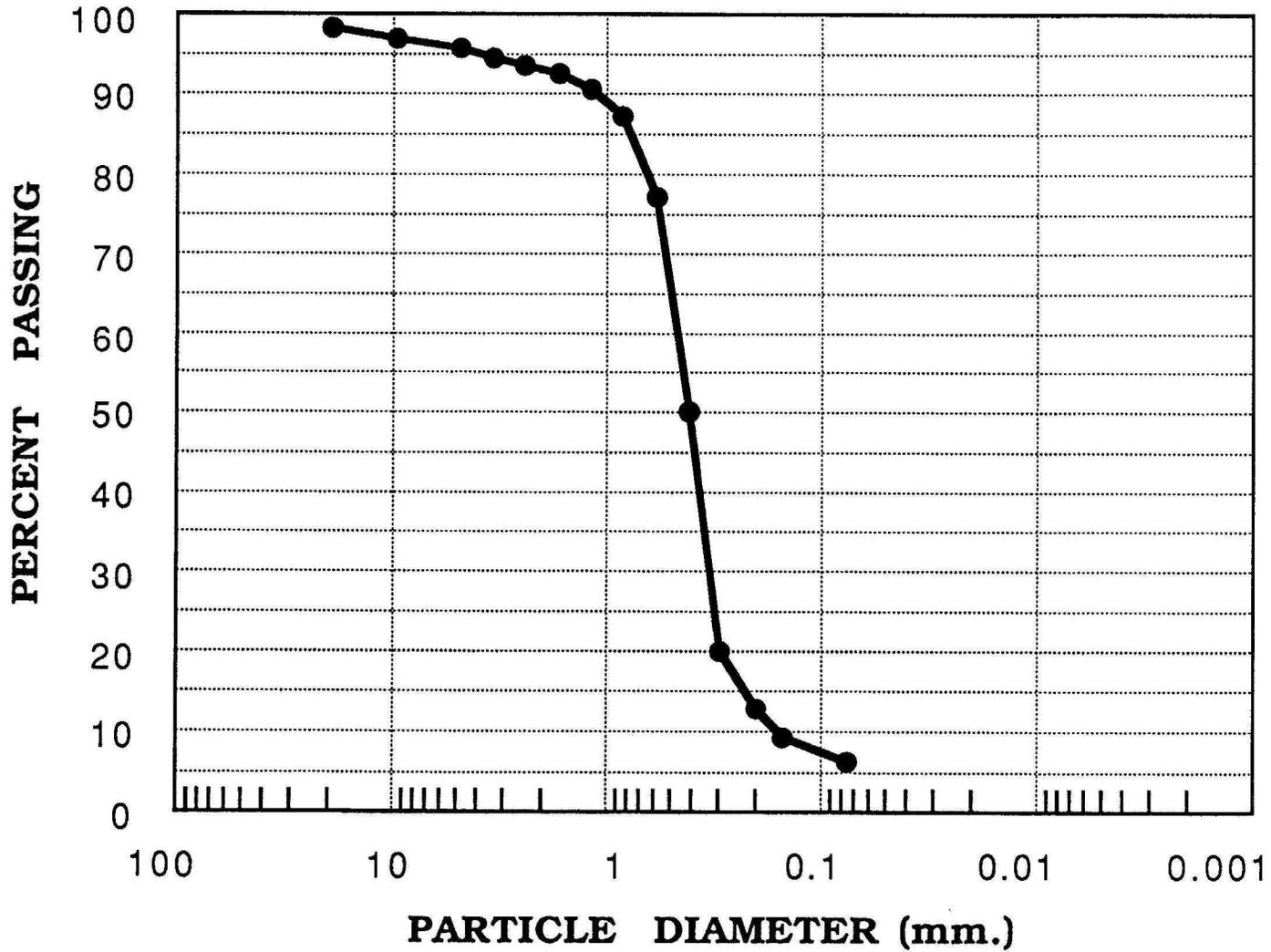
LINE # 4A3 E-W
USBR SITE # 13+00
SAMPLING DEPTH (ft.) 33-41

Particle Diameter @ 60% Passing = 0.40 mm.(0.016 in.)



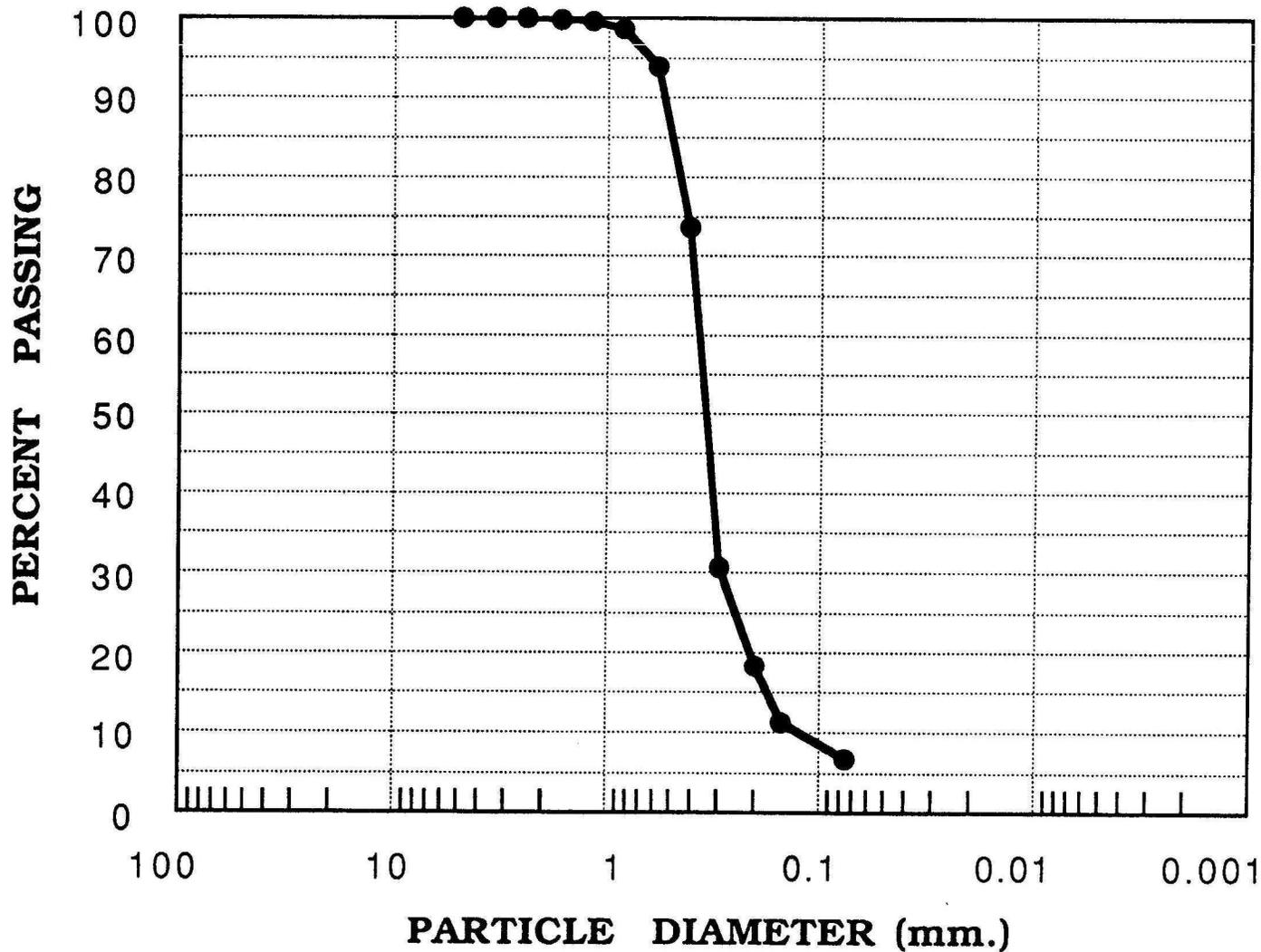
LINE # 4A3 E-W
USBR SITE # 13+00
SAMPLING DEPTH (ft.) 41-47.5

Particle Diameter @ 60% Passing = 0.46 mm.(0.018 in.)



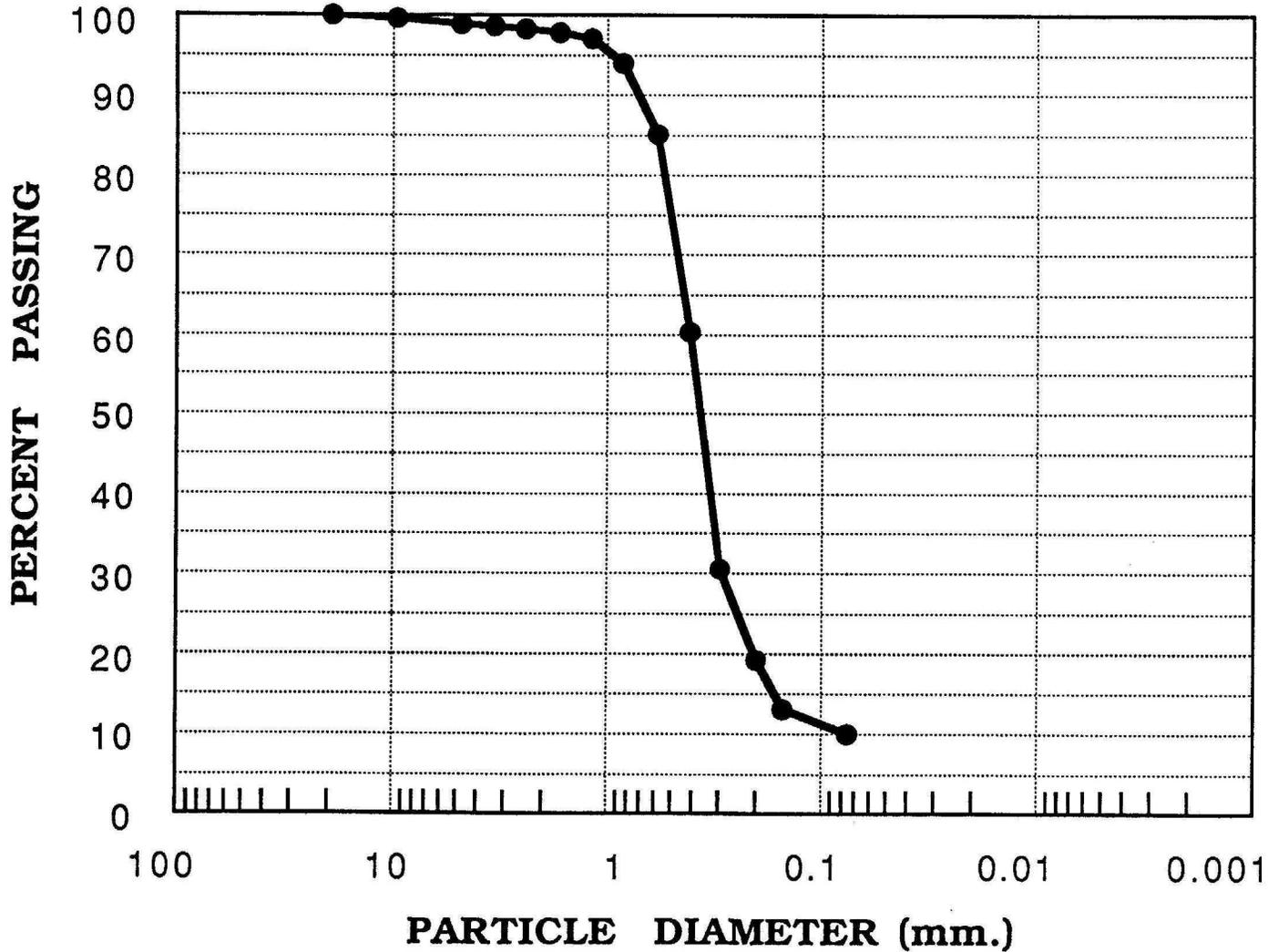
LINE # 4A3 E-W
USBR SITE # 17+00
SAMPLING DEPTH (ft.) 30-38

Particle Diameter @ 60% Passing = 0.36 mm.(0.014 in.)



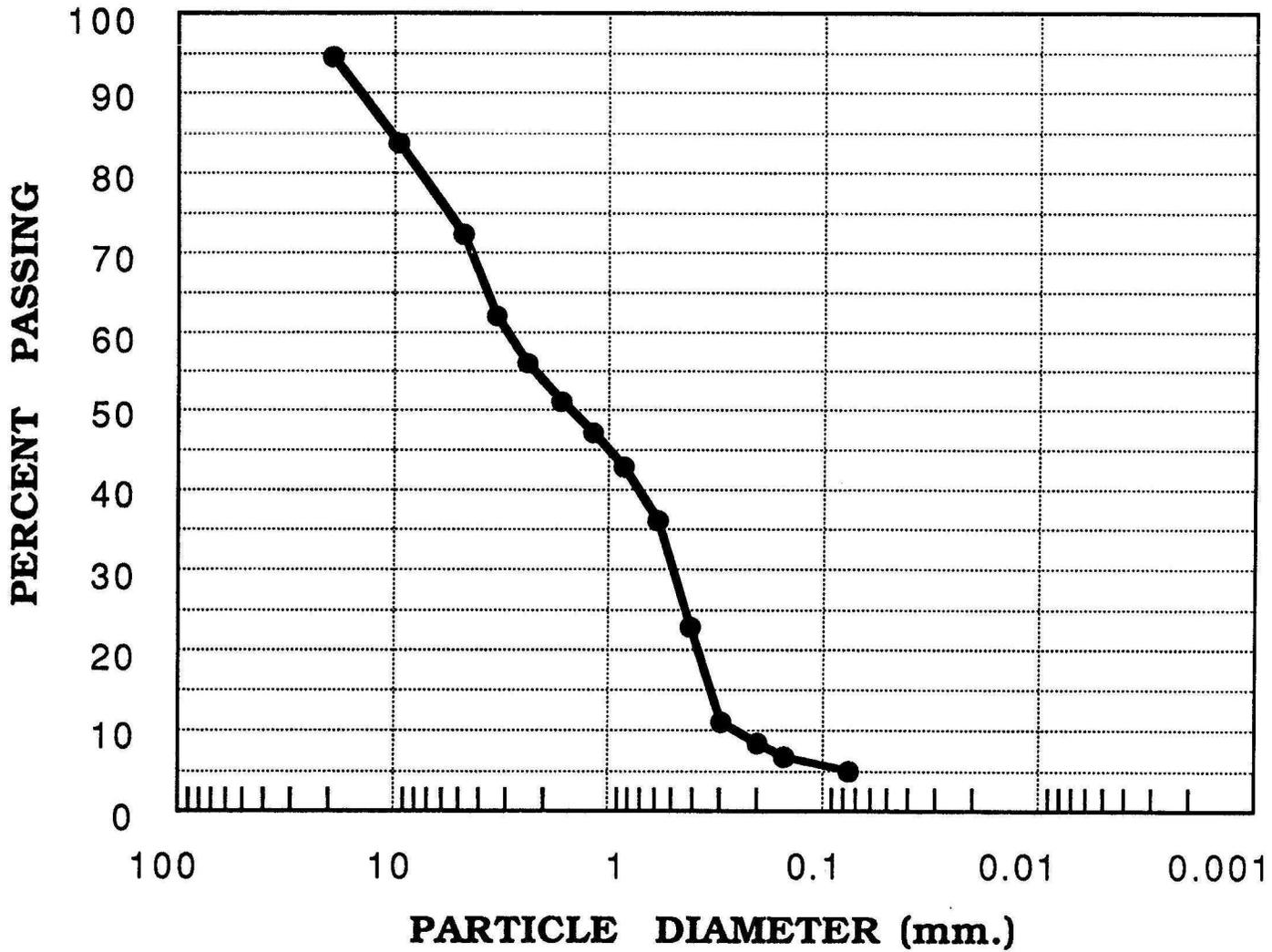
LINE # 4A3 E-W
USBR SITE # 17+00
SAMPLING DEPTH (ft.) 38-43

Particle Diameter @ 60% Passing = 0.40 mm.(0.016 in.)



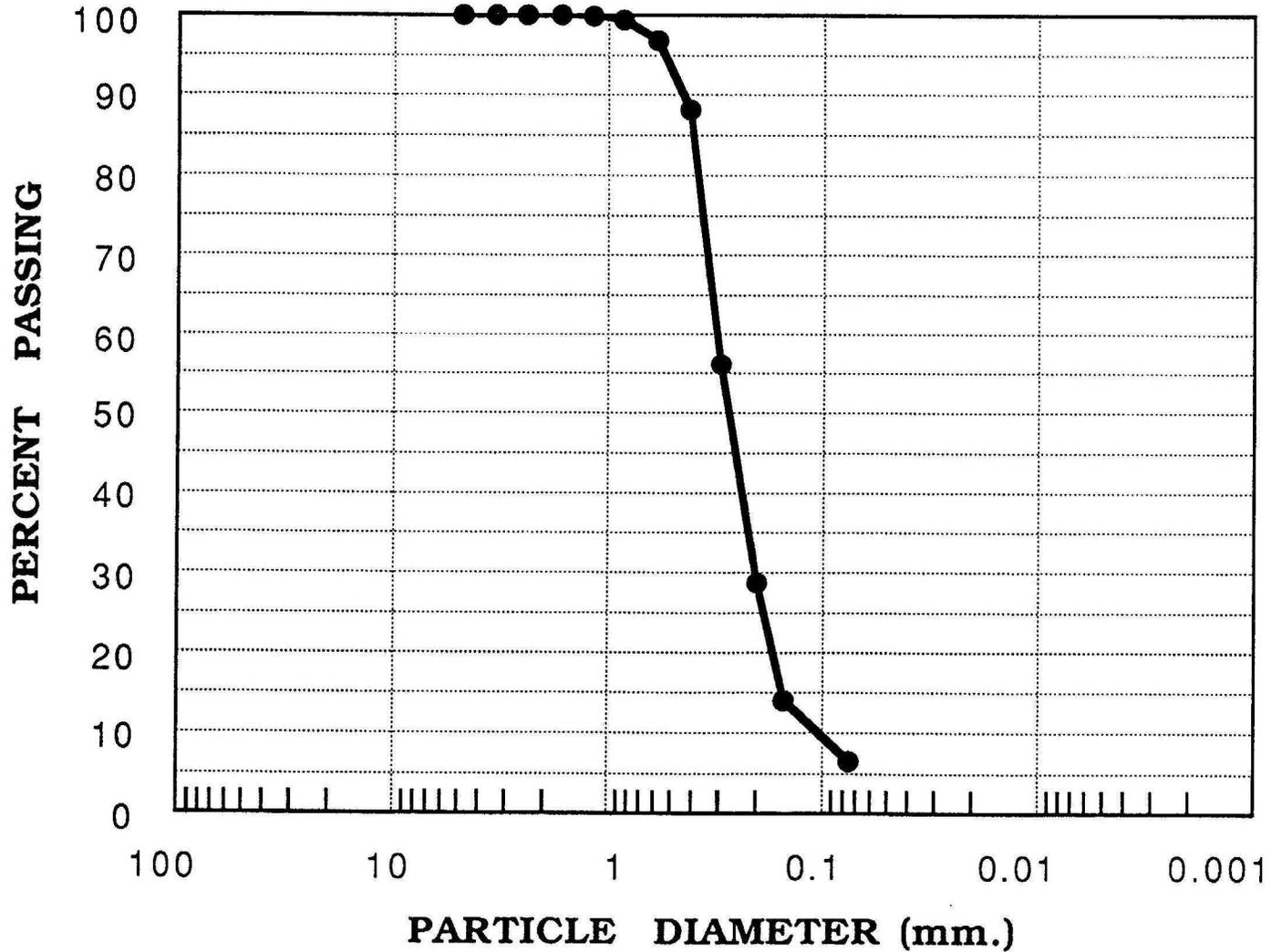
LINE # 4A3 E-W
USBR SITE # 17+00
SAMPLING DEPTH (ft.) 43-48

Particle Diameter @ 60% Passing = 2.99 mm.(0.118 in.)



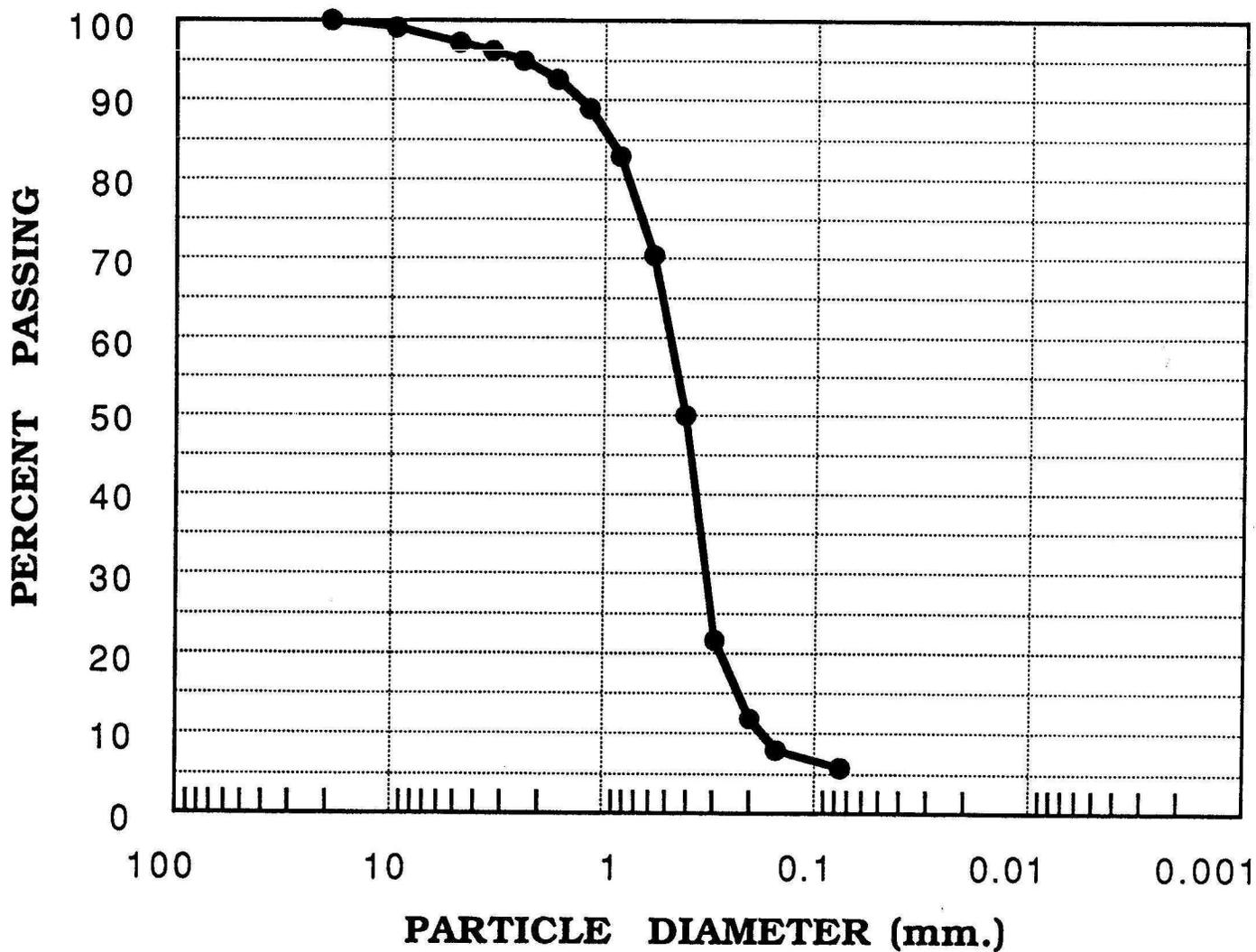
LINE # 4A3 E-W
USBR SITE # 21+00
SAMPLING DEPTH (ft.) 24-34.5

Particle Diameter @ 60% Passing = 0.30 mm.(0.012 in.)



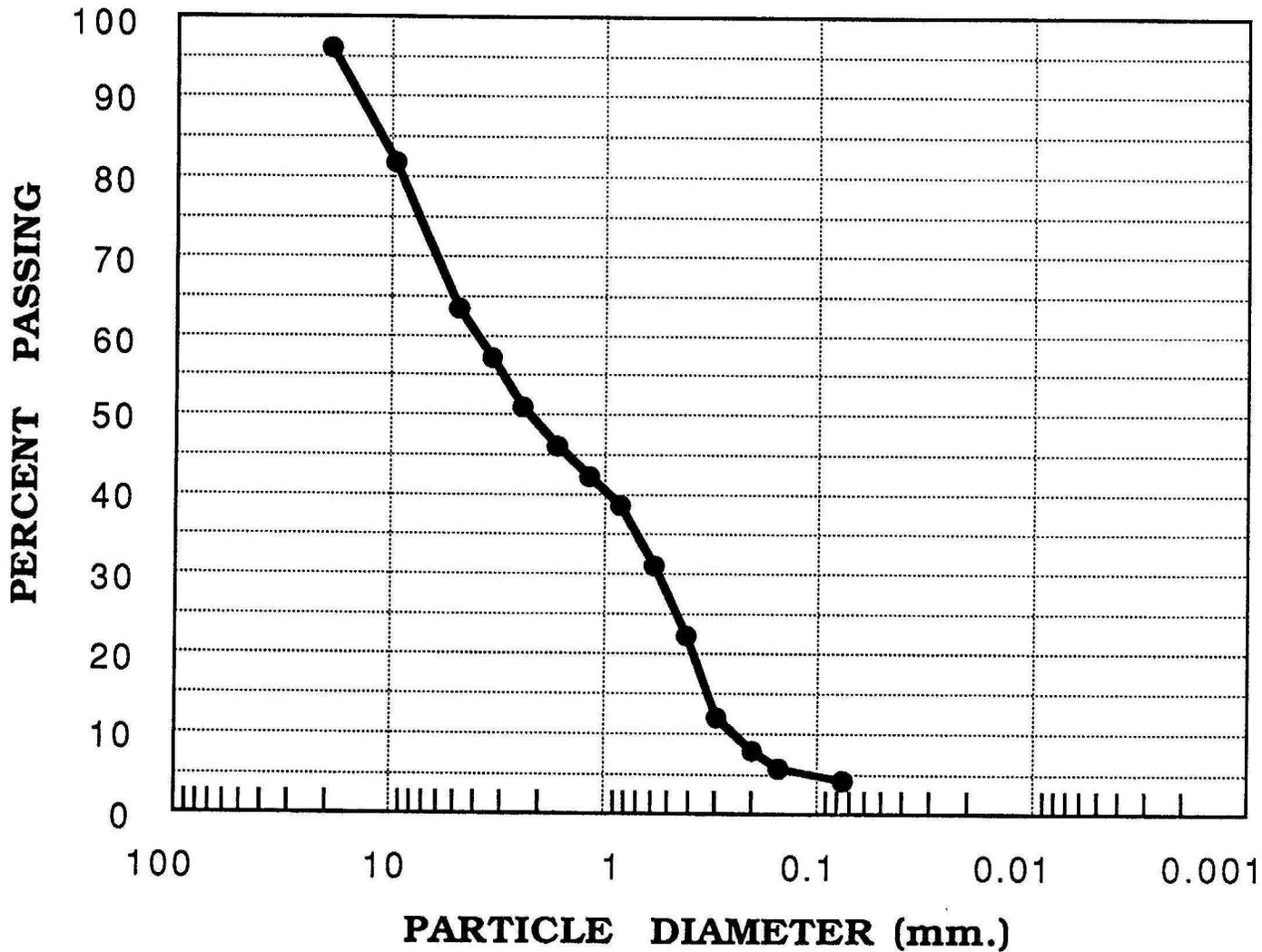
LINE # 4A3 E-W
USBR SITE # 21+00
SAMPLING DEPTH (ft.) 34.5-43

Particle Diameter @ 60% Passing = 0.48 mm.(0.019 in.)



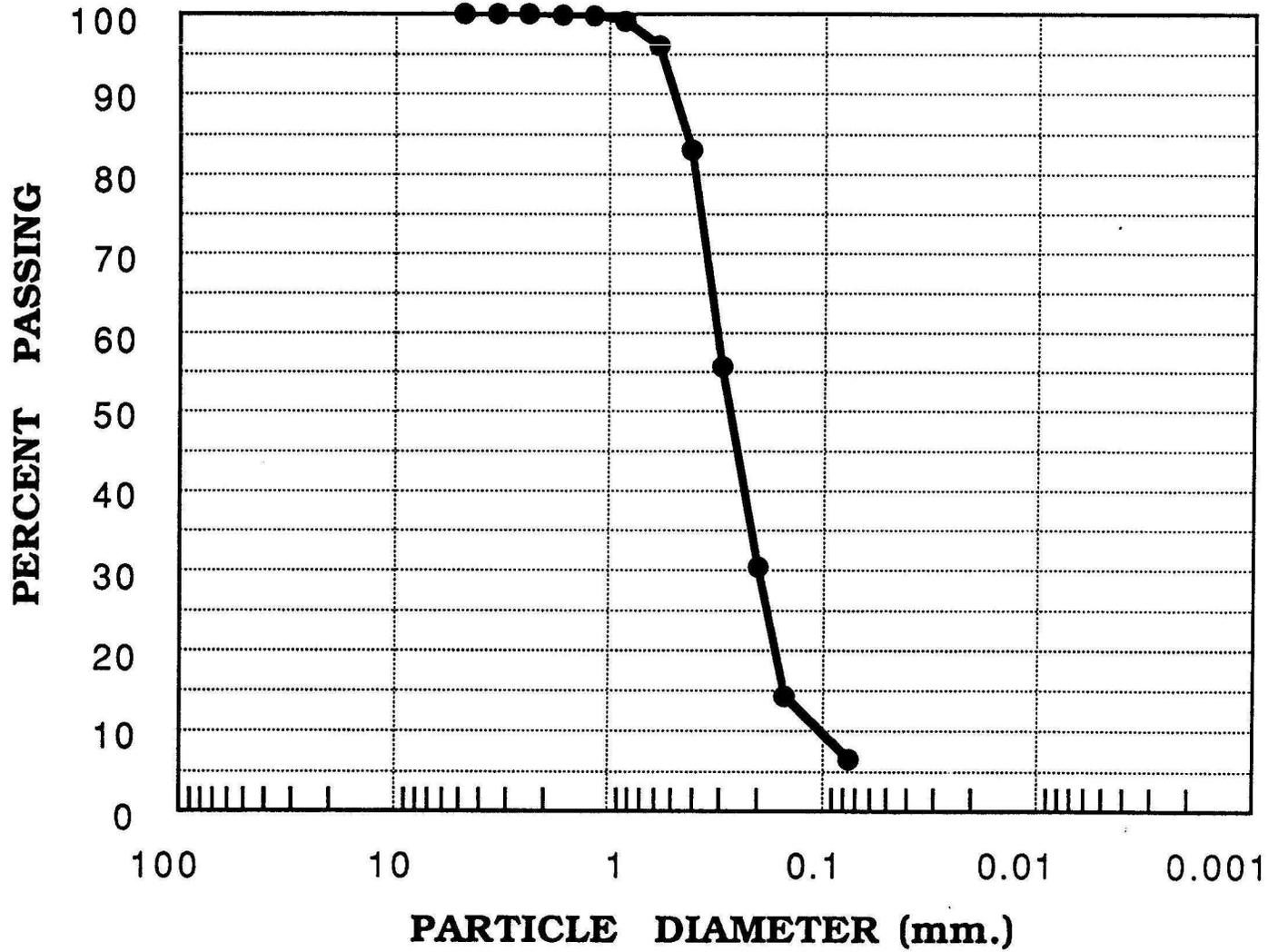
LINE # 4A3 E-W
USBR SITE # 21+00
SAMPLING DEPTH (ft.) 43-52

Particle Diameter @ 60% Passing = 3.76 mm.(0.148 in.)



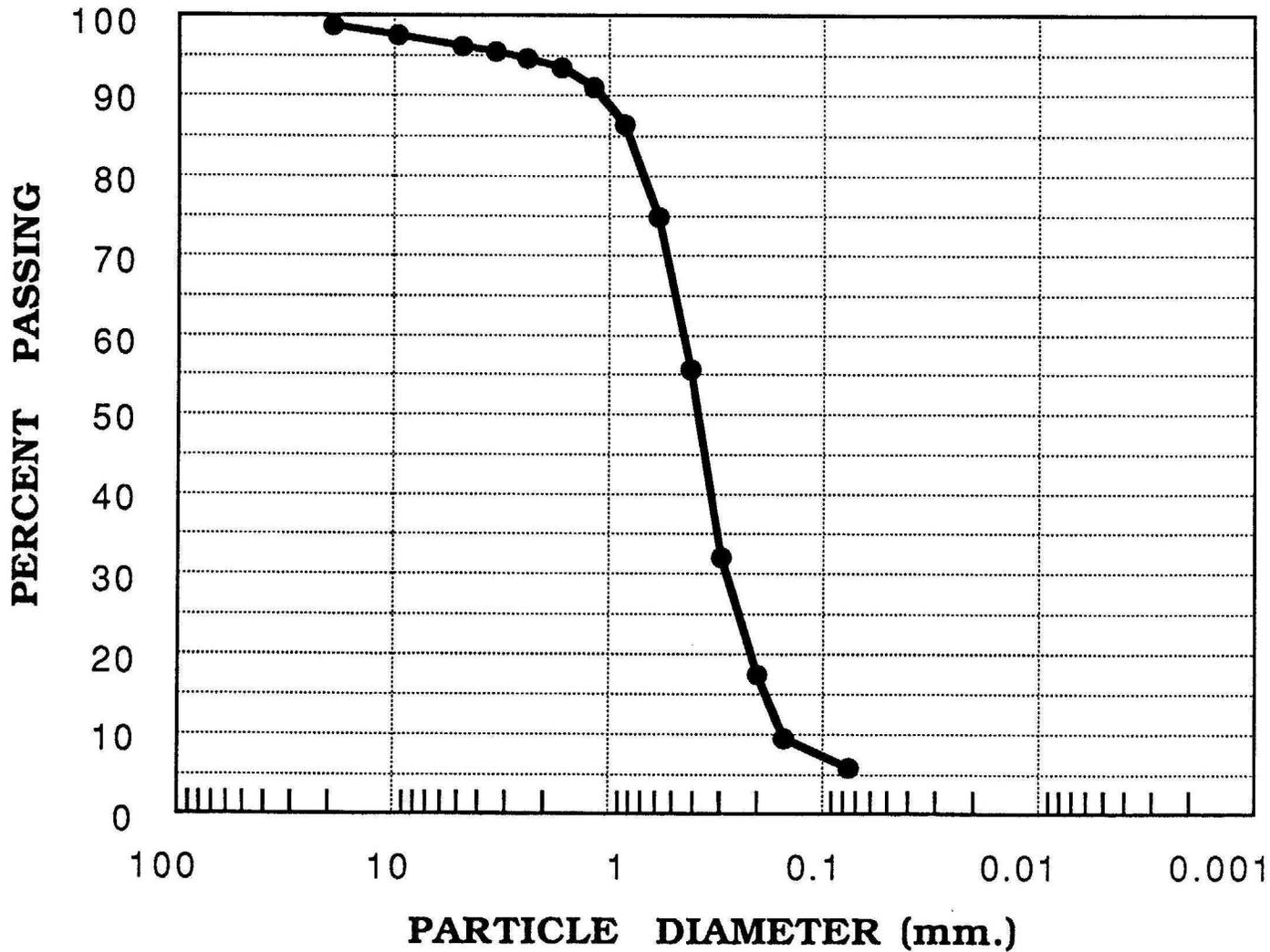
LINE # 4A3 E-W
USBR SITE # 23+00
SAMPLING DEPTH (ft.) 30-35.5

Particle Diameter @ 60% Passing = 0.30 mm.(0.012 in.)



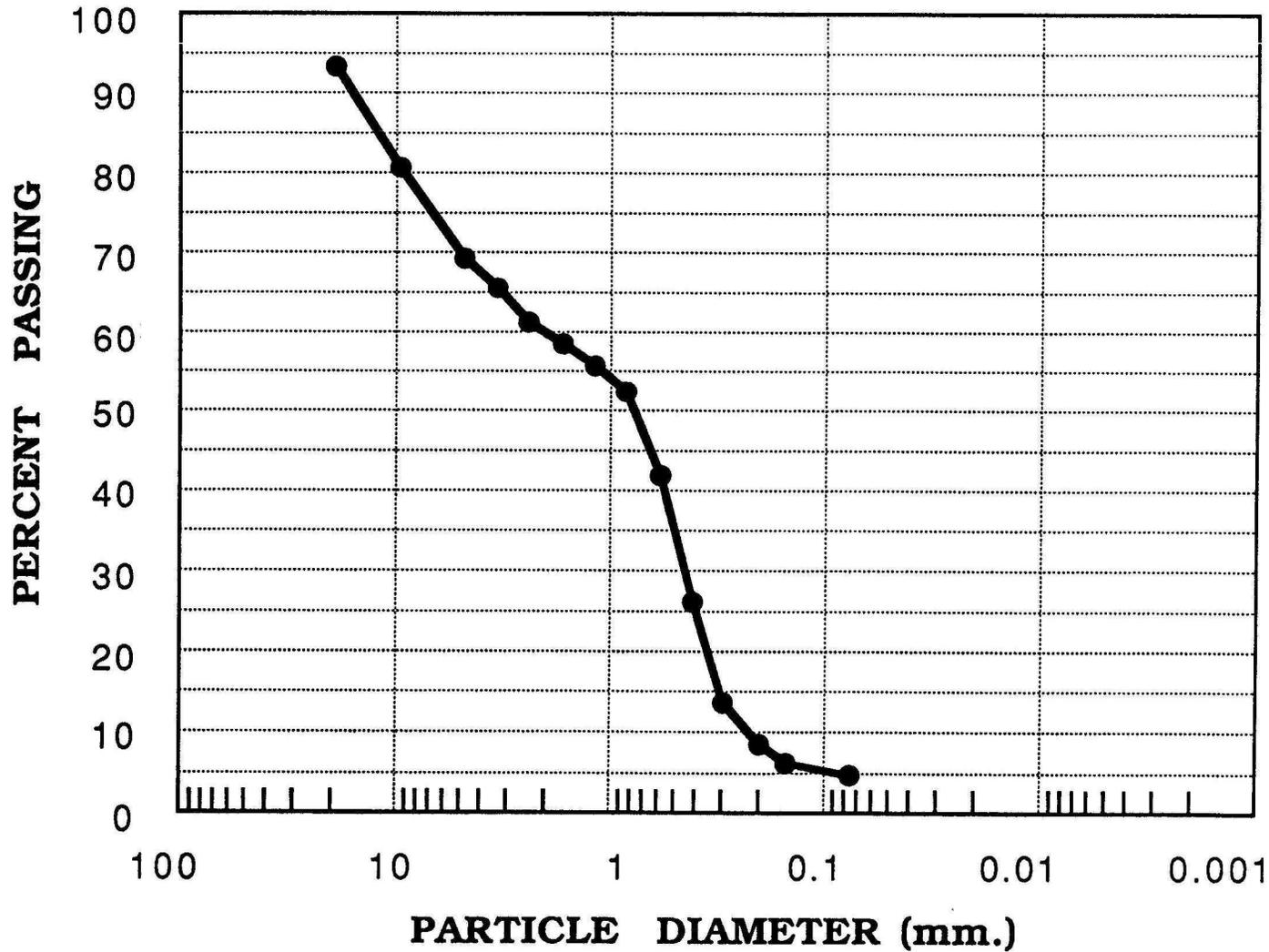
LINE # 4A3 E-W
USBR SITE # 23+00
SAMPLING DEPTH (ft.) 35.5-41.5

Particle Diameter @ 60% Passing = 0.44 mm.(0.017 in.)



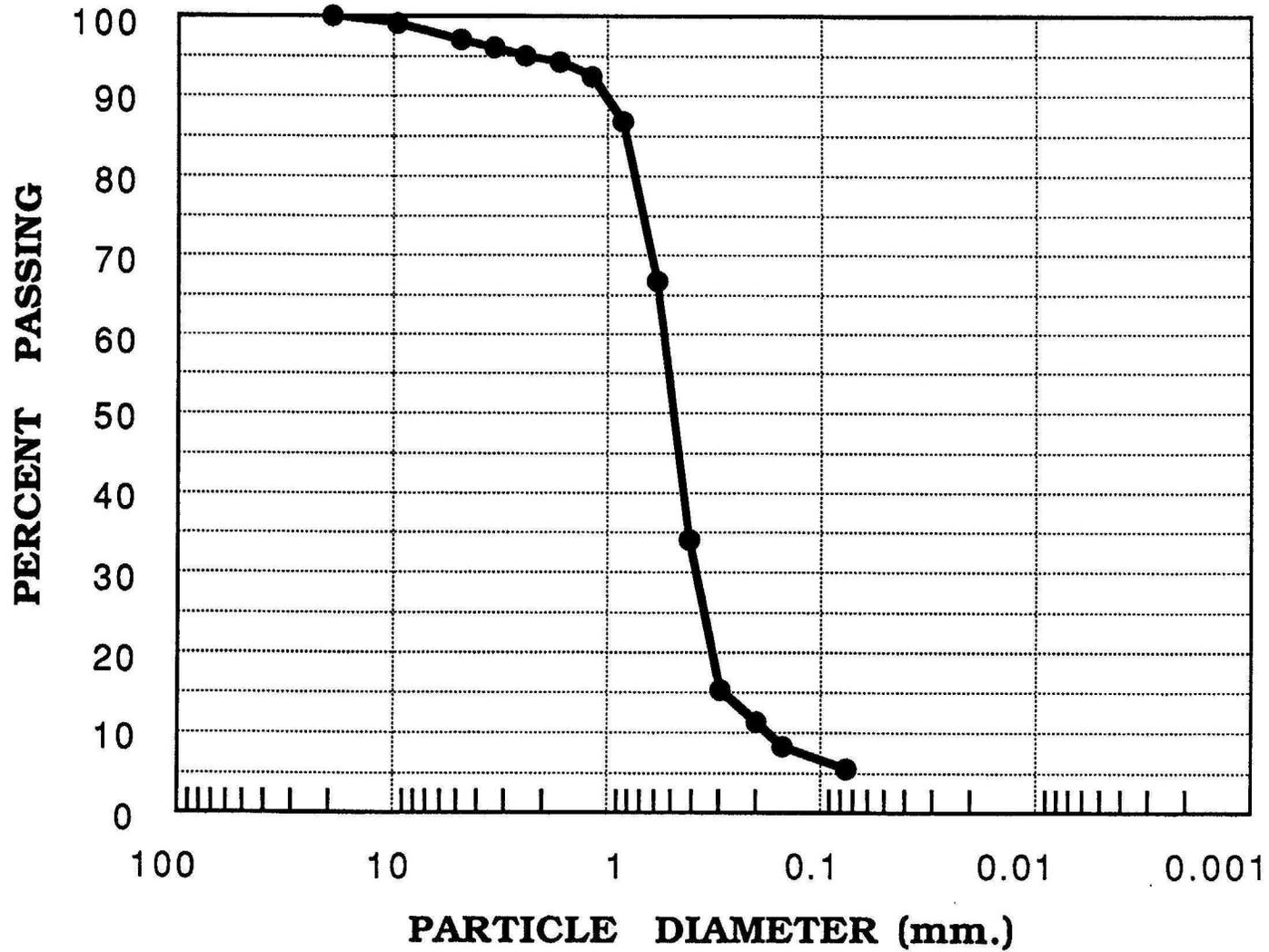
LINE # 4A3 E-W
USBR SITE # 23+00
SAMPLING DEPTH (ft.) 41.5-49

Particle Diameter @ 60% Passing = 2.17 mm.(0.085 in.)



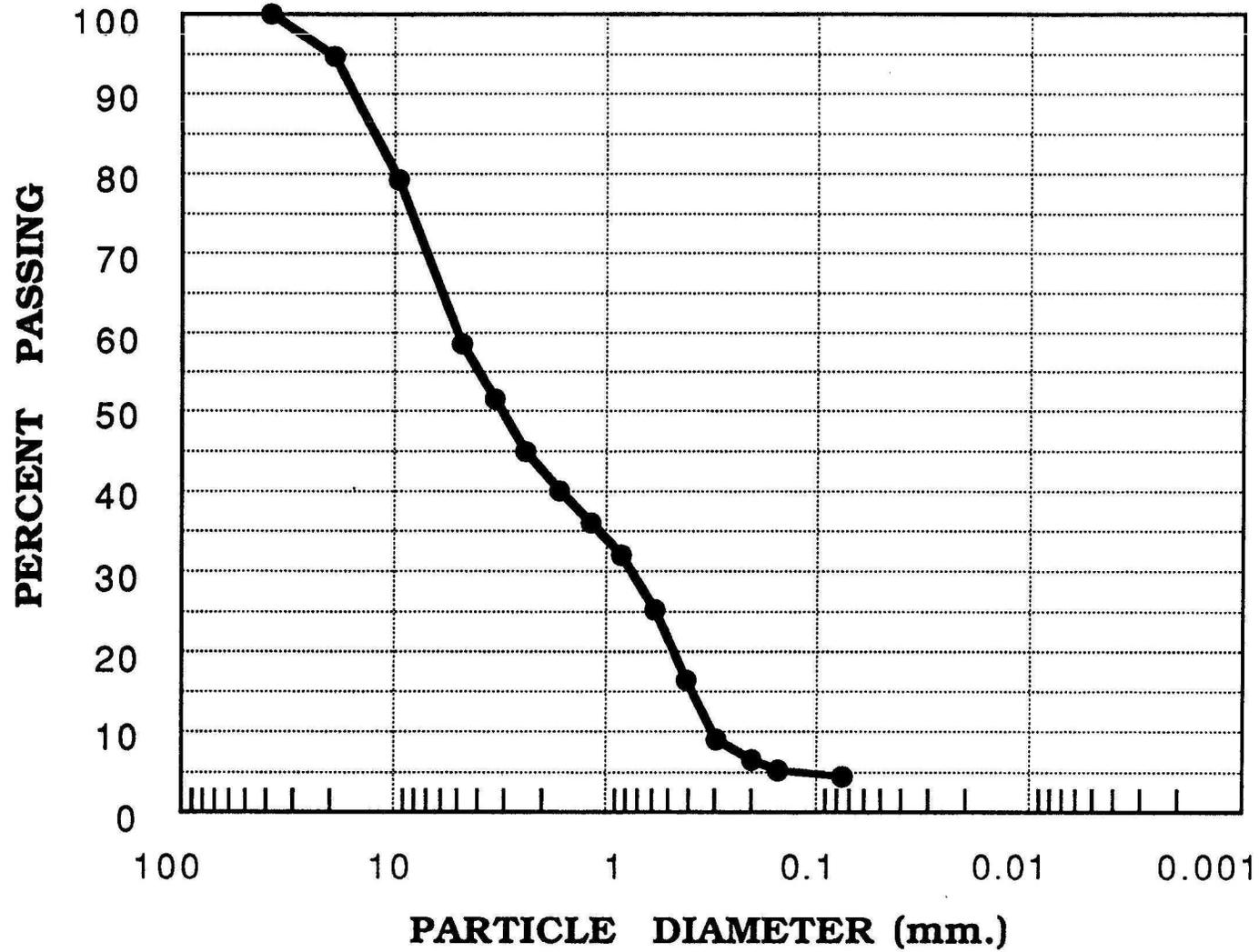
LINE # 4A4 N-S
USBR SITE # 33+67
SAMPLING DEPTH (ft.) 18-30

Particle Diameter @ 60% Passing = 0.53 mm.(0.021 in.)



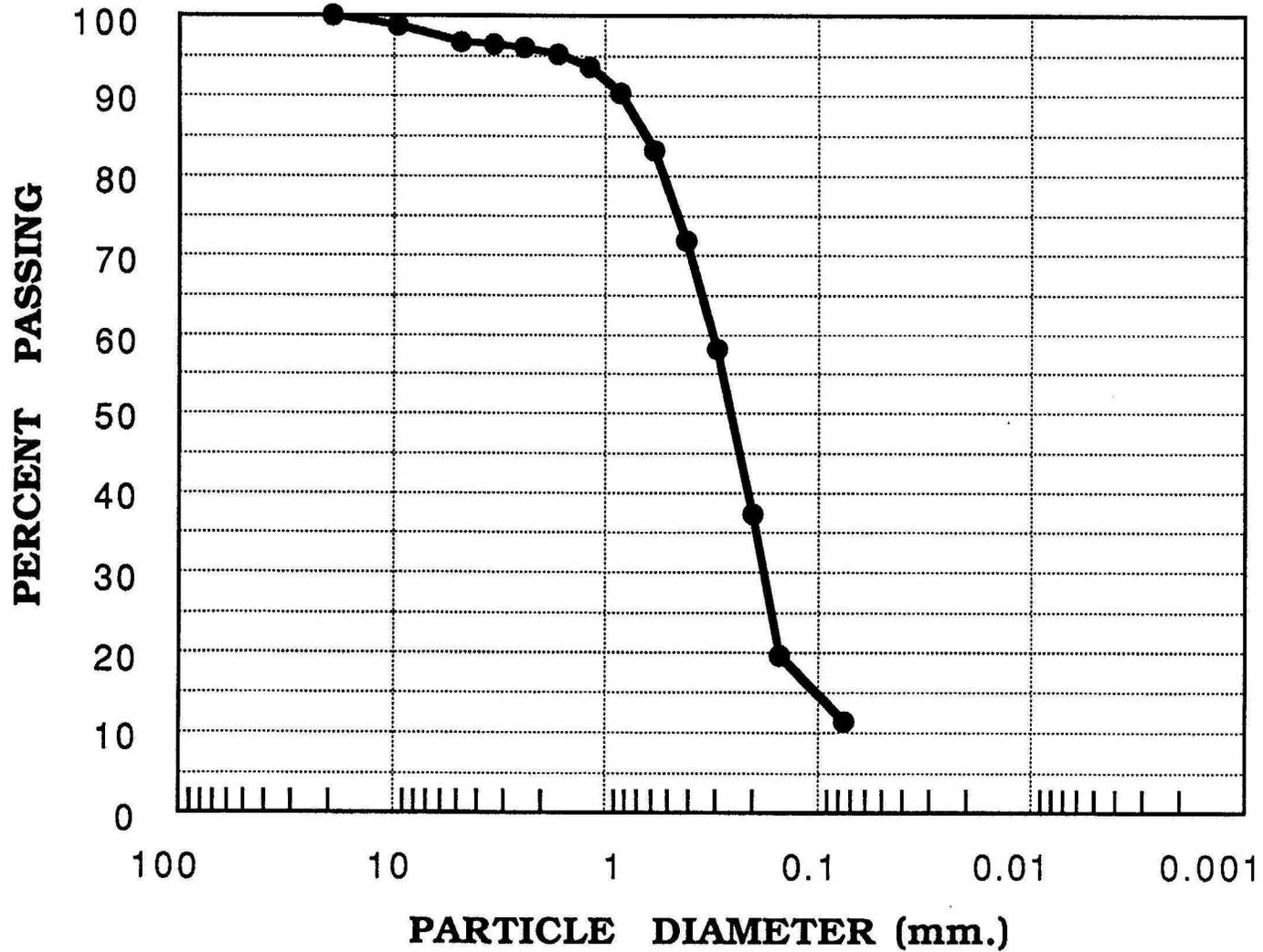
LINE # 4A4 N-S
USBR SITE # 33+67
SAMPLING DEPTH (ft.) 30-35

Particle Diameter @ 60% Passing = 4.95 mm.(0.195 in.)



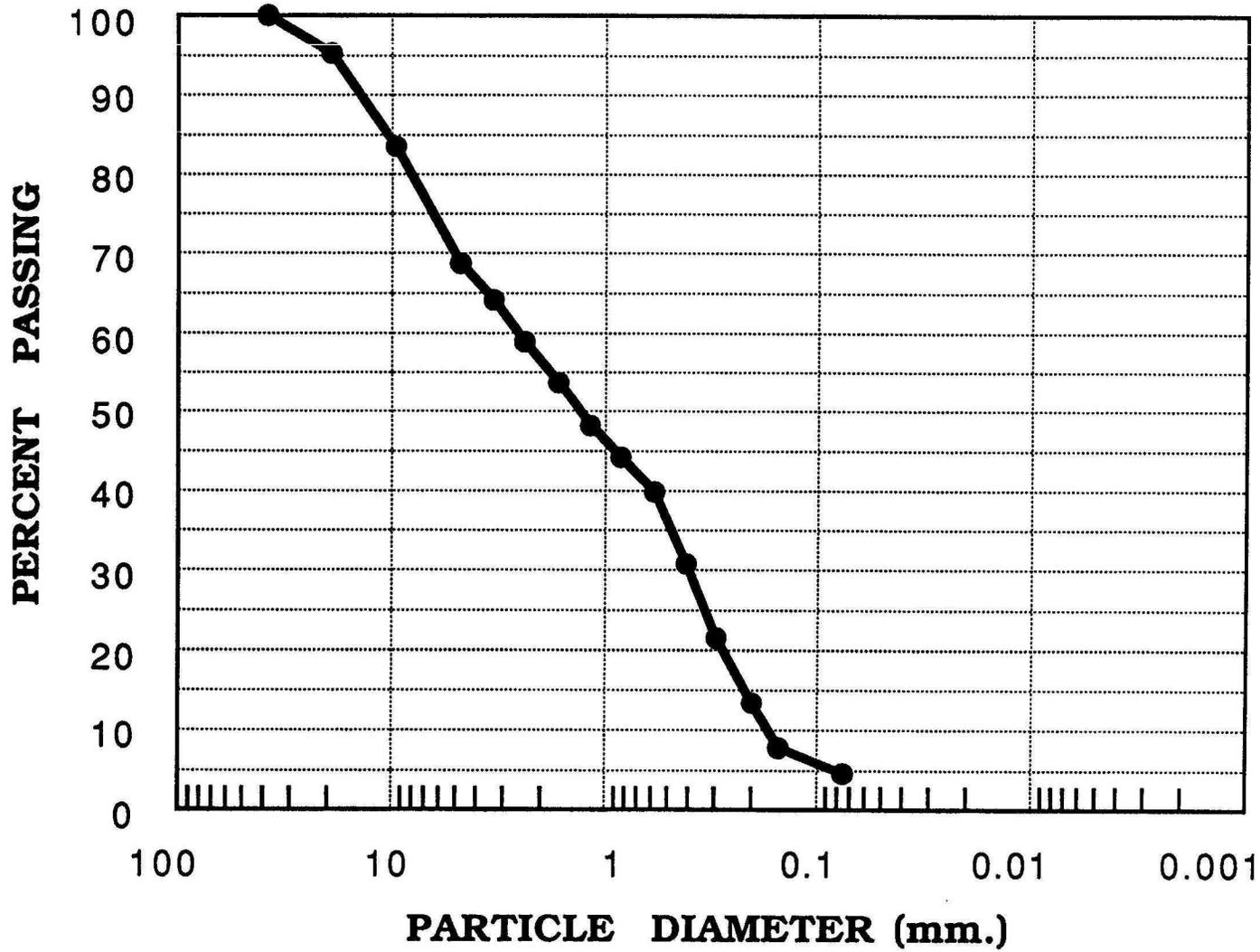
LINE # 4A4 N-S
USBR SITE # 41+77
SAMPLING DEPTH (ft.) 9-22.5

Particle Diameter @ 60% Passing = 0.30 mm.(0.012 in.)



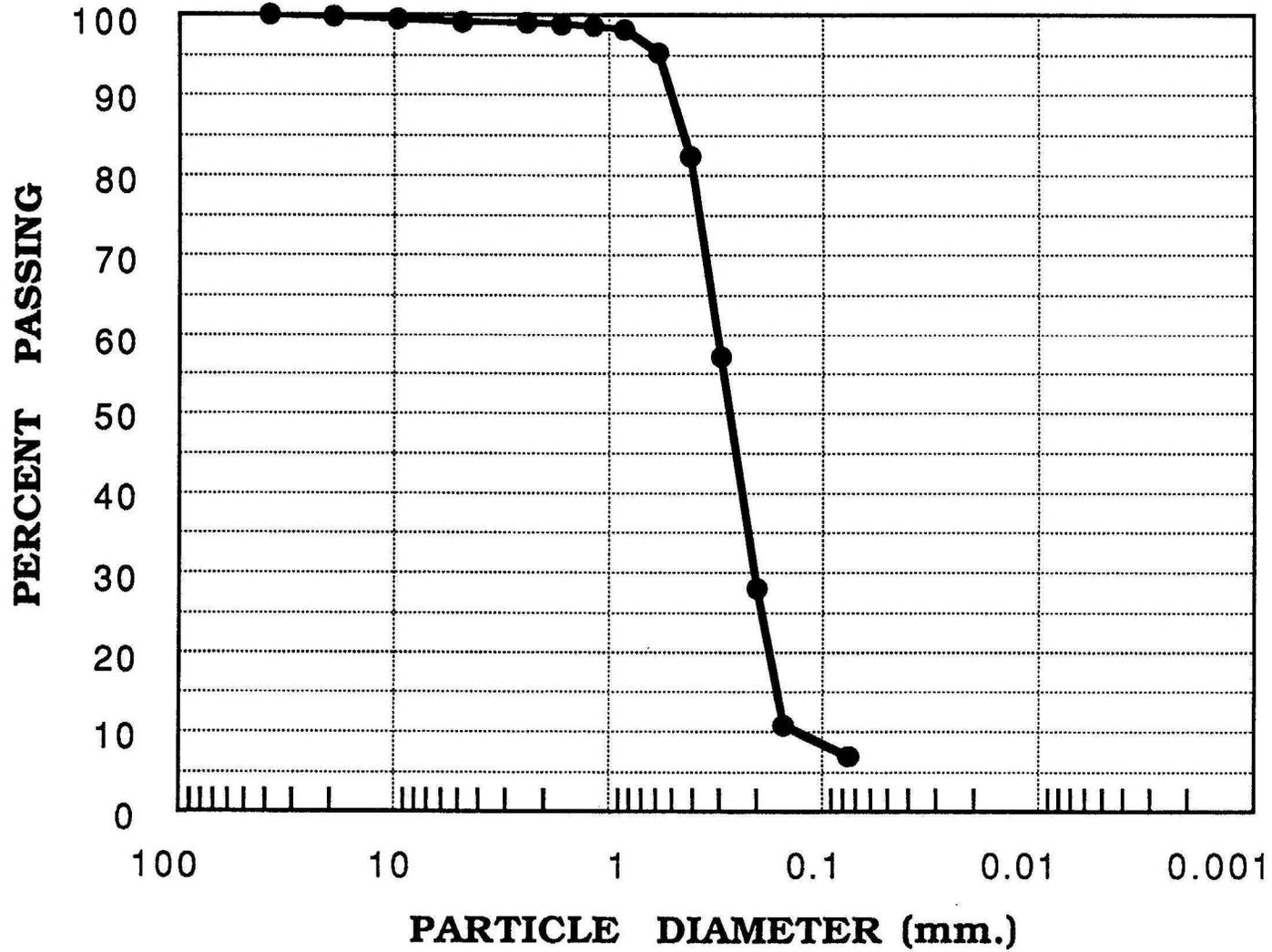
LINE # 4A4 N-S
USBR SITE # 41+77
SAMPLING DEPTH (ft.) 22.5-30

Particle Diameter @ 60% Passing = 2.49 mm.(0.098 in.)



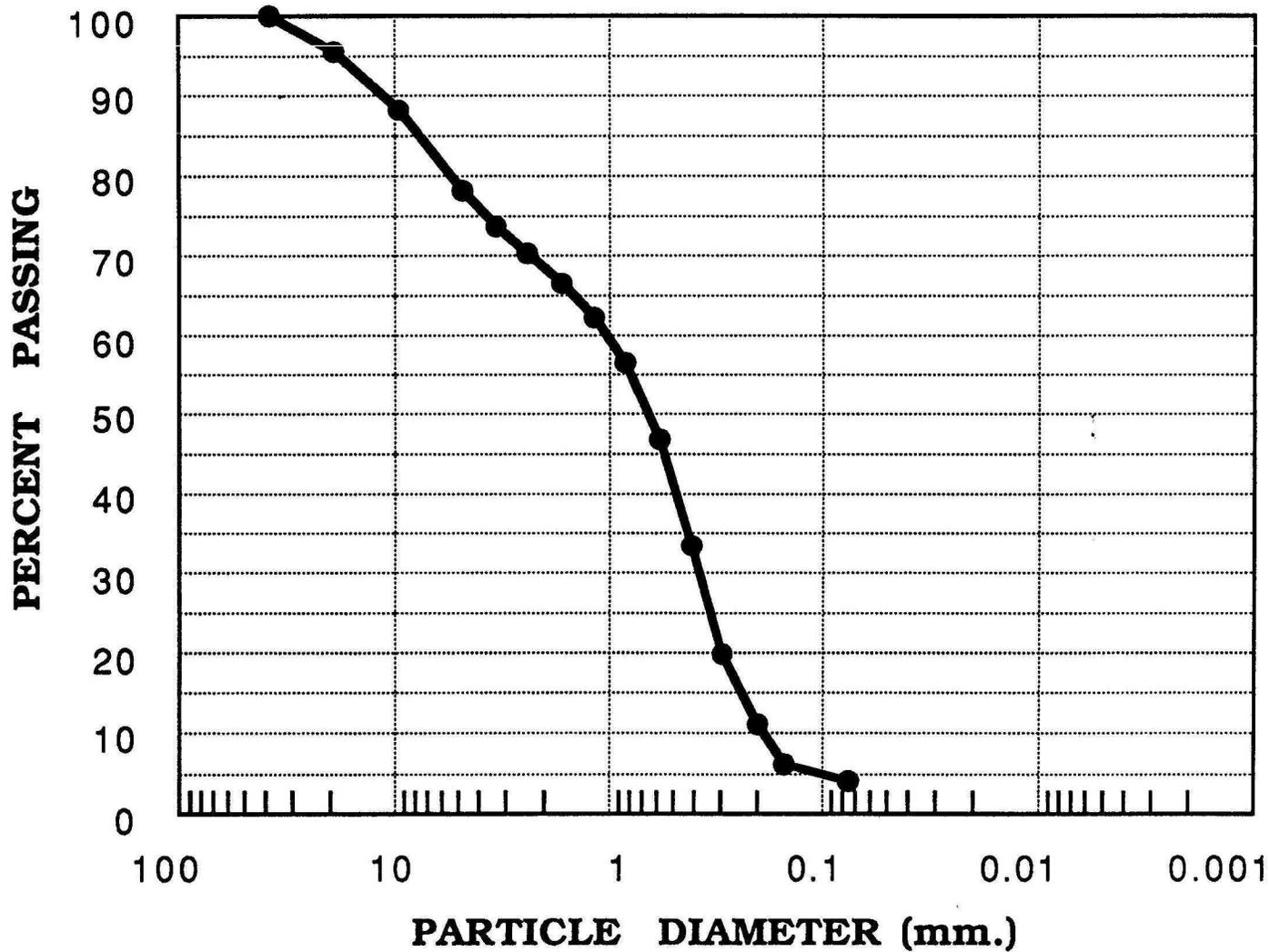
LINE # 4A4 N-S
USBR SITE # 42+27
SAMPLING DEPTH (ft.) 18-23

Particle Diameter @ 60% Passing = 0.30 mm.(0.012 in.)



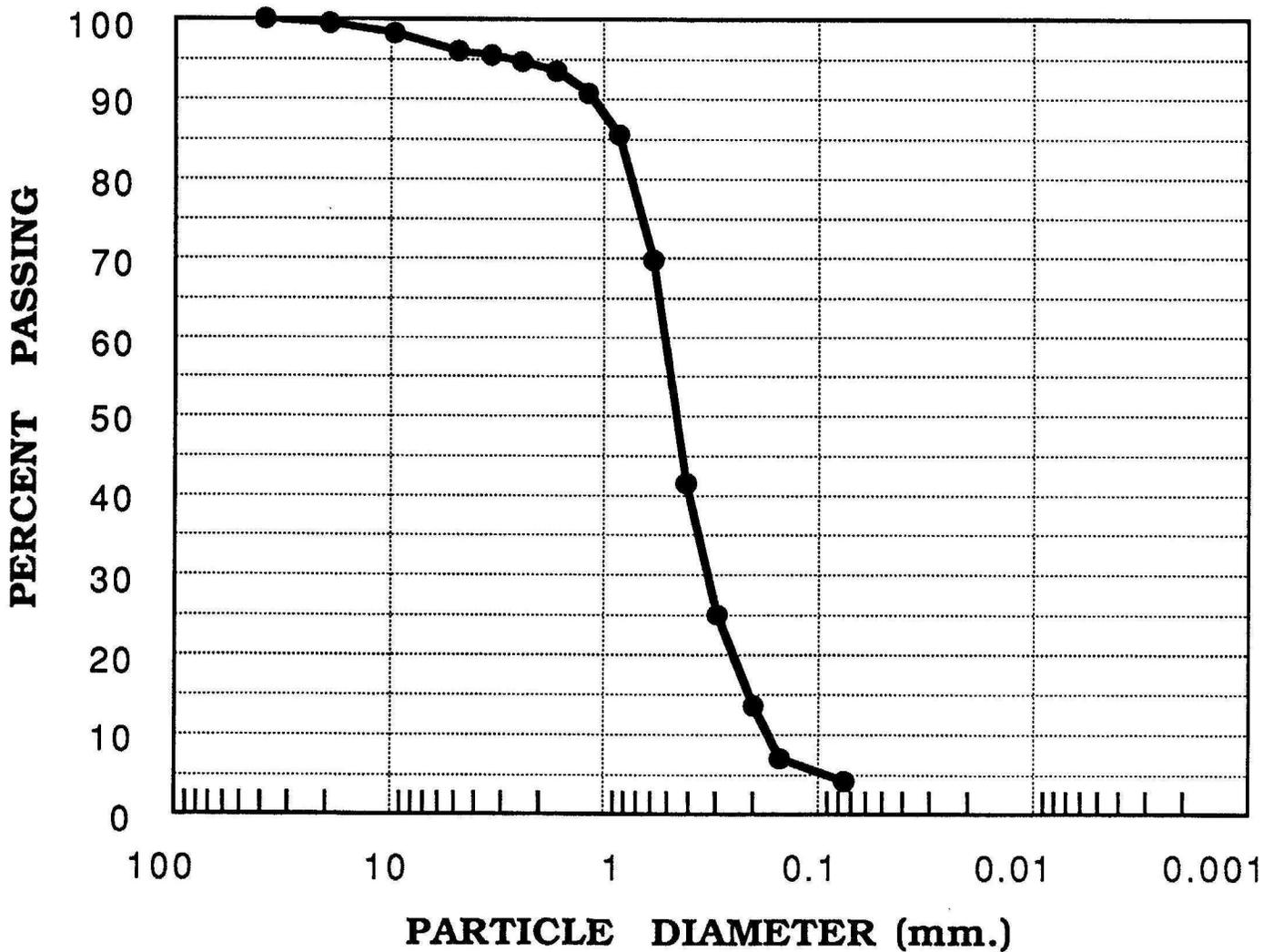
LINE # 4A4 N-S
USBR SITE # 42+27
SAMPLING DEPTH (ft.) 23-28

Particle Diameter @ 60% Passing = 0.95 mm.(0.037 in.)



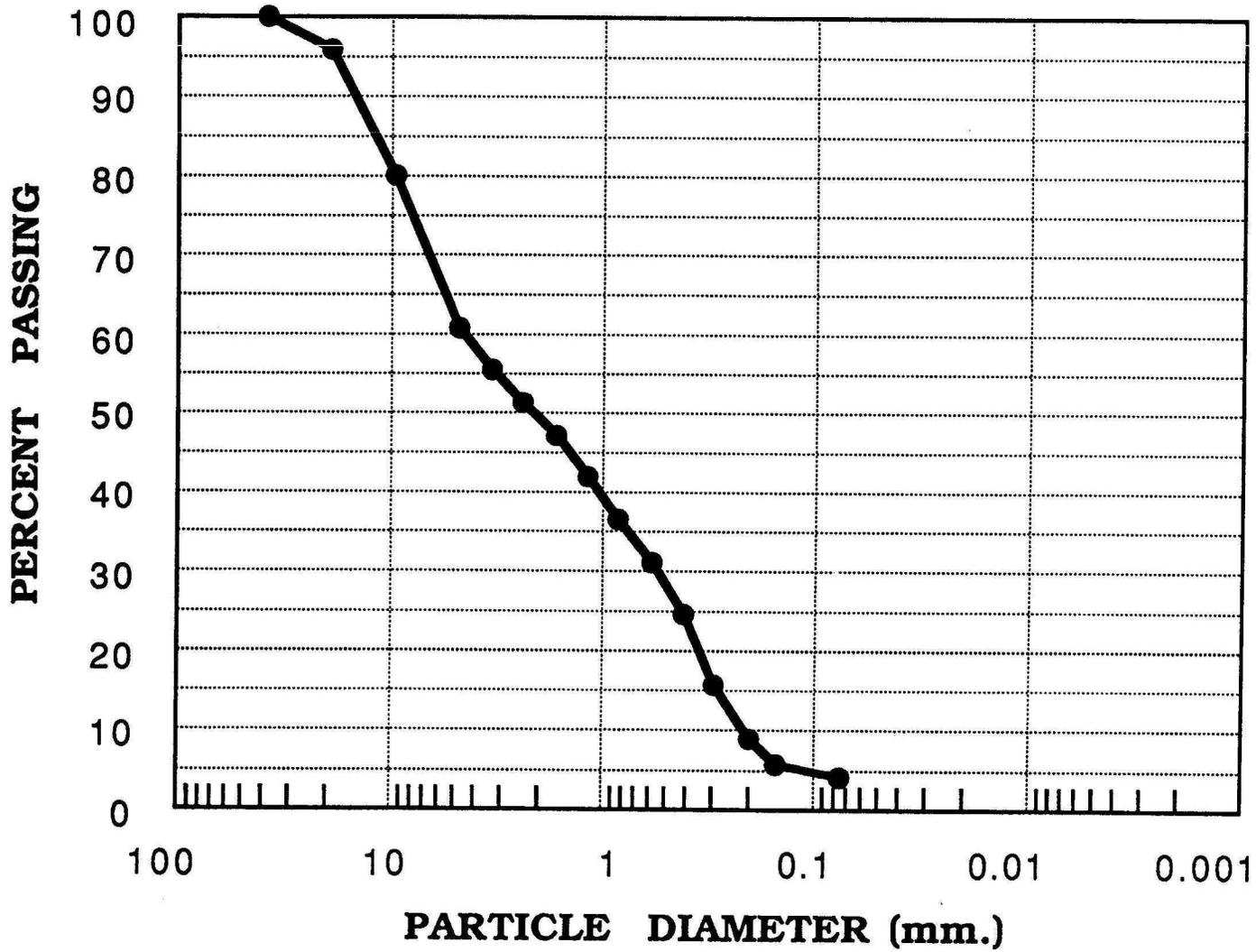
LINE # 4A4 N-S
USBR SITE # 42+77
SAMPLING DEPTH (ft.) 8-22

Particle Diameter @ 60% Passing = 0.50 mm.(0.020 in.)



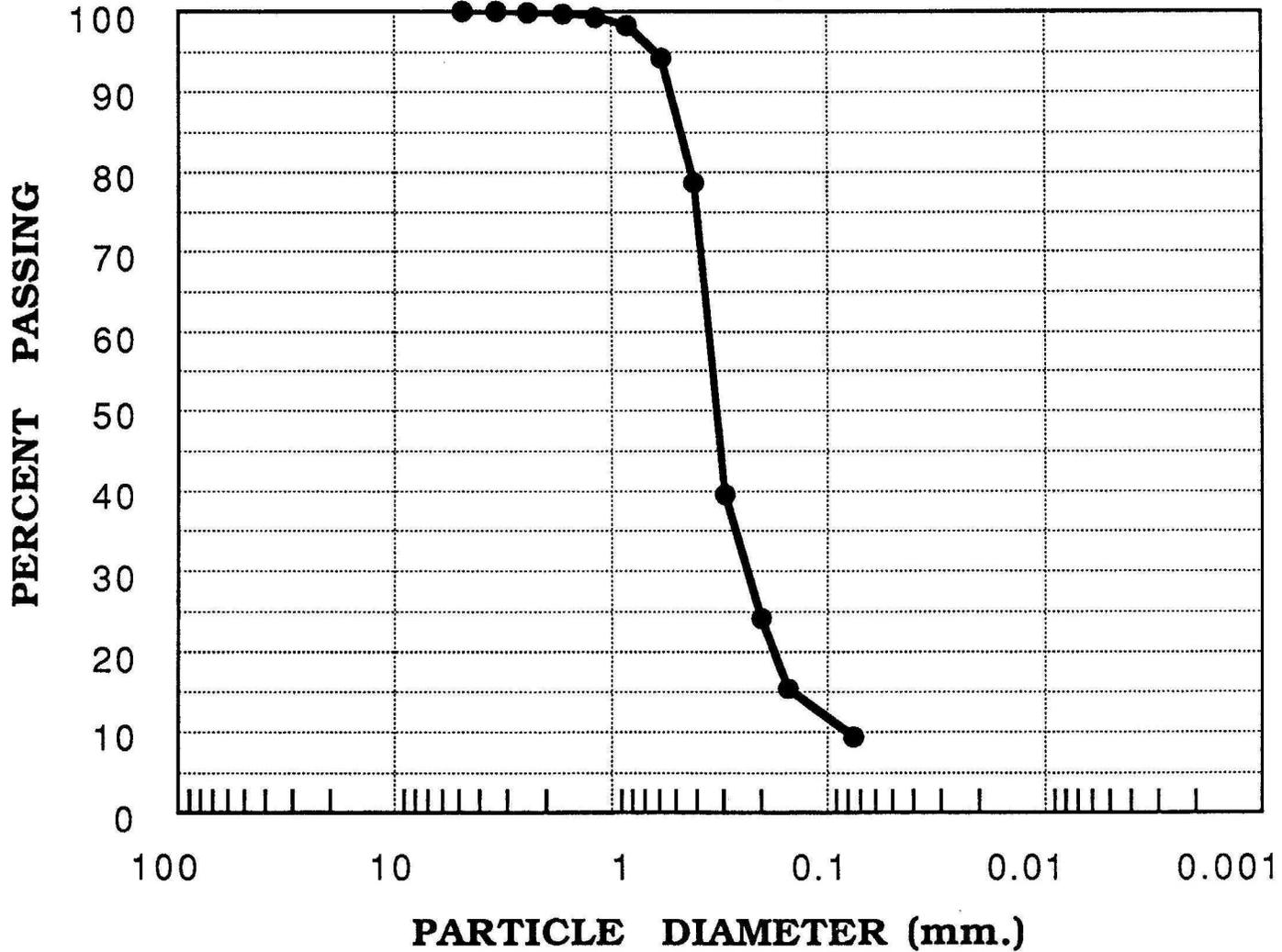
LINE # 4A4 N-S
USBR SITE # 42+77
SAMPLING DEPTH (ft.) 22-28

Particle Diameter @ 60% Passing = 4.31 mm.(0.170 in.)



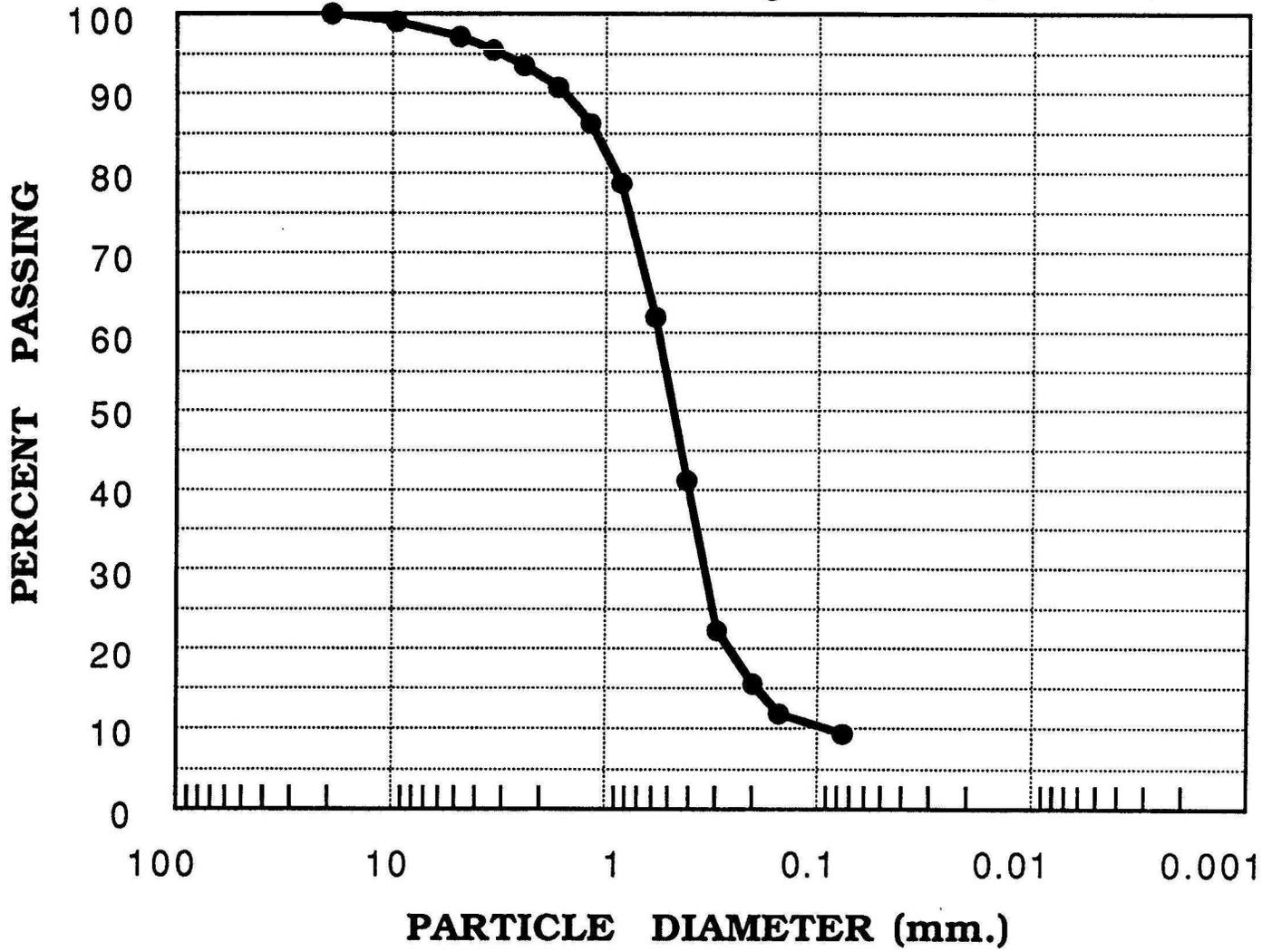
LINE # 4B1 N-S
USBR SITE # 24+00
SAMPLING DEPTH (ft.) 32-36

Particle Diameter @ 60% Passing = 0.35 mm.(0.014 in.)



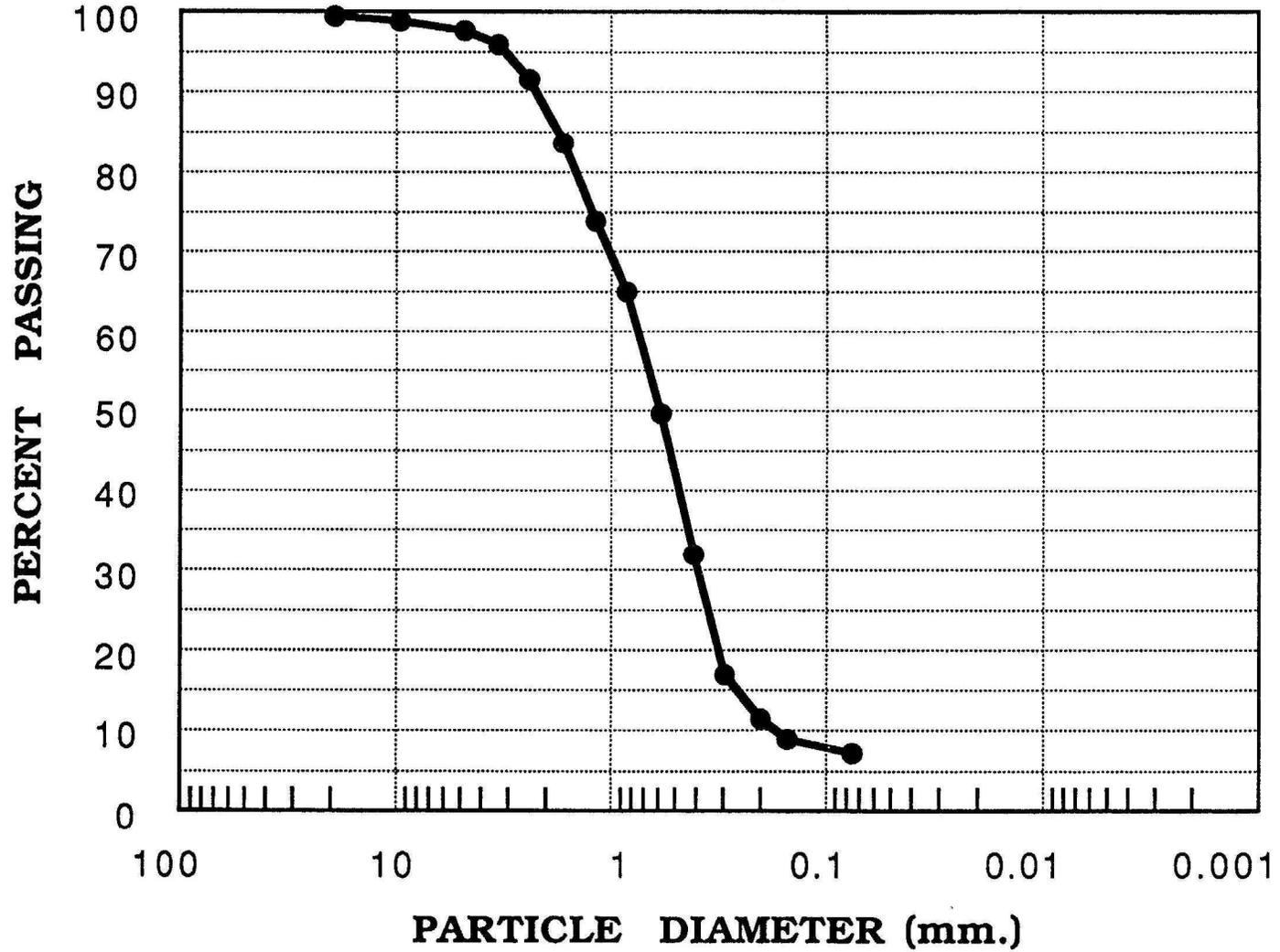
LINE # 4B1 N-S
USBR SITE # 28+00
SAMPLING DEPTH (ft.) 18-28

Particle Diameter @ 60% Passing = 0.55 MM.(0.022 IN.)



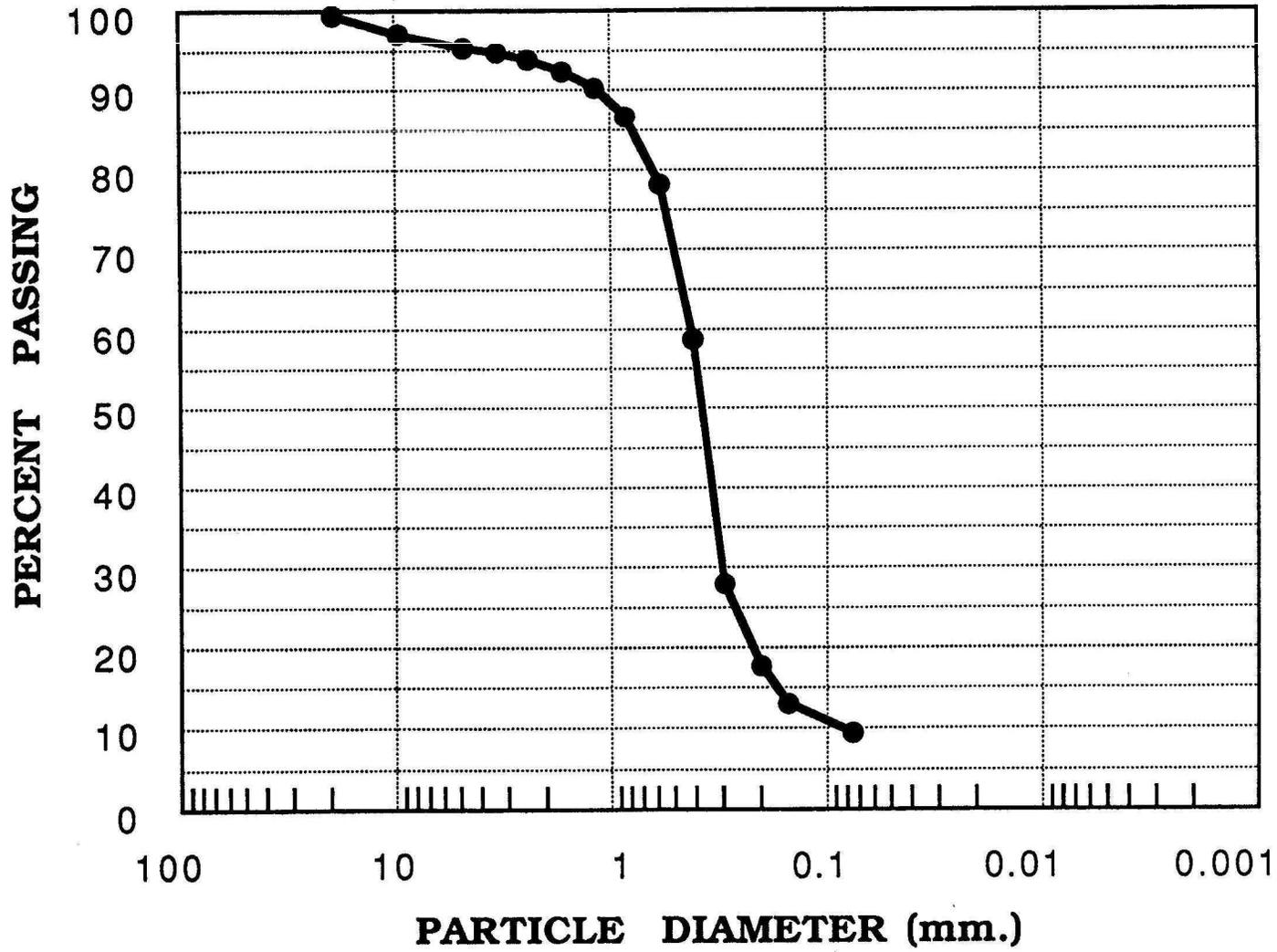
LINE # 4B1 N-S
USBR SITE # 28+00
SAMPLING DEPTH (ft.) 28-34

Particle Diameter @ 60% Passing = 0.76 MM.(0.030 IN.)



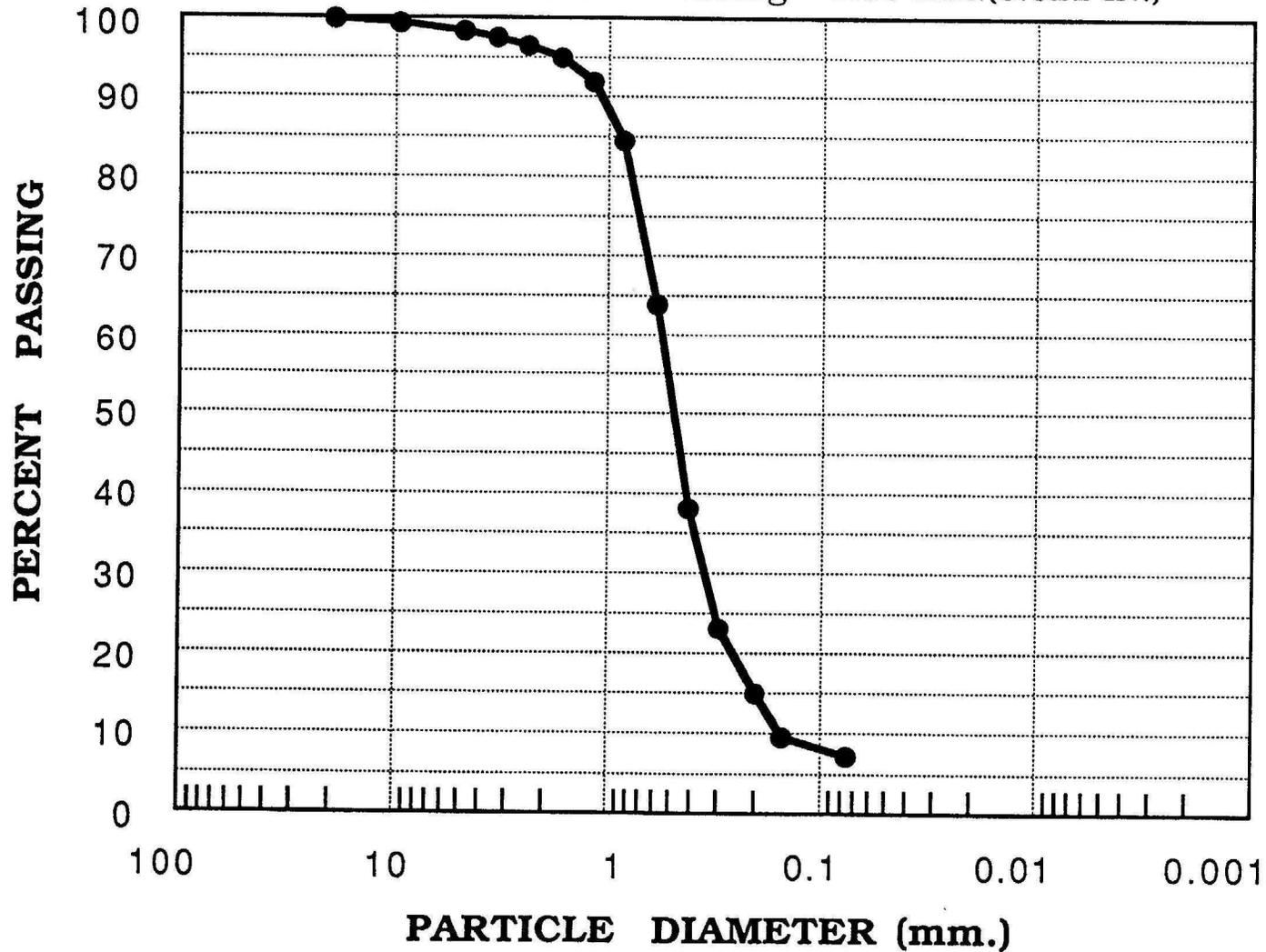
LINE # 4B1 N-S
USBR SITE # 28+00
SAMPLING DEPTH (ft.) 34-40

Particle Diameter @ 60% Passing = 0.42 MM.(0.017 IN.)



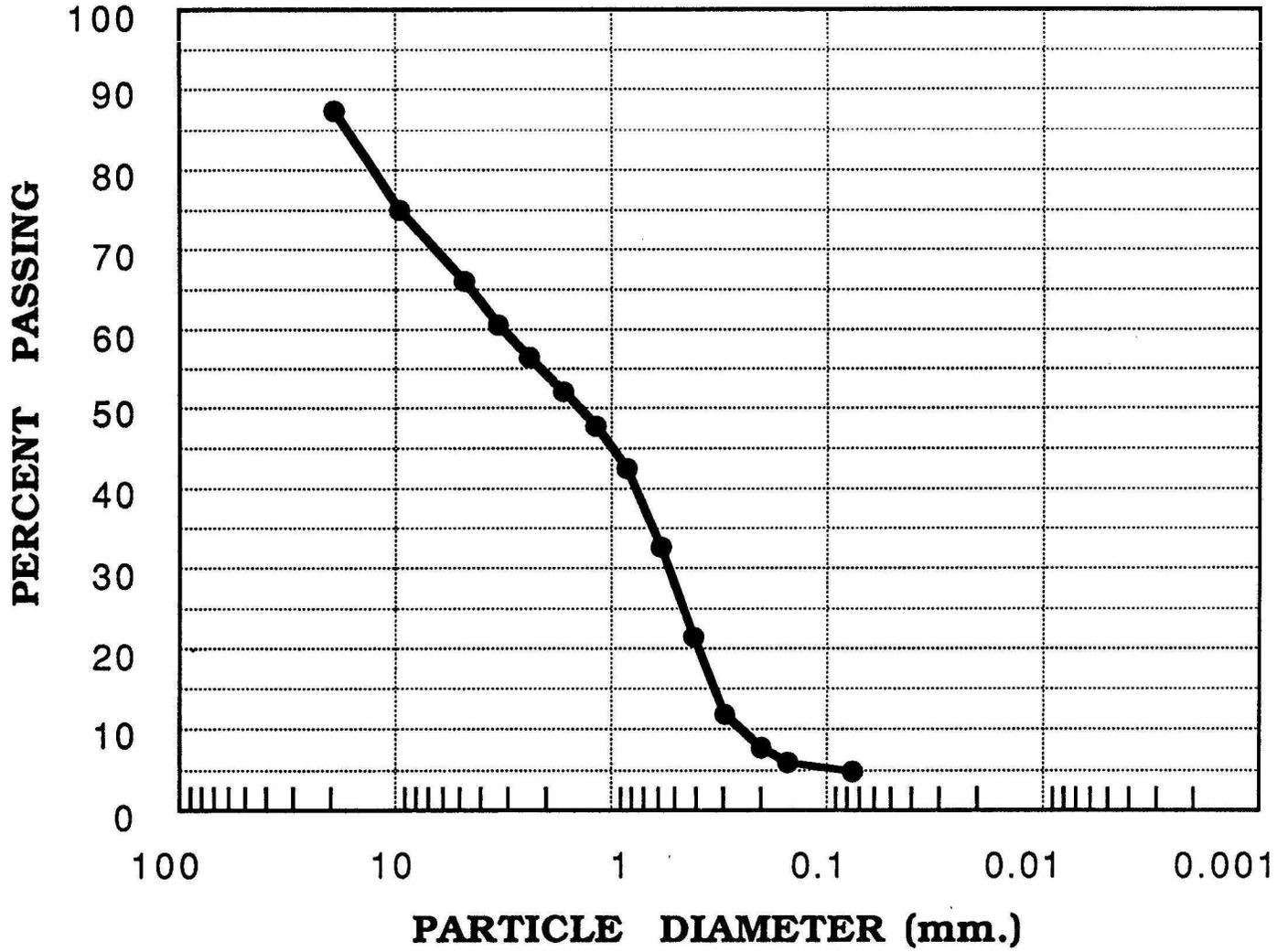
LINE # 4B1 N-S
USBR SITE # 32+00
SAMPLING DEPTH (ft.) 23-29.5

Particle Diameter @ 60% Passing = 0.55 MM.(0.022 IN.)



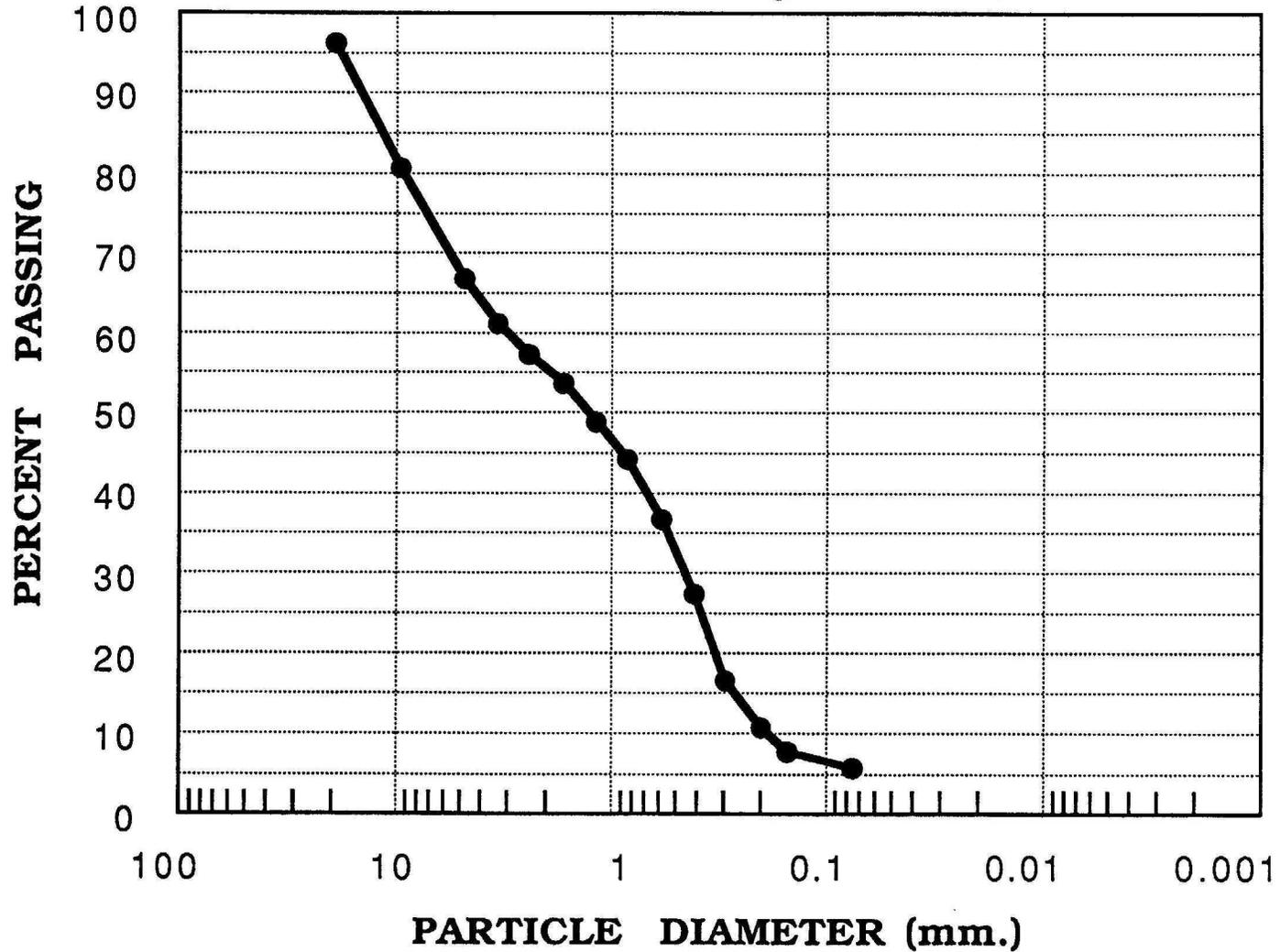
LINE # 4B1 N-S
USBR SITE # 32+00
SAMPLING DEPTH (ft.) 29.5-34

Particle Diameter @ 60% Passing = 3.28 MM.(0.129 IN.)



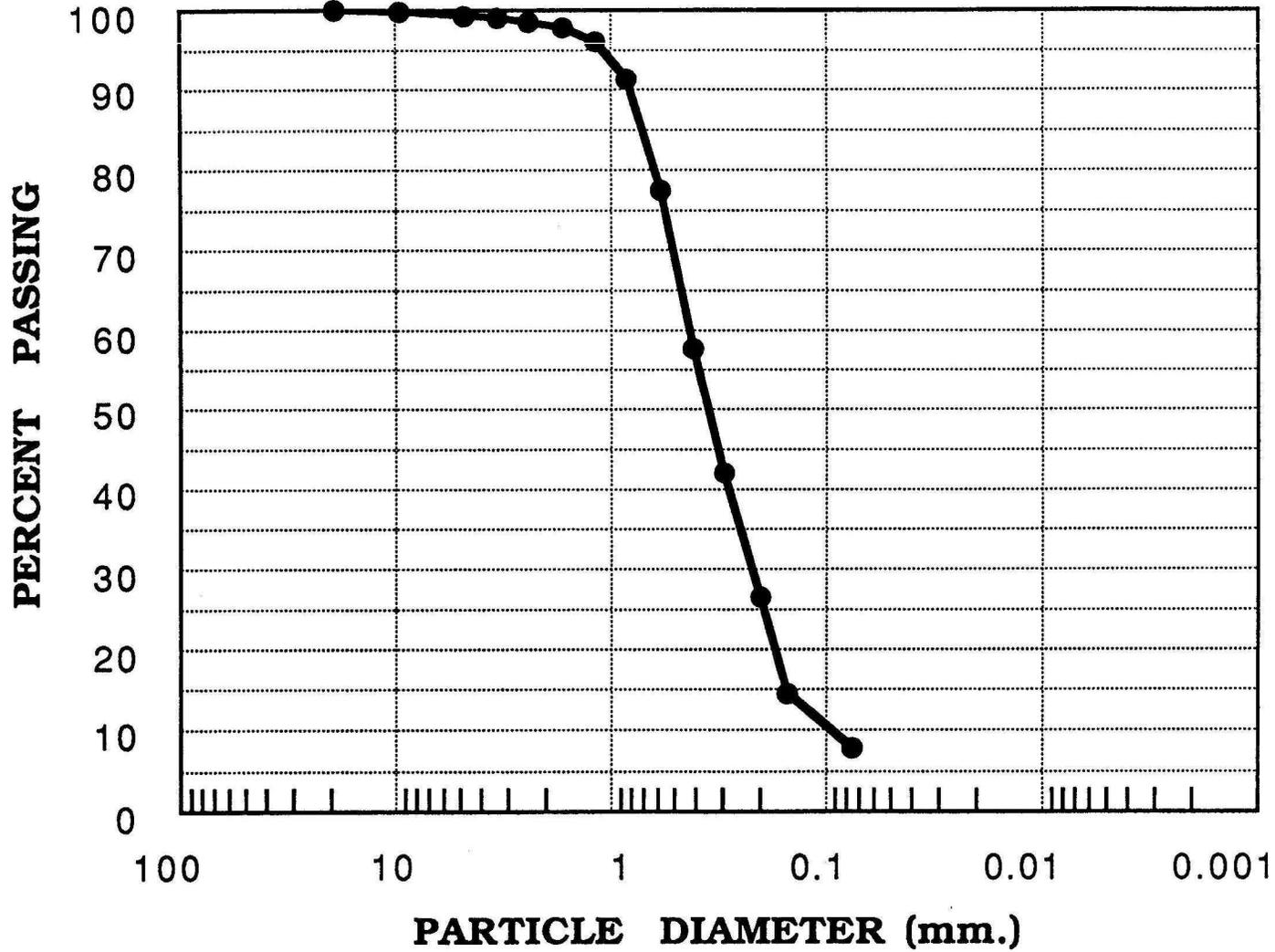
LINE # 4B1 N-S
USBR SITE # 32+00
SAMPLING DEPTH (ft.) 34-43

Particle Diameter @ 60% Passing = 2.86 MM.(0.113 IN.)



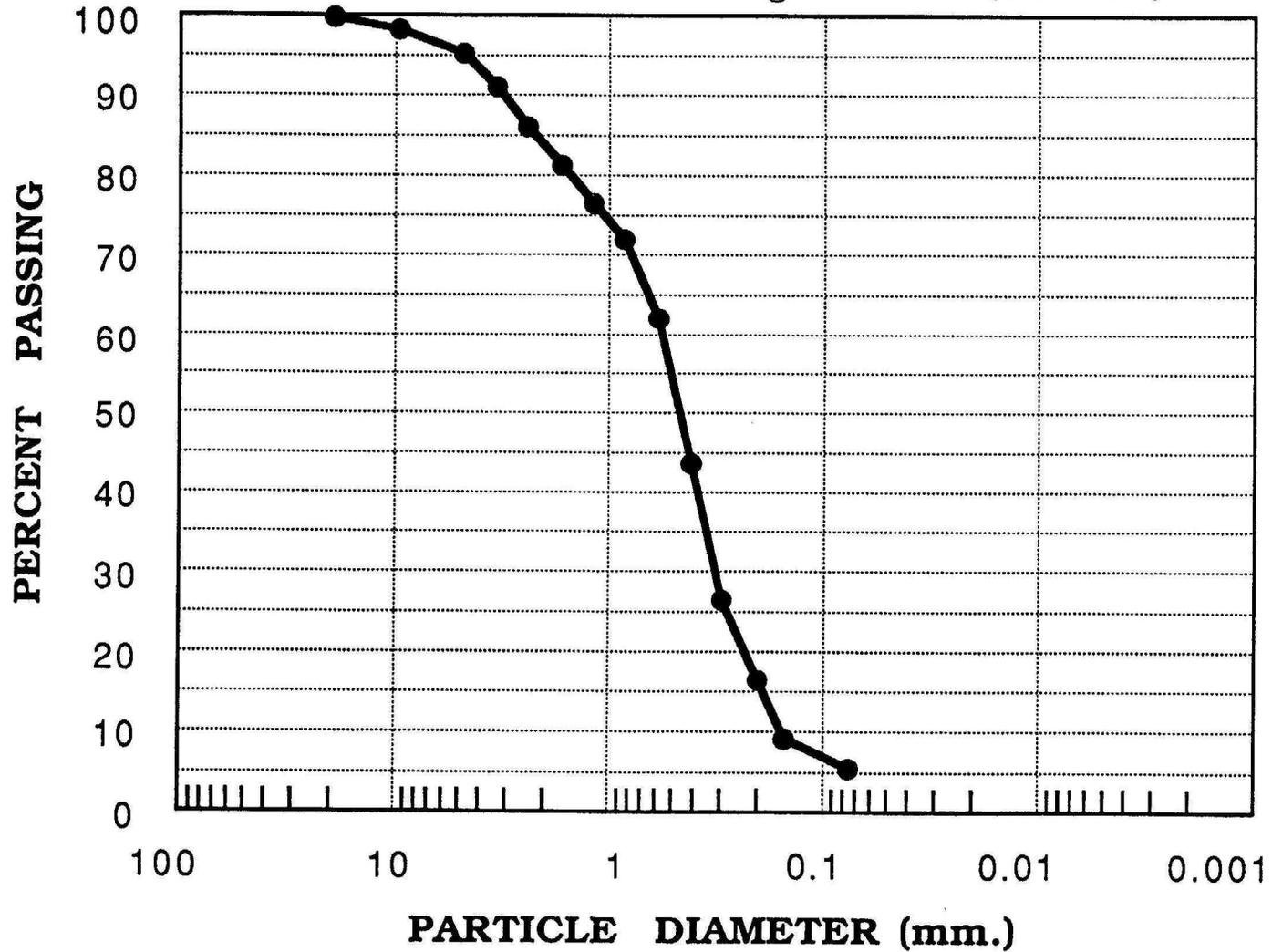
LINE # 4B1 N-S
USBR SITE # 36+00
SAMPLING DEPTH (ft.) 23-31

Particle Diameter @ 60% Passing = 0.42 MM.(0.017 IN.)



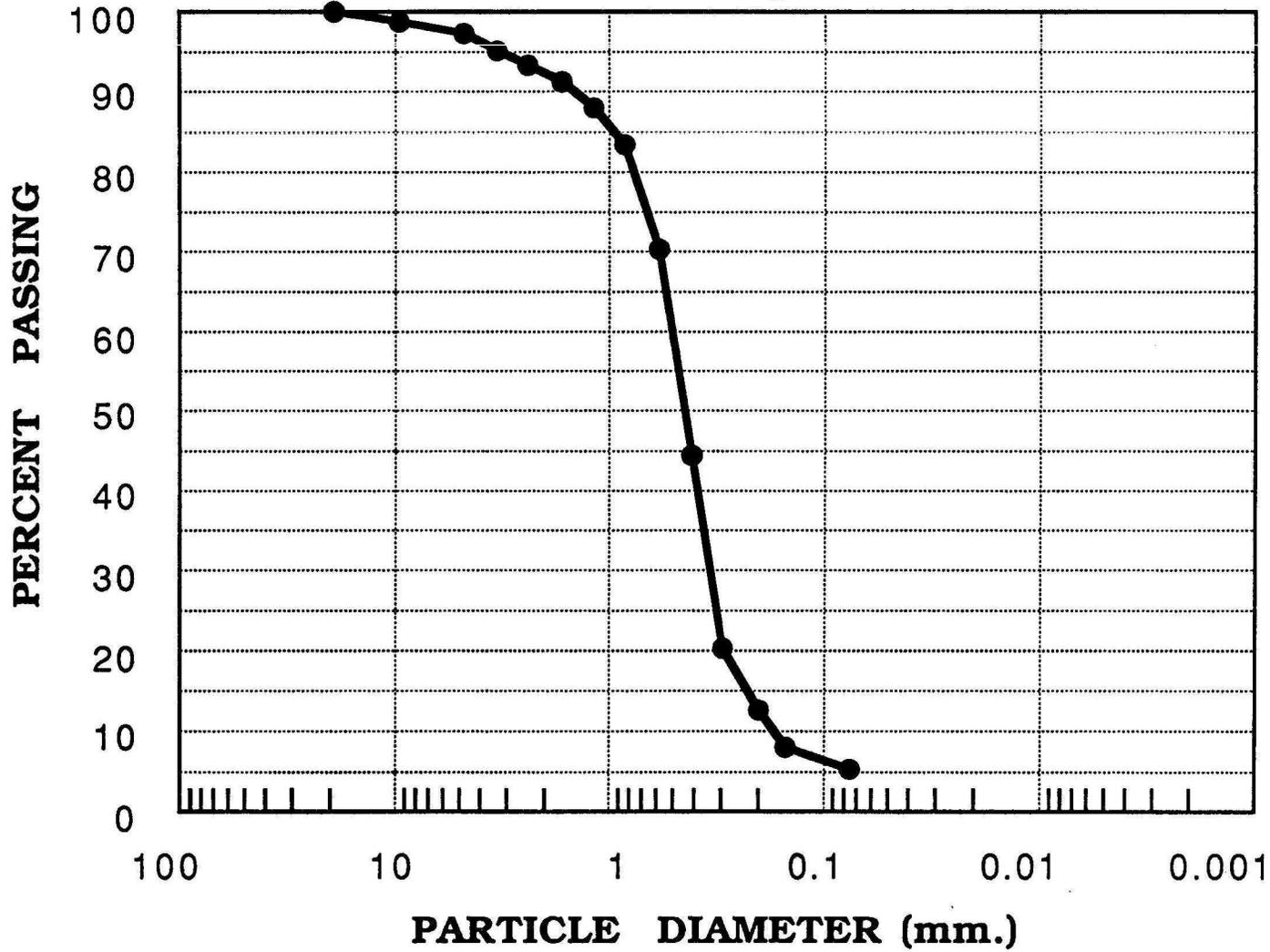
LINE # 4B1 N-S
USBR SITE # 36+00
SAMPLING DEPTH (ft.) 31-36

Particle Diameter @ 60% Passing = 0.55 MM.(0.022 IN.)



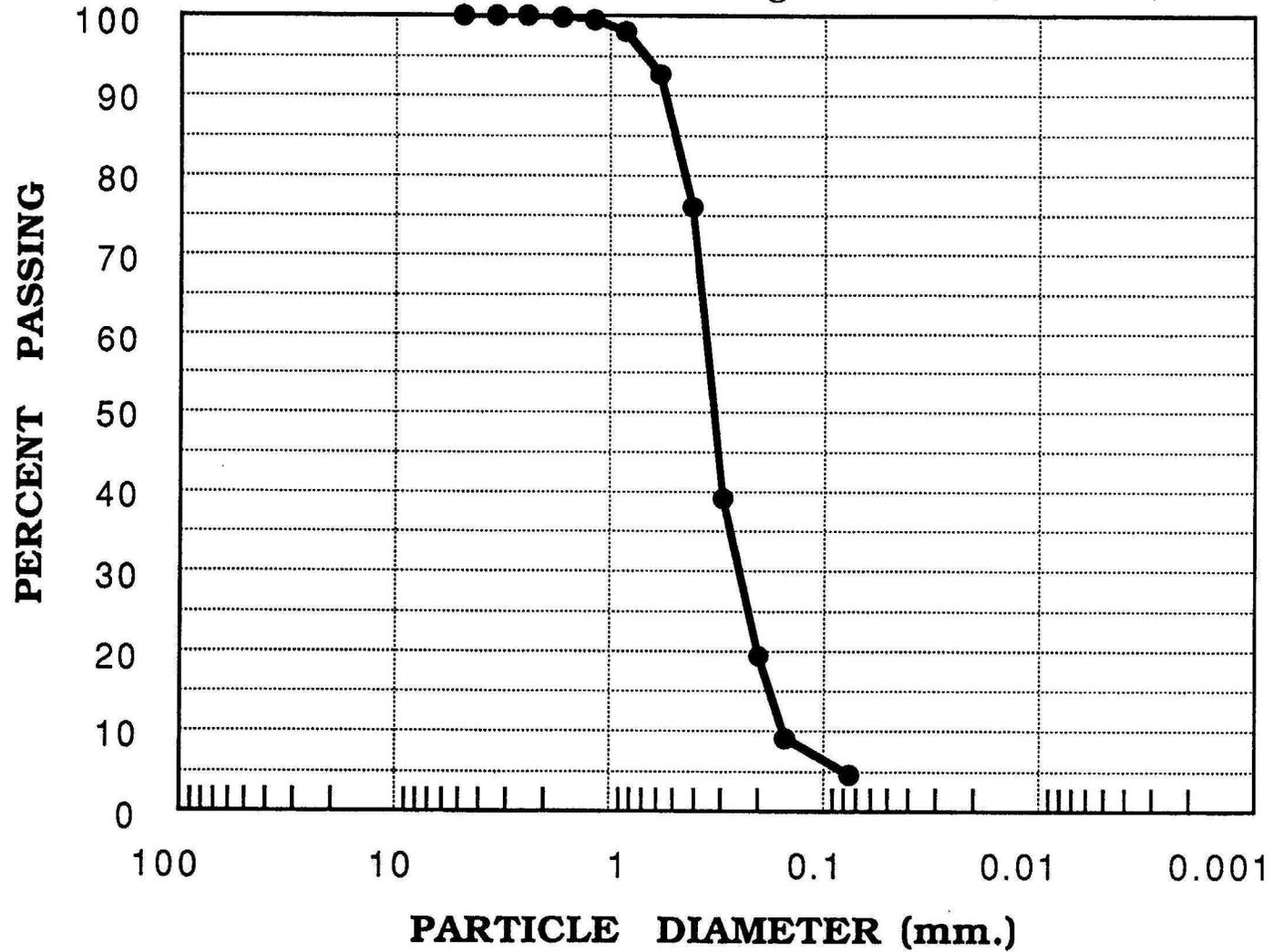
LINE # 4B1 N-S
USBR SITE # 36+00
SAMPLING DEPTH (ft.) 36-41

Particle Diameter @ 60% Passing = 0.55 MM.(0.022 IN.)



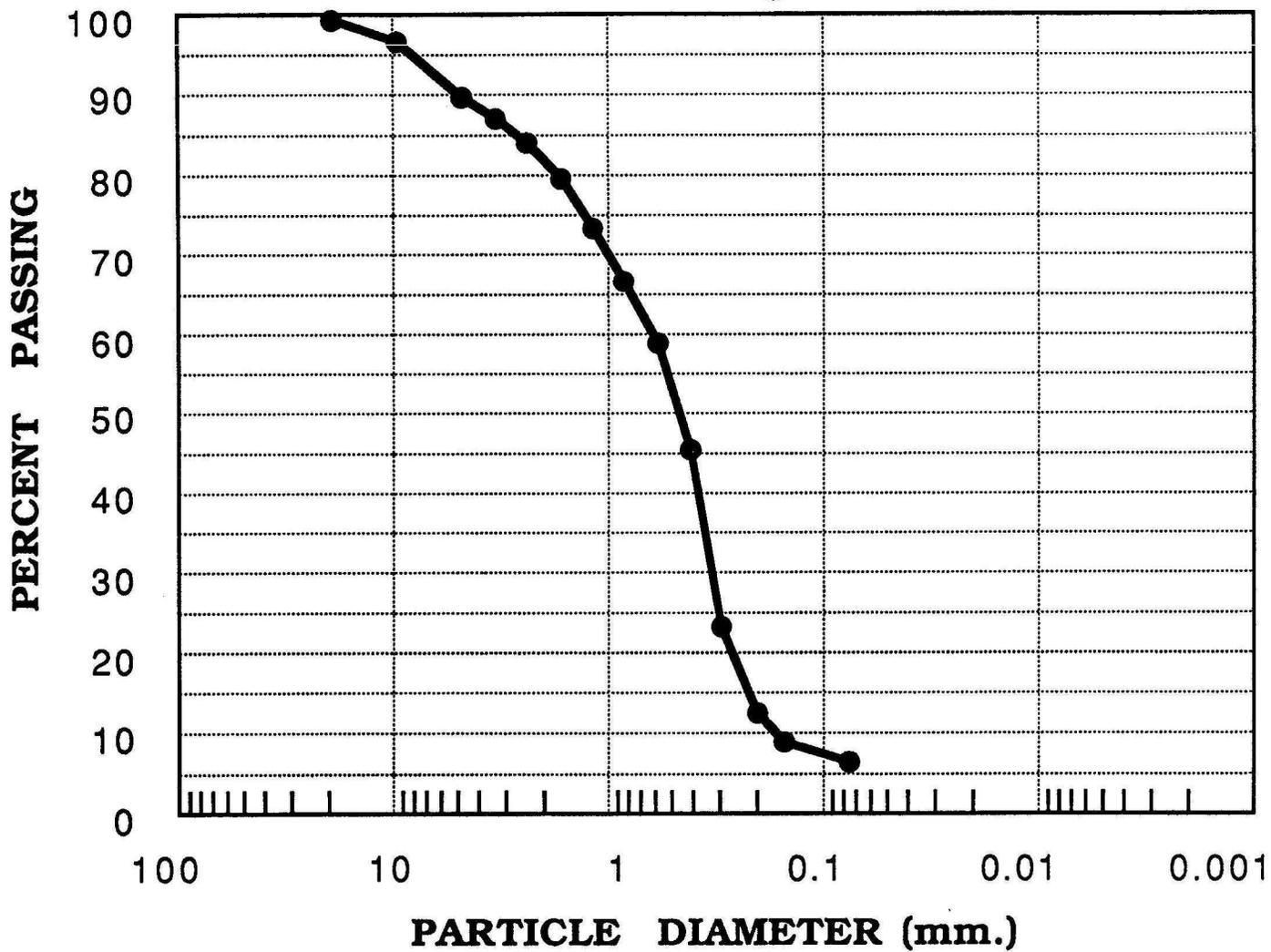
LINE # 4B1 N-S
USBR SITE # 38+00
SAMPLING DEPTH (ft.) 22-29.5

Particle Diameter @ 60% Passing = 0.35 MM.(0.014 IN.)



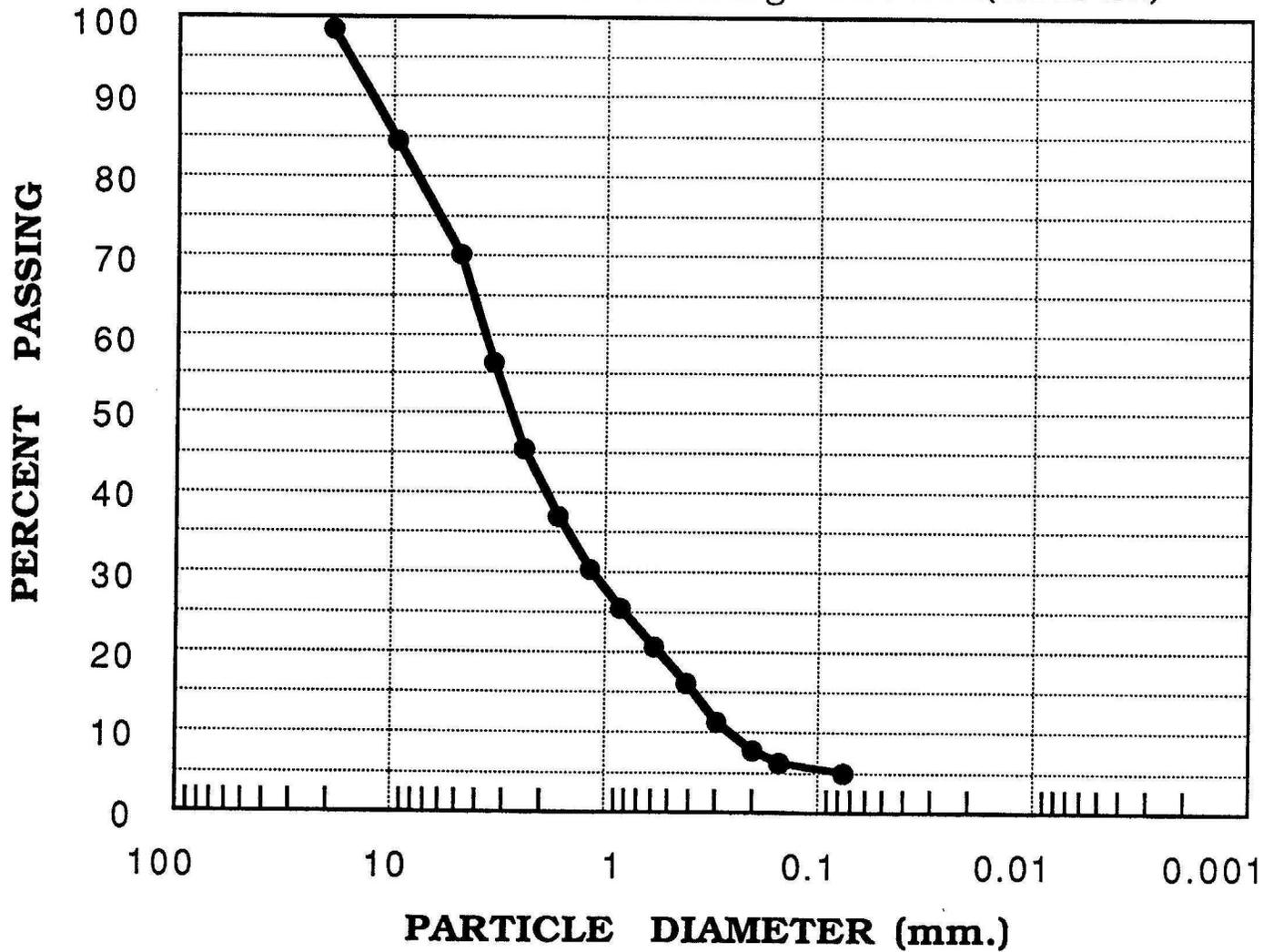
LINE # 4B1 N-S
USBR SITE # 38+00
SAMPLING DEPTH (ft.) 29.5-36

Particle Diameter @ 60% Passing = 0.60 MM.(0.024 IN.)



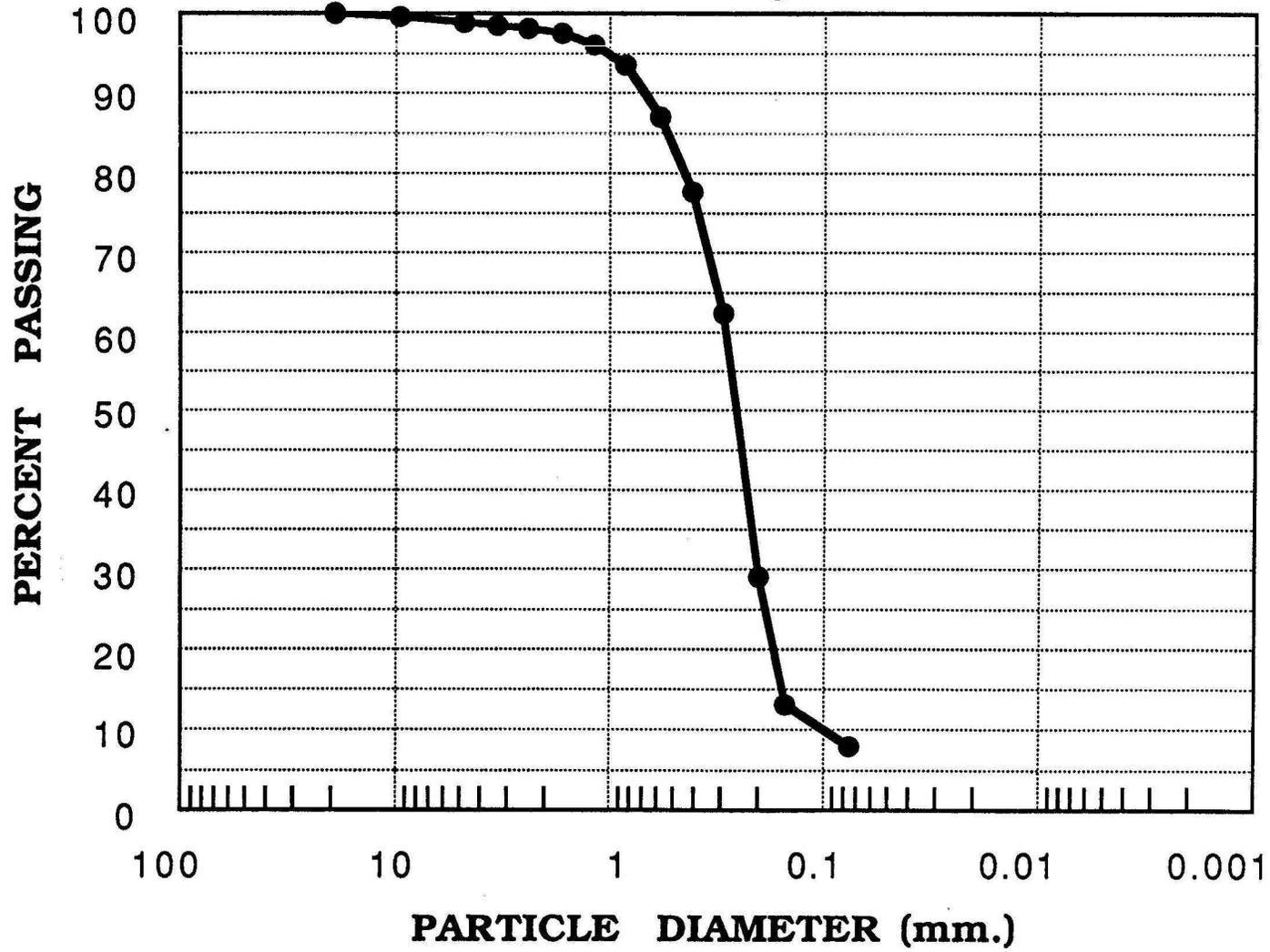
LINE # 4B1 N-S
USBR SITE # 40+00
SAMPLING DEPTH (ft.) 26.5-36.5

Particle Diameter @ 60% Passing = 3.76 MM.(0.148 IN.)



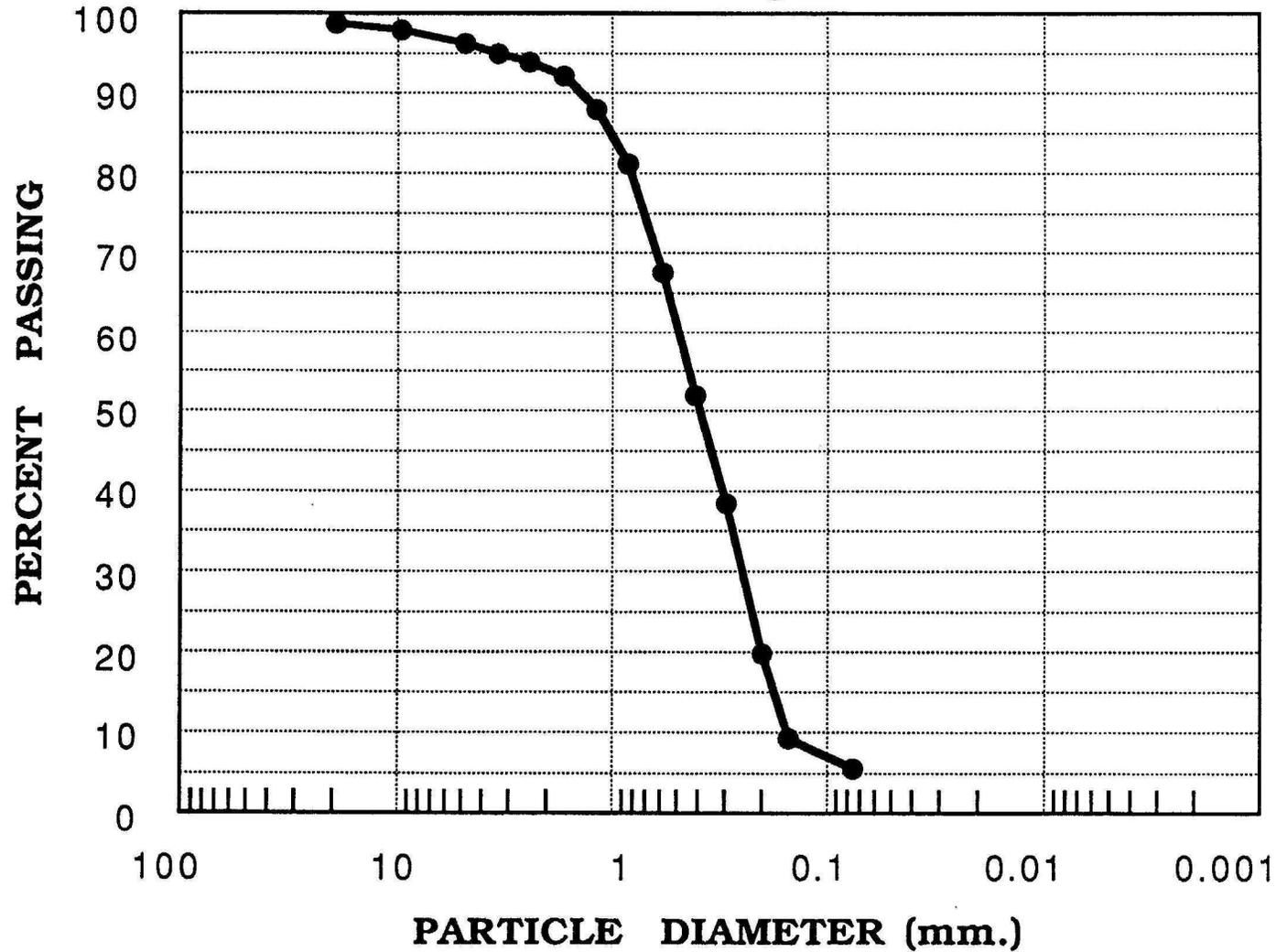
LINE # 4B1 N-S
USBR SITE # 44+00
SAMPLING DEPTH (ft.) 18-23

Particle Diameter @ 60% Passing = 0.29 MM.(0.011 IN.)



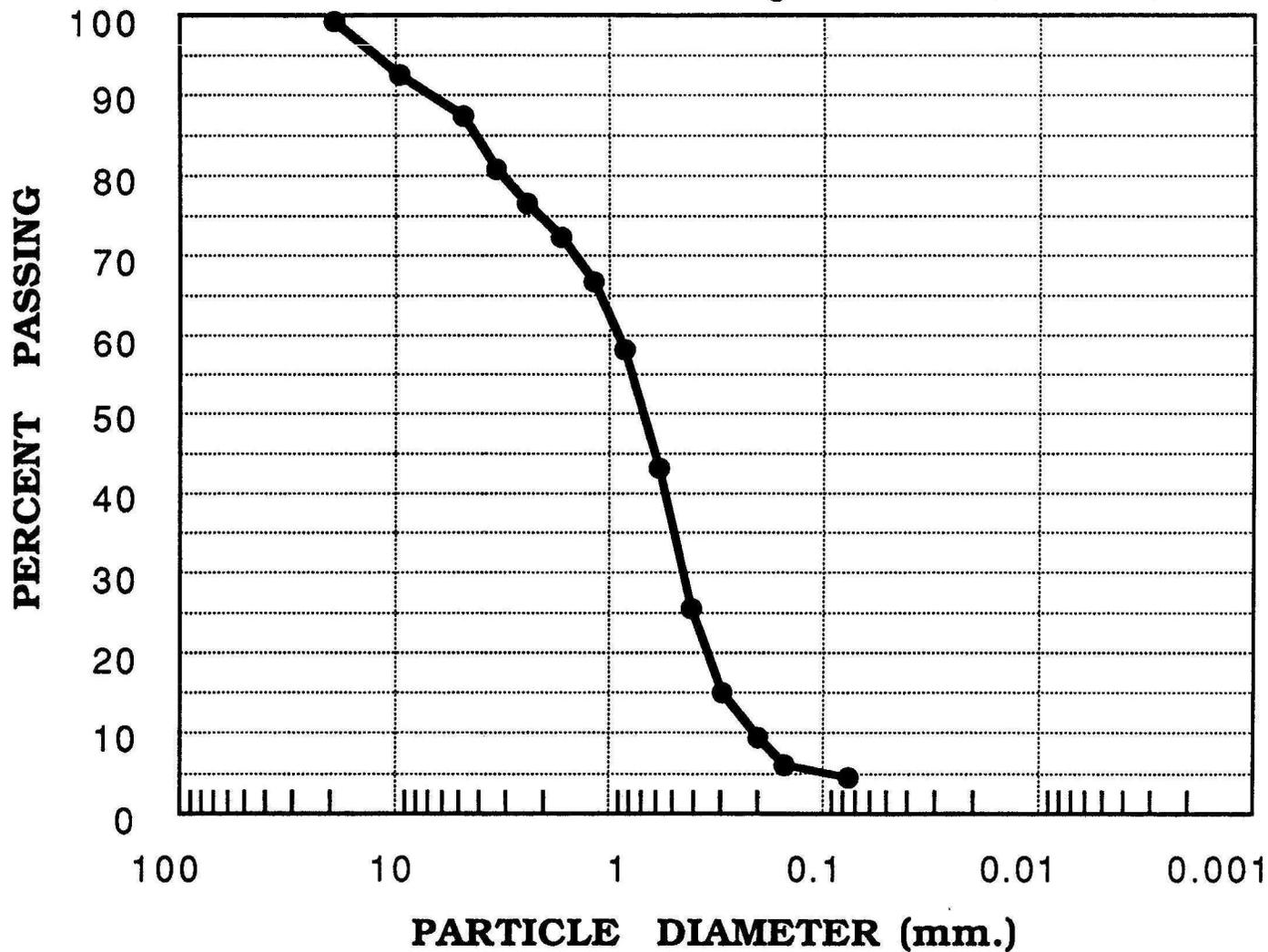
LINE # 4B1 N-S
USBR SITE # 44+00
SAMPLING DEPTH (ft.) 23-28

Particle Diameter @ 60% Passing = 0.48 MM. (0.019 IN.)



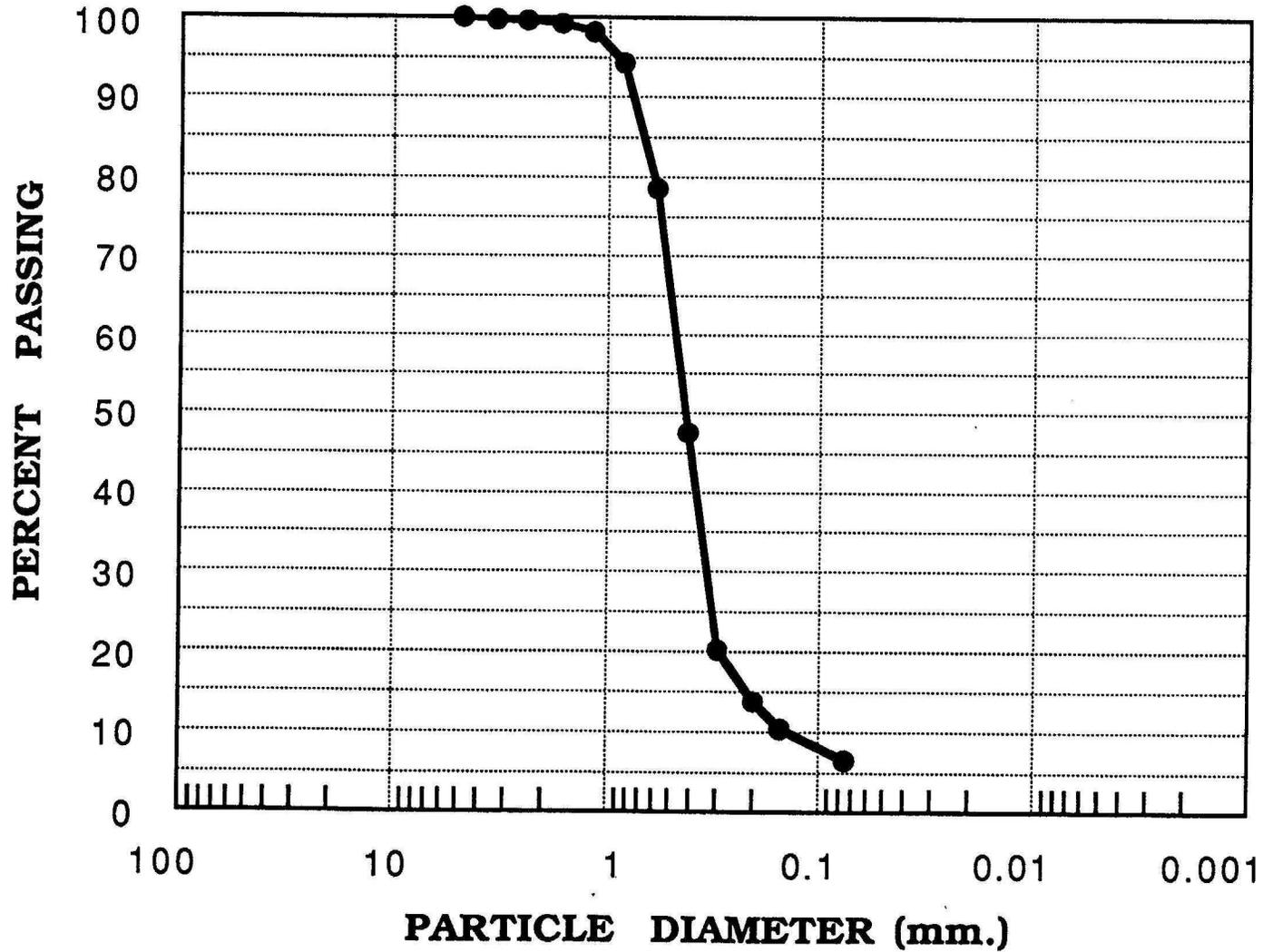
LINE # 4B1 N-S
USBR SITE # 44+00
SAMPLING DEPTH (ft.) 28-35.5

Particle Diameter @ 60% Passing = 0.87 MM.(0.034 IN.)



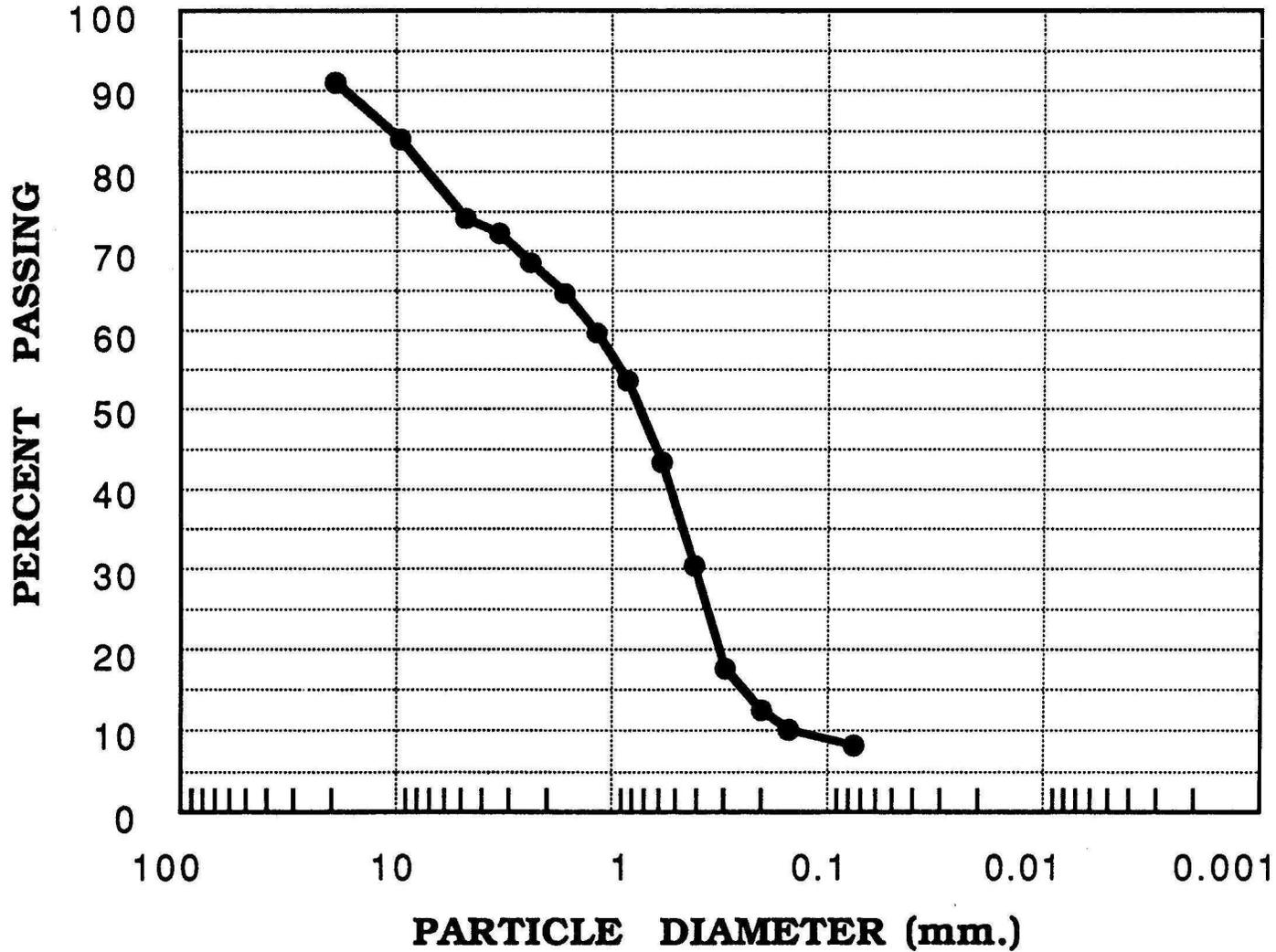
LINE # 4BLAT N-S
USBR SITE # 34+00
SAMPLING DEPTH (ft.) 13-30

Particle Diameter @ 60% Passing = 0.48 mm.(0.019 in.)



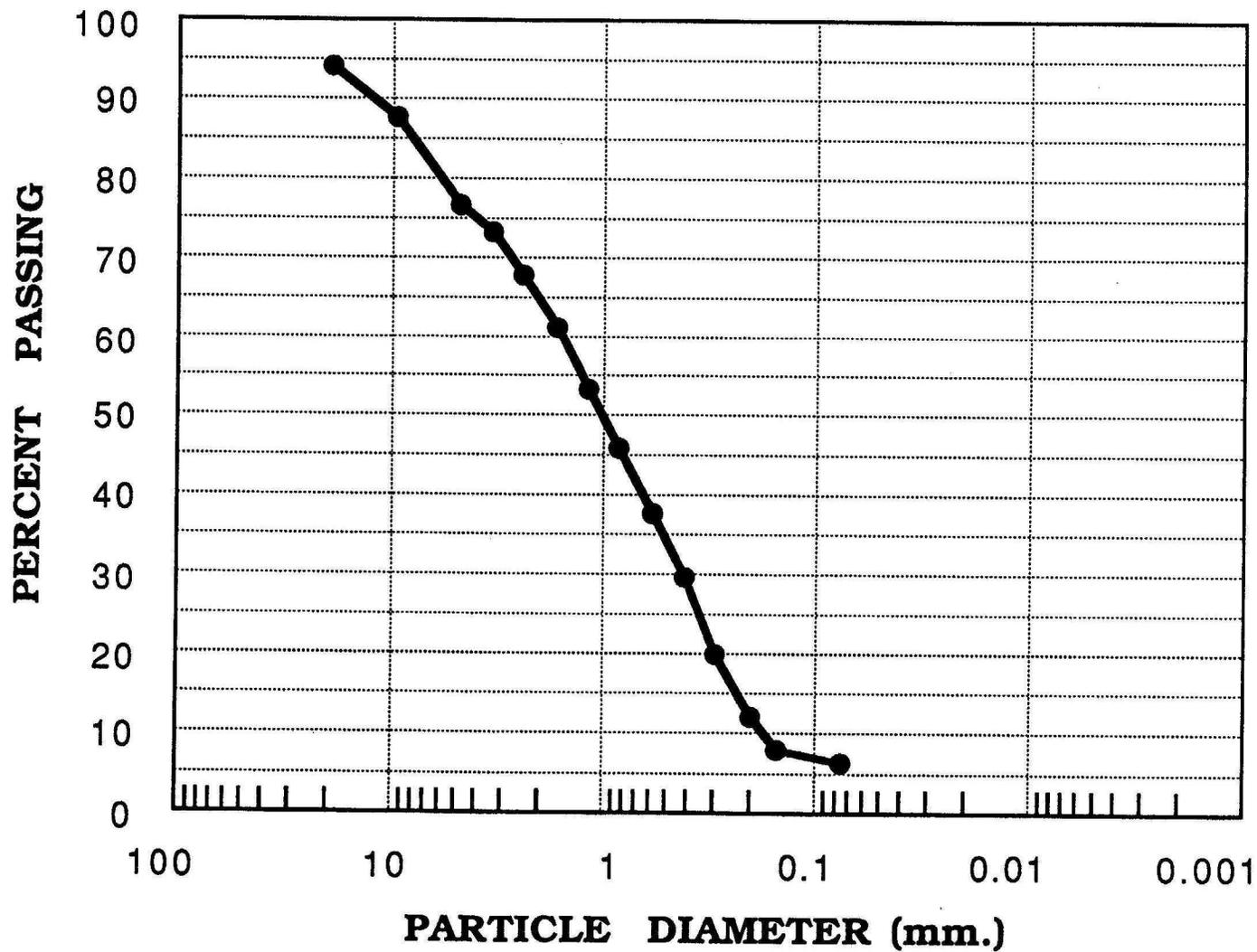
LINE # 4BLAT N-S
USBR SITE # 34+00
SAMPLING DEPTH (ft.) 30-36

Particle Diameter @ 60% Passing = 1.15 mm.(0.045 in.)



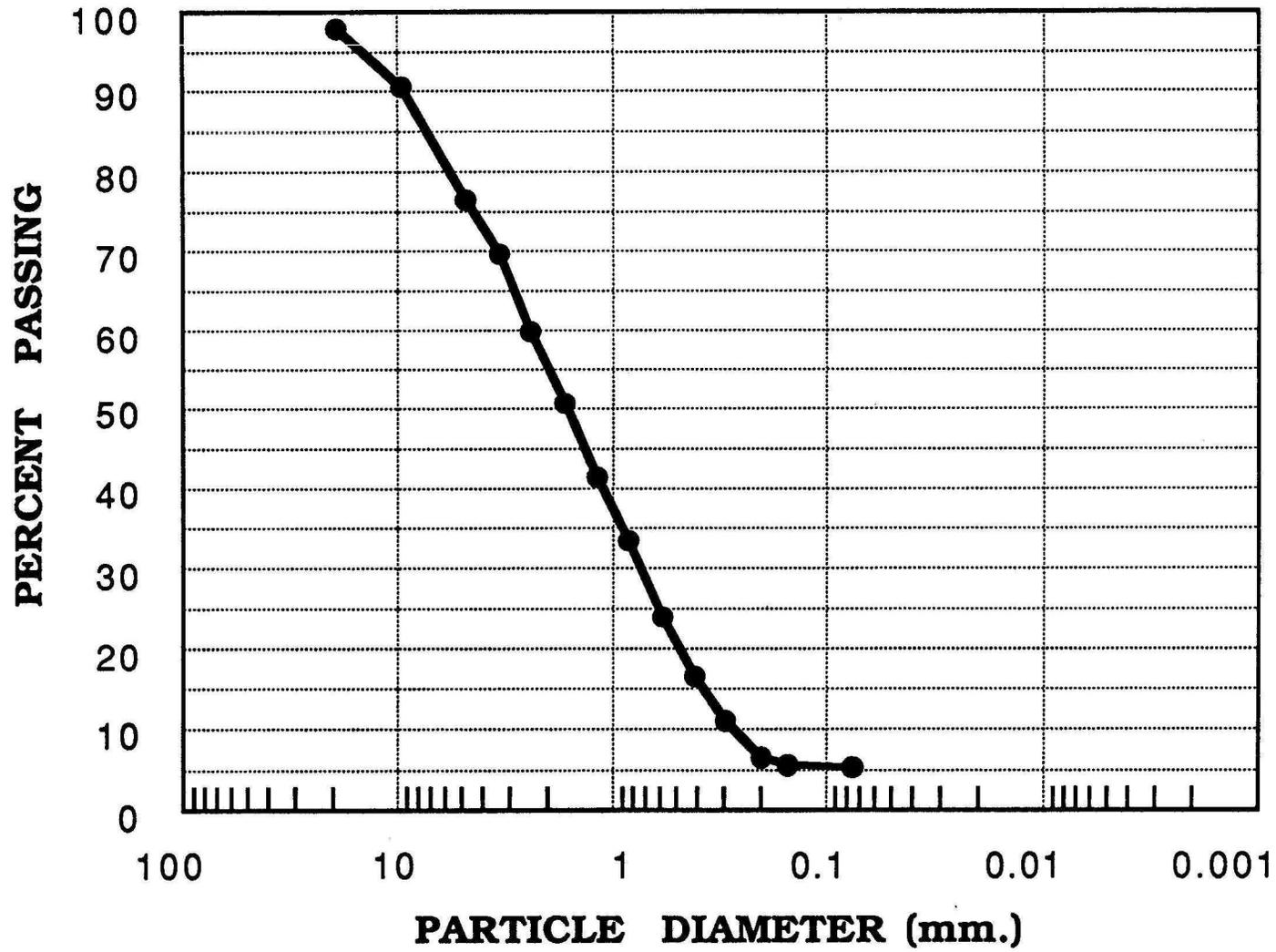
LINE # 4BLAT N-S
USBR SITE # 38+00
SAMPLING DEPTH (ft.) 27-42.5

Particle Diameter @ 60% Passing = 1.58 mm.(0.062 in.)



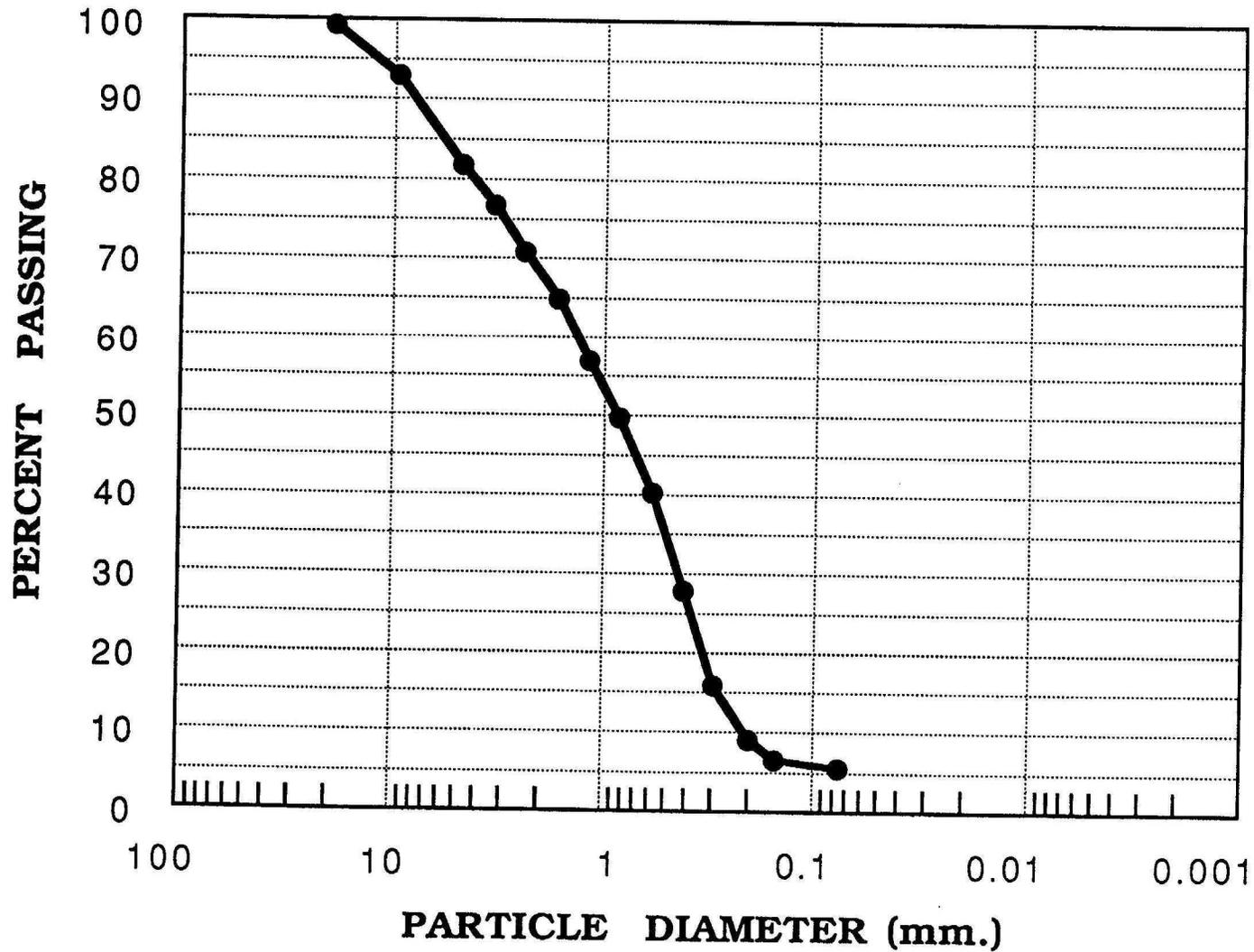
LINE # 4BLAT N-S
USBR SITE # 42+00
SAMPLING DEPTH (ft.) 27-36

Particle Diameter @ 60% Passing = 2.49 mm.(0.098 in.)



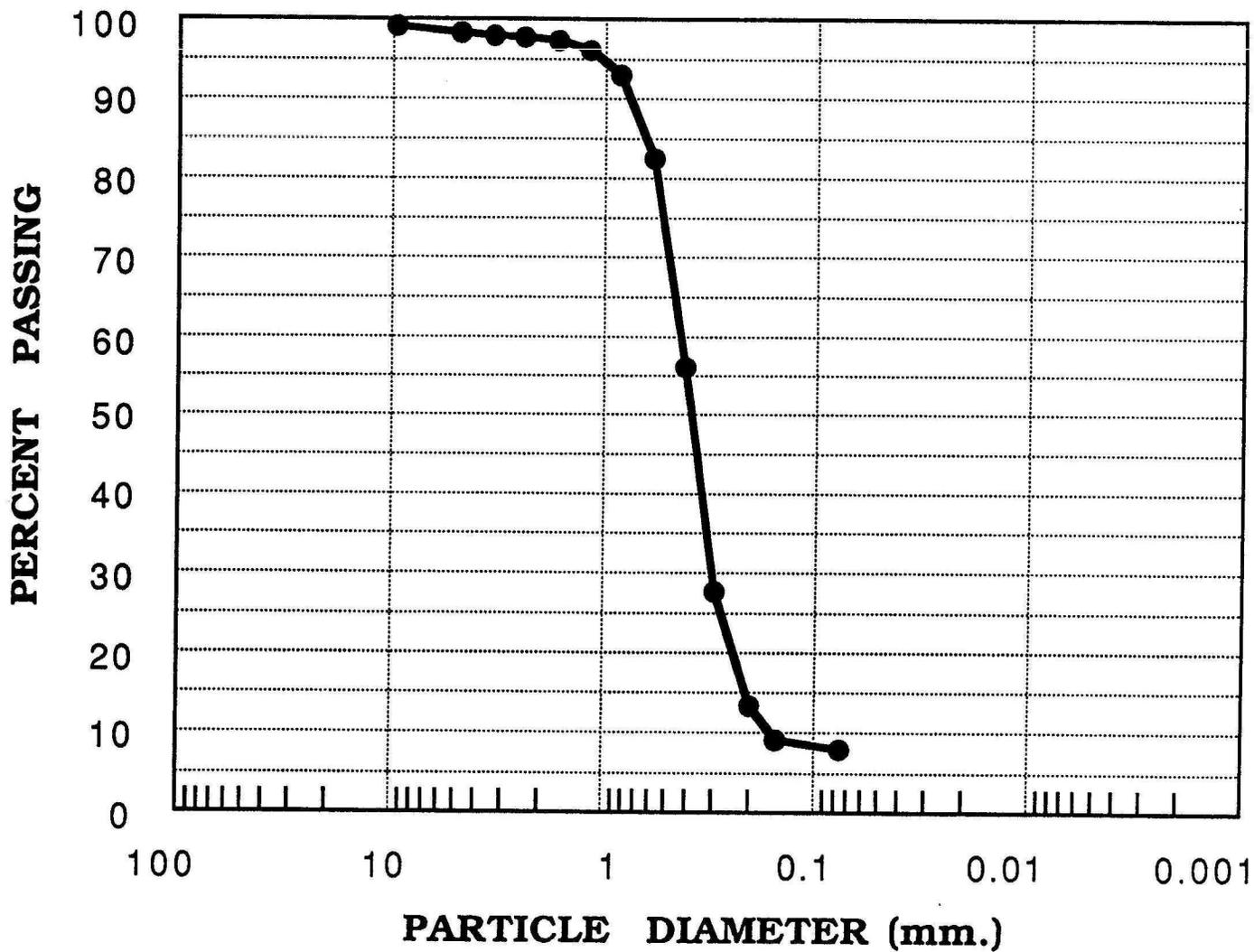
LINE # 4C N-S
USBR SITE # 46+27
SAMPLING DEPTH (ft.) 23-33

Particle Diameter @ 60% Passing = 1.31 mm.(0.052 in.)



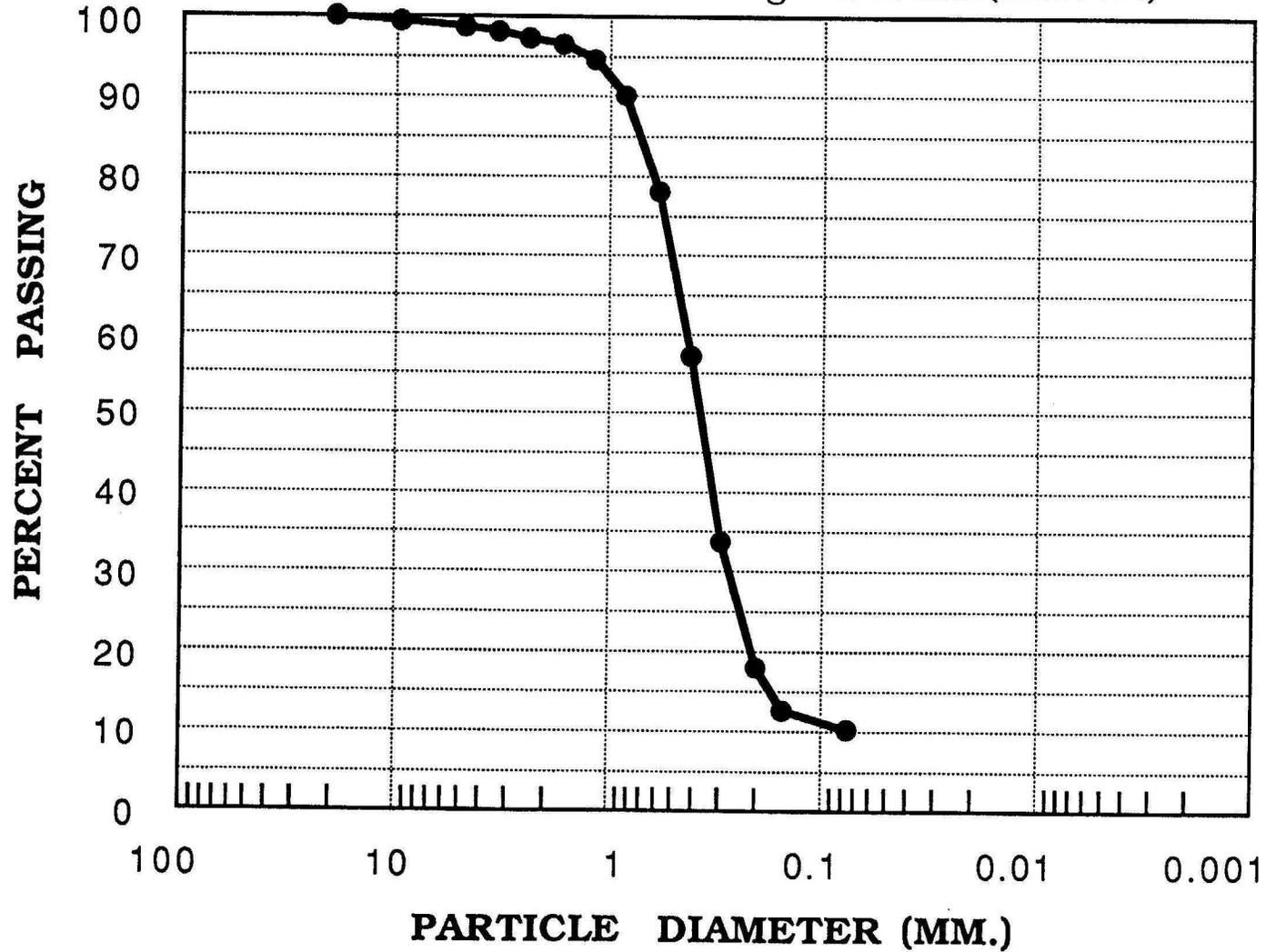
LINE # 4C N-S
USBR SITE # 46+27
SAMPLING DEPTH (ft.) 13.5-23

Particle Diameter @ 60% Passing = 0.42 mm.(0.017 in.)



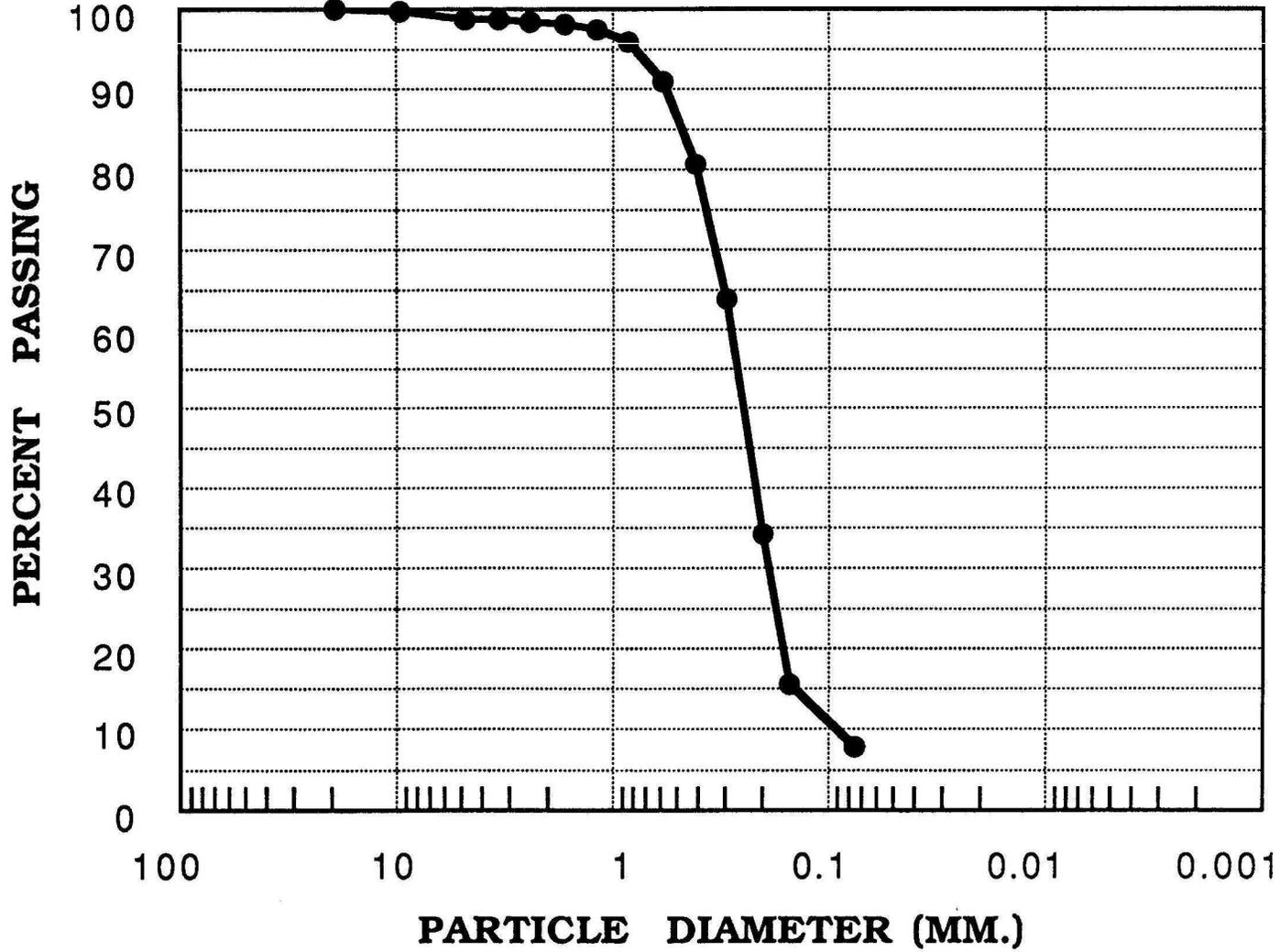
LINE # 4C N-S
USBR SITE # 48+00
SAMPLING DEPTH (ft.) 13-18

Particle Diameter @ 60% Passing = 0.44 mm.(0.017 in.)



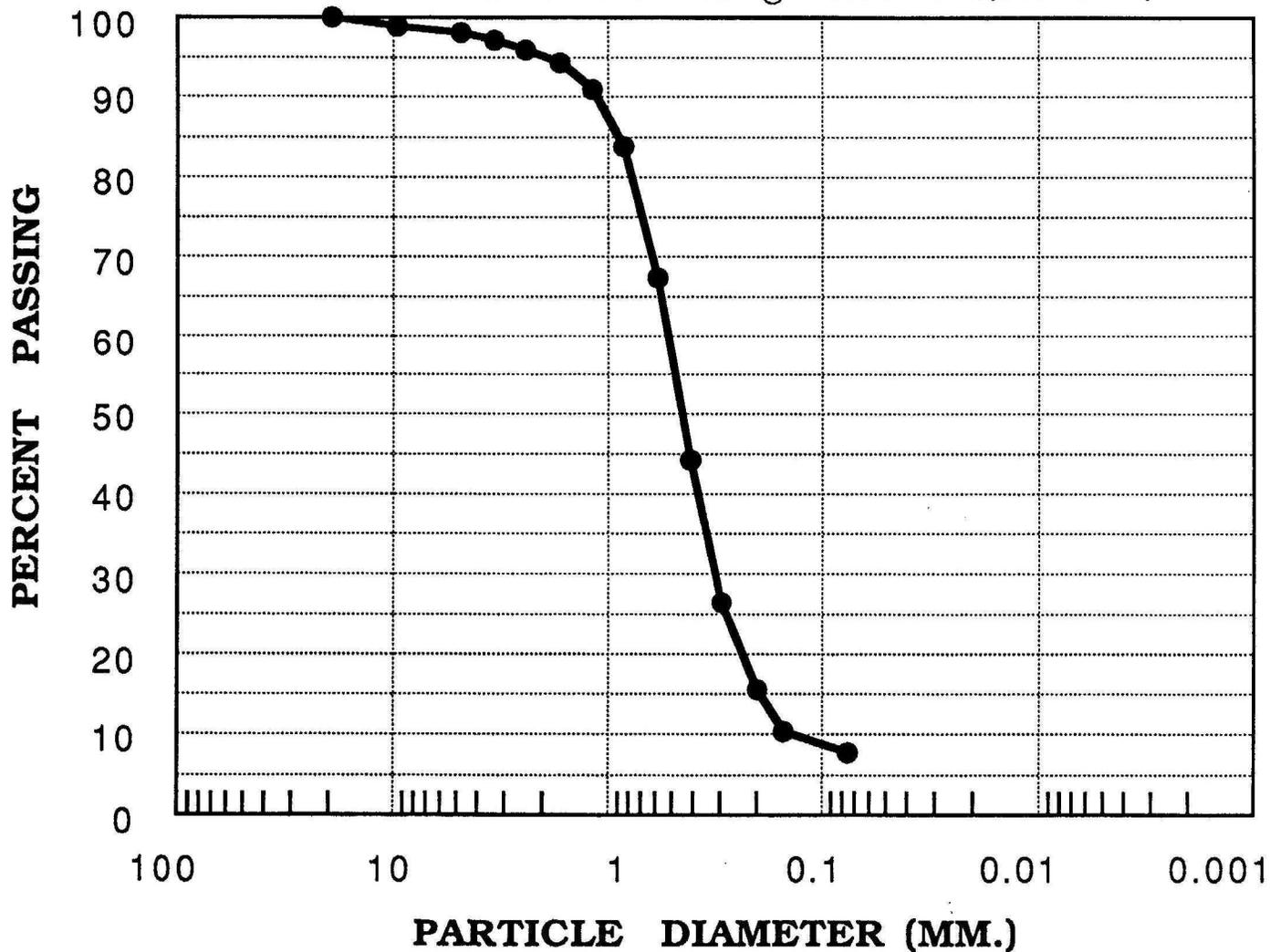
LINE # 4C N-S
USBR SITE # 48+00
SAMPLING DEPTH (ft.) 18-23

Particle Diameter @ 60% Passing = 0.28 mm.(0.011 in.)



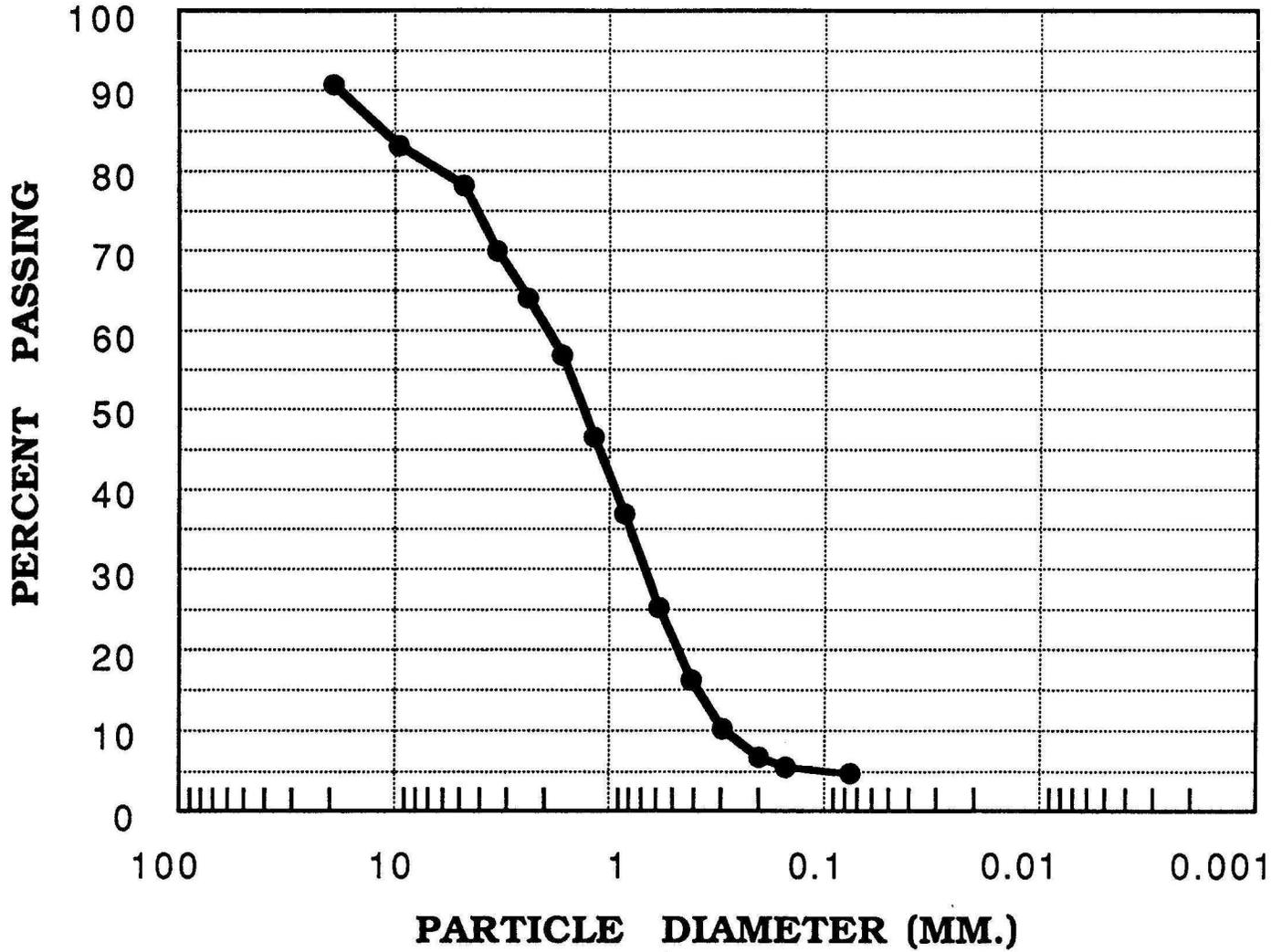
LINE # 4C N-S
USBR SITE # 48+00
SAMPLING DEPTH (ft.) 23-27.5

Particle Diameter @ 60% Passing = 0.50 mm.(0.020 in.)



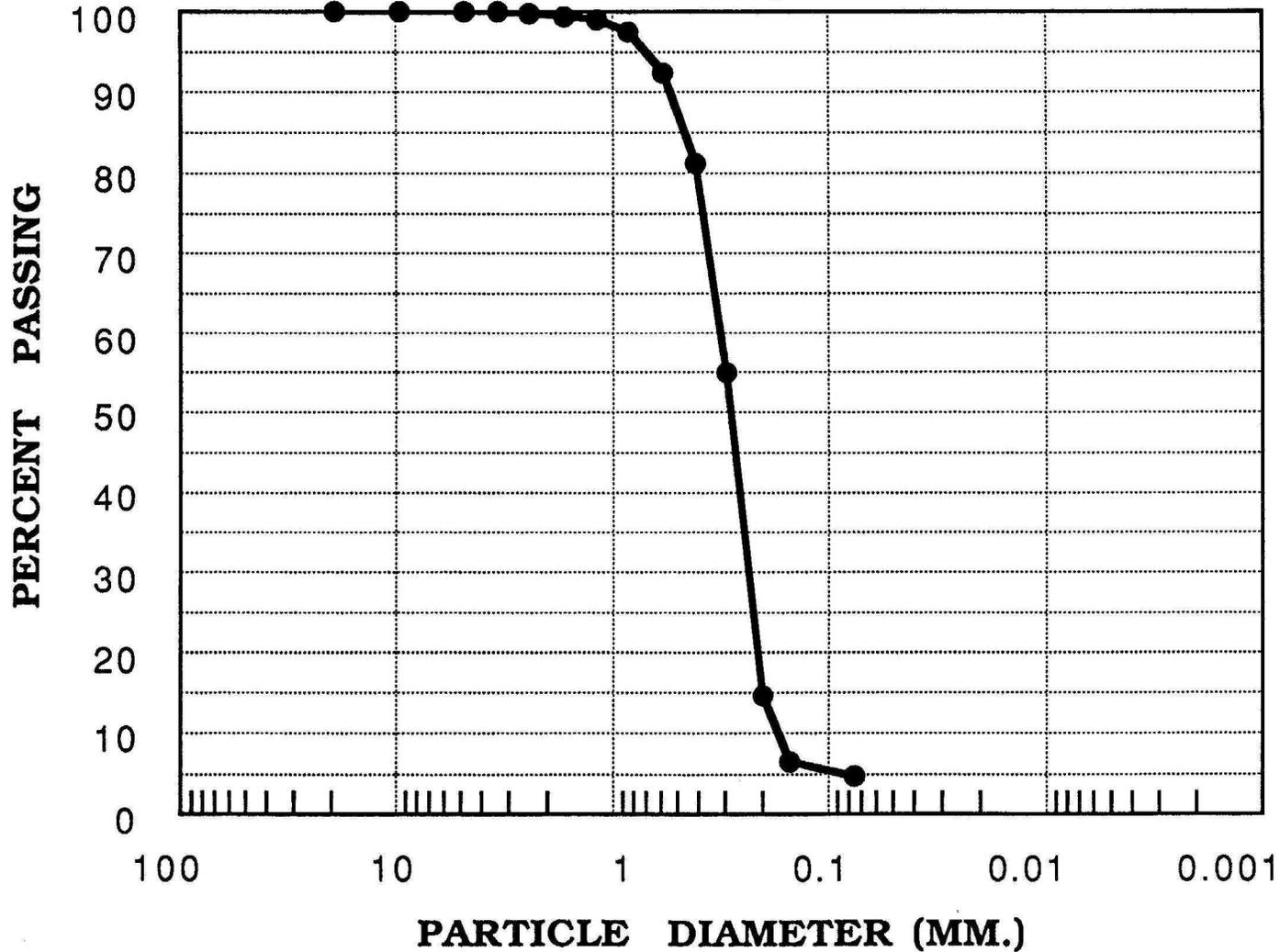
LINE # 4C N-S
USBR SITE # 48+00
SAMPLING DEPTH (ft.) 27.5-33.5

Particle Diameter @ 60% Passing = 1.90 mm.(0.075 in.)



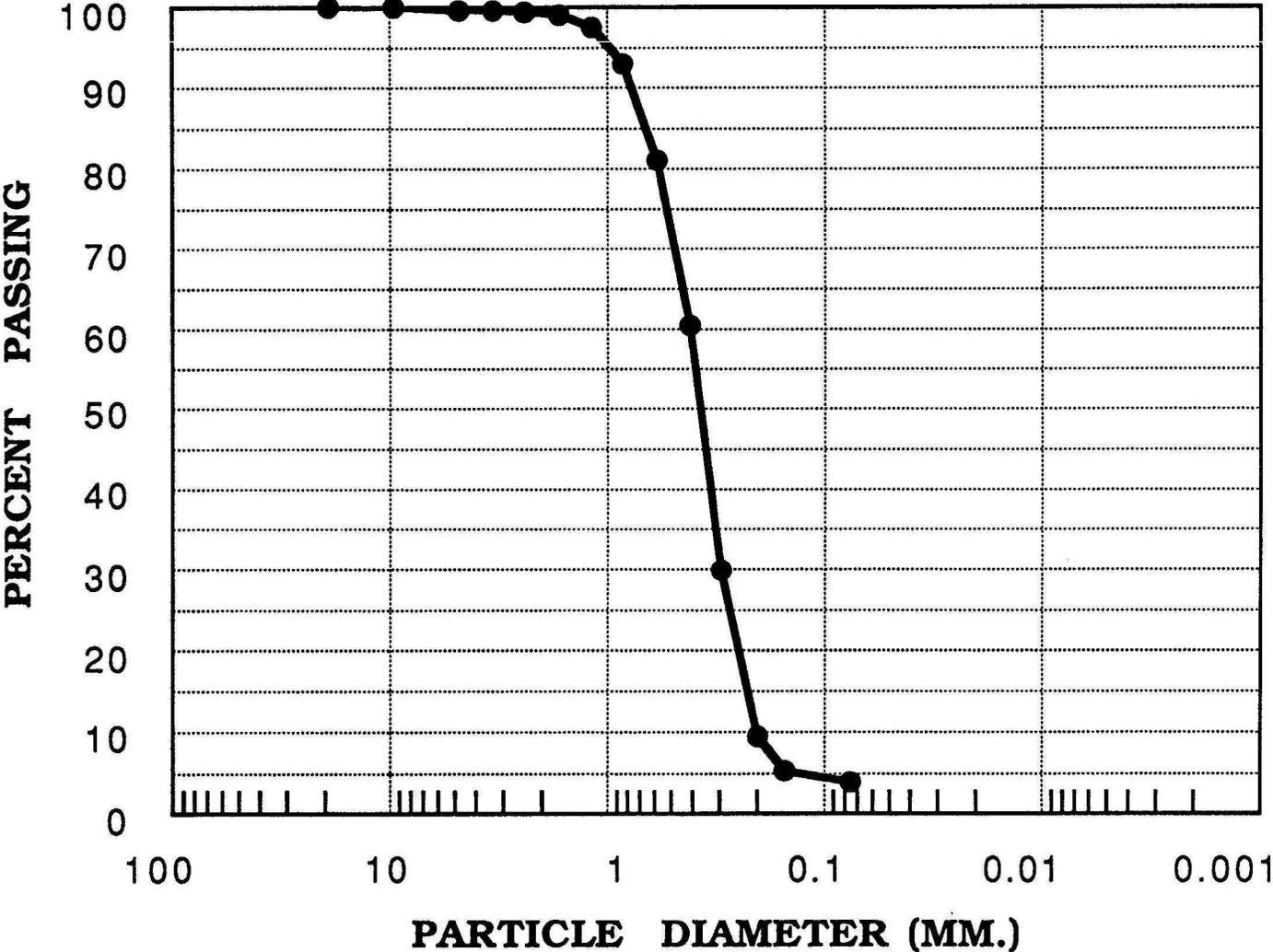
LINE # 4C N-S
USBR SITE #50+00
SAMPLING DEPTH (ft.) 20-25

Particle Diameter @ 60% Passing = 0.32 mm.(0.013 in.)



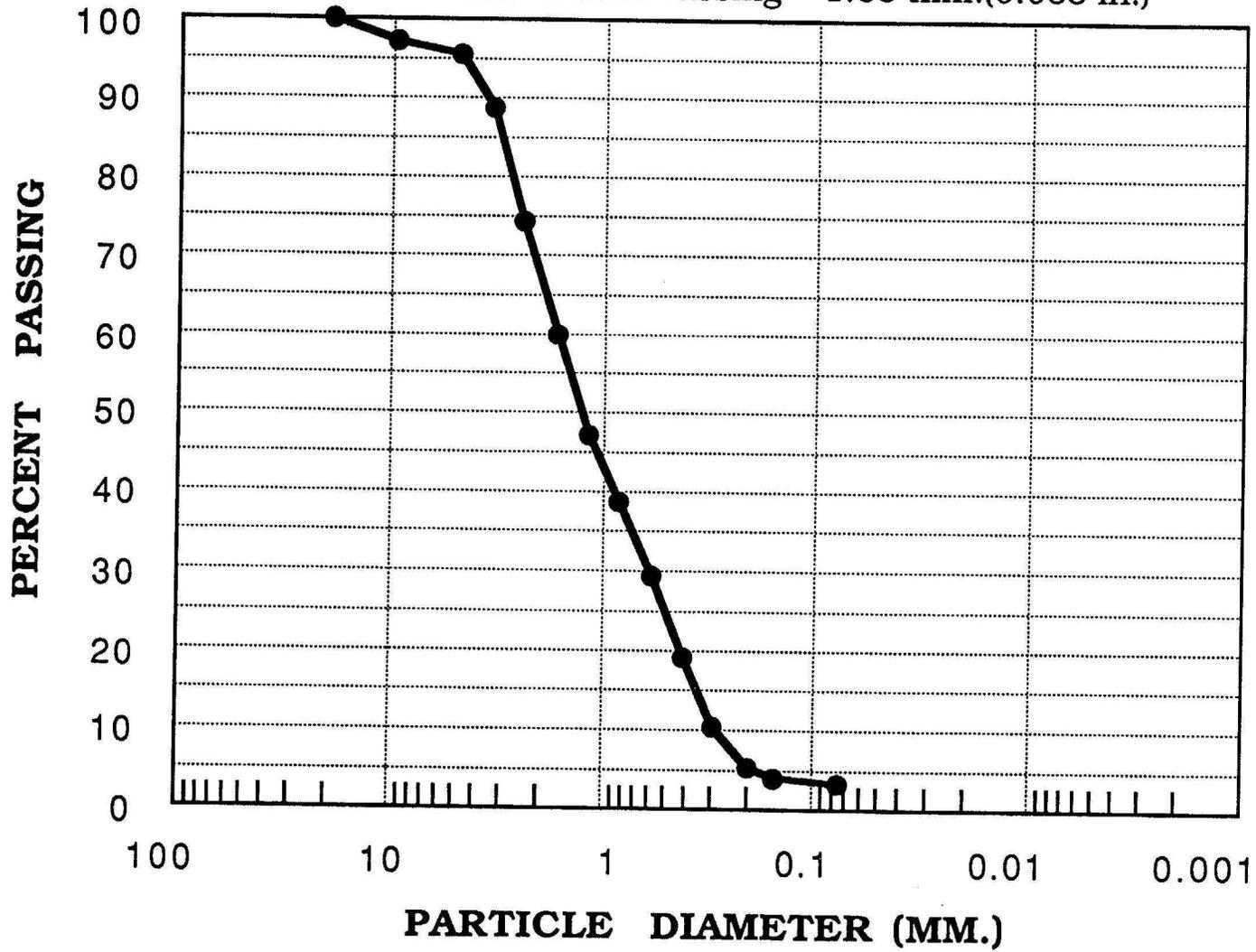
LINE # 4C N-S
USBR SITE #50+00
SAMPLING DEPTH (ft.) 25-30

Particle Diameter @ 60% Passing = 0.42 mm.(0.017 in.)



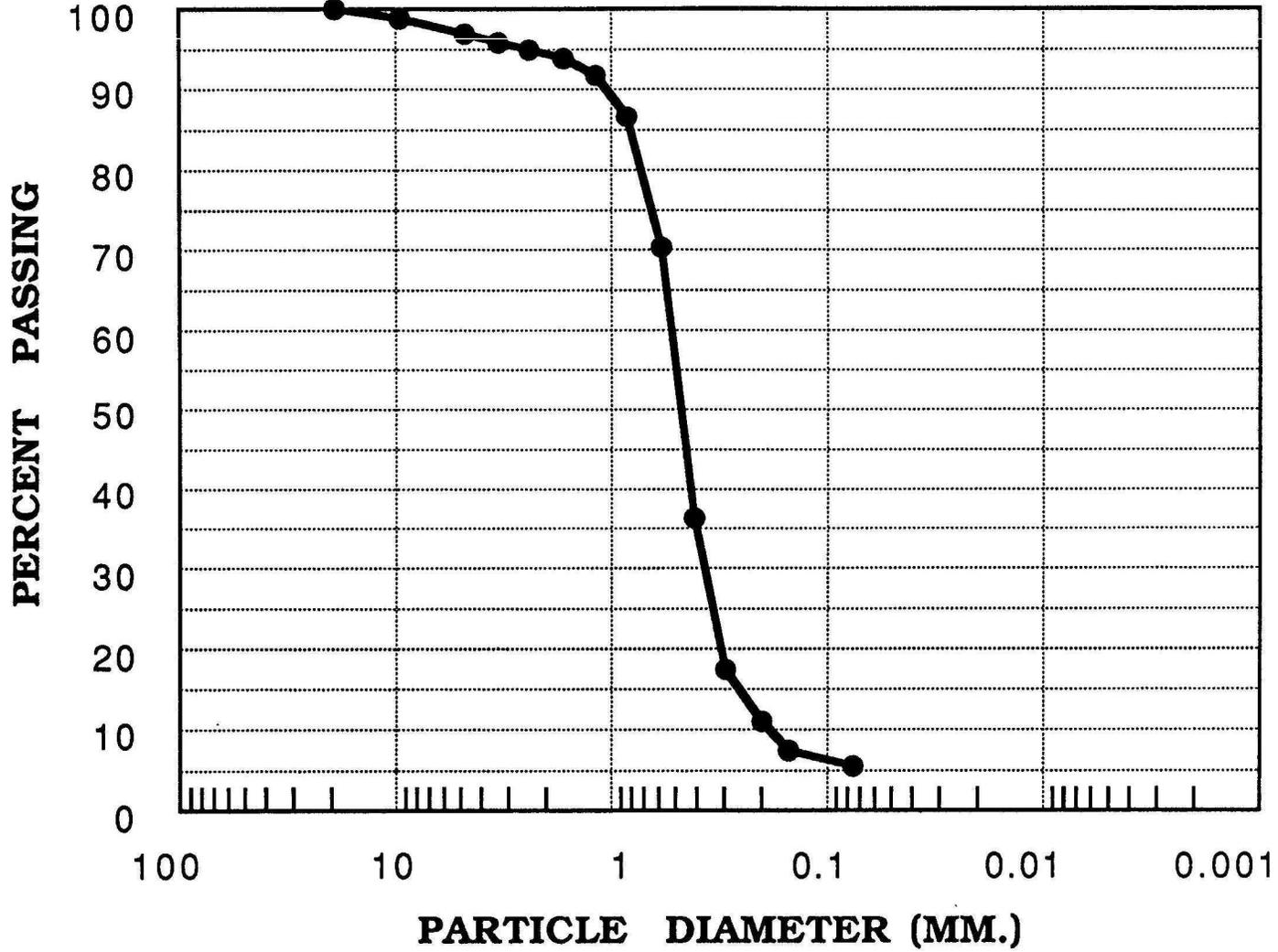
LINE # 4C N-S
USBR SITE #50+00
SAMPLING DEPTH (ft.) 30-35

Particle Diameter @ 60% Passing = 1.65 mm.(0.065 in.)



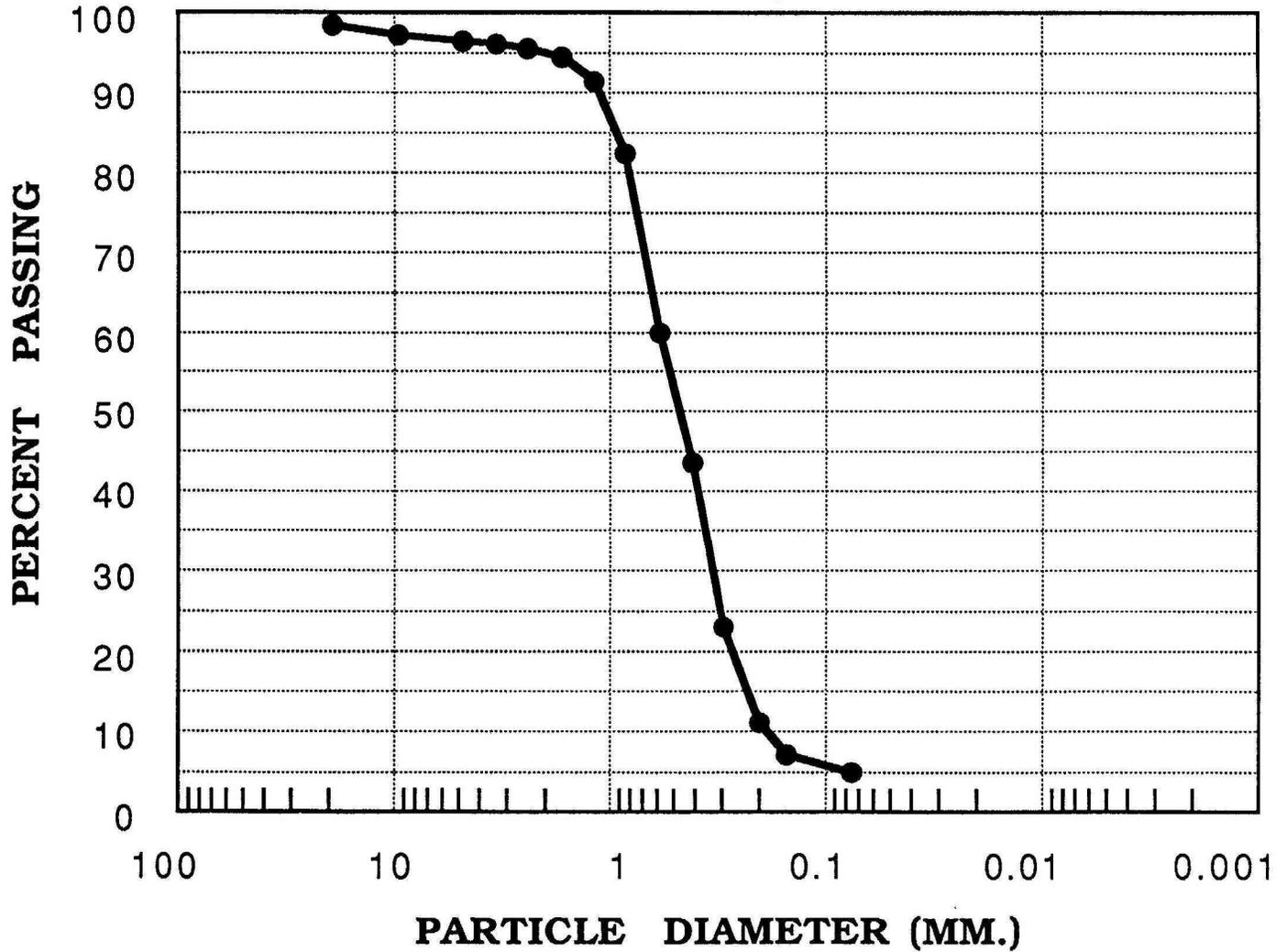
LINE # 4C N-S
USBR SITE #52+00
SAMPLING DEPTH (ft.) 10-22

Particle Diameter @ 60% Passing = 0.53 mm.(0.021 in.)



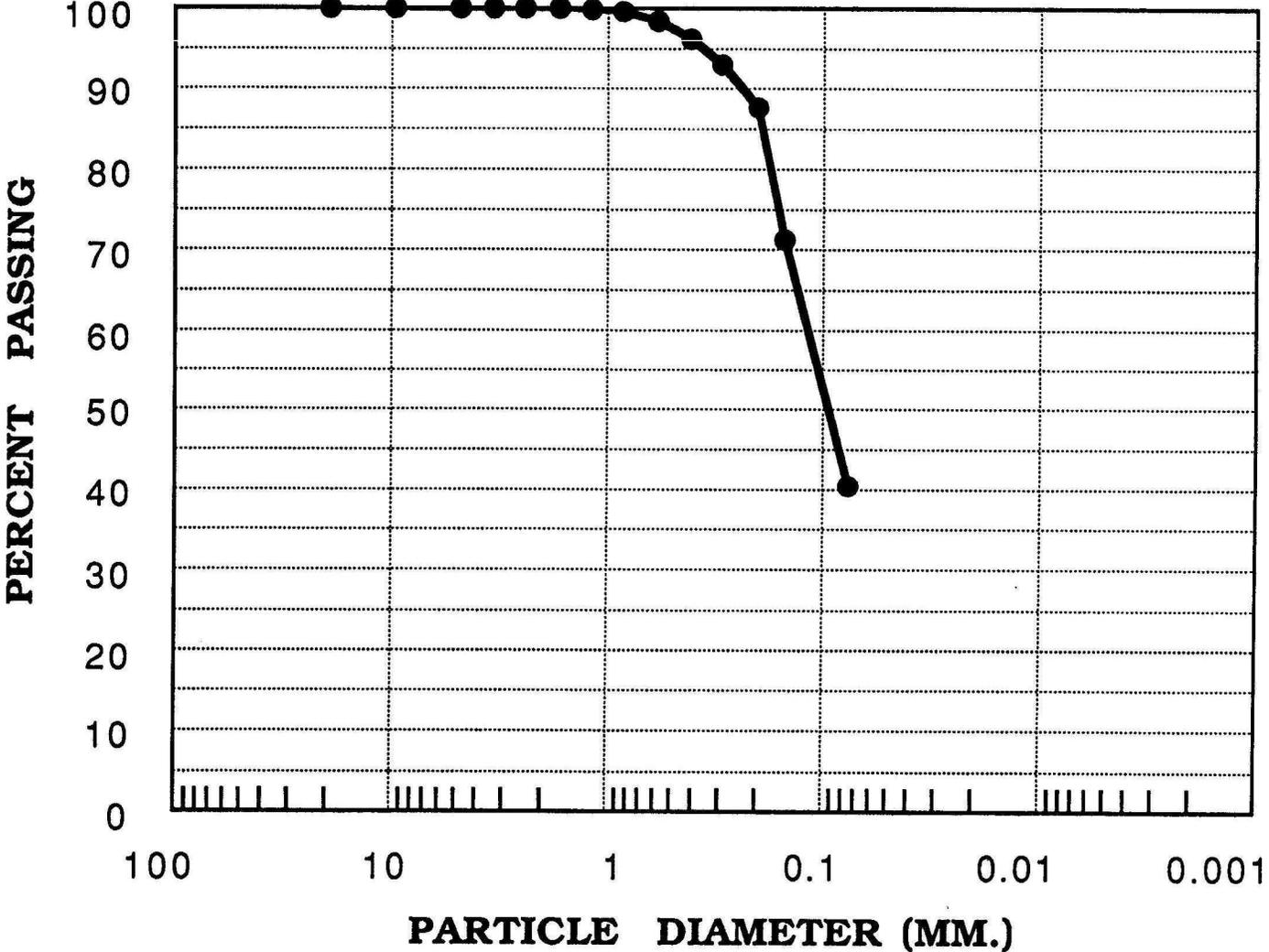
LINE # 4C N-S
USBR SITE #56+00
SAMPLING DEPTH (ft.) 12-19

Particle Diameter @ 60% Passing = 0.58 mm.(0.023 in.)



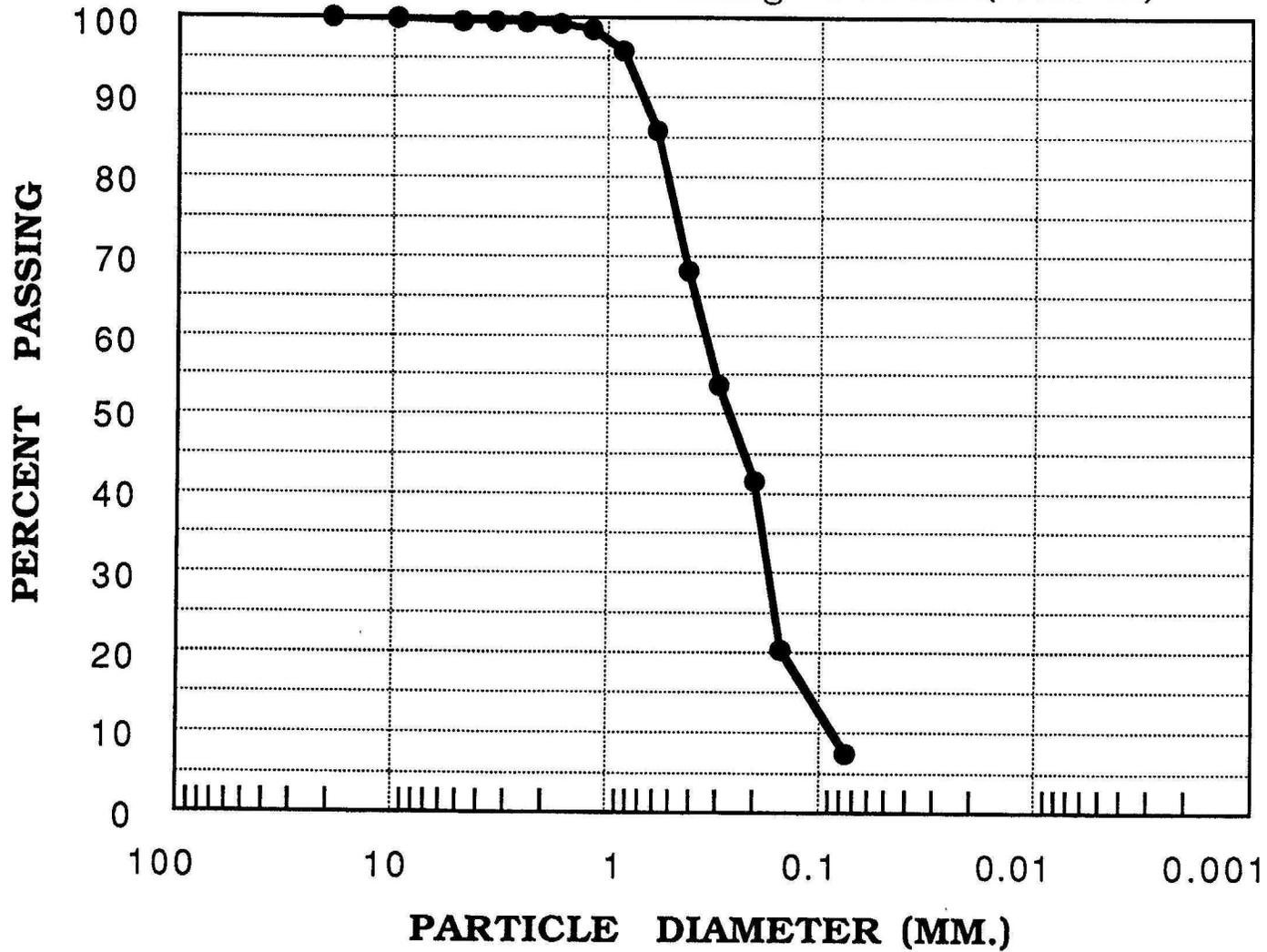
LINE # 4C N-S
USBR SITE #60+00
SAMPLING DEPTH (ft.) 9-14

Particle Diameter @ 60% Passing = 0.11 mm.(0.004 in.)



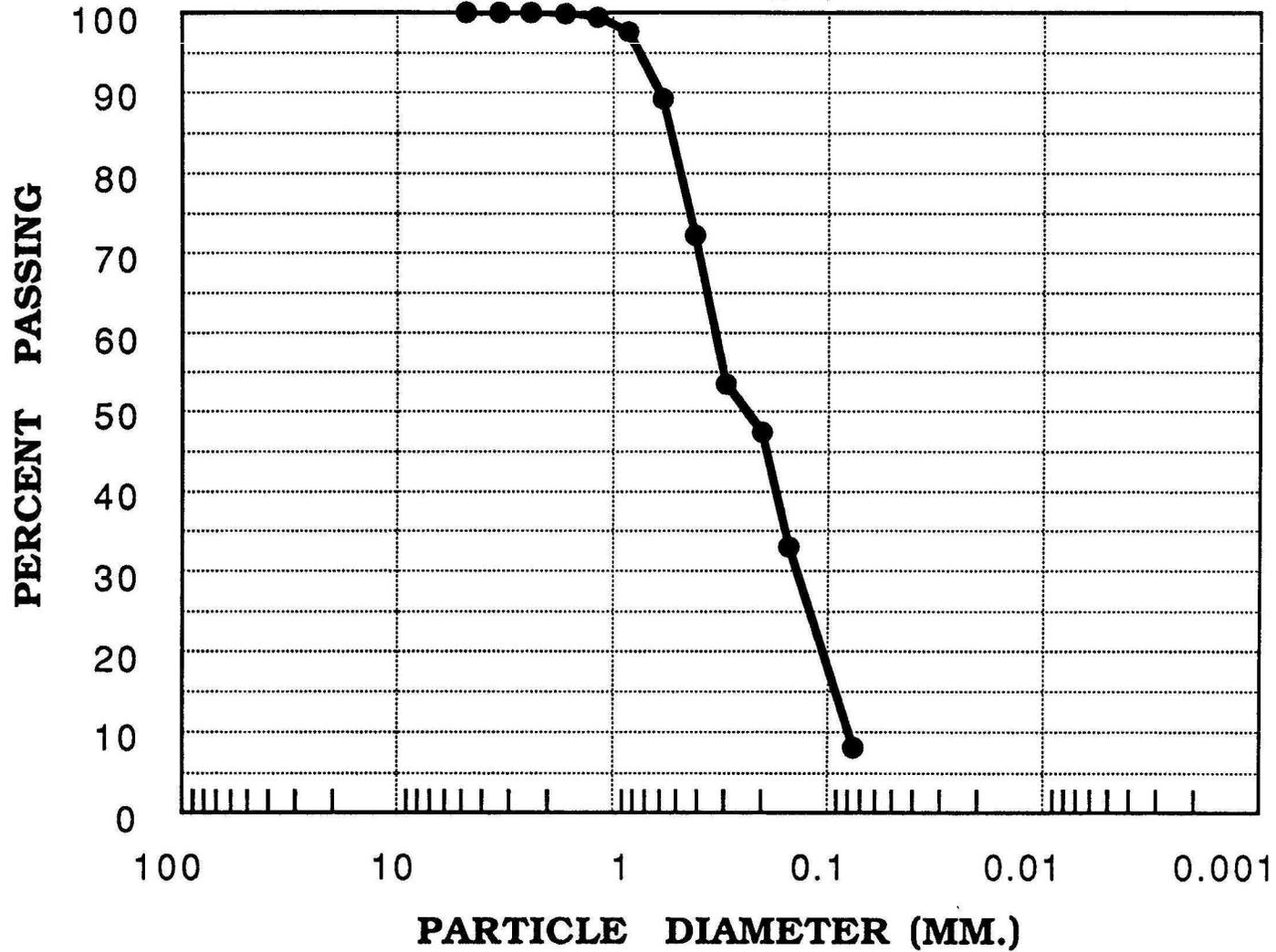
LINE # 4C N-S
USBR SITE #60+00
SAMPLING DEPTH (ft.) 14-21

Particle Diameter @ 60% Passing = 0.33 mm.(0.013 in.)



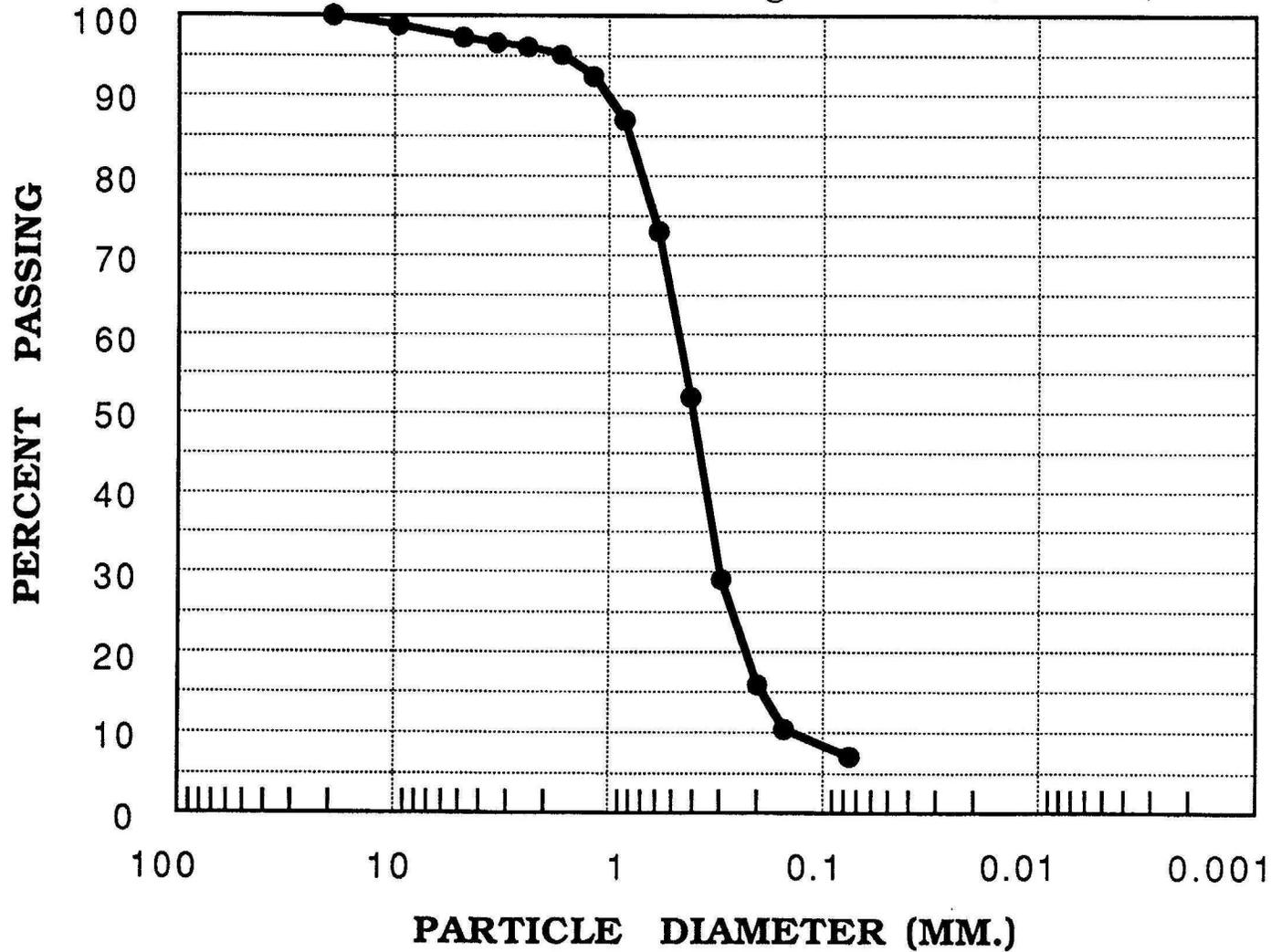
LINE # 4C N-S
USBR SITE #64+00
SAMPLING DEPTH (ft.) 9-15

Particle Diameter @ 60% Passing = 0.32 mm.(0.013 in.)



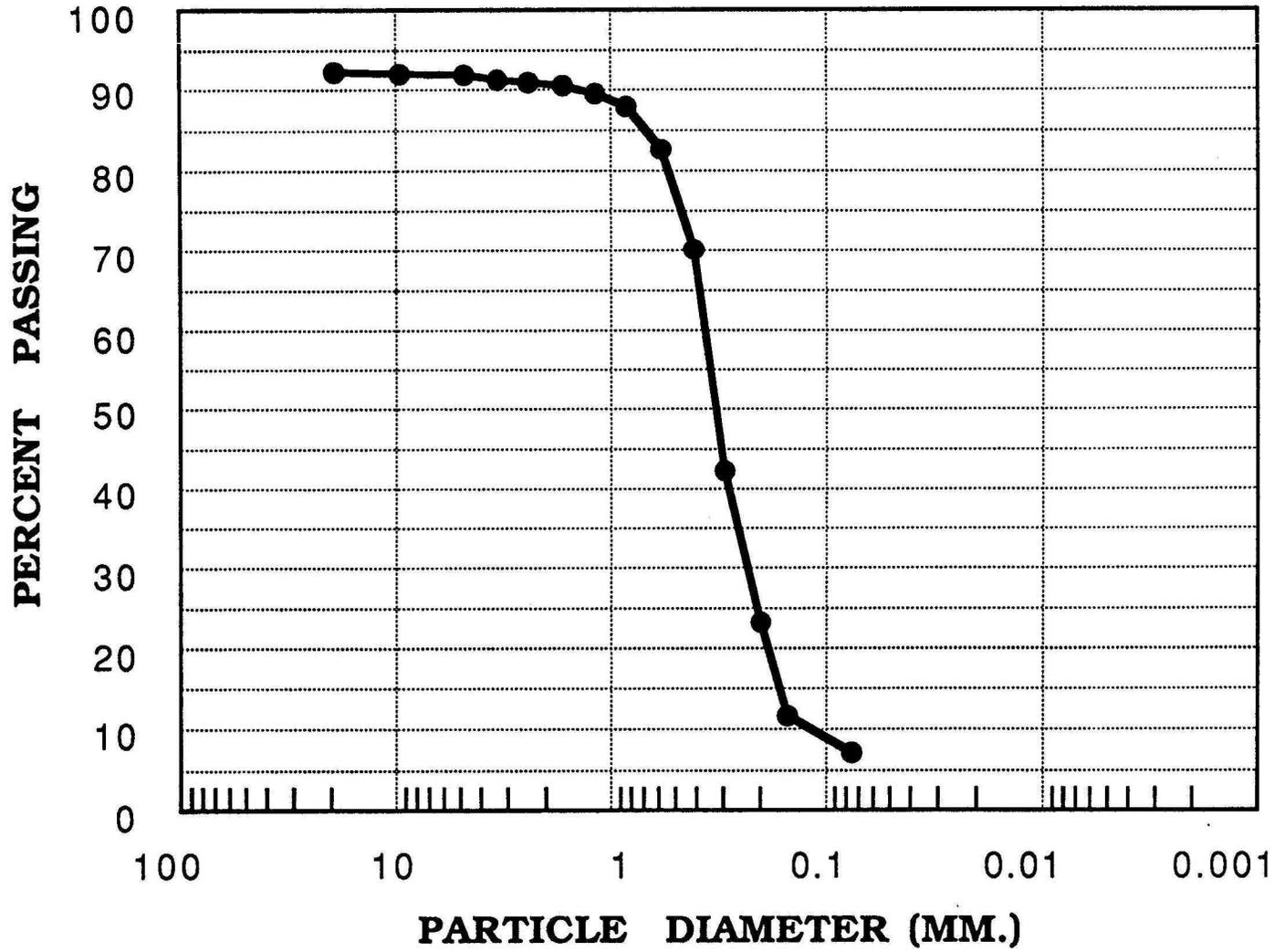
LINE # 4C N-S
USBR SITE #64+00
SAMPLING DEPTH (ft.) 15-22

Particle Diameter @ 60% Passing = 0.46 mm.(0.018 in.)



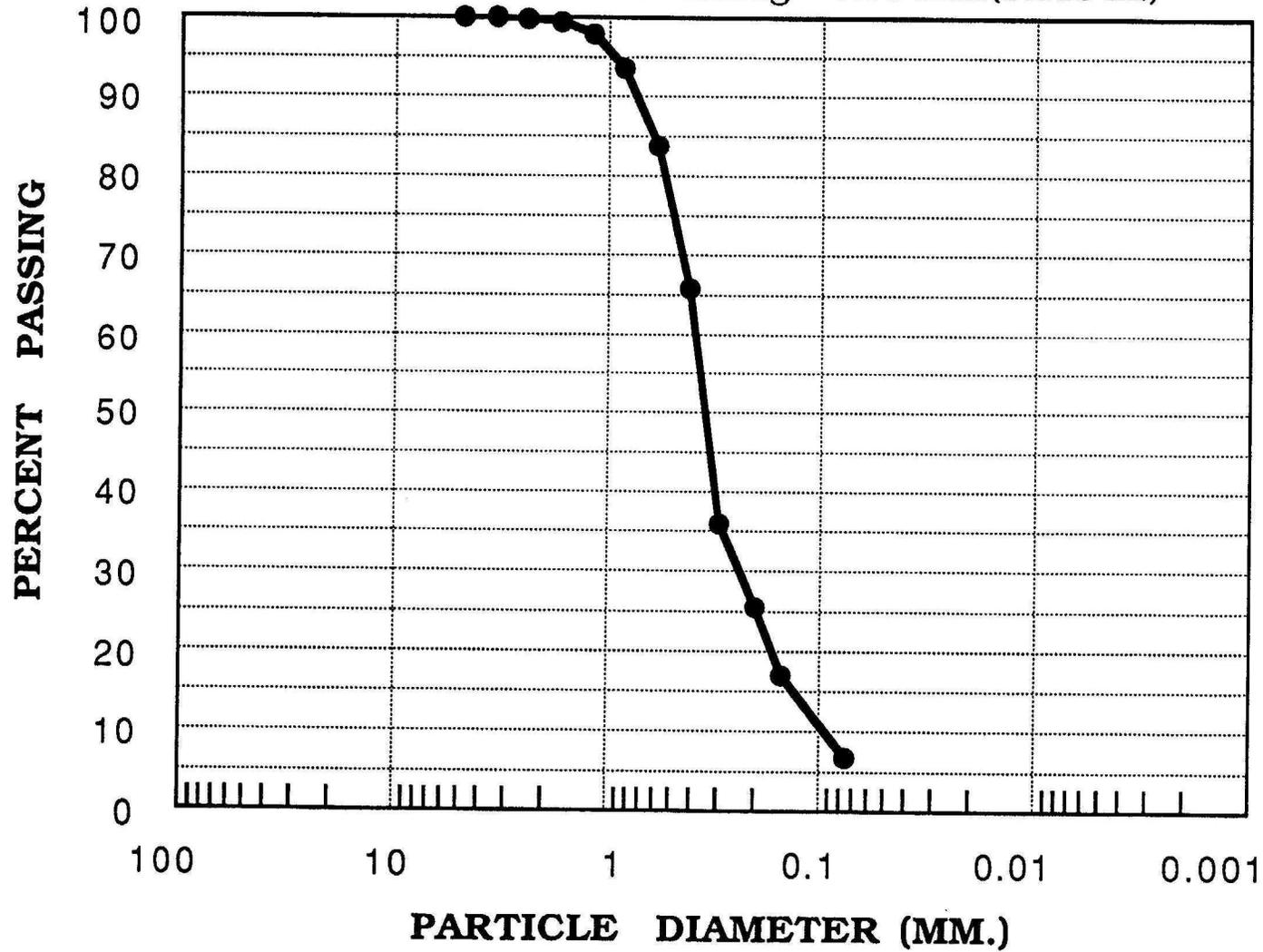
LINE # 4C N-S
USBR SITE #68+00
SAMPLING DEPTH (ft.) 11-18.7

Particle Diameter @ 60% Passing = 0.36 mm.(0.014 in.)



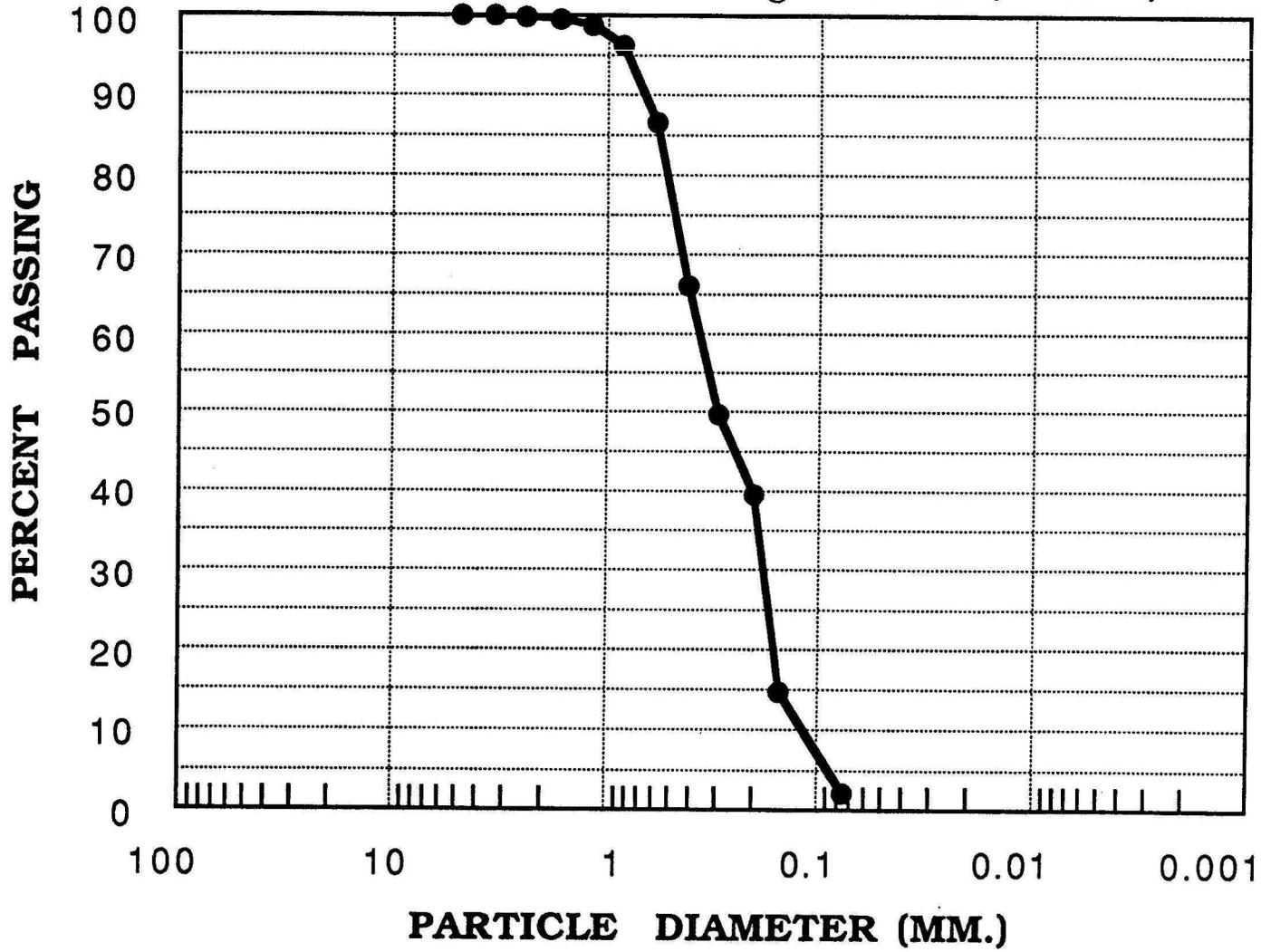
LINE # 4C N-S
USBR SITE #70+00
SAMPLING DEPTH (ft.) 10-15

Particle Diameter @ 60% Passing = 0.38 mm.(0.015 in.)



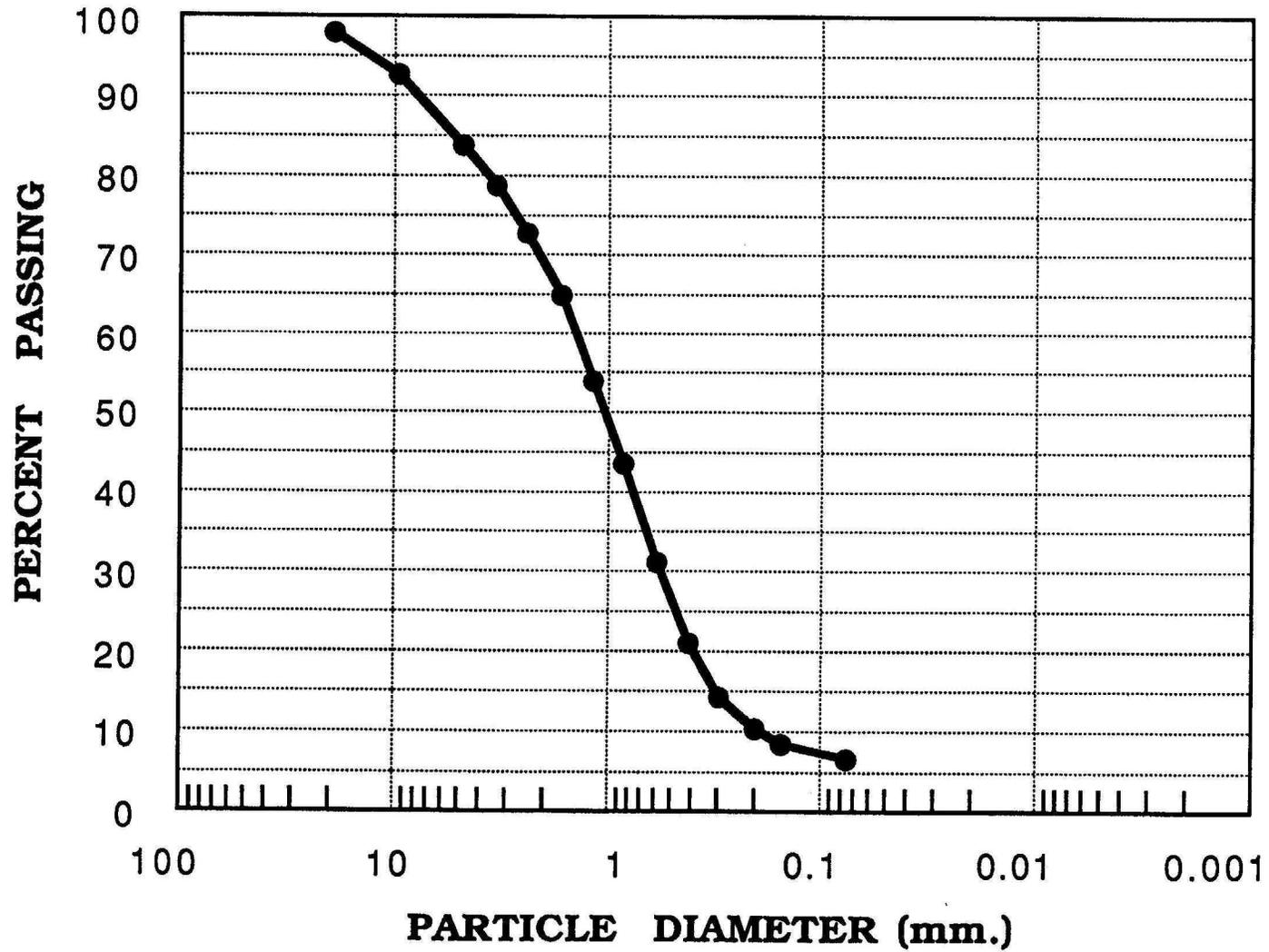
LINE # 4C N-S
USBR SITE #70+00
SAMPLING DEPTH (ft.) 15-20

Particle Diameter @ 60% Passing = 0.35 mm.(0.014 in.)



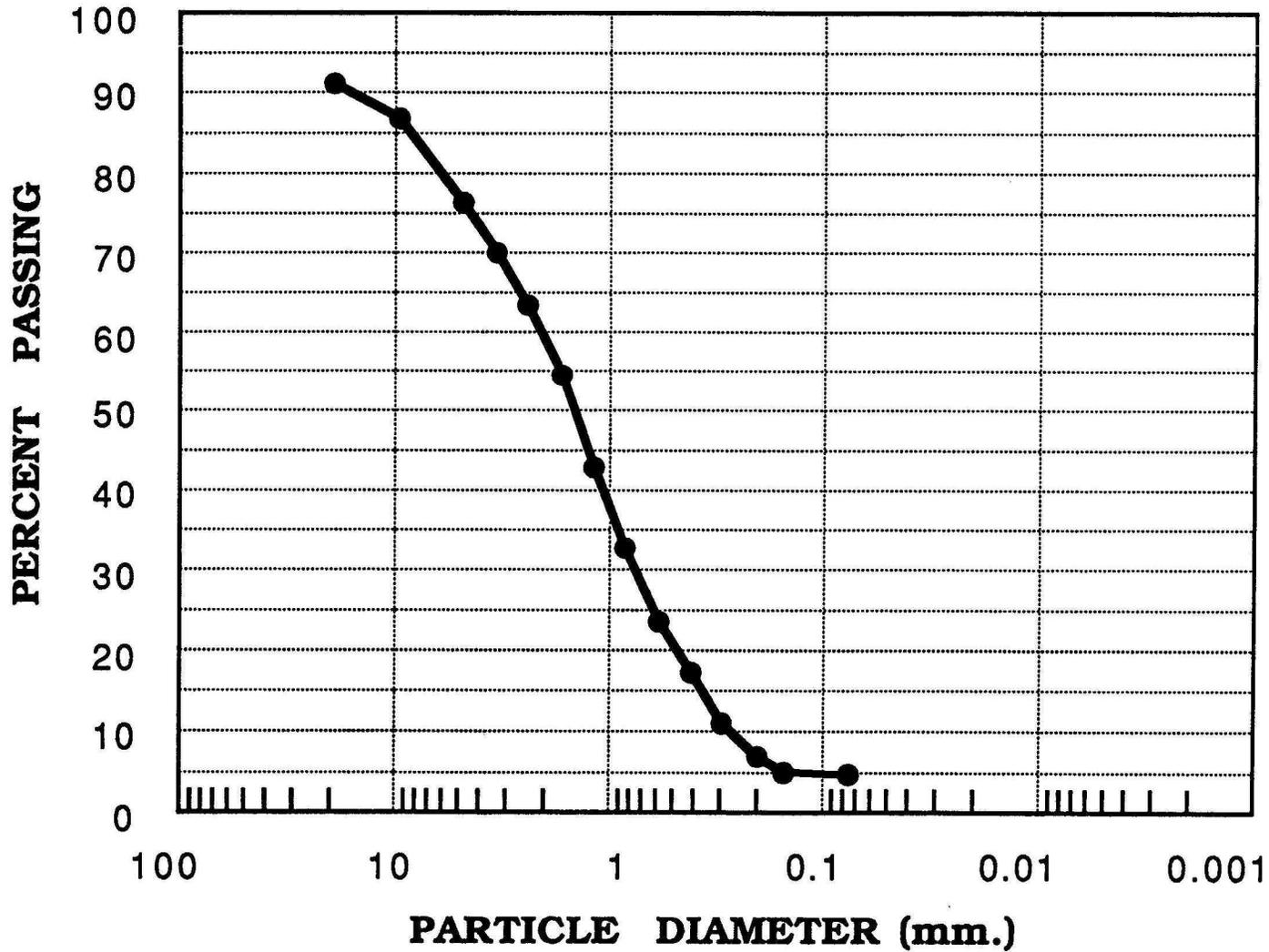
**LINE # 4CLAT N-S
USBR SITE # 46+00
SAMPLING DEPTH (ft.) 23-30**

Particle Diameter @ 60% Passing = 1.44 mm.(0.057 in.)



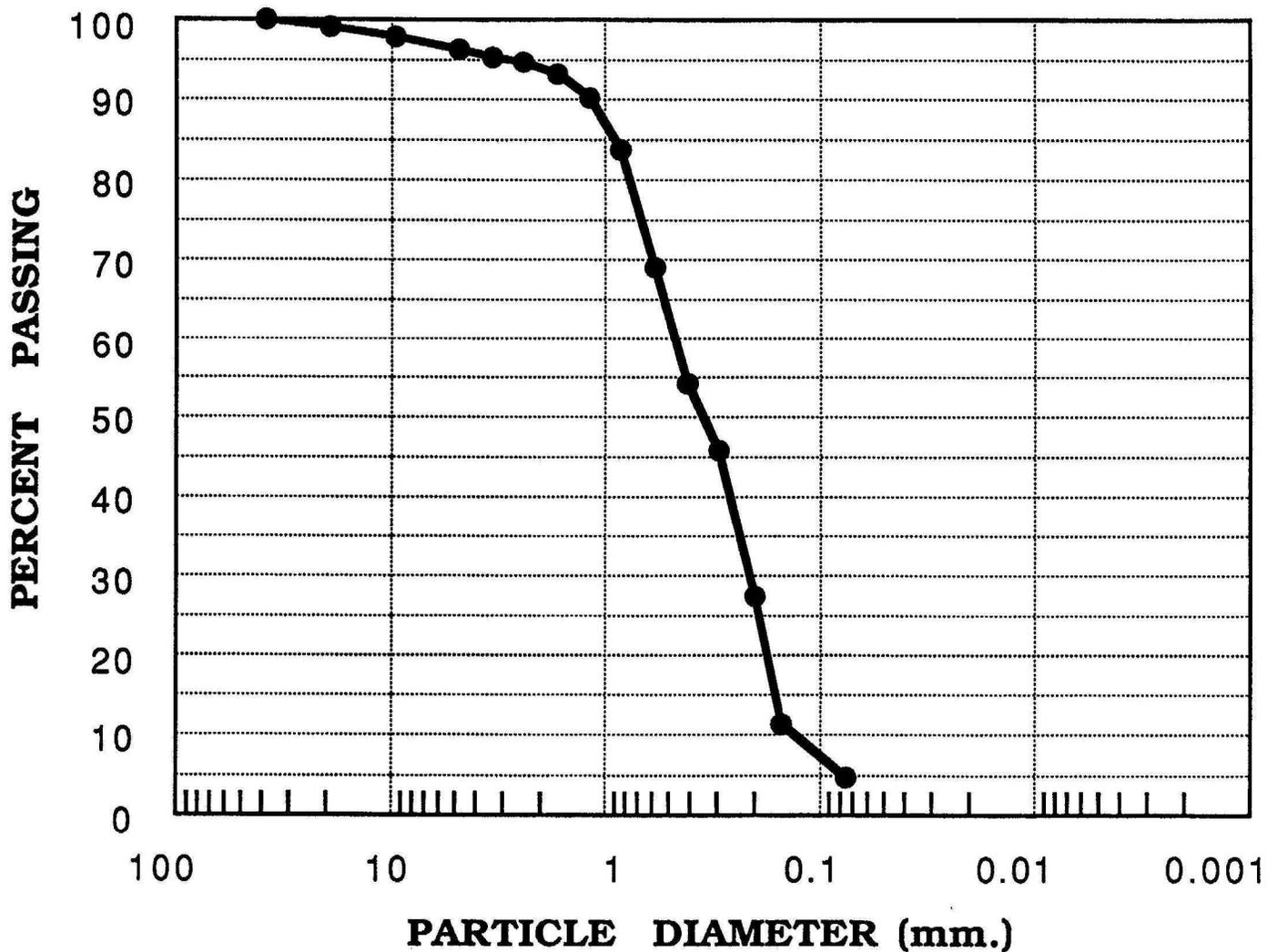
**LINE # 4CLAT N-S
USBR SITE # 50+00
SAMPLING DEPTH (ft.) 26-32**

Particle Diameter @ 60% Passing = 2.08 mm.(0.082 in.)



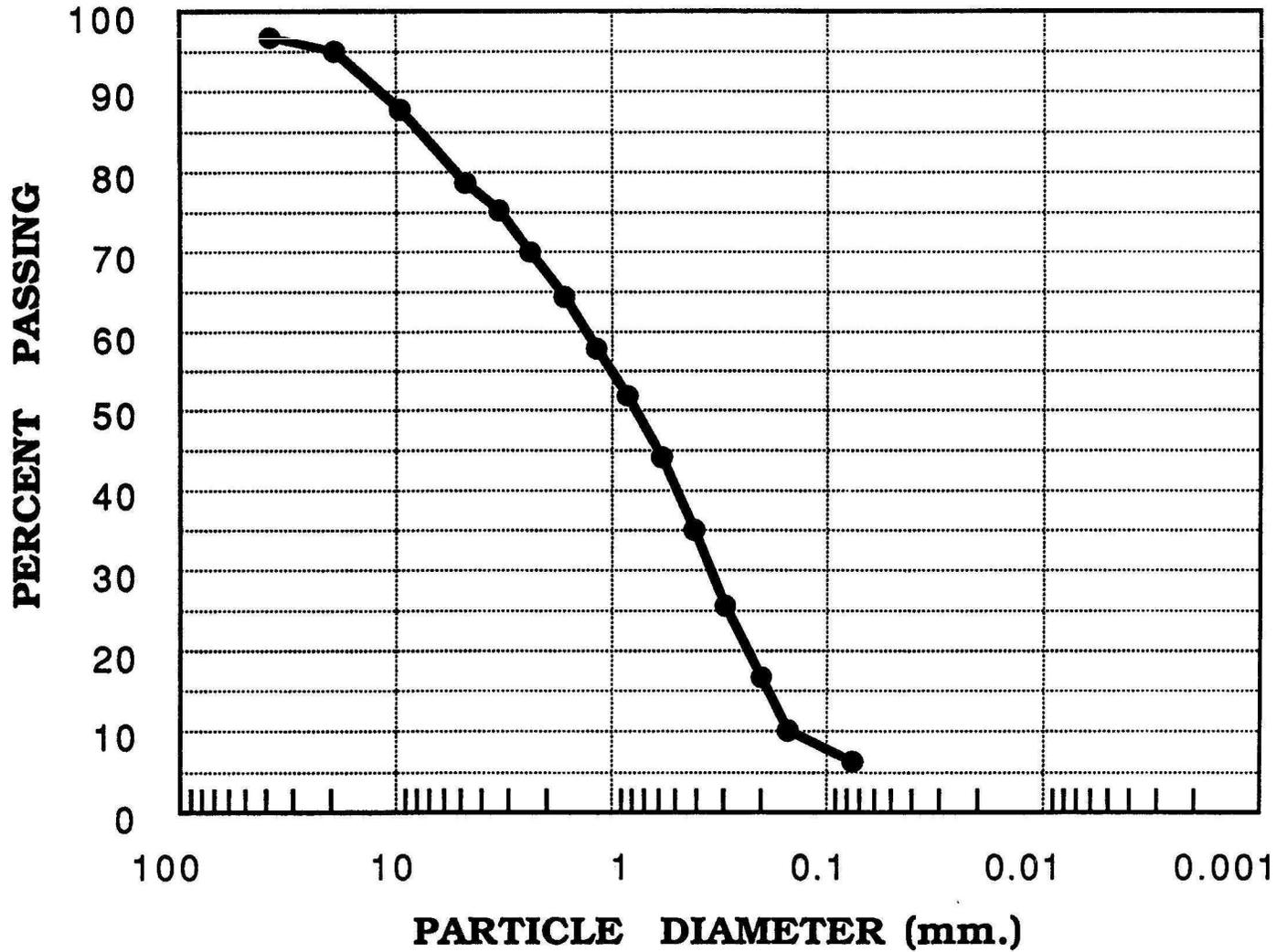
LINE # 4D1 N-S
USBR SITE # 46+27
SAMPLING DEPTH (ft.) 18-23

Particle Diameter @ 60% Passing = 0.46 mm.(0.018 in.)



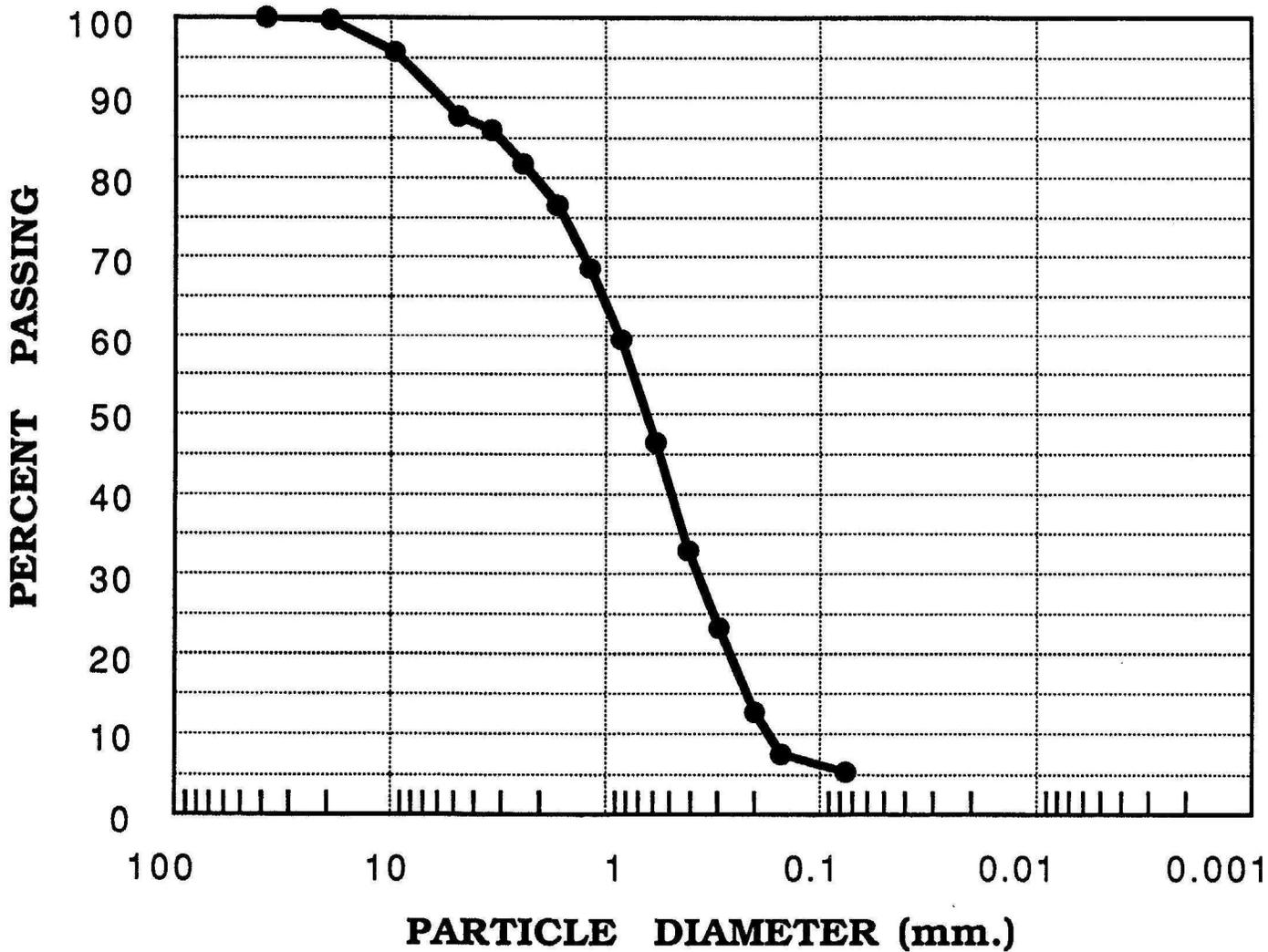
LINE # 4D1 N-S
USBR SITE # 46+27
SAMPLING DEPTH (ft.) 23-27

Particle Diameter @ 60% Passing = 1.31mm.(0.052 in.)



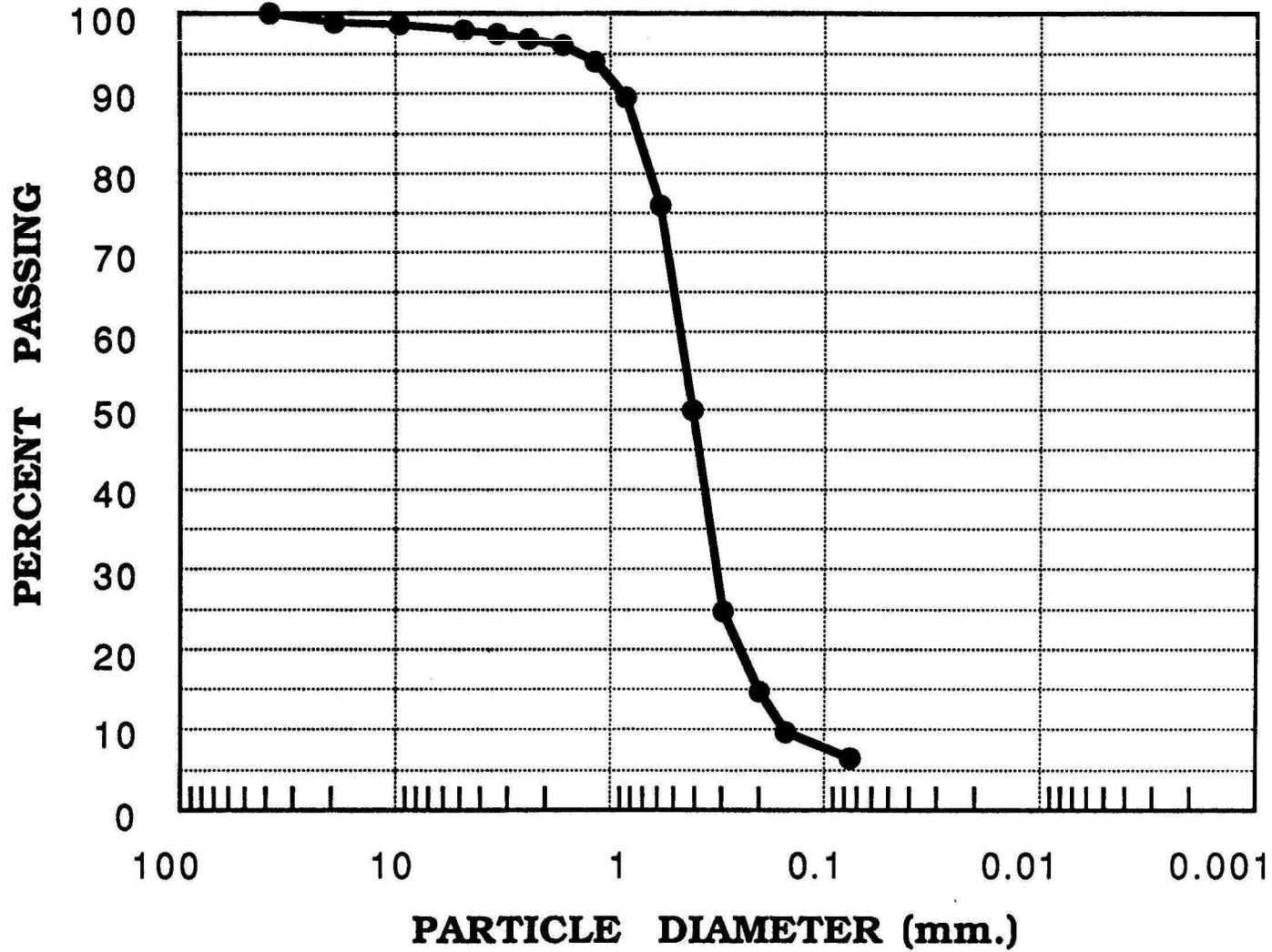
LINE # 4D1 N-S
USBR SITE # 48+30
SAMPLING DEPTH (ft.) 20-27

Particle Diameter @ 60% Passing = 0.83mm.(0.033 in.)



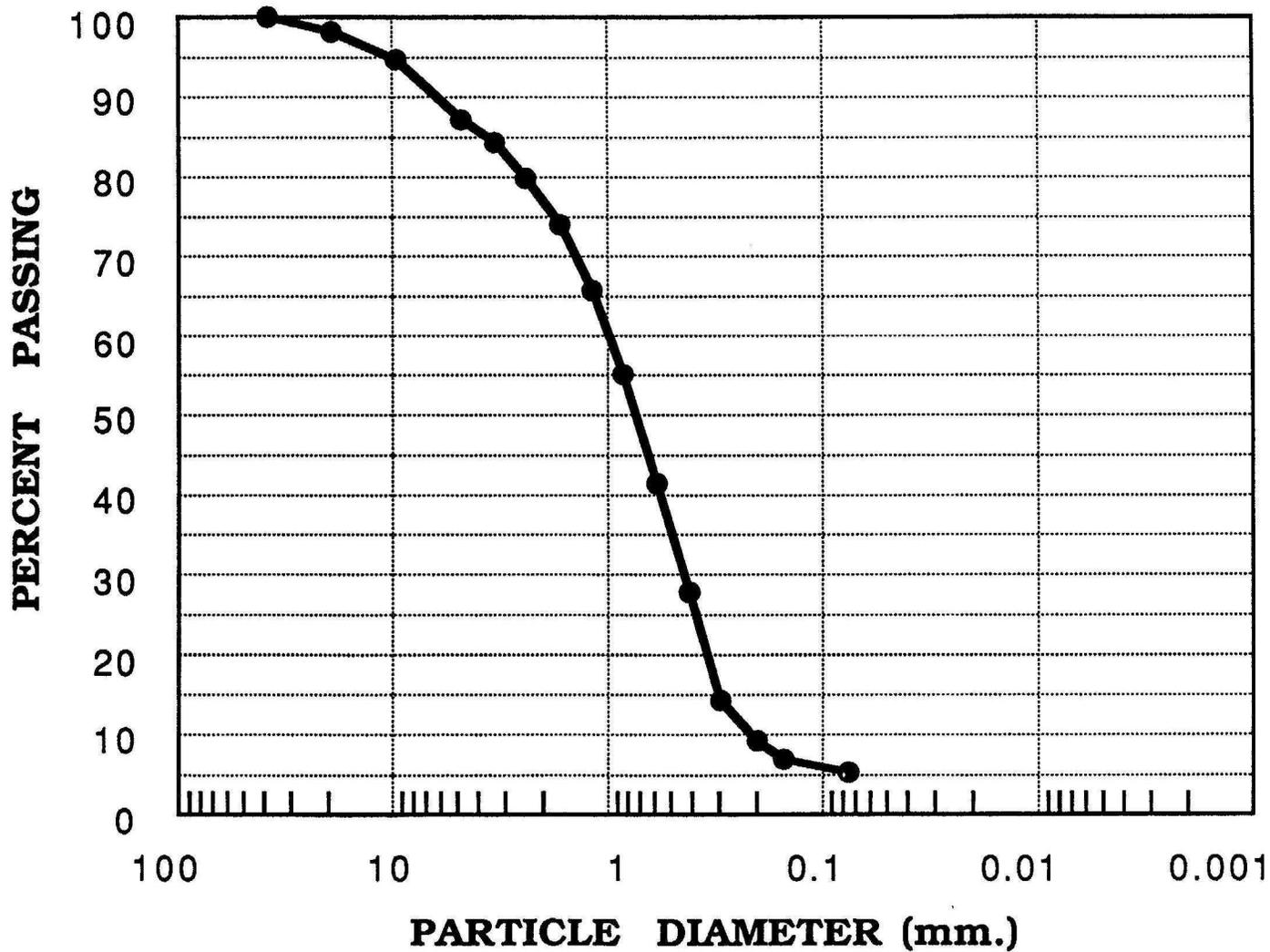
LINE # 4D1 N-S
USBR SITE # 50+27
SAMPLING DEPTH (ft.) 18-23

Particle Diameter @ 60% Passing = 0.46mm.(0.018 in.)



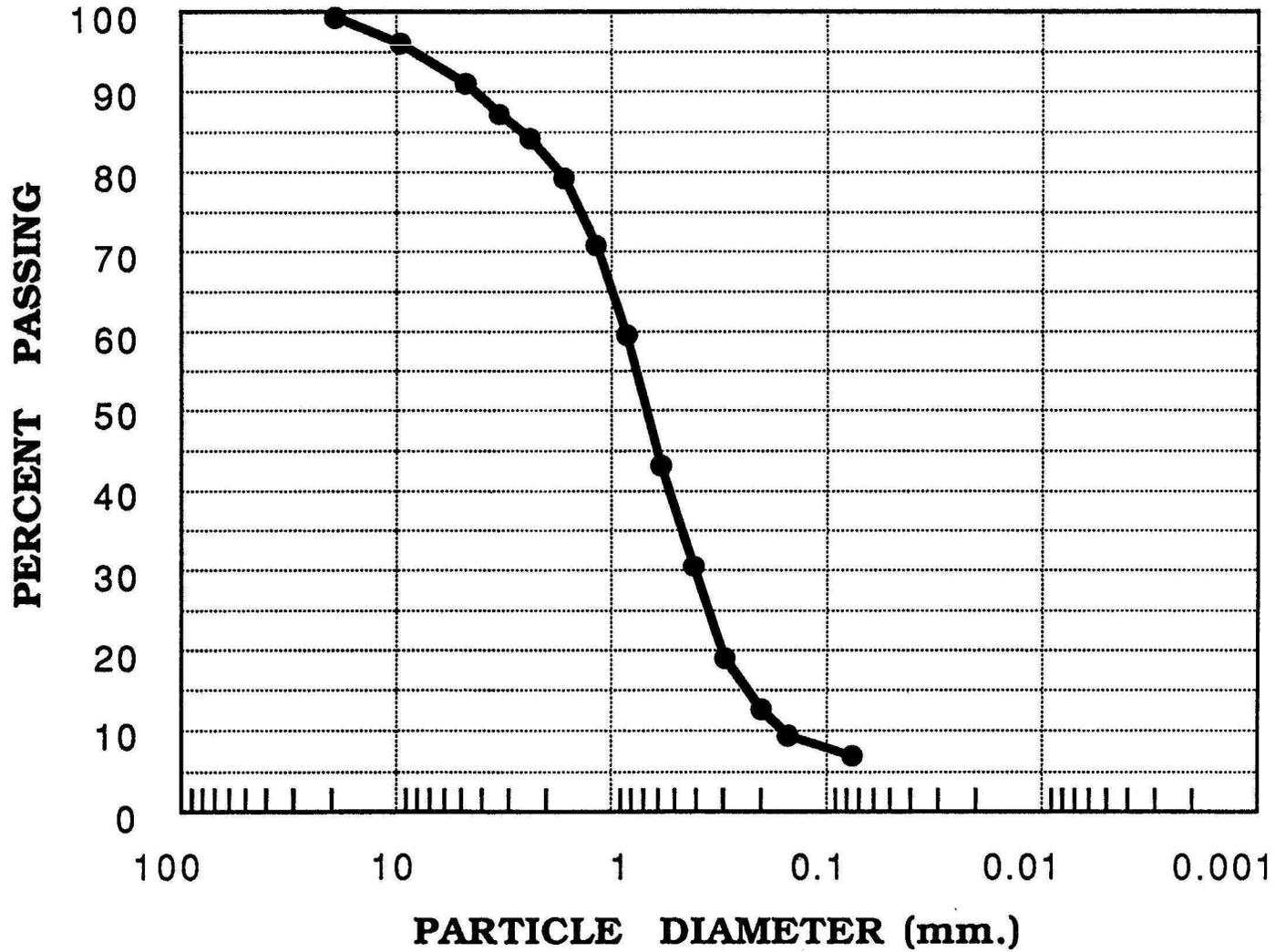
LINE # 4D1 N-S
USBR SITE # 50+27
SAMPLING DEPTH (ft.) 23-30

Particle Diameter @ 60% Passing = 0.95 mm.(0.037 in.)



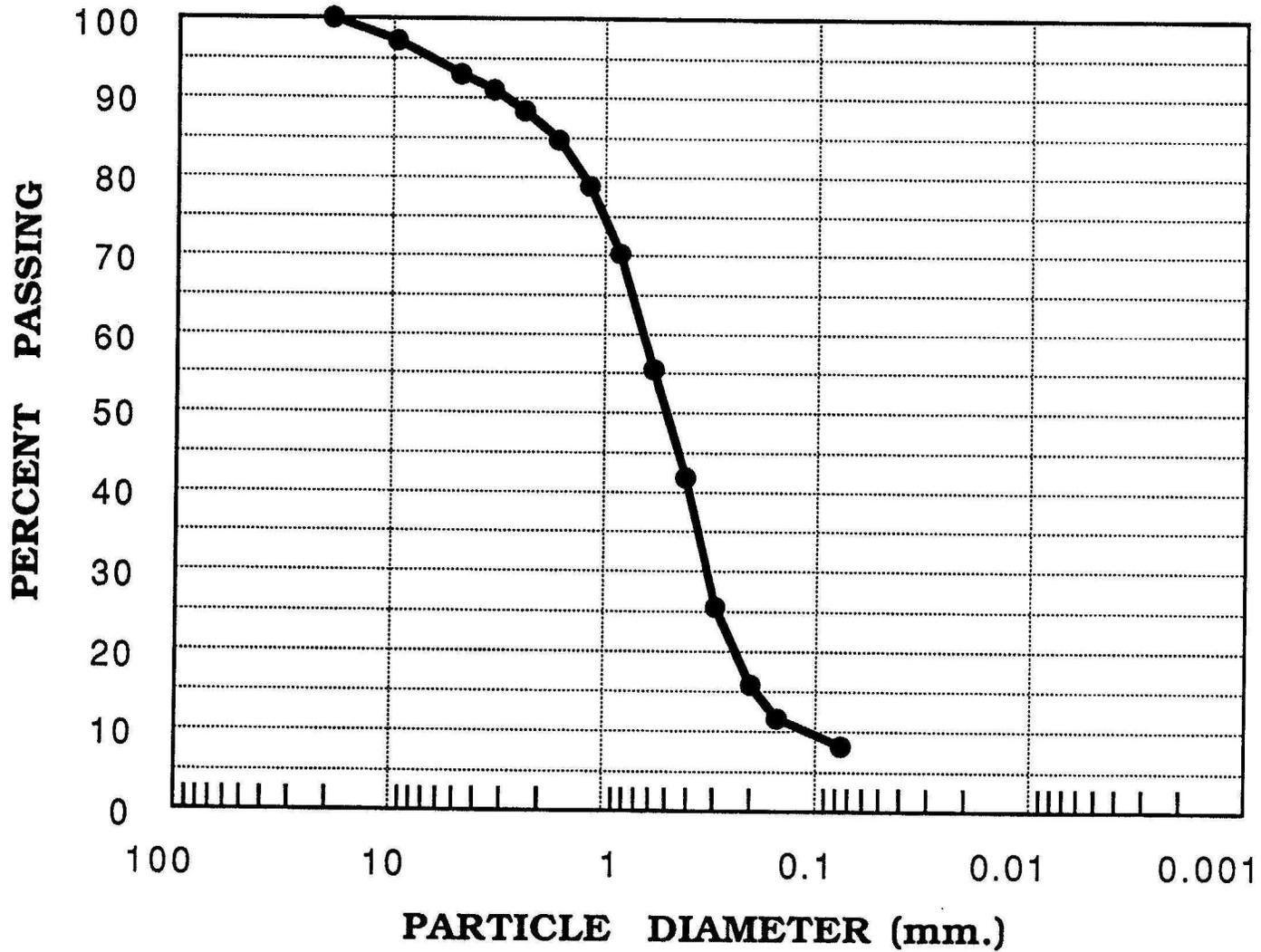
LINE # 16A W-E
USBR SITE # 1+00
SAMPLING DEPTH (ft.) 13-18

Particle Diameter @ 60% Passing = 0.83 mm.(0.033 in.)



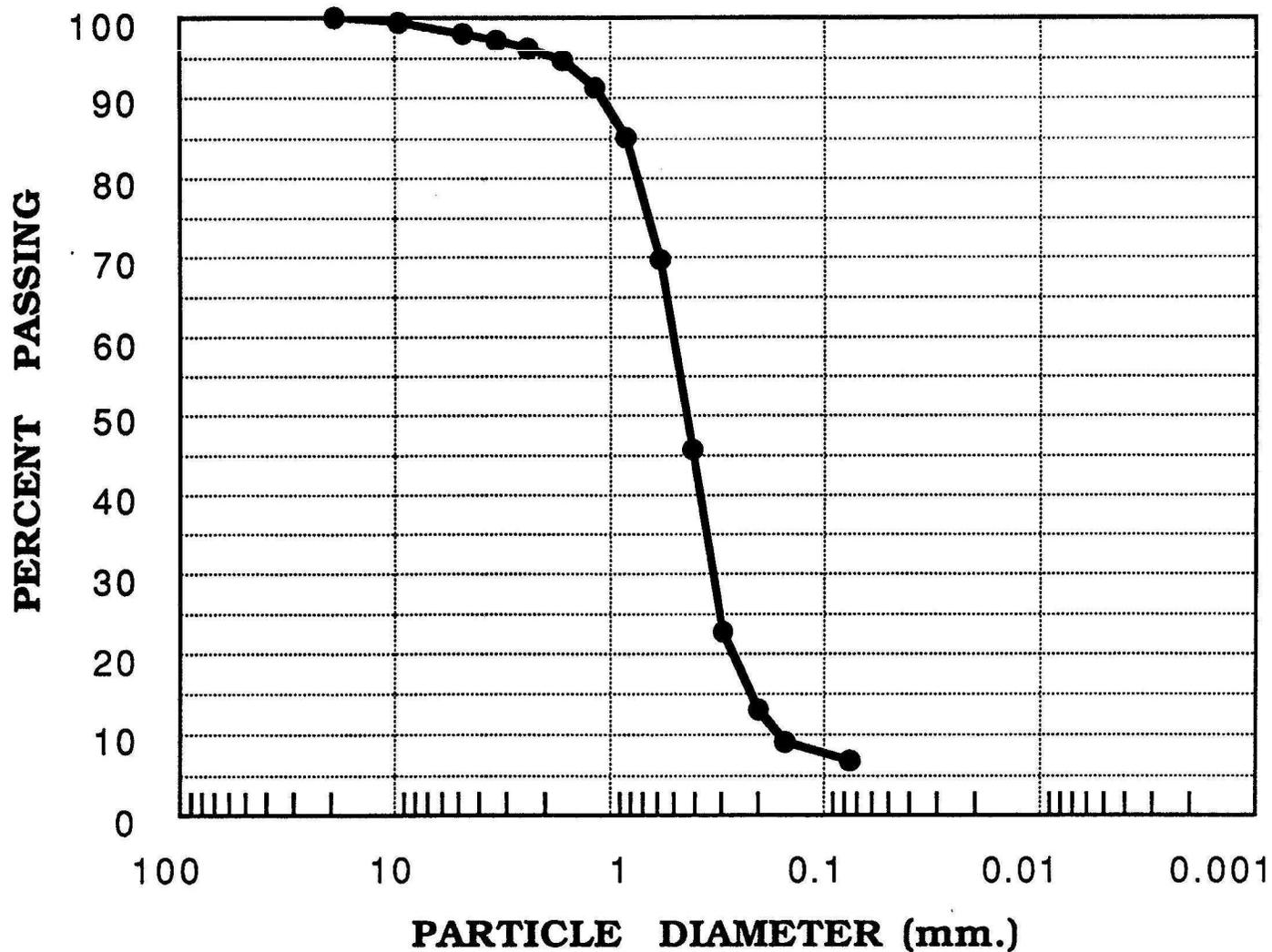
LINE # 16A W-E
USBR SITE # 1+00
SAMPLING DEPTH (ft.) 18-24.5

Particle Diameter @ 60% Passing = 0.63 mm.(0.025 in.)



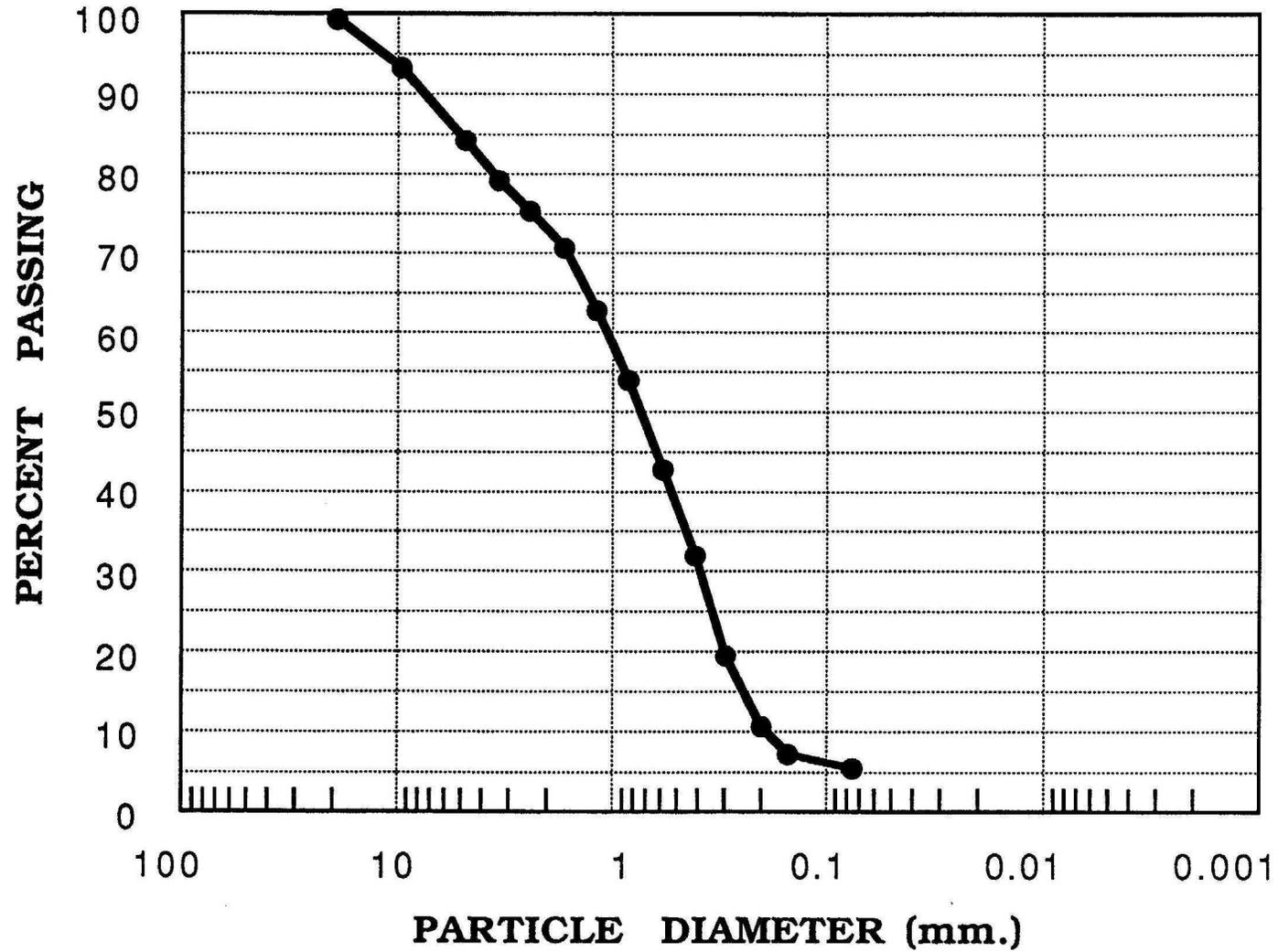
LINE # 16A W-E
USBR SITE # 5+00
SAMPLING DEPTH (ft.) 13-18

Particle Diameter @ 60% Passing = 0.50 mm.(0.020 in.)



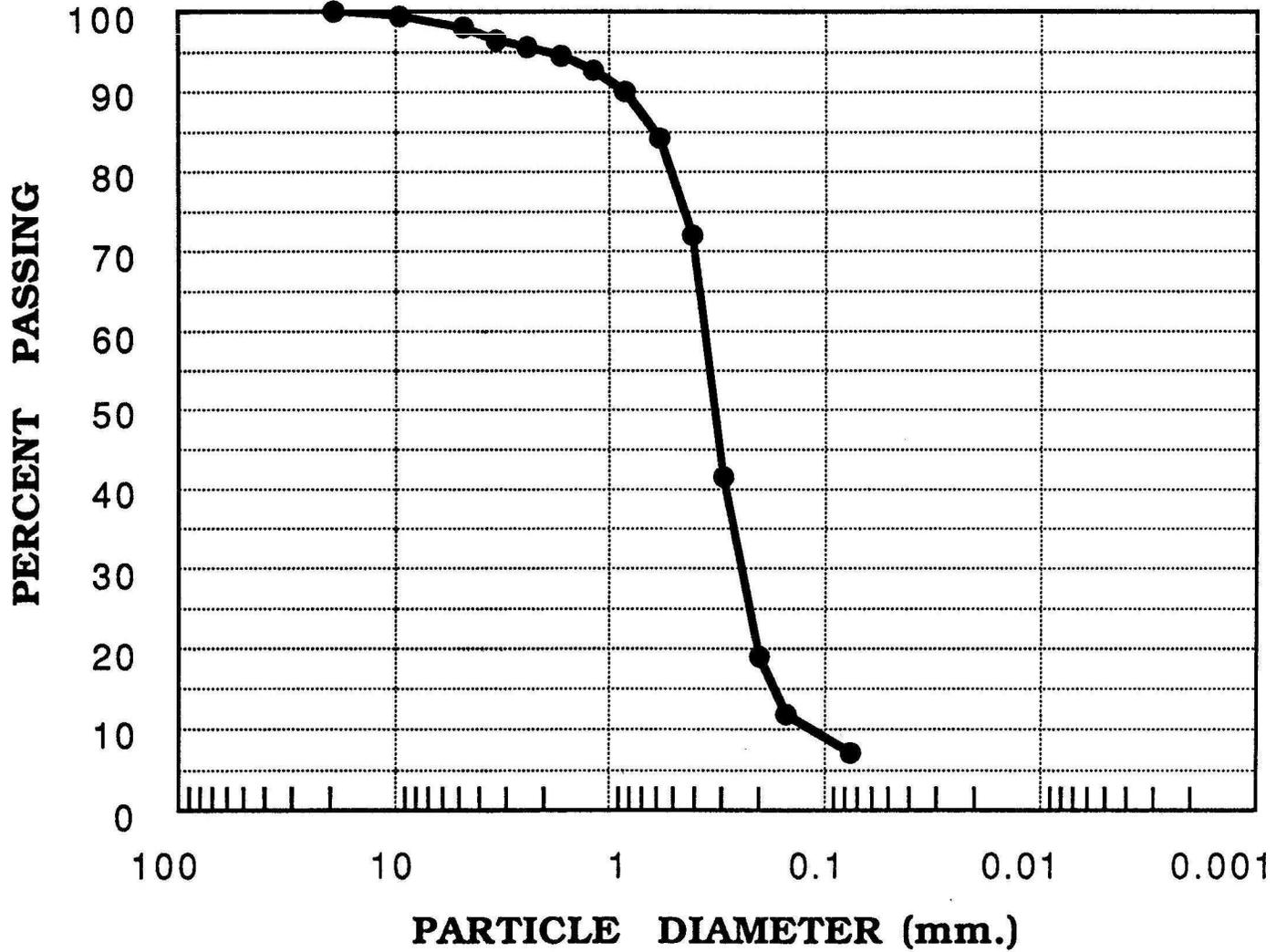
LINE # 16A W-E
USBR SITE # 5+00
SAMPLING DEPTH (ft.) 18-21

Particle Diameter @ 60% Passing = 1.04 mm.(0.041 in.)



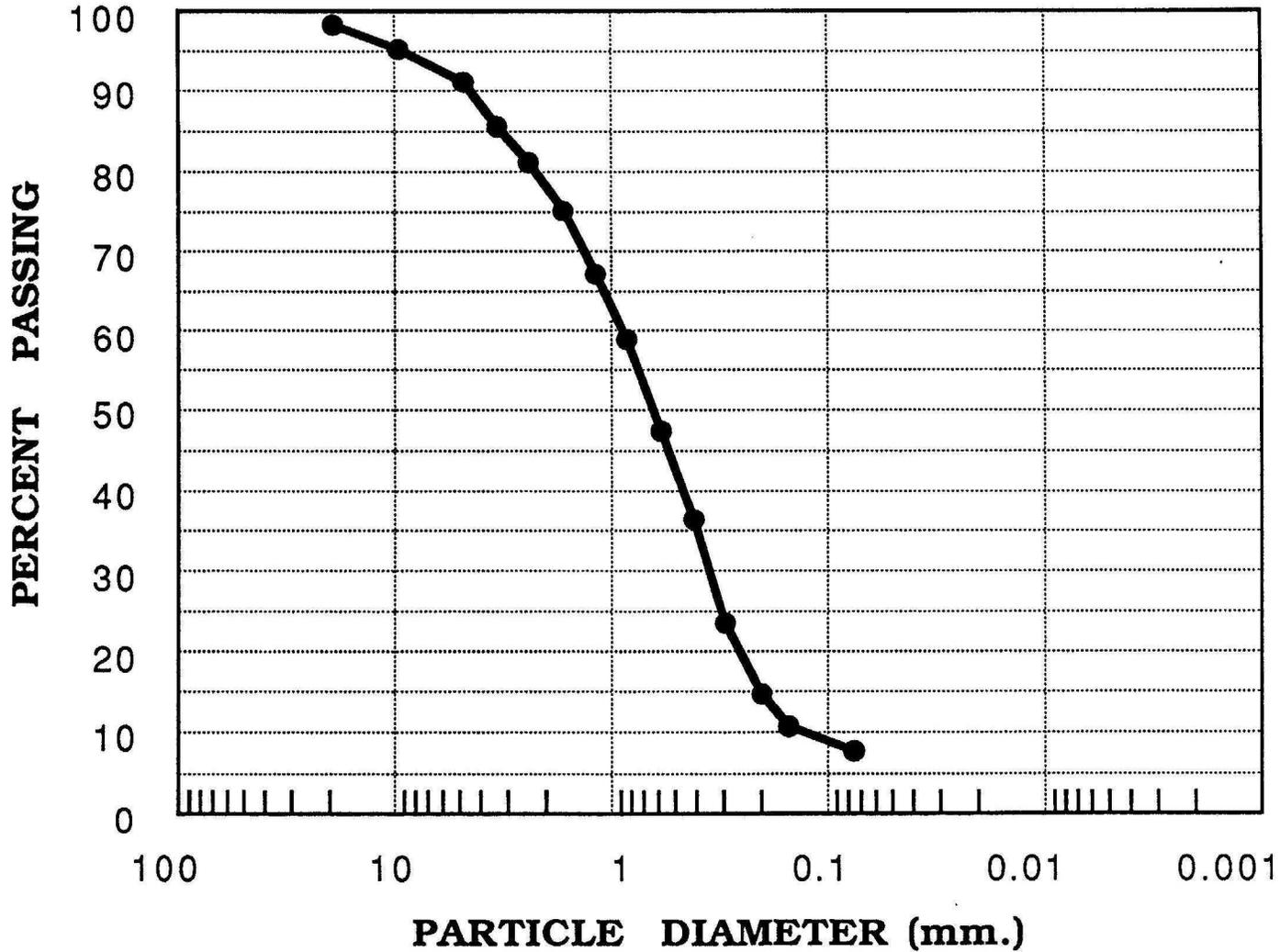
LINE # 16A W-E
USBR SITE # 5+00
SAMPLING DEPTH (ft.) 21-27

Particle Diameter @ 60% Passing = 0.35 mm.(0.014 in.)



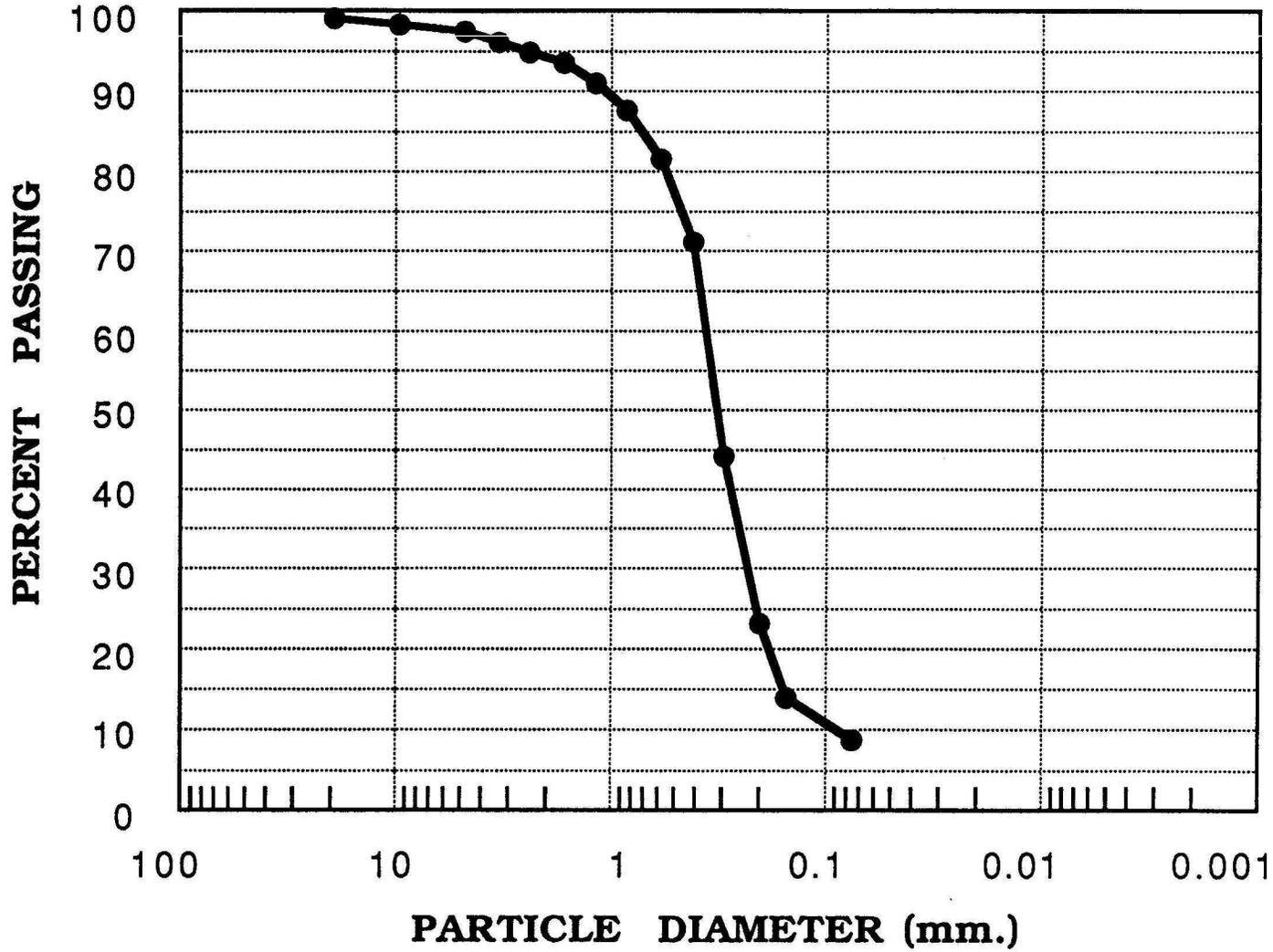
LINE # 16A W-E
USBR SITE # 9+00
SAMPLING DEPTH (ft.) 13-16

Particle Diameter @ 60% Passing = 0.87 mm.(0.034 in.)



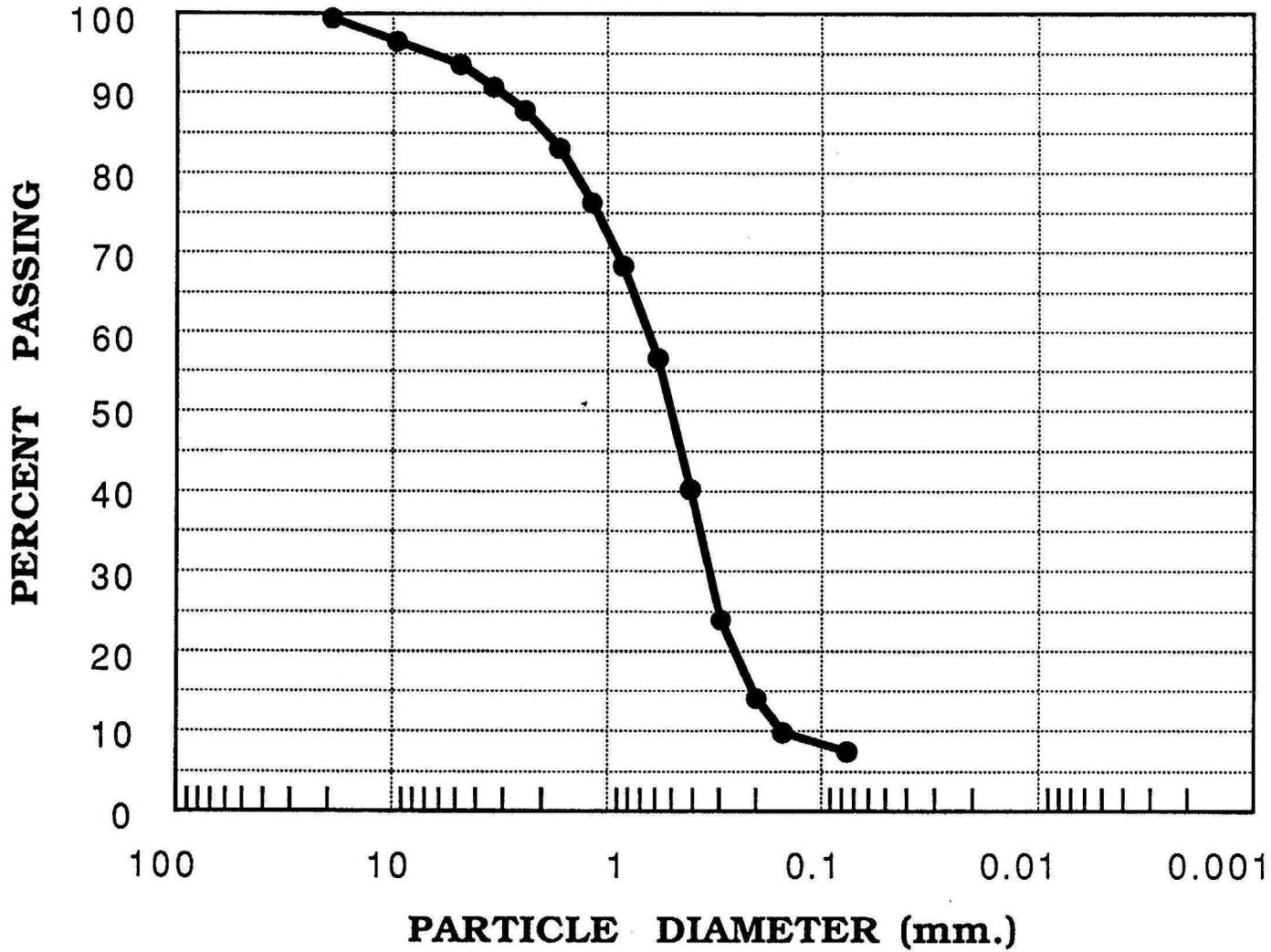
LINE # 16A W-E
USBR SITE # 9+00
SAMPLING DEPTH (ft.) 16-21

Particle Diameter @ 60% Passing = 0.35 mm.(0.014 in.)



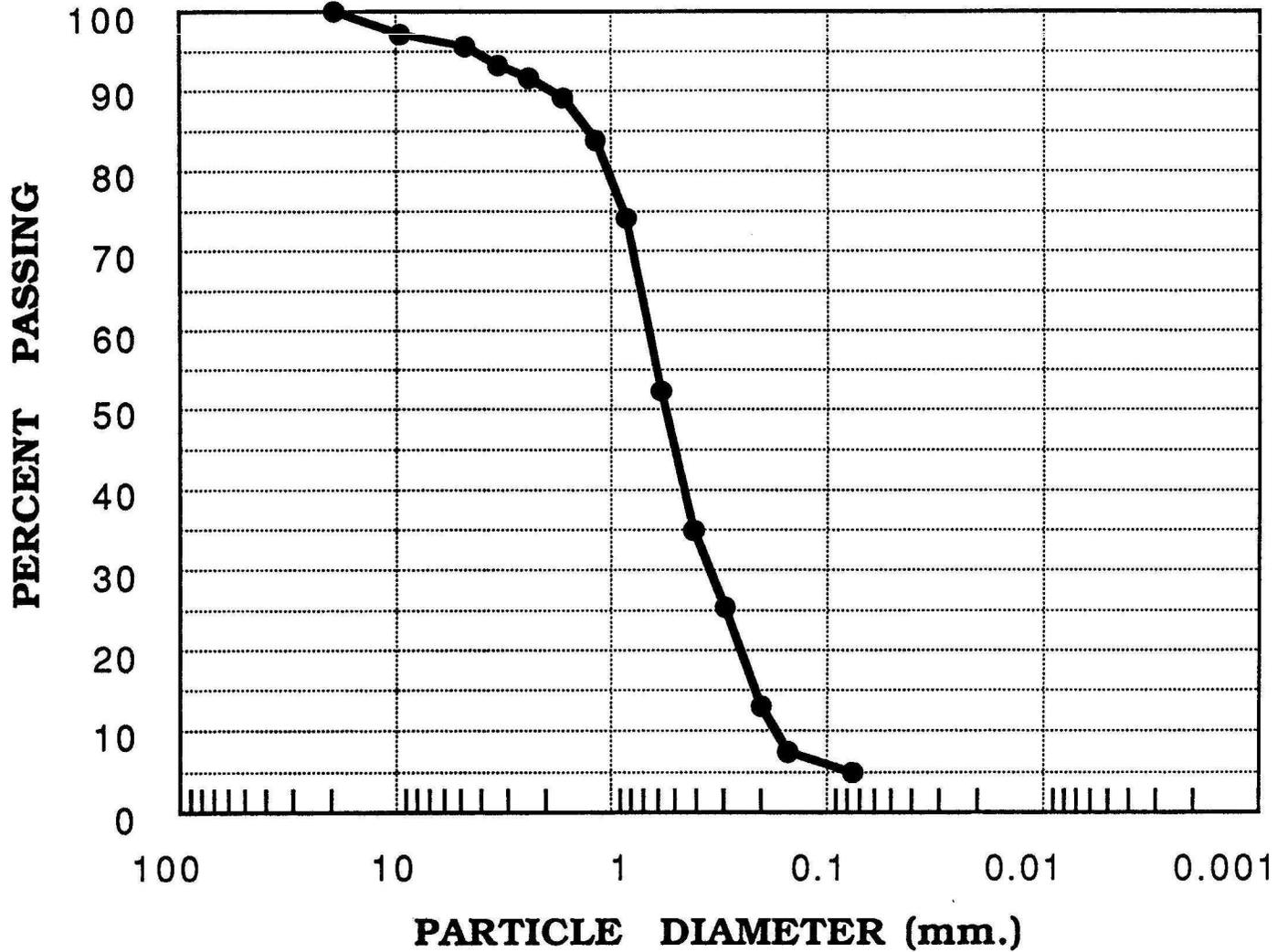
LINE # 16A W-E
USBR SITE # 13+00
SAMPLING DEPTH (ft.) 13-18

Particle Diameter @ 60% Passing = 0.63 mm.(0.025 in.)



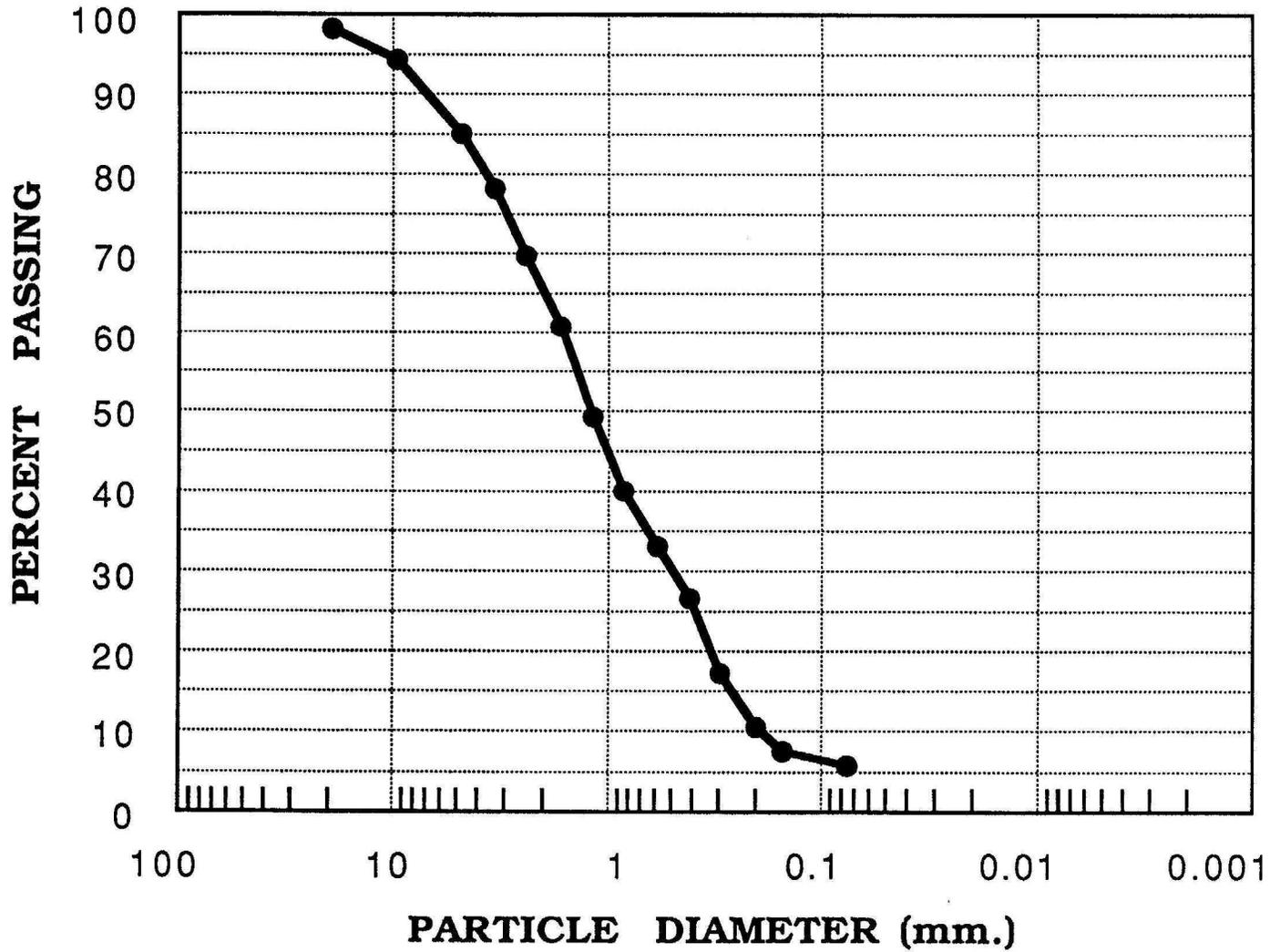
LINE # 16A W-E
USBR SITE # 13+00
SAMPLING DEPTH (ft.) 18-23

Particle Diameter @ 60% Passing = 0.63 mm.(0.025 in.)



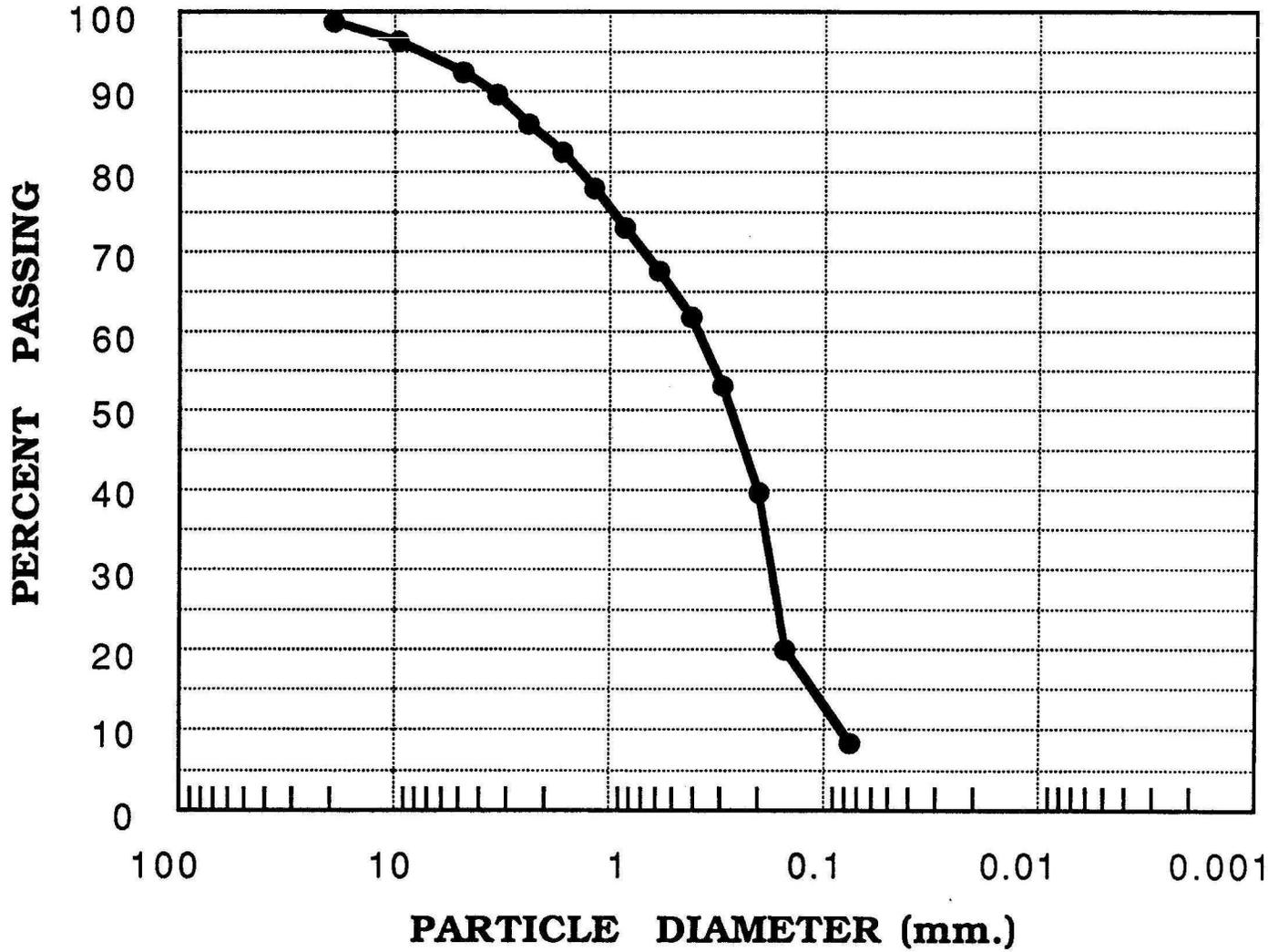
LINE # 16A W-E
USBR SITE # 17+00
SAMPLING DEPTH (ft.) 14-18

Particle Diameter @ 60% Passing = 1.58 mm.(0.062 in.)



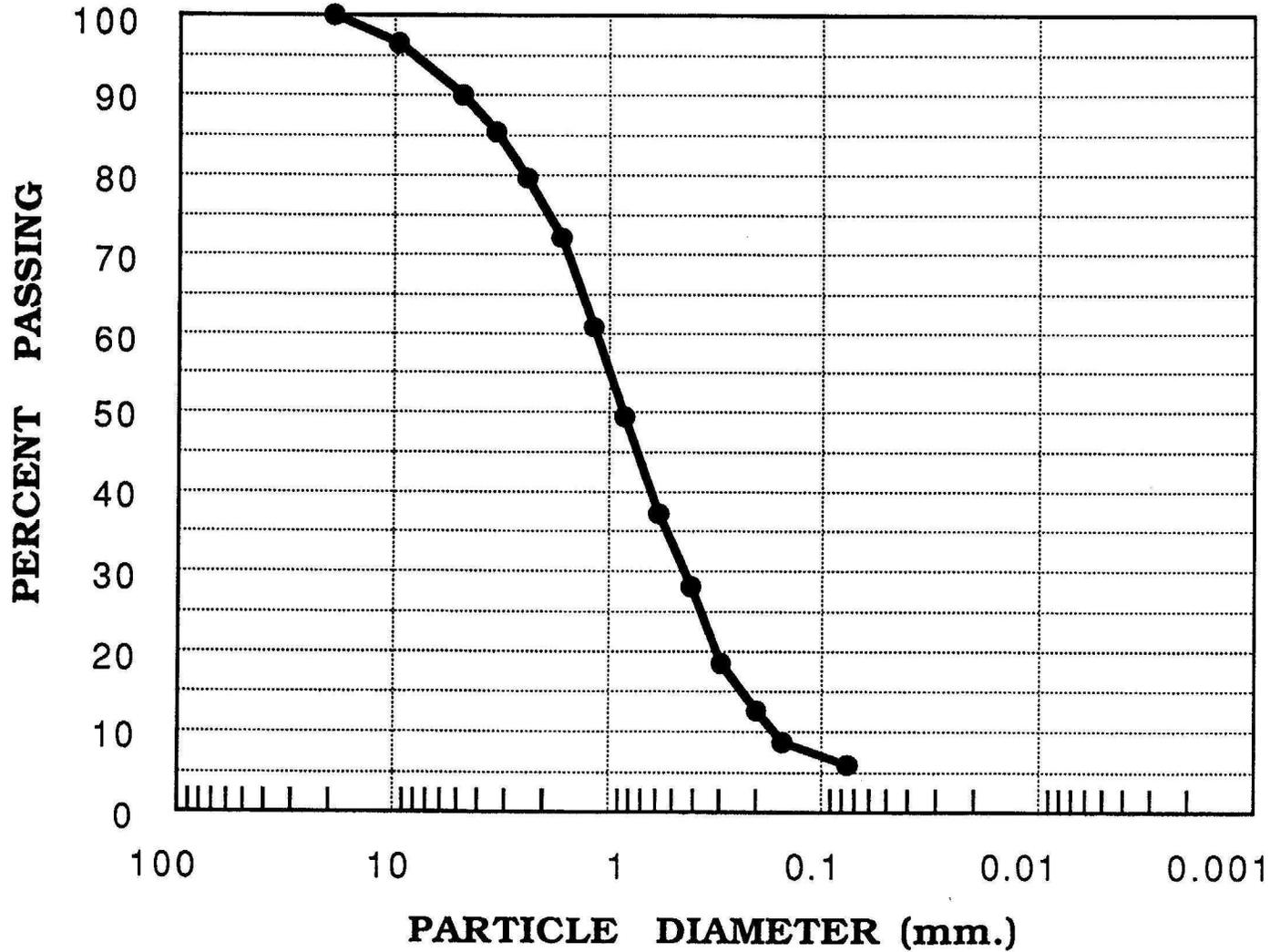
LINE # 16A W-E
USBR SITE # 17+00
SAMPLING DEPTH (ft.) 18-21.5

Particle Diameter @ 60% Passing = 0.36 mm.(0.014 in.)



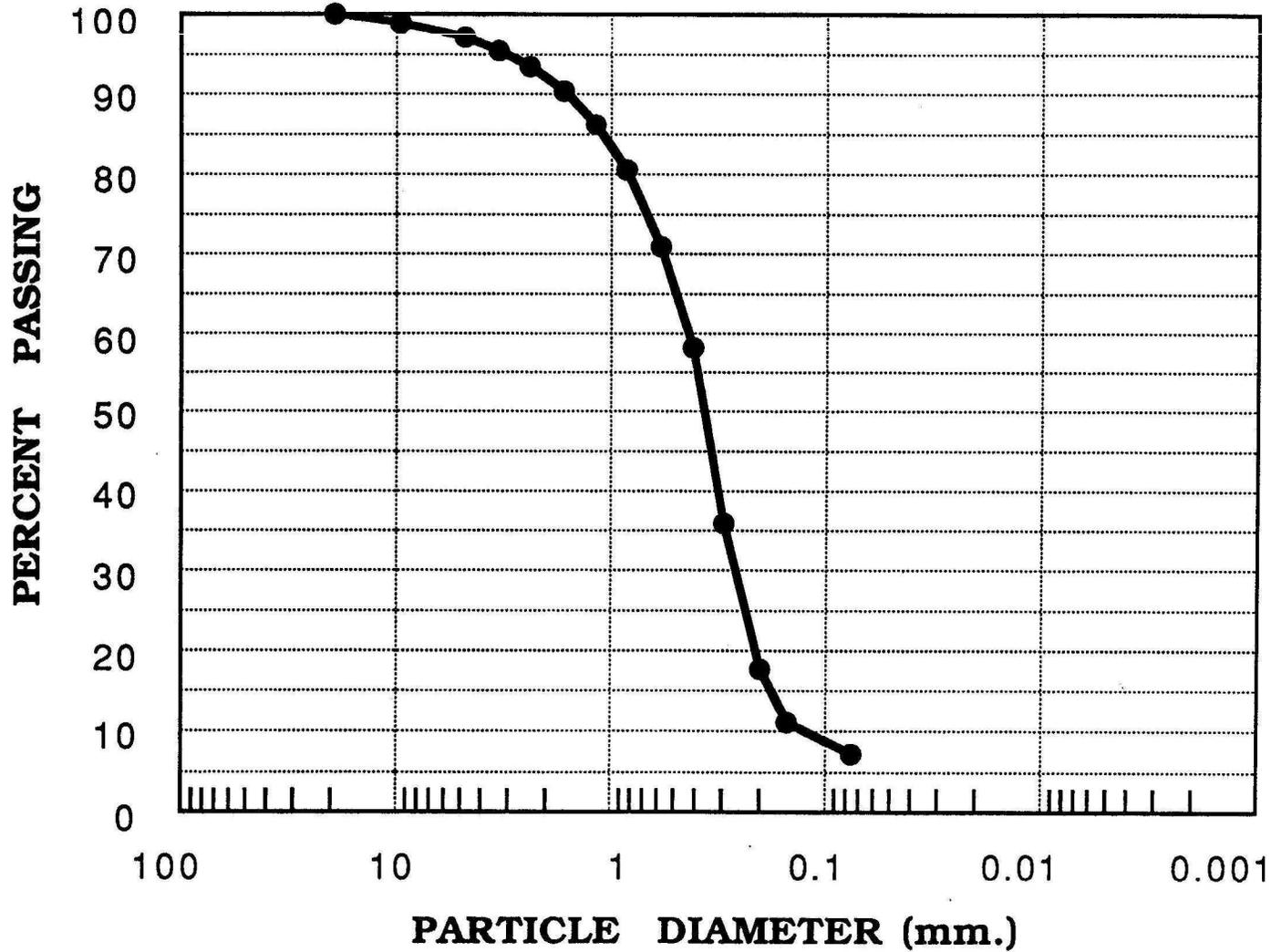
LINE # 16A W-E
USBR SITE # 21+00
SAMPLING DEPTH (ft.) 13-18

Particle Diameter @ 60% Passing = 1.15 mm.(0.045 in.)



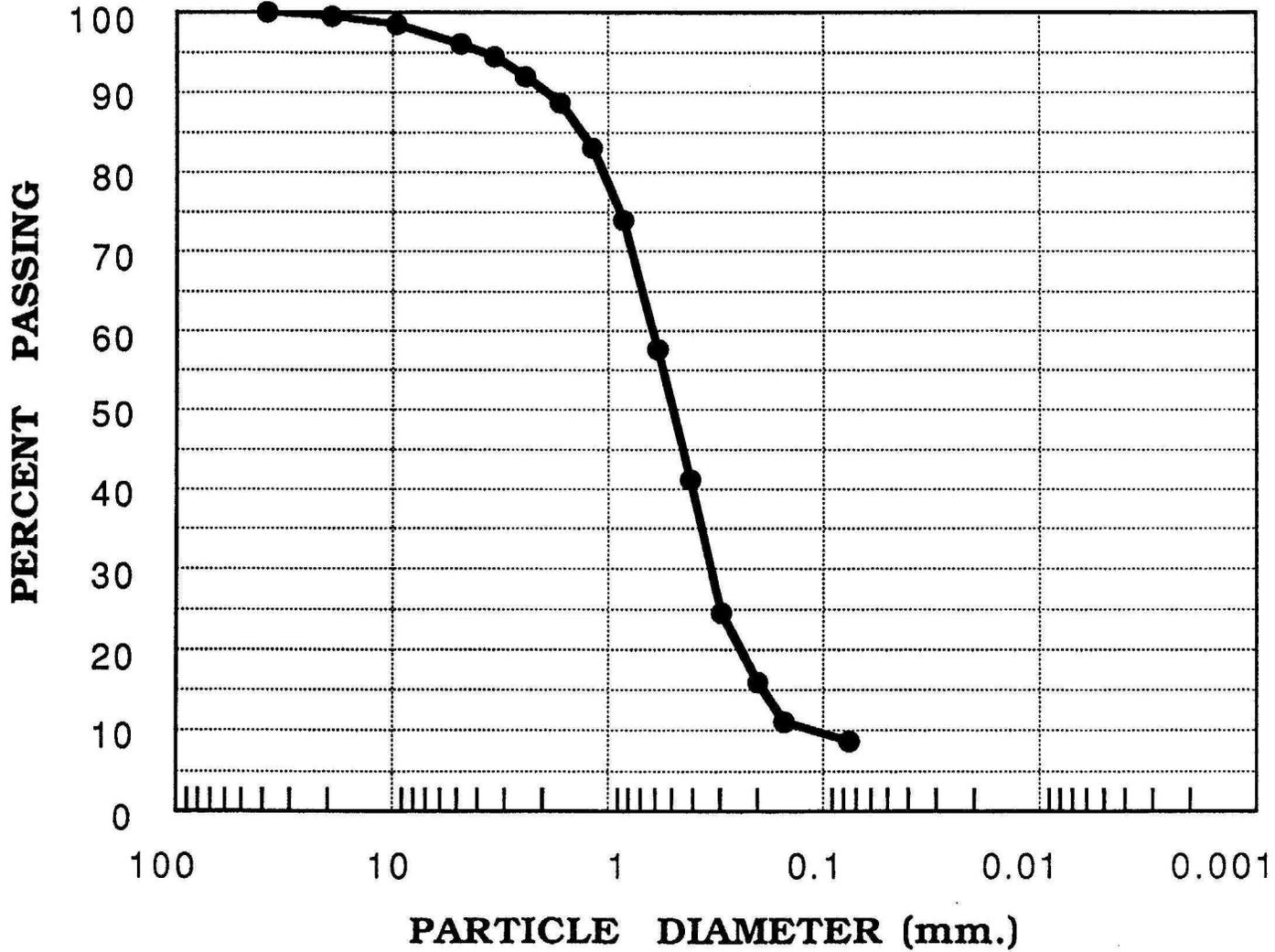
LINE # 16A W-E
USBR SITE # 21+00
SAMPLING DEPTH (ft.) 18-22

Particle Diameter @ 60% Passing = 0.42 mm.(0.017 in.)



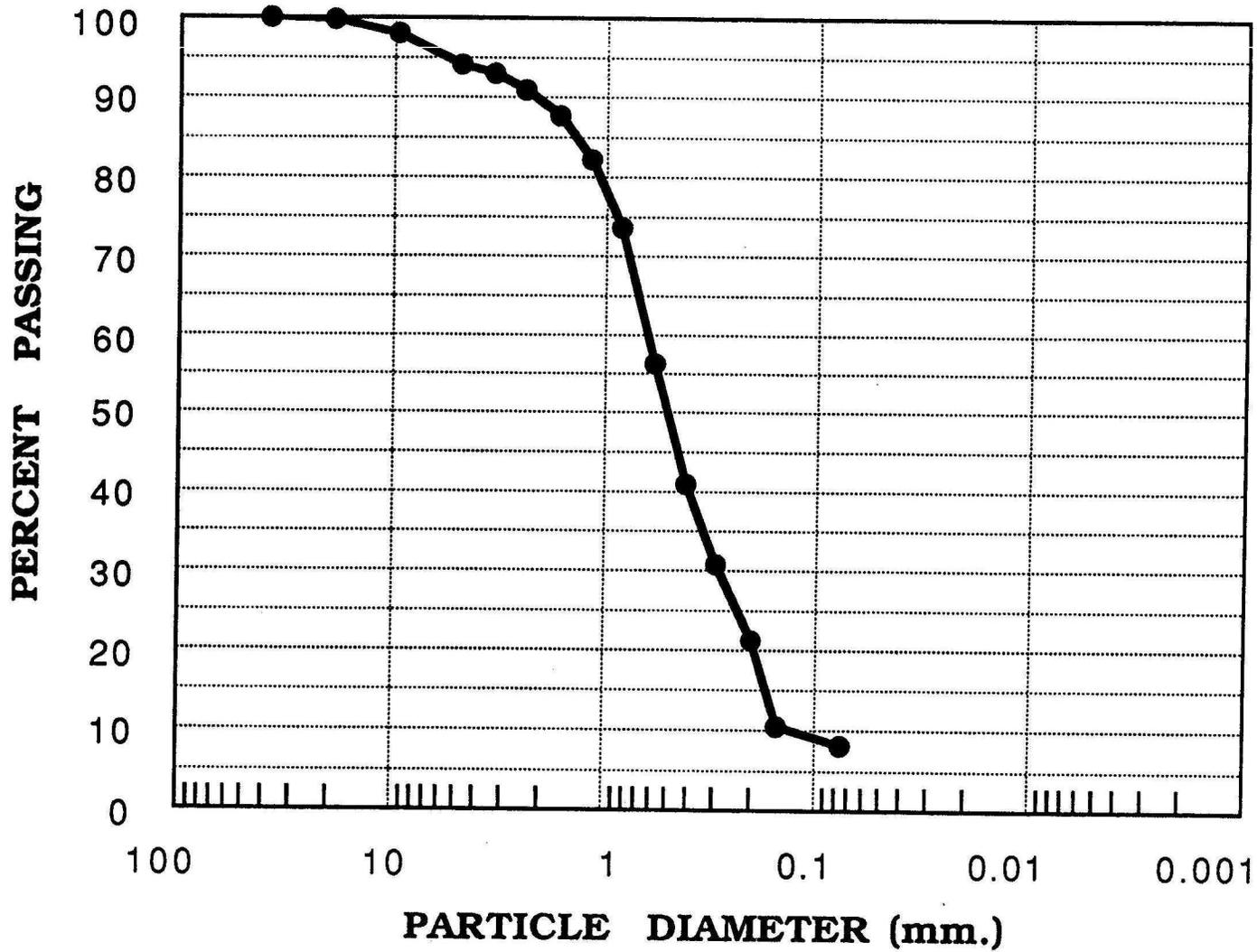
LINE # 16A2 E-W
USBR SITE # 2+00
SAMPLING DEPTH (ft.) 13-28

Particle Diameter @ 60% Passing = 0.60 mm.(0.024 in.)



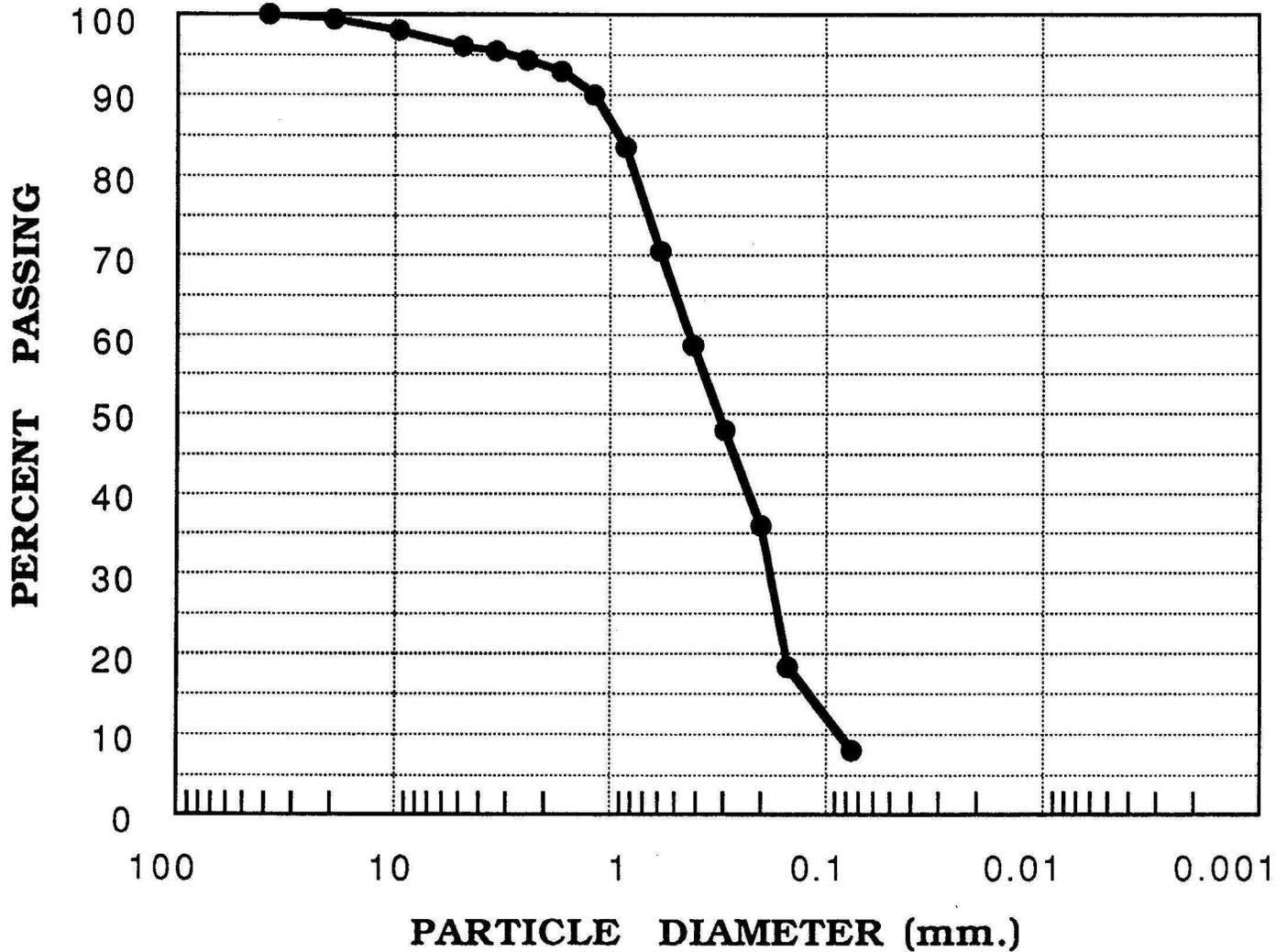
LINE # 16A2 E-W
USBR SITE # 6+00
SAMPLING DEPTH (ft.) 13-29

Particle Diameter @ 60% Passing = 0.63 mm.(0.025 in.)



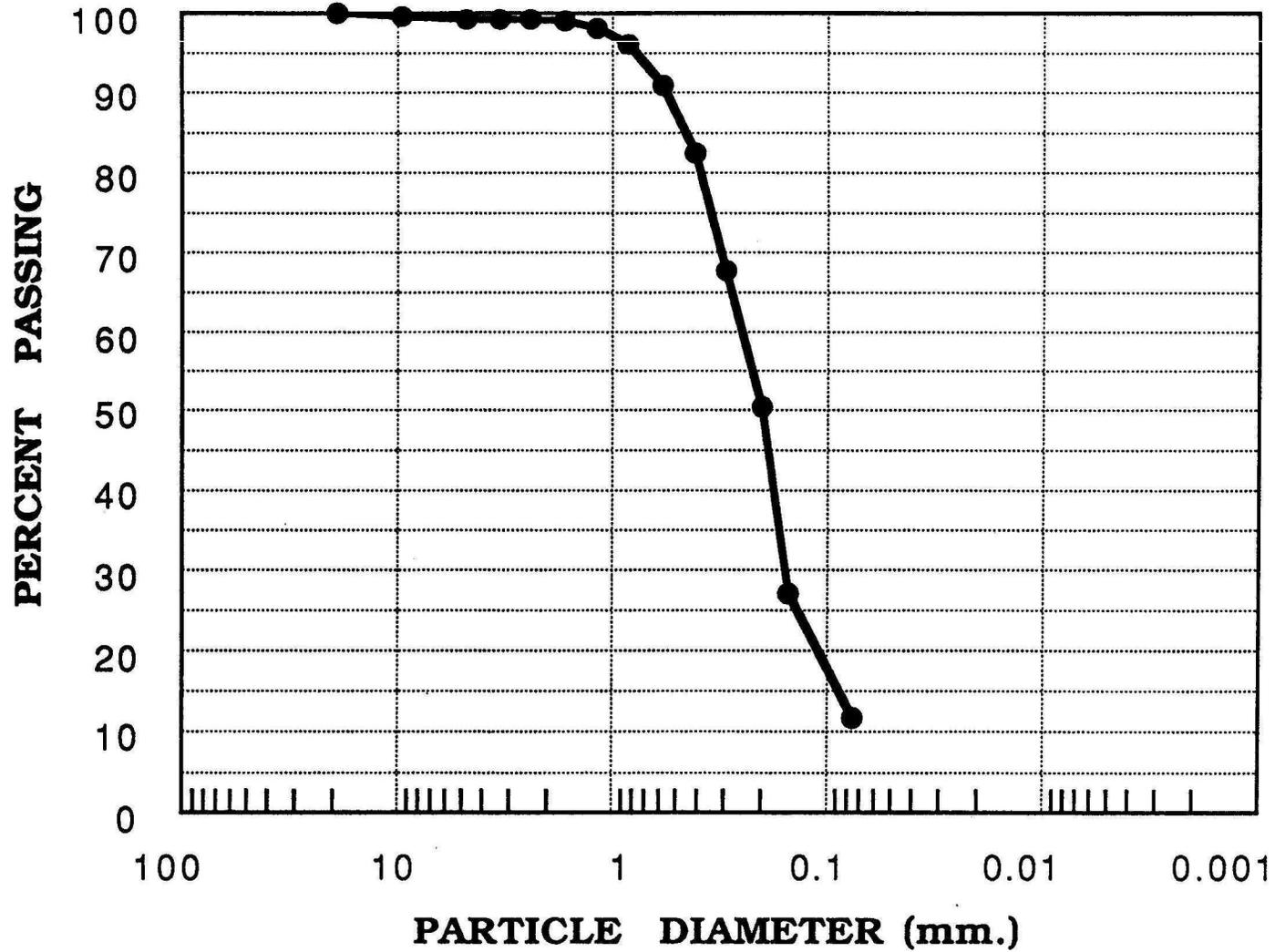
LINE # 16A2 E-W
USBR SITE # 10+00
SAMPLING DEPTH (ft.) 14-21

Particle Diameter @ 60% Passing = 0.42 mm.(0.017 in.)



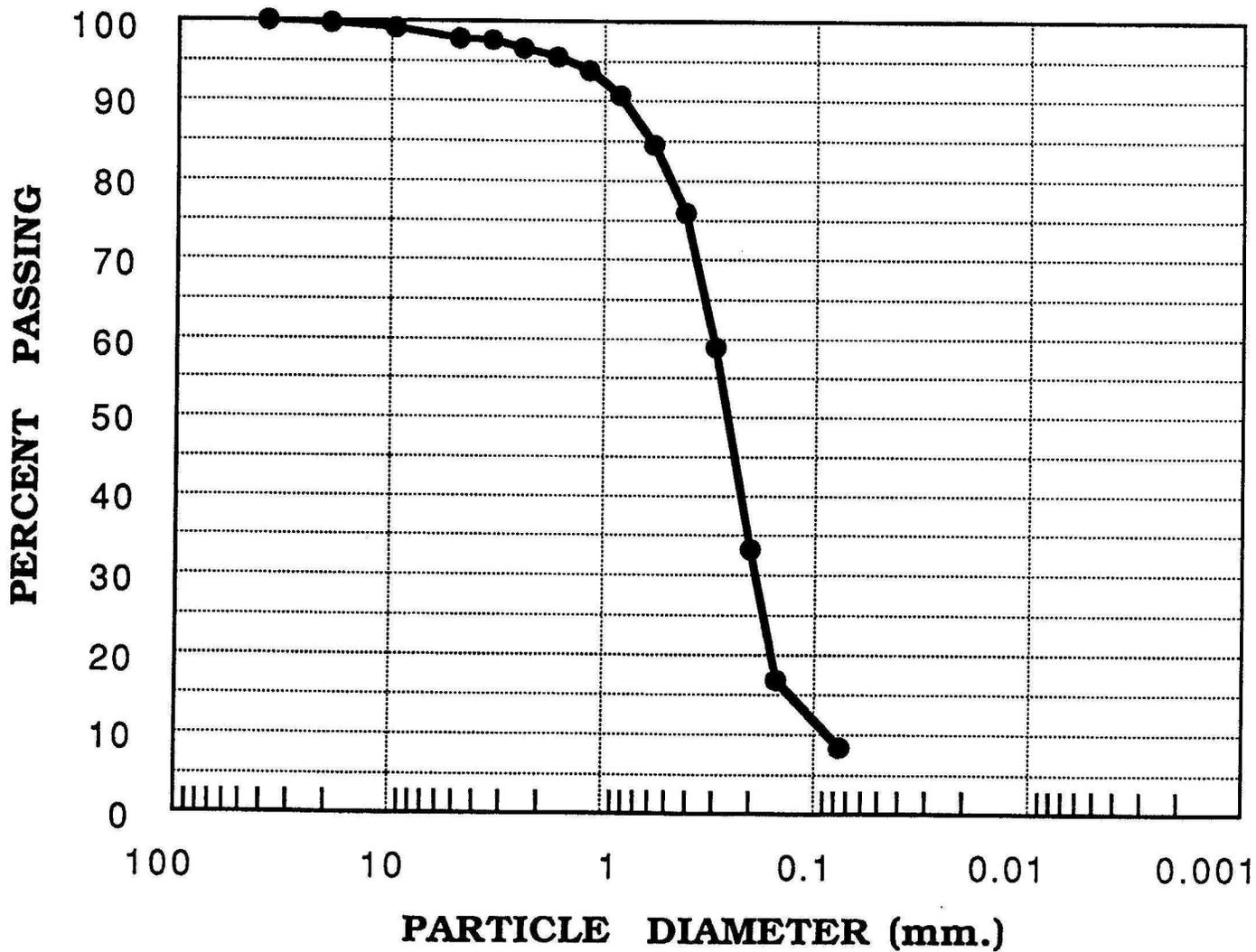
LINE # 16A2 E-W
USBR SITE # 10+00
SAMPLING DEPTH (ft.) 21-28

Particle Diameter @ 60% Passing = 0.25 mm.(0.010 in.)



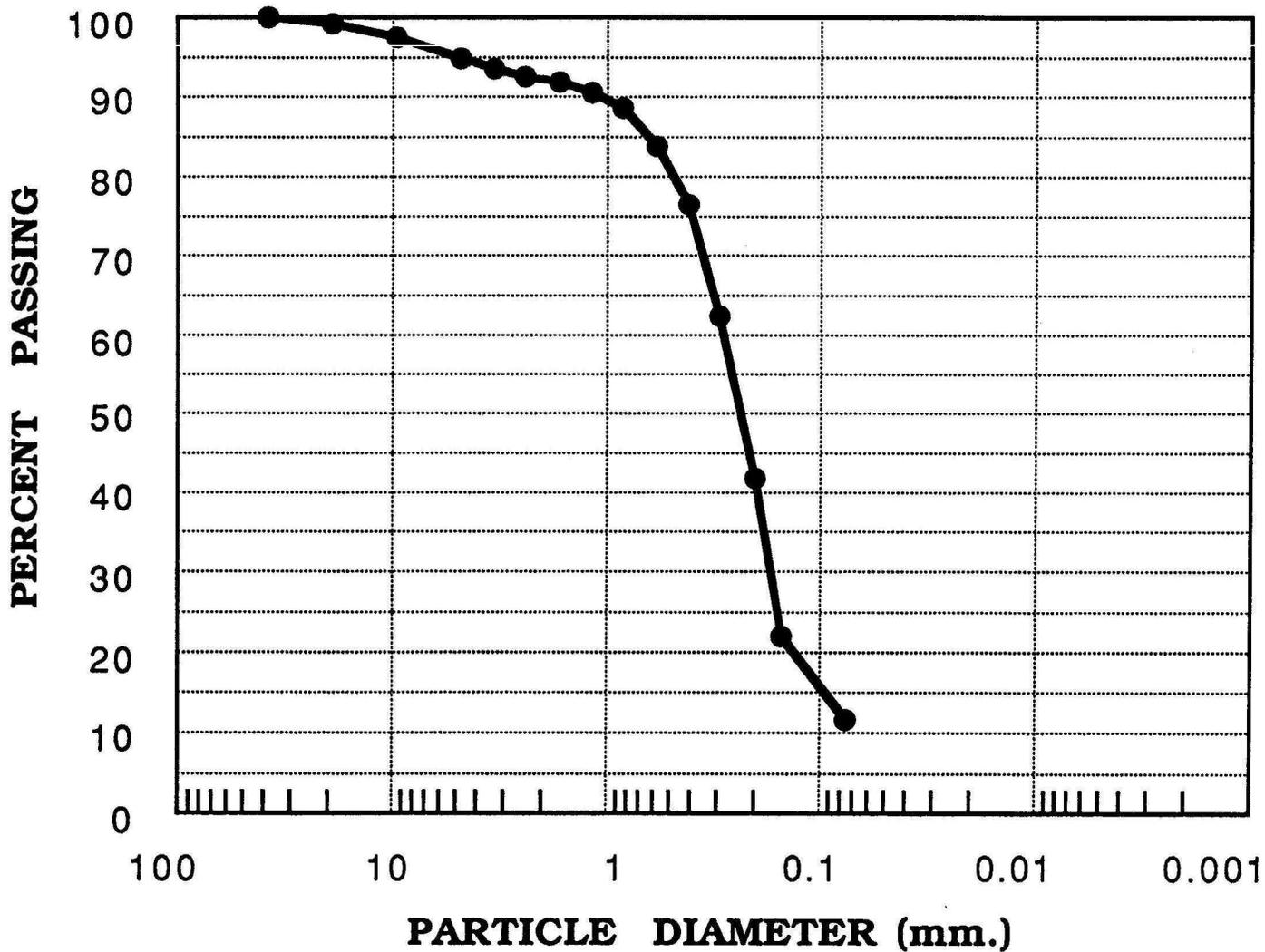
LINE # 16A2 E-W
USBR SITE # 12+00
SAMPLING DEPTH (ft.) 18-25

Particle Diameter @ 60% Passing = 0.29 mm.(0.011 in.)



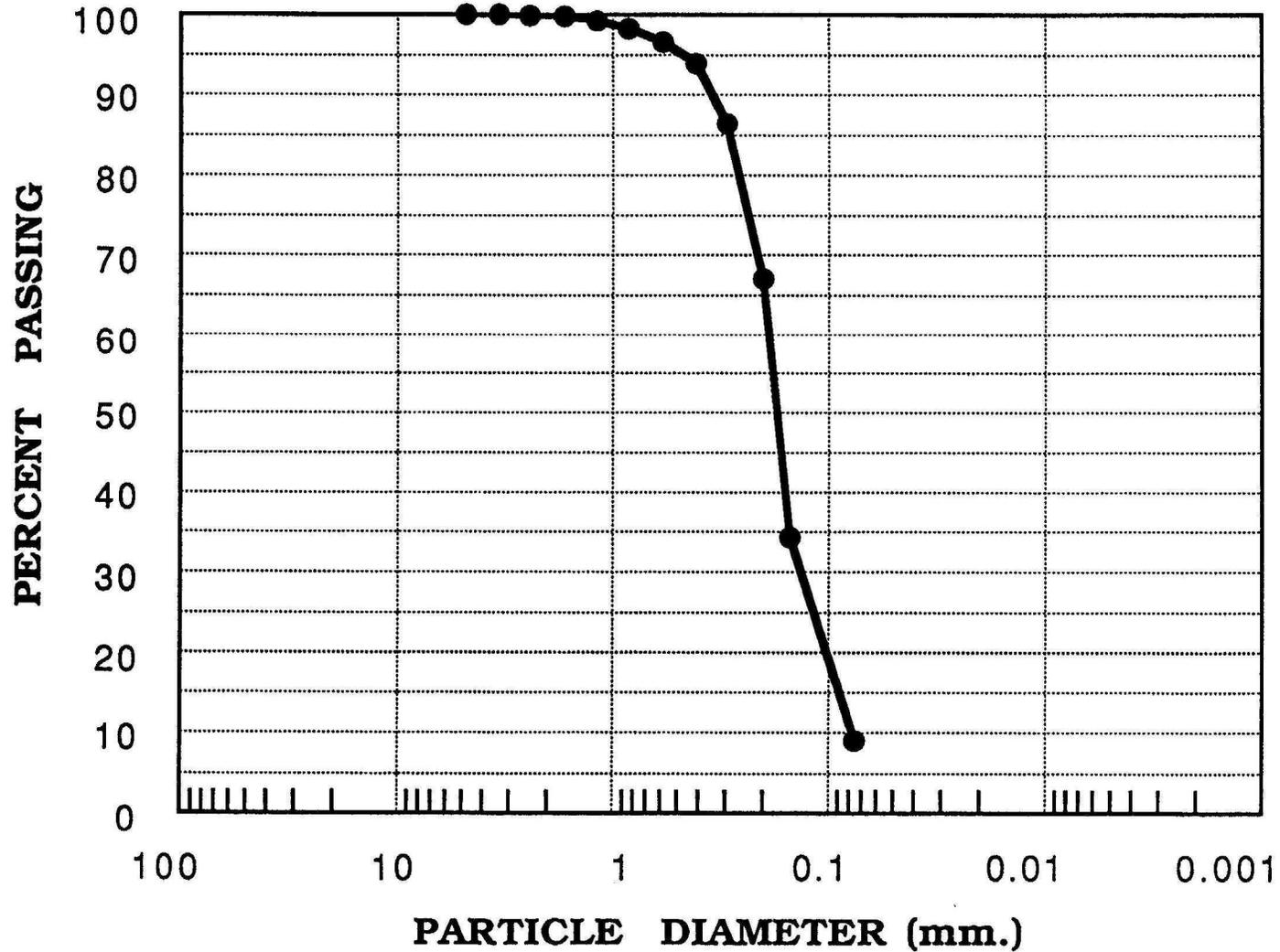
LINE # 16A2 E-W
USBR SITE # 12+00
SAMPLING DEPTH (ft.) 25-33

Particle Diameter @ 60% Passing = 0.29 mm.(0.011 in.)



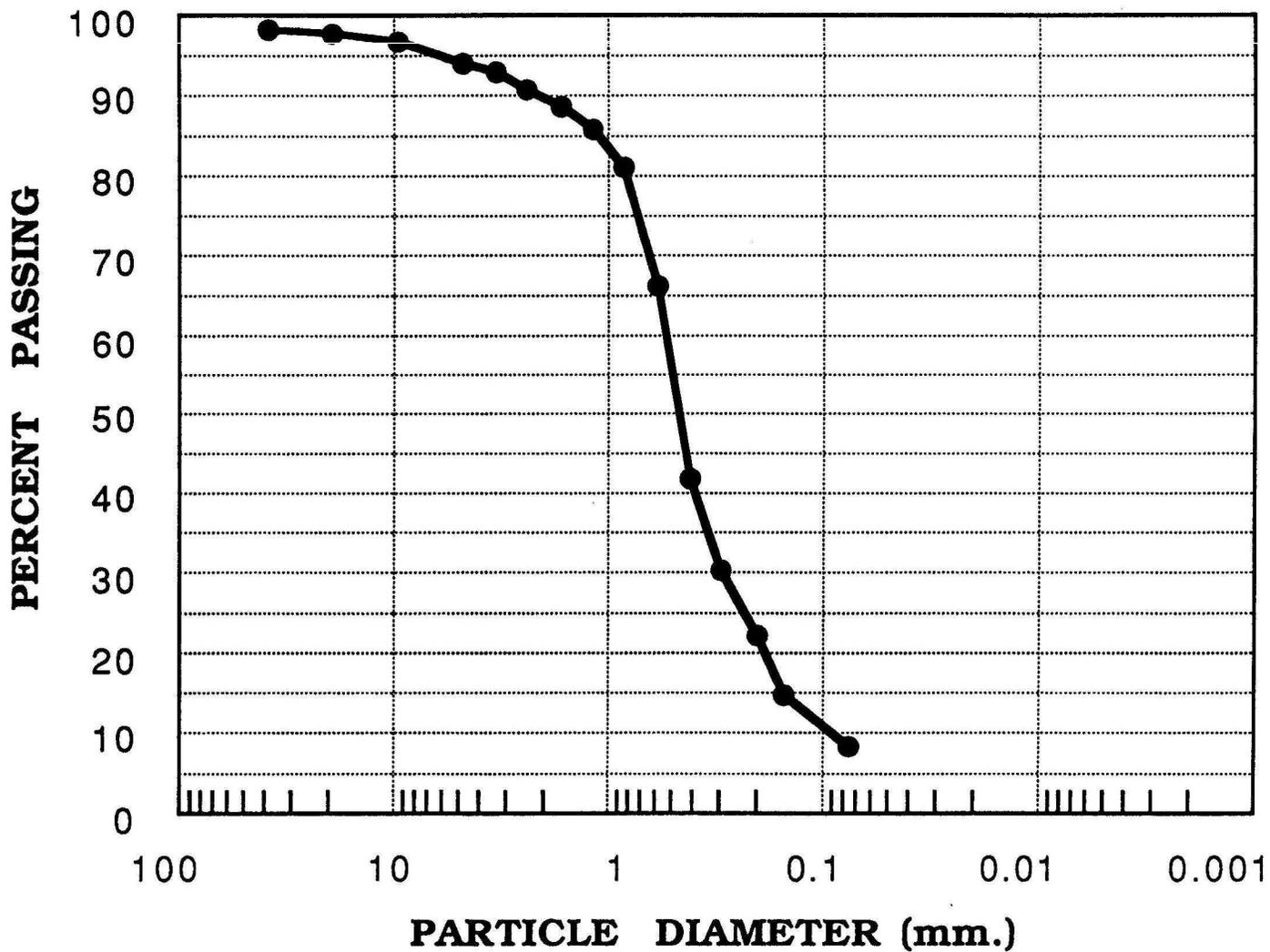
LINE # 16A2 E-W
USBR SITE # 14+00
SAMPLING DEPTH (ft.) 18-30

Particle Diameter @ 60% Passing = 0.19 mm.(0.007 in.)



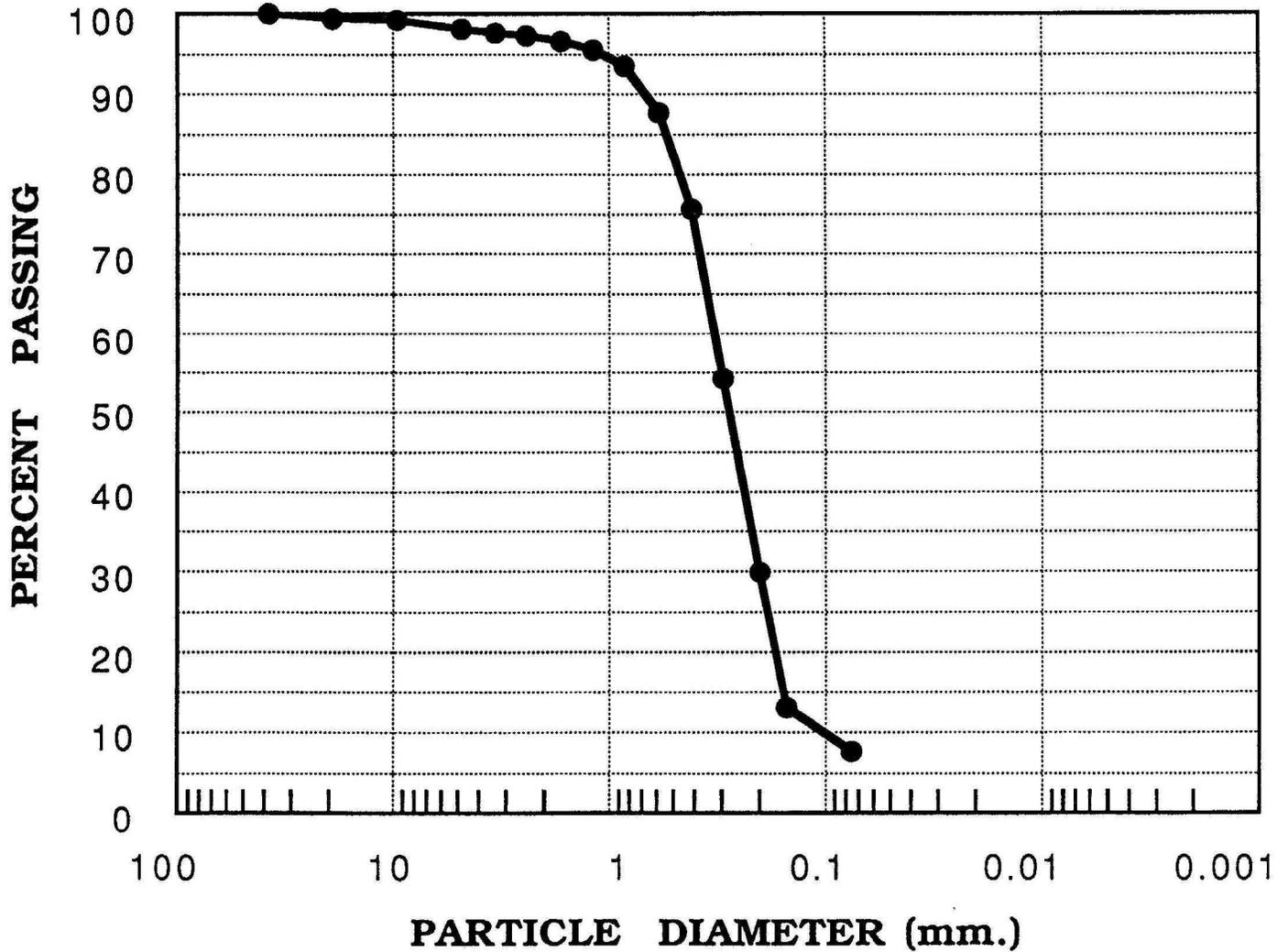
LINE # 16A2 E-W
USBR SITE # 18+00
SAMPLING DEPTH (ft.) 13-24

Particle Diameter @ 60% Passing = 0.53 mm.(0.021 in.)



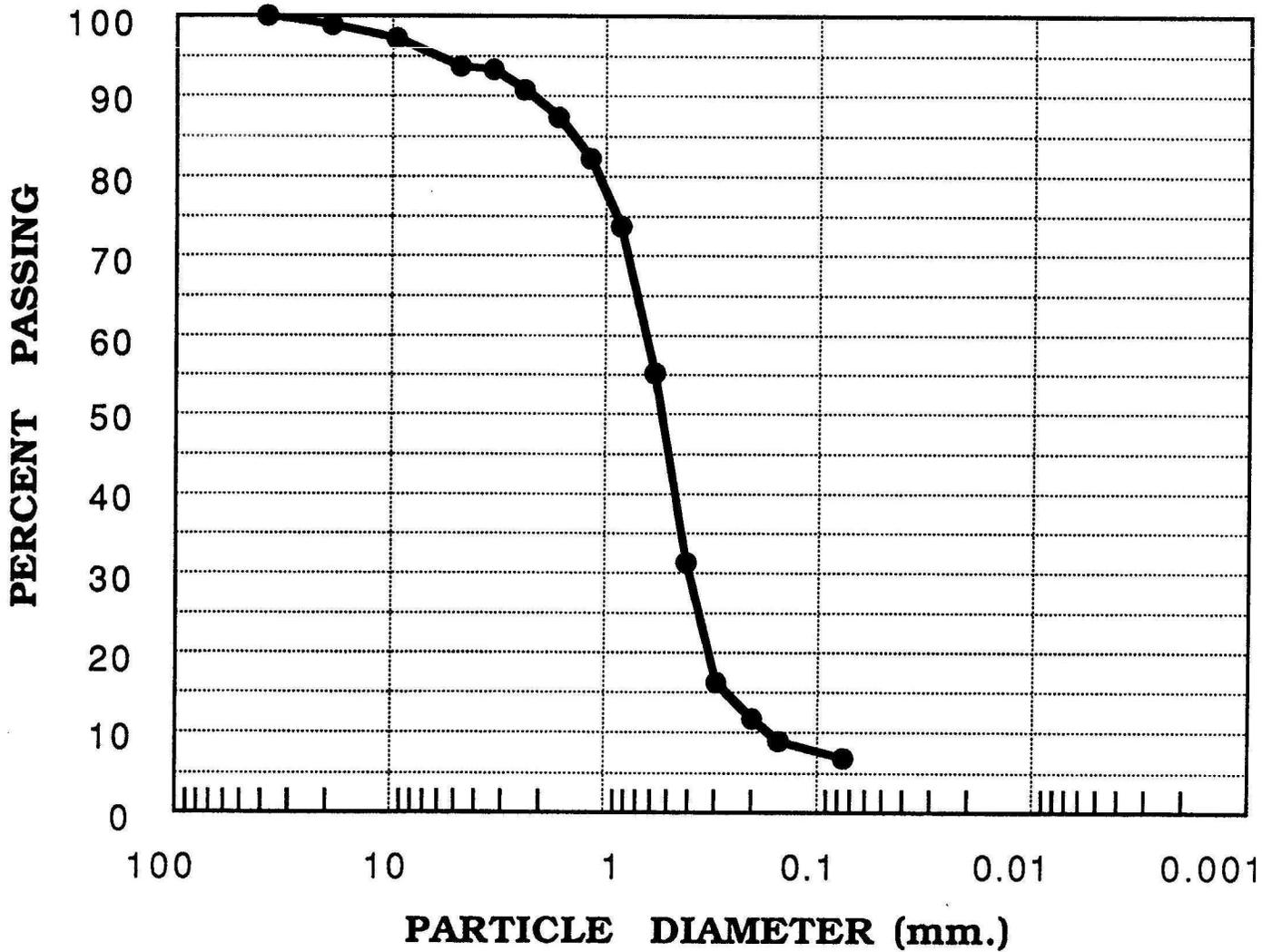
LINE # 16A2 E-W
USBR SITE # 18+00
SAMPLING DEPTH (ft.) 24-37

Particle Diameter @ 60% Passing = 0.32 mm.(0.013 in.)



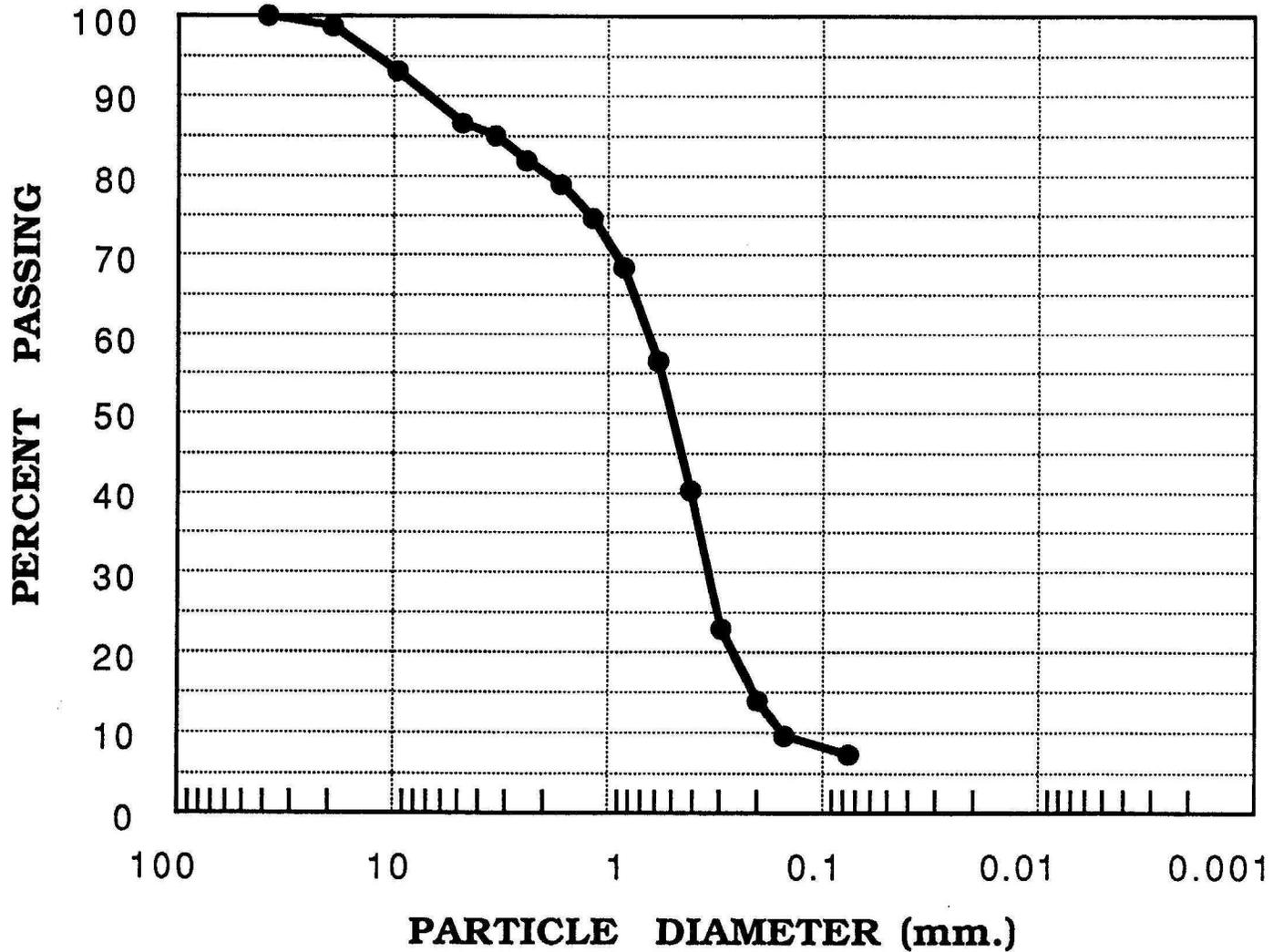
LINE # 16A2 E-W
USBR SITE # 22+00
SAMPLING DEPTH (ft.) 12-31

Particle Diameter @ 60% Passing = 0.63 mm.(0.025 in.)



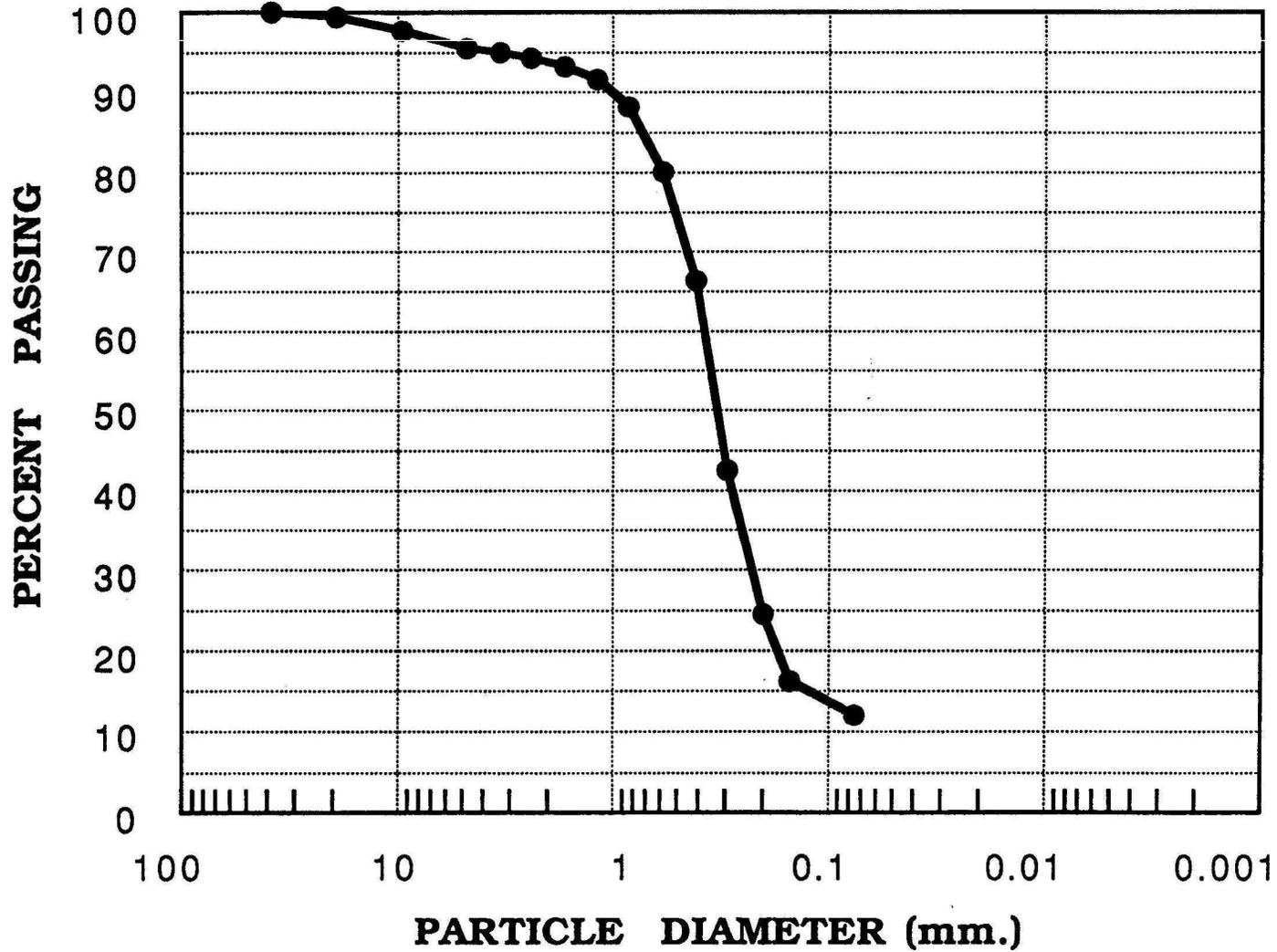
LINE # 16A2 E-W
USBR SITE # 23+00
SAMPLING DEPTH (ft.) 12.5-18

Particle Diameter @ 60% Passing = 0.63 mm.(0.025 in.)



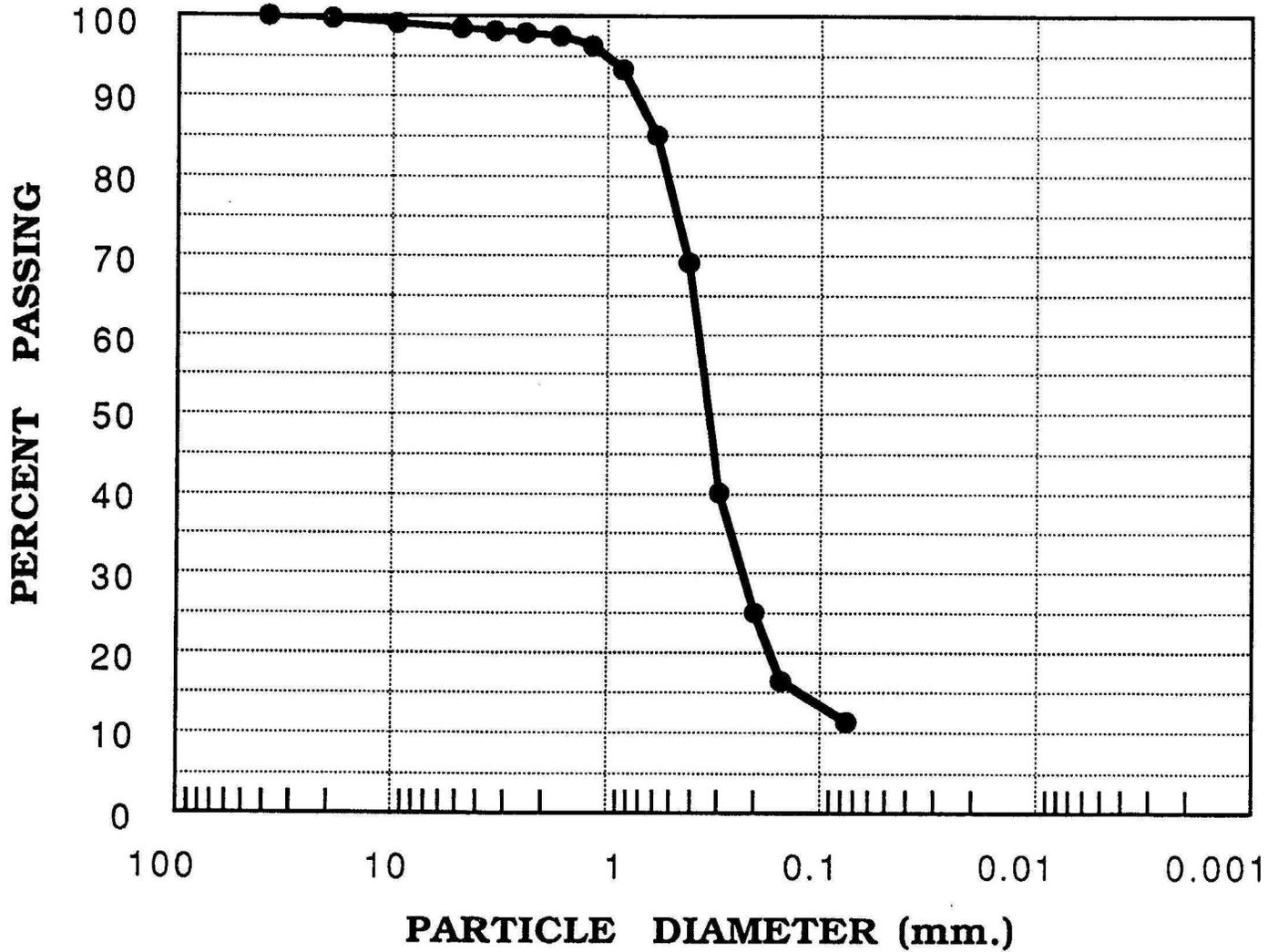
LINE # 16A2 E-W
USBR SITE # 23+00
SAMPLING DEPTH (ft.) 18-26

Particle Diameter @ 60% Passing = 0.36 mm.(0.014 in.)



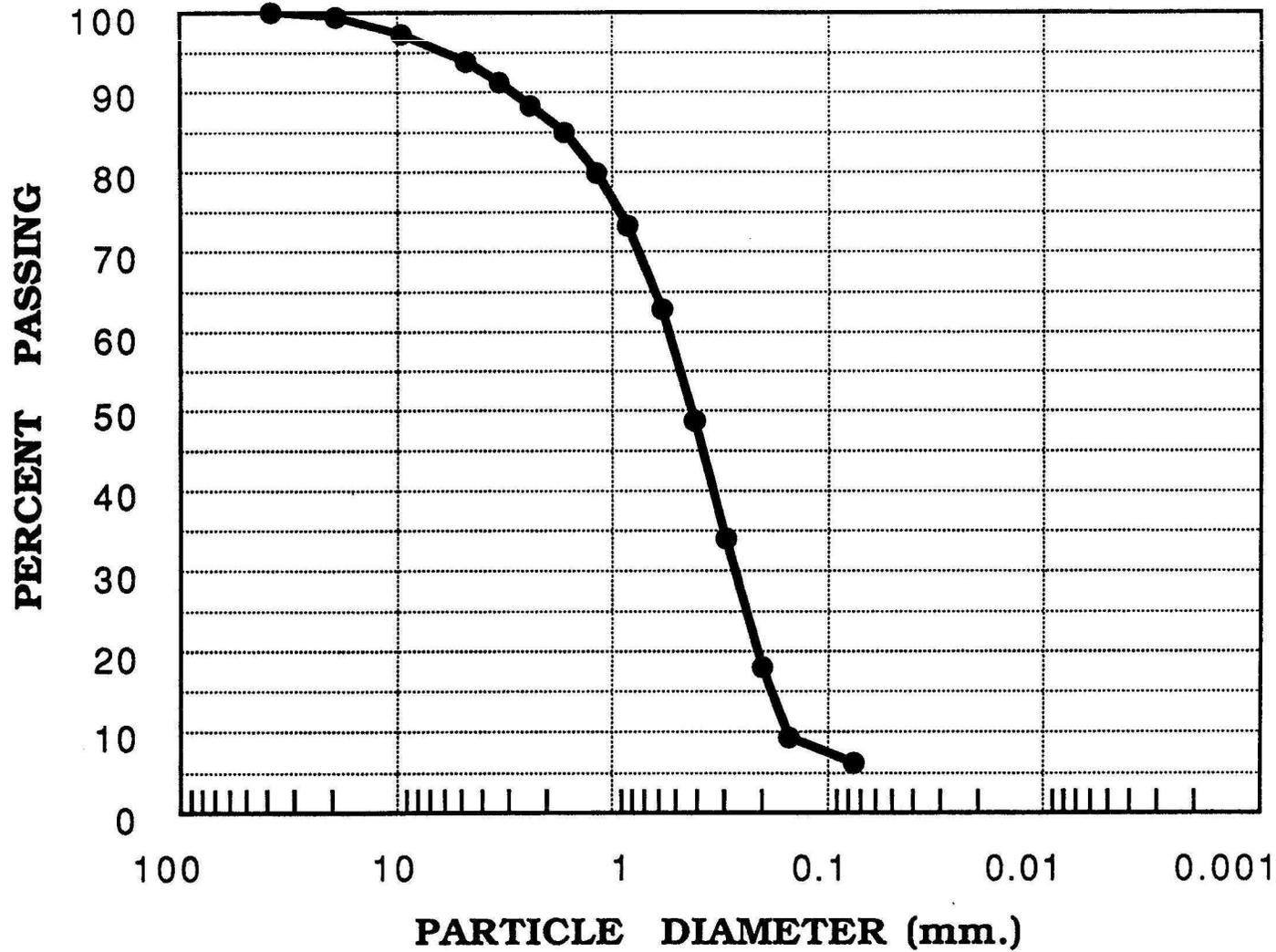
LINE # 16A2 E-W
USBR SITE # 26+00
SAMPLING DEPTH (ft.) 13-25

Particle Diameter @ 60% Passing = 0.36 mm.(0.014 in.)



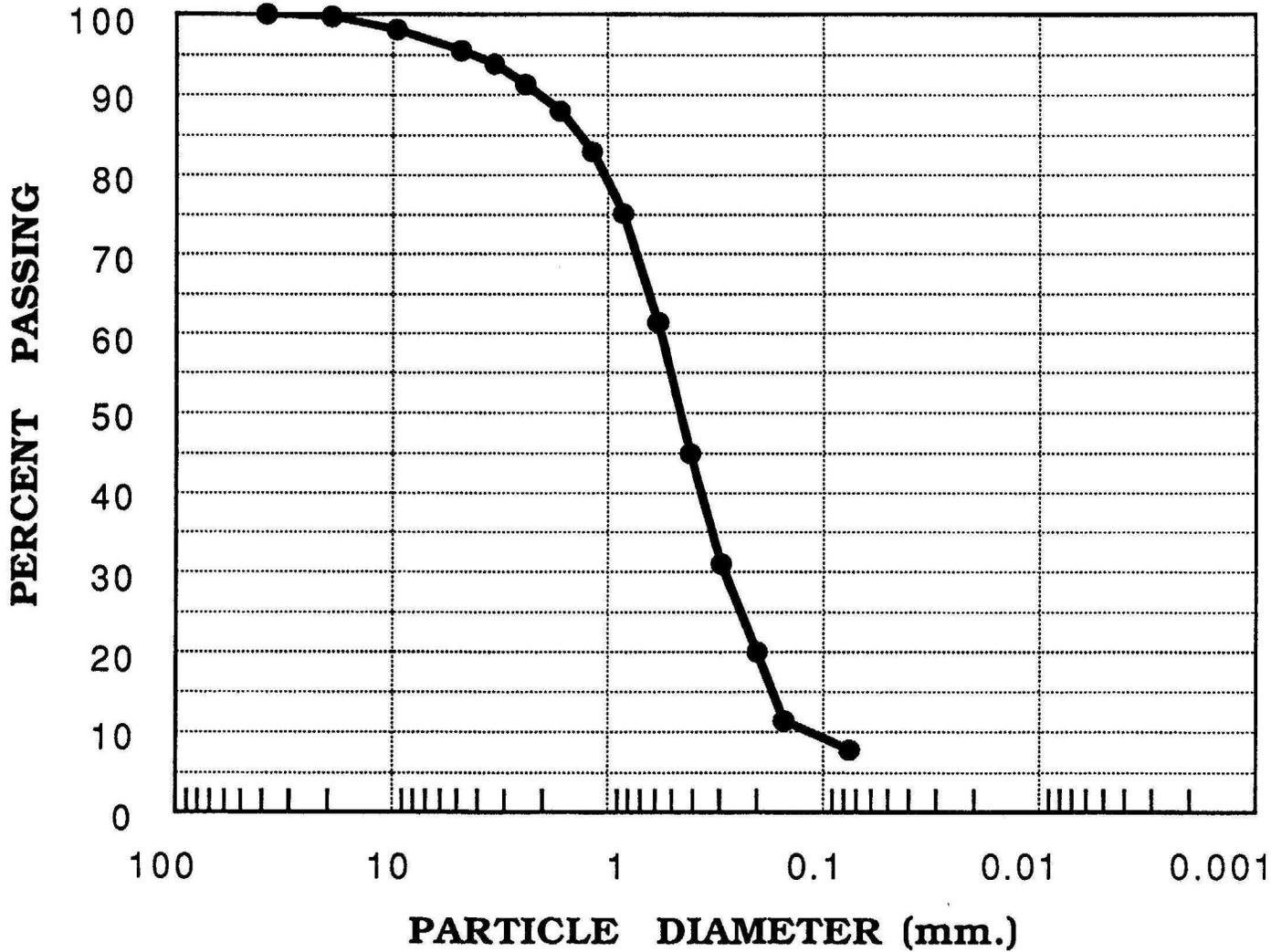
LINE # 16A3 E-W
USBR SITE # 2+00
SAMPLING DEPTH (ft.) 18-30

Particle Diameter @ 60% Passing = 0.55 mm.(0.022 in.)



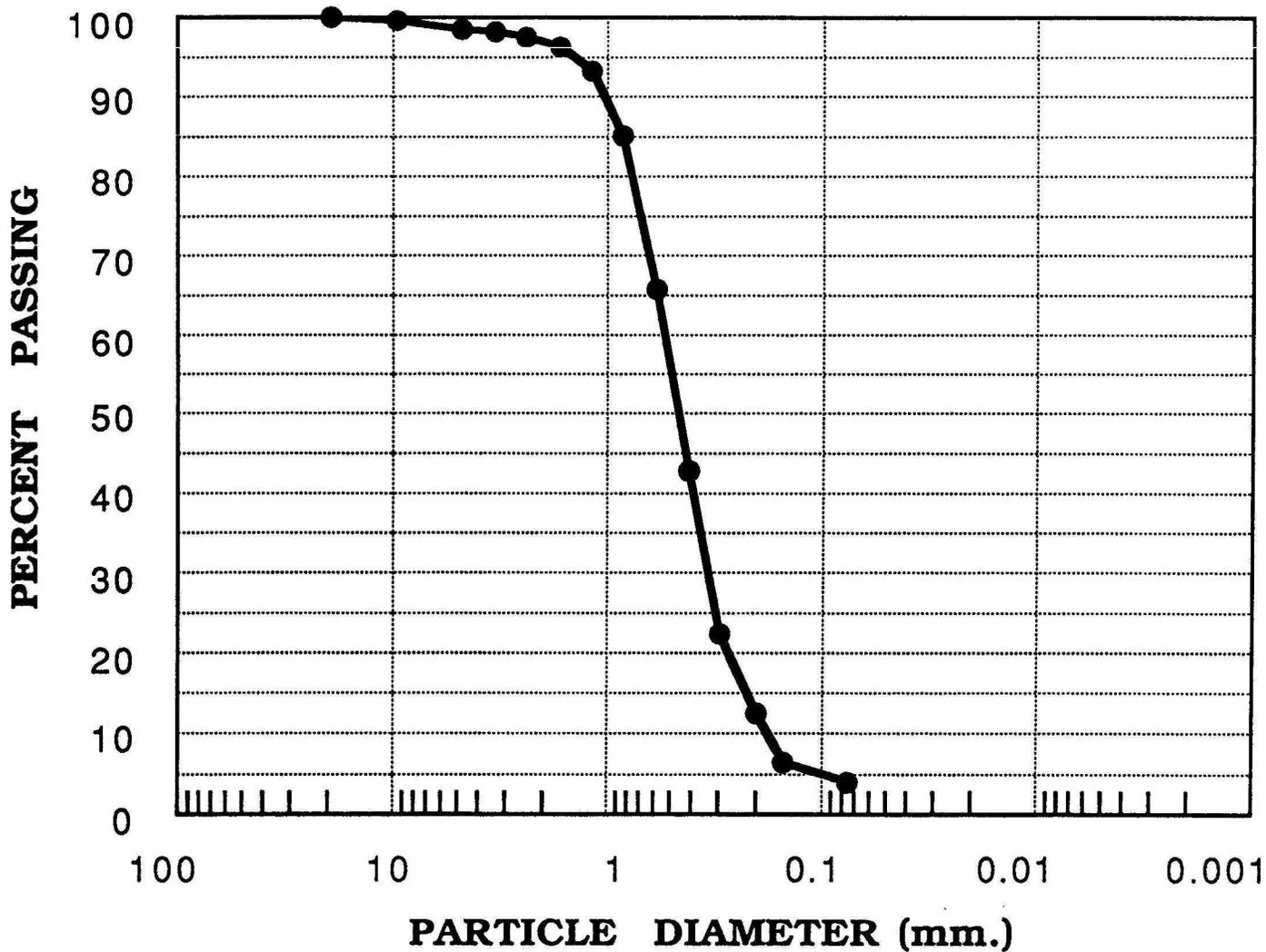
**LINE # 16A3 E-W
USBR SITE # 6+00
SAMPLING DEPTH (ft.) 19-29**

Particle Diameter @ 60% Passing = 0.58 mm.(0.023 in.)



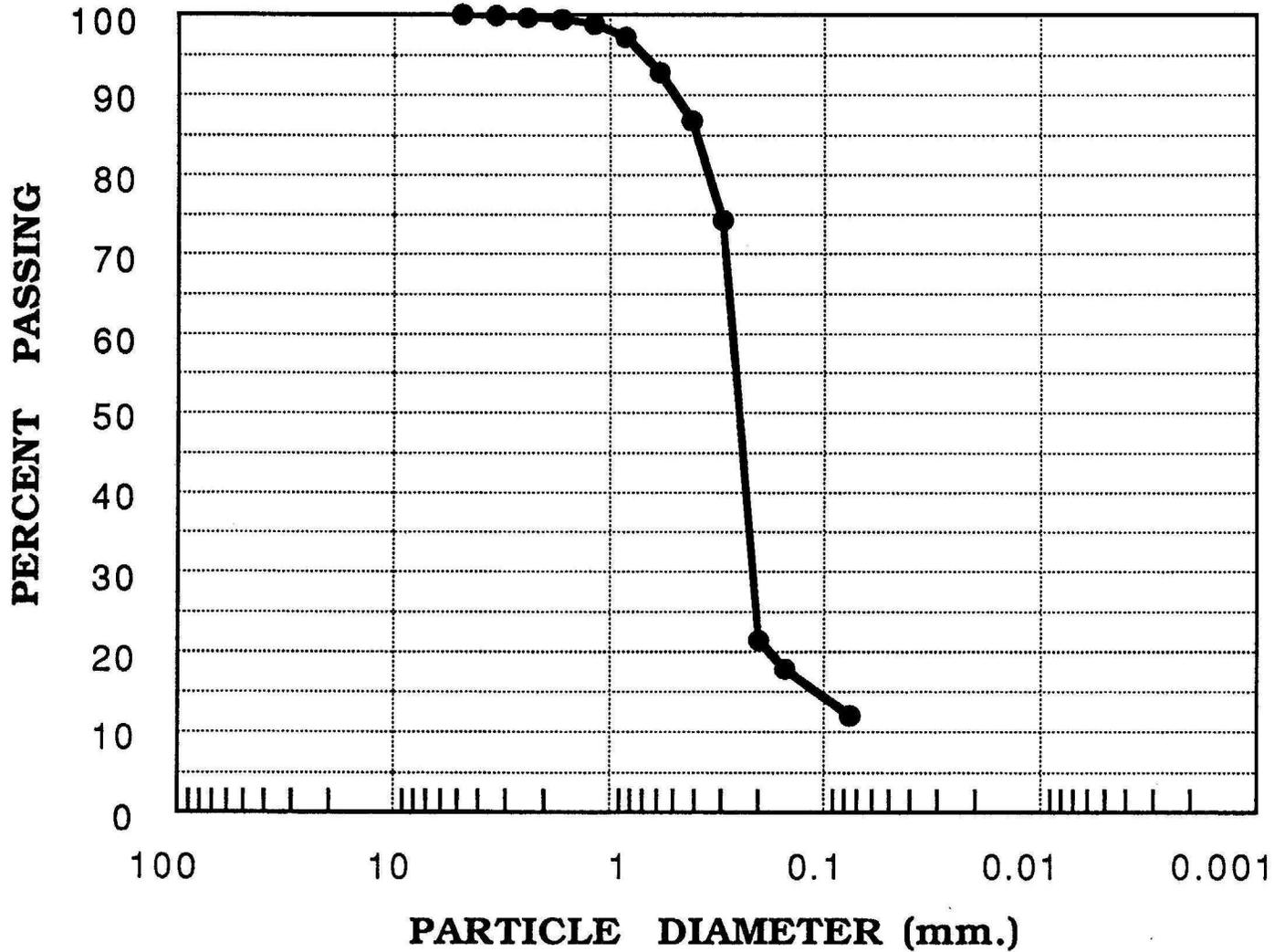
LINE # 16A3 E-W
USBR SITE # 10+00
SAMPLING DEPTH (ft.) 18-32

Particle Diameter @ 60% Passing = 0.53 mm.(0.021 in.)



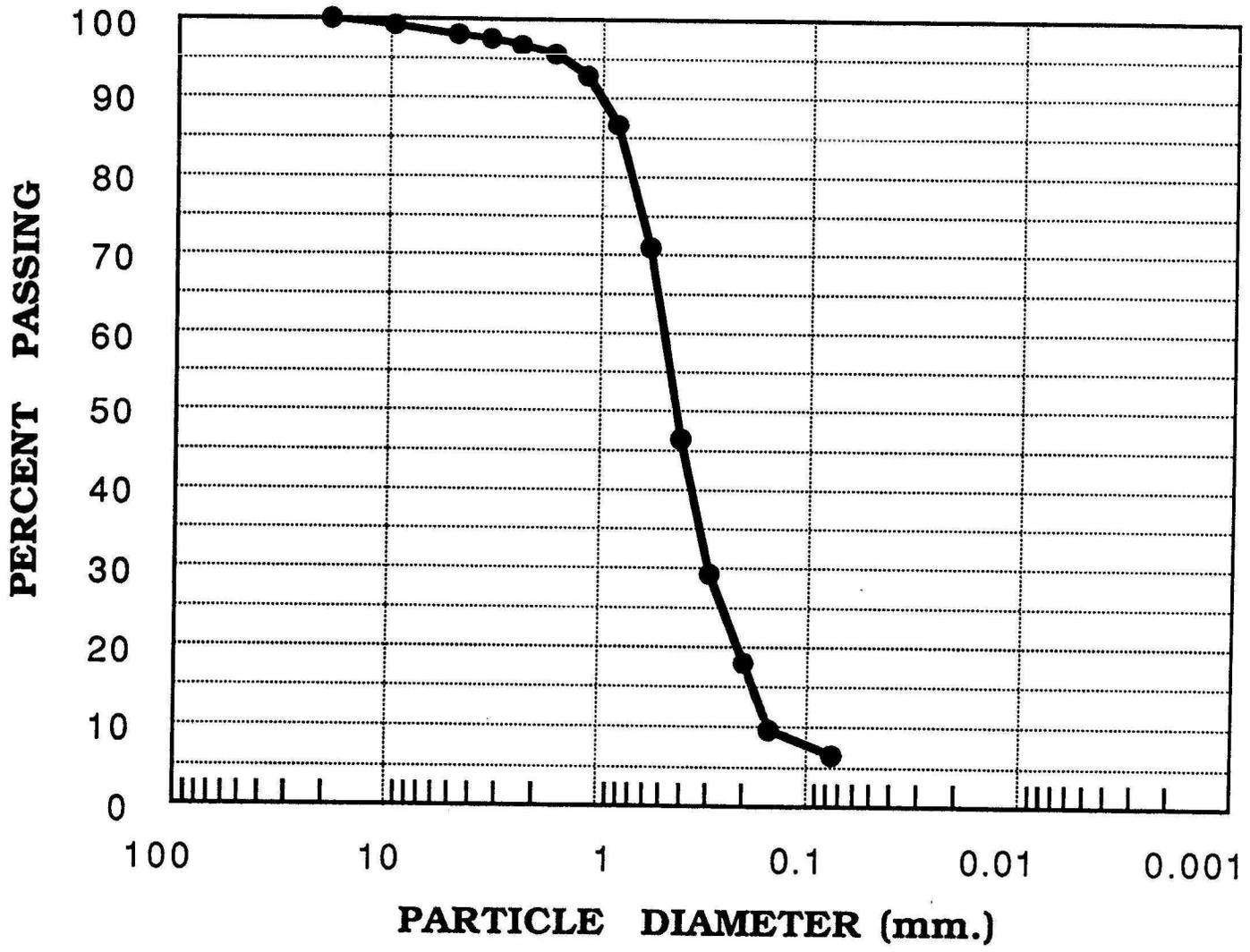
LINE # 16A3 E-W
USBR SITE # 14+00
SAMPLING DEPTH (ft.) 19-29

Particle Diameter @ 60% Passing = 0.26 mm.(0.010 in.)



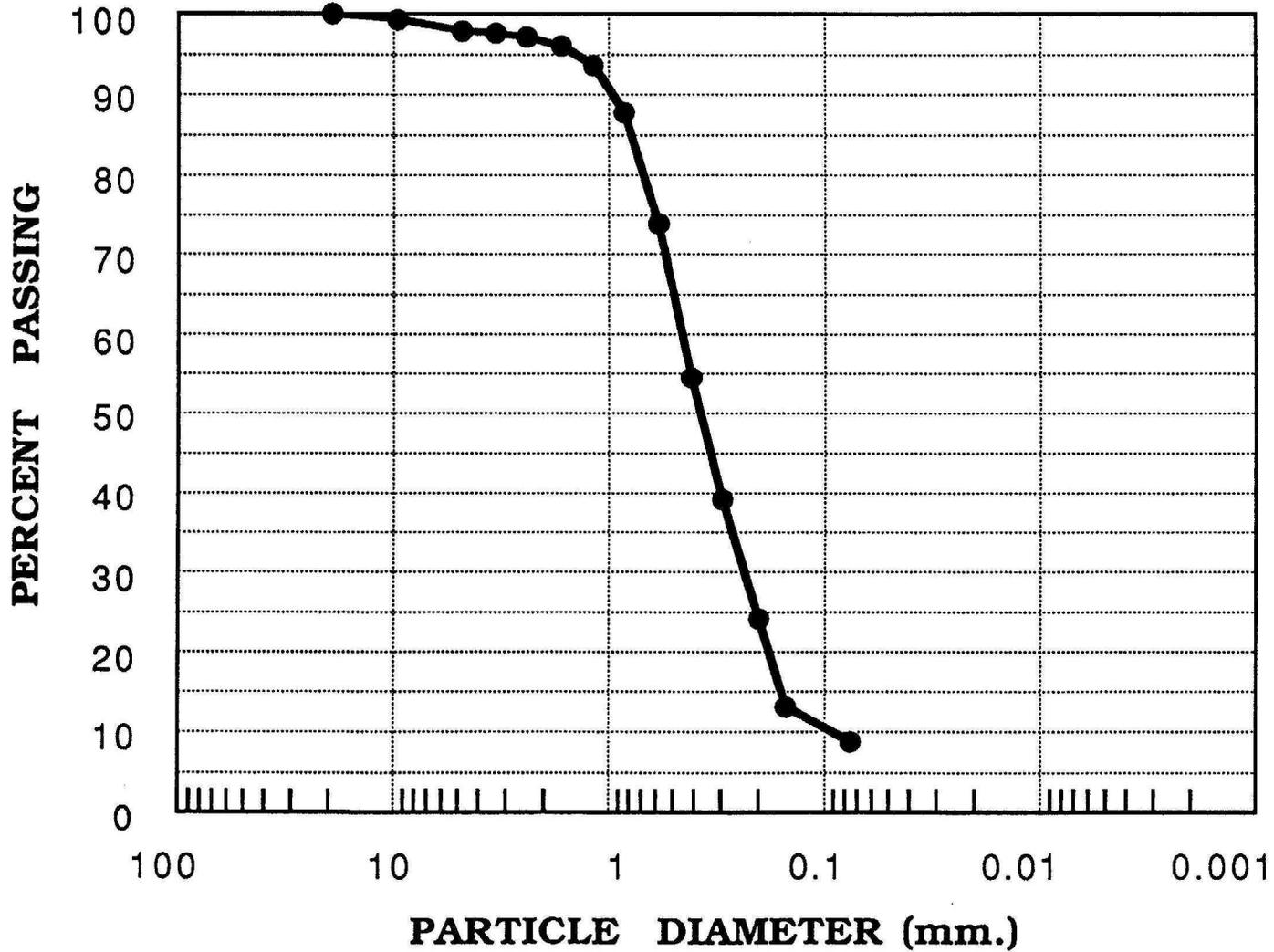
LINE # 16A3 E-W
USBR SITE # 17+00
SAMPLING DEPTH (ft.) 20-36

Particle Diameter @ 60% Passing = 0.48 mm.(0.019 in.)



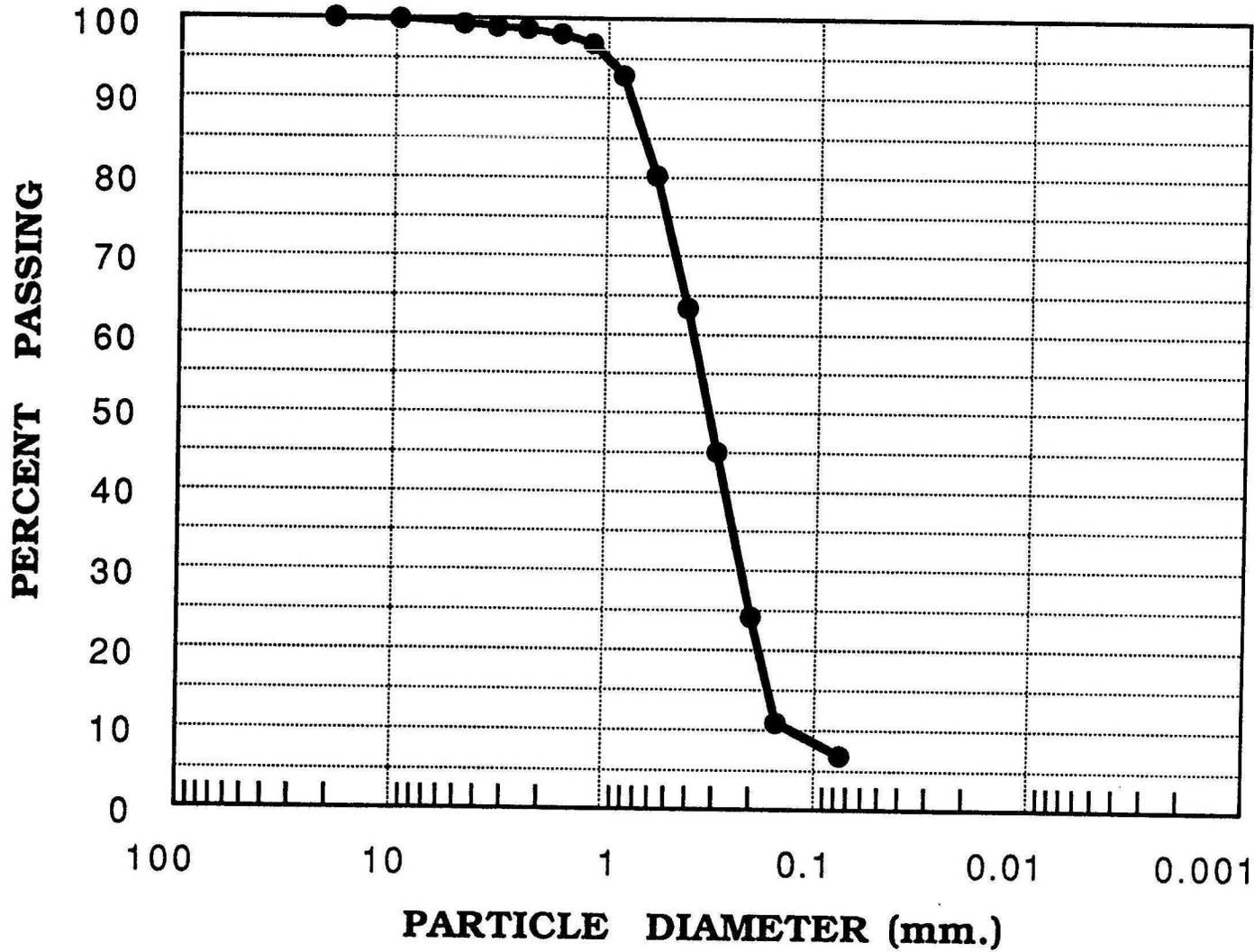
LINE # 16A3 E-W
USBR SITE # 18+00
SAMPLING DEPTH (ft.) 15-27.5

Particle Diameter @ 60% Passing = 0.44 mm.(0.017 in.)



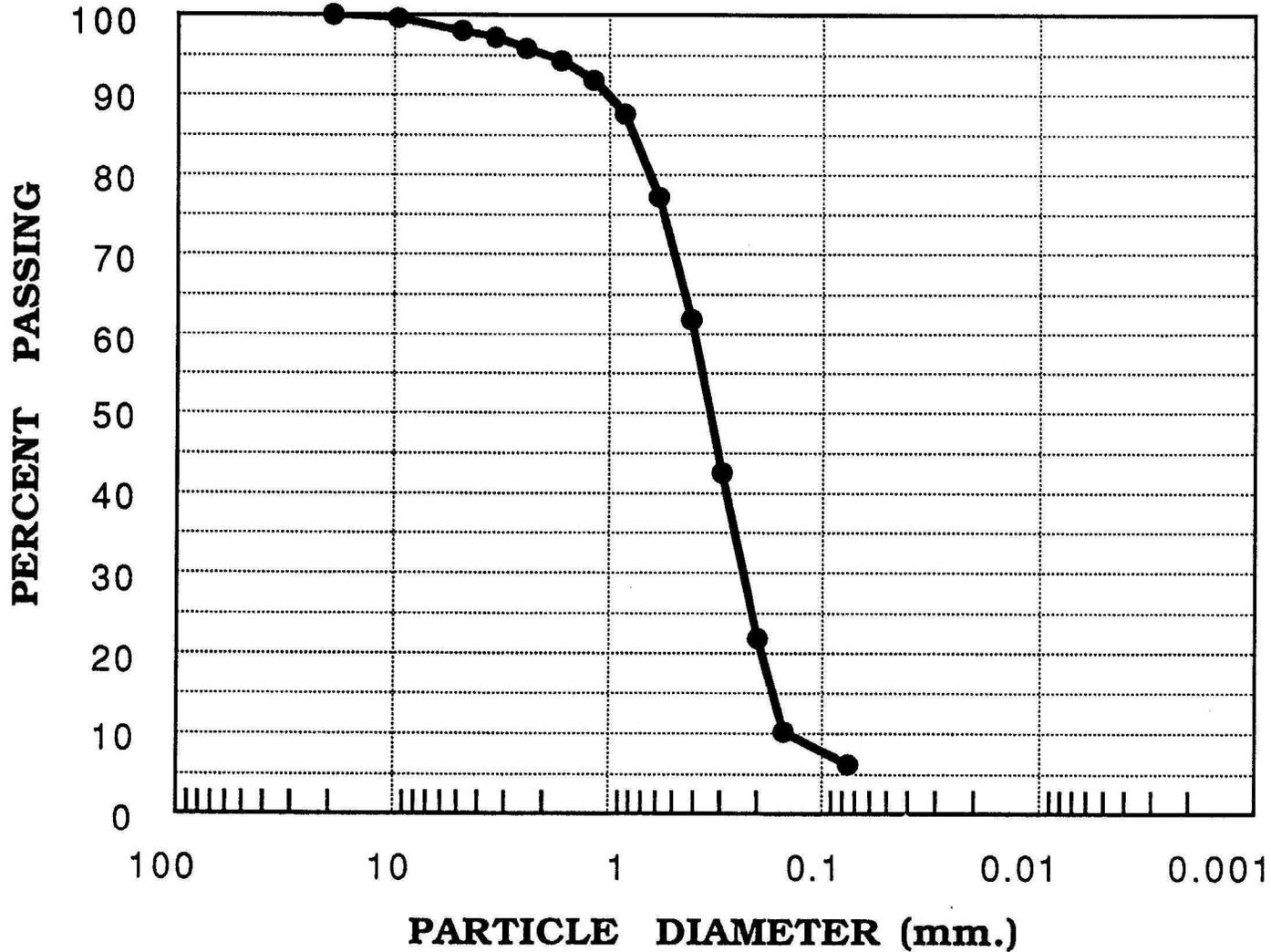
LINE # 16A3 E-W
USBR SITE # 18+00
SAMPLING DEPTH (ft.) 15-27.5

Particle Diameter @ 60% Passing = 0.38 mm.(0.015 in.)



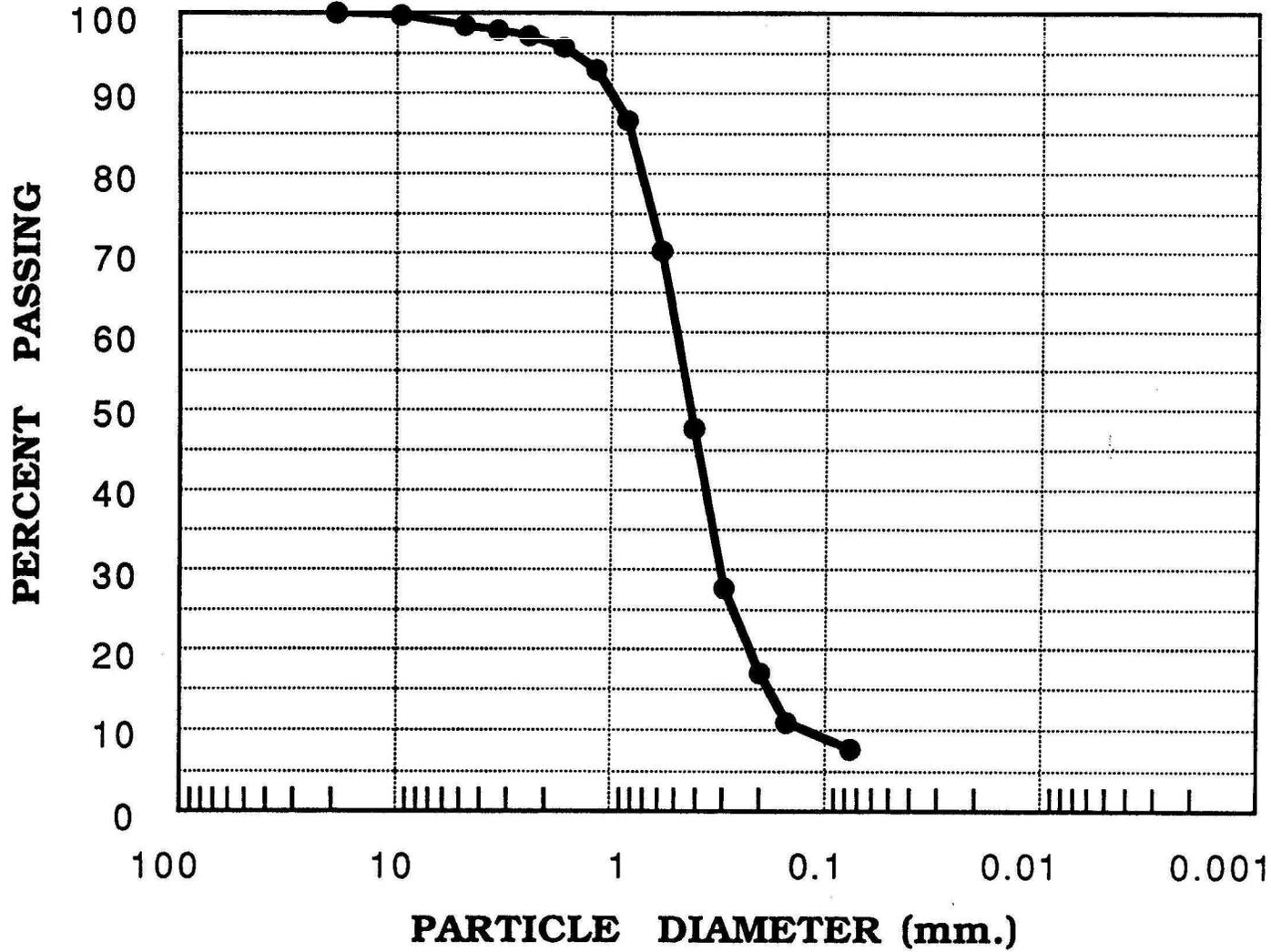
LINE # 16A3 E-W
USBR SITE # 22+00
SAMPLING DEPTH (ft.) 18-33.5

Particle Diameter @ 60% Passing = 0.40 mm.(0.016 in.)



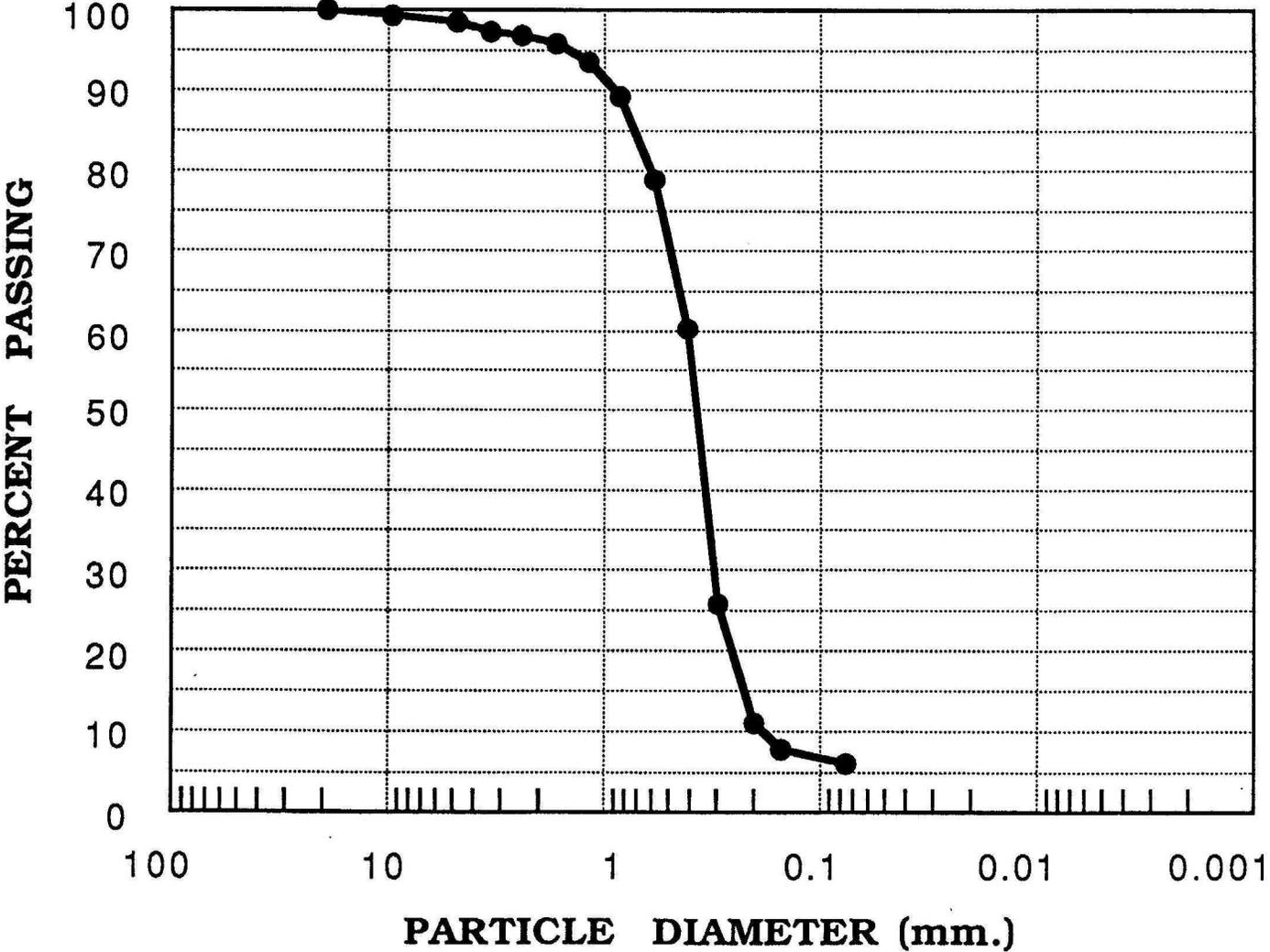
LINE # 16A3 E-W
USBR SITE # 25+77
SAMPLING DEPTH (ft.) 15-33

Particle Diameter @ 60% Passing = 0.50 mm.(0.020 in.)



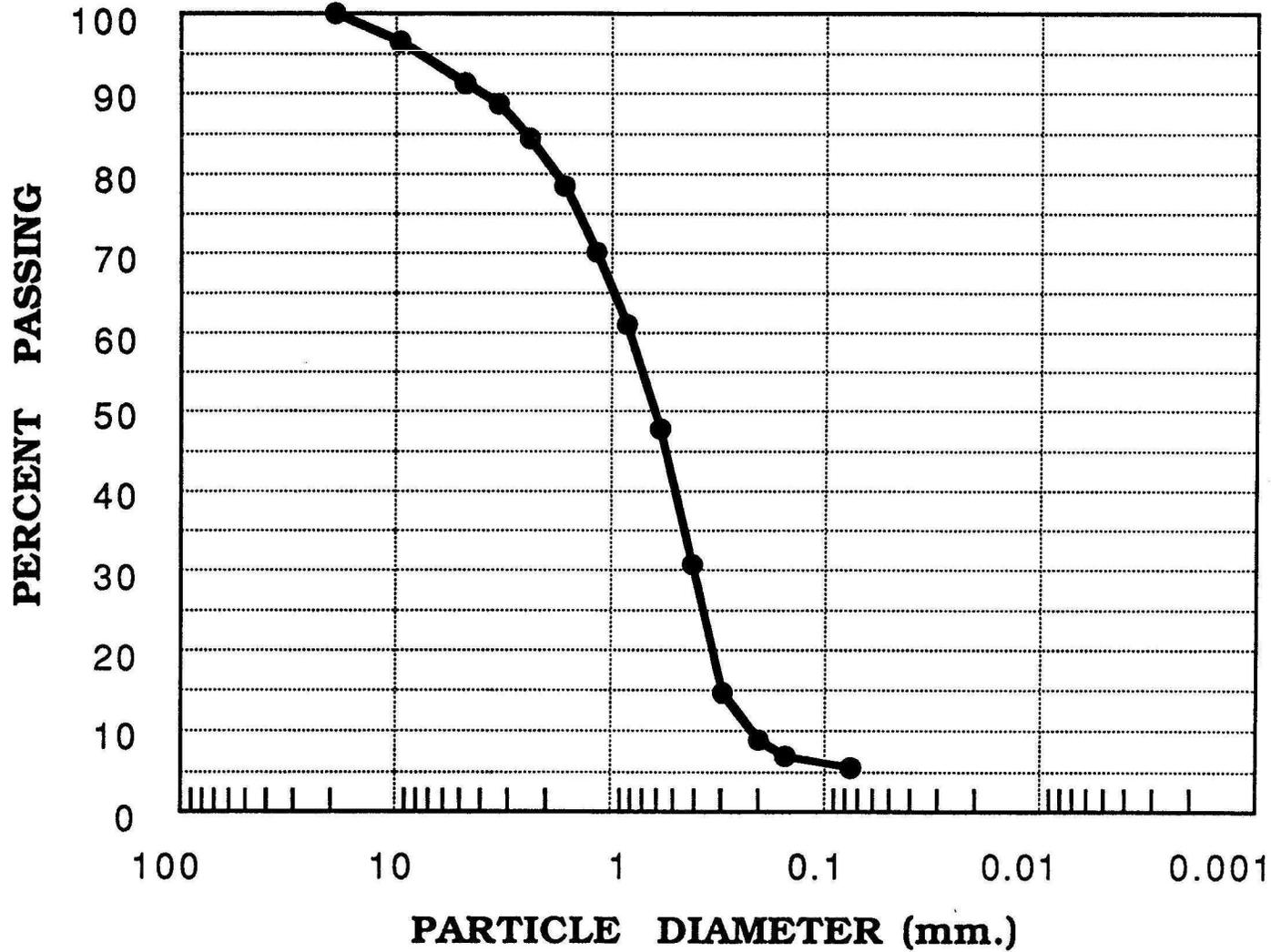
LINE # 16B2 N-S
USBR SITE # 207+00
SAMPLING DEPTH (ft.) 18-23

Particle Diameter @ 60% Passing = 0.44 mm.(0.017 in.)



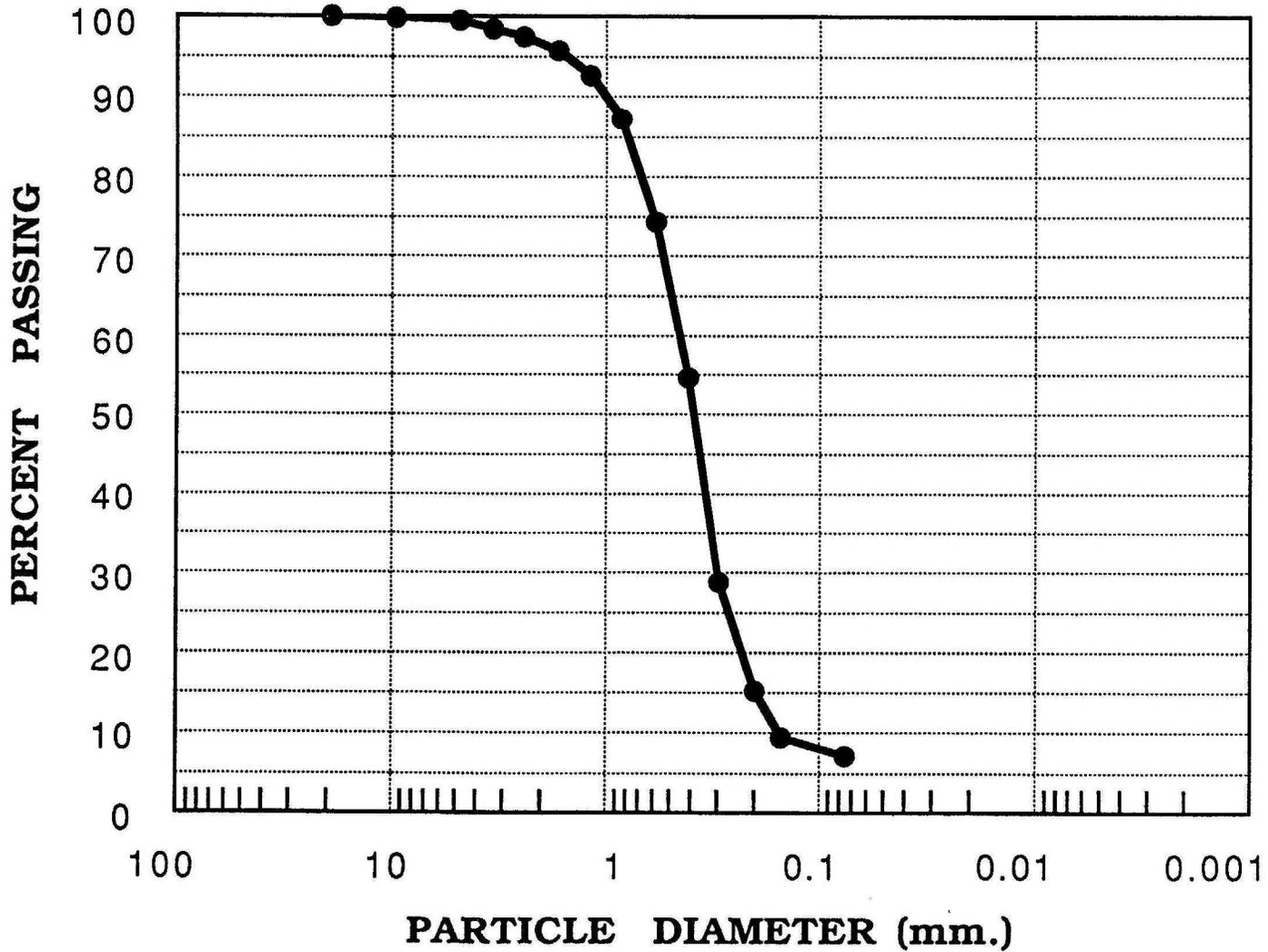
LINE # 16B2 N-S
USBR SITE # 207+00
SAMPLING DEPTH (ft.) 23-28

Particle Diameter @ 60% Passing = 0.76 mm.(0.030 in.)



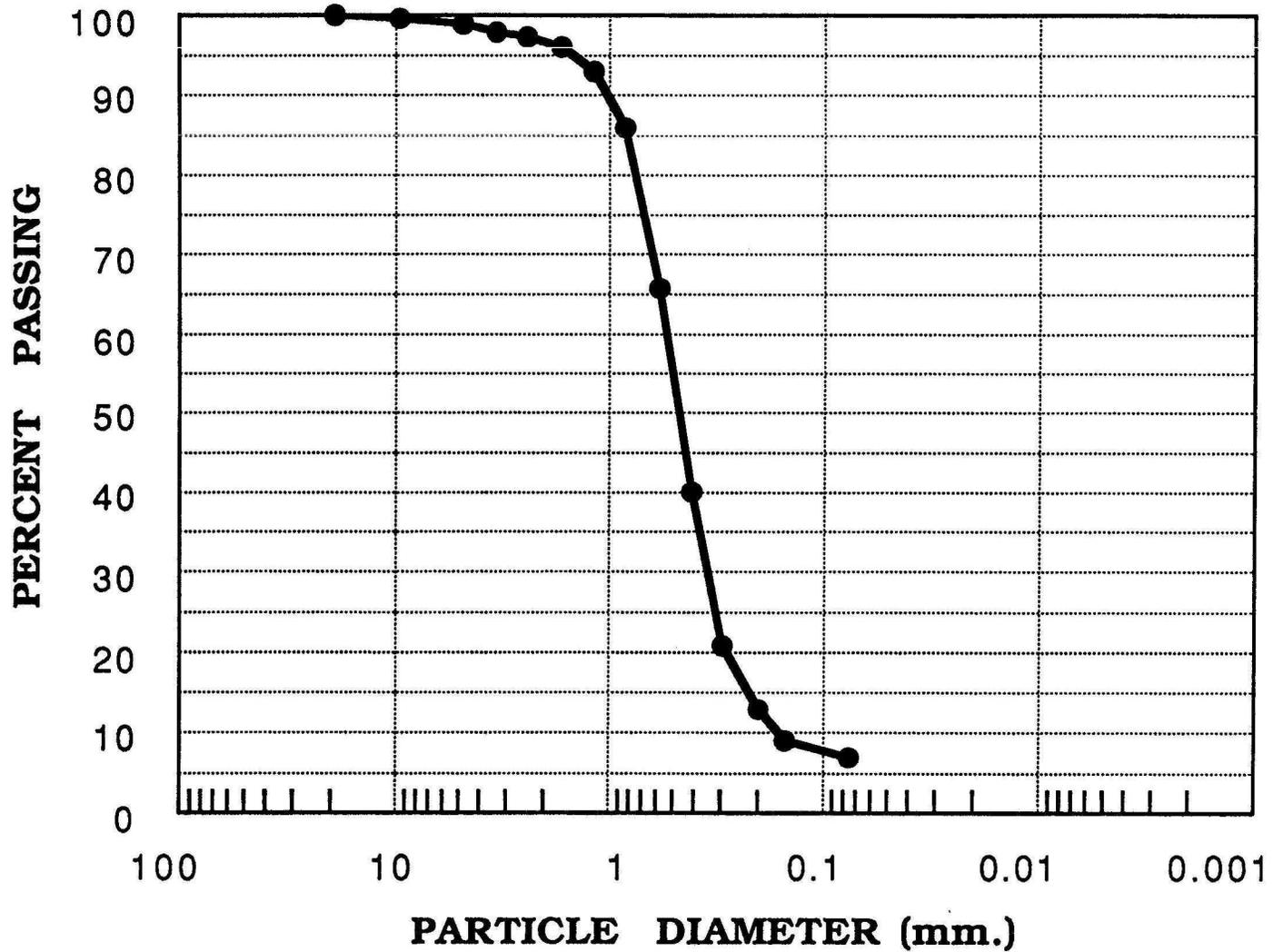
LINE # 16B2 N-S
USBR SITE # 213+00
SAMPLING DEPTH (ft.) 18-23

Particle Diameter @ 60% Passing = 0.46 mm.(0.018 in.)



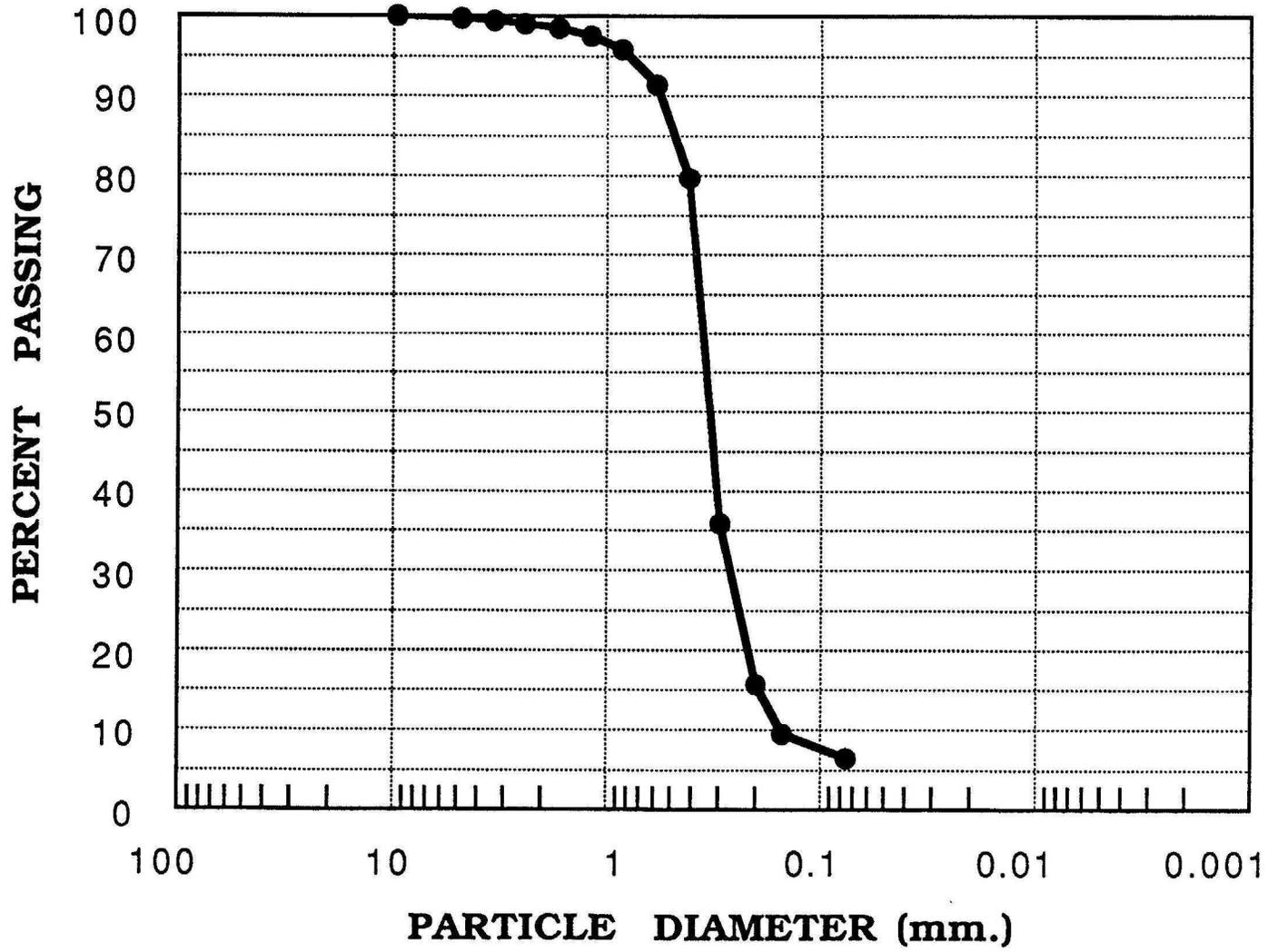
LINE # 16B2 N-S
USBR SITE # 213+00
SAMPLING DEPTH (ft.) 23-28

Particle Diameter @ 60% Passing = 0.53 mm.(0.021 in.)



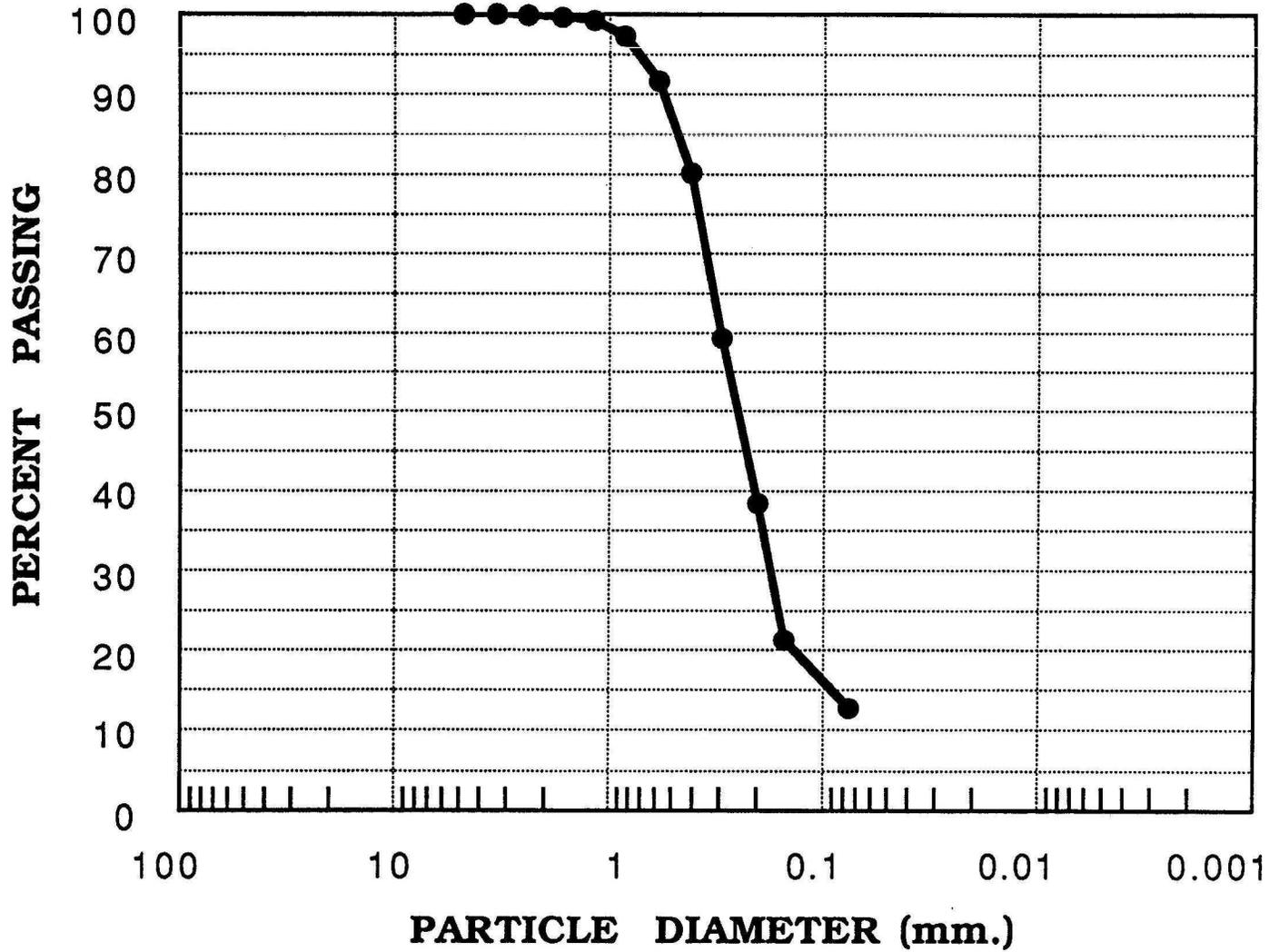
LINE # 16C N-S
USBR SITE # 218+00
SAMPLING DEPTH (ft.) 19-25

Particle Diameter @ 60% Passing = 0.36 mm.(0.014 in.)



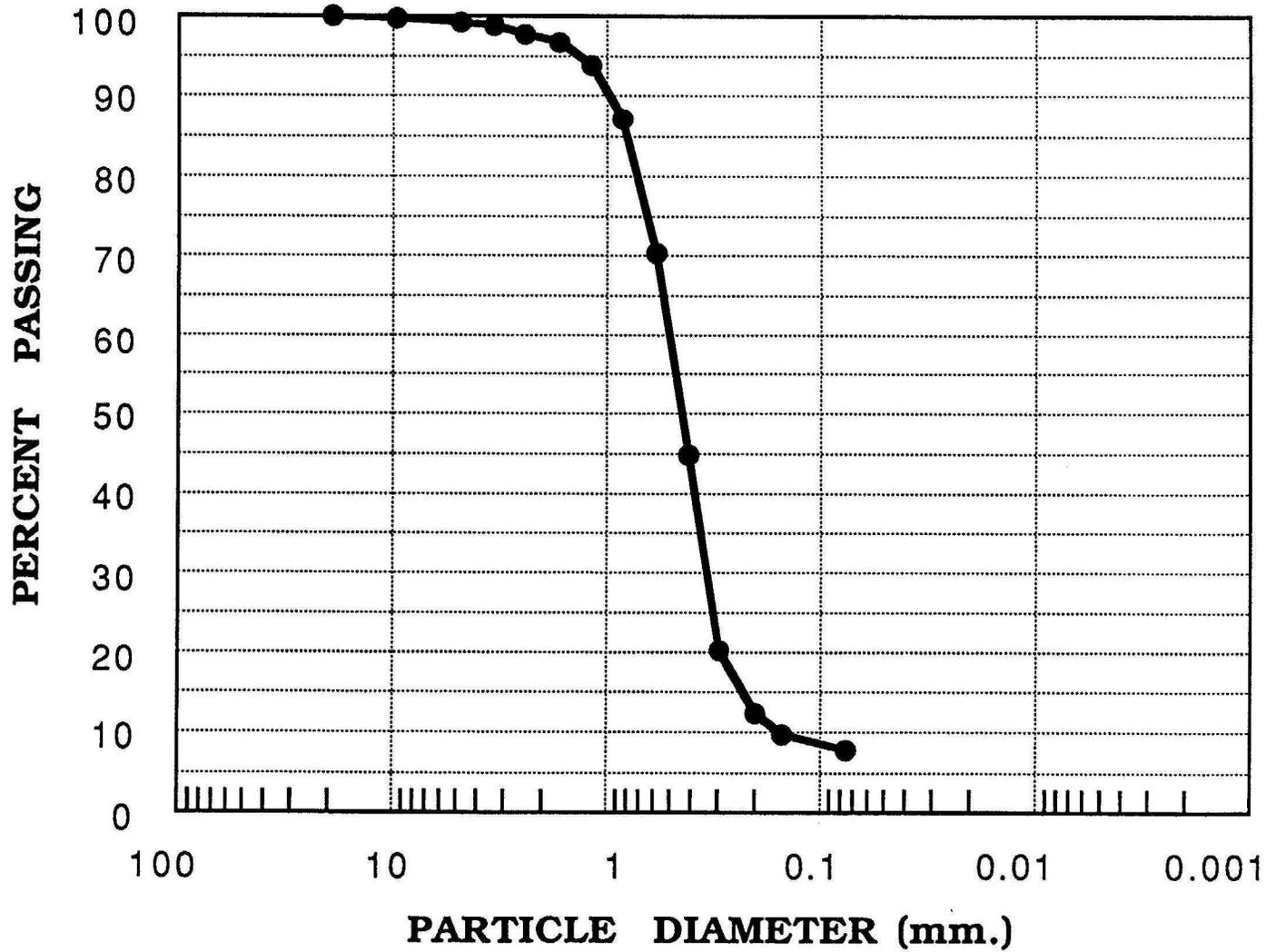
LINE # 16C N-S
USBR SITE # 218+00
SAMPLING DEPTH (ft.) 25-32

Particle Diameter @ 60% Passing = 0.30 mm.(0.012 in.)



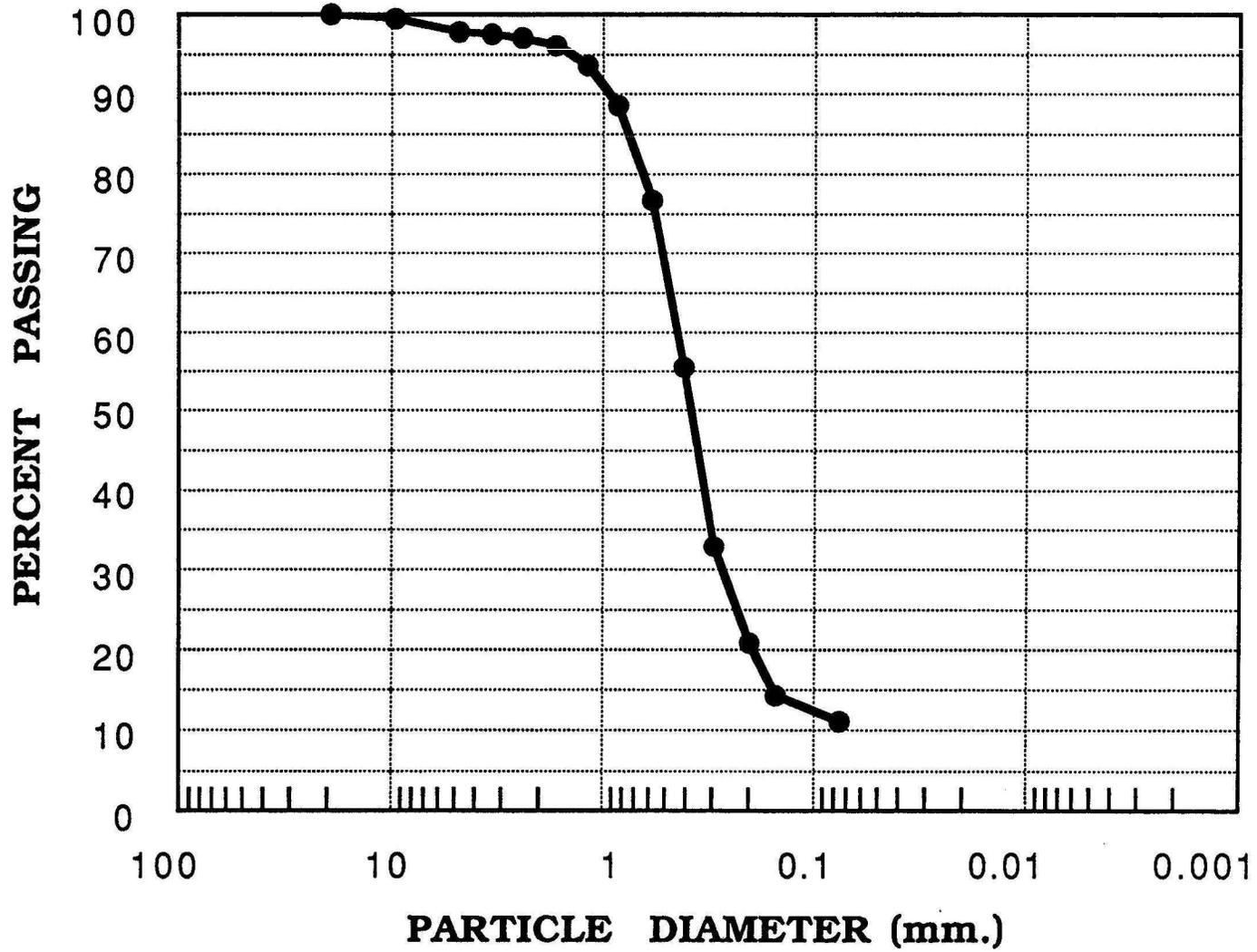
LINE # 16C N-S
USBR SITE # 219+00
SAMPLING DEPTH (ft.) 27-32

Particle Diameter @ 60% Passing = 0.50 mm.(0.020 in.)



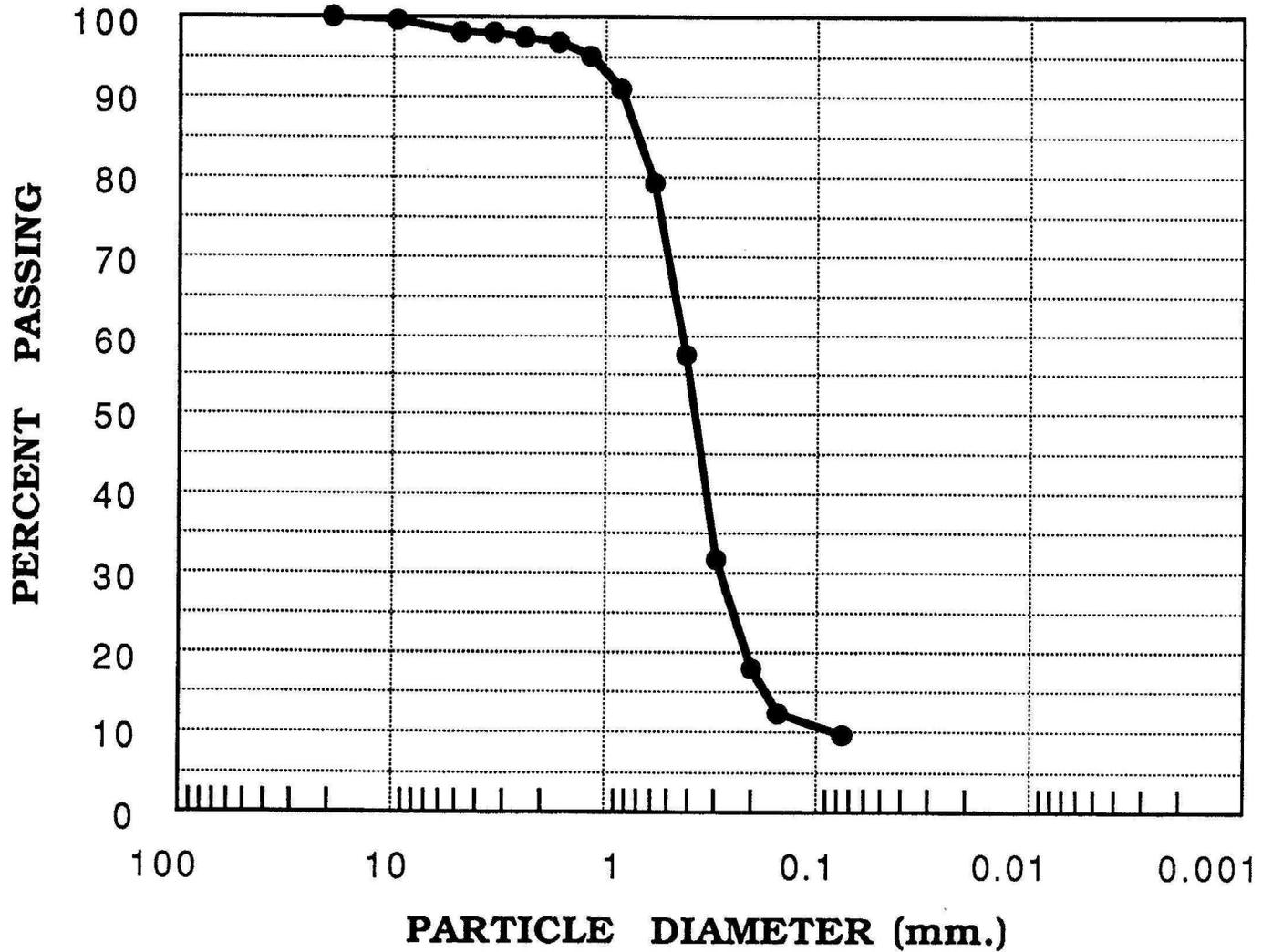
LINE # 16C N-S
USBR SITE # 219+00
SAMPLING DEPTH (ft.) 32-37

Particle Diameter @ 60% Passing = 0.44 mm.(0.017 in.)



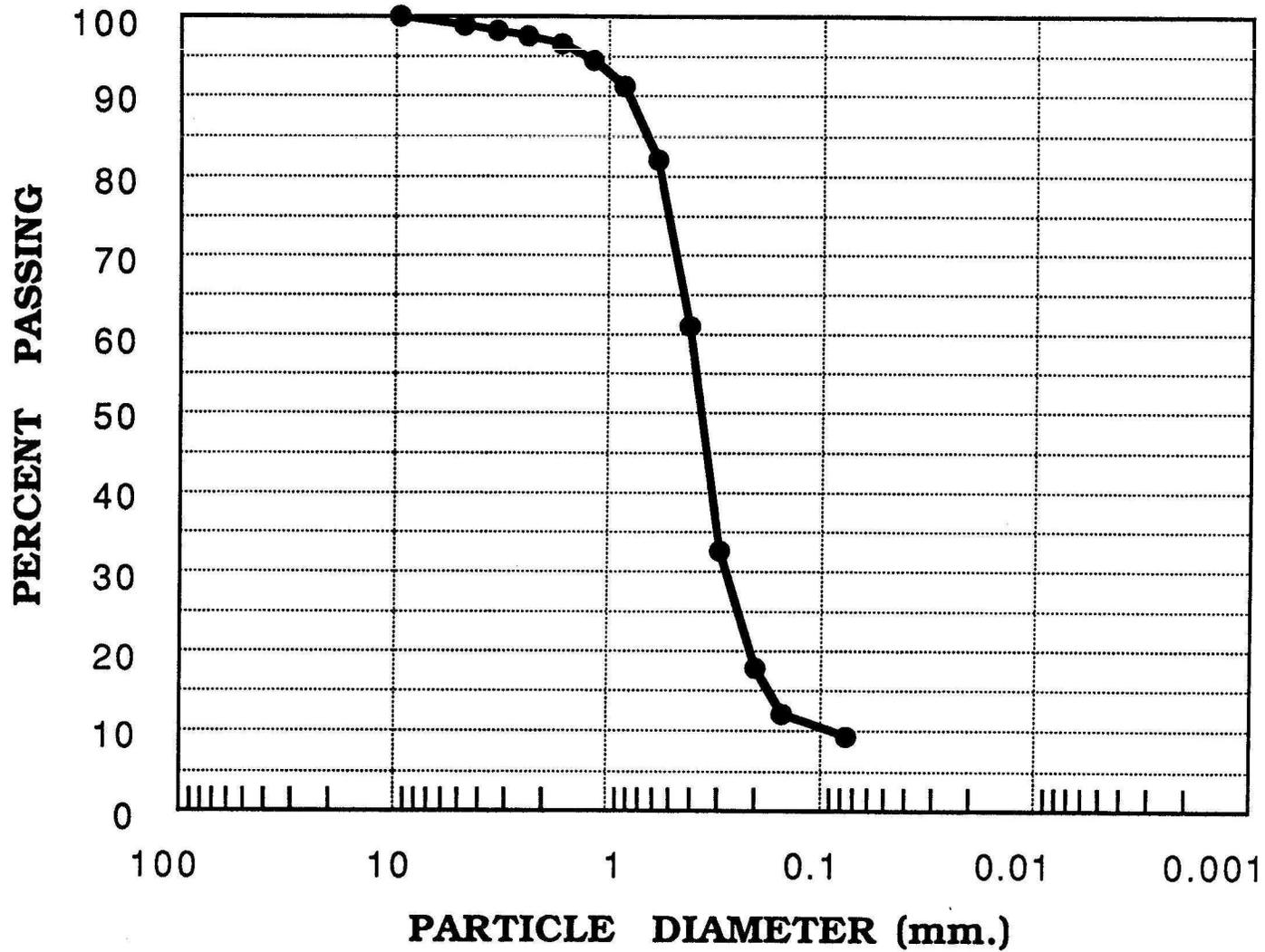
LINE # 16C N-S
USBR SITE # 220+00
SAMPLING DEPTH (ft.) 23.5-28

Particle Diameter @ 60% Passing = 0.42 mm.(0.017 in.)



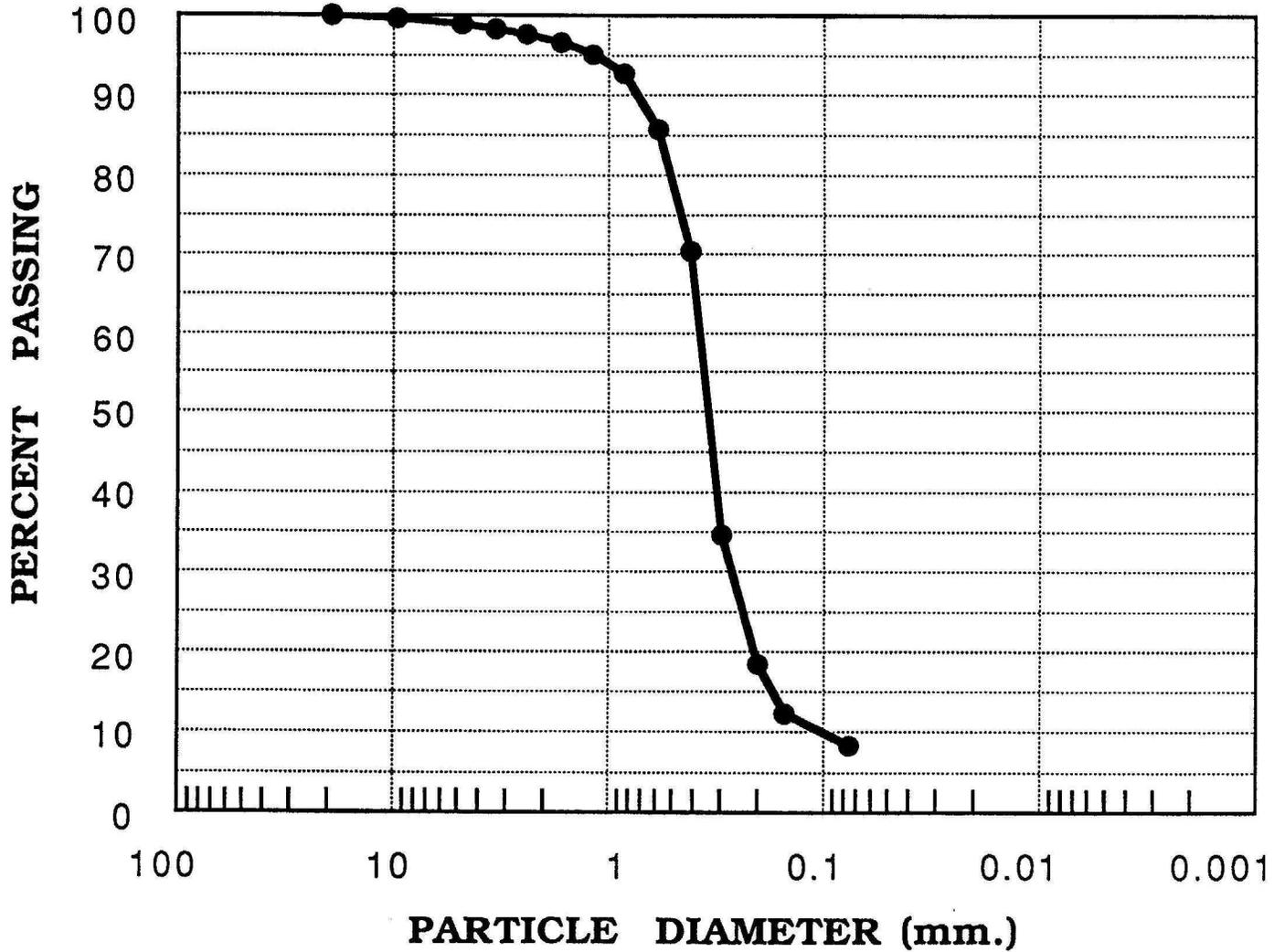
LINE # 16C N-S
USBR SITE # 220+00
SAMPLING DEPTH (ft.) 28-32

Particle Diameter @ 60% Passing = 0.44 mm.(0.017 in.)



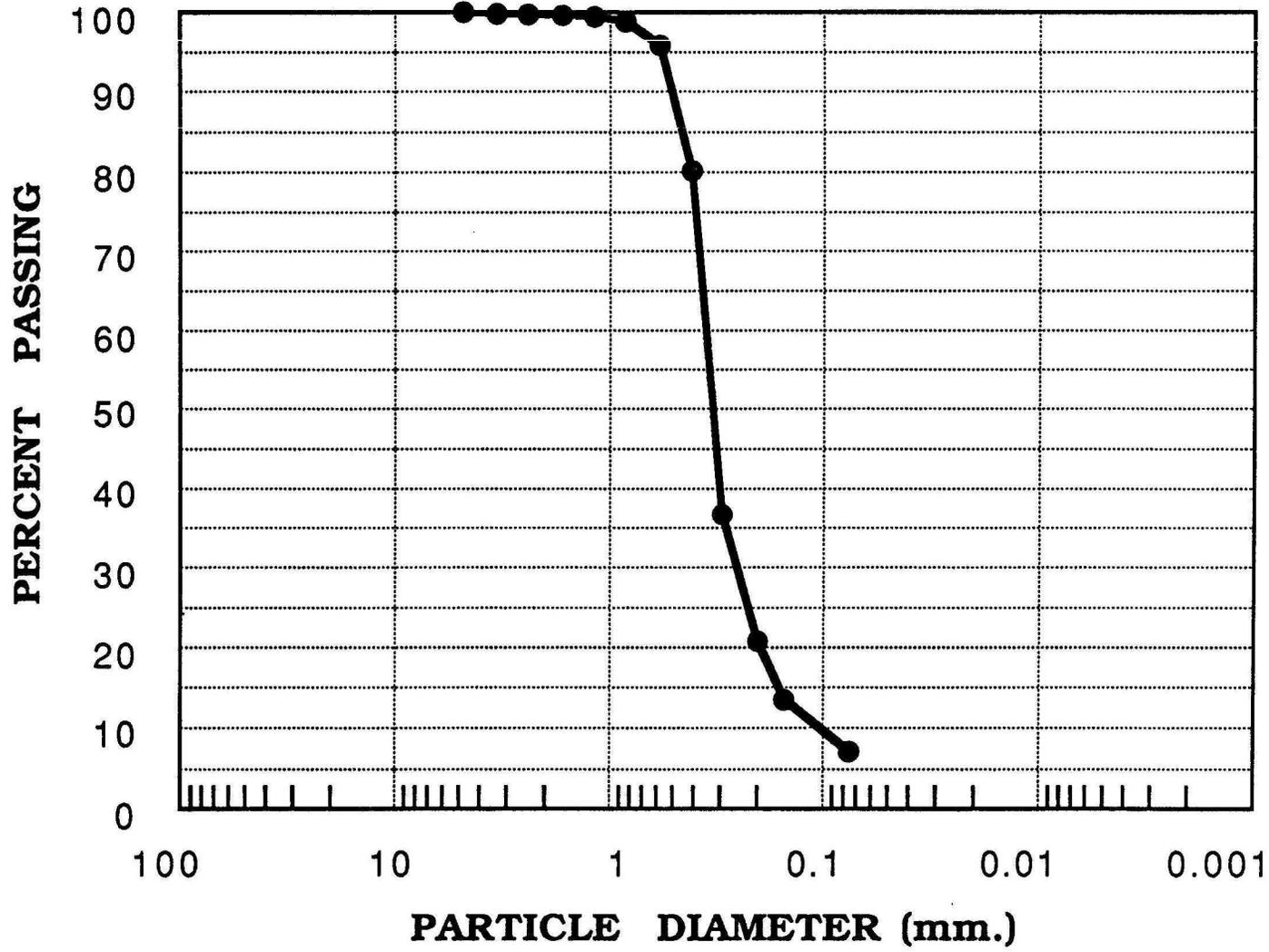
LINE # 16C N-S
USBR SITE # 222+00
SAMPLING DEPTH (ft.) 17.5-29

Particle Diameter @ 60% Passing = 0.36 mm.(0.014 in.)



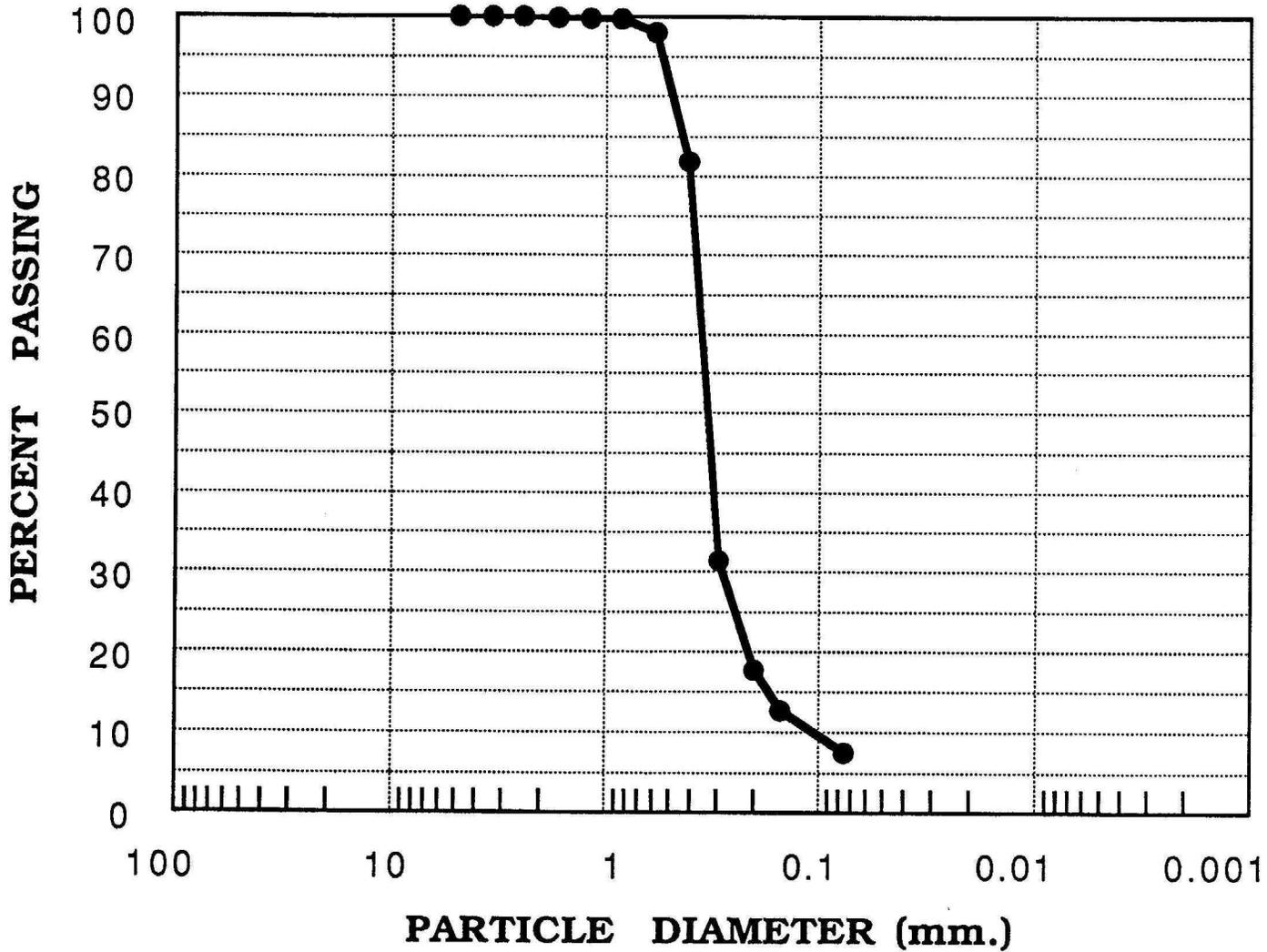
LINE # 16C N-S
USBR SITE # 223+00
SAMPLING DEPTH (ft.) 25-30

Particle Diameter @ 60% Passing = 0.35 mm.(0.014 in.)



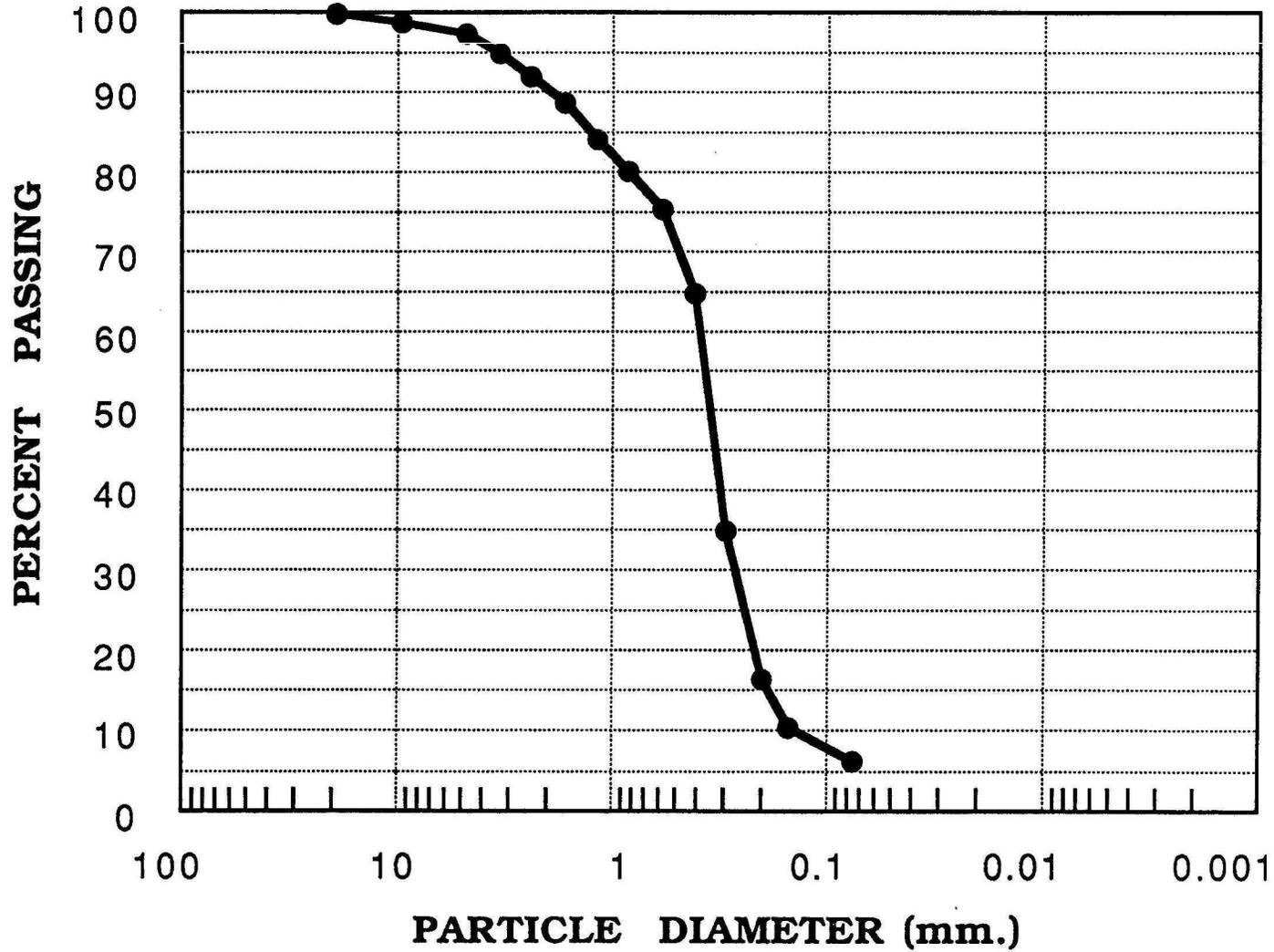
LINE # 16C N-S
USBR SITE # 223+00
SAMPLING DEPTH (ft.) 30-34

Particle Diameter @ 60% Passing = 0.35 mm.(0.014 in.)

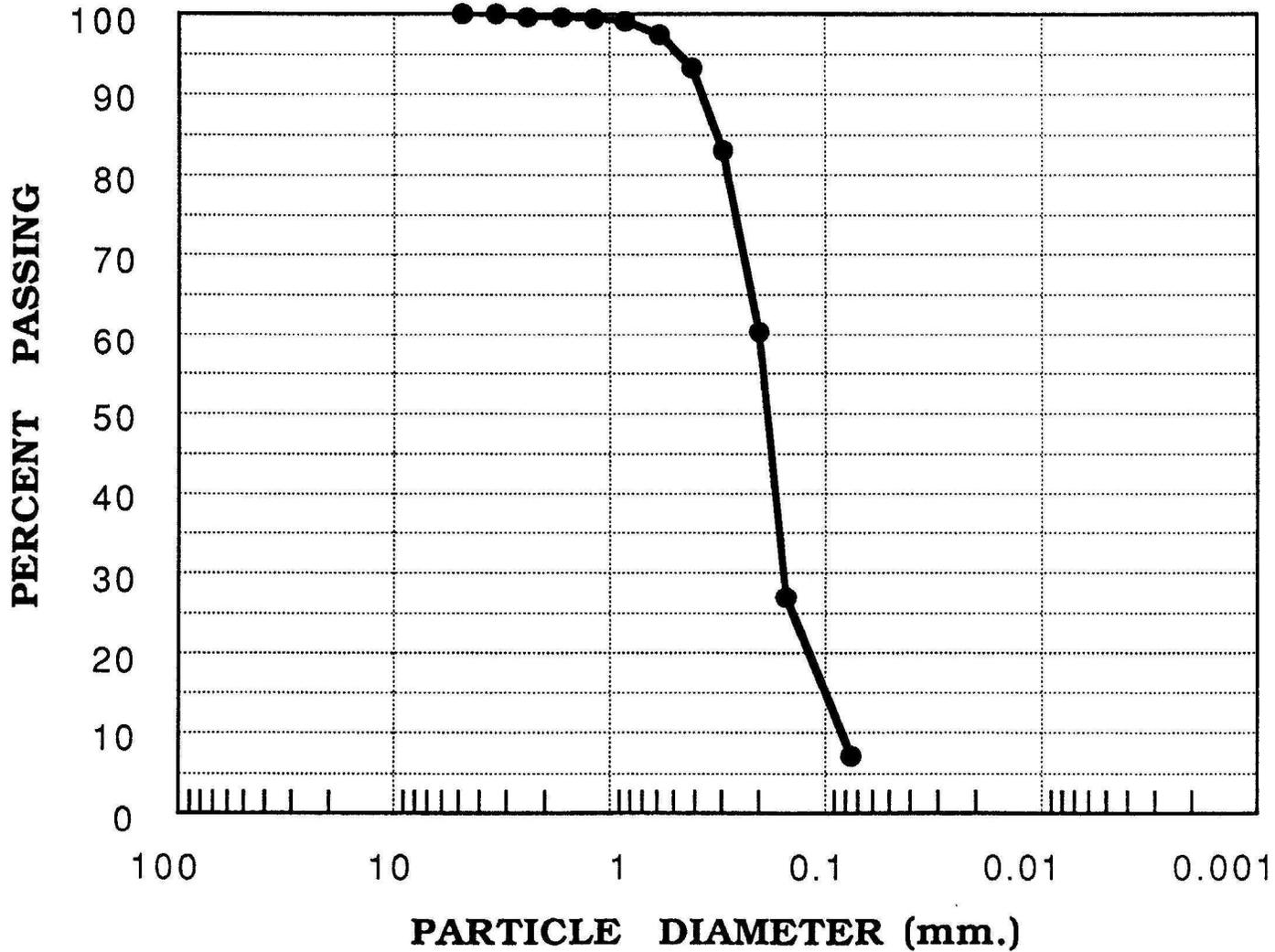


LINE # 16C N-S
USBR SITE # 227+00
SAMPLING DEPTH (ft.) 26-32

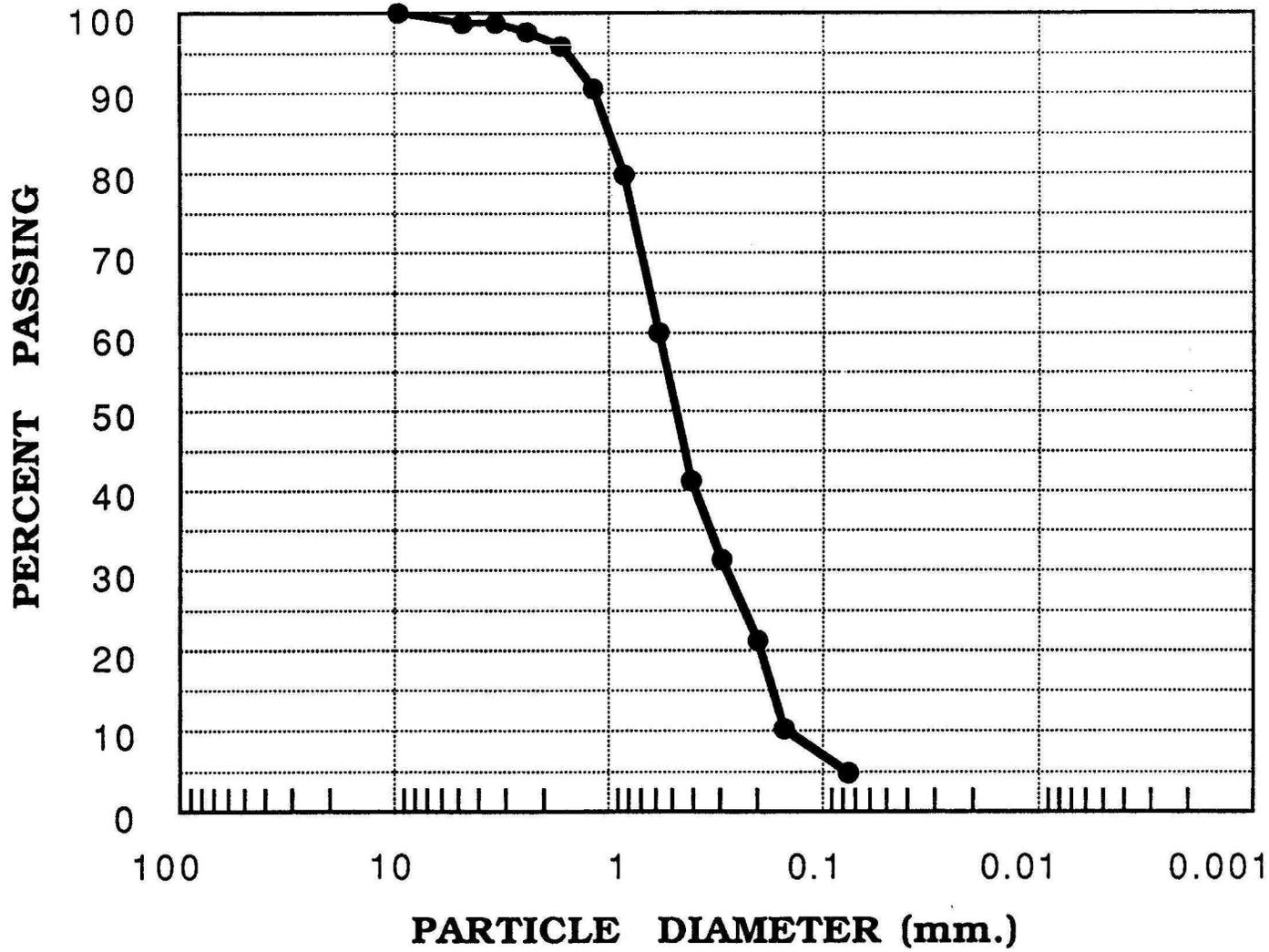
Particle Diameter @ 60% Passing = 0.38 mm.(0.0149 in.)



LINE # 16C N-S
USBR SITE # 229+00 (5 Ft. South of Test Well)
SAMPLING DEPTH (ft.) 15-20
Particle Diameter @ 60% Passing = 0.20 mm.(0.008 in.)



LINE # 16C N-S
USBR SITE # 229+00 (5 Ft. South of Test Well)
SAMPLING DEPTH (ft.) 20-25
Particle Diameter @ 60% Passing = 0.58mm.(0.023 in.)

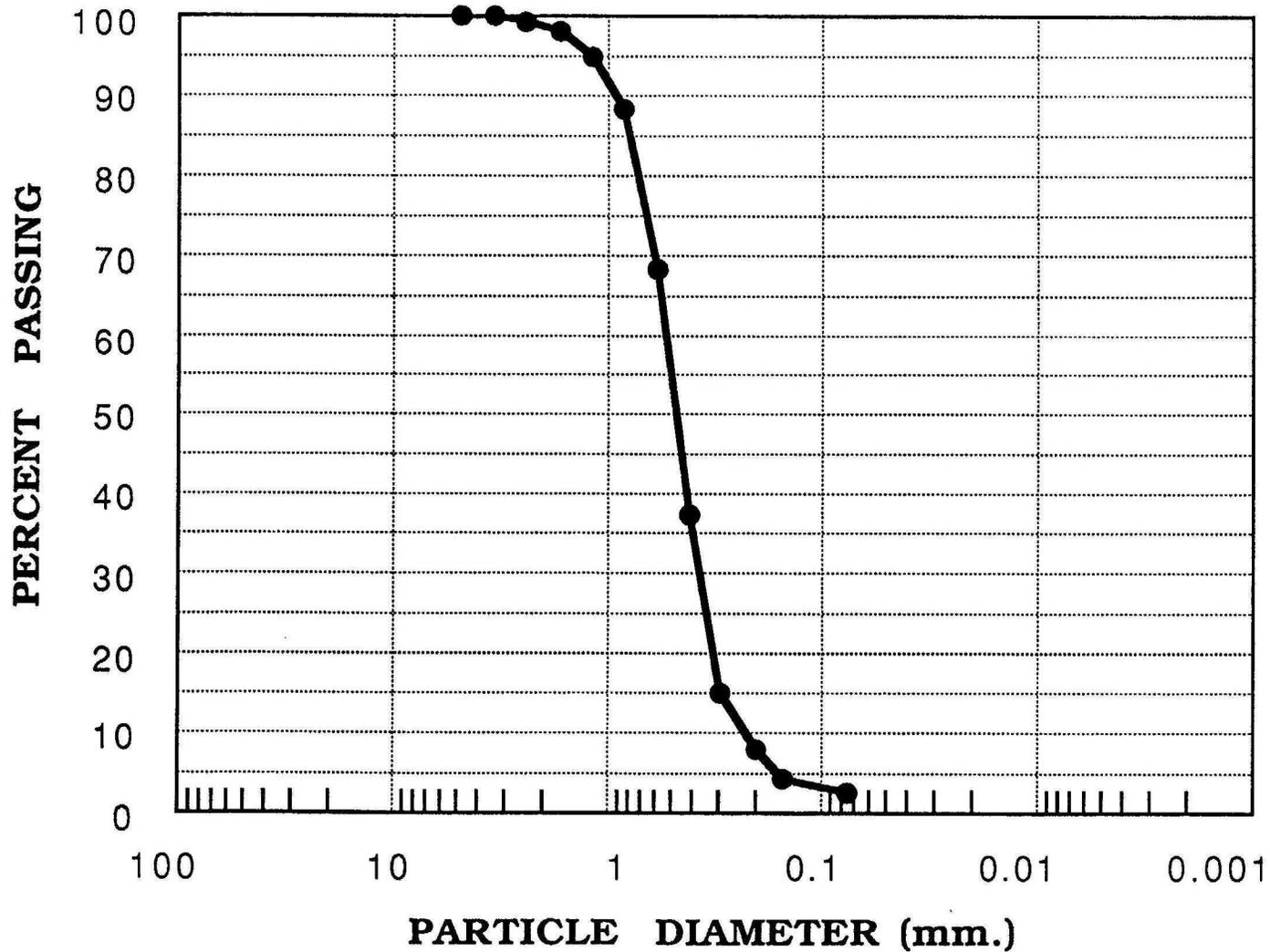


LINE # 16C N-S

USBR SITE # 229+00 (5 Ft. South of Test Well)

SAMPLING DEPTH (ft.) 25-30

Particle Diameter @ 60% Passing = 0.53mm.(0.021 in.)

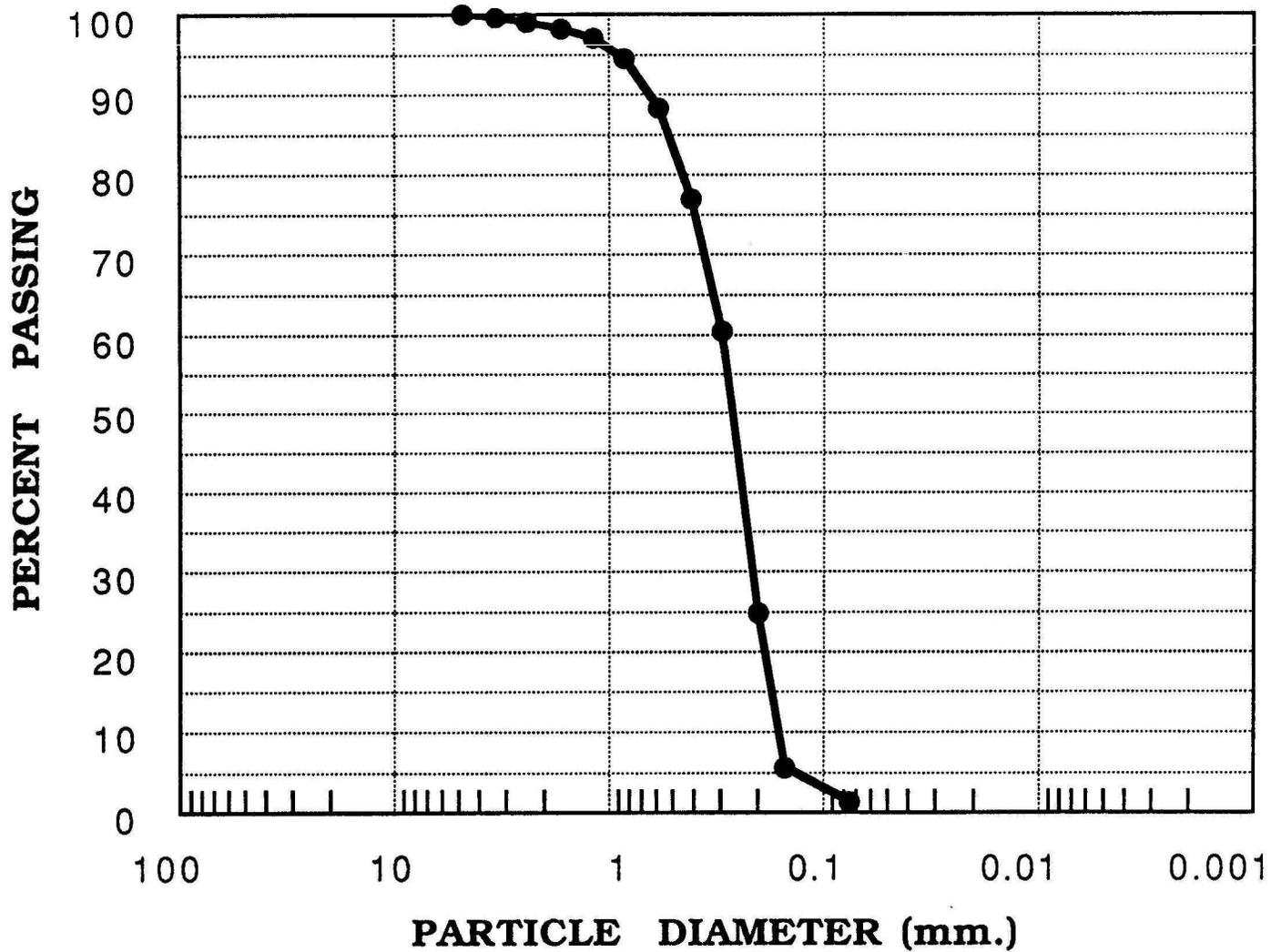


LINE # 16C N-S

USBR SITE # 229+00 (5 Ft. South of Test Well)

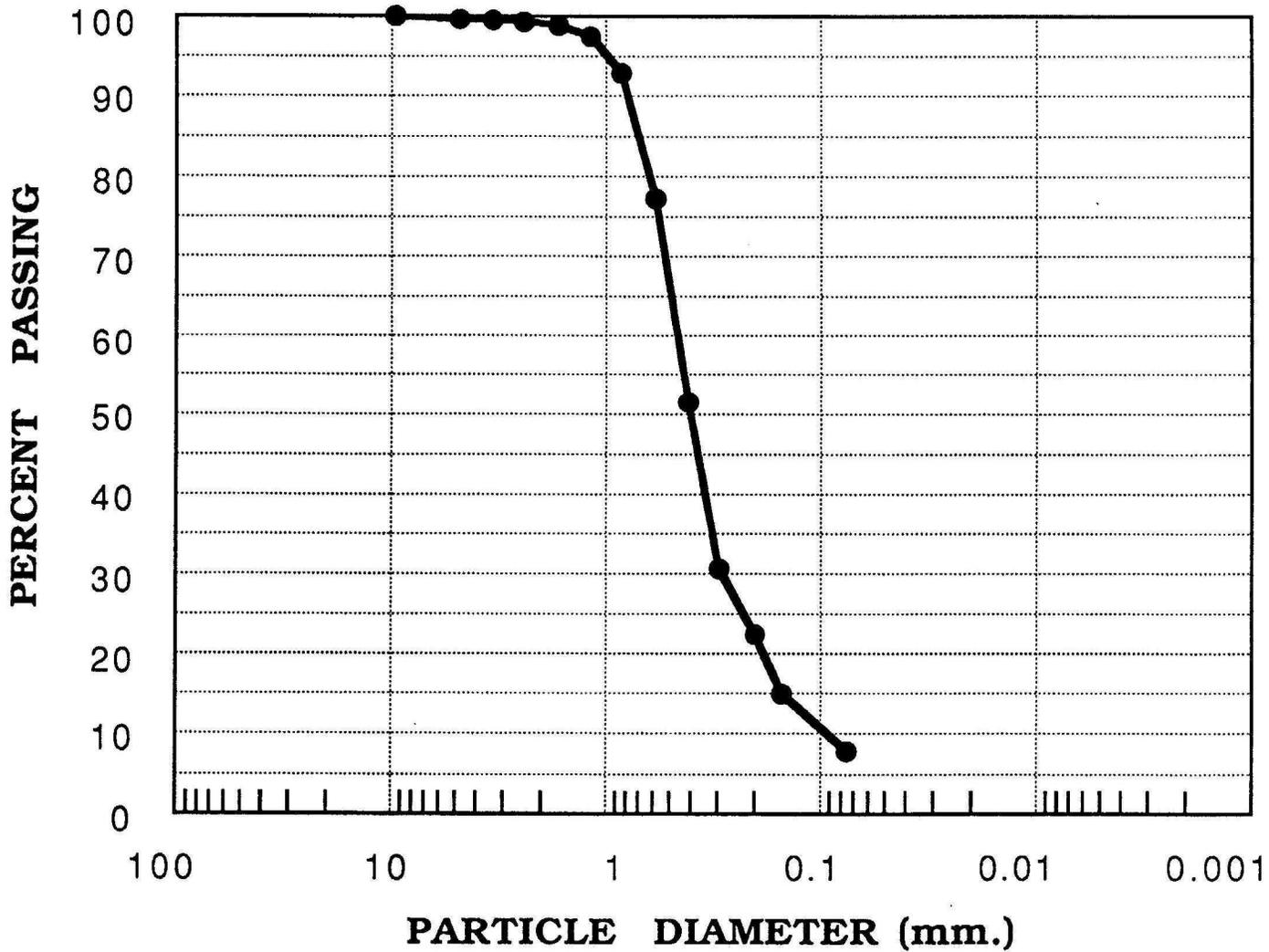
SAMPLING DEPTH (ft.) 30-35

Particle Diameter @ 60% Passing = 0.29mm.(0.011 in.)



LINE # 16C N-S
USBR SITE # 229+00 (17.5 Ft. North of Test Well)
SAMPLING DEPTH (ft.) 17.5-26

Particle Diameter @ 60% Passing = 0.46 mm.(0.018 in.)

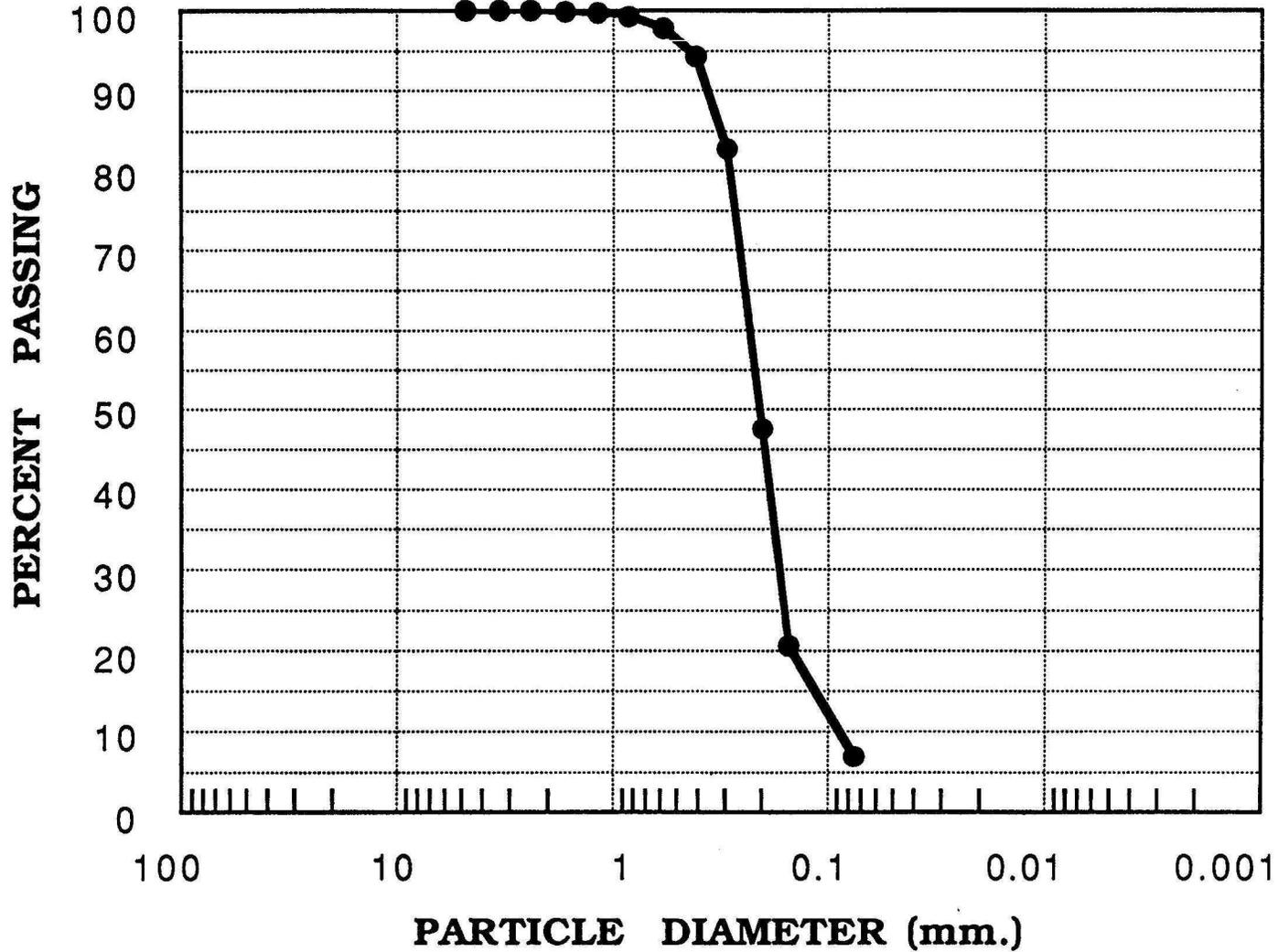


LINE # 16C N-S

USBR SITE # 229+00 (17.5 Ft. North of Test Well)

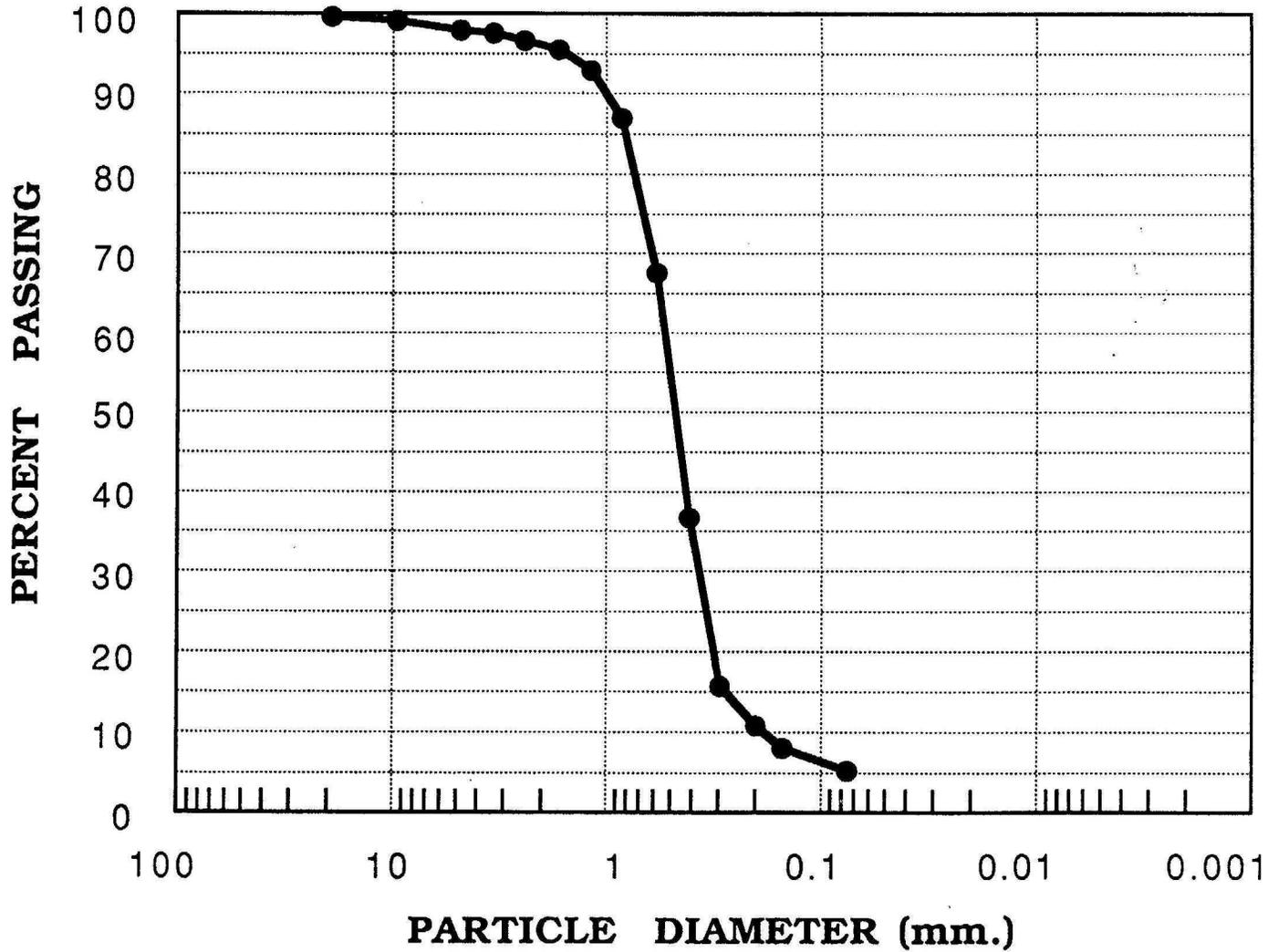
SAMPLING DEPTH (ft.) 26-33

Particle Diameter @ 60% Passing = 0.23 mm.(0.009 in.)



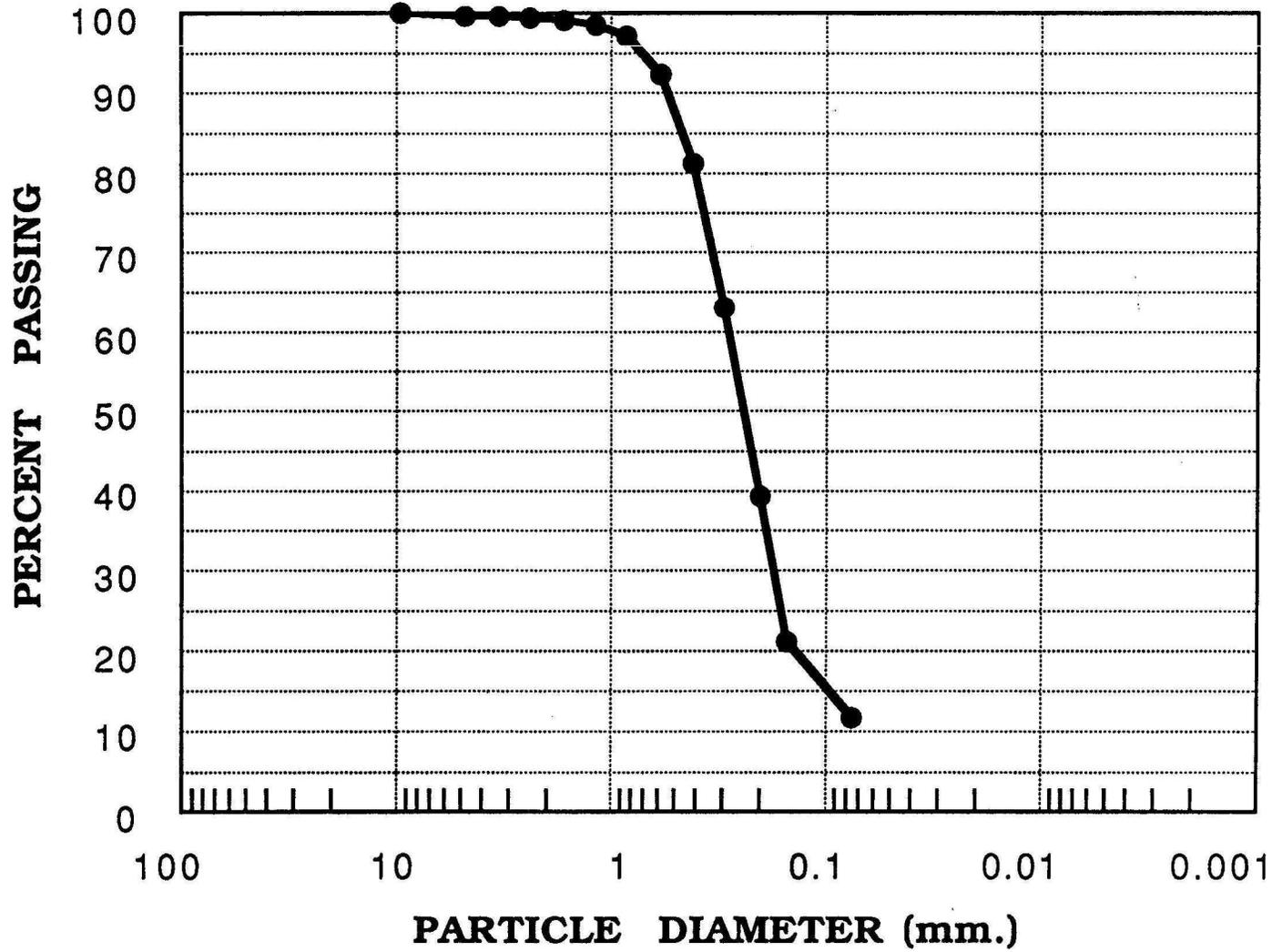
LINE # 16C N-S
USBR SITE # 230+00
SAMPLING DEPTH (ft.) 23-31.5

Particle Diameter @ 60% Passing = 0.52 mm.(0.021 in.)



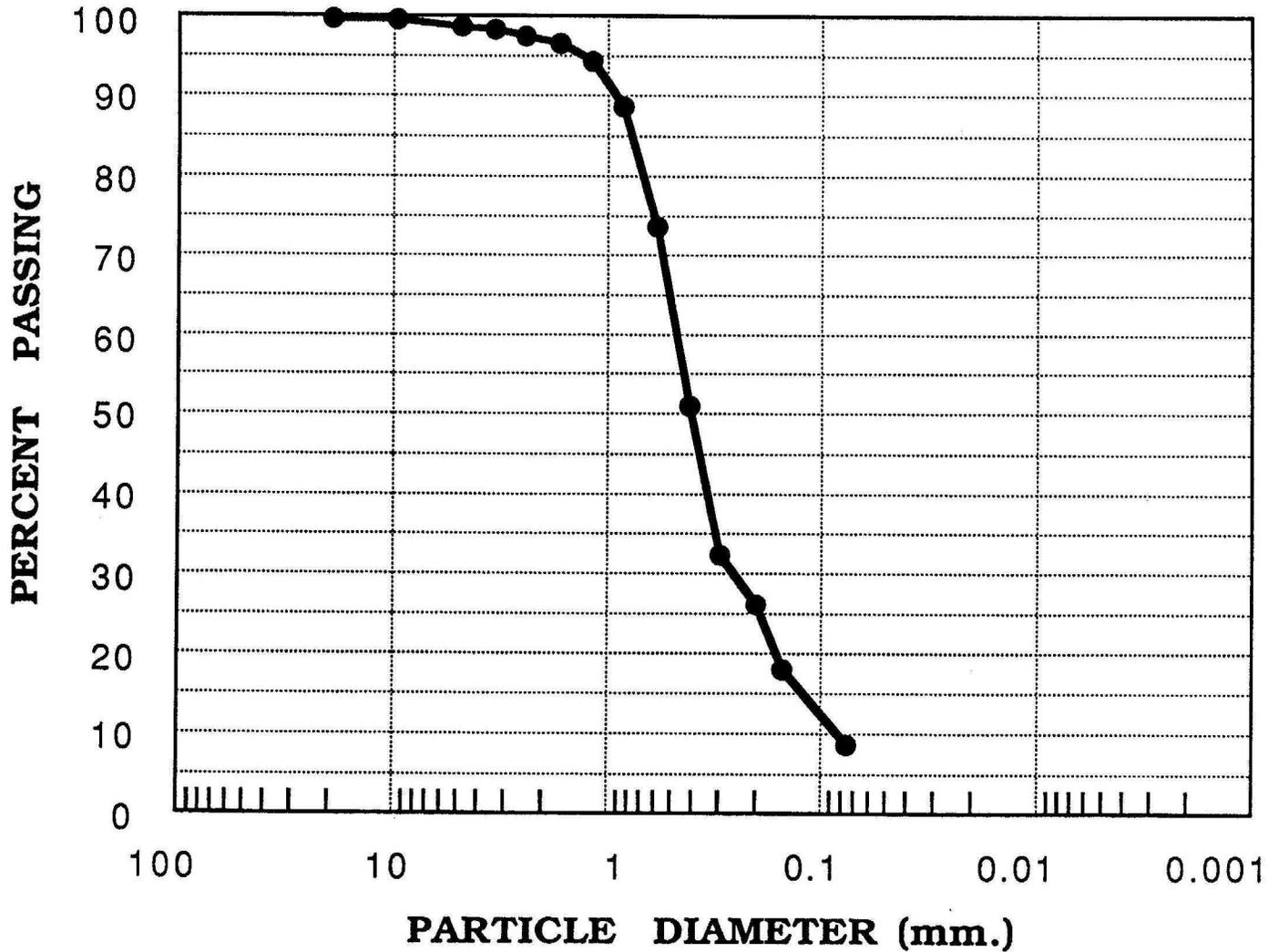
LINE # 16C N-S
USBR SITE # 230+00
SAMPLING DEPTH (ft.) 31.5-33

Particle Diameter @ 60% Passing = 0.29 mm.(0.011 in.)



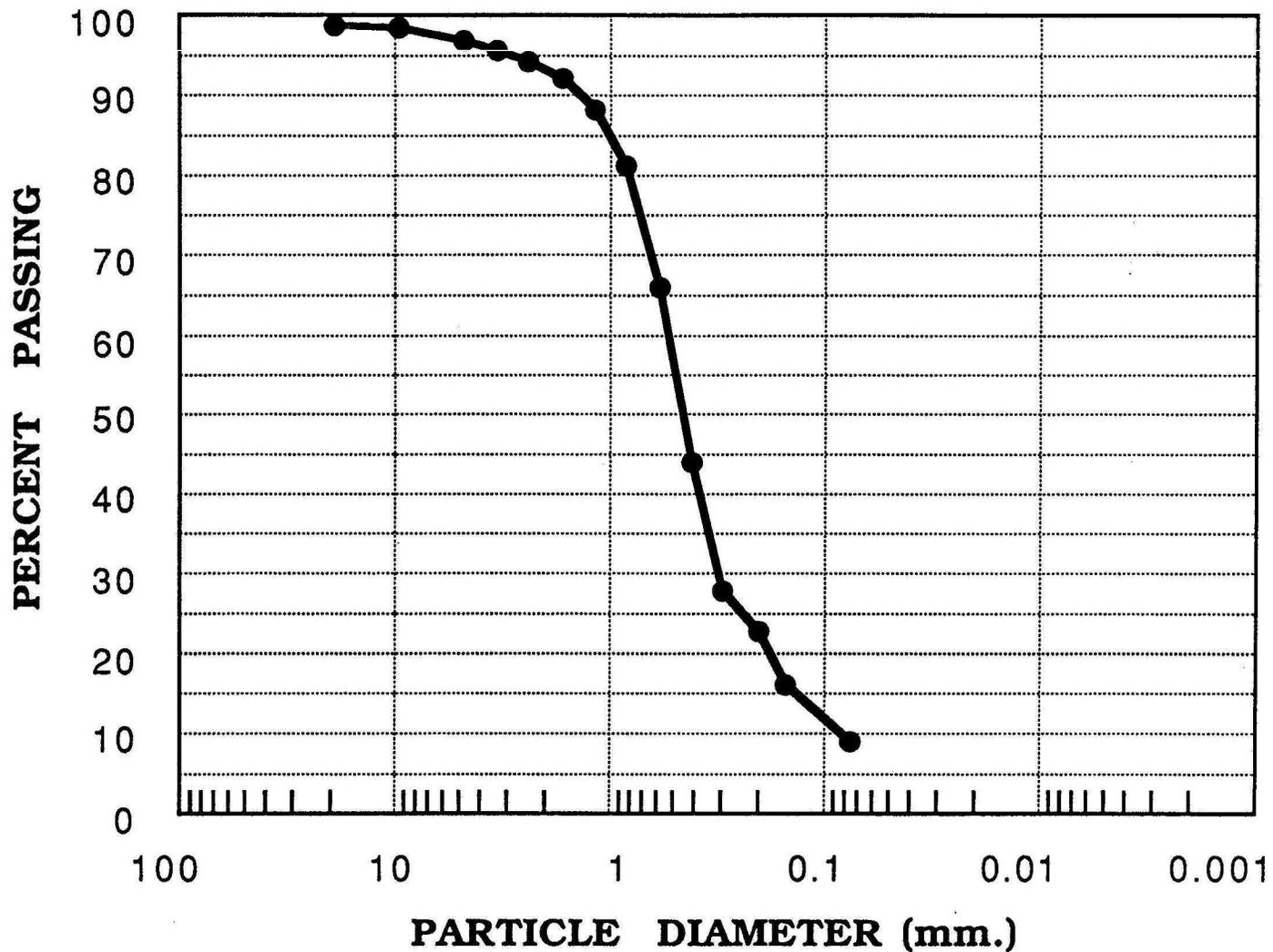
LINE # 16C N-S
USBR SITE # 231+00
SAMPLING DEPTH (ft.) 19-27

Particle Diameter @ 60% Passing = 0.46 mm.(0.018 in.)



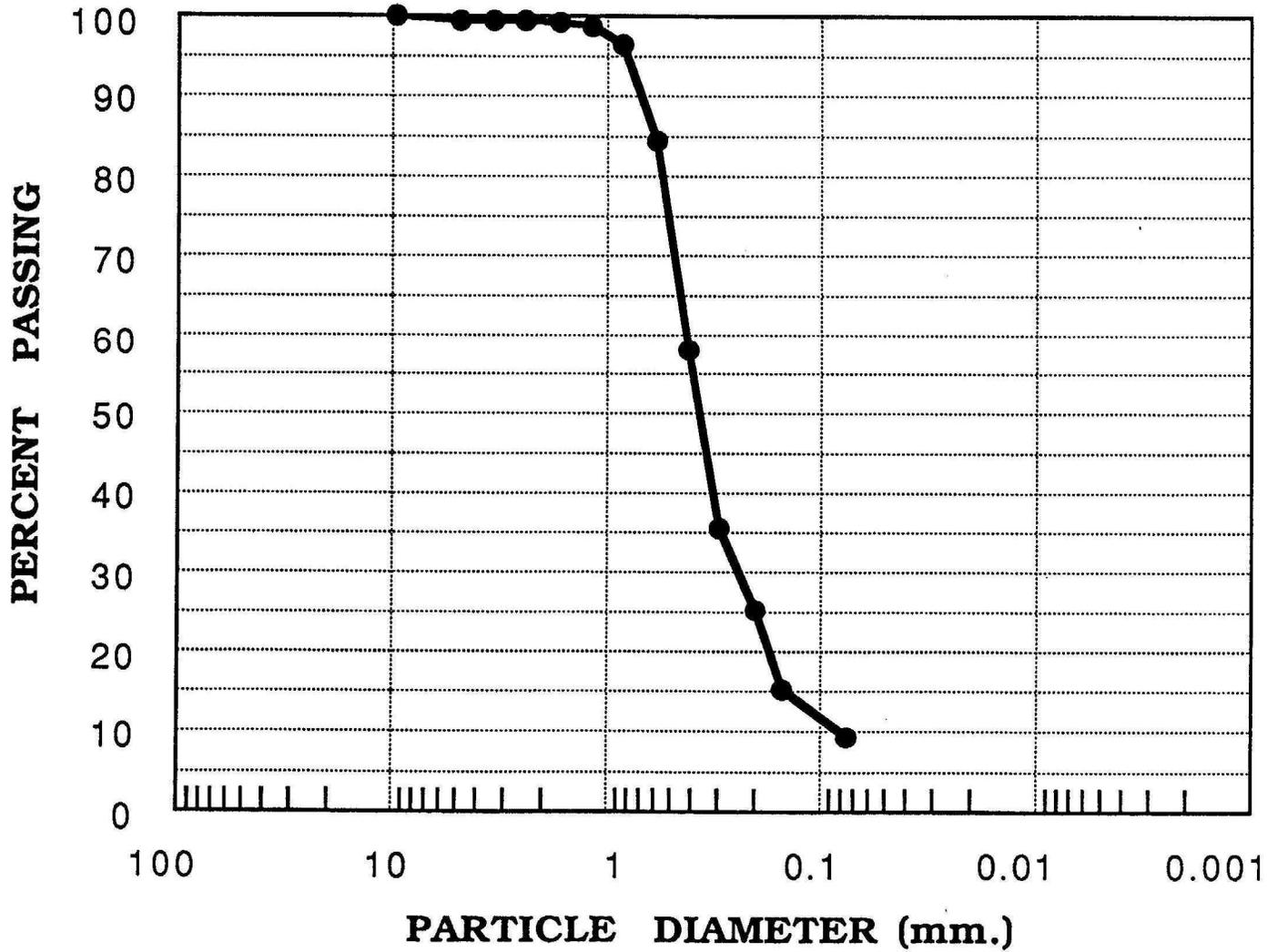
LINE # 16C N-S
USBR SITE # 231+00
SAMPLING DEPTH (ft.) 27-34.5

Particle Diameter @ 60% Passing = 0.53 mm.(0.021 in.)



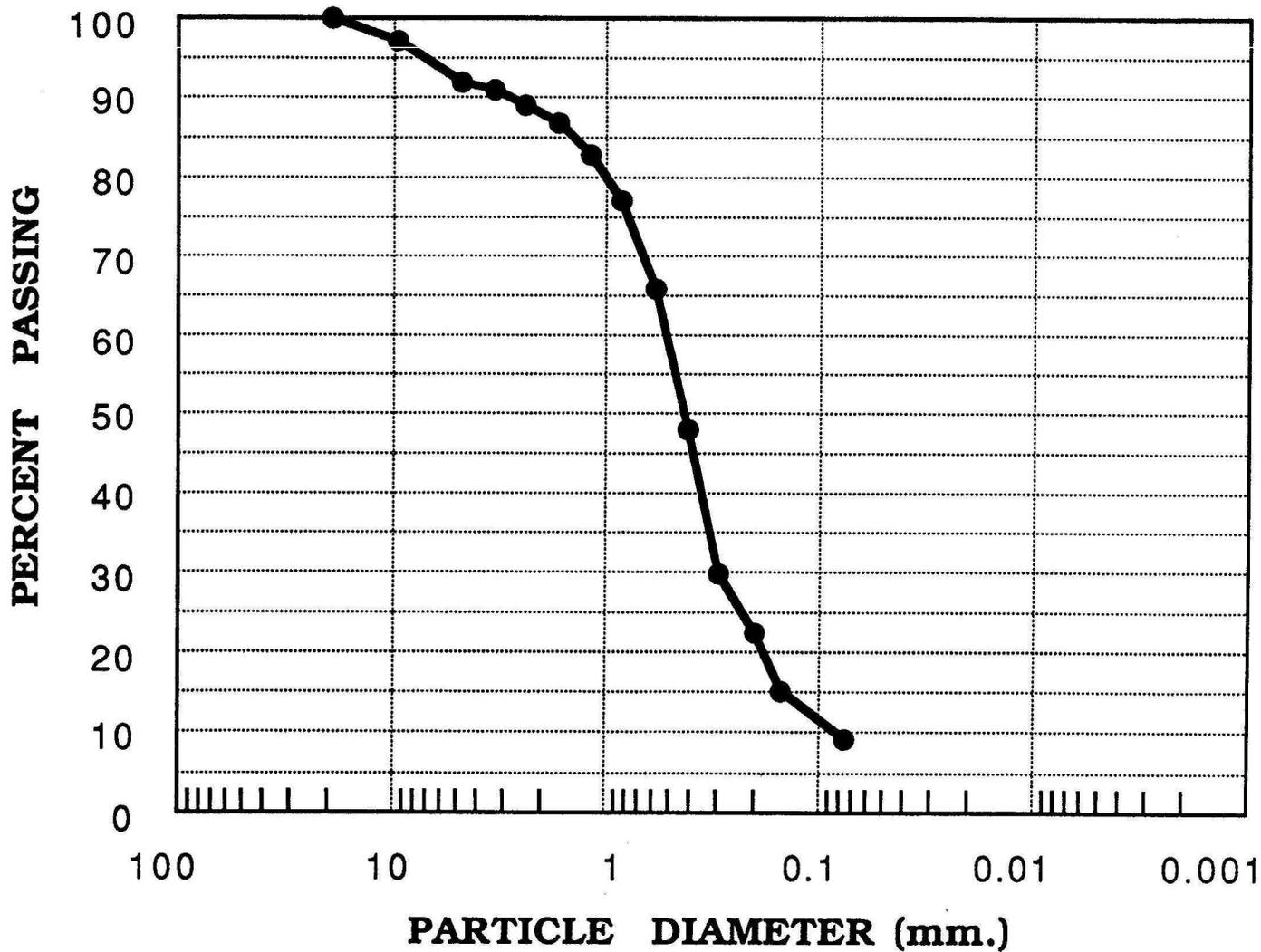
LINE # 16C N-S
USBR SITE # 232+00
SAMPLING DEPTH (ft.) 22-26

Particle Diameter @ 60% Passing = 0.42 mm.(0.017 in.)



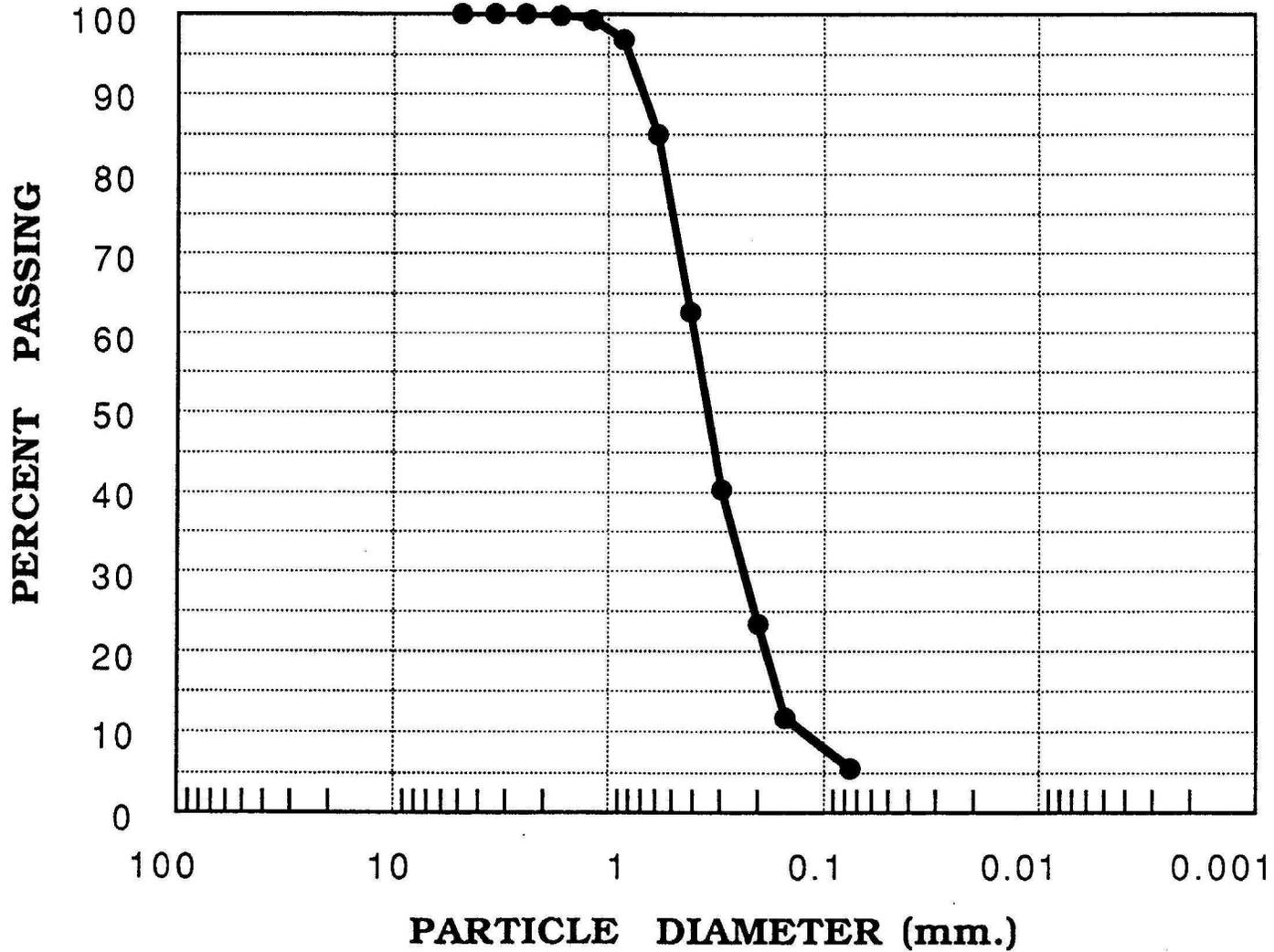
LINE # 16C N-S
USBR SITE # 232+00
SAMPLING DEPTH (ft.) 26-31

Particle Diameter @ 60% Passing = 0.52 mm.(0.020 in.)



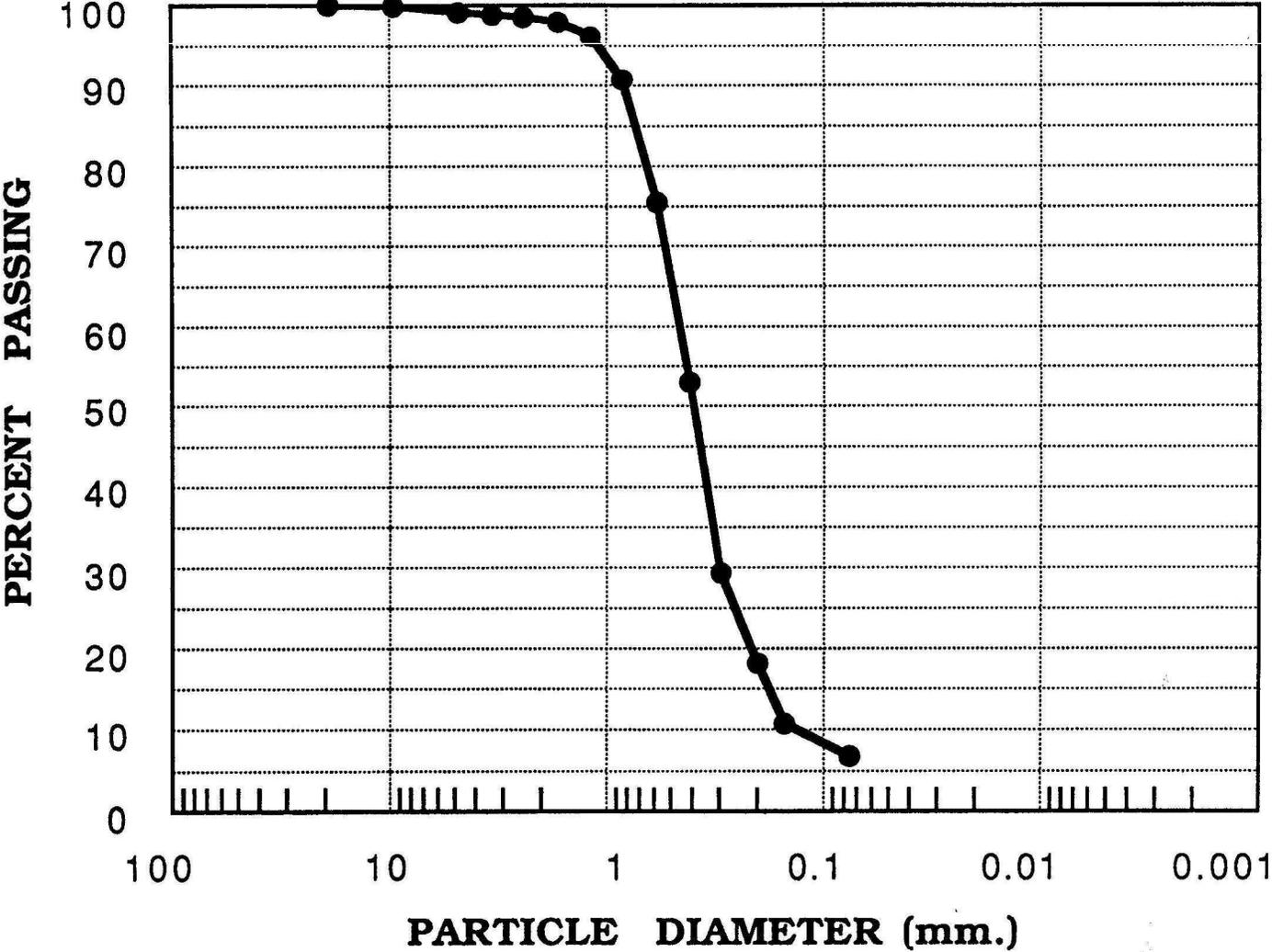
LINE # 16C N-S
USBR SITE # 235+00
SAMPLING DEPTH (ft.) 17-22

Particle Diameter @ 60% Passing = 0.38 mm.(0.015 in.)



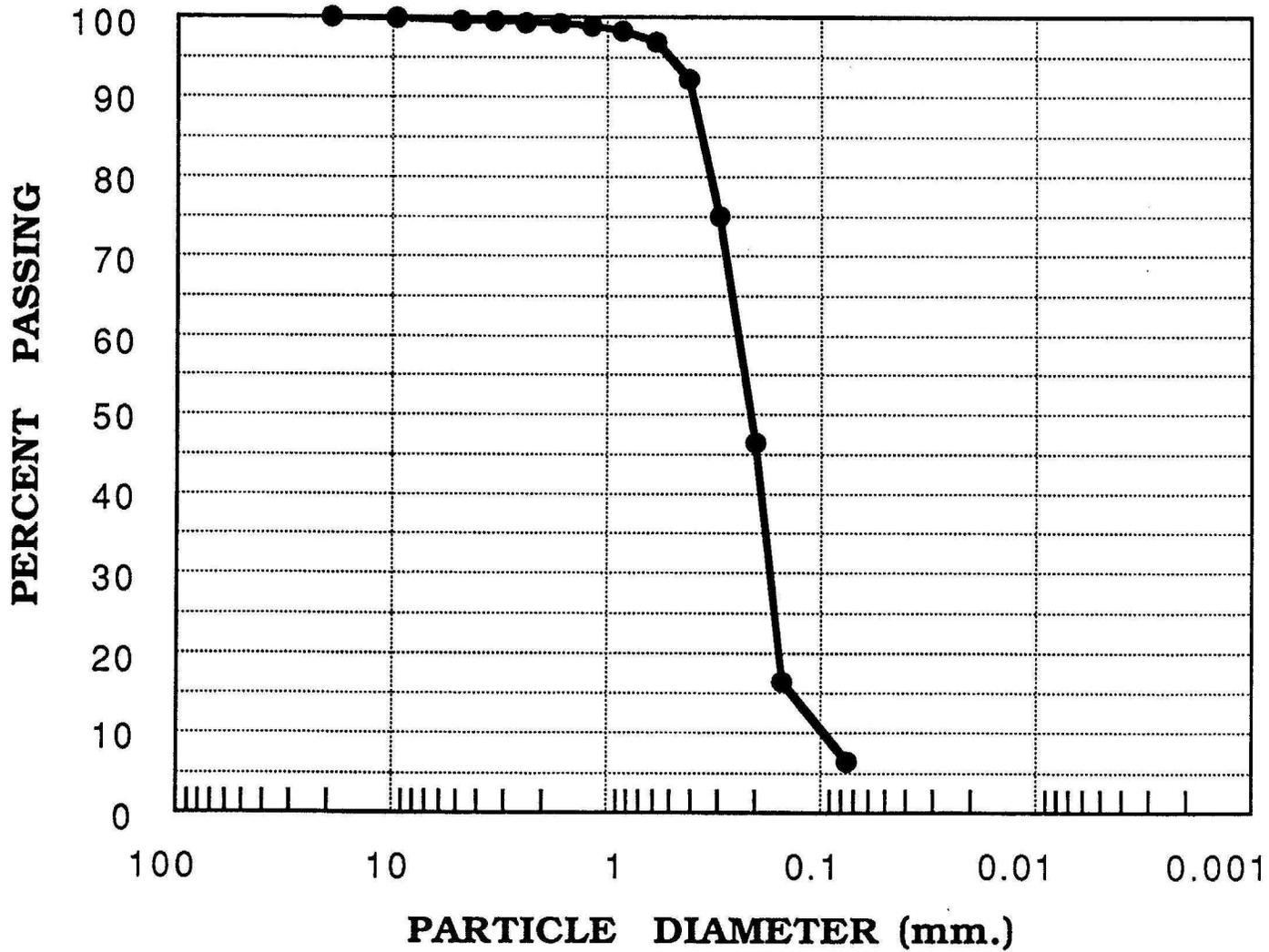
LINE # 16C N-S
USBR SITE # 235+00
SAMPLING DEPTH (ft.) 22-26.5

Particle Diameter @ 60% Passing = 0.44 mm.(0.017 in.)



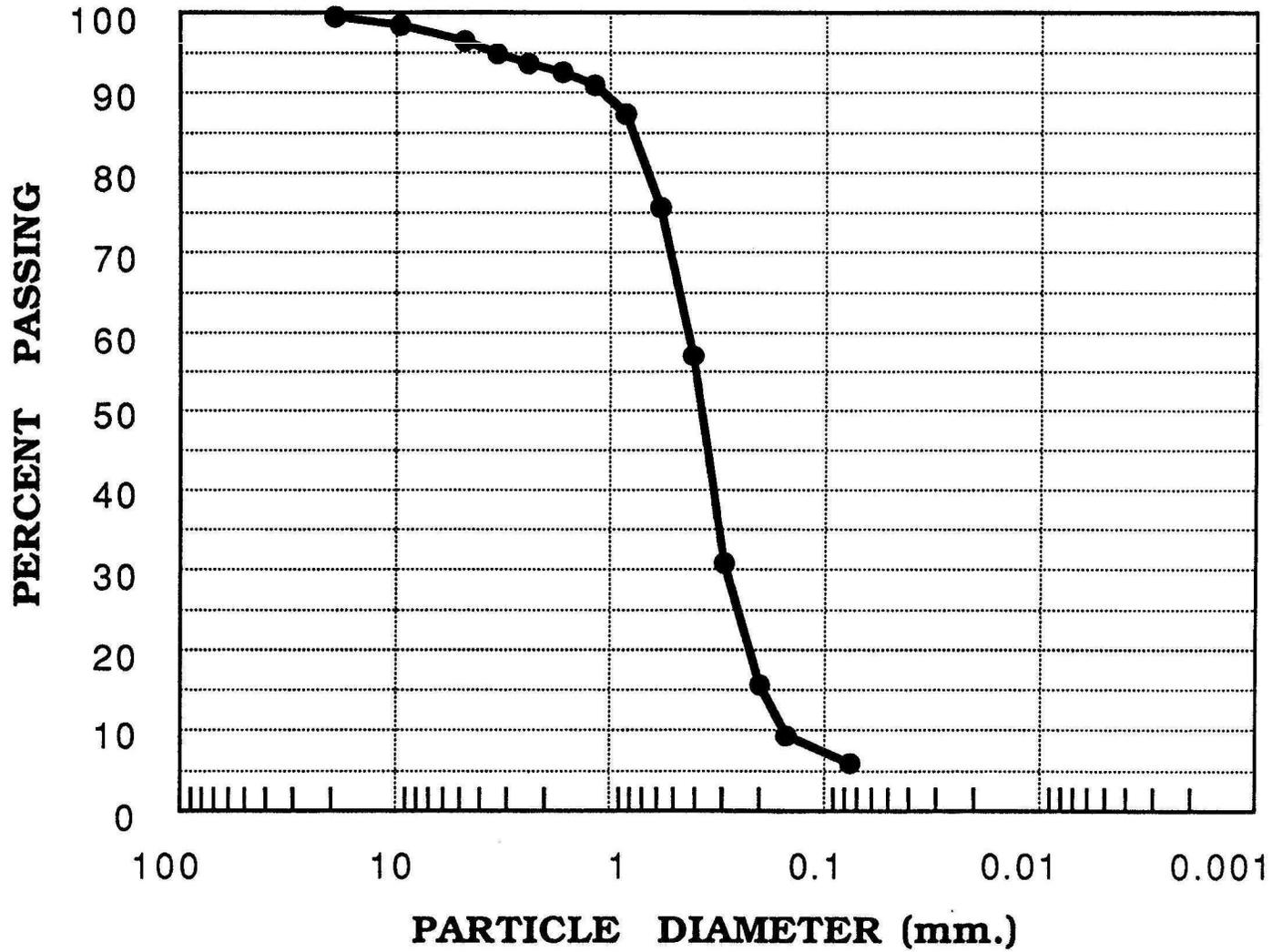
LINE # 16C N-S
USBR SITE # 239+00
SAMPLING DEPTH (ft.) 13-23

Particle Diameter @ 60% Passing = 0.24 mm.(0.009 in.)



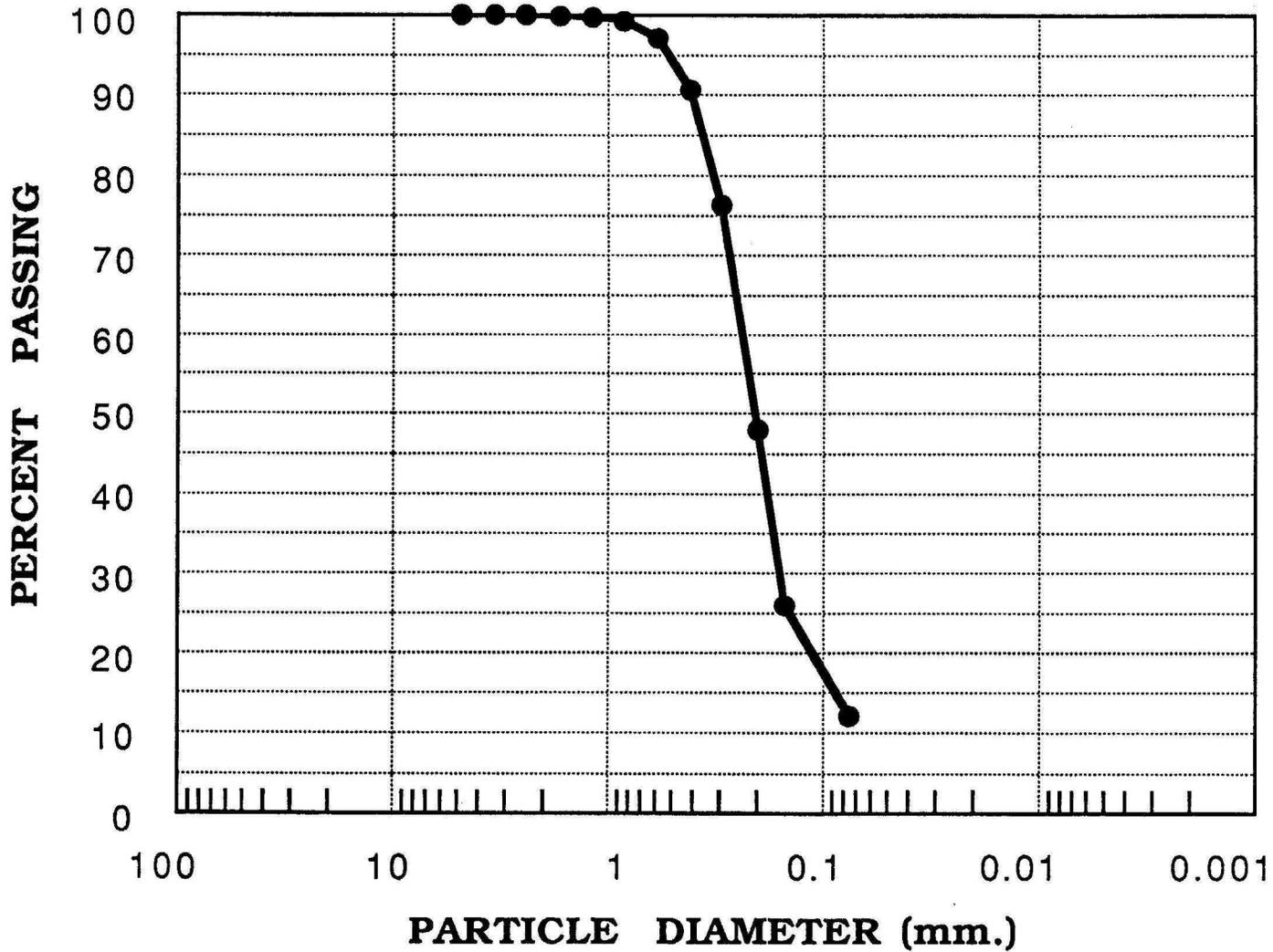
LINE # 16C N-S
USBR SITE # 239+00
SAMPLING DEPTH (ft.) 23-27

Particle Diameter @ 60% Passing = 0.44 mm.(0.017 in.)



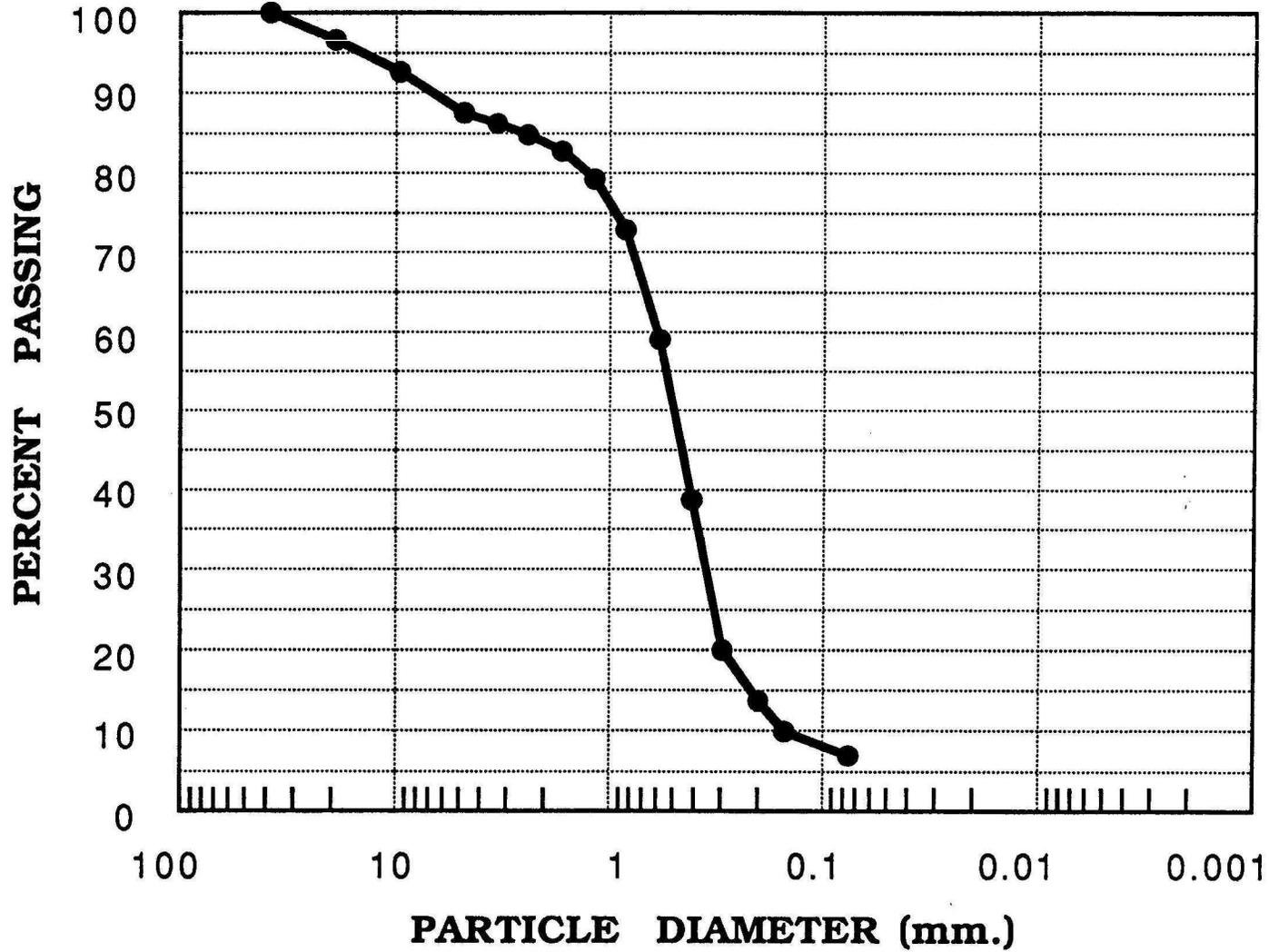
LINE # 3C1 N-S
USBR SITE # 2+00
SAMPLING DEPTH (ft.) 27-32

Particle Diameter @ 60% Passing = 0.23mm.(0.009 in.)



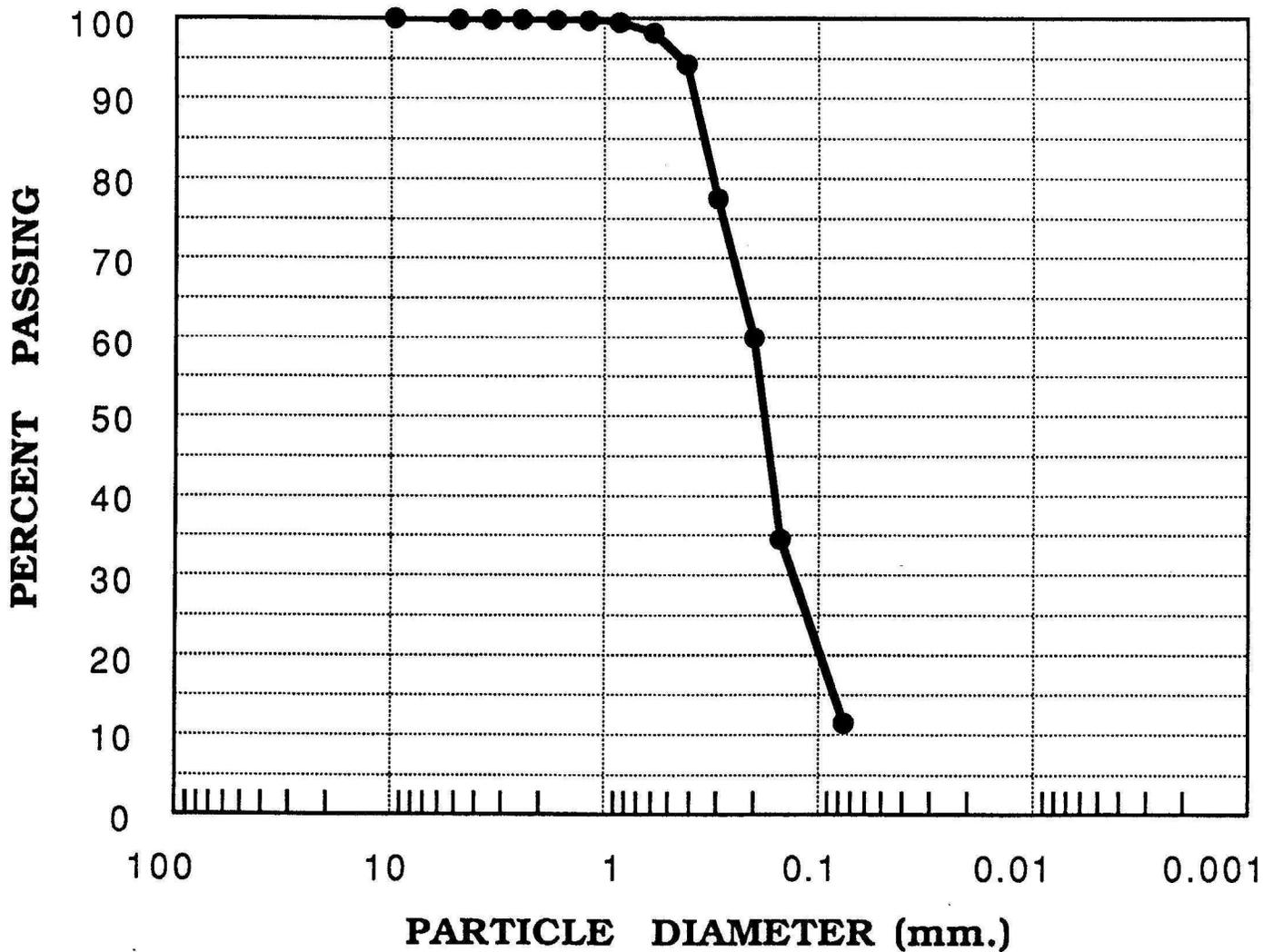
LINE # 3C1 N-S
USBR SITE # 2+00
SAMPLING DEPTH (ft.) 32-38

Particle Diameter @ 60% Passing = 0.60mm.(0.024 in.)



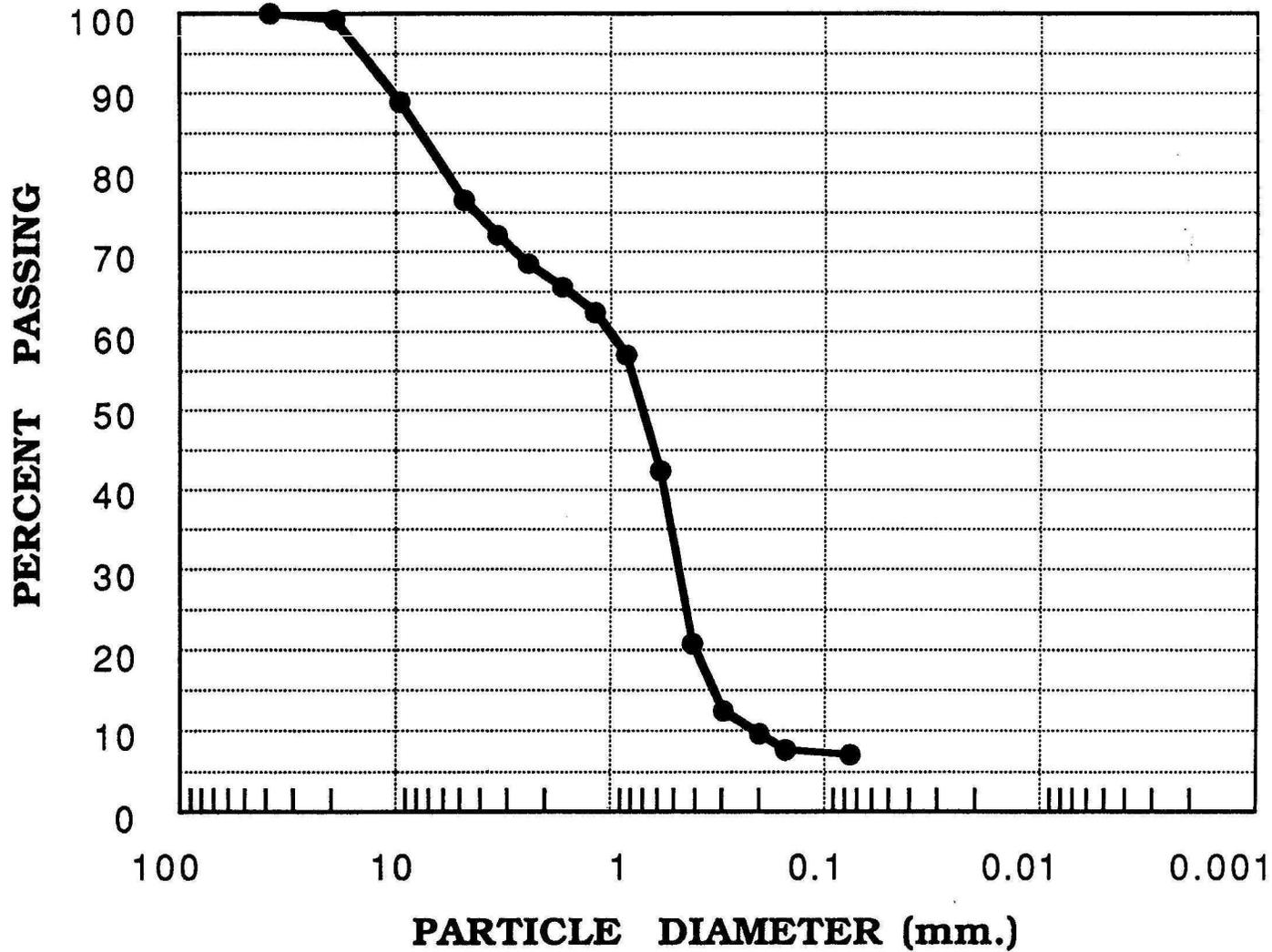
LINE # 3C1 N-S
USBR SITE # 4+00
SAMPLING DEPTH (ft.) 20.5-35.5

Particle Diameter @ 60% Passing = 0.21mm.(0.008 in.)



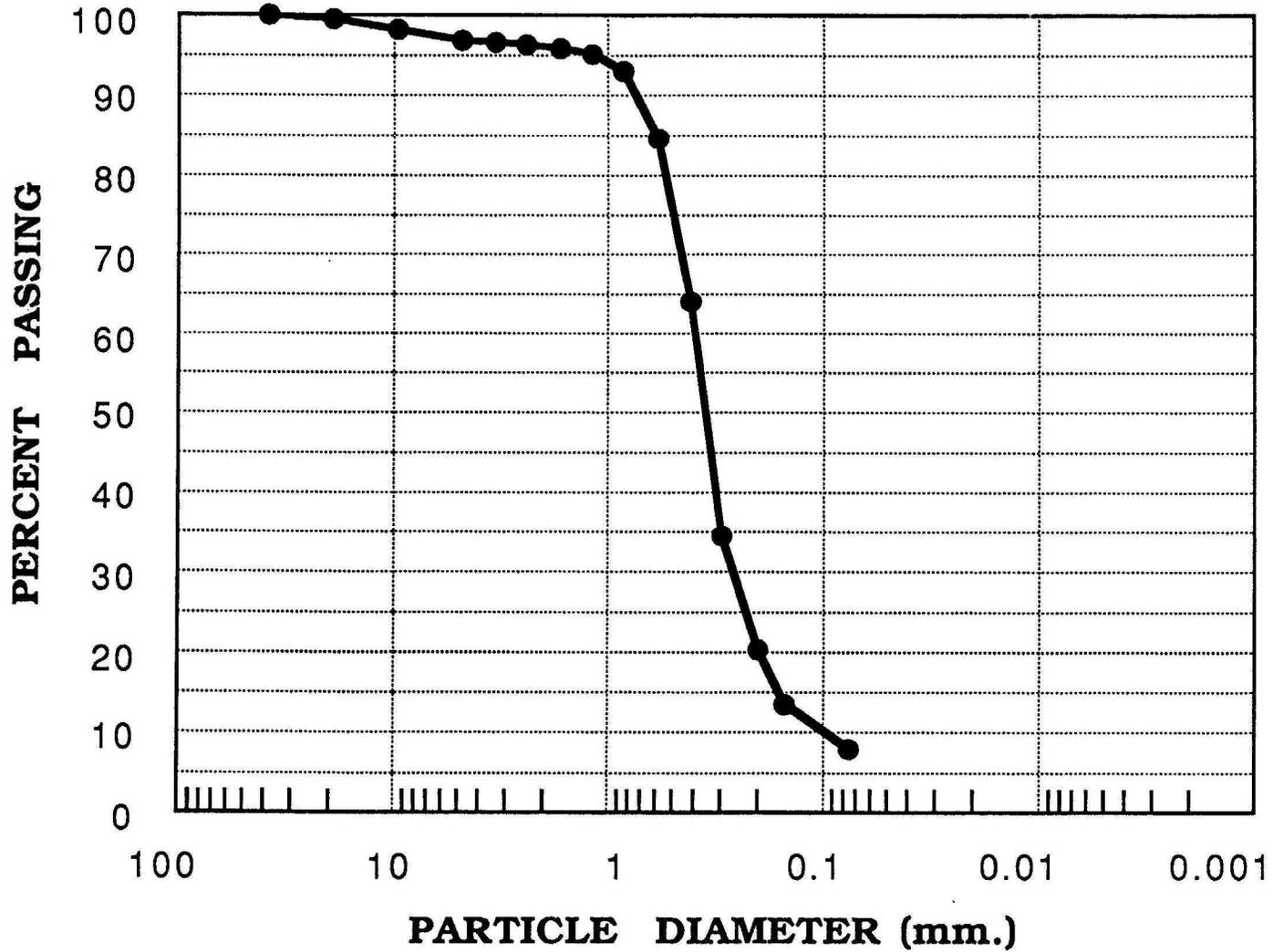
LINE # 3C1 N-S
USBR SITE #4+00
SAMPLING DEPTH (ft.) 35.5-40.5

Particle Diameter @ 60% Passing = 1.00 mm.(0.039 in.)



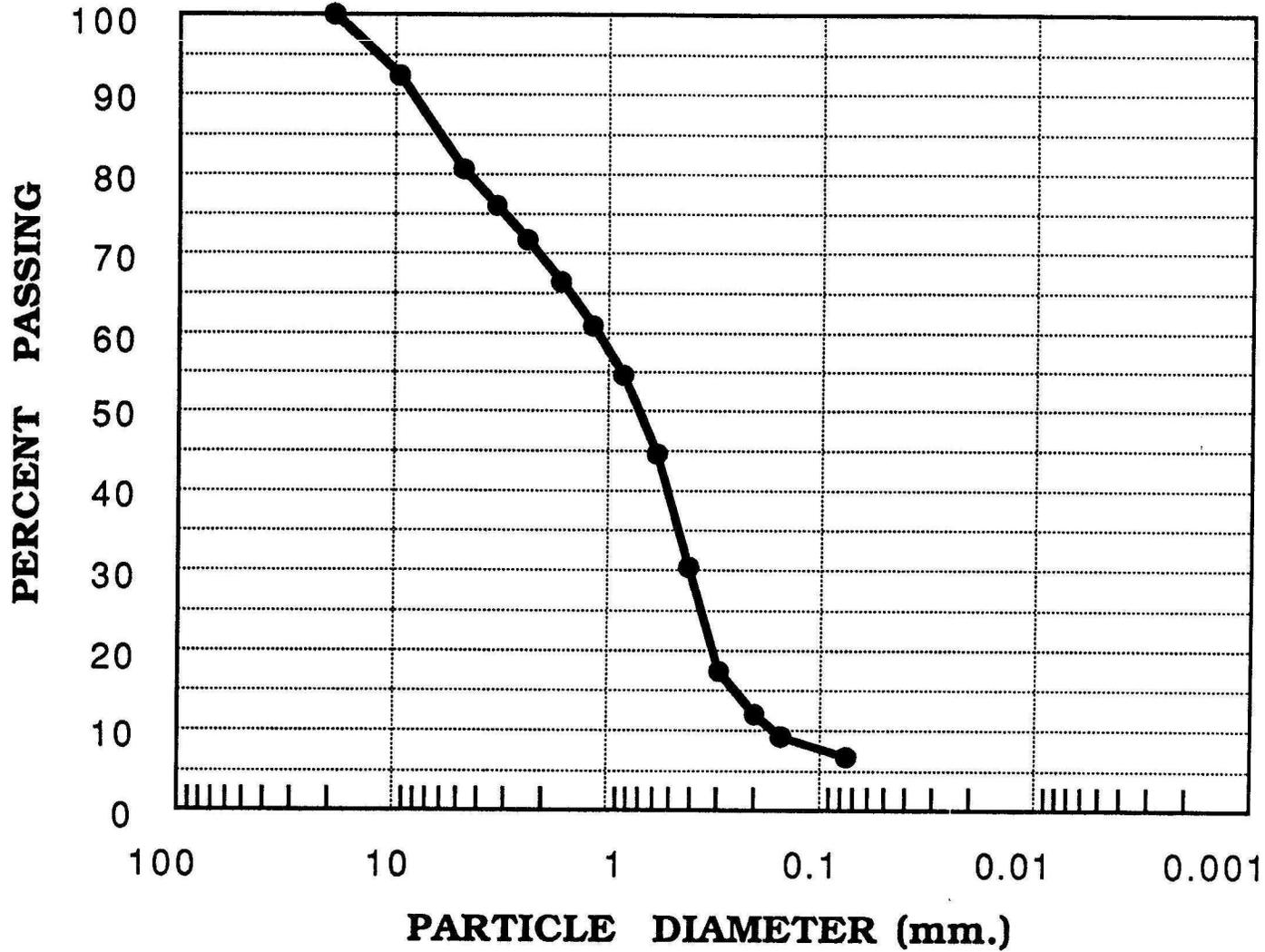
LINE # 3C1 N-S
USBR SITE #6+00
SAMPLING DEPTH (ft.) 22-33

Particle Diameter @ 60% Passing = 0.40 mm.(0.016in.)



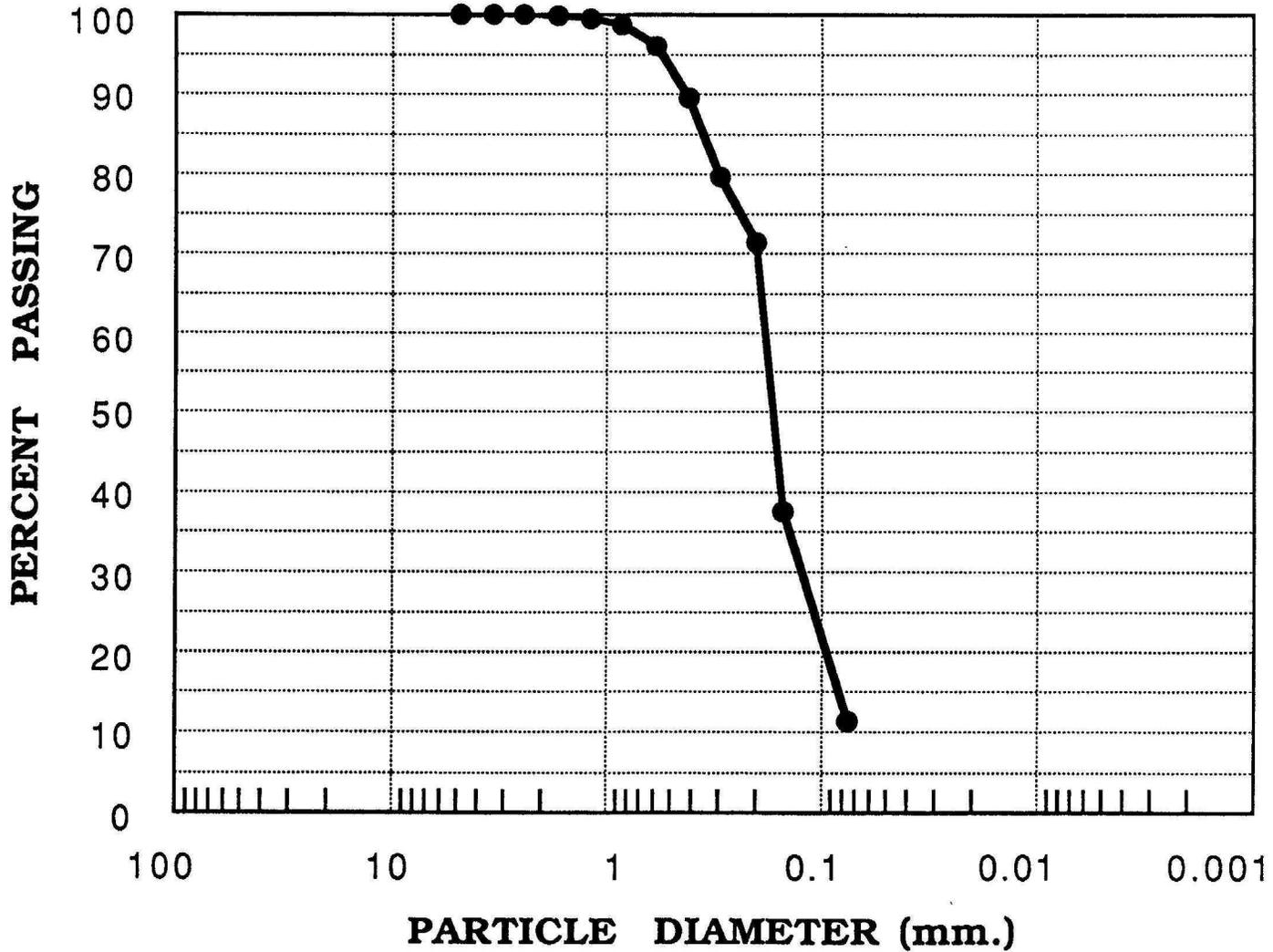
LINE # 3C1 N-S
USBR SITE #6+00
SAMPLING DEPTH (ft.) 33-37

Particle Diameter @ 60% Passing = 1.09 mm.(0.043 in.)



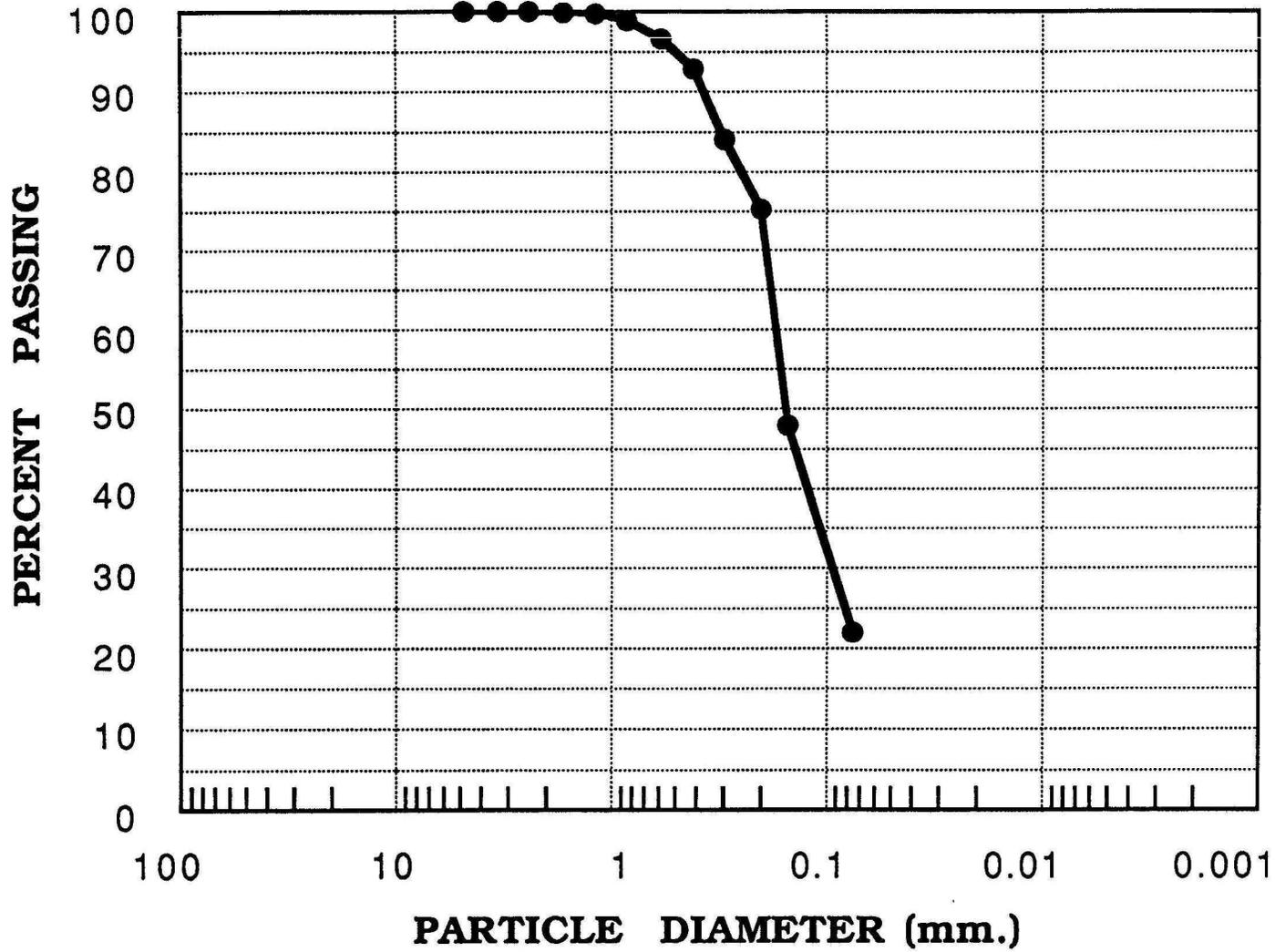
LINE # 3C1 N-S
USBR SITE #8+00
SAMPLING DEPTH (ft.) 27.0-31.5

Particle Diameter @ 60% Passing = 0.18mm.(0.007 in.)



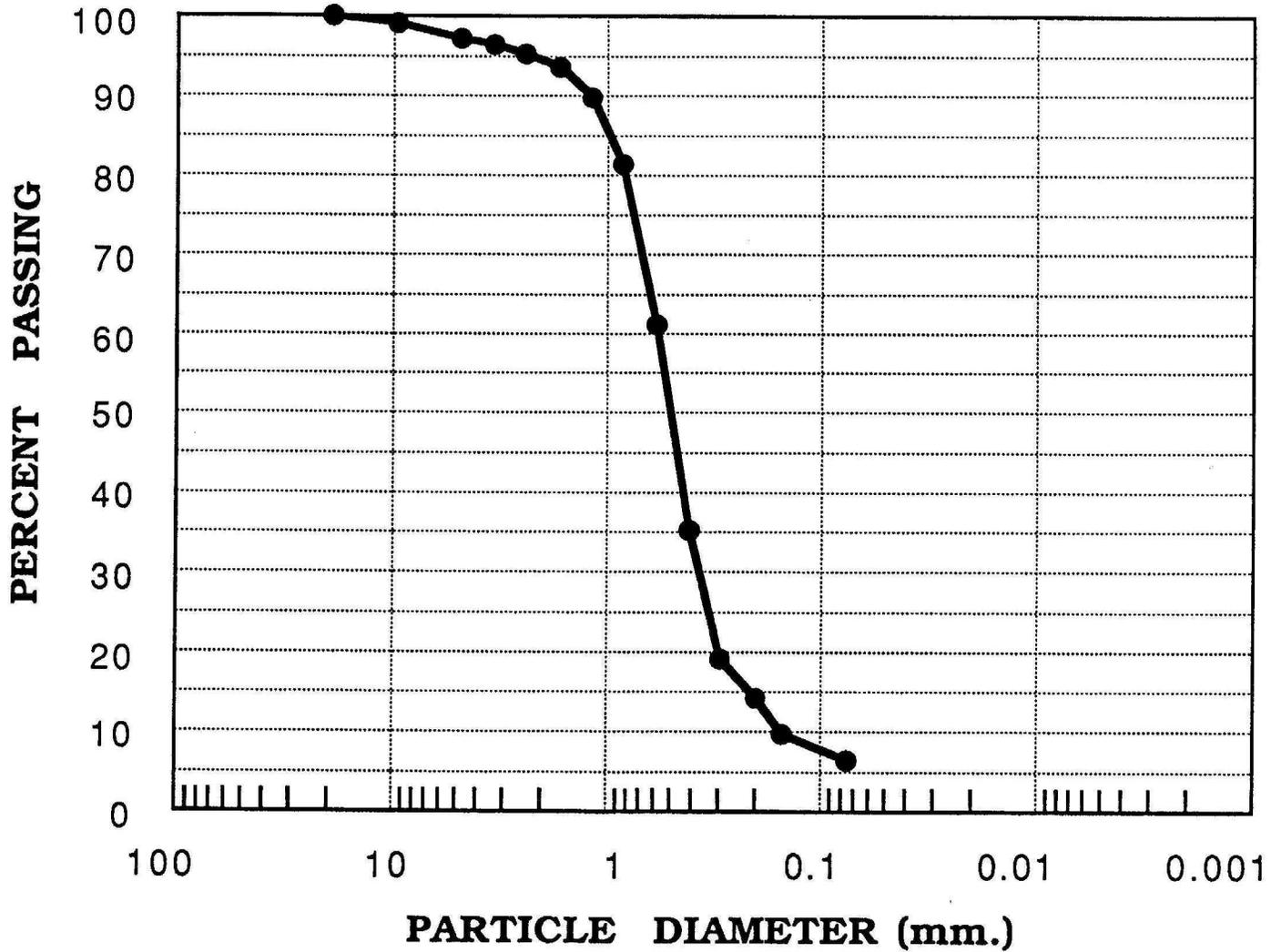
LINE # 3C1 N-S
USBR SITE #8+00
SAMPLING DEPTH (ft.) 31.5-34.5

Particle Diameter @ 60% Passing = 0.18mm.(0.007 in.)



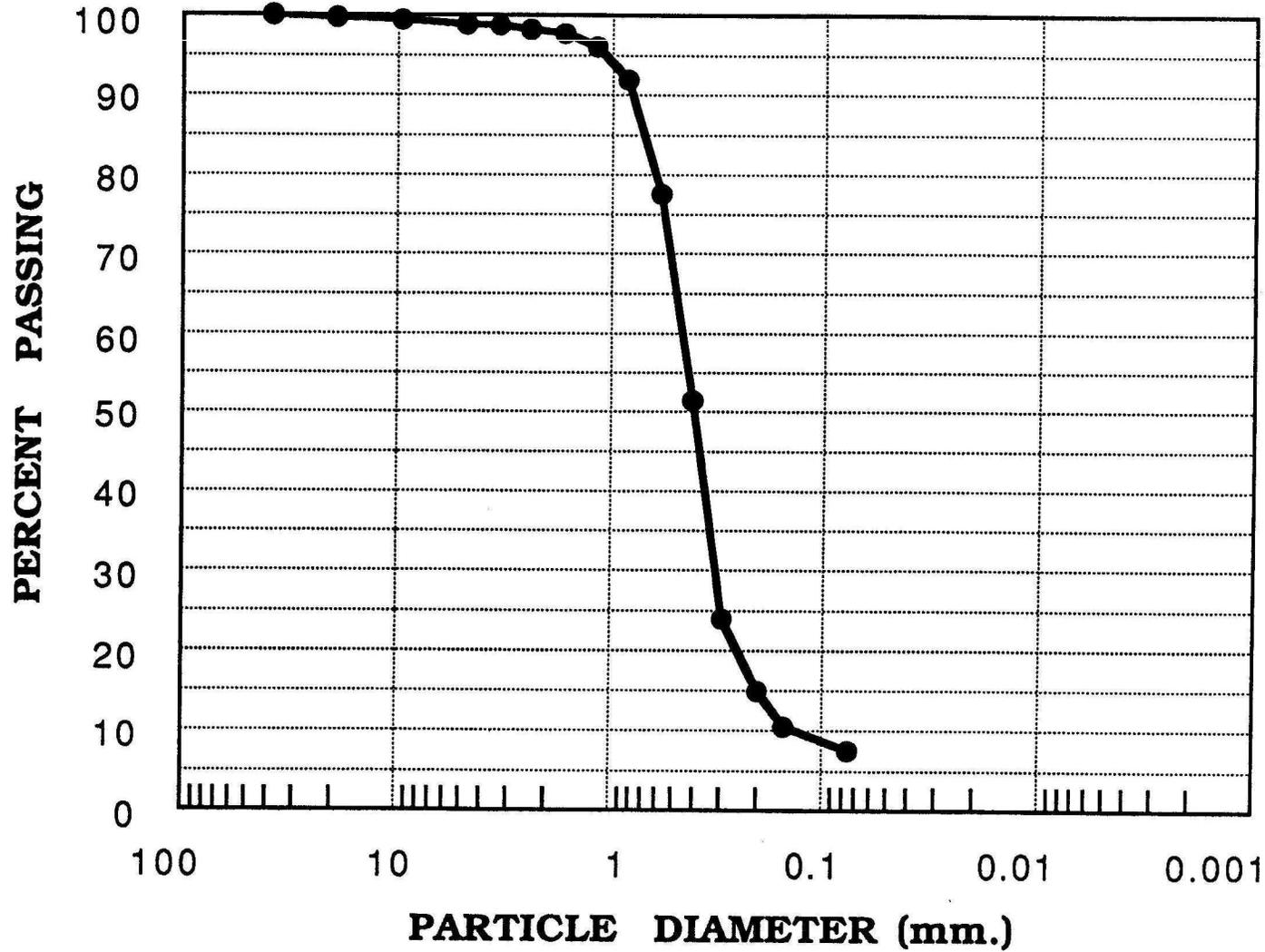
LINE # 3C1 N-S
USBR SITE #8+00
SAMPLING DEPTH (ft.) 34.5-41.0

Particle Diameter @ 60% Passing = 0.58mm.(0.023 in.)



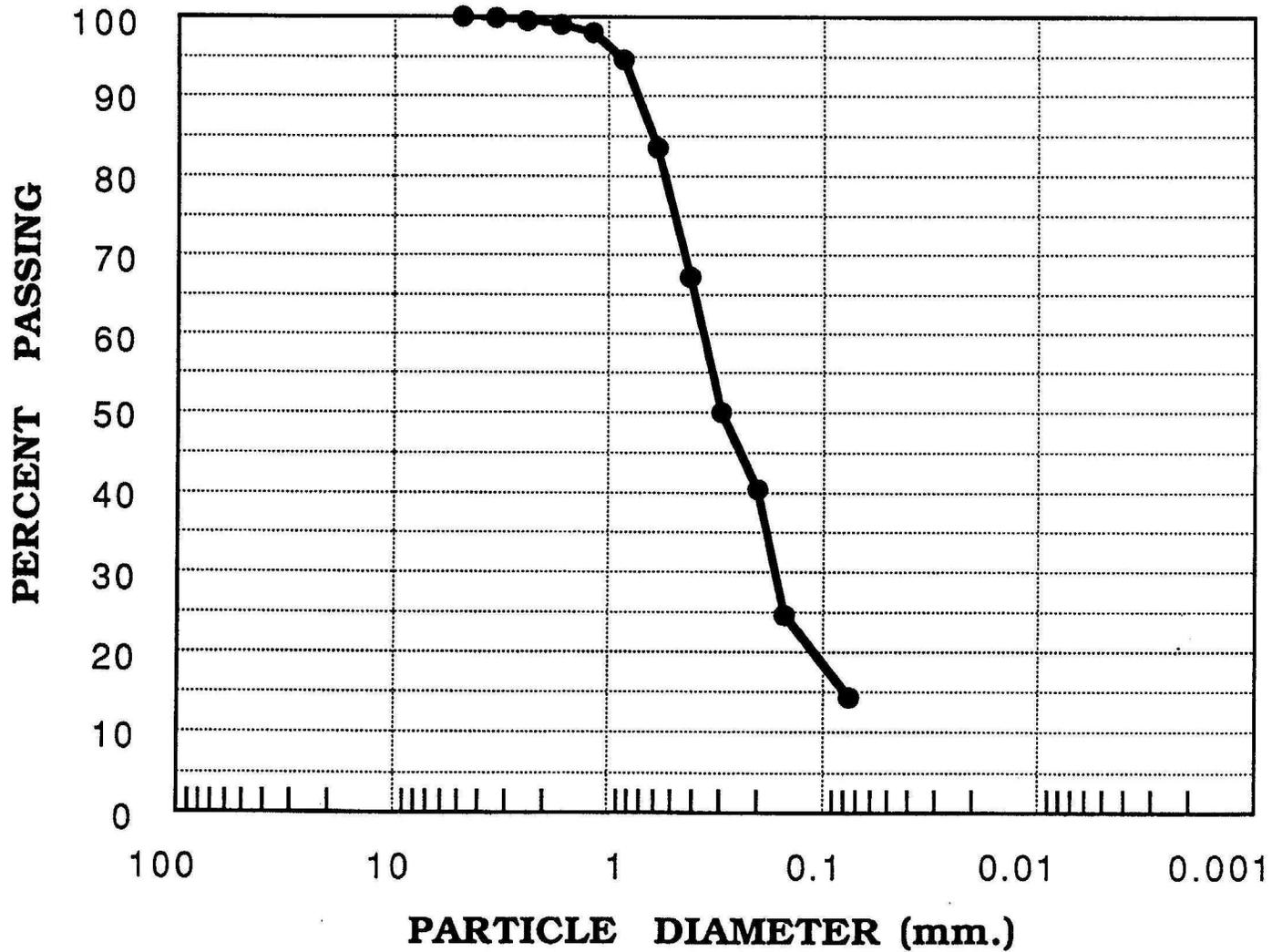
LINE # 3C1 N-S
USBR SITE #10+00
SAMPLING DEPTH (ft.) 18-33

Particle Diameter @ 60% Passing = 0.46 mm.(0.018 in.)



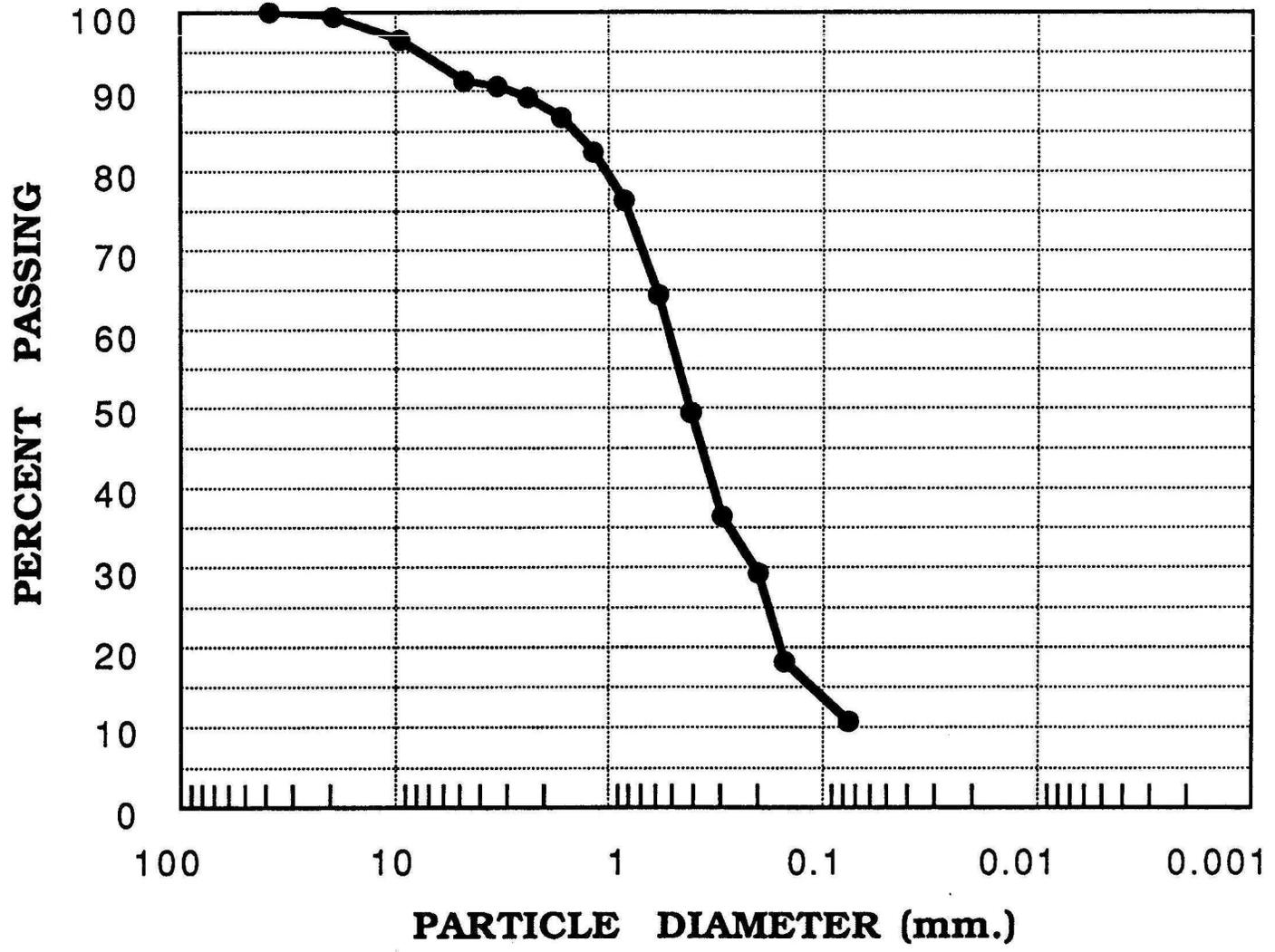
LINE # 3C1 N-S
USBR SITE #10+00
SAMPLING DEPTH (ft.) 33-43

Particle Diameter @ 60% Passing = 0.36 mm.(0.014 in.)



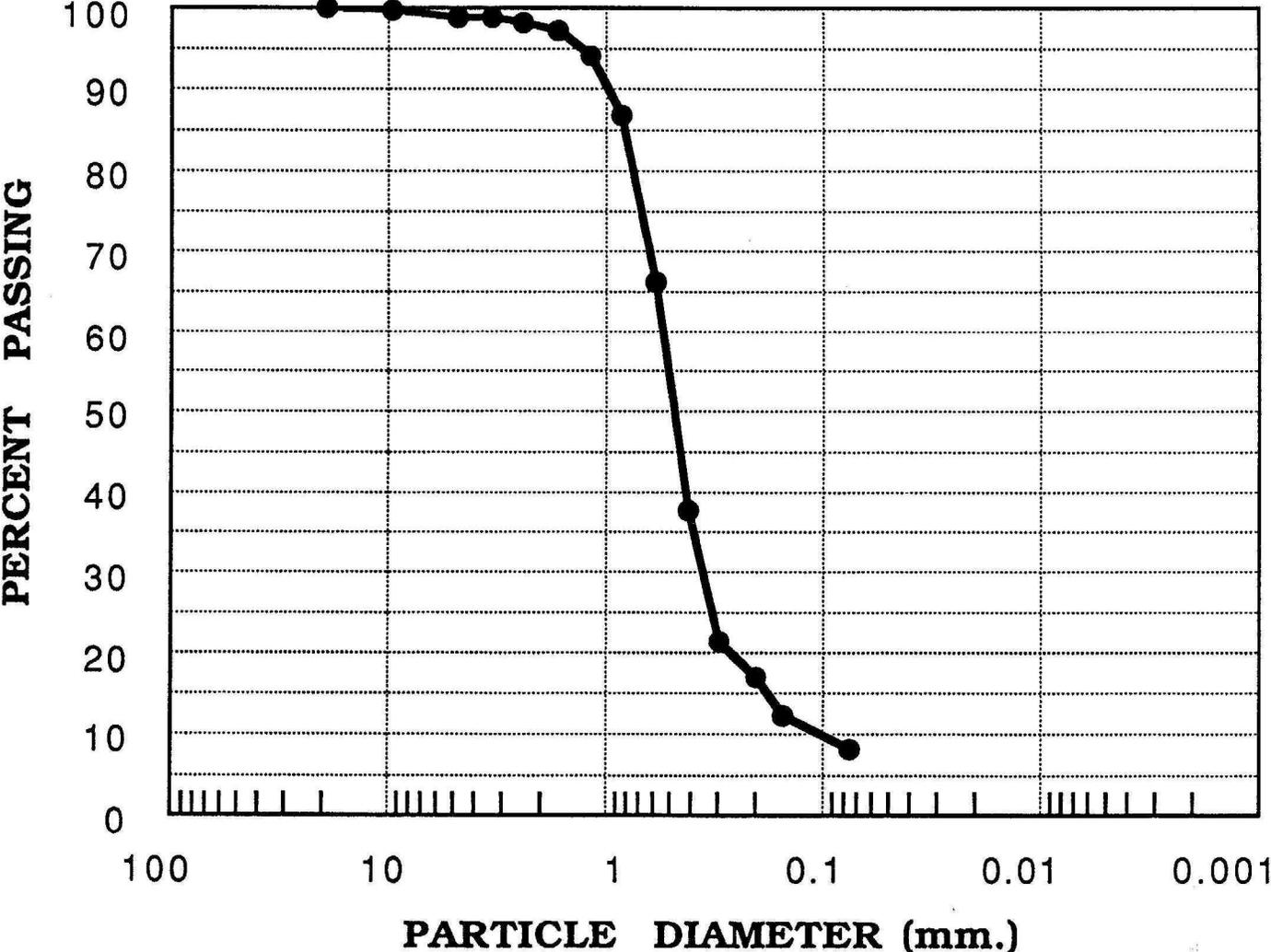
LINE # 3C1 N-S
USBR SITE #12+00
SAMPLING DEPTH (ft.) 27.5-31.5

Particle Diameter @ 60% Passing = 0.53mm.(0.021 in.)



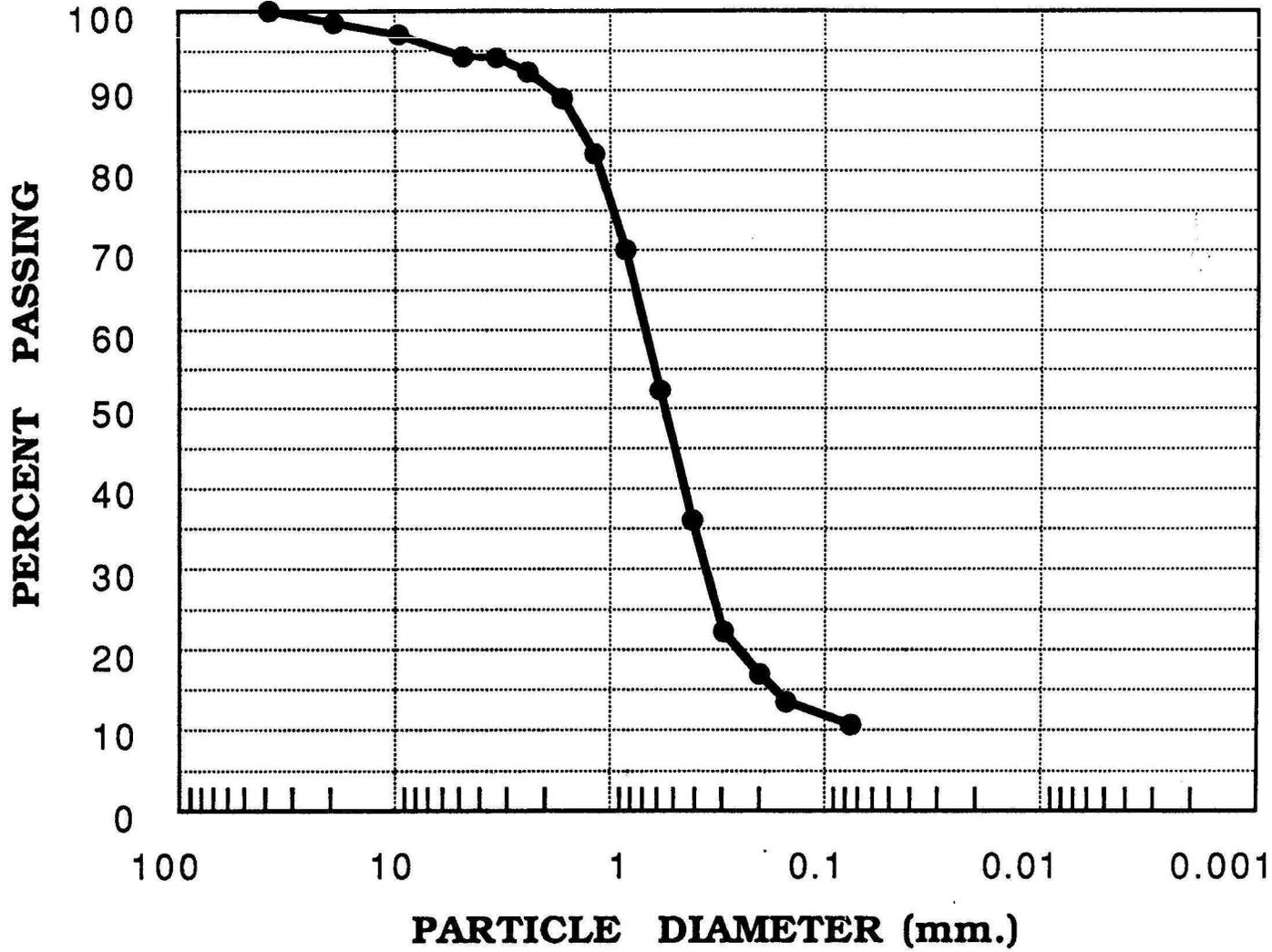
LINE # 3C1 N-S
USBR SITE #12+00
SAMPLING DEPTH (ft.) 31.5-37.0

Particle Diameter @ 60% Passing = 0.55 mm.(0.022 in.)



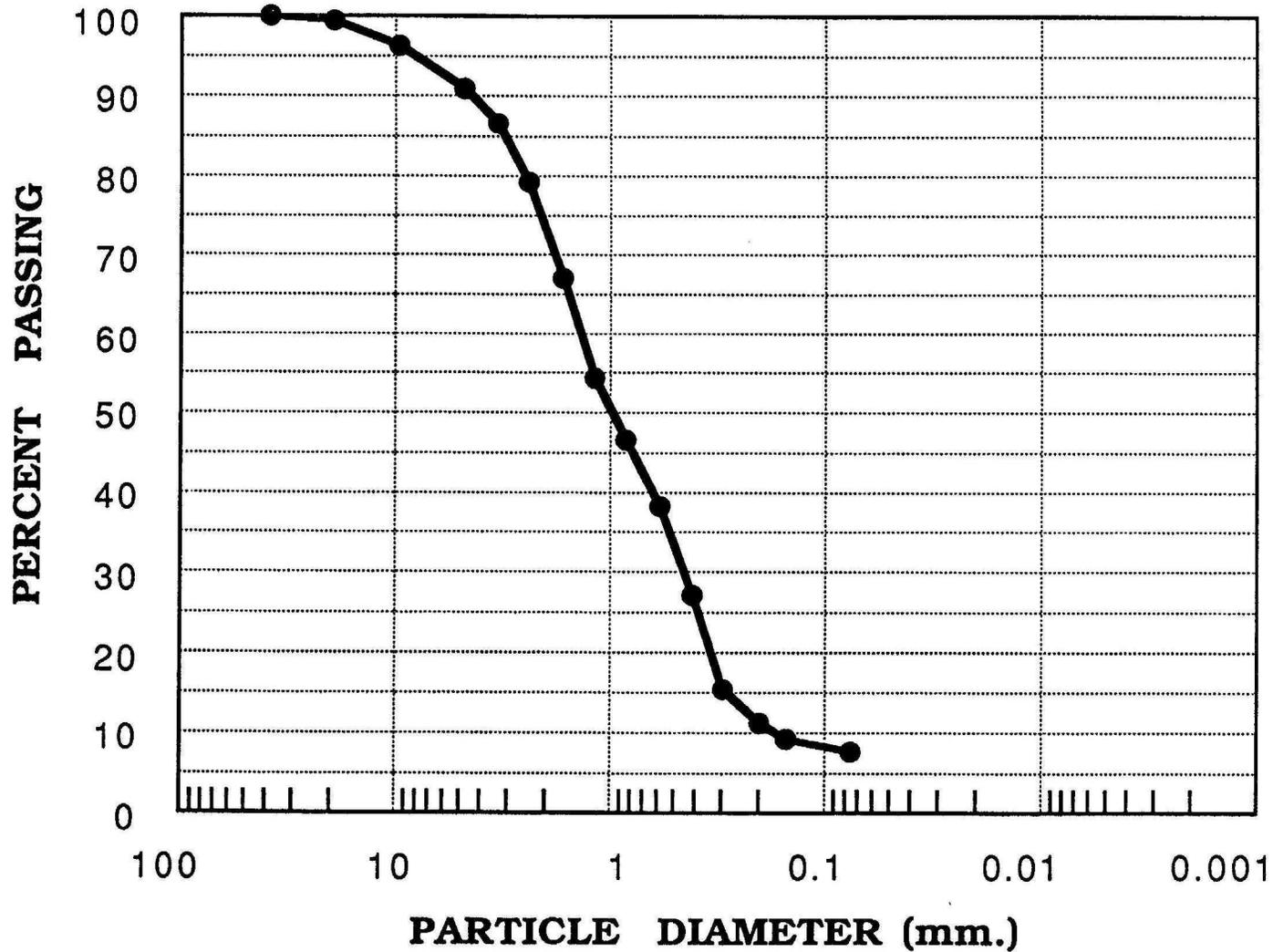
LINE # 3C1 N-S
USBR SITE #16+00
SAMPLING DEPTH (ft.) 23-26

Particle Diameter @ 60% Passing = 0.69mm.(0.027 in.)



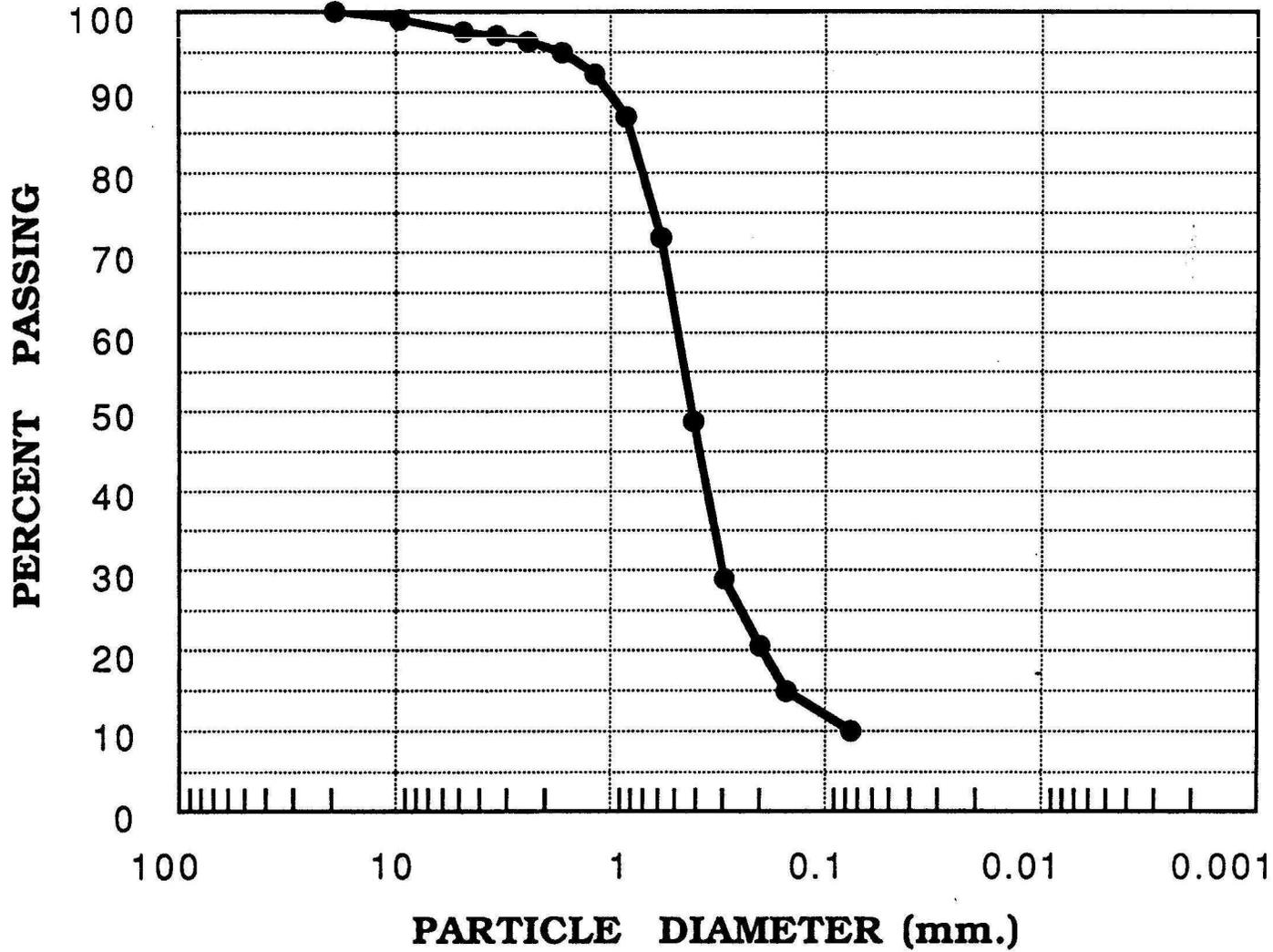
LINE # 3C1 N-S
USBR SITE #16+00
SAMPLING DEPTH (ft.) 26-34

Particle Diameter @ 60% Passing = 1.37mm.(0.054 in.)



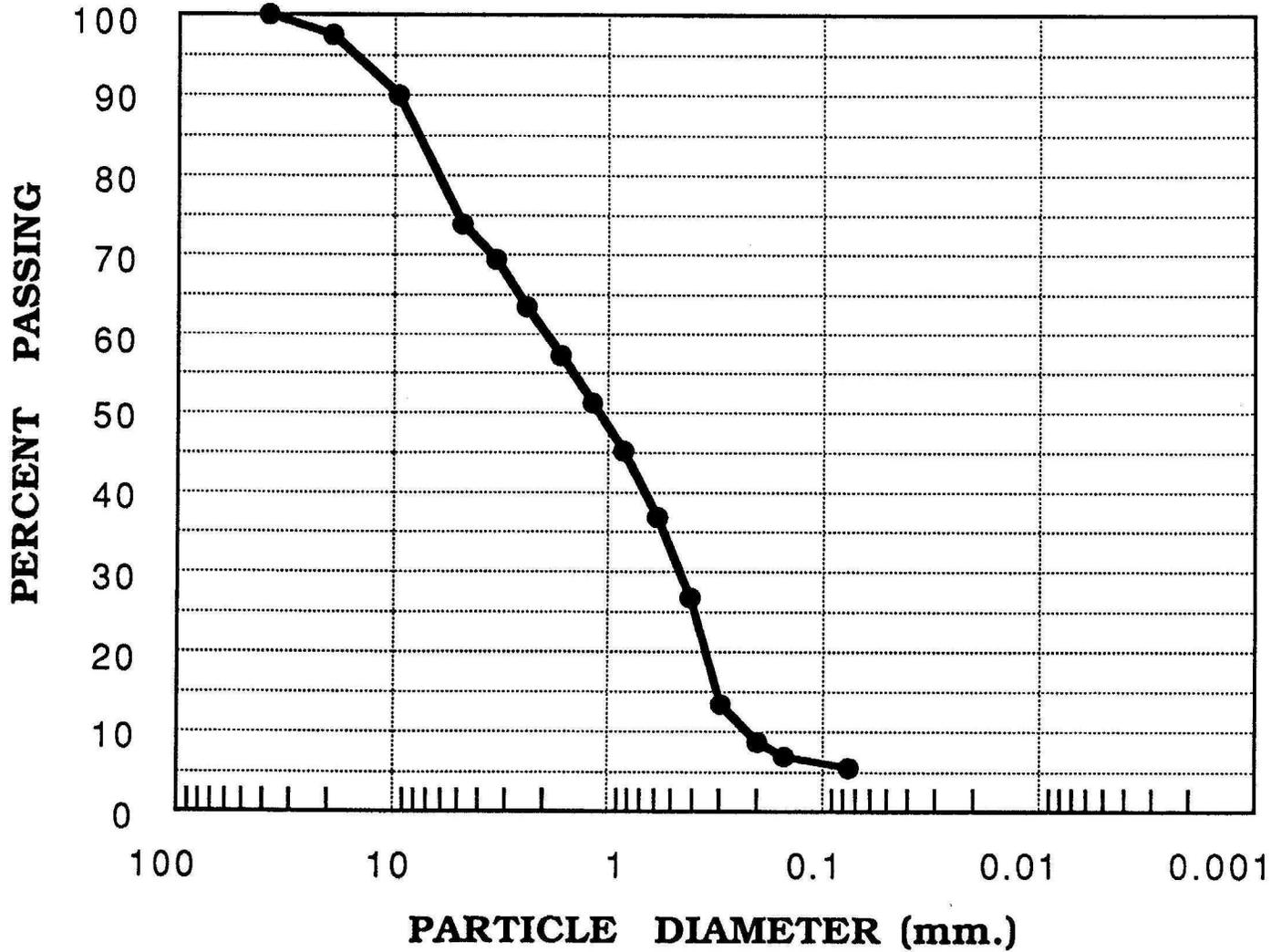
LINE # 3C1 N-S
USBR SITE #20+00
SAMPLING DEPTH (ft.) 13-23.5

Particle Diameter @ 60% Passing = 0.48mm.(0.019 in.)



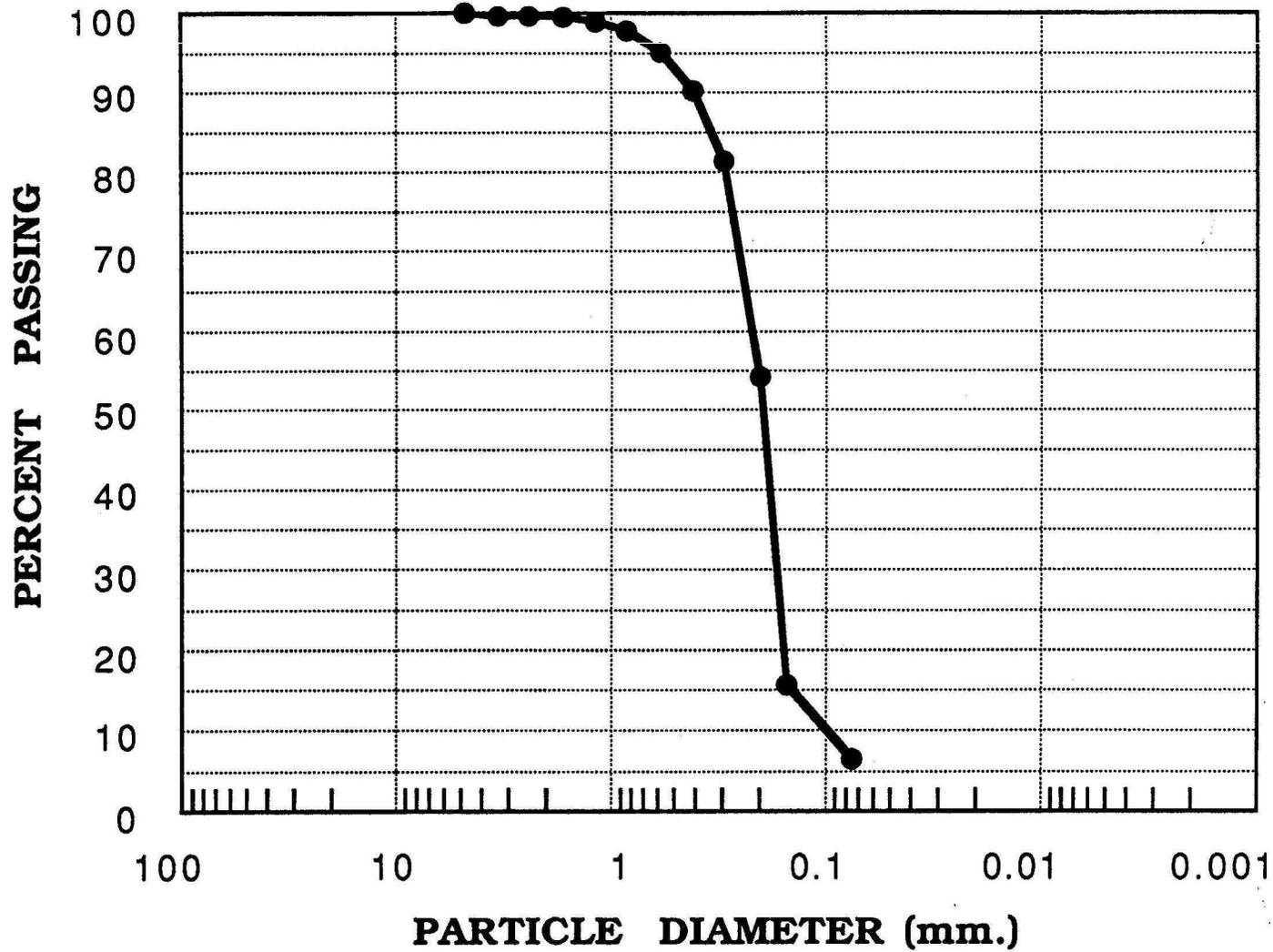
LINE # 3C1 N-S
USBR SITE #20+00
SAMPLING DEPTH (ft.) 23.5-31.0

Particle Diameter @ 60% Passing = 1.98 mm.(0.078 in.)



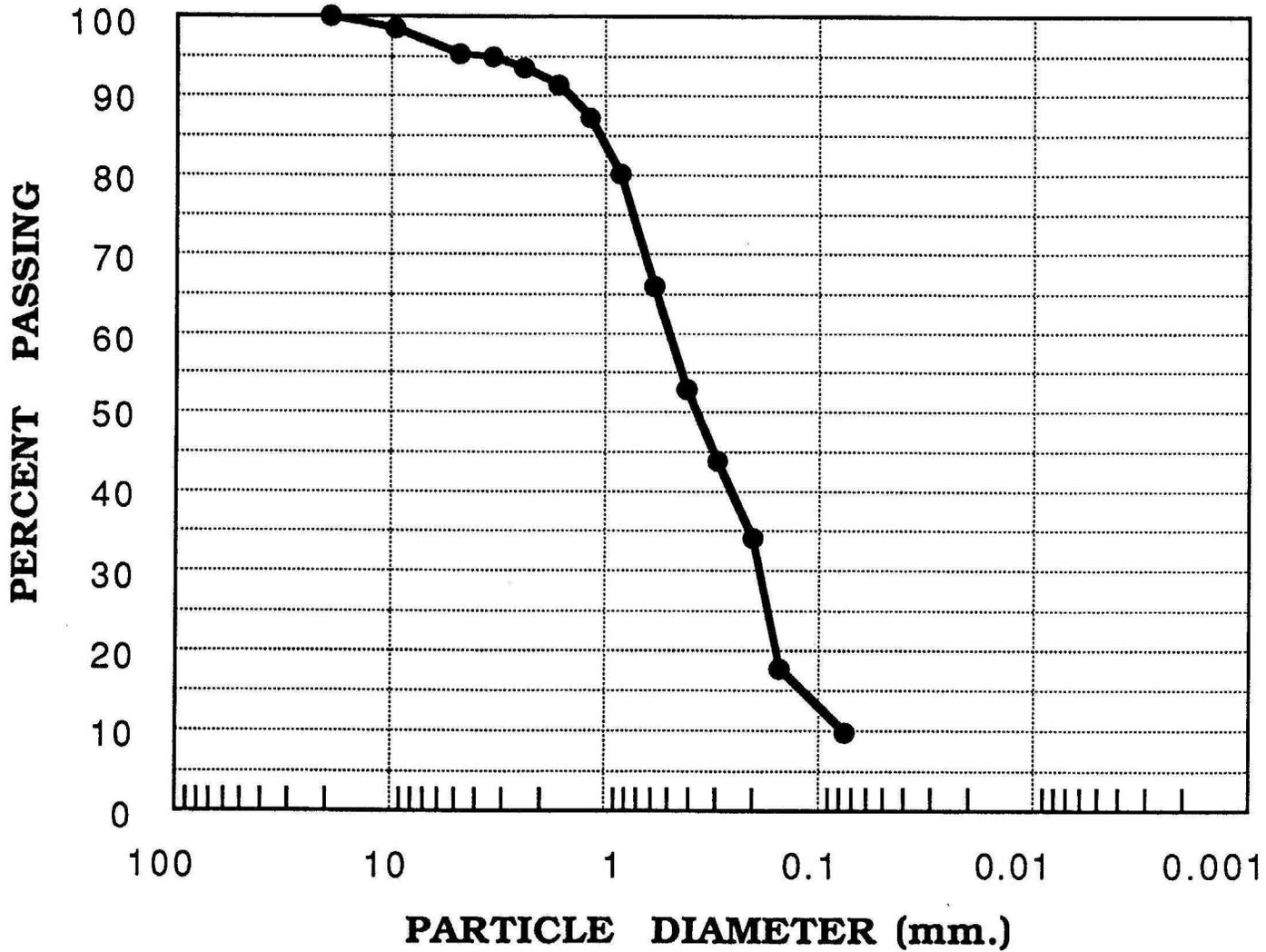
LINE # 3C1 N-S
USBR SITE #23+00
SAMPLING DEPTH (ft.) 10.5-20.5

Particle Diameter @ 60% Passing = 0.22 mm.(0.009 in.)



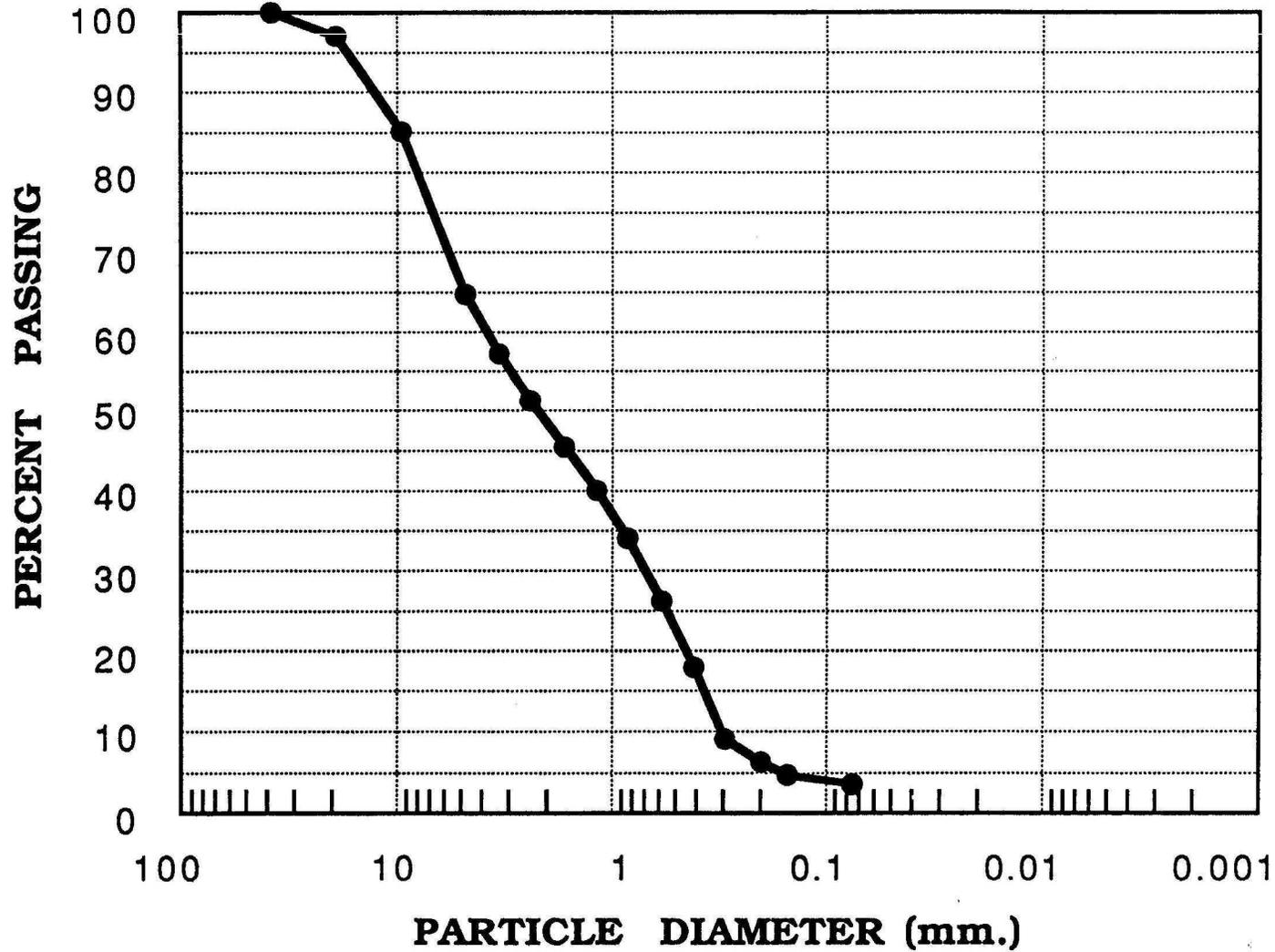
LINE # 3C1 N-S
USBR SITE #23+00
SAMPLING DEPTH (ft.) 20.5-25.5

Particle Diameter @ 60% Passing = 0.50 mm.(0.020 in.)



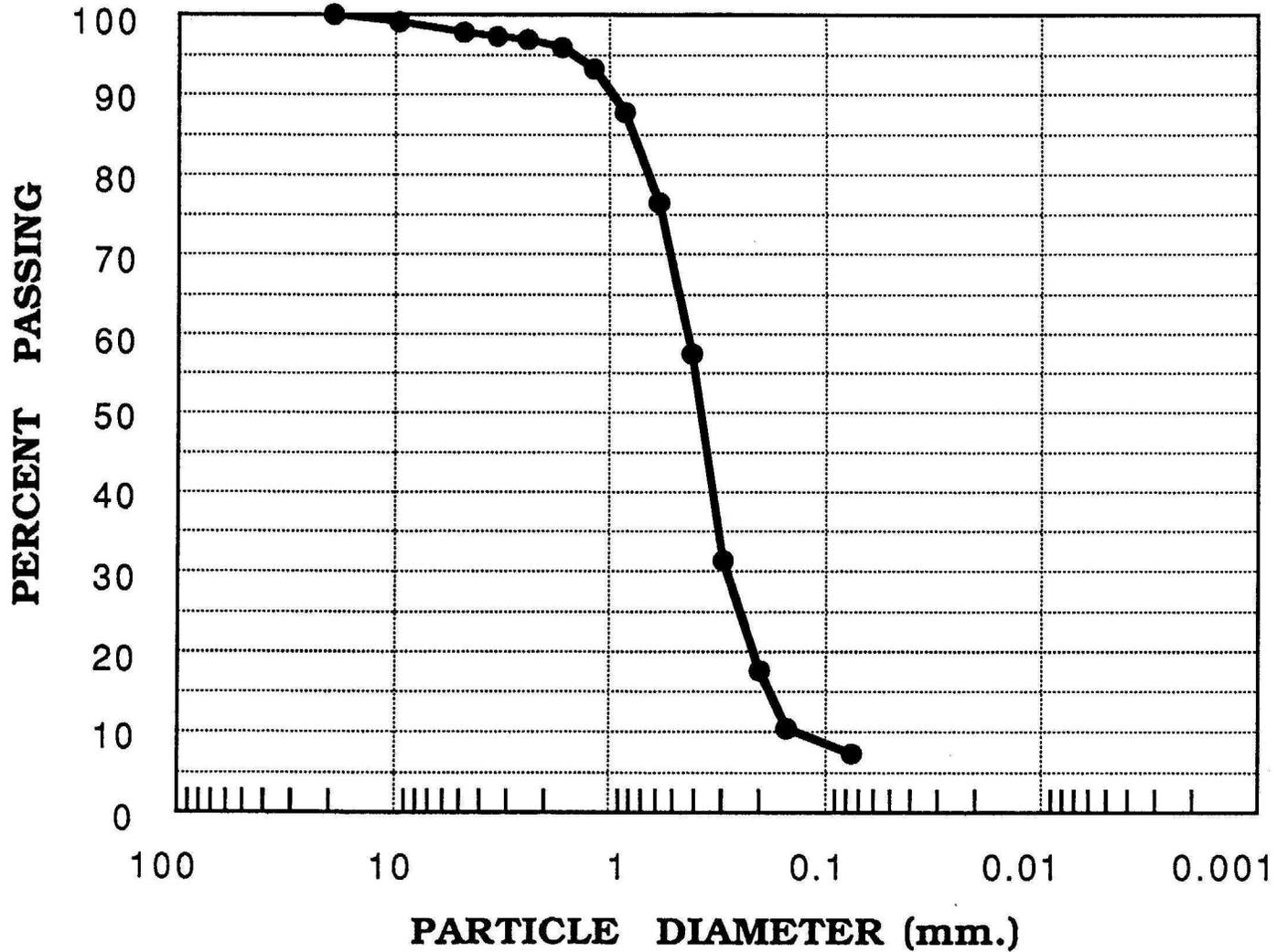
LINE # 3C2 W-E
USBR SITE #2+00
SAMPLING DEPTH (ft.) 34-43

Particle Diameter @ 60% Passing = 3.76 mm.(0.148 in.)



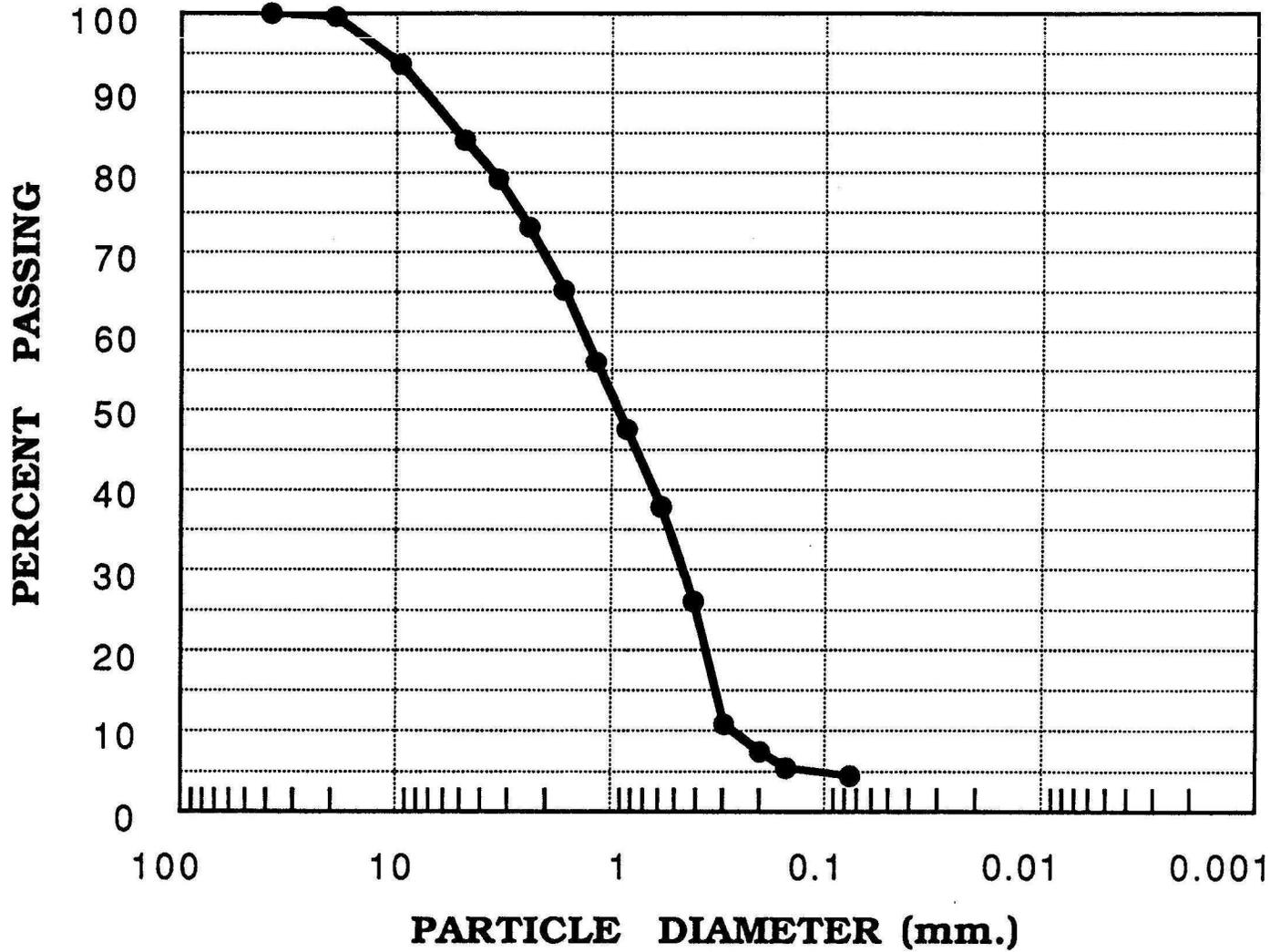
**LINE # 3C2 E-W
USBR SITE #4+00
SAMPLING DEPTH (ft.) 23-36**

Particle Diameter @ 60% Passing = 0.44 mm.(0.017 in.)



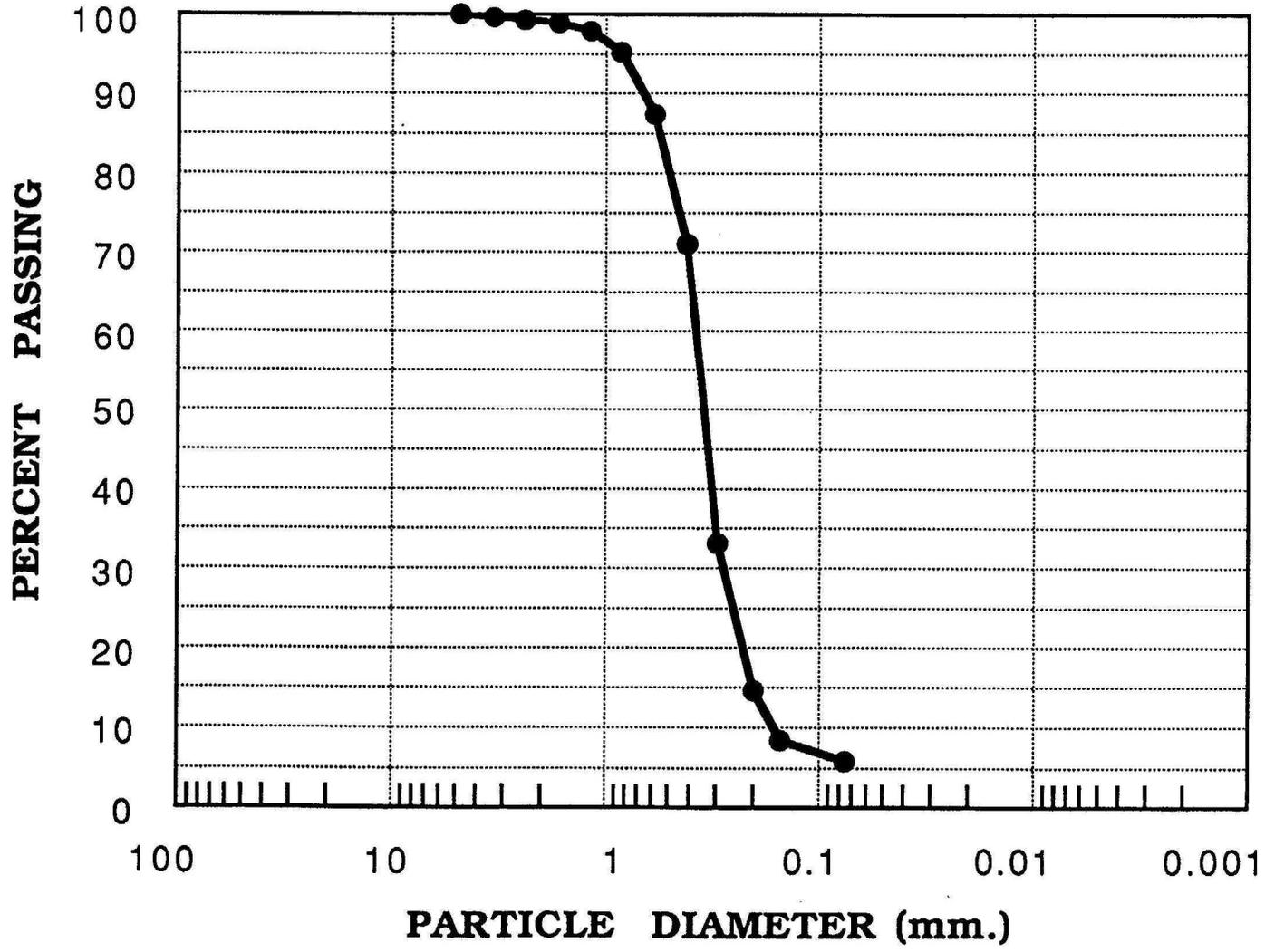
LINE # 3C2 E-W
USBR SITE #4+00
SAMPLING DEPTH (ft.) 36-42

Particle Diameter @ 60% Passing = 1.37 mm.(0.054 in.)



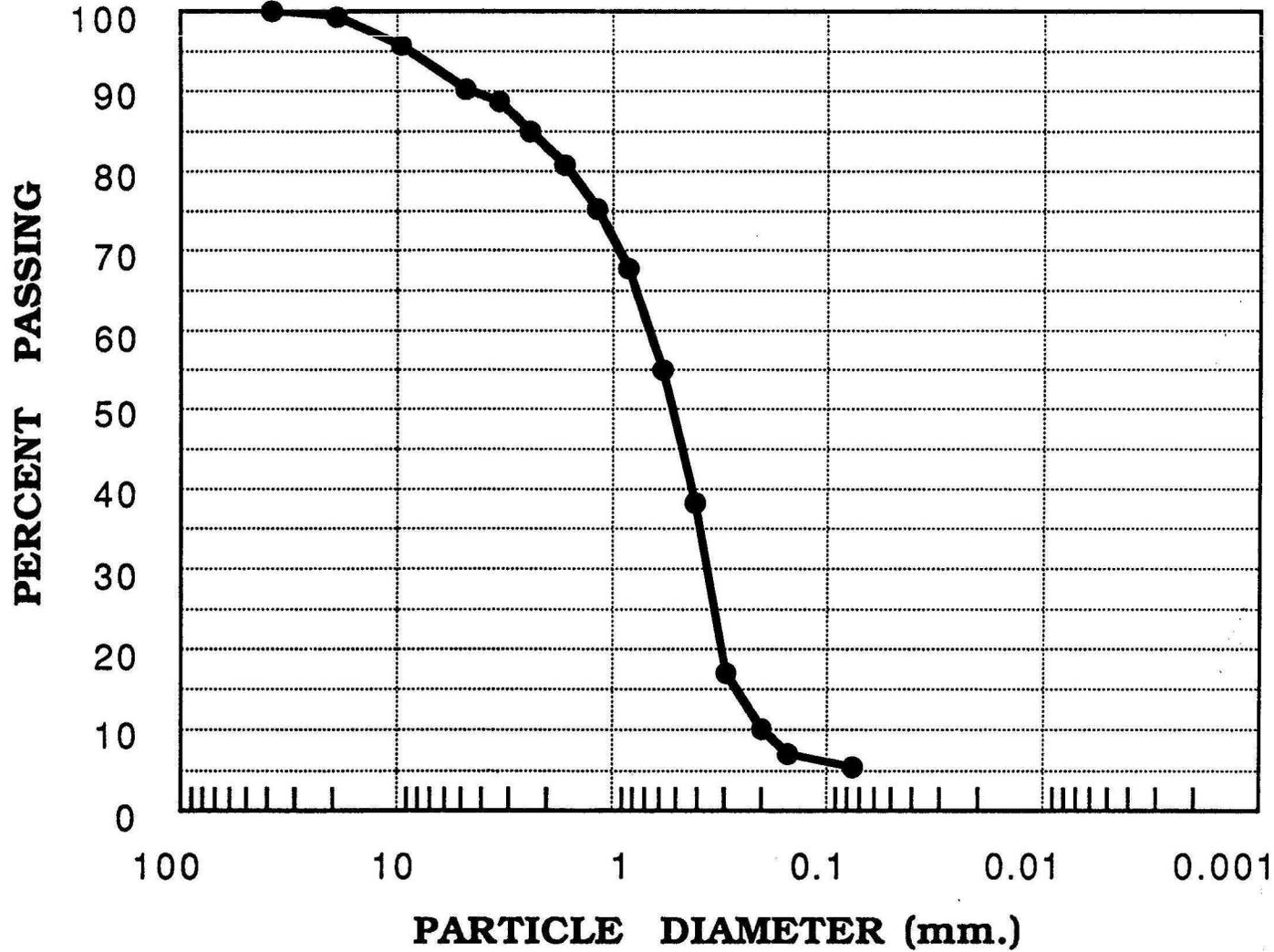
LINE # 3C2 W-E
USBR SITE #6+00
SAMPLING DEPTH (ft.) 8-31.5

Particle Diameter @ 60% Passing = 0.36 mm.(0.014 in.)



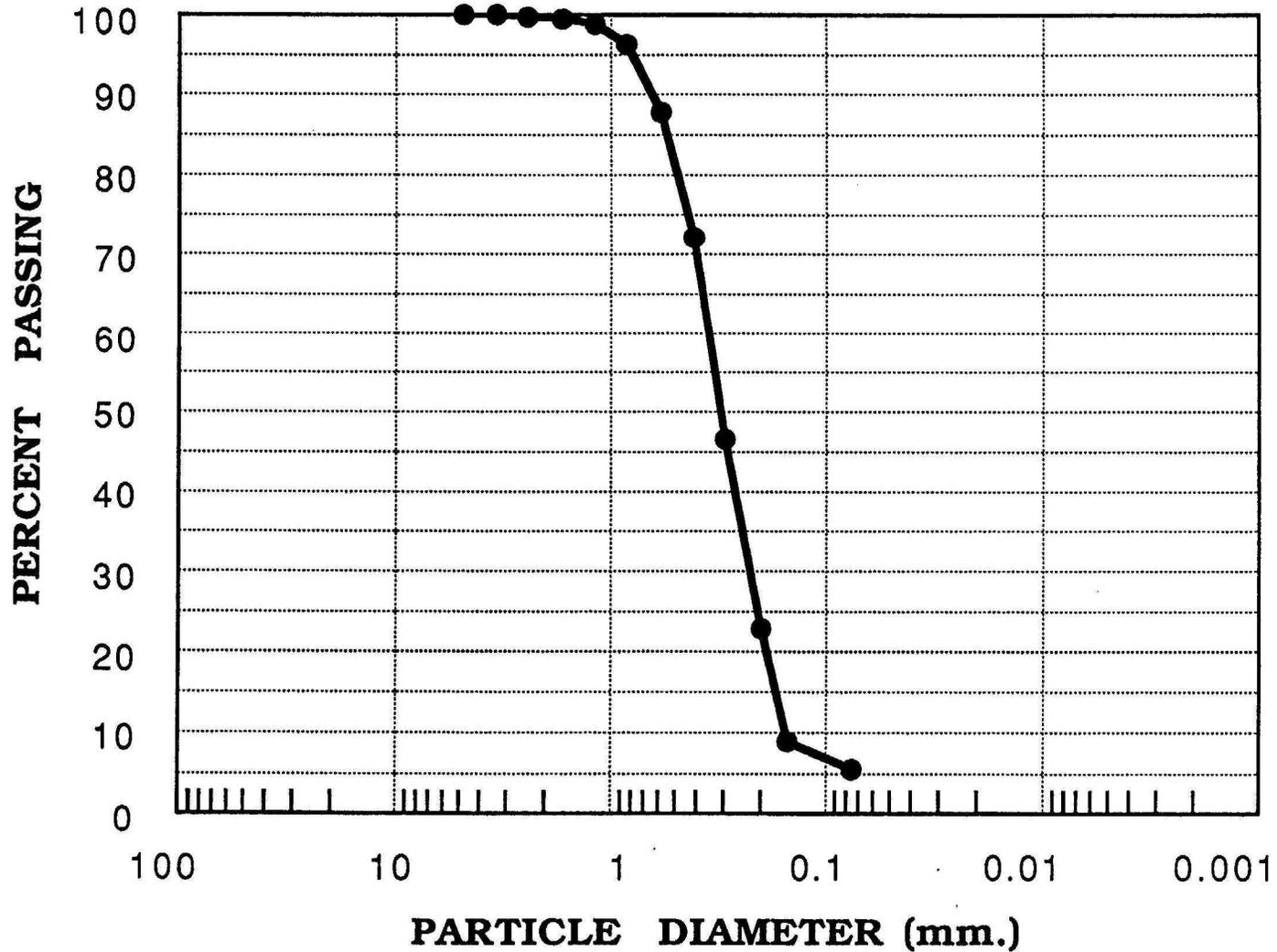
LINE # 3C2 W-E
USBR SITE #6+00
SAMPLING DEPTH (ft.) 31.5-41

Particle Diameter @ 60% Passing = 0.66 mm.(0.026 in.)



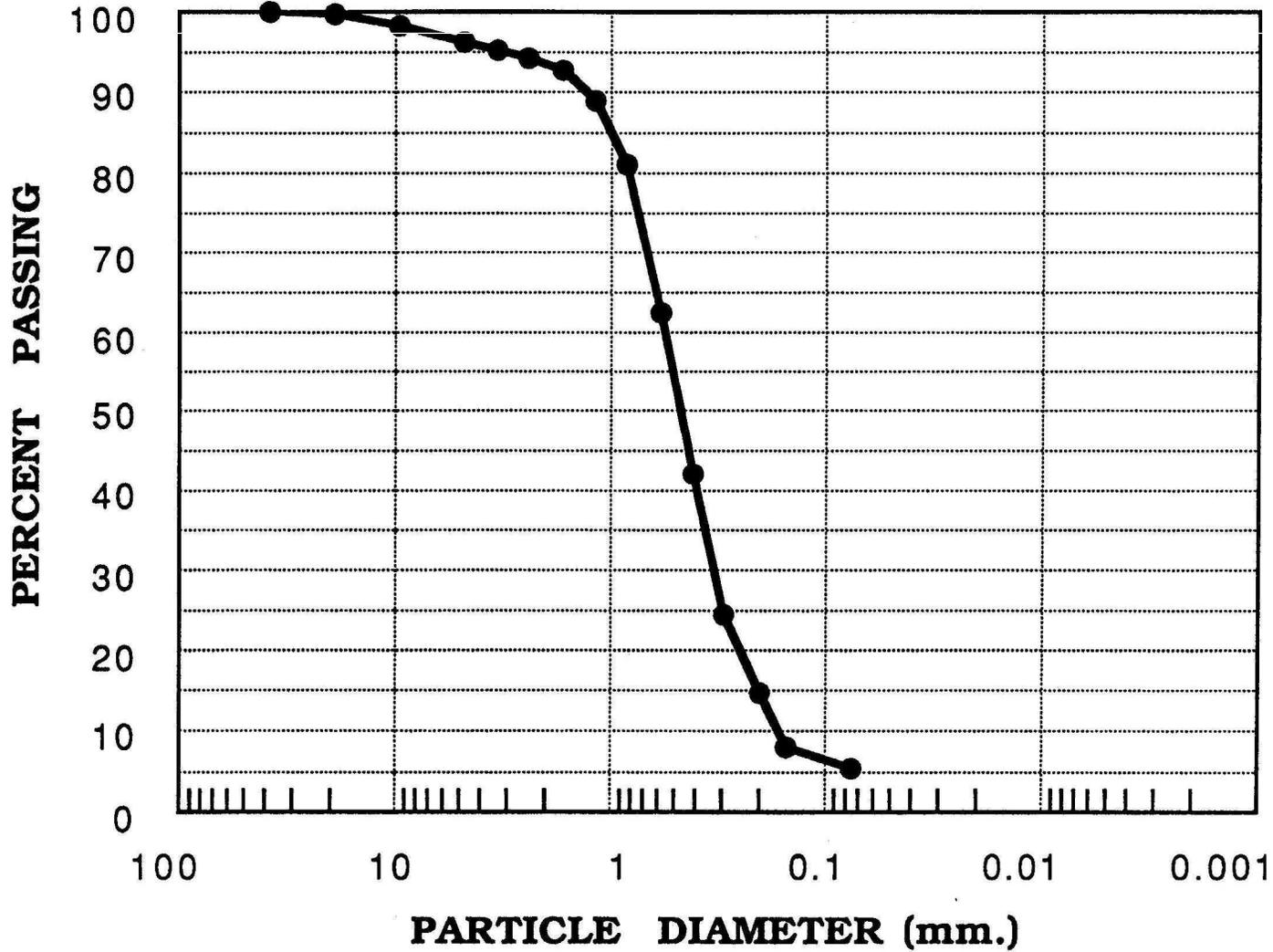
**LINE # 3C2 E-W
USBR SITE #8+00
SAMPLING DEPTH (ft.) 9-33**

Particle Diameter @ 60% Passing = 0.35 mm.(0.014 in.)



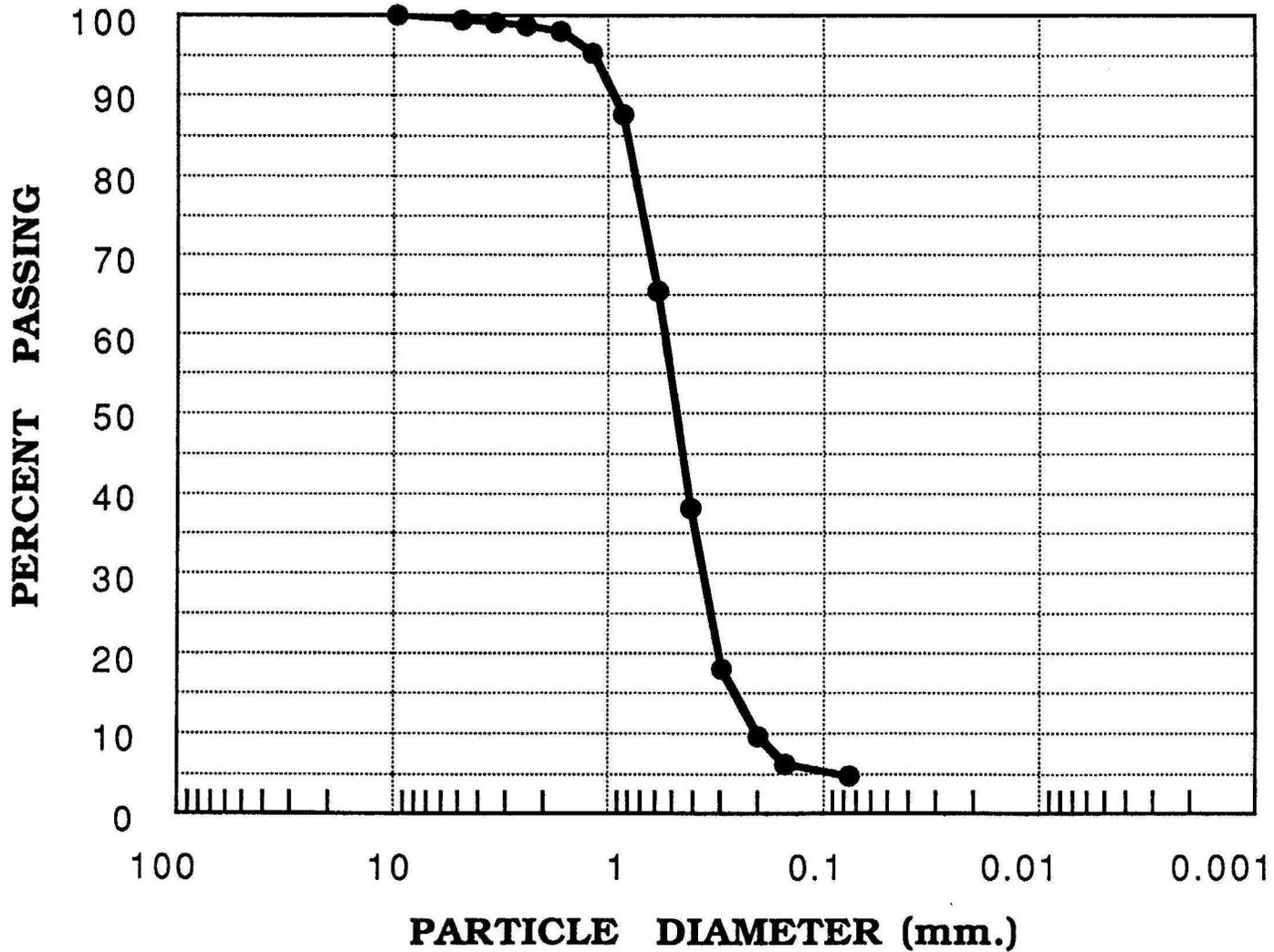
LINE # 3C2 E-W
USBR SITE #8+00
SAMPLING DEPTH (ft.) 33-38

Particle Diameter @ 60% Passing = 0.58 mm.(0.023 in.)



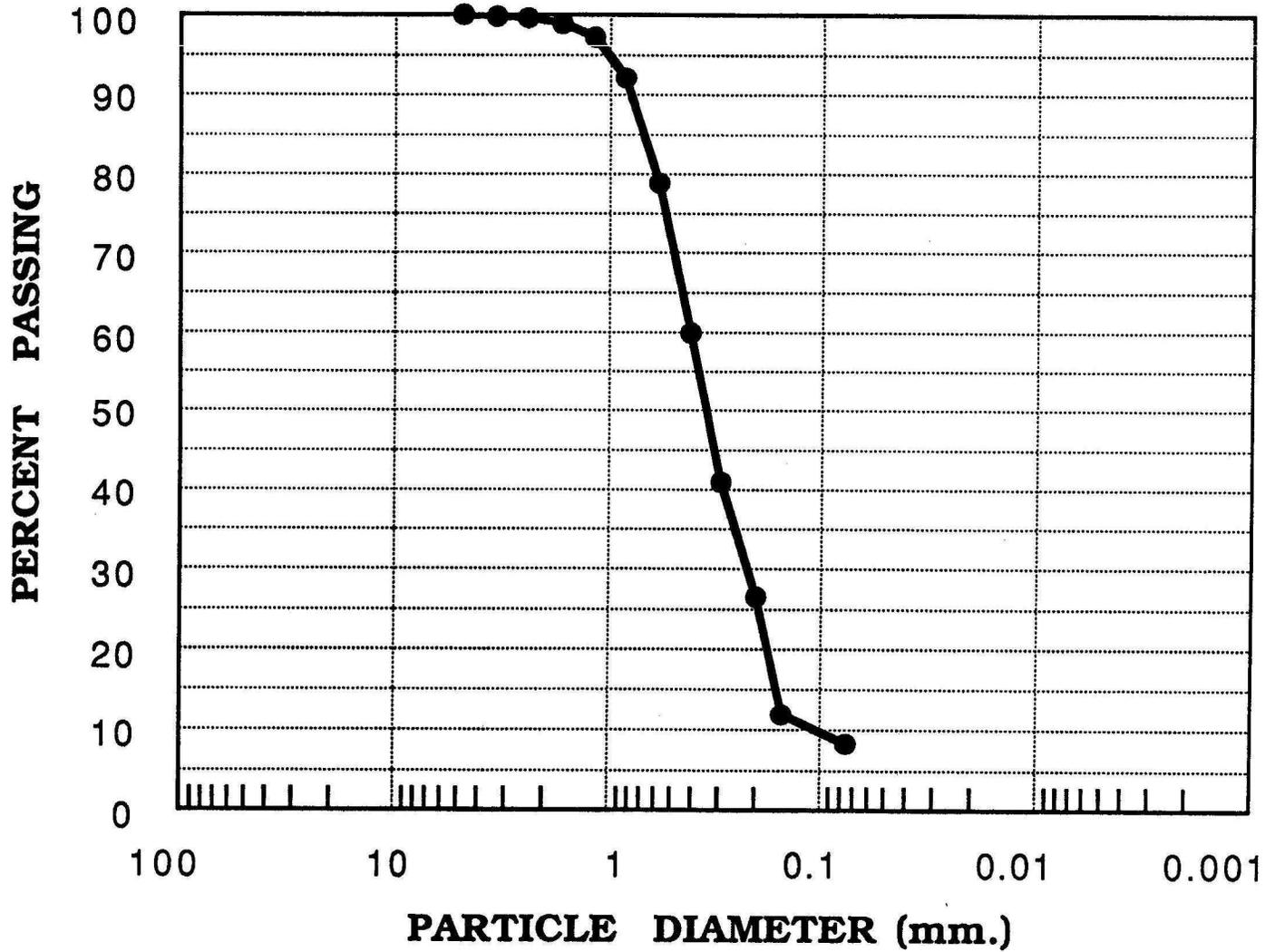
LINE # 3C2 W-E
USBR SITE #10+00
SAMPLING DEPTH (ft.) 8-23

Particle Diameter @ 60% Passing = 0.55 mm.(0.022 in.)



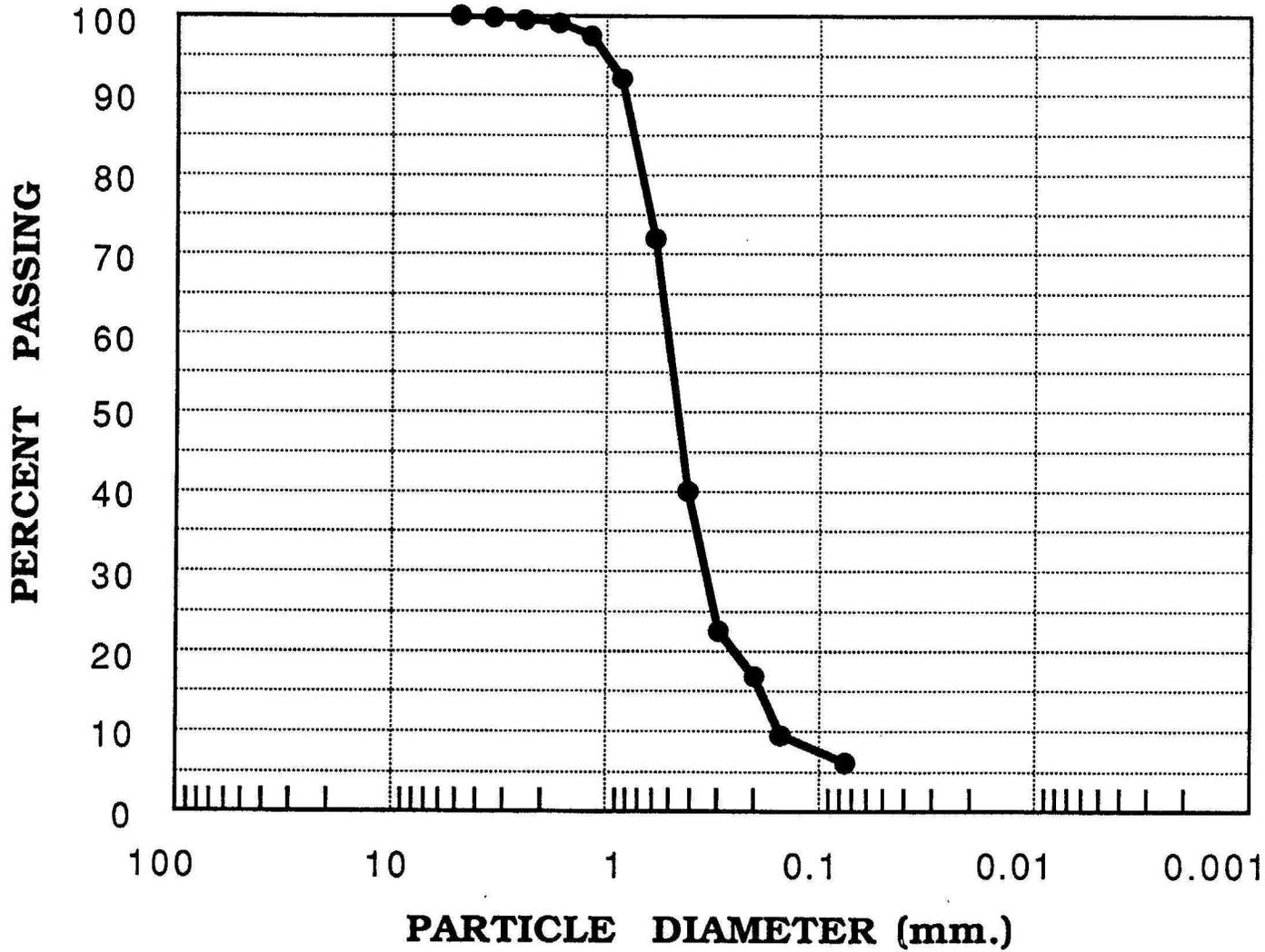
LINE # 3C2 W-E
USBR SITE #10+00
SAMPLING DEPTH (ft.) 23-38

Particle Diameter @ 60% Passing = 0.42 mm.(0.017 in.)



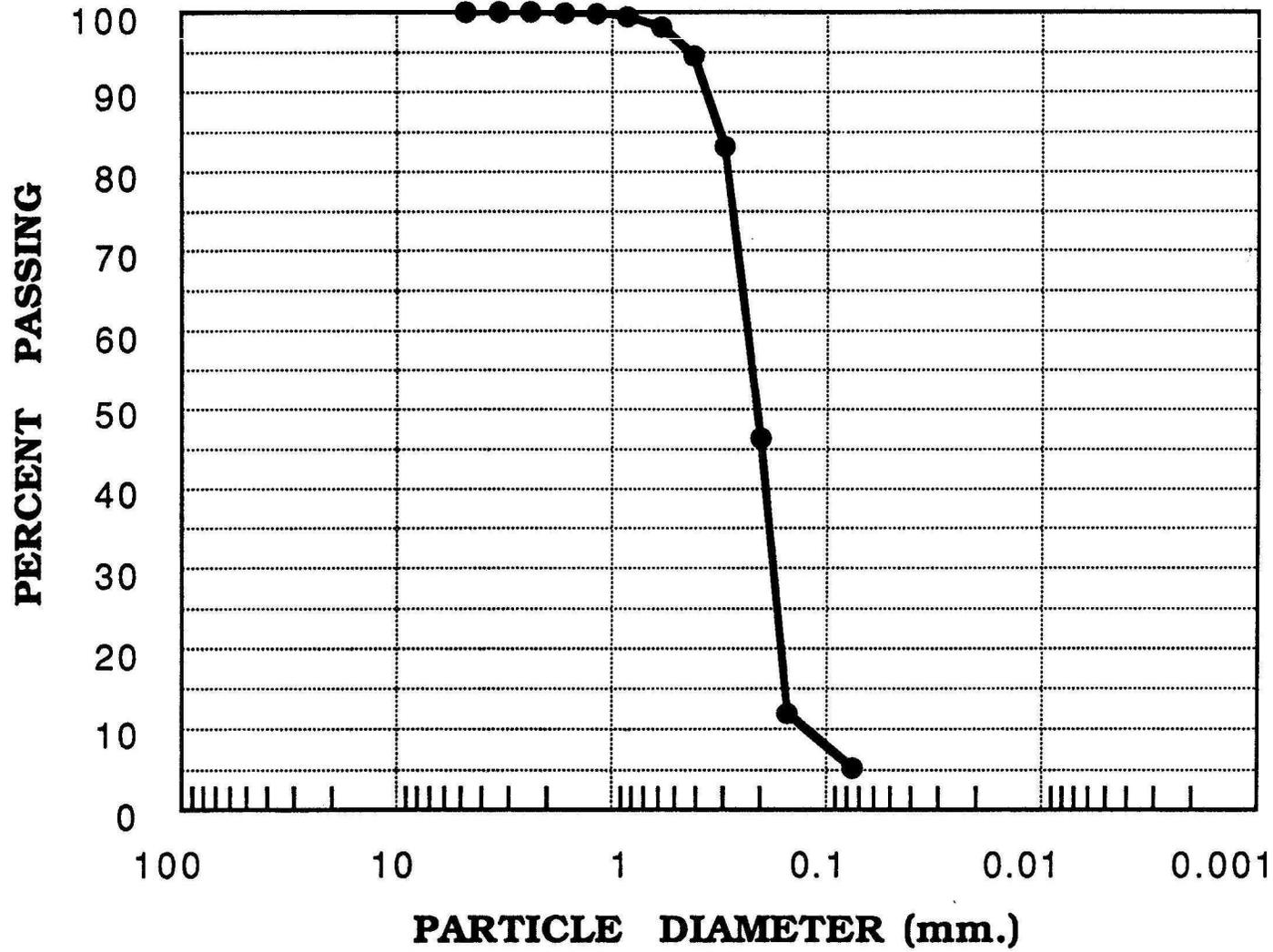
LINE # 3C2 W-E
USBR SITE #10+00
SAMPLING DEPTH (ft.) 28-33.5

Particle Diameter @ 60% Passing = 0.53 mm.(0.021 in.)



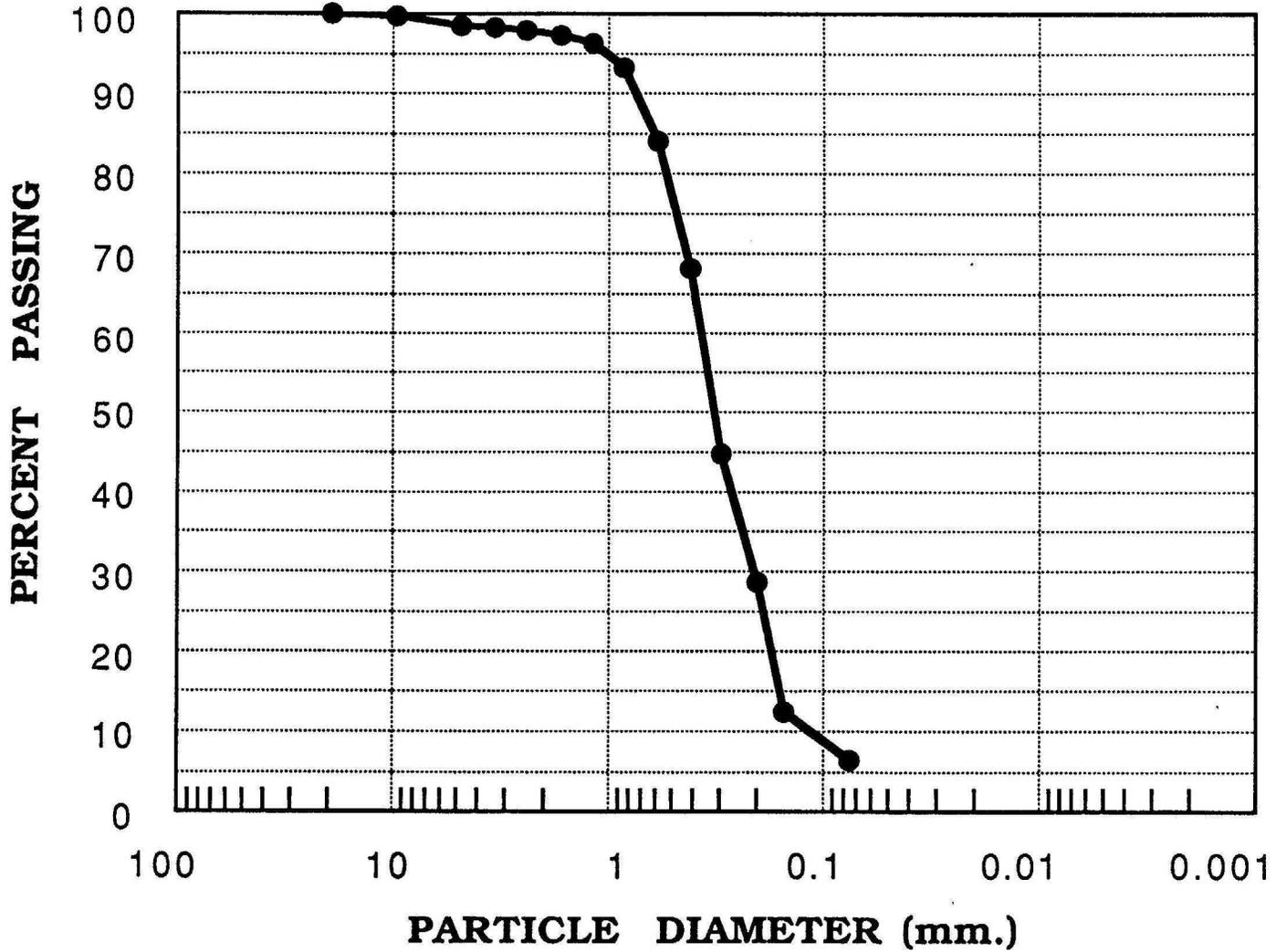
LINE # 3C2 W-E
USBR SITE #14+00
SAMPLING DEPTH (ft.) 11-18

Particle Diameter @ 60% Passing = 0.22 mm.(0.009 in.)



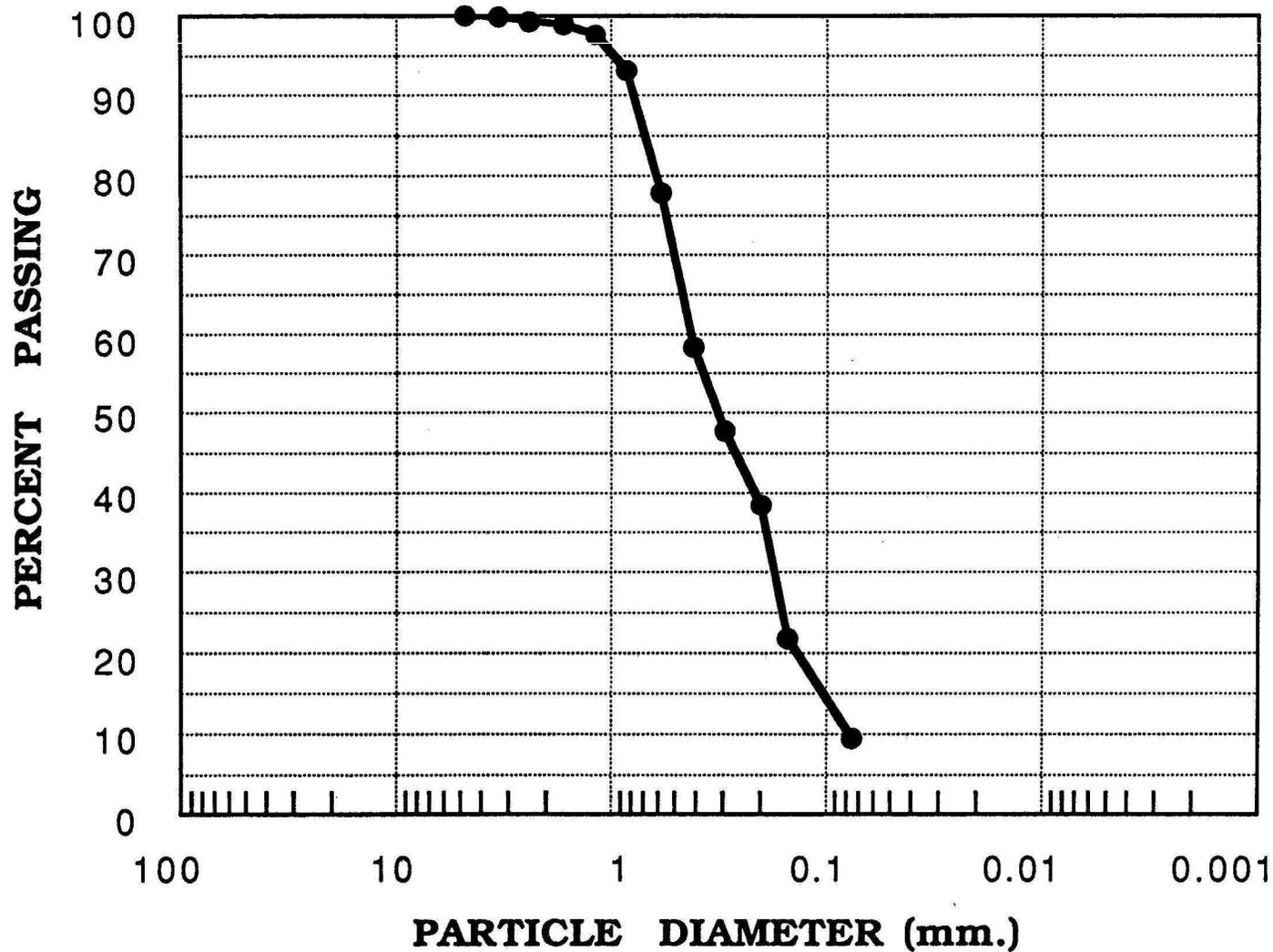
LINE # 3C2 W-E
USBR SITE #14+00
SAMPLING DEPTH (ft.) 18-37.5

Particle Diameter @ 60% Passing = 0.35 mm.(0.014 in.)



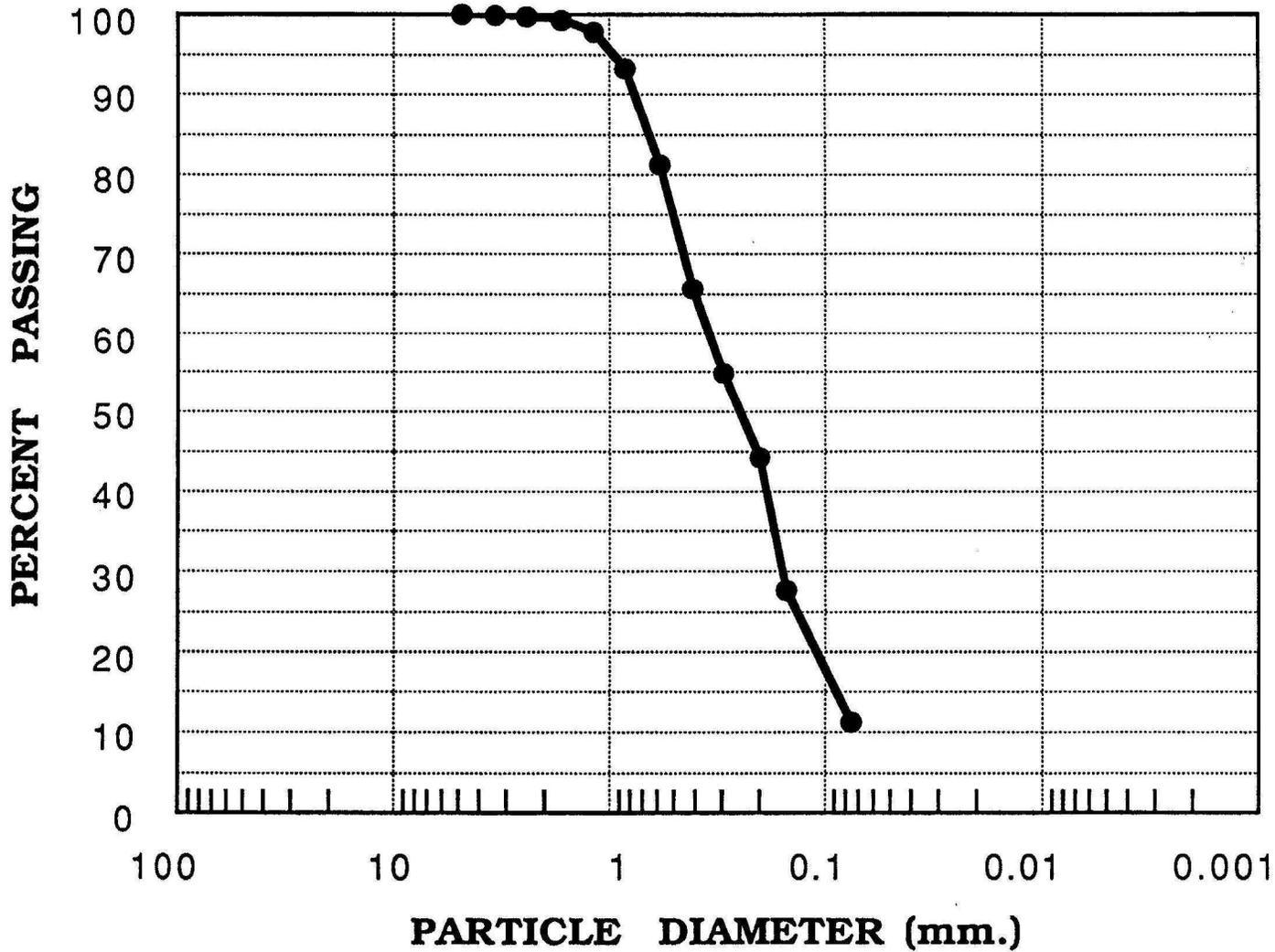
LINE # 3C2 W-E
USBR SITE #18+00
SAMPLING DEPTH (ft.) 23-32

Particle Diameter @ 60% Passing = 0.42 mm.(0.017 in.)



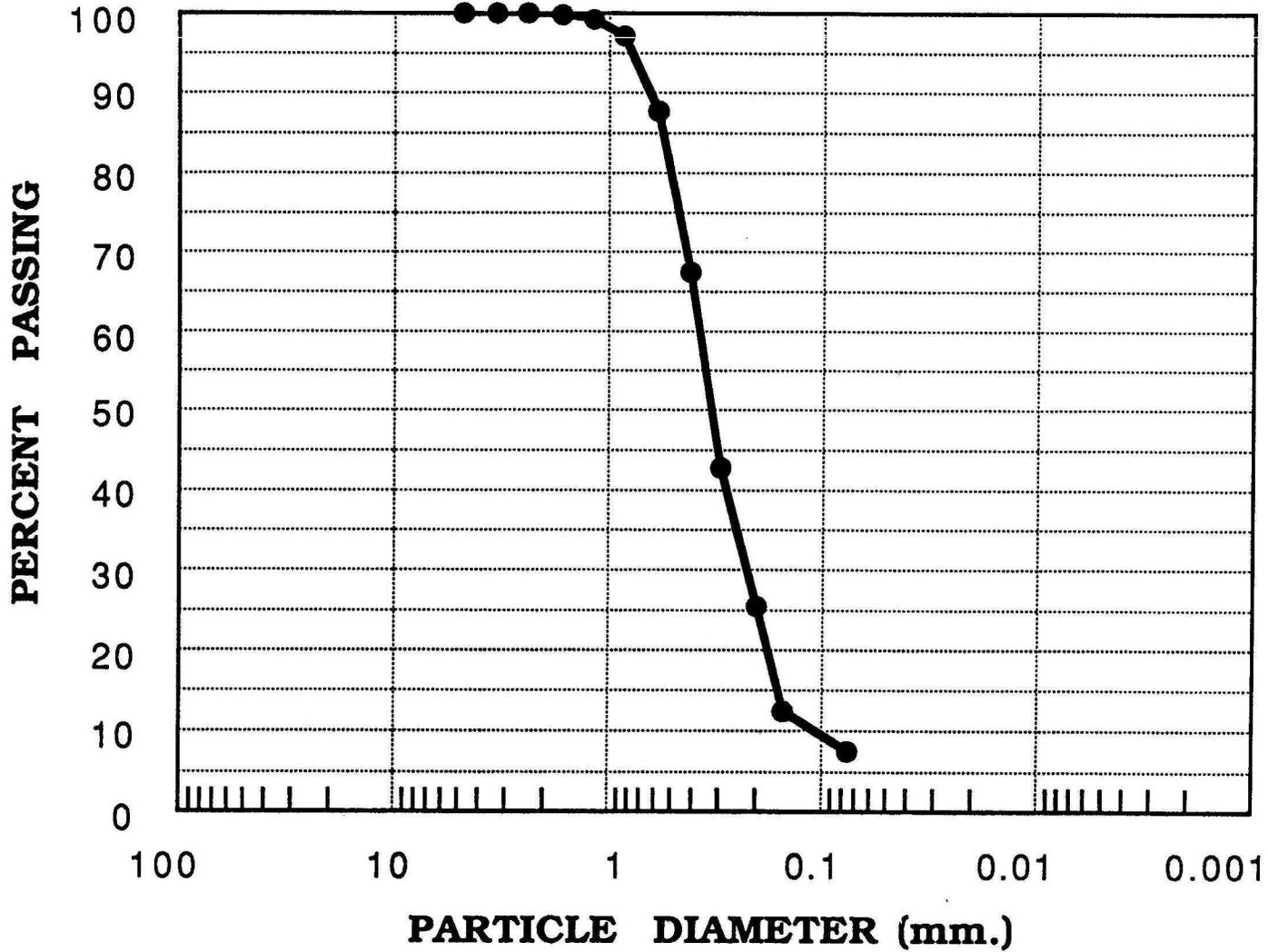
LINE # 3C2 W-E
USBR SITE #18+00
SAMPLING DEPTH (ft.) 32-36

Particle Diameter @ 60% Passing = 0.35 mm.(0.014 in.)



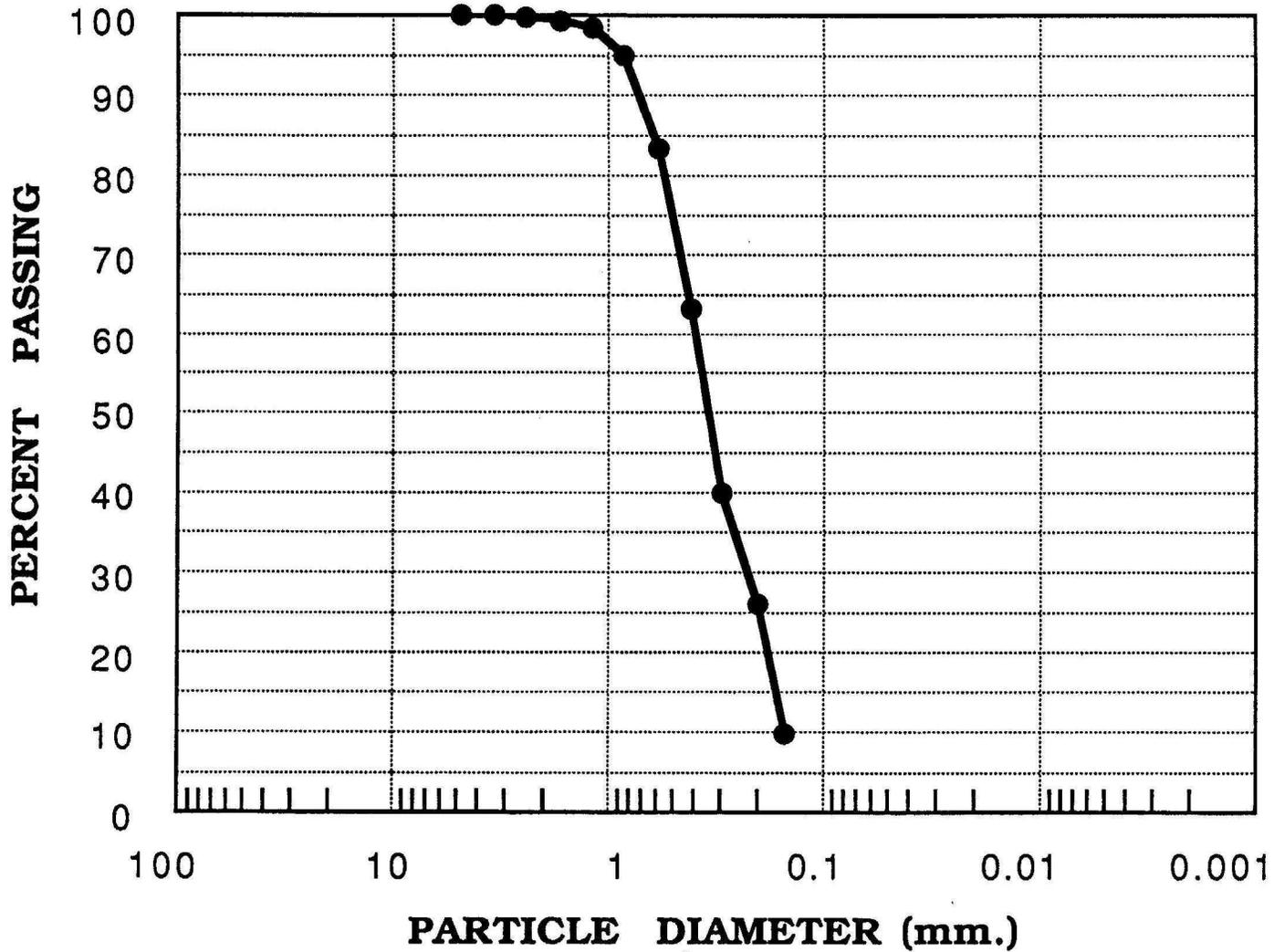
LINE # 3C2 W-E
USBR SITE #22+00
SAMPLING DEPTH (ft.) 18-26

Particle Diameter @ 60% Passing = 0.36 mm.(0.014 in.)



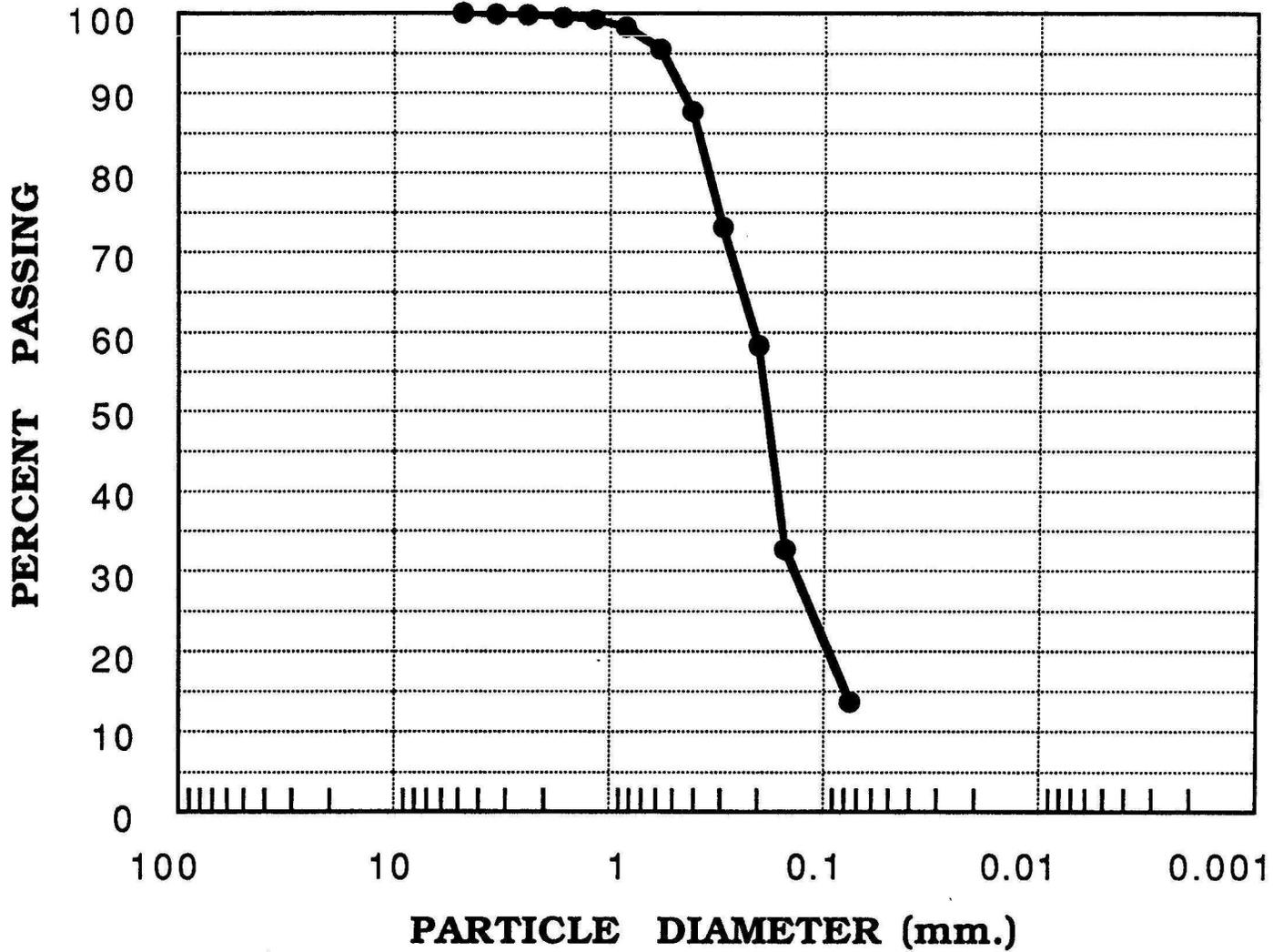
LINE # 3C2 W-E
USBR SITE #22+00
SAMPLING DEPTH (ft.) 26-37

Particle Diameter @ 60% Passing = 0.38 mm.(0.015 in.)



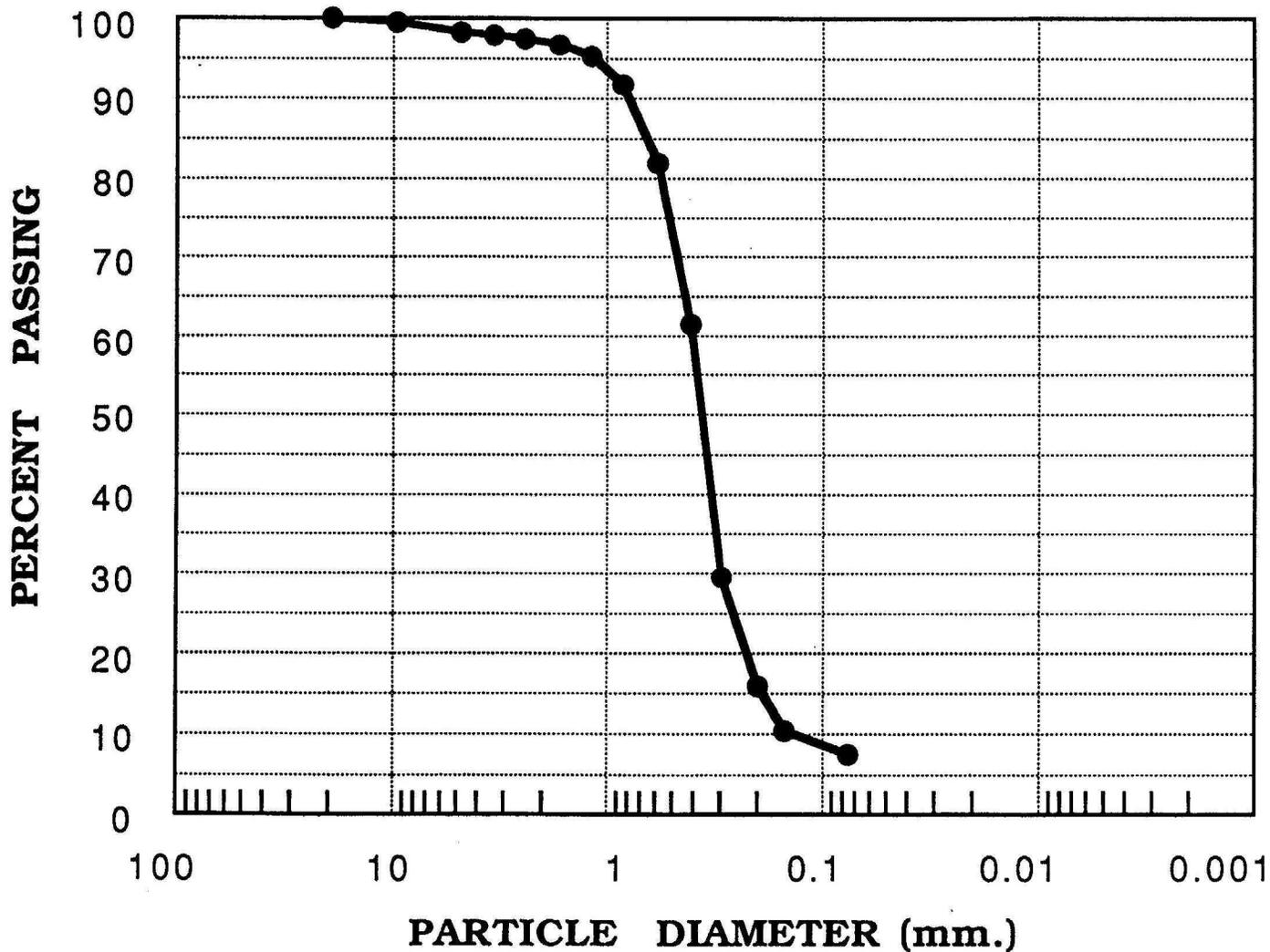
LINE # 3C3 W-E
USBR SITE #4+00
SAMPLING DEPTH (ft.) 23-34

Particle Diameter @ 60% Passing = 0.21 mm.(0.008 in.)



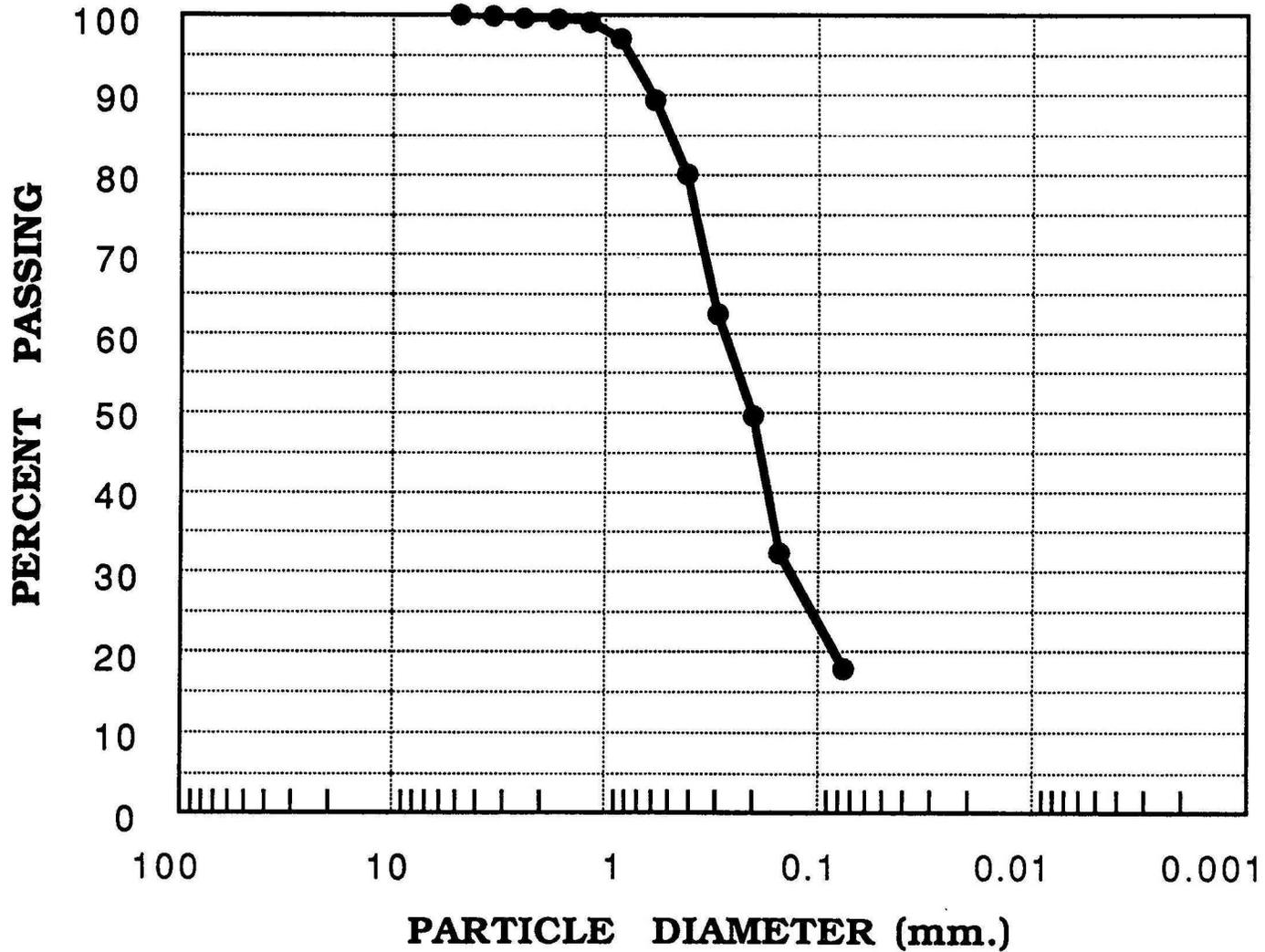
LINE # 3C3 E-W
USBR SITE # 6+00
SAMPLING DEPTH (ft.) 26.5-30.5

Particle Diameter @ 60% Passing = 0.40 mm.(0.016 in.)



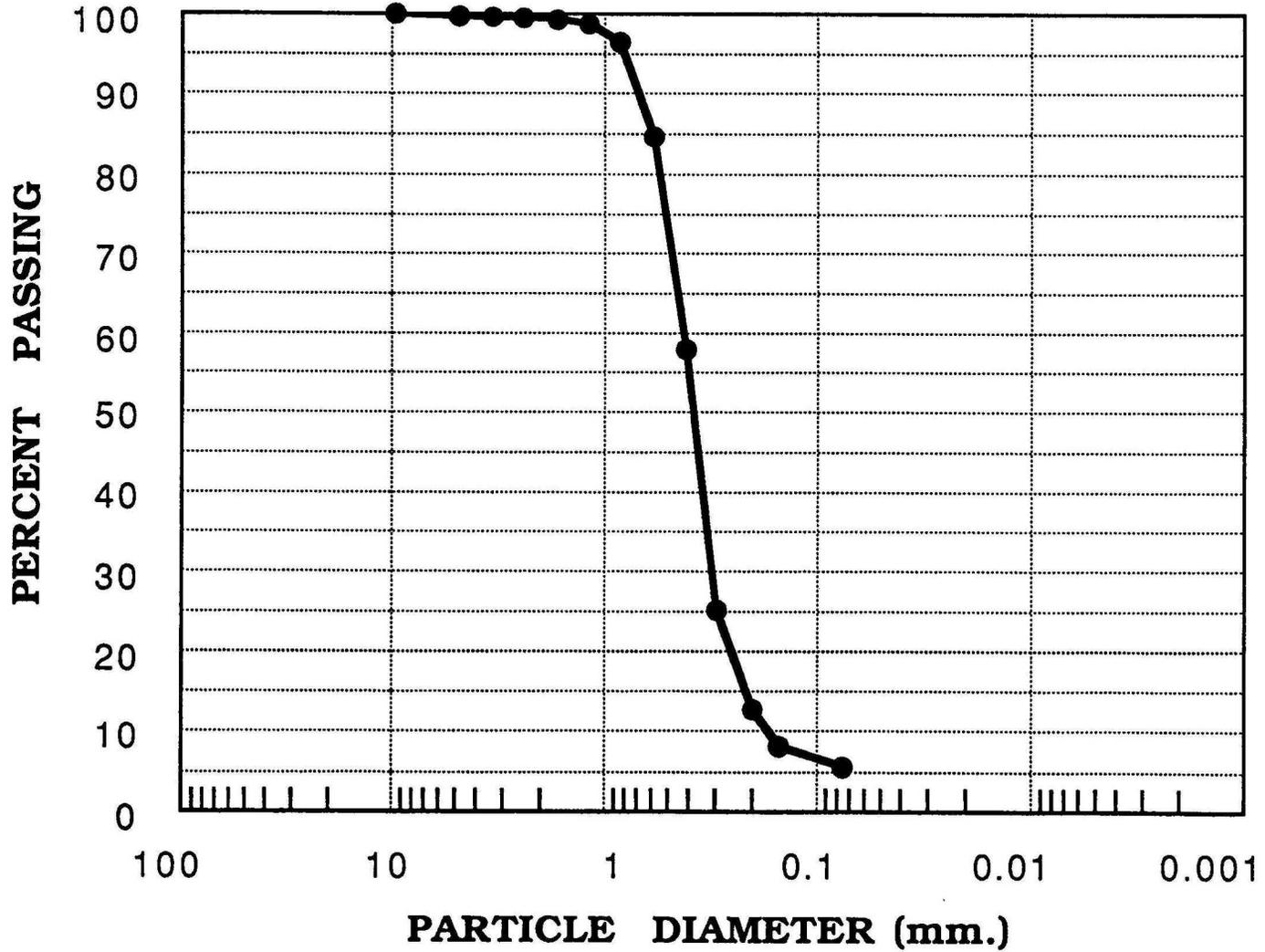
LINE # 3C3 E-W
USBR SITE # 6+00
SAMPLING DEPTH (ft.) 30.5-35

Particle Diameter @ 60% Passing = 0.28 mm.(0.011 in.)



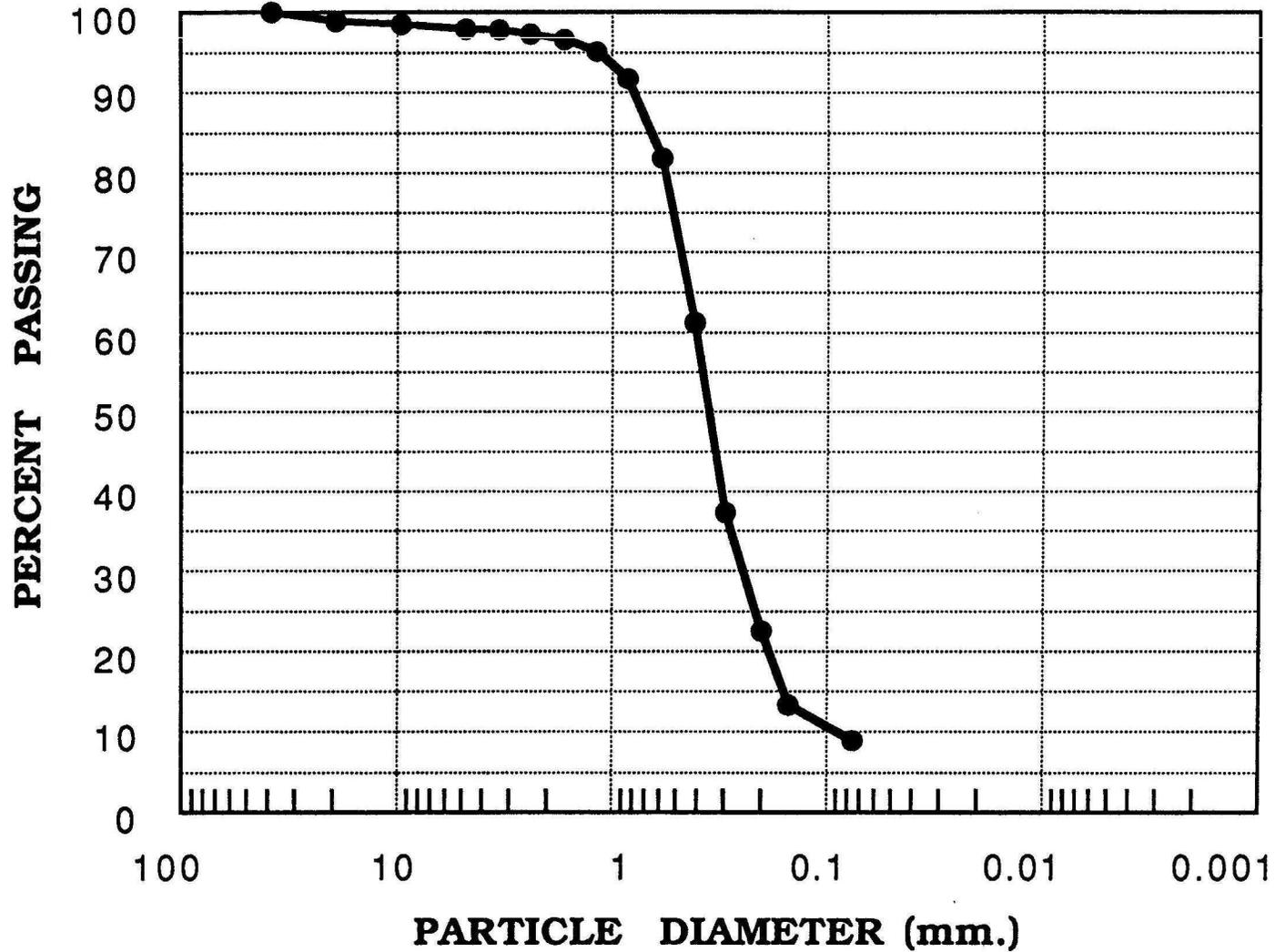
LINE # 3C3 W-E
USBR SITE #8+00
SAMPLING DEPTH (ft.) 23-34

Particle Diameter @ 60% Passing = 0.42 mm.(0.017 in.)



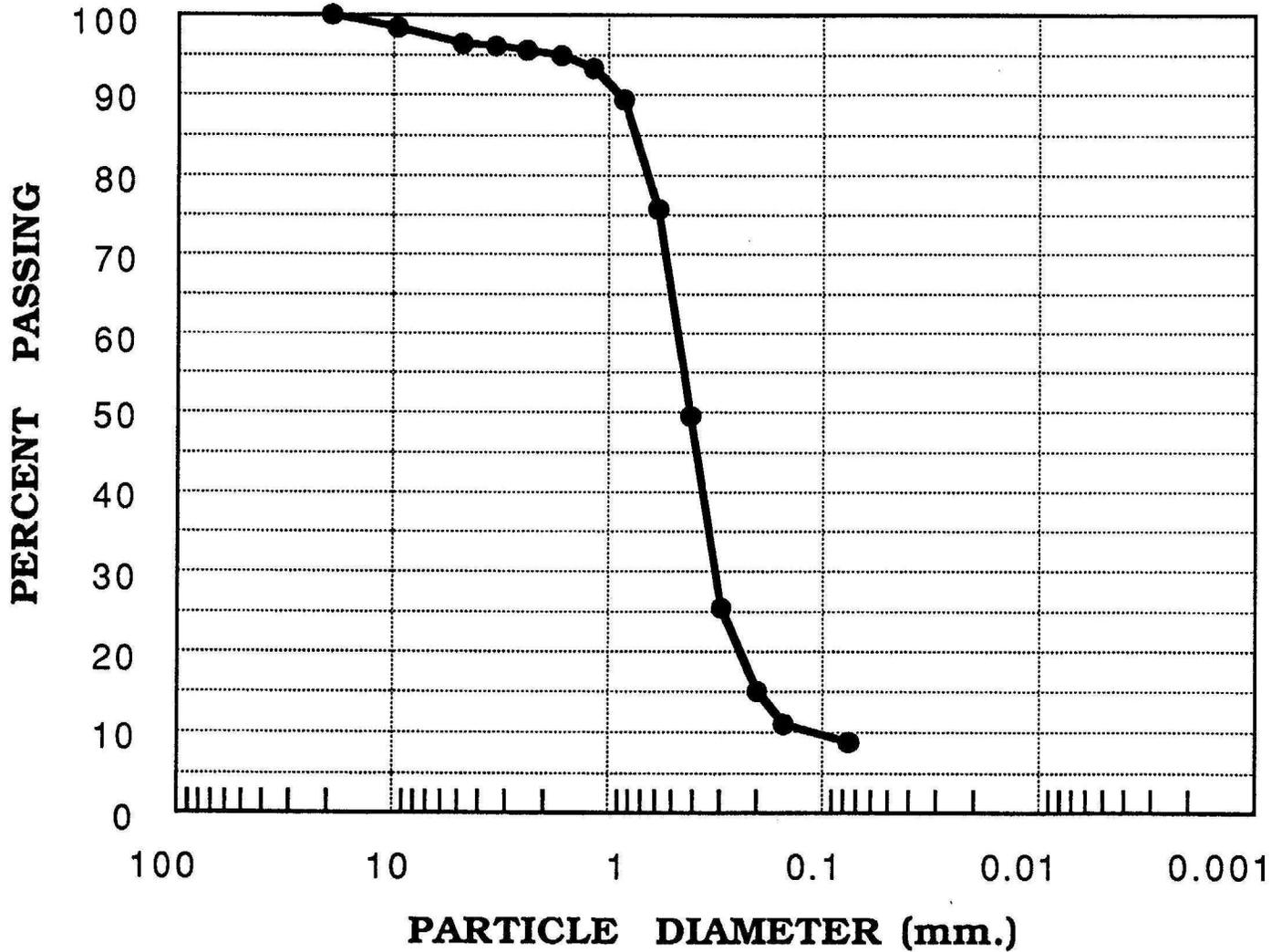
LINE # 3C3 W-E
USBR SITE #12+00
SAMPLING DEPTH (ft.) 23-28

Particle Diameter @ 60% Passing = 0.40 mm.(0.016 in.)



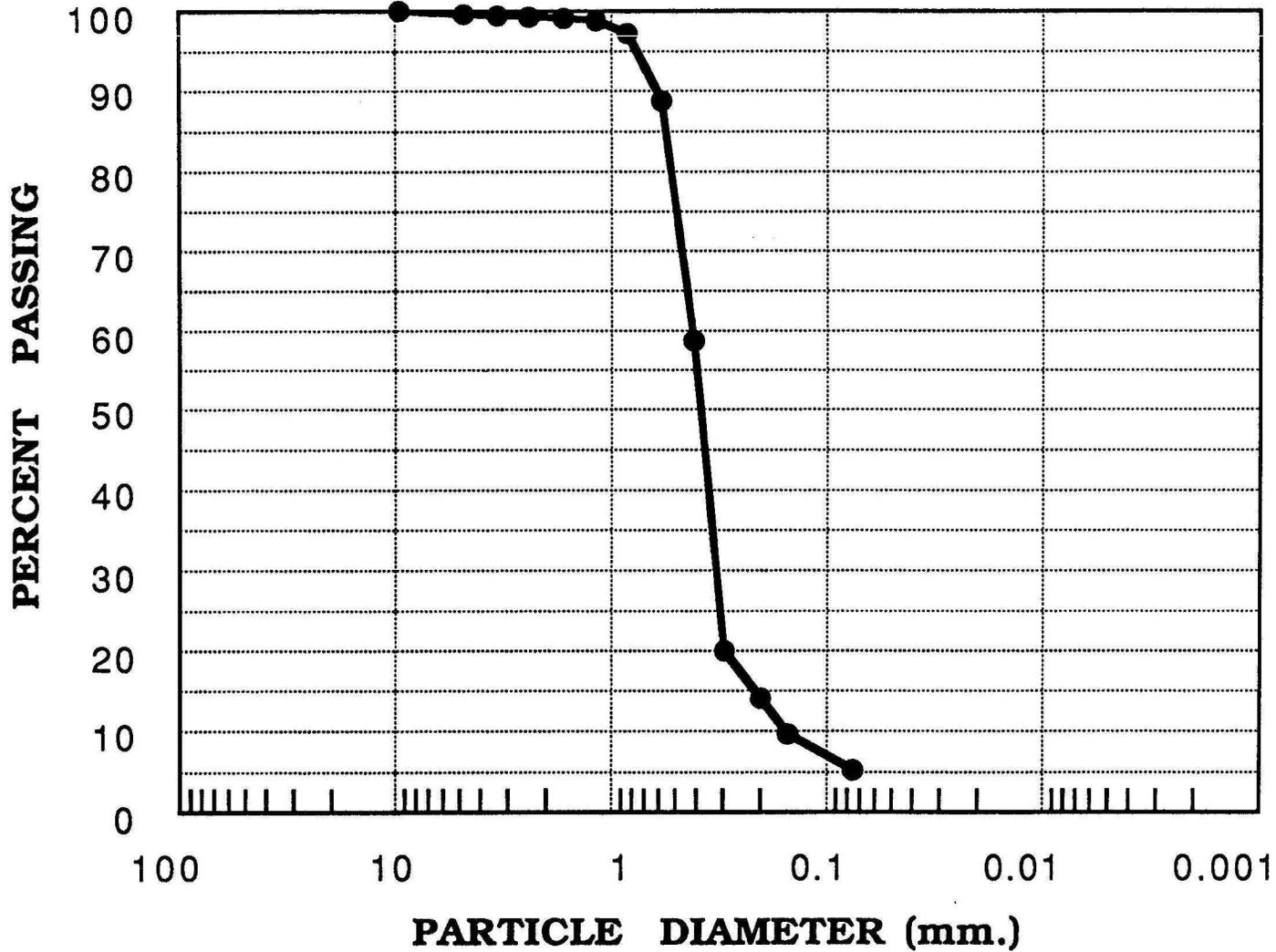
LINE # 3C3 W-E
USBR SITE #12+00
SAMPLING DEPTH (ft.) 28-33

Particle Diameter @ 60% Passing = 0.48 mm.(0.019 in.)



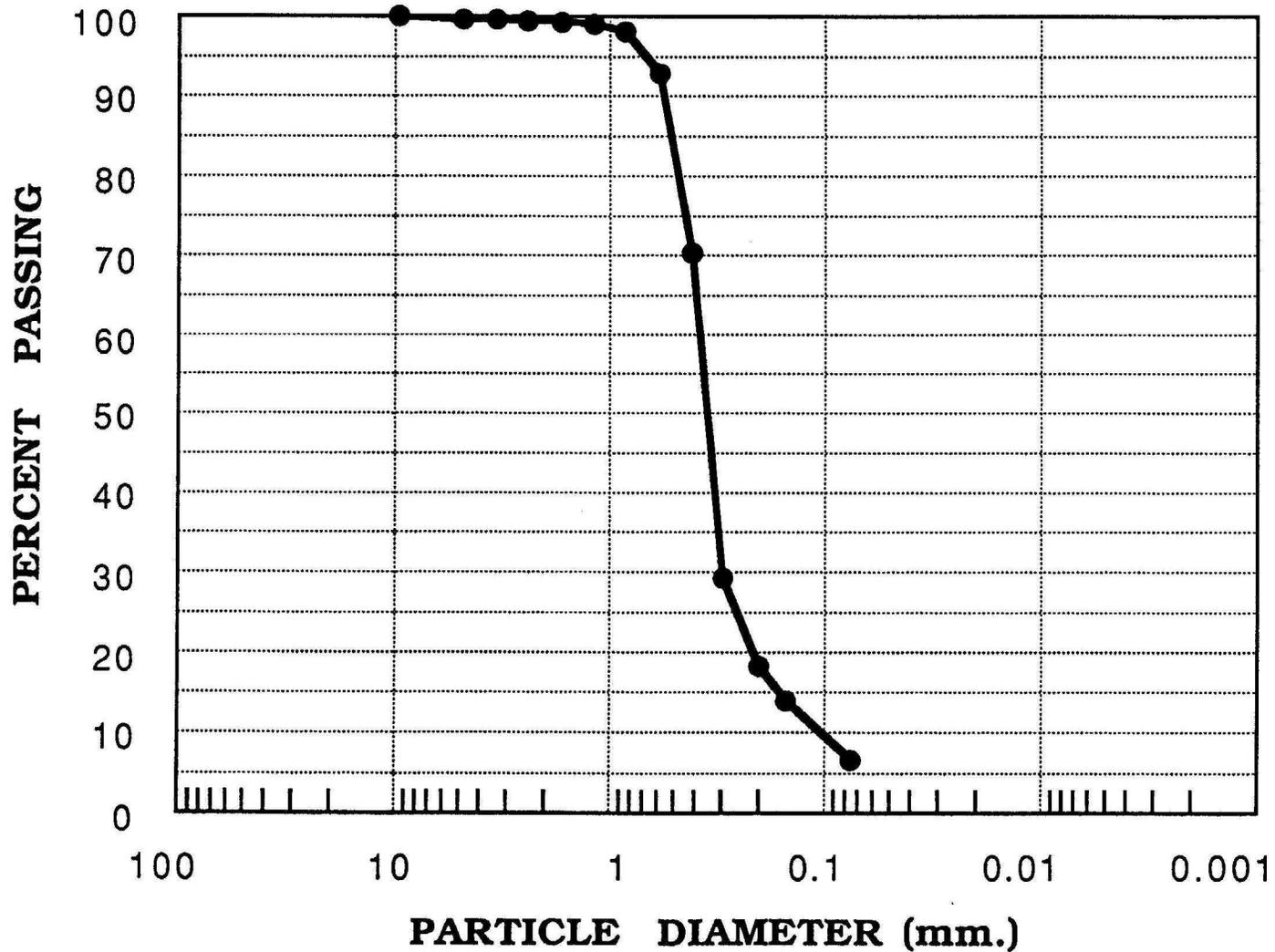
LINE # 3C3 W-E
USBR SITE #16+00
SAMPLING DEPTH (ft.) 26-35

Particle Diameter @ 60% Passing = 0.42 mm.(0.017 in.)



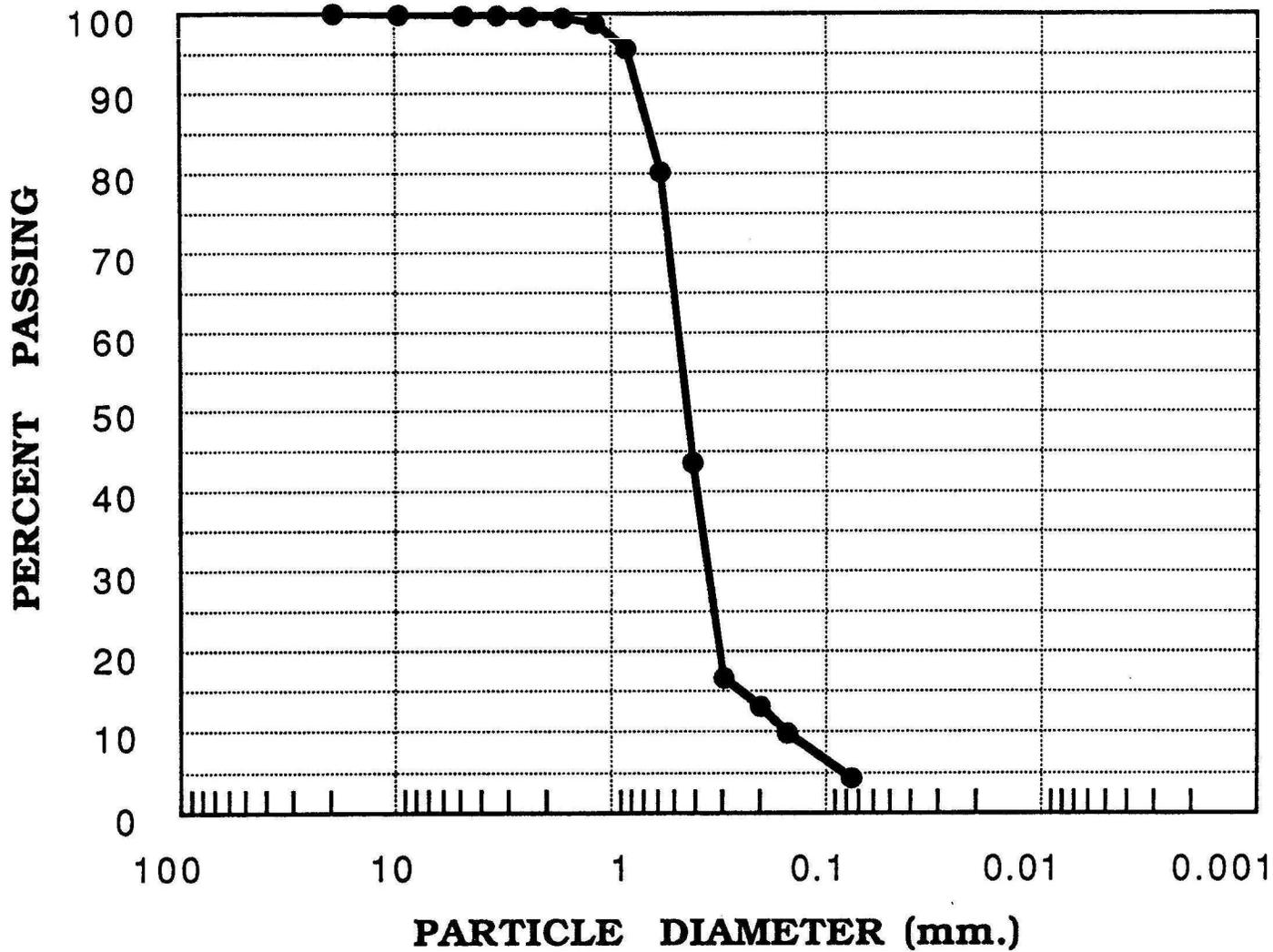
LINE # 3C3 W-E
USBR SITE #20+00
SAMPLING DEPTH (ft.) 19-32

Particle Diameter @ 60% Passing = 0.38 mm.(0.015 in.)



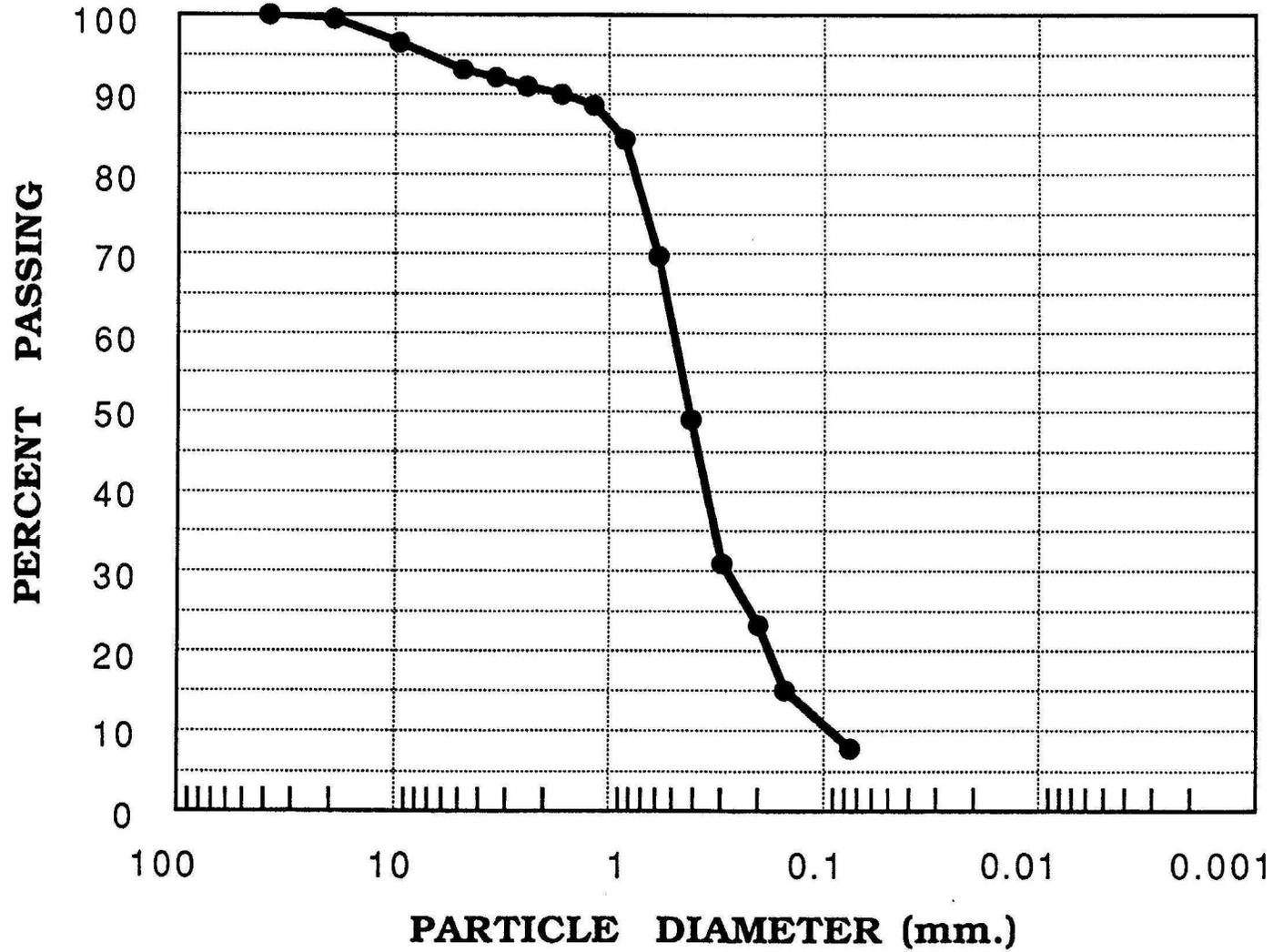
LINE # 3C3 W-E
USBR SITE #24+00
SAMPLING DEPTH (ft.) 21-27

Particle Diameter @ 60% Passing = 0.48 mm.(0.019 in.)



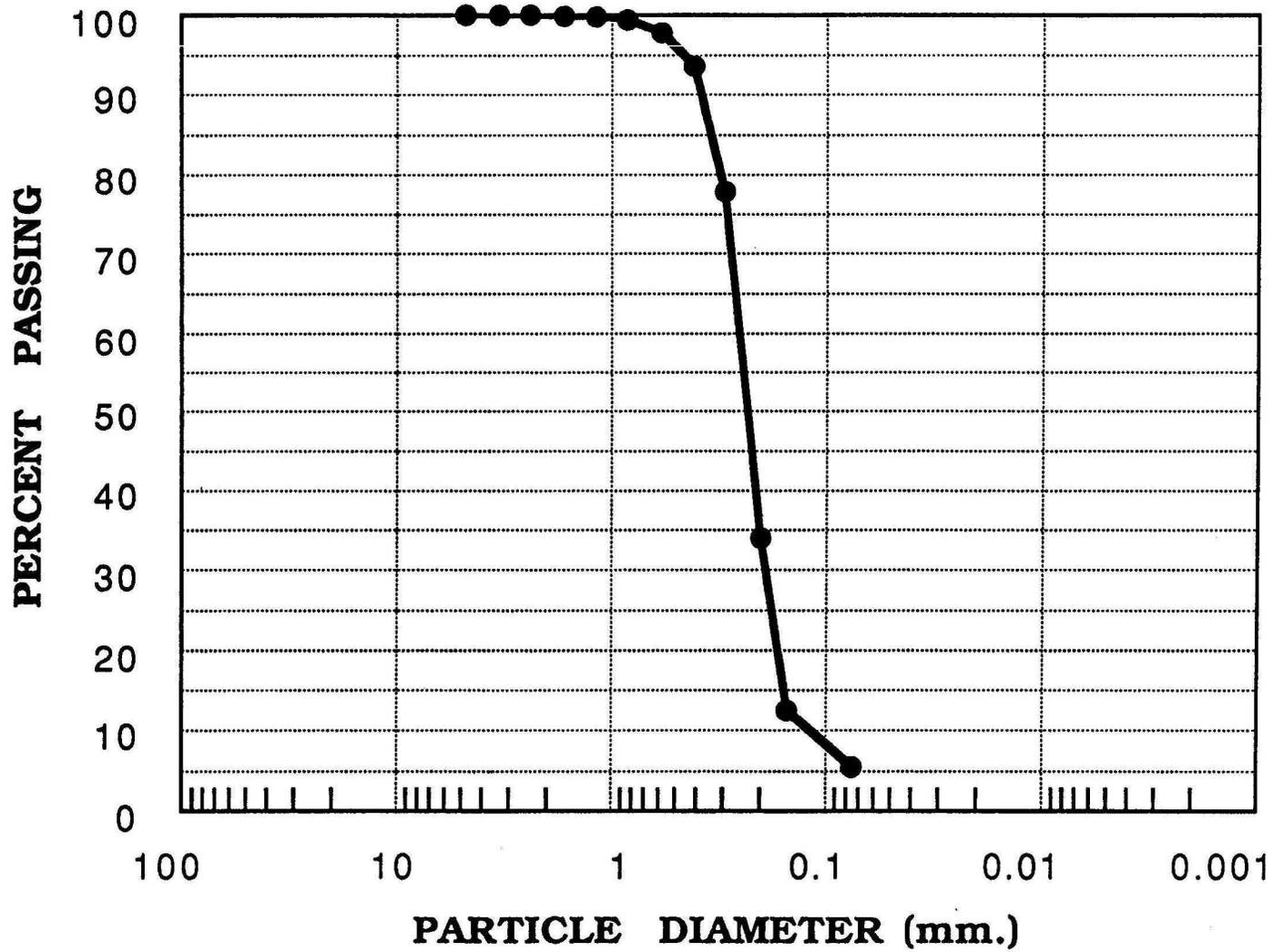
LINE # 3C3 W-E
USBR SITE #24+00
SAMPLING DEPTH (ft.) 27-33

Particle Diameter @ 60% Passing = 0.48 mm.(0.019 in.)



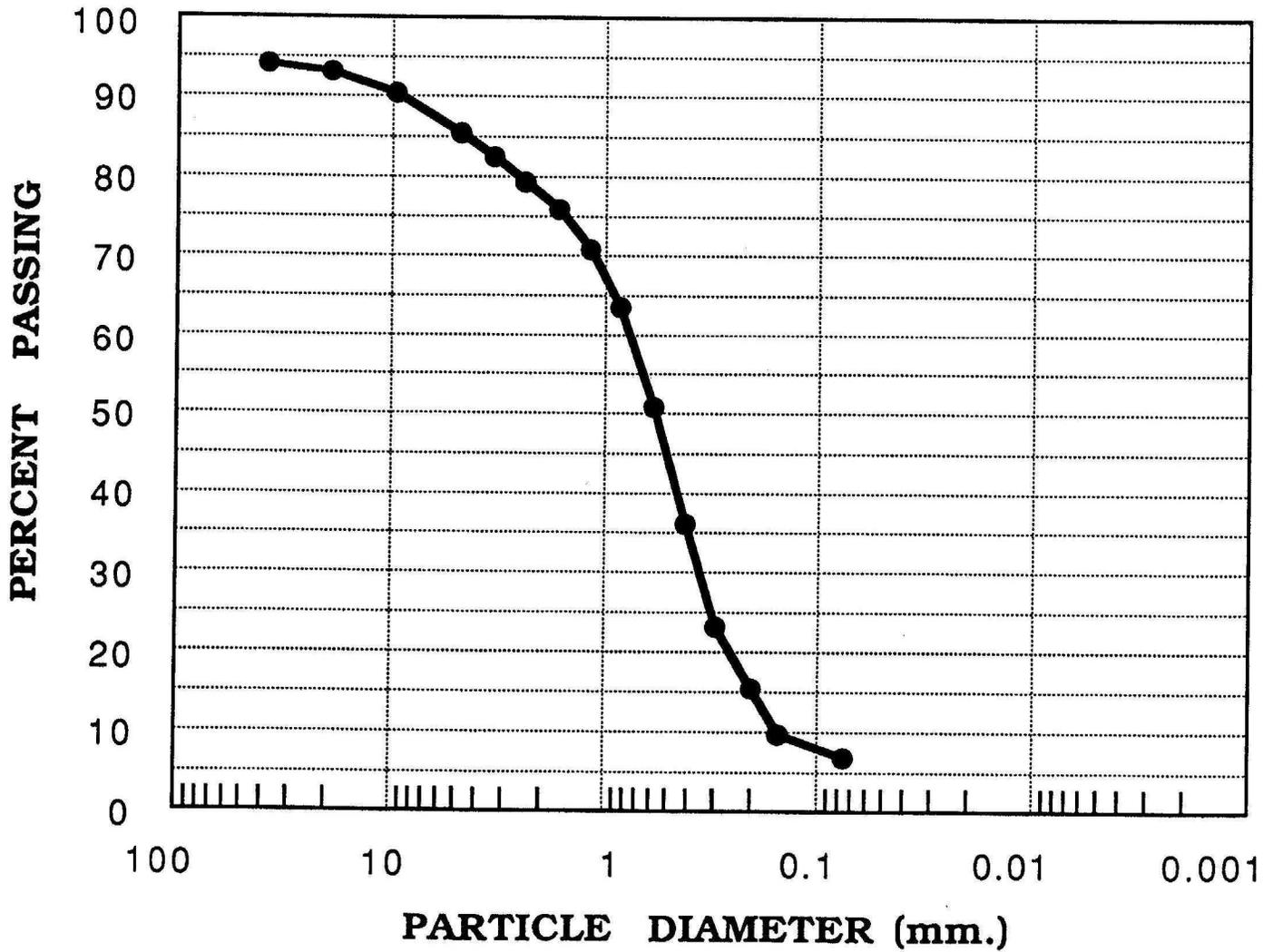
LINE # 3C4 E-W
USBR SITE #2+00
SAMPLING DEPTH (ft.) 8-20

Particle Diameter @ 60% Passing = 0.25 mm.(0.010 in.)



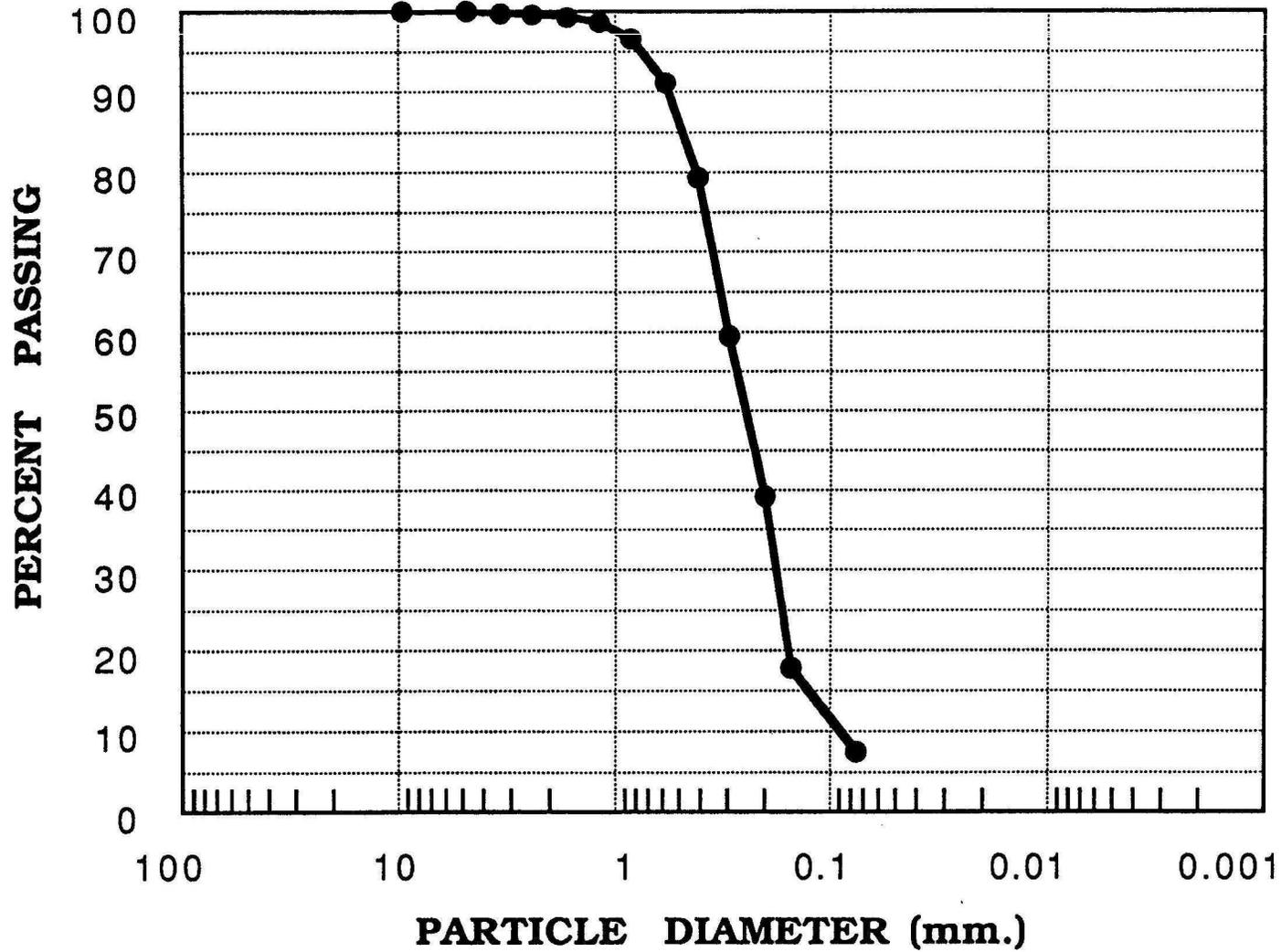
LINE # 3C4 E-W
USBR SITE #2+00
SAMPLING DEPTH (ft.) 20-23

Particle Diameter @ 60% Passing = 0.76 mm.(0.030 in.)



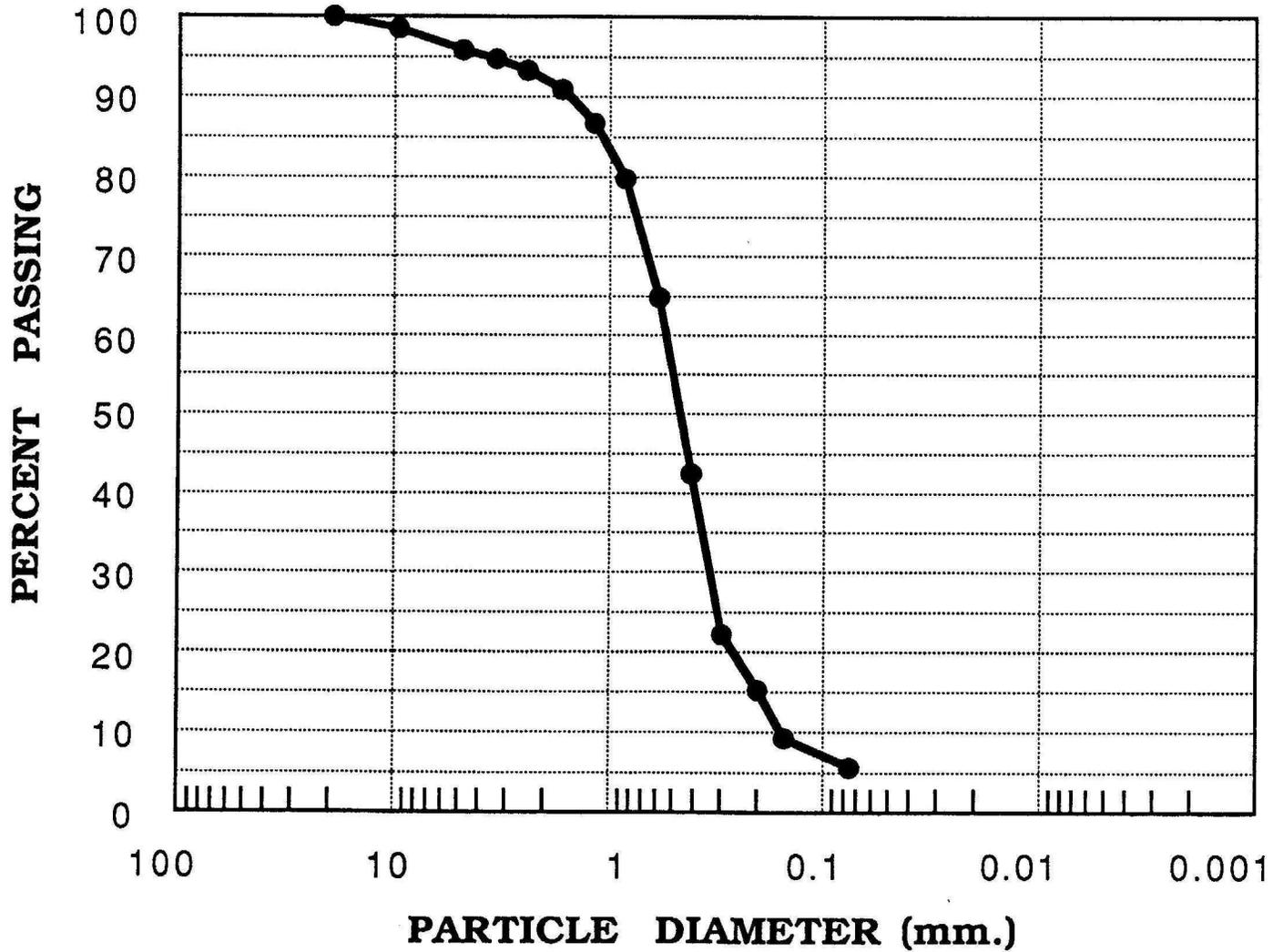
LINE # 3C4 W-E
USBR SITE #6+00
SAMPLING DEPTH (ft.) 10.5-18

Particle Diameter @ 60% Passing = 0.30 mm.(0.012 in.)



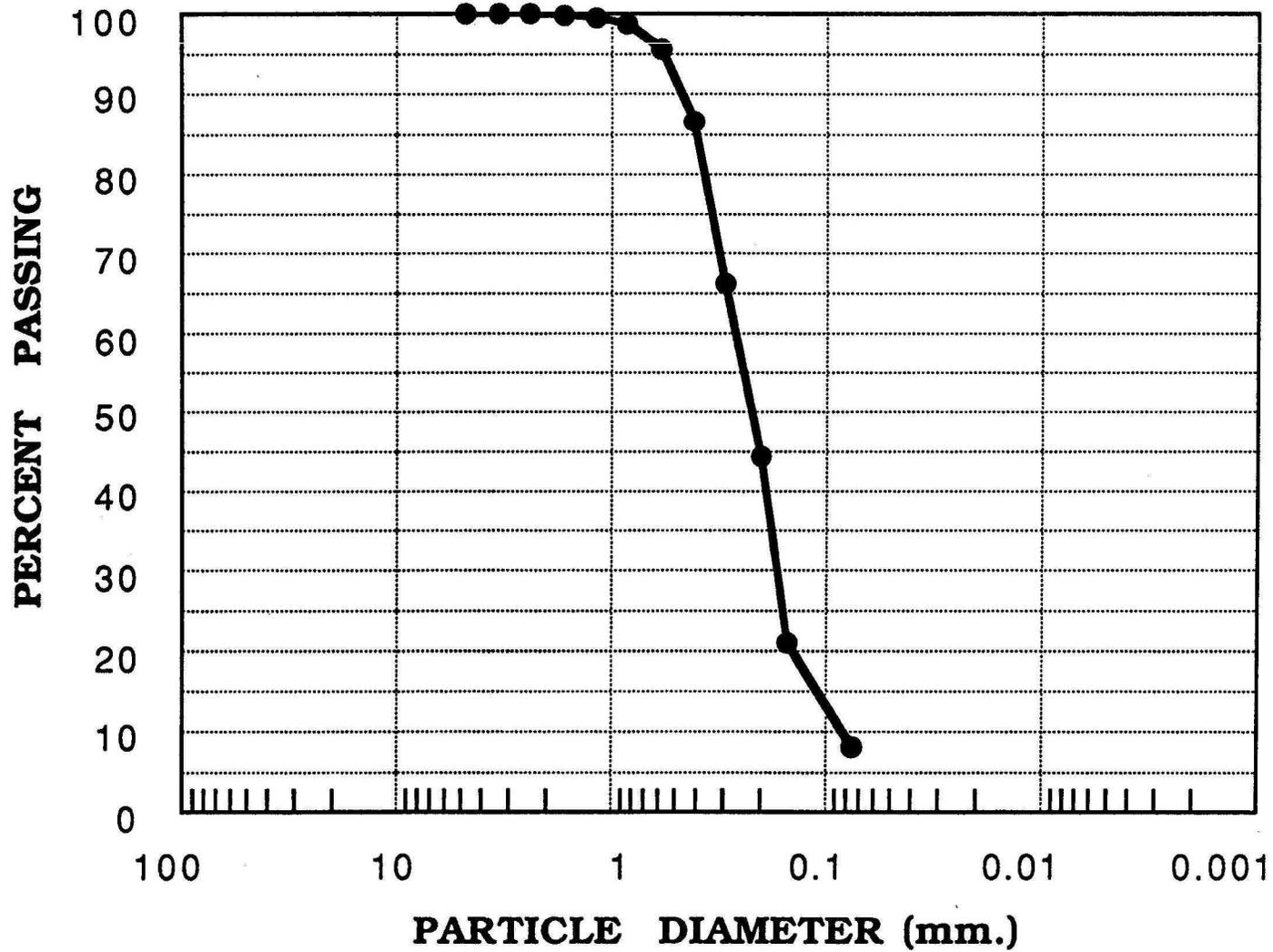
LINE # 3C4 W-E
USBR SITE #6+00
SAMPLING DEPTH (ft.) 18-27

Particle Diameter @ 60% Passing = 0.52 mm.(0.021 in.)



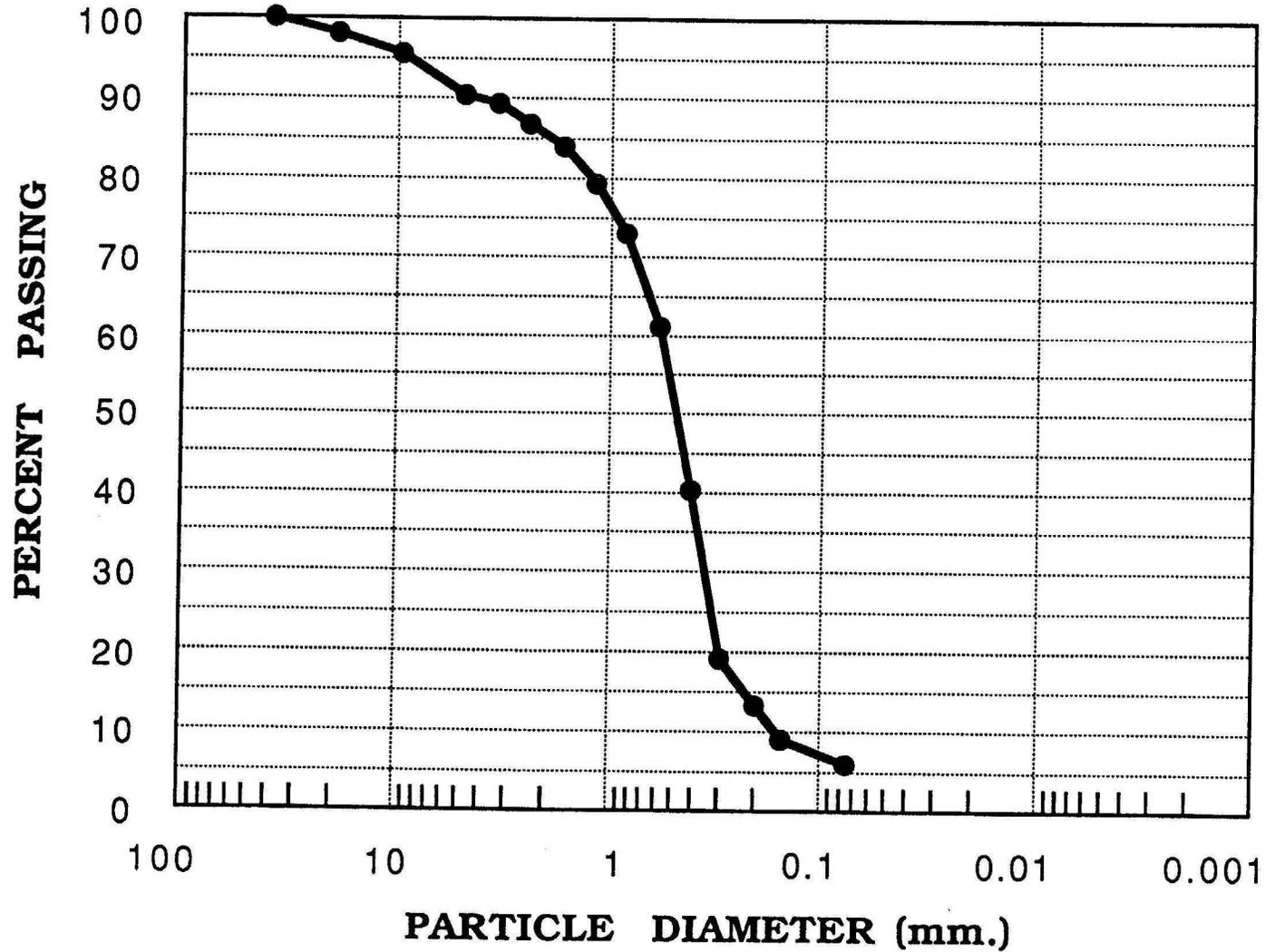
LINE # 3C4 E-W
USBR SITE #8+00
SAMPLING DEPTH (ft.) 9.5-20

Particle Diameter @ 60% Passing = 0.26 mm.(0.010 in.)



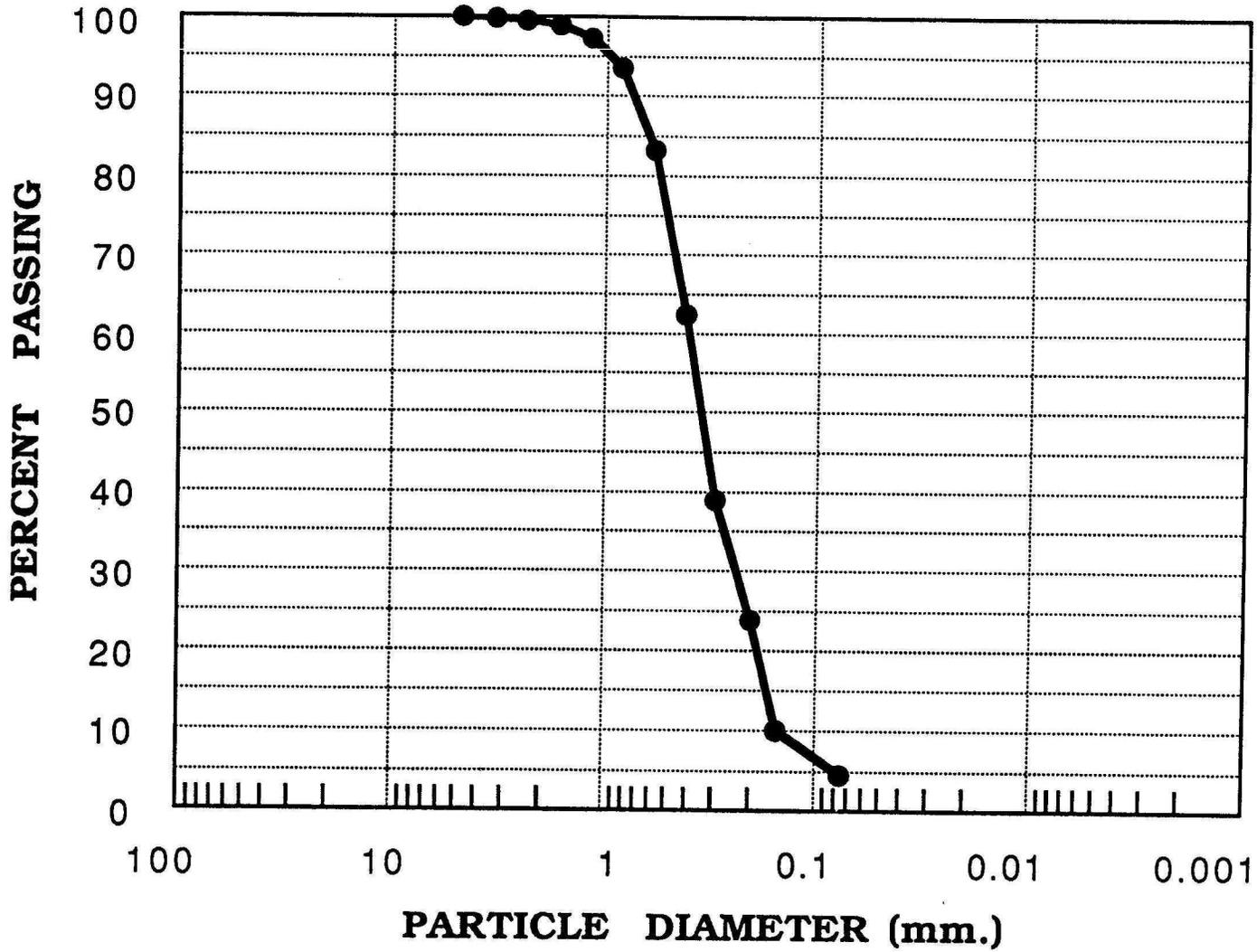
LINE # 3C4 E-W
USBR SITE #8+00
SAMPLING DEPTH (ft.) 20-29

Particle Diameter @ 60% Passing = 0.58 mm.(0.023 in.)



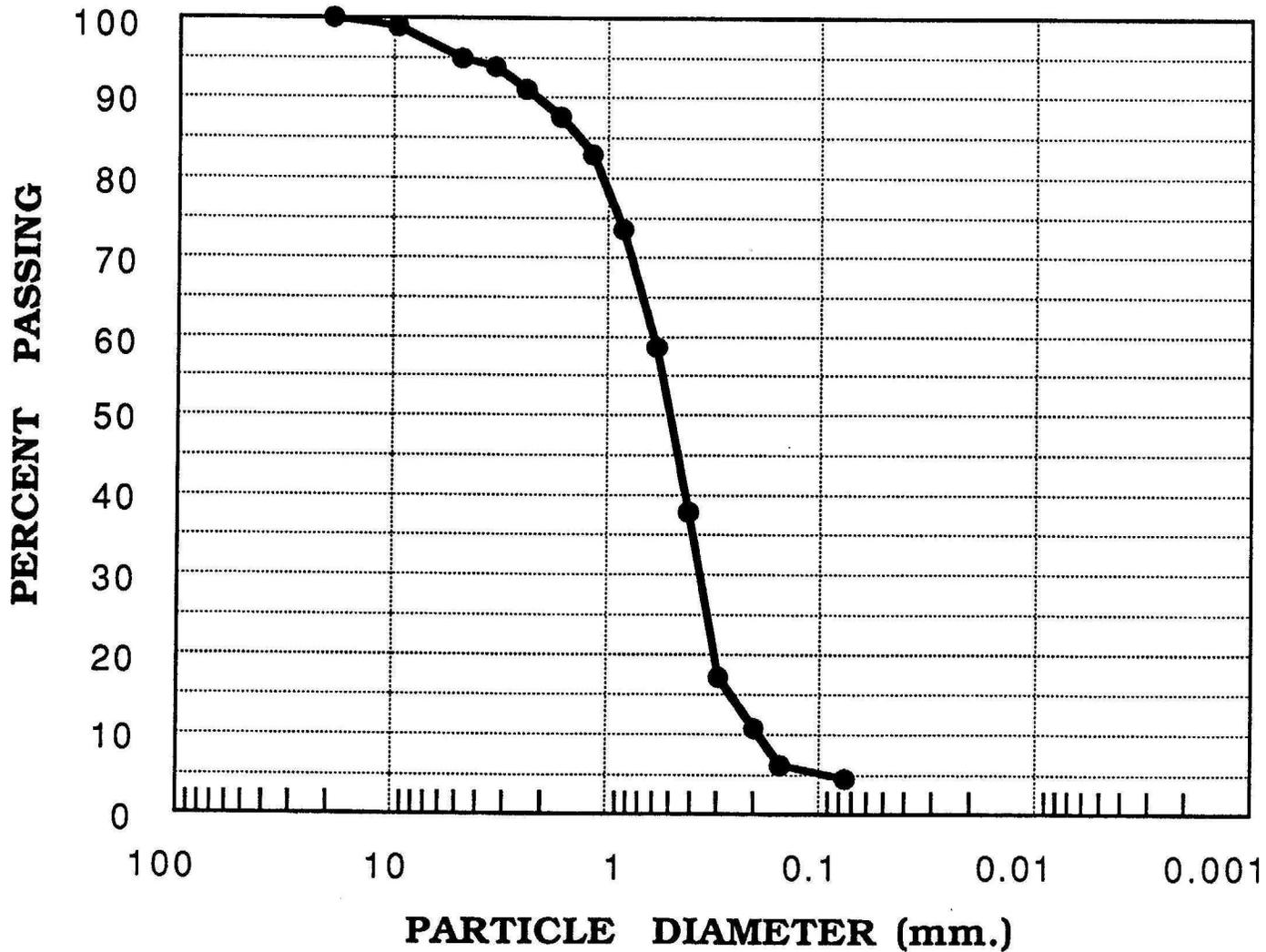
LINE # 3C4 E-W
USBR SITE #9+93
SAMPLING DEPTH (ft.) 9-23

Particle Diameter @ 60% Passing = 0.40 mm.(0.016 in.)



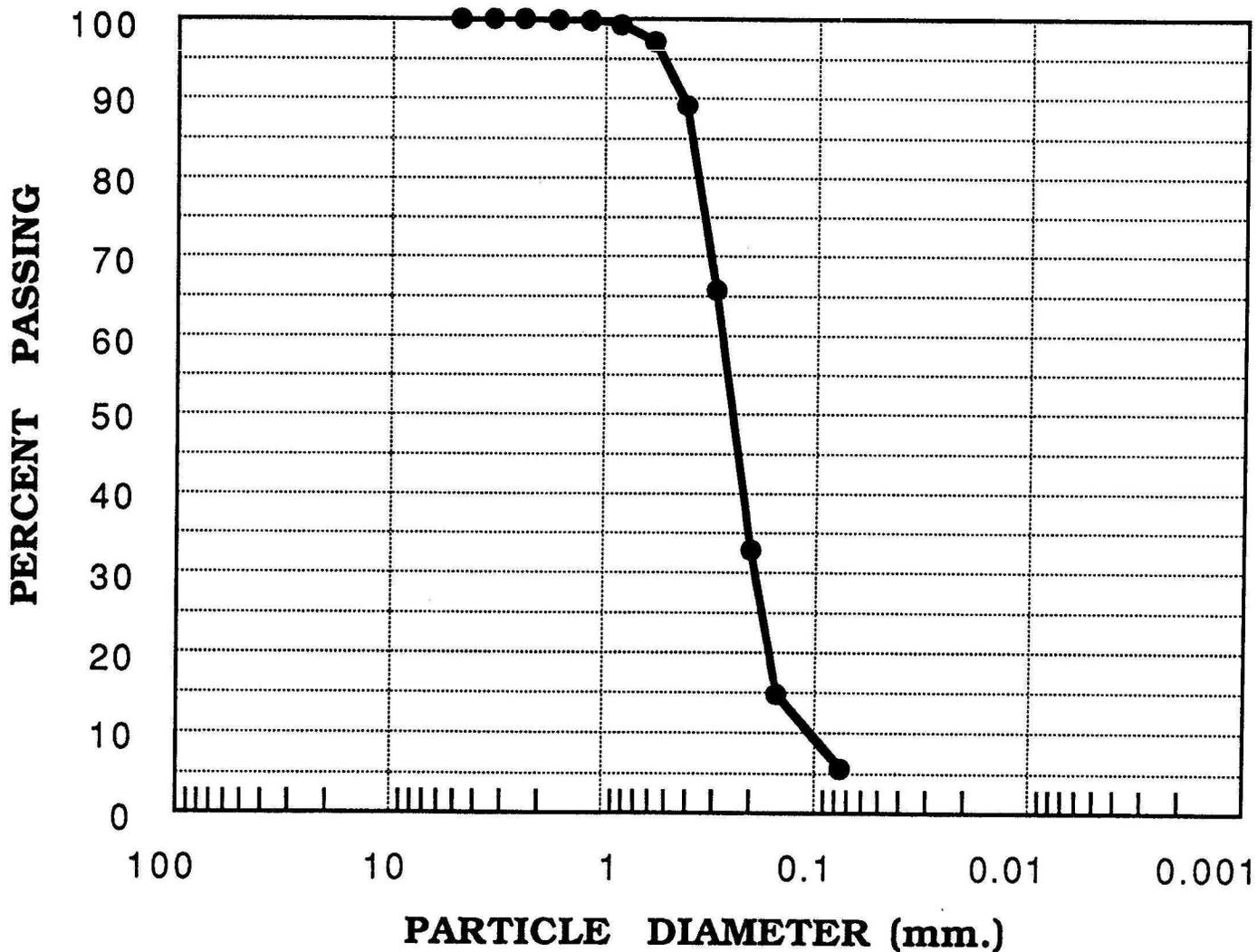
LINE # 3C4 E-W
USBR SITE #9+93
SAMPLING DEPTH (ft.) 23-36

Particle Diameter @ 60% Passing = 0.58 mm.(0.023 in.)



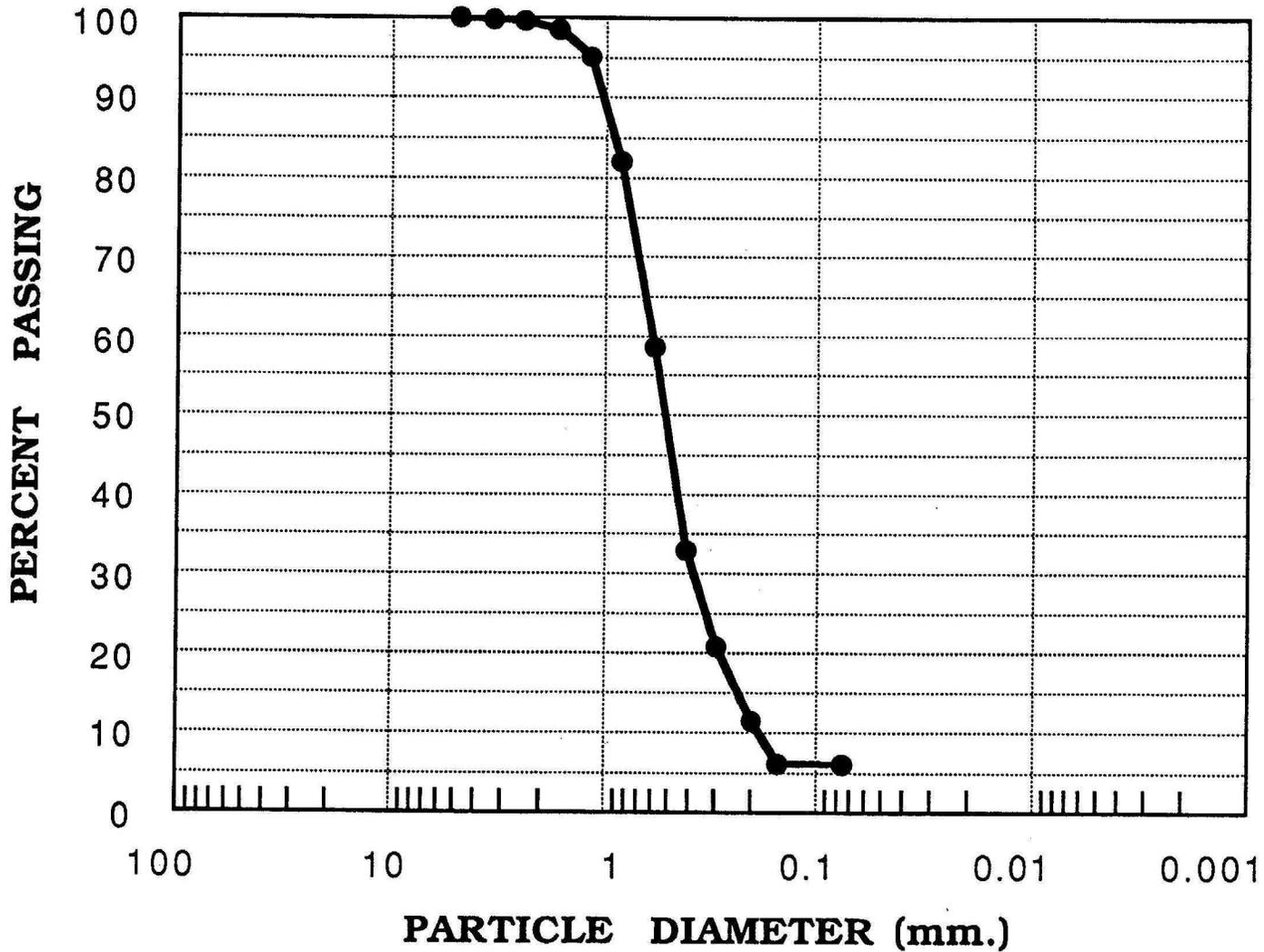
LINE # 3C4 E-W
USBR SITE #12+00
SAMPLING DEPTH (ft.) 11-22

Particle Diameter @ 60% Passing = 0.28 mm.(0.011 in.)



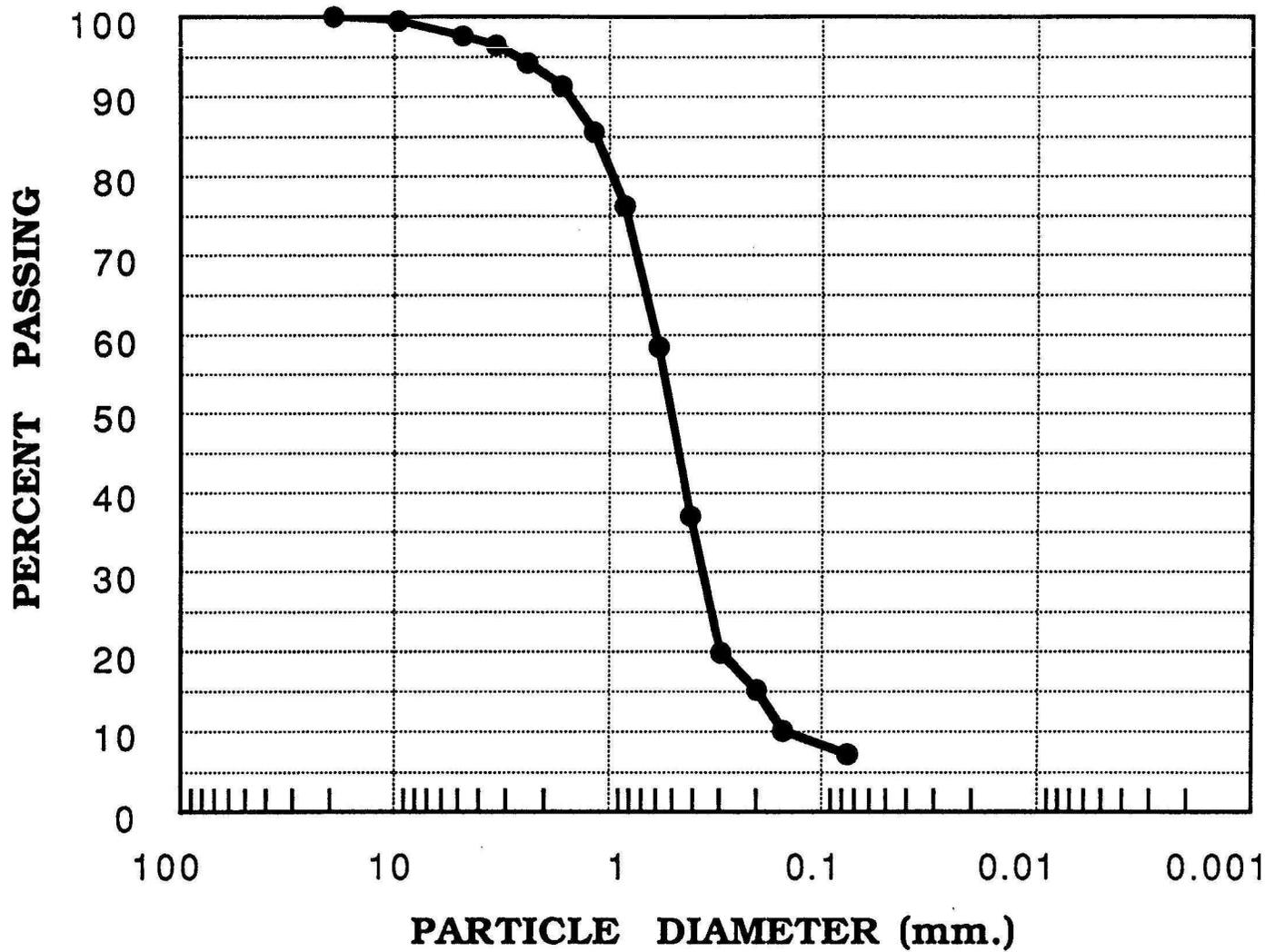
LINE # 3C4 E-W
USBR SITE #14+00
SAMPLING DEPTH (ft.) 18-22

Particle Diameter @ 60% Passing = 0.58 mm.(0.023 in.)



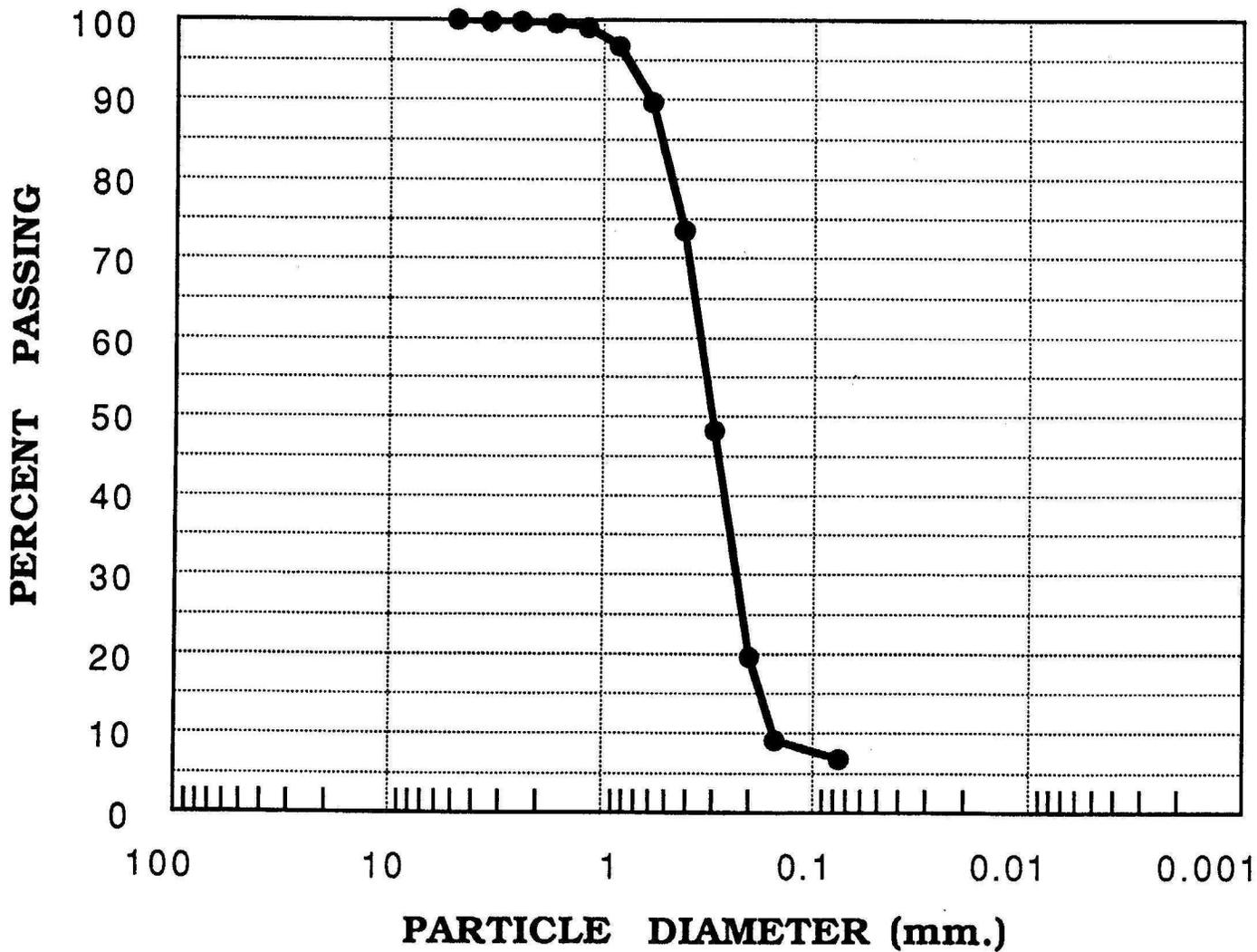
LINE # 3C4 E-W
USBR SITE #14+00
SAMPLING DEPTH (ft.) 22-26

Particle Diameter @ 60% Passing = 0.60 mm.(0.024 in.)



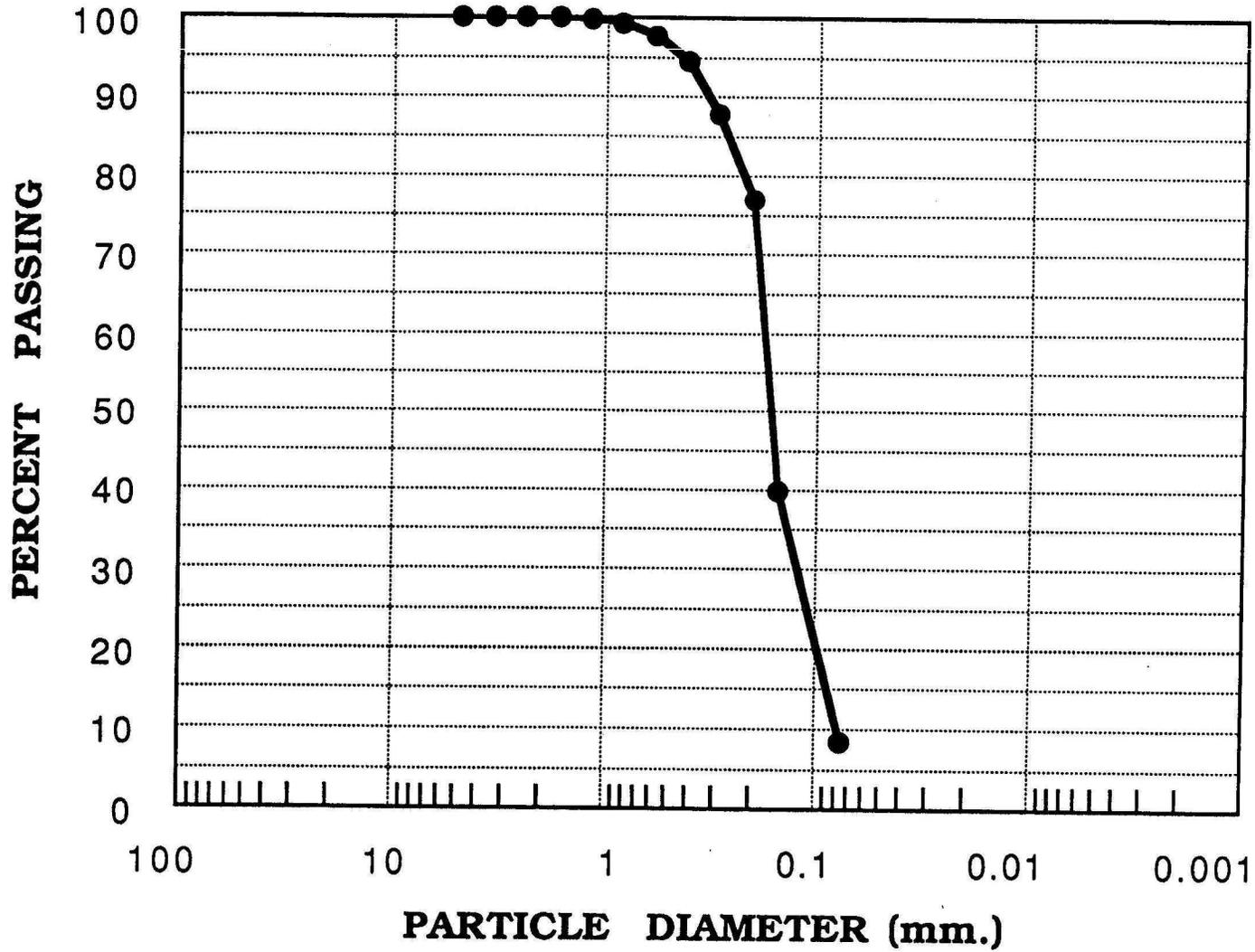
LINE # 3C4 E-W
USBR SITE #18+00
SAMPLING DEPTH (ft.) 18-22

Particle Diameter @ 60% Passing = 0.33 mm.(0.013 in.)



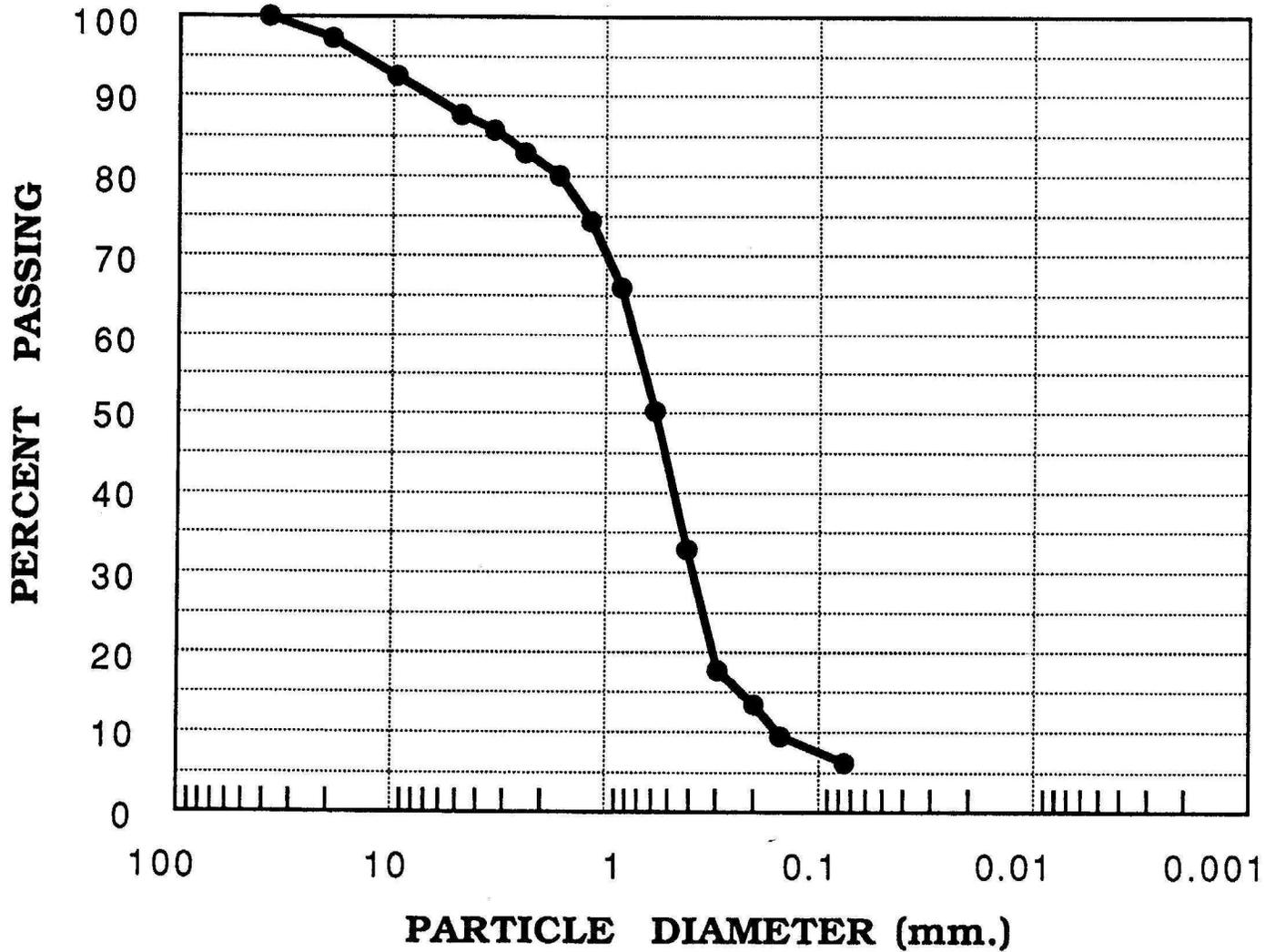
LINE # 3C4 E-W
USBR SITE #18+00
SAMPLING DEPTH (ft.) 22-25.5

Particle Diameter @ 60% Passing = 0.18 mm.(0.007 in.)



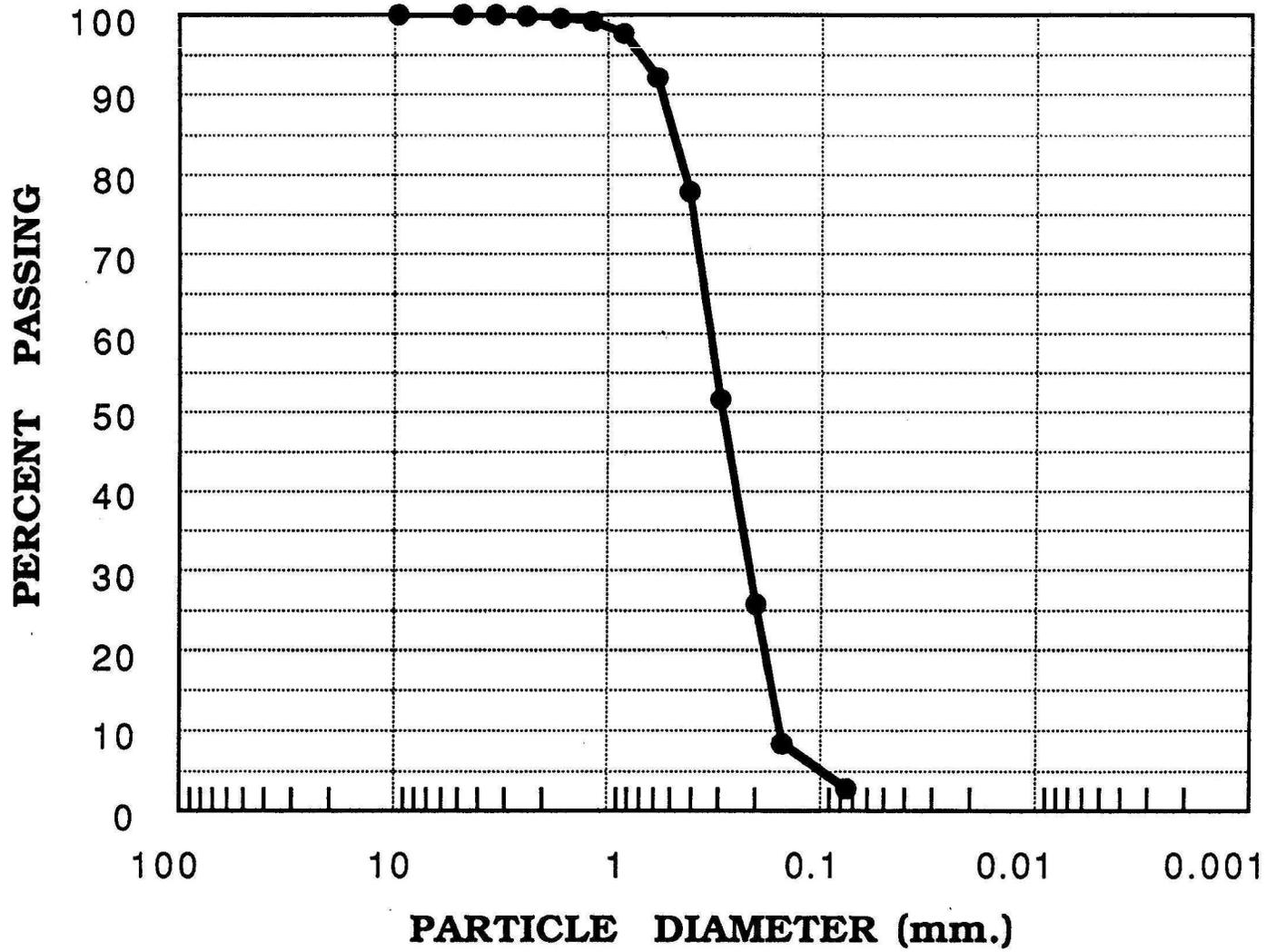
LINE # 3C4 E-W
USBR SITE #18+00
SAMPLING DEPTH (ft.) 25.5-29

Particle Diameter @ 60% Passing = 0.72mm.(0.028 in.)



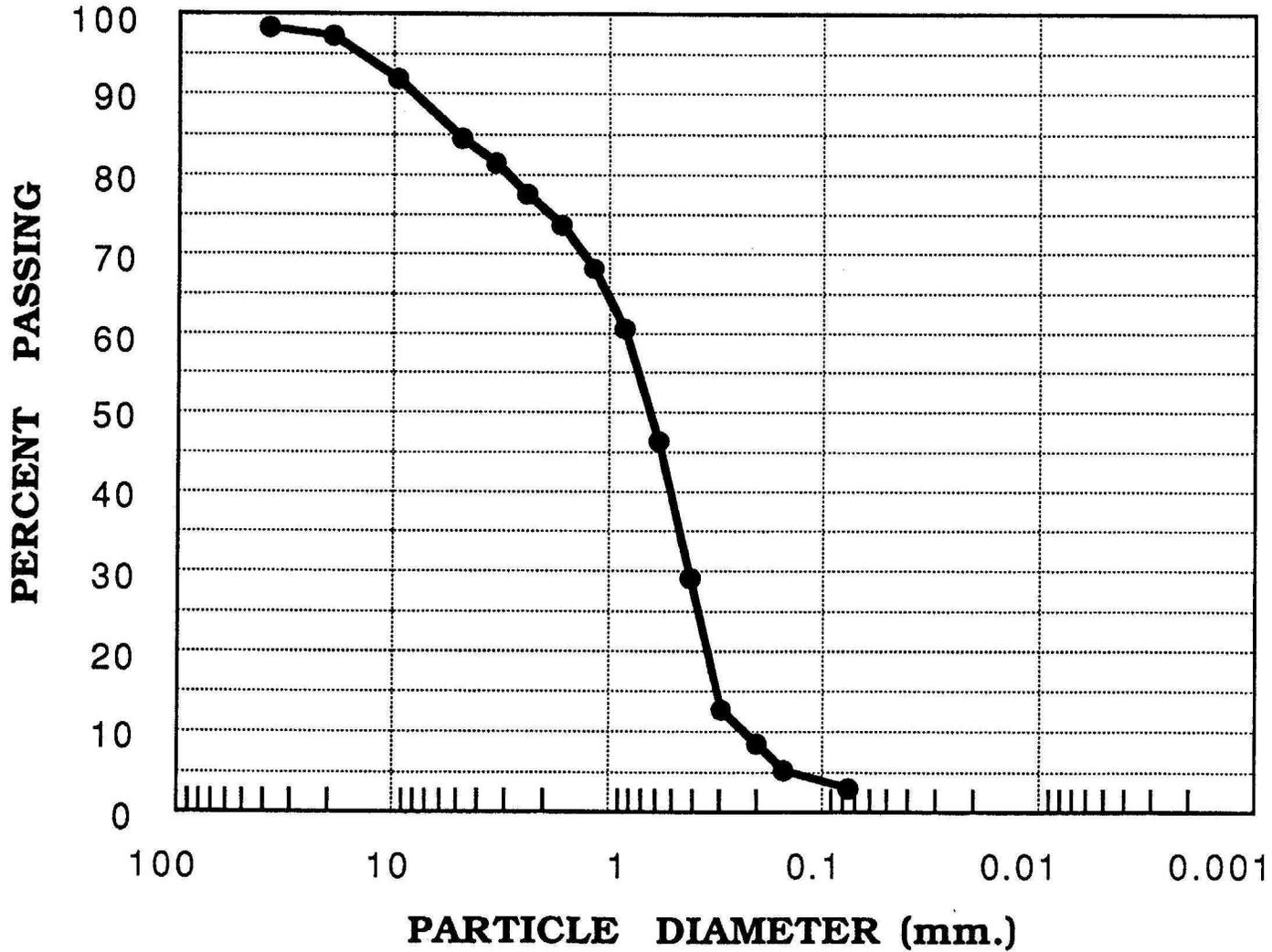
LINE # 3C4 E-W
USBR SITE #22+00
SAMPLING DEPTH (ft.) 18-27

Particle Diameter @ 60% Passing = 0.33 mm.(0.013 in.)



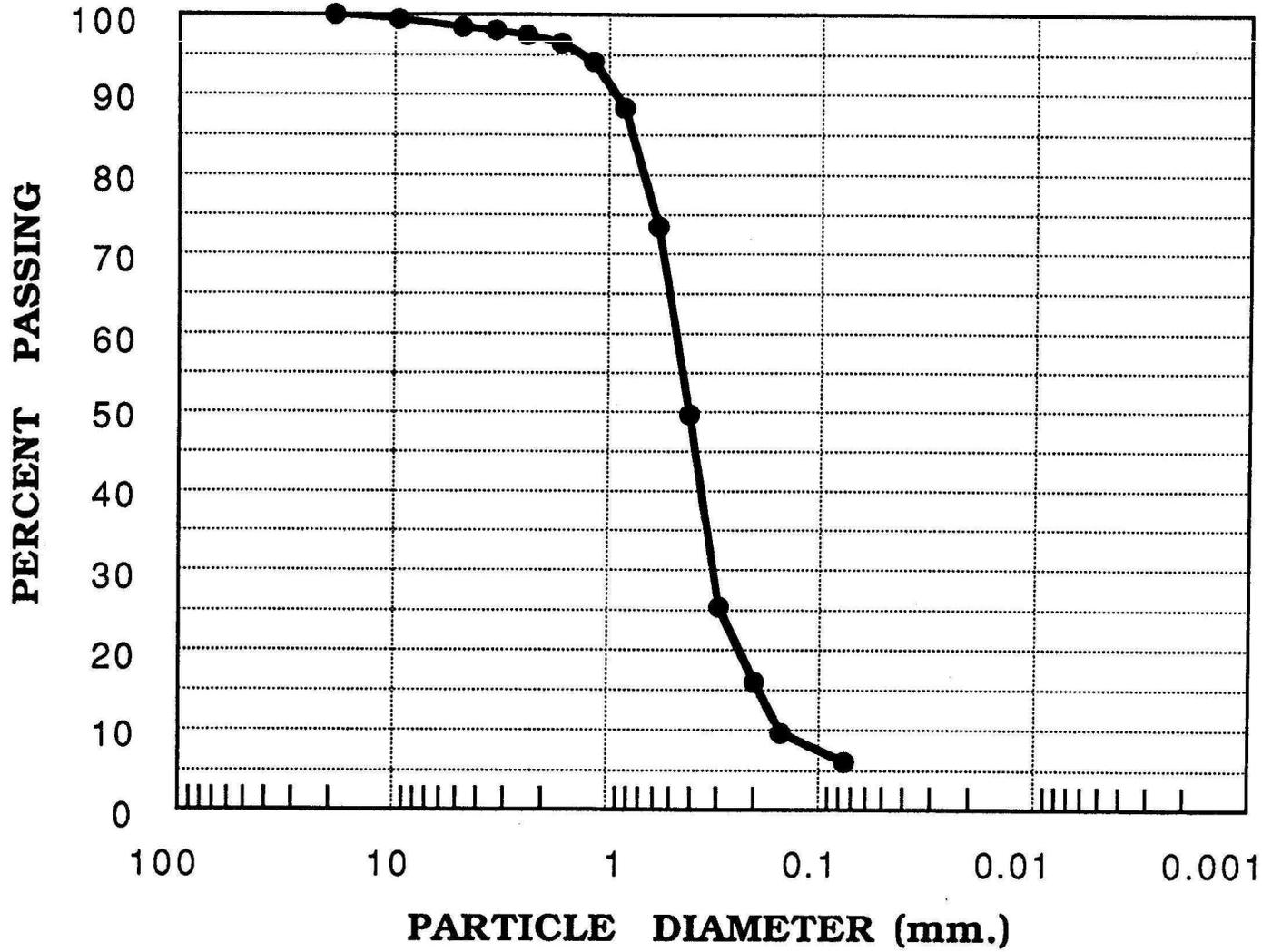
LINE # 3C4 E-W
USBR SITE #22+00
SAMPLING DEPTH (ft.) 27-32

Particle Diameter @ 60% Passing = 0.83 mm.(0.033 in.)



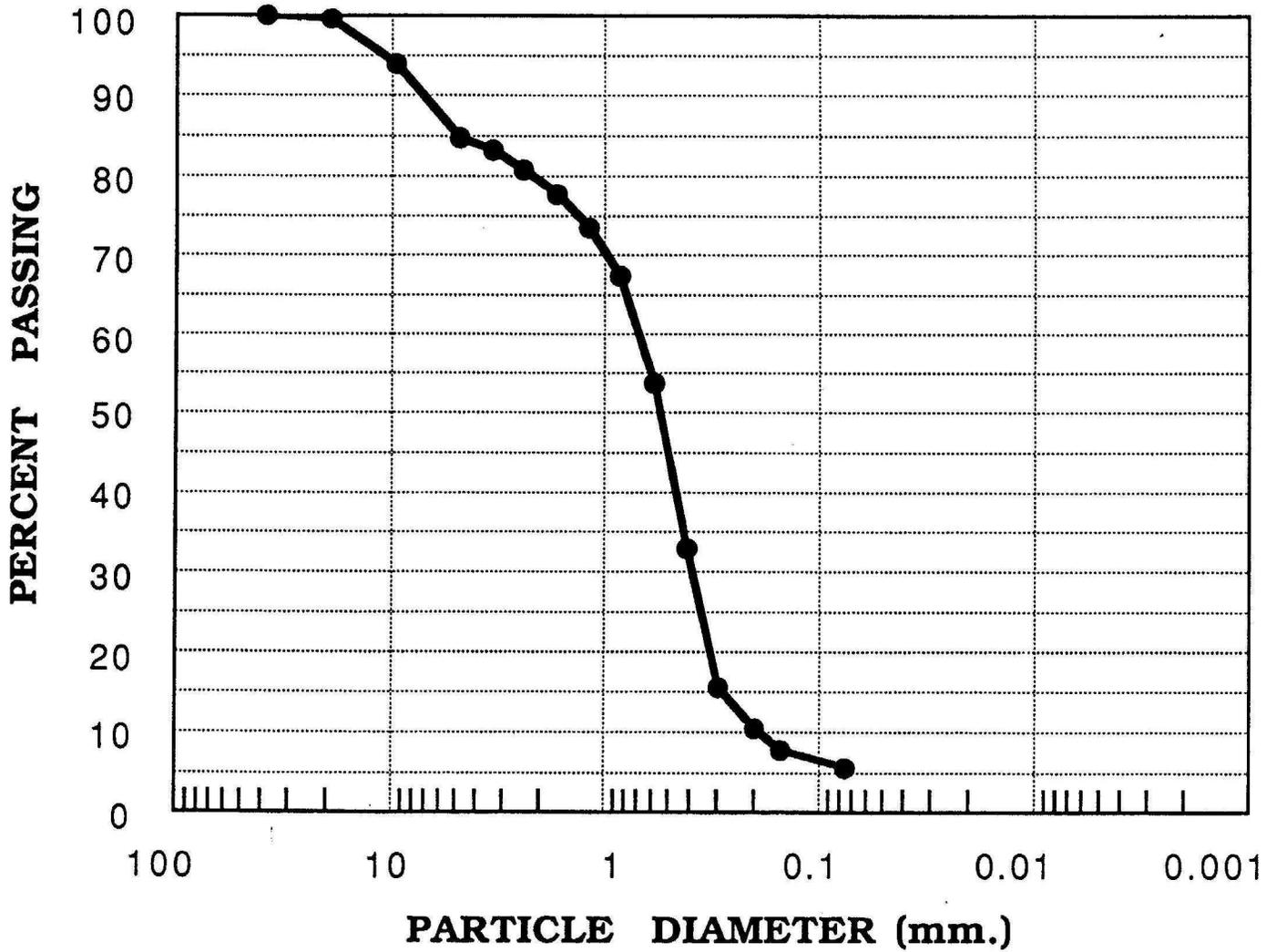
LINE # 3C4 W-E
USBR SITE #26+00
SAMPLING DEPTH (ft.) 23-30

Particle Diameter @ 60% Passing = 0.48 mm.(0.019 in.)



LINE # 3C4 W-E
USBR SITE #26+00
SAMPLING DEPTH (ft.) 30-35

Particle Diameter @ 60% Passing = 0.66 mm.(0.026 in.)

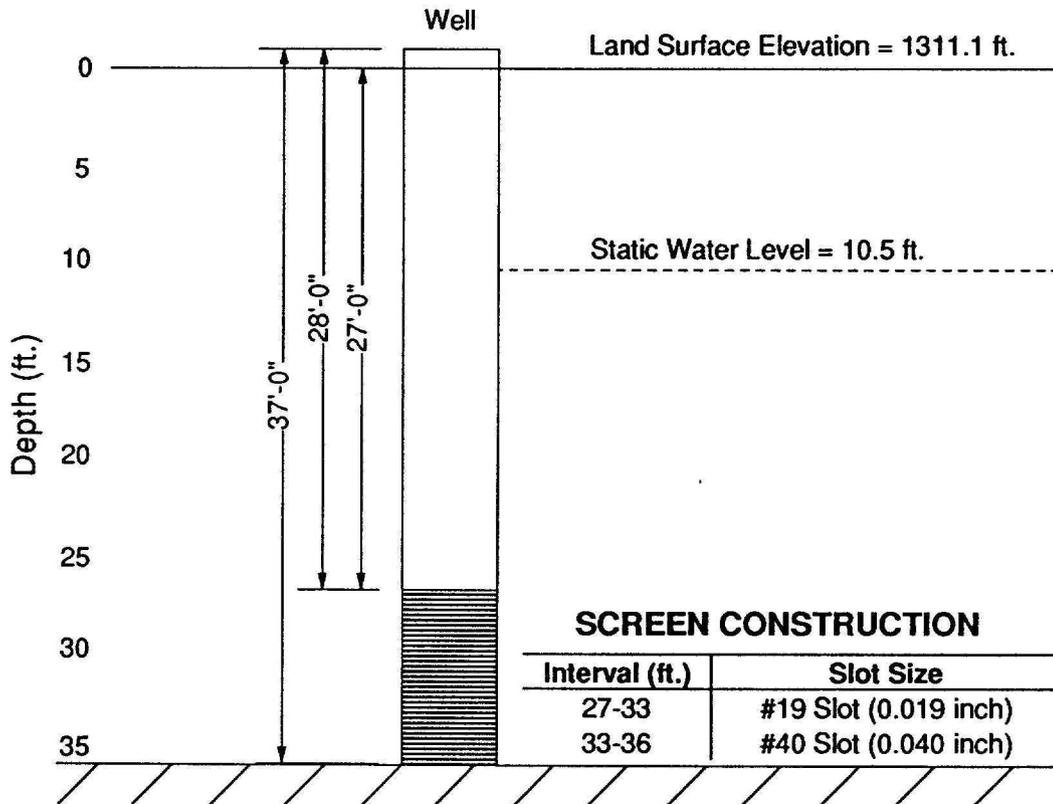


APPENDIX 3

Drawings Showing Well-Design Specifications

INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

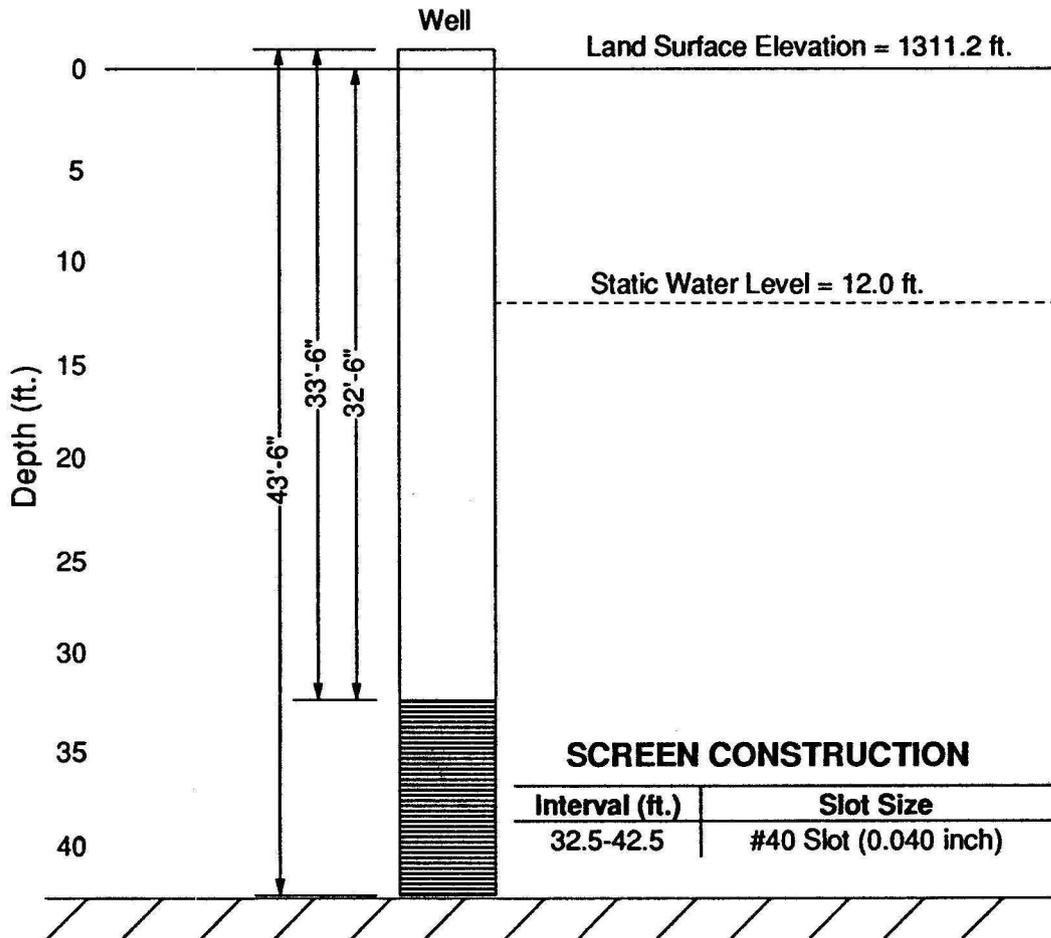
WELL NUMBER	1
USBR LINE NUMBER	4B LAT
USBR SITE NUMBER	34+00



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	28
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	9
		Screened Interval (ft.)	27-36

INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

WELL NUMBER	2
USBR LINE NUMBER	4B LAT
USBR SITE NUMBER	38+00



WELL DESIGN SPECIFICATIONS

Casing Type	8 - inch Diameter PVC SDR-21
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Casing Length (ft.)	33.5
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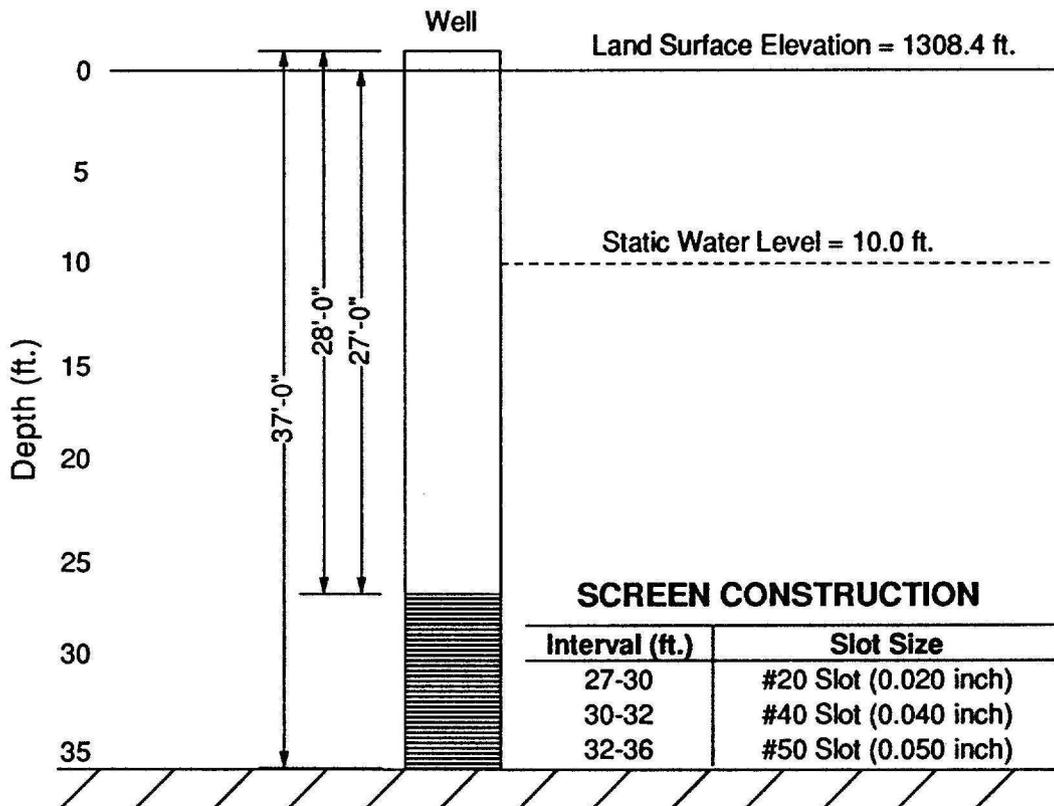
Screen Type	8 - inch Diameter Stainless Steel V - Slot
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Screen Length (ft.)	10
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Screened Interval (ft.)	32.5-42.5
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INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

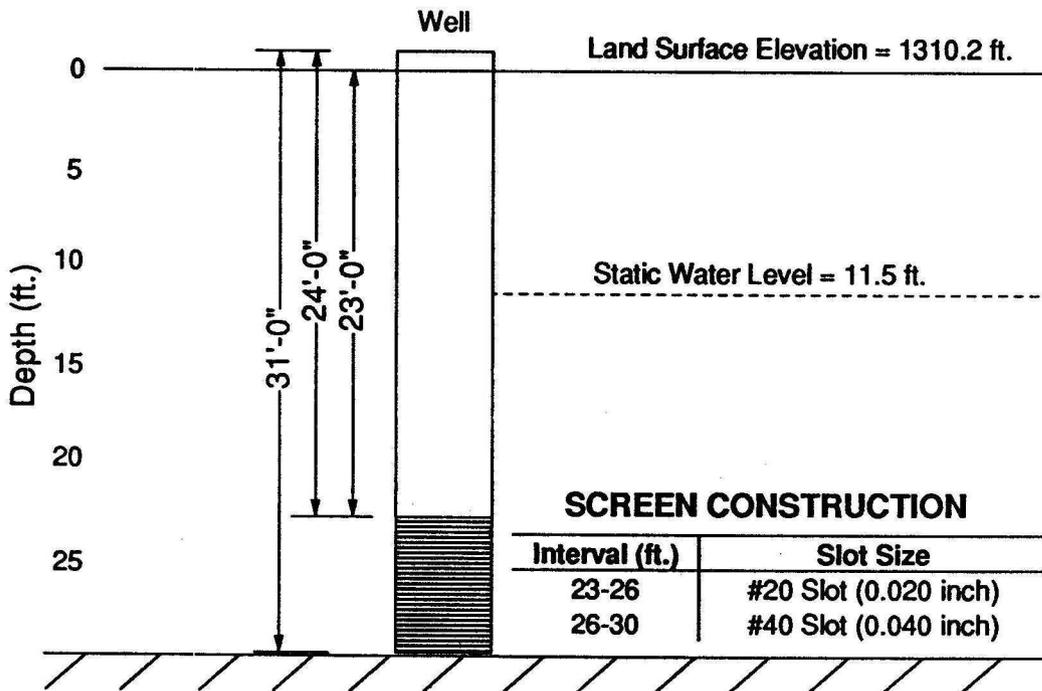
WELL NUMBER	3
USBR LINE NUMBER	4B LAT
USBR SITE NUMBER	42+00



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	28
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	9
		Screened Interval (ft.)	27-36

**INTERIM GROUND-WATER SUPPLY,
WEST OAKES IRRIGATION AREA**

WELL NUMBER	4
USBR LINE NUMBER	4C LAT
USBR SITE NUMBER	46+00



WELL DESIGN SPECIFICATIONS

Casing Type	8 - inch Diameter PVC SDR-21
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Casing Length (ft.)	24
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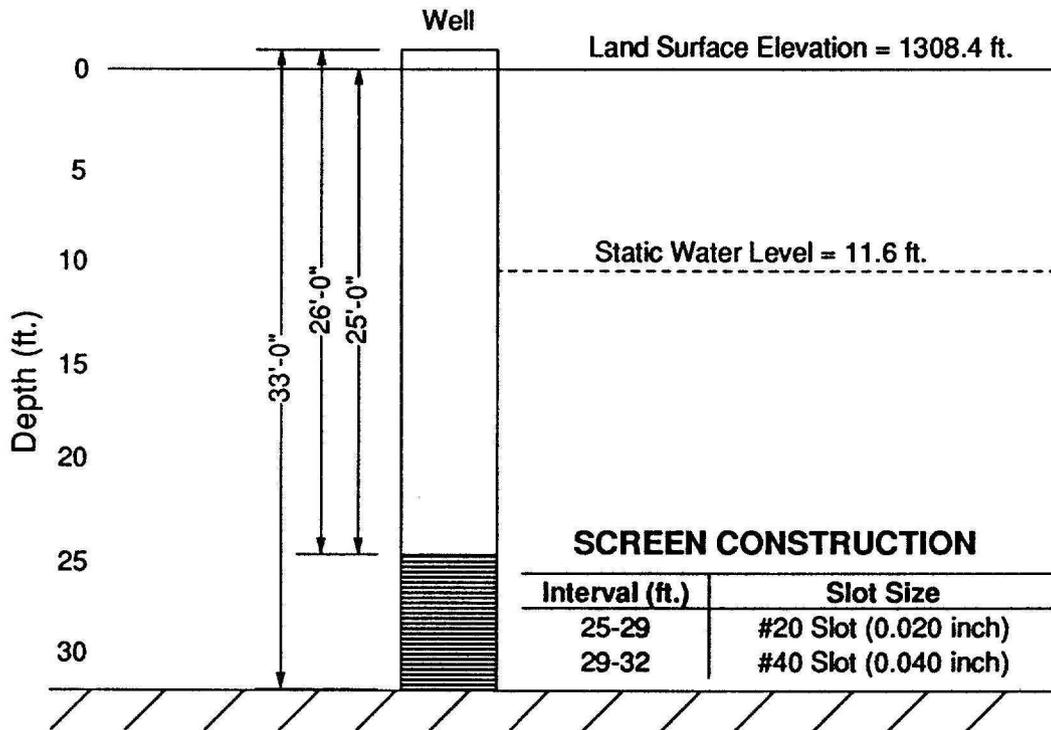
Screen Type	8 - inch Diameter Stainless Steel V - Slot
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Screen Length (ft.)	7
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Screened Interval (ft.)	23-30
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INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

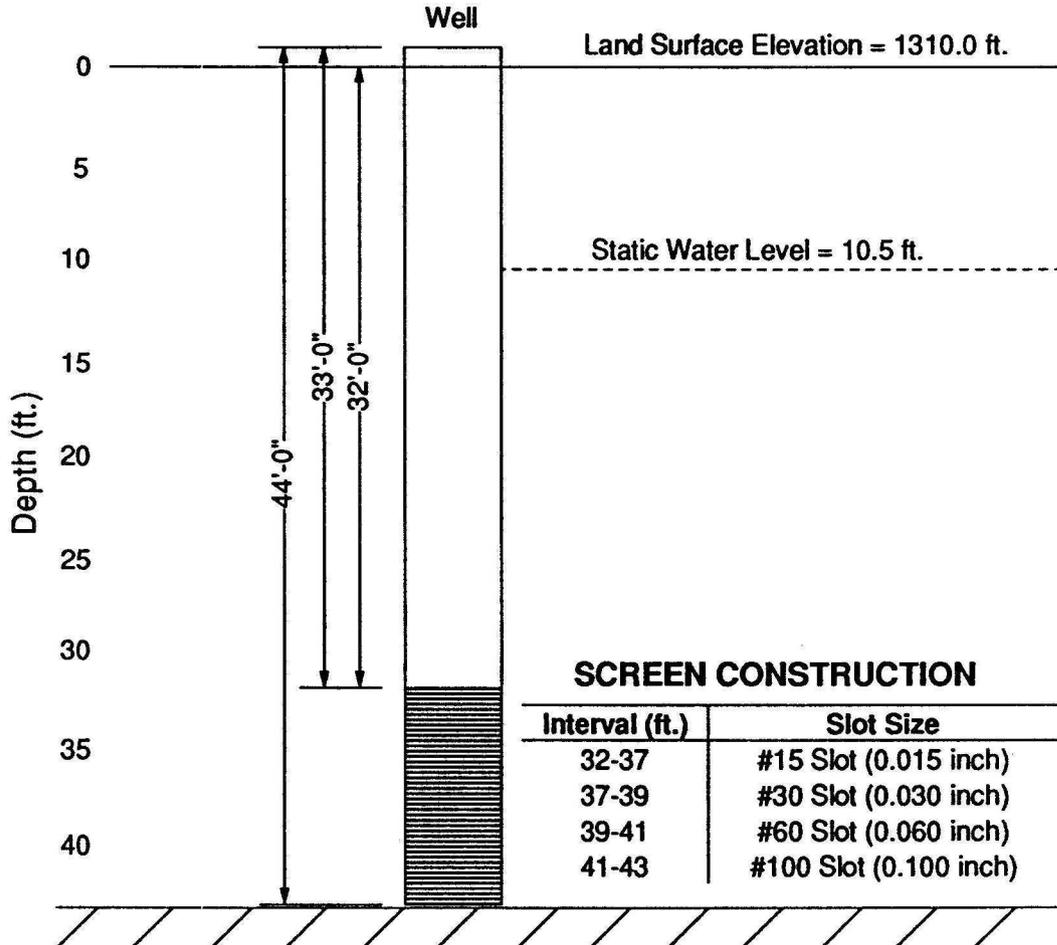
WELL NUMBER	5
USBR LINE NUMBER	4C LAT
USBR SITE NUMBER	50+00



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	26
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	7
		Screened Interval (ft.)	25-32

INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

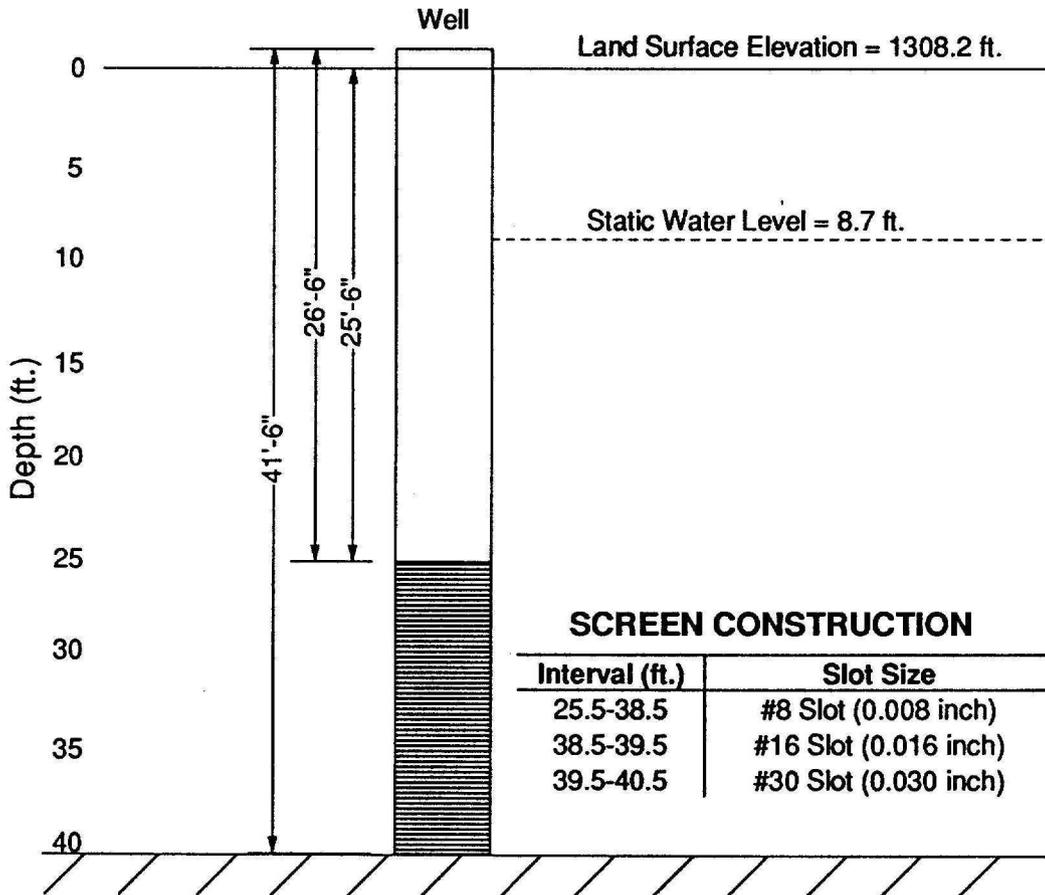
WELL NUMBER	6
USBR LINE NUMBER	3C2
USBR SITE NUMBER	2+00



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	33
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	11
		Screened Interval (ft.)	32-43

INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

WELL NUMBER	7
USBR LINE NUMBER	3C1
USBR SITE NUMBER	4+00



WELL DESIGN SPECIFICATIONS

Casing Type	8 - inch Diameter PVC SDR-21
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Casing Length (ft.)	26.5
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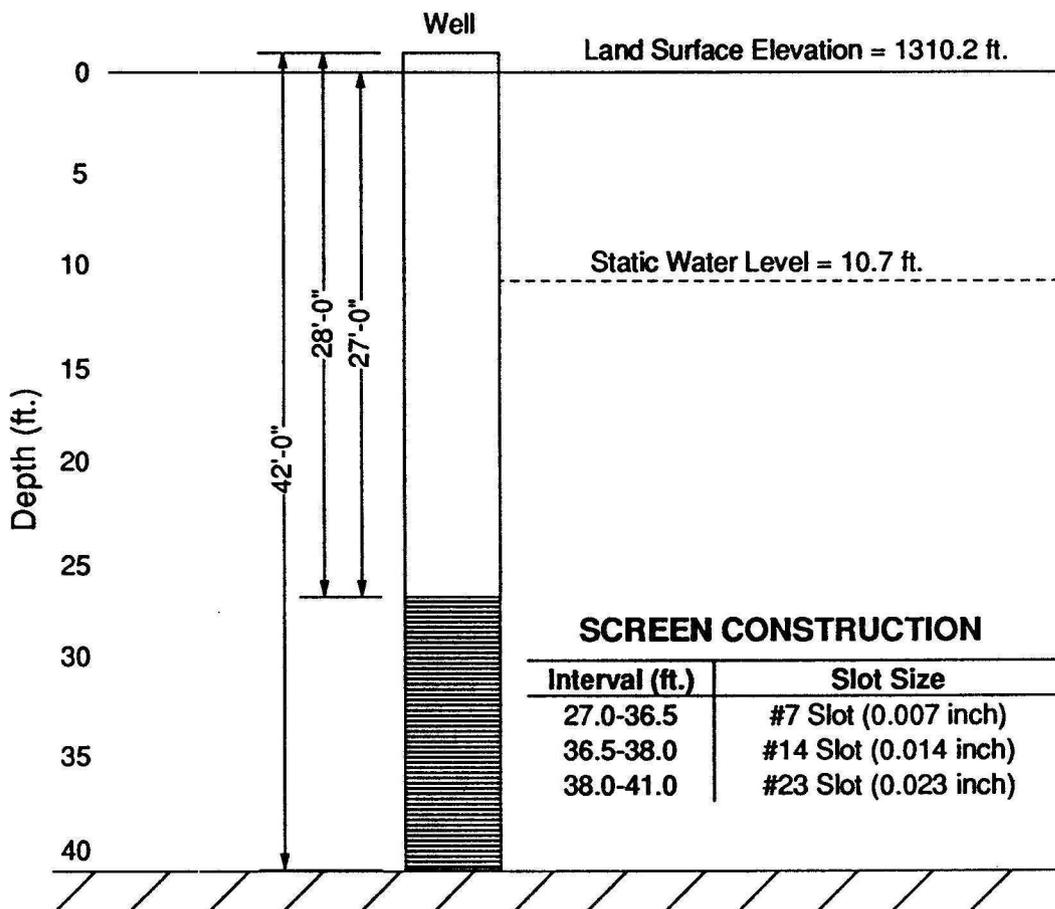
Screen Type	8 - inch Diameter Stainless Steel V - Slot
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Screen Length (ft.)	15
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Screened Interval (ft.)	25.5-40.5
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INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

WELL NUMBER	8
USBR LINE NUMBER	3C1
USBR SITE NUMBER	8+00



WELL DESIGN SPECIFICATIONS

Casing Type	8 - inch Diameter PVC SDR-21
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Screen Type	8 - inch Diameter Stainless Steel V - Slot
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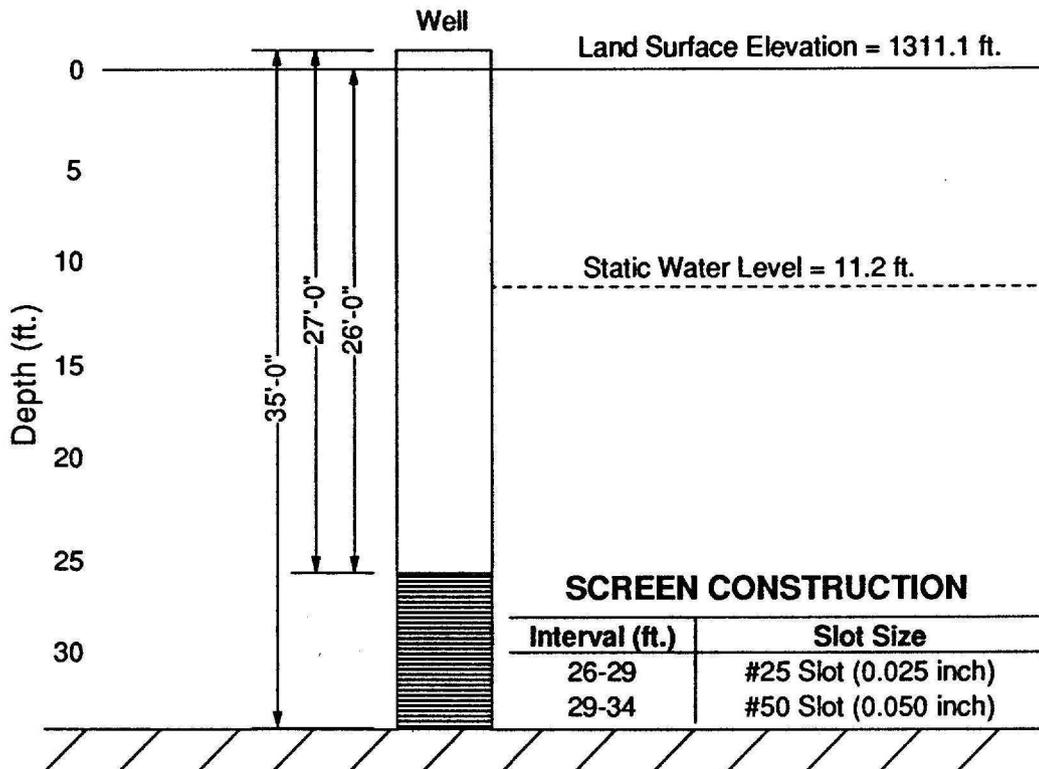
Casing Length (ft.)	28
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Screen Length (ft.)	14
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Screened Interval (ft.)	27-41
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**INTERIM GROUND-WATER SUPPLY,
WEST OAKES IRRIGATION AREA**

WELL NUMBER	9
USBR LINE NUMBER	3C1
USBR SITE NUMBER	16+00



WELL DESIGN SPECIFICATIONS

Casing Type	8 - inch Diameter PVC SDR-21
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Casing Length (ft.)	27
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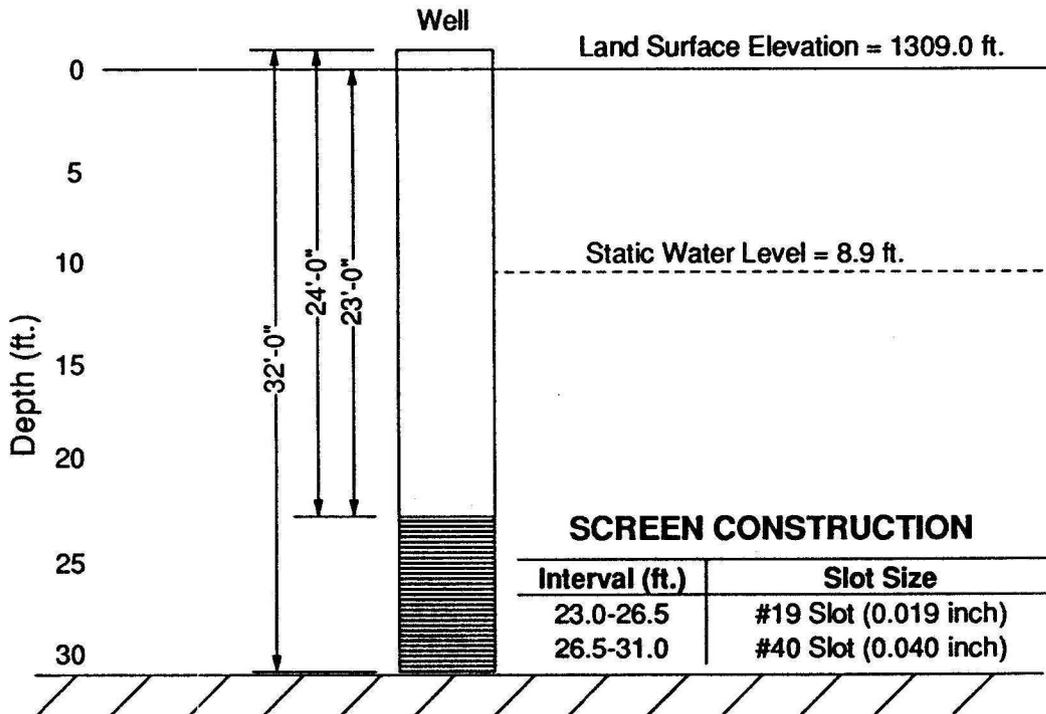
Screen Type	8 - inch Diameter Stainless Steel V - Slot
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Screen Length (ft.)	8
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Screened Interval (ft.)	26-34
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INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

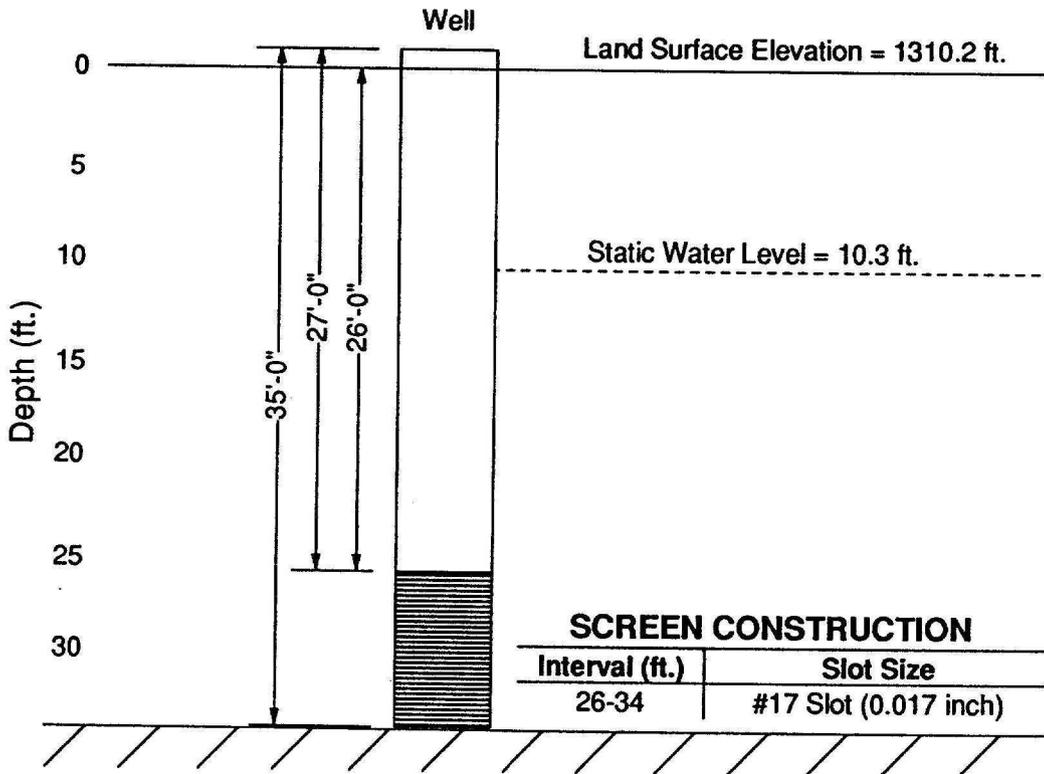
WELL NUMBER	10
USBR LINE NUMBER	3C1
USBR SITE NUMBER	20+00



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	24
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	8
		Screened Interval (ft.)	23-31

INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

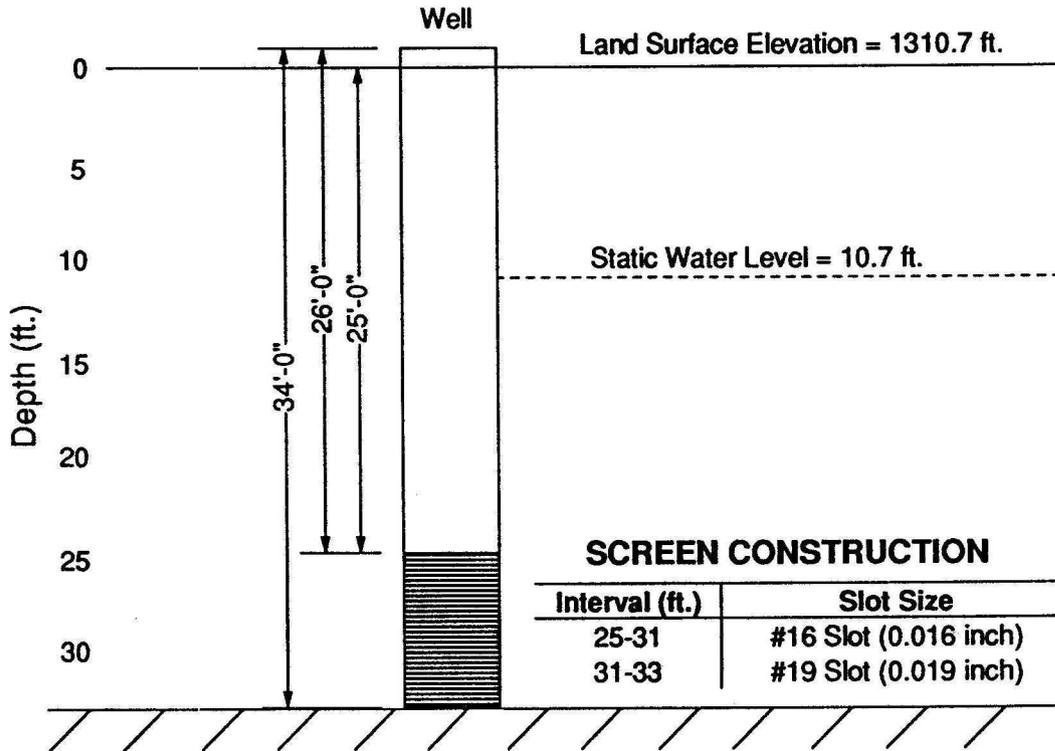
WELL NUMBER	11
USBR LINE NUMBER	3C3
USBR SITE NUMBER	8+00



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	27
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	8
		Screened Interval (ft.)	26-34

INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

WELL NUMBER	12
USBR LINE NUMBER	3C3
USBR SITE NUMBER	12+00



WELL DESIGN SPECIFICATIONS

Casing Type	8 - inch Diameter PVC SDR-21
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Screen Type	8 - inch Diameter Stainless Steel V - Slot
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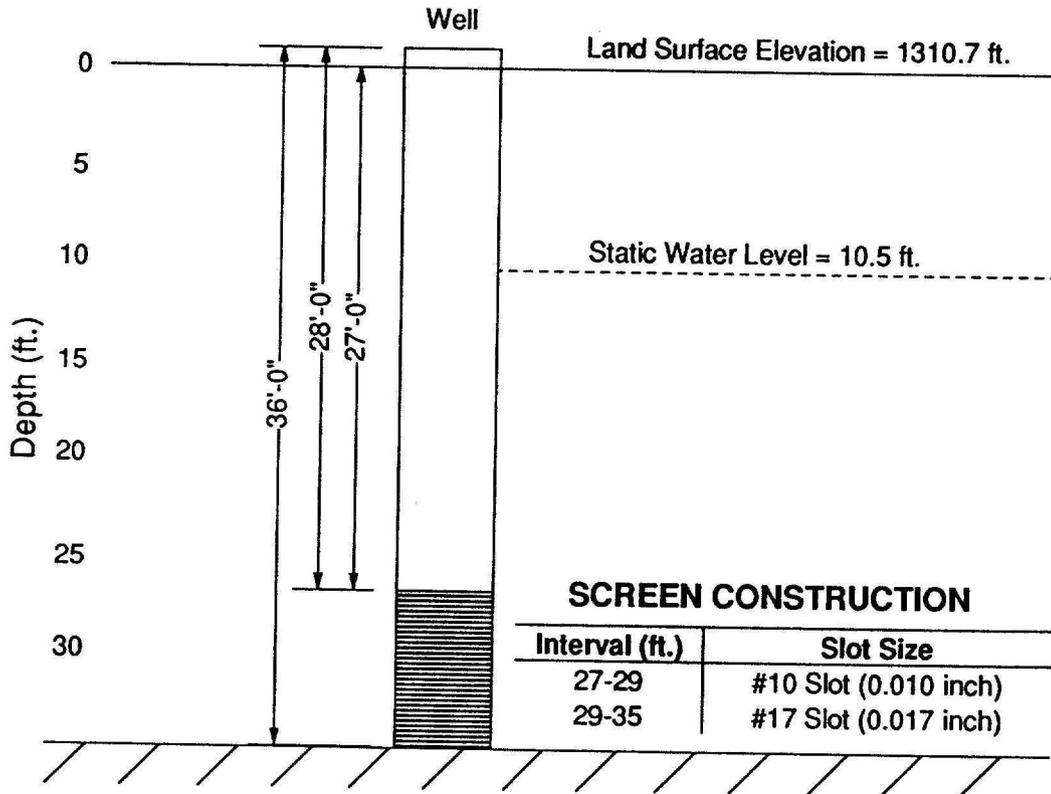
Casing Length (ft.)	26
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Screen Length (ft.)	8
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Screened Interval (ft.)	25-33
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INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

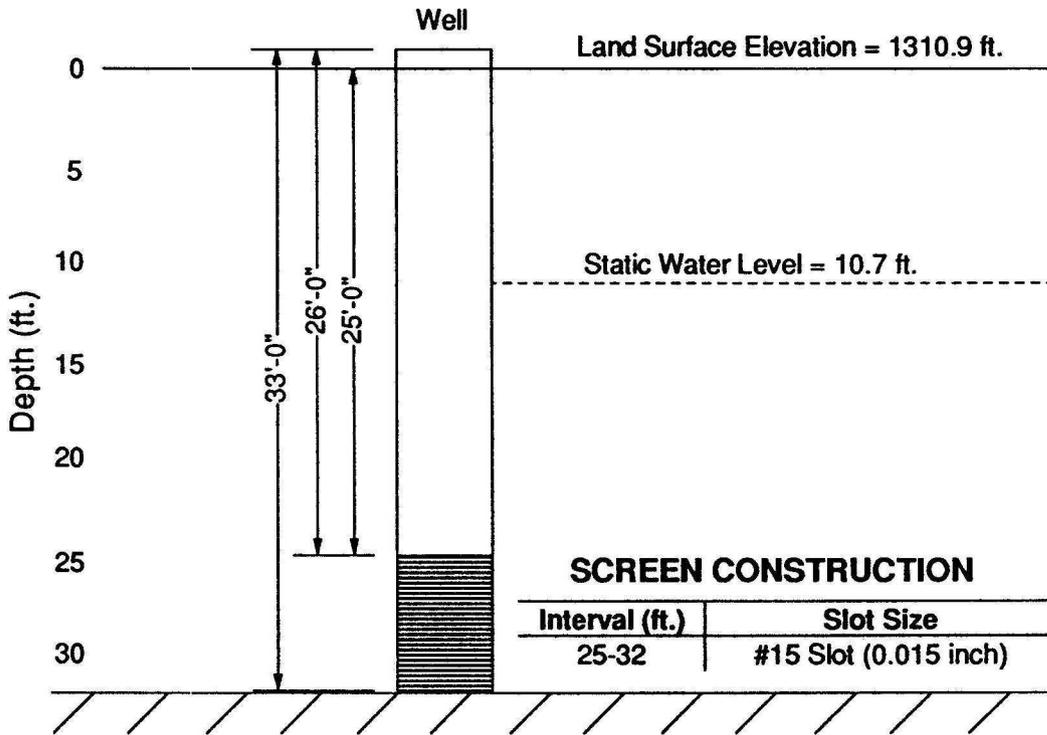
WELL NUMBER	13
USBR LINE NUMBER	3C3
USBR SITE NUMBER	16+00



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	28
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	8
		Screened Interval (ft.)	27-35

**INTERIM GROUND-WATER SUPPLY,
WEST OAKES IRRIGATION AREA**

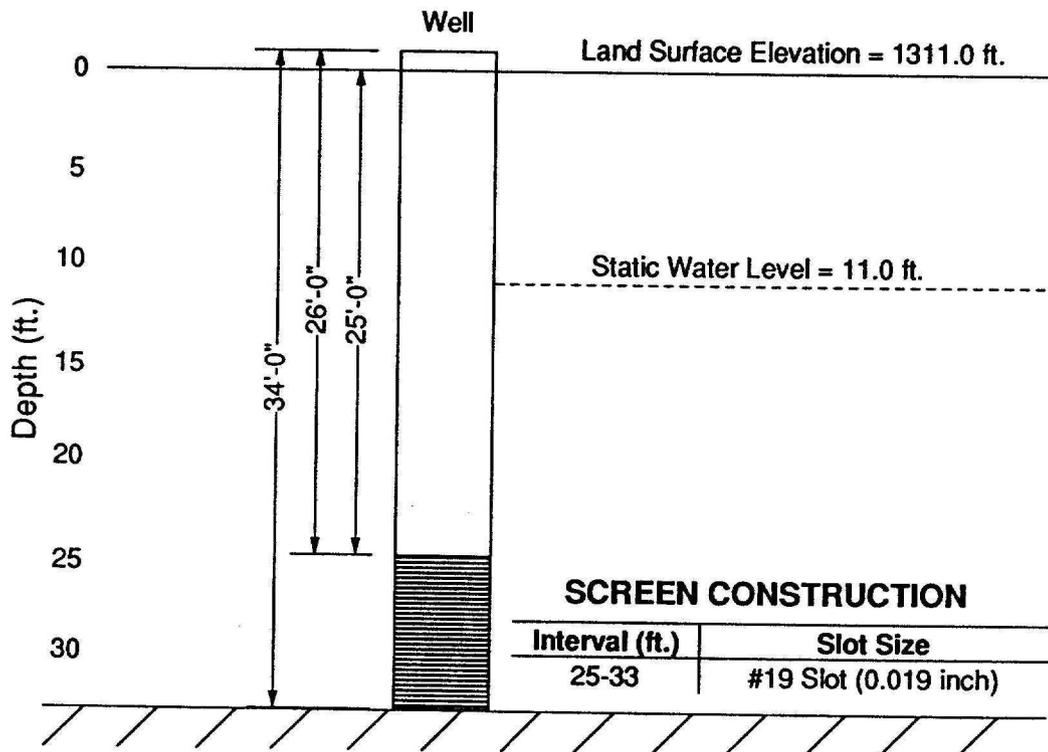
WELL NUMBER	14
USBR LINE NUMBER	3C3
USBR SITE NUMBER	20+00



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	26
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	7
		Screened Interval (ft.)	25-32

INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

WELL NUMBER	15
USBR LINE NUMBER	3C3
USBR SITE NUMBER	24+00



WELL DESIGN SPECIFICATIONS

Casing Type	8 - inch Diameter PVC SDR-21
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Casing Length (ft.)	26
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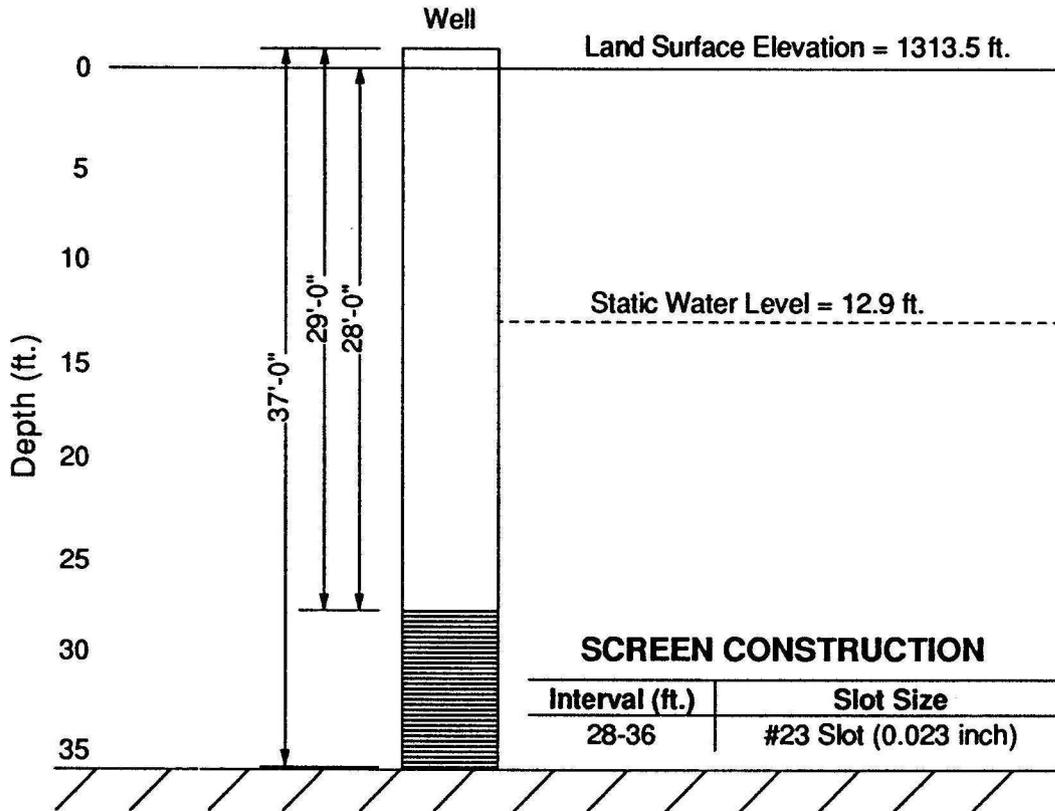
Screen Type	8 - inch Diameter Stainless Steel V - Slot
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Screen Length (ft.)	8
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Screened Interval (ft.)	25-33
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**INTERIM GROUND-WATER SUPPLY,
WEST OAKES IRRIGATION AREA**

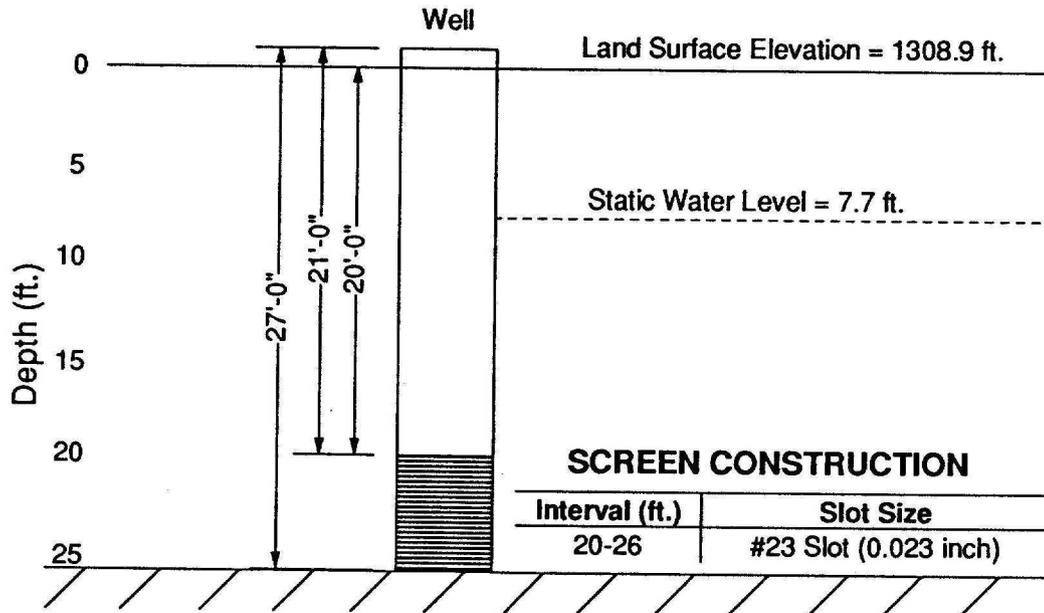
WELL NUMBER	16
USBR LINE NUMBER	3C4
USBR SITE NUMBER	9+93



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	29
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	8
		Screened Interval (ft.)	28-36

INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

WELL NUMBER	17
USBR LINE NUMBER	3C4
USBR SITE NUMBER	14+00



WELL DESIGN SPECIFICATIONS

Casing Type	8 - inch Diameter PVC SDR-21
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Casing Length (ft.)	21
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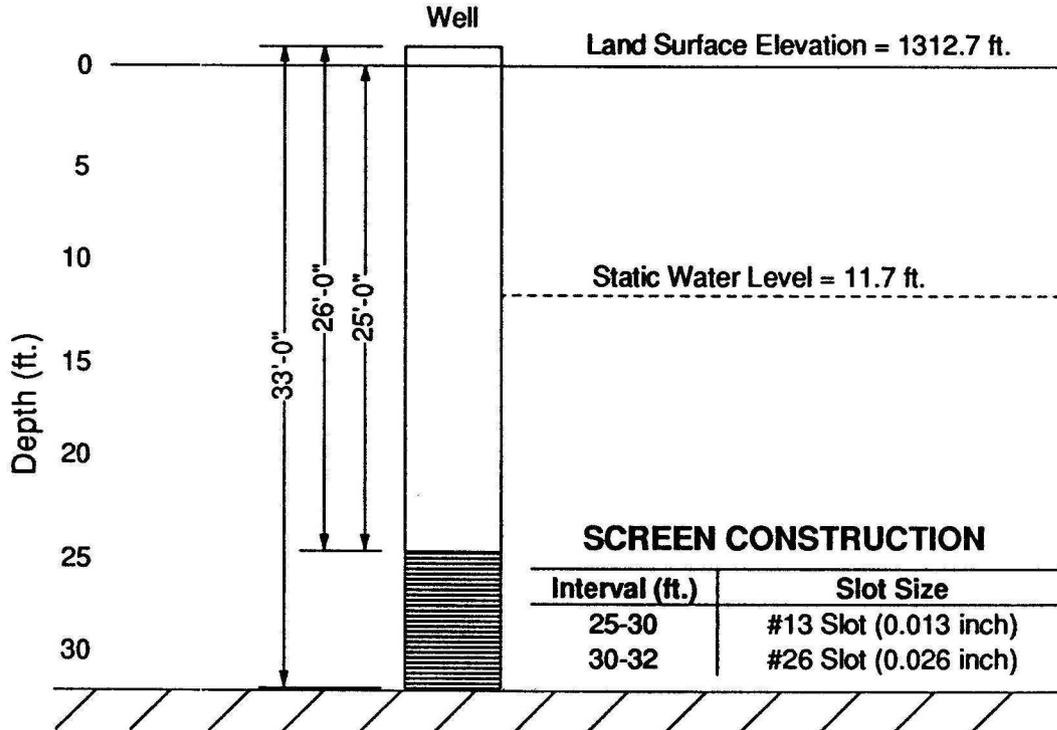
Screen Type	8 - inch Diameter Stainless Steel V - Slot
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Screen Length (ft.)	6
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Screened Interval (ft.)	20-26
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**INTERIM GROUND-WATER SUPPLY,
WEST OAKES IRRIGATION AREA**

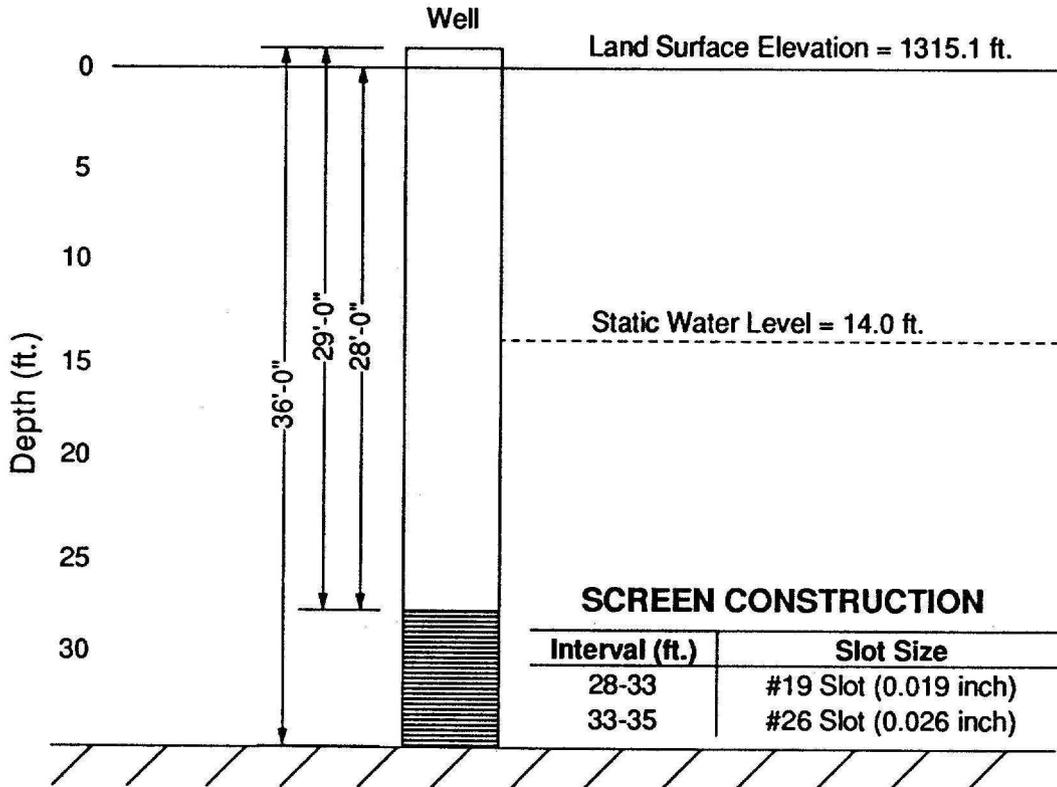
WELL NUMBER	18
USBR LINE NUMBER	3C4
USBR SITE NUMBER	22+00



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	26
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	7
		Screened Interval (ft.)	25-32

INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

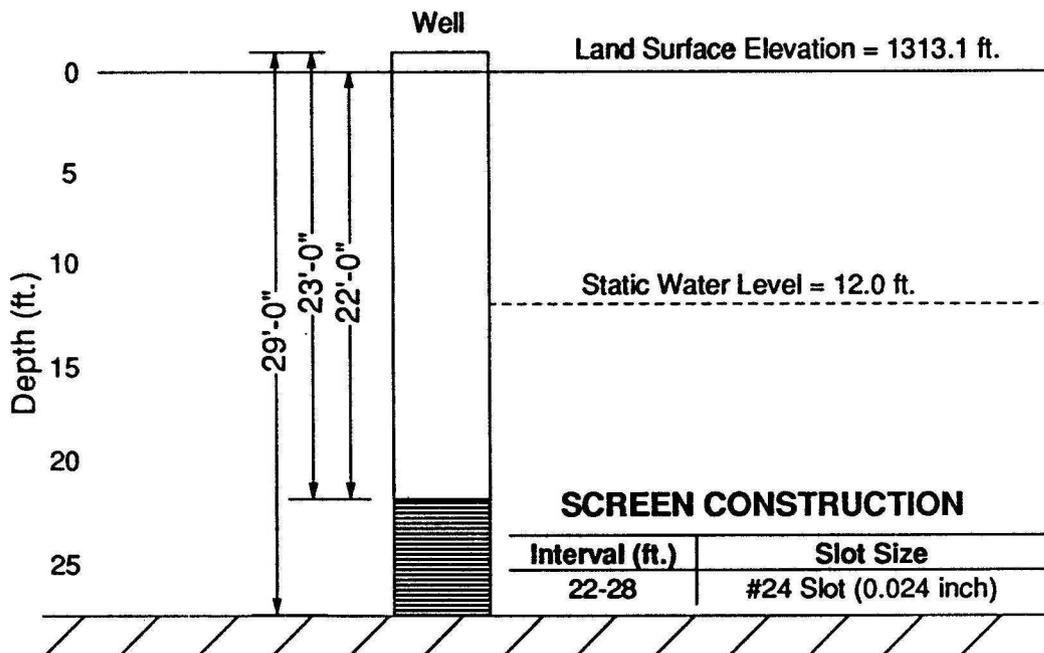
WELL NUMBER	19
USBR LINE NUMBER	3C4
USBR SITE NUMBER	26+00



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	29
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	7
		Screened Interval (ft.)	28-35

INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

WELL NUMBER	20
USBR LINE NUMBER	16A2
USBR SITE NUMBER	2+00



WELL DESIGN SPECIFICATIONS

Casing Type	8 - inch Diameter PVC SDR-21
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Screen Type	8 - inch Diameter Stainless Steel V - Slot
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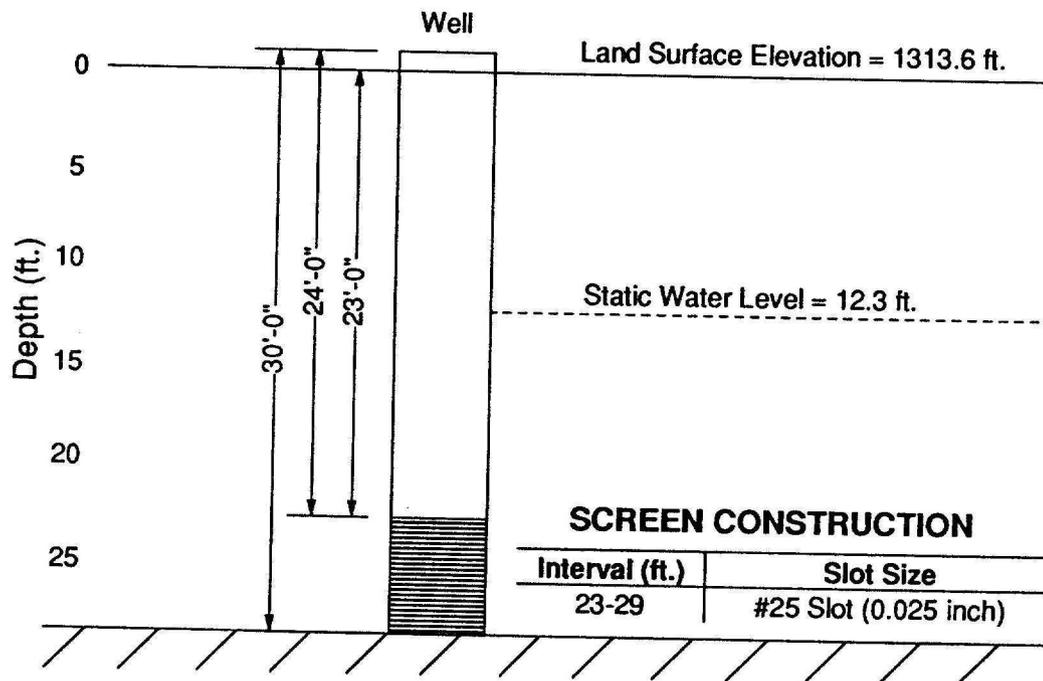
Casing Length (ft.)	23
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Screen Length (ft.)	6
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Screened Interval (ft.)	22-28
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INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

WELL NUMBER	21
USBR LINE NUMBER	16A2
USBR SITE NUMBER	6+00



WELL DESIGN SPECIFICATIONS

Casing Type	8 - inch Diameter PVC SDR-21
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Screen Type	8 - inch Diameter Stainless Steel V - Slot
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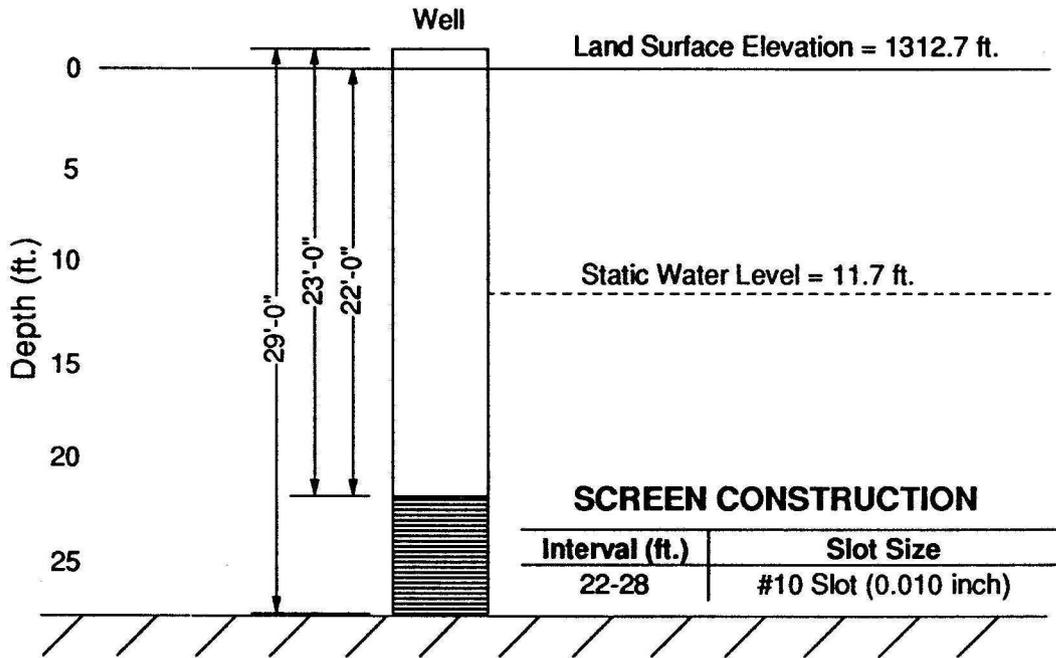
Casing Length (ft.)	24
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Screen Length (ft.)	6
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Screened Interval (ft.)	23-29
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**INTERIM GROUND-WATER SUPPLY,
WEST OAKES IRRIGATION AREA**

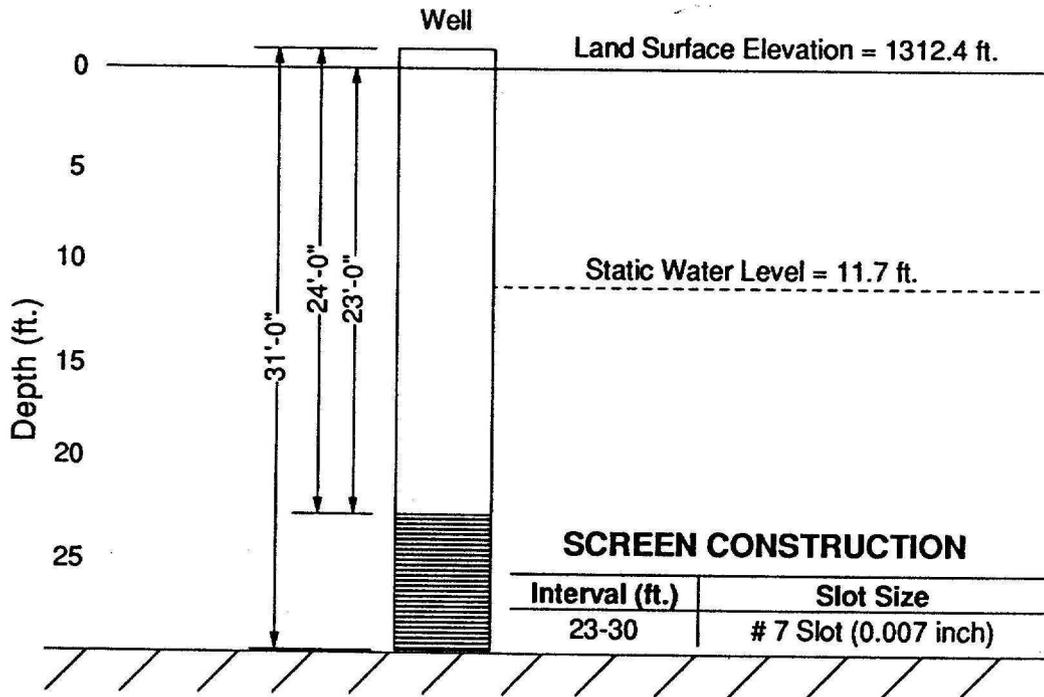
WELL NUMBER	22
USBR LINE NUMBER	16A2
USBR SITE NUMBER	10+00



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	23
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	6
		Screened Interval (ft.)	22-28

INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

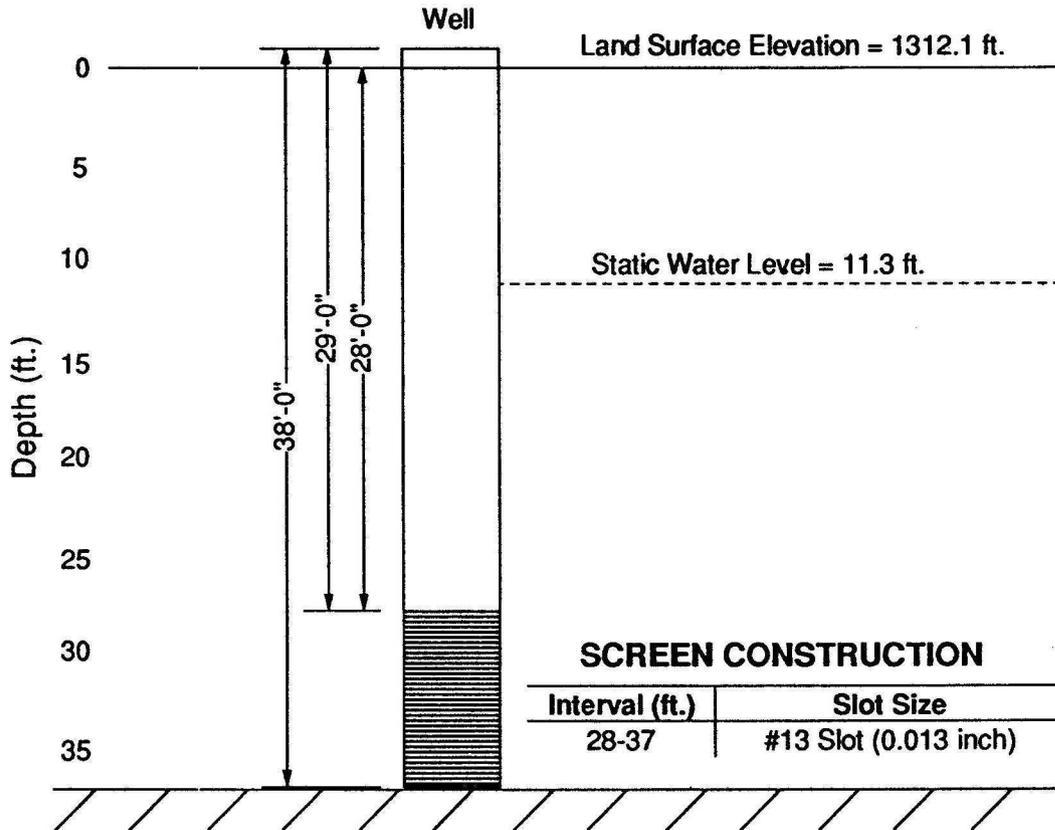
WELL NUMBER	23
USBR LINE NUMBER	16A2
USBR SITE NUMBER	14+00



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	24
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	7
		Screened Interval (ft.)	23-30

INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

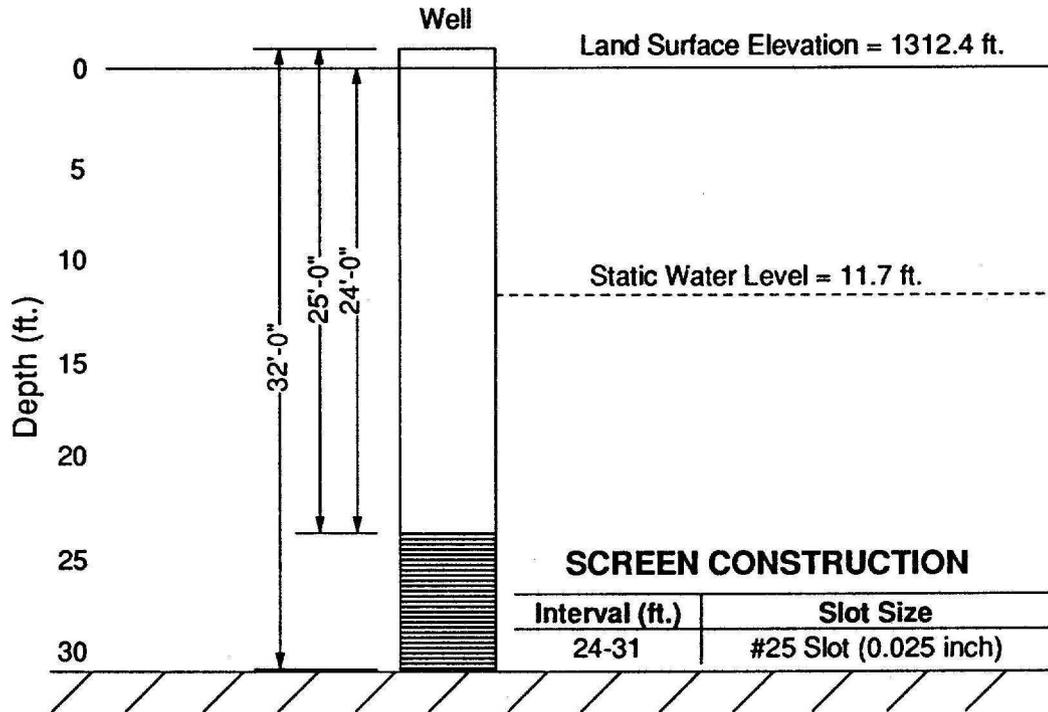
WELL NUMBER	24
USBR LINE NUMBER	16A2
USBR SITE NUMBER	18+00



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	29
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	9
		Screened Interval (ft.)	28-37

INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

WELL NUMBER	25
USBR LINE NUMBER	16A2
USBR SITE NUMBER	22+00



WELL DESIGN SPECIFICATIONS

Casing Type	8 - inch Diameter PVC SDR-21
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Casing Length (ft.)	25
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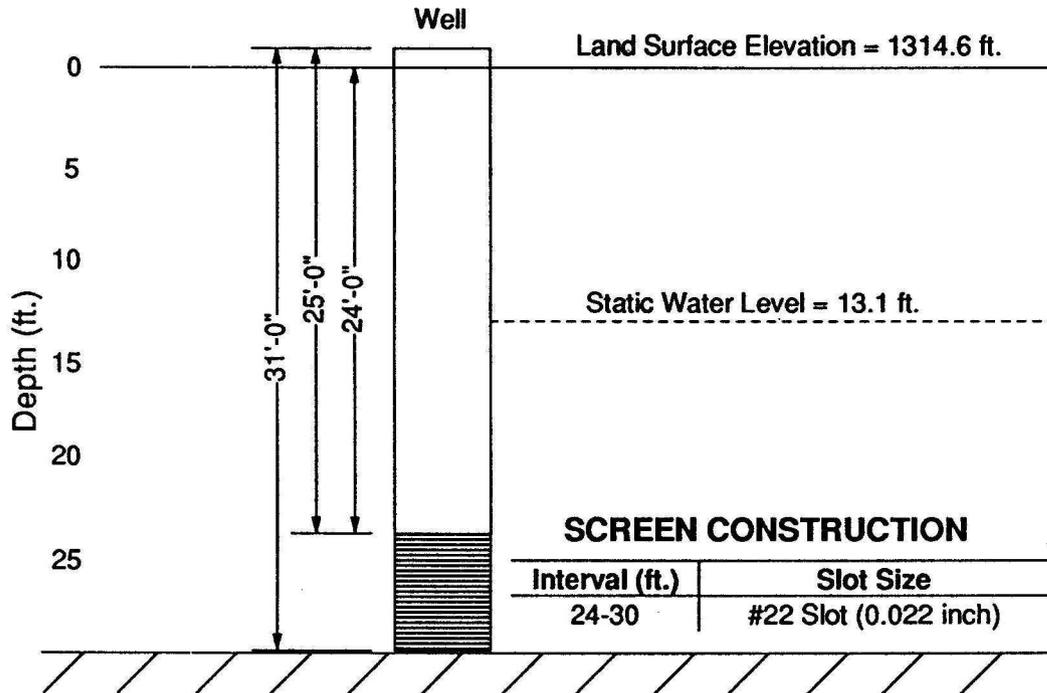
Screen Type	8 - inch Diameter Stainless Steel V - Slot
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Screen Length (ft.)	7
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Screened Interval (ft.)	24-31
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**INTERIM GROUND-WATER SUPPLY,
WEST OAKES IRRIGATION AREA**

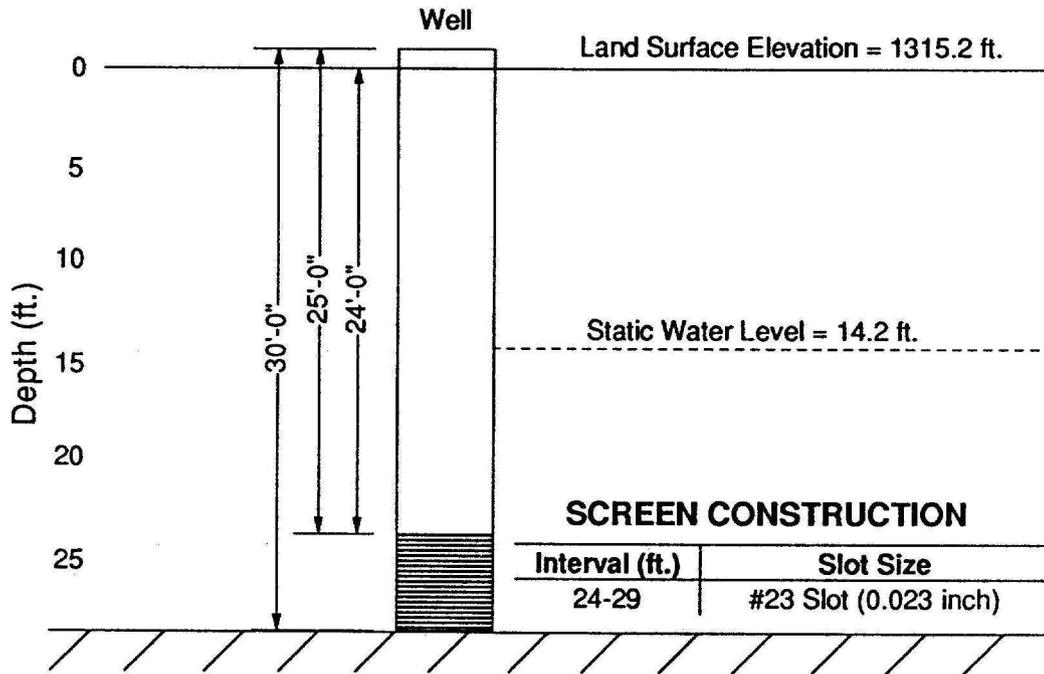
WELL NUMBER	26
USBR LINE NUMBER	16A3
USBR SITE NUMBER	2+00



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	25
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	6
		Screened Interval (ft.)	24-30

**INTERIM GROUND-WATER SUPPLY,
WEST OAKES IRRIGATION AREA**

WELL NUMBER	27
USBR LINE NUMBER	16A3
USBR SITE NUMBER	6+00



WELL DESIGN SPECIFICATIONS

Casing Type	8 - inch Diameter PVC SDR-21
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Casing Length (ft.)	25
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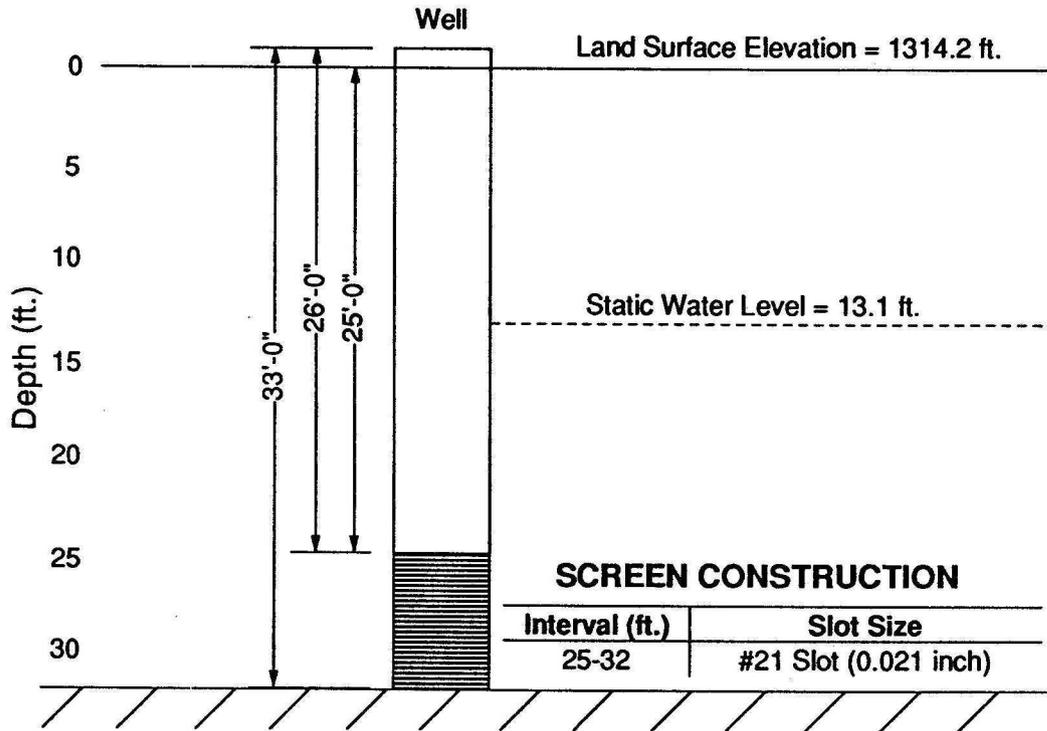
Screen Type	8 - inch Diameter Stainless Steel V - Slot
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Screen Length (ft.)	5
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Screened Interval (ft.)	24-29
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INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

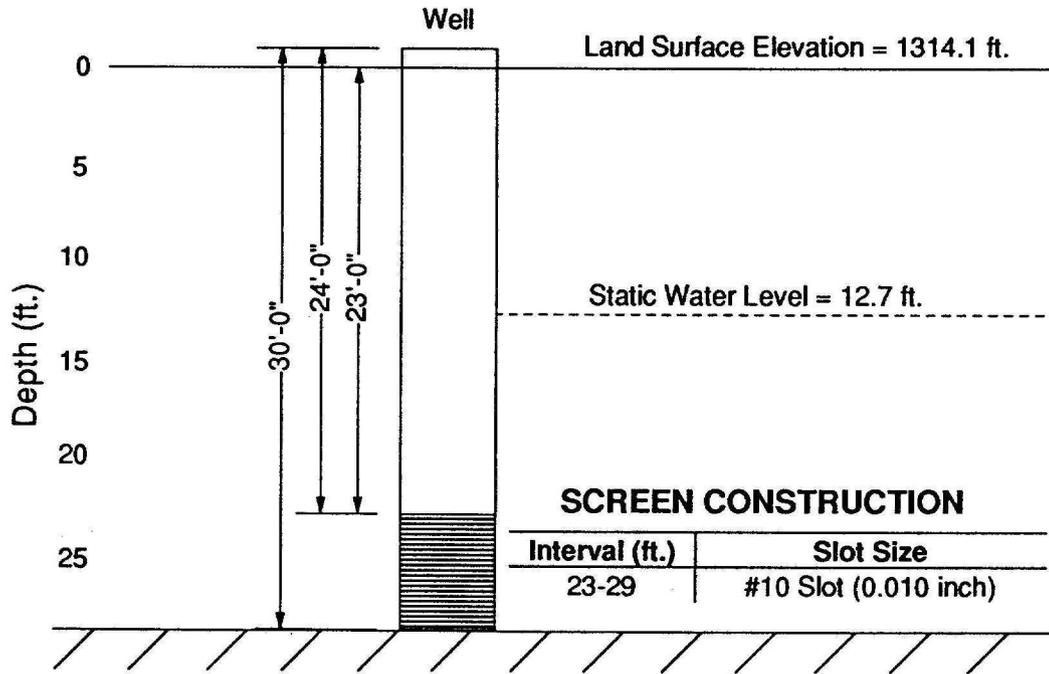
WELL NUMBER	28
USBR LINE NUMBER	16A3
USBR SITE NUMBER	10+00



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	26
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	7
		Screened Interval (ft.)	25-32

**INTERIM GROUND-WATER SUPPLY,
WEST OAKES IRRIGATION AREA**

WELL NUMBER	29
USBR LINE NUMBER	16A3
USBR SITE NUMBER	14+00



WELL DESIGN SPECIFICATIONS

Casing Type	8 - inch Diameter PVC SDR-21
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Casing Length (ft.)	24
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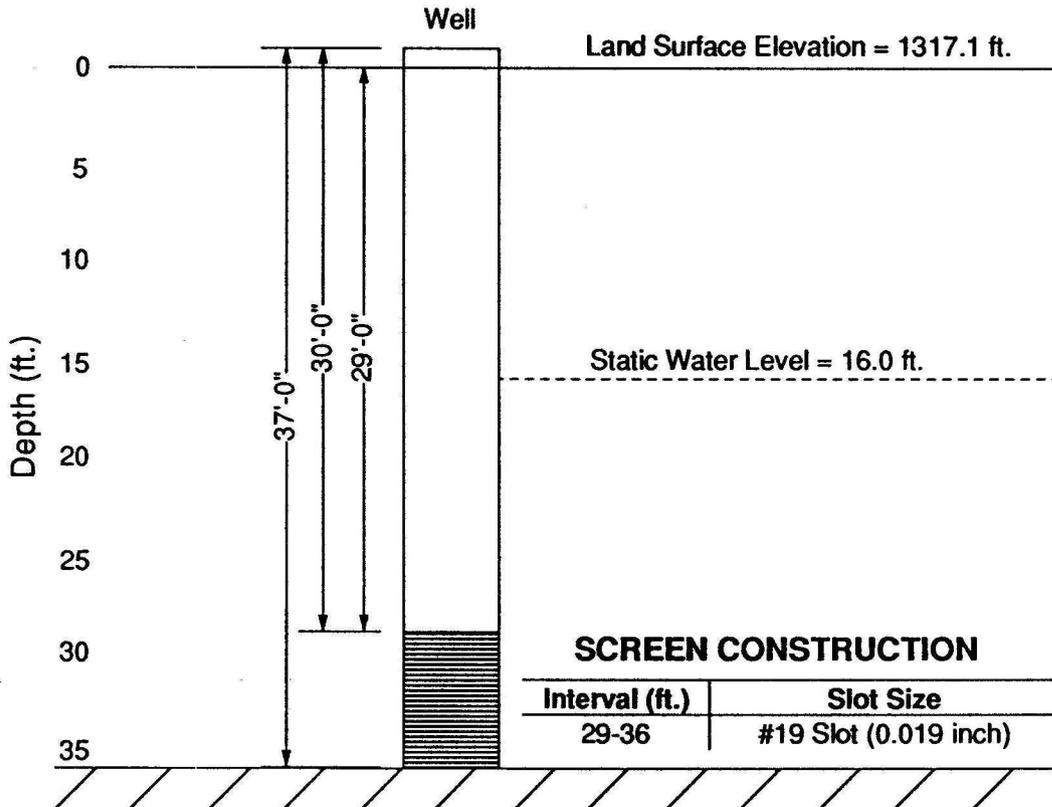
Screen Type	8 - inch Diameter Stainless Steel V - Slot
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Screen Length (ft.)	6
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Screened Interval (ft.)	23-29
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INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

WELL NUMBER	30
USBR LINE NUMBER	16A3
USBR SITE NUMBER	17+00



WELL DESIGN SPECIFICATIONS

Casing Type	8 - inch Diameter PVC SDR-21
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Screen Type	8 - inch Diameter Stainless Steel V - Slot
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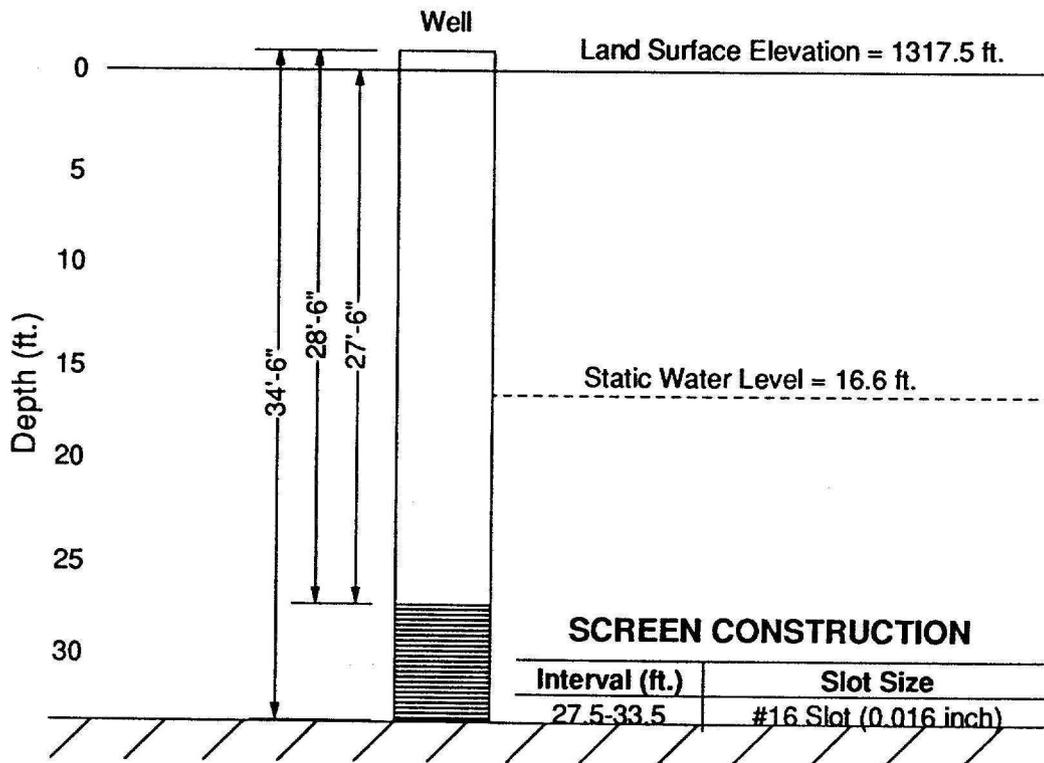
Casing Length (ft.)	30
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Screen Length (ft.)	7
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Screened Interval (ft.)	29-36
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INTERIM GROUND-WATER SUPPLY, WEST OAKES IRRIGATION AREA

WELL NUMBER	31
USBR LINE NUMBER	16A3
USBR SITE NUMBER	22+00



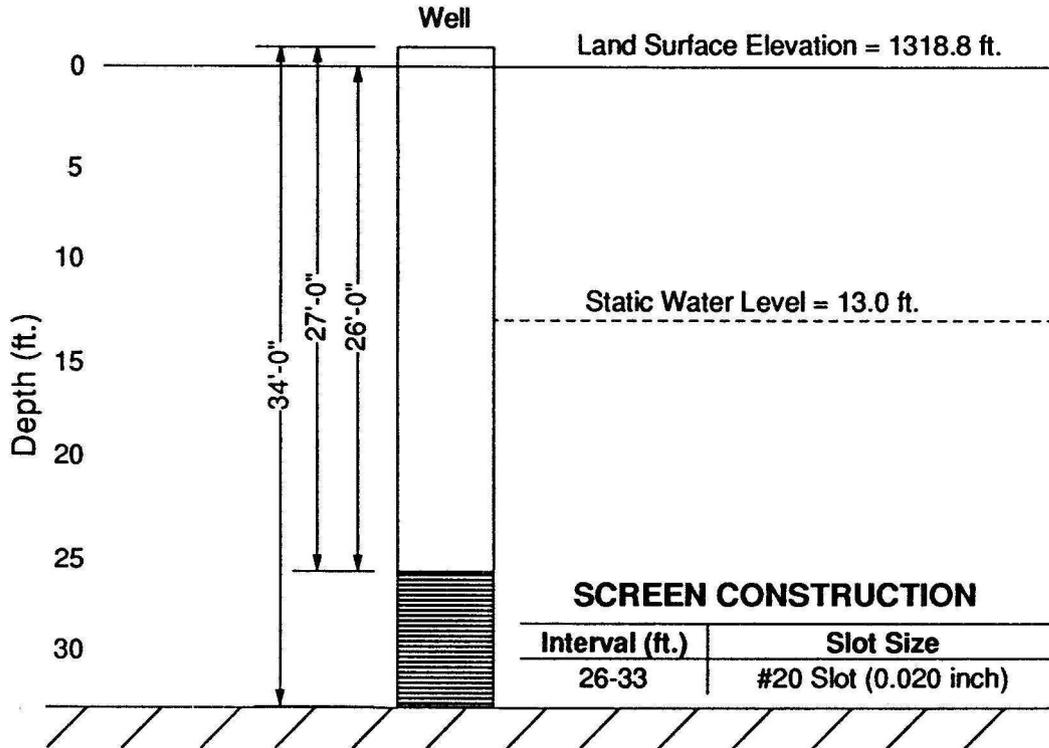
WELL DESIGN SPECIFICATIONS

Casing Type	8 - inch Diameter PVC SDR-21
Screen Type	8 - inch Diameter Stainless Steel V - Slot

Casing Length (ft.)	28.5
Screen Length (ft.)	6
Screened Interval (ft.)	27.5-33.5

**INTERIM GROUND-WATER SUPPLY,
WEST OAKES IRRIGATION AREA**

WELL NUMBER	32
USBR LINE NUMBER	16A3
USBR SITE NUMBER	25+77



WELL DESIGN SPECIFICATIONS			
Casing Type	8 - inch Diameter PVC SDR-21	Casing Length (ft.)	27
Screen Type	8 - inch Diameter Stainless Steel V - Slot	Screen Length (ft.)	7
		Screened Interval (ft.)	26-33