Contract Report 527

Sedimentation Survey of Paris West Lake, Edgar County, Illinois

by William C. Bogner
Office of Hydraulics & River Mechanics

Prepared for the
City of Paris

March 1992

Illinois State Water Survey
Hydrology Division
Champaign, Illinois

A Division of the Illinois Department of Energy and Natural Resources

Sedimentation Survey of Paris West Lake, Edgar County, Illinois

by William C. Bogner

Prepared for the
City of Paris

Illinois State Water Survey
2204 Griffith Drive
Champaign, Illinois 61820-7495

March 1992

ISSN 0733-3927

The body of this report was printed on recycled and recyclable paper

CONTENTS

SEDIMENTATION SURVEY OF PARIS WEST LAKE, EDGAR COUNTY, ILLINOIS

by William C. Bogner

INTRODUCTION

The Illinois State Water Survey, in cooperation with the city of Paris and Cochran & Wilken, Inc., Consulting Engineers, conducted a sedimentation survey of Paris West Lake in November and December 1991. The results of this survey are presented in this report and compared with those from a survey conducted by Dr. Byron Barton of Eastern Illinois University in 1954.

Reservoir Location

Paris West Lake is located in Edgar County, 1 mile north of Paris (figure 1). West Lake Dam lies at 39°38'09" north latitude and 87°41'33" west longitude in the southeast quarter of Section 25, Township 14N., Range 12W.

The dam impounds Sugar Creek, a tributary to the Wabash River. The watershed is a portion of hydrologic unit 05120111.

Water Supply History

Paris Twin Lakes provide the public water supply for the city of Paris, Illinois. The lake system (figure 1) consists of West Lake, old East Lake, and new East Lake. Design water surface elevations differ by less than 1 foot, and the new East Lake spillway elevation now is the control elevation for all three lakes. The fill of the old East Lake Dam has been breached and would no longer maintain a separate pool. Original specifications for these lakes are given in table 1.

Table 1. Paris Twin Lake Design Specifications

Lake	*Year built*	*Drainage area (square miles)*	*Reservoir capacity (acre-feet)*	*Surface area (acres)*
West Lake	1896	17.6	511	80
Old East Lake	1916	no individual data available		
East Lake	1961	20.0	1661	163

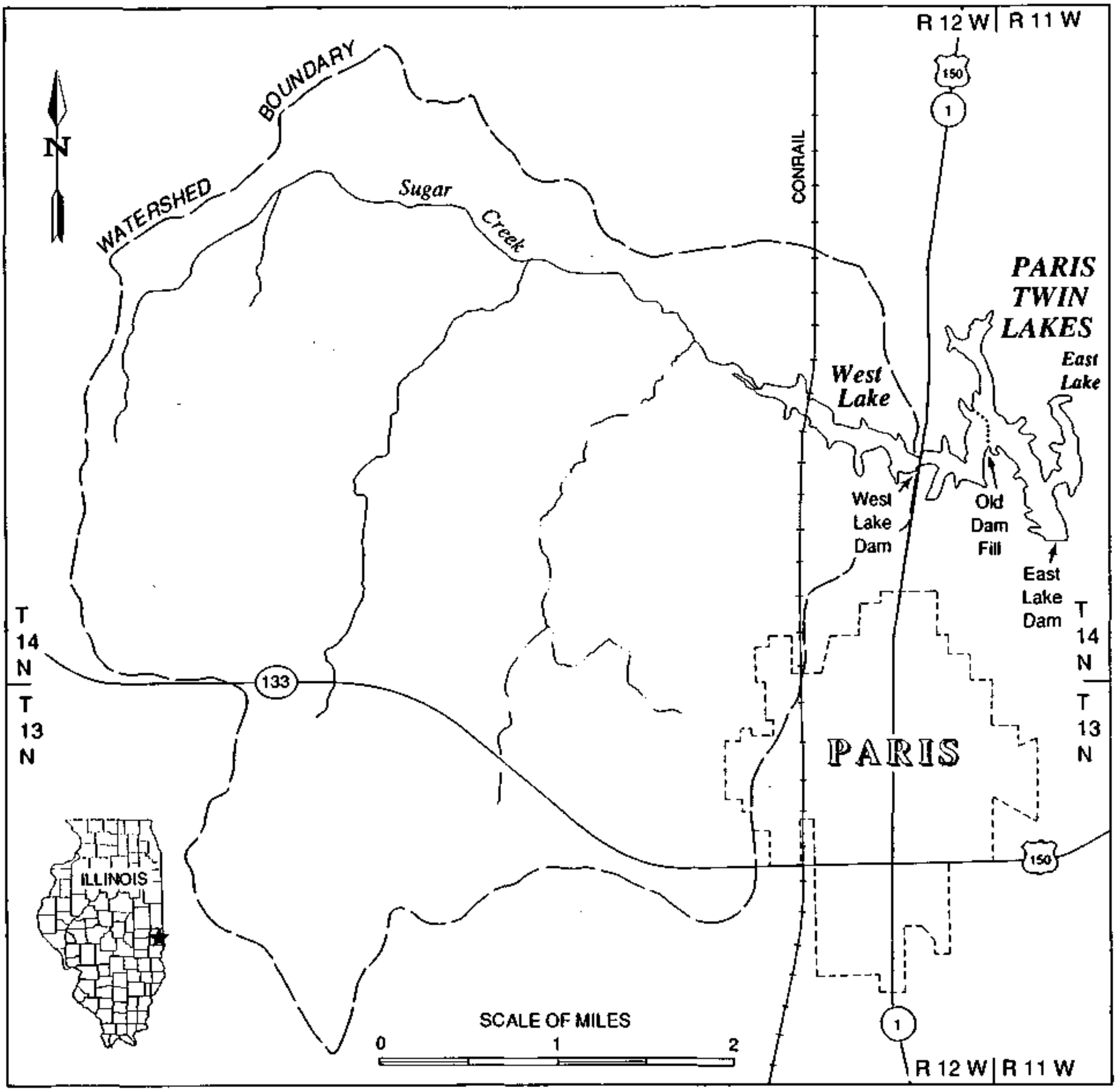


Figure 1. Location of Paris West Lake and its watershed.

Paris West Lake, the object of this study, now serves primarily as a recreational resource and sedimentation basin for the main East Lake. The present water supply intake is located immediately downstream of West Lake Dam. Thus West Lake water is no longer directly accessible for water supply use.

The first public water supply system for Paris was installed in the late 1800s. This water supply was not treated or used for drinking water until a filtration plant was built in 1923. Prior to this, private wells were the general source of drinking water.

Wells driven on the west side of town were the original source for the public water supply system. In 1896 the well supply was replaced by the construction of what is now termed West Lake. Reservoir capacity was increased in 1915-1916 by the construction of the old East Lake. In 1923 the filter plant was built to furnish filtered water for personal consumption. In 1932 steam power was replaced by electrical power for the pumps.

A drought period from 1952 to 1954 severely strained the capacity of the water supply system. Old East Lake was effectively drained and was 15 feet below spillway level. In December 1954 West Lake was also down over 5 feet. During the latter half of 1954, five wells were drilled to supplement the lake supply. These supplemental wells slowed the drawdown of the lake but were not capable of sustaining the full water supply demand.

The failure of old East Lake Dam in 1957 spurred approval for the construction of the present East Lake Dam in May 1959. East Lake was impounded in 1961. A dredging program was initiated on West Lake, with the assistance of state funding under Department of Transportation management, in late summer 1973 and continued by the city through 1979. The volume of sediment removed has been estimated at 88 acre-feet (ac-ft) or 140,000 cubic yards. This estimate is approximate due to the limited records kept for the dredging project.

Watershed

The watershed of Paris West Lake consists of the 17.6-square-mile area drained by Sugar Creek above the dam site. Average annual precipitation (1951-1980) in the area is 39.5 inches (at Paris Waterworks), and the average annual runoff (1909-1990) is 11.5 inches (Embarras River near Camargo). Average annual lake evaporation rates in the area are 32 inches per year (Roberts and Stall, 1967). The highest point in the watershed is at an elevation of 735 feet msl, and the lowest point is the lake surface at 660 feet msl.

The majority of the soils in the watershed are upland prairie soils formed in loess deposits overlying a glacial base laid down by the Wisconsin glacier. These soils are rich in organic matter and in this area are generally well drained. The area immediately surrounding the lake has upland timber soils formed from similar materials but with much lower organic content (Hopkins et al., 1917).

LAKE SEDIMENTATION SURVEYS

The 1954 survey of Paris West Lake was conducted by Dr. Byron Barton of Eastern Illinois University to determine the remaining storage during the 1950s drought. Very little data is available on this survey except vague references in Water Survey file material indicating that less than 50 million gallons of water remained in the lake at the time of the survey. Additionally, a newspaper reference indicates that Dr. Barton stated that the reservoir was 26 inches below spillway level at the time of the survey. This information was used to estimate the 1954 lake volume at 281 ac-ft.

The 1991 survey was conducted by the Water Survey in cooperation with the city of Paris and Cochran & Wilken, Inc., Consulting Engineers. For this survey, 11 transects were established as shown in figure 2. These transects were indicated by concrete posts marked with State Water Survey brass tablets embedded in the top.

Horizontal control for the 1991 survey was maintained by stretching a marked polyethylene cable stretched between range-end monuments. Vertical control was referenced to the water surface, and depth was adjusted to the West Lake spillway crest elevation. Plots of all surveyed cross sections are presented in appendix I.

Lake Basin Volumes

Calculations of the capacity of Paris West Lake were made using methods described in the *National Engineering Handbook* of the U.S. Soil Conservation Service (USDA-SCS, 1968).

The reference elevation used in all calculations was the spillway crest of West Lake Dam. This elevation is approximately 0.05 feet below the present control of the East Lake spillway.

The results of the 1991 survey are presented in table 2. Also included in table 2 are the results of the 1954 Eastern Illinois University survey as estimated from available reference materials. The volumes presented in this table represent the capacity of the lake basin below the reference spillway elevation.

The 1991 water capacity presented in table 2 is the existing volume based on the survey measurements. In tables summarizing sedimentation rates in the following sections, the sediment volume will be adjusted for the estimated 88 ac-ft of sediment removed by dredging during the 1970s. The basin capacity was reduced from 511 ac-ft in 1896 to 239 ac-ft in 1991. The 1991 basin capacity was 47% of the 1896 capacity. For water supply purposes, these volumes convert to capacities of 166 million gallons (mg) in 1896, 92 mg in 1954, and 78 mg in 1991.

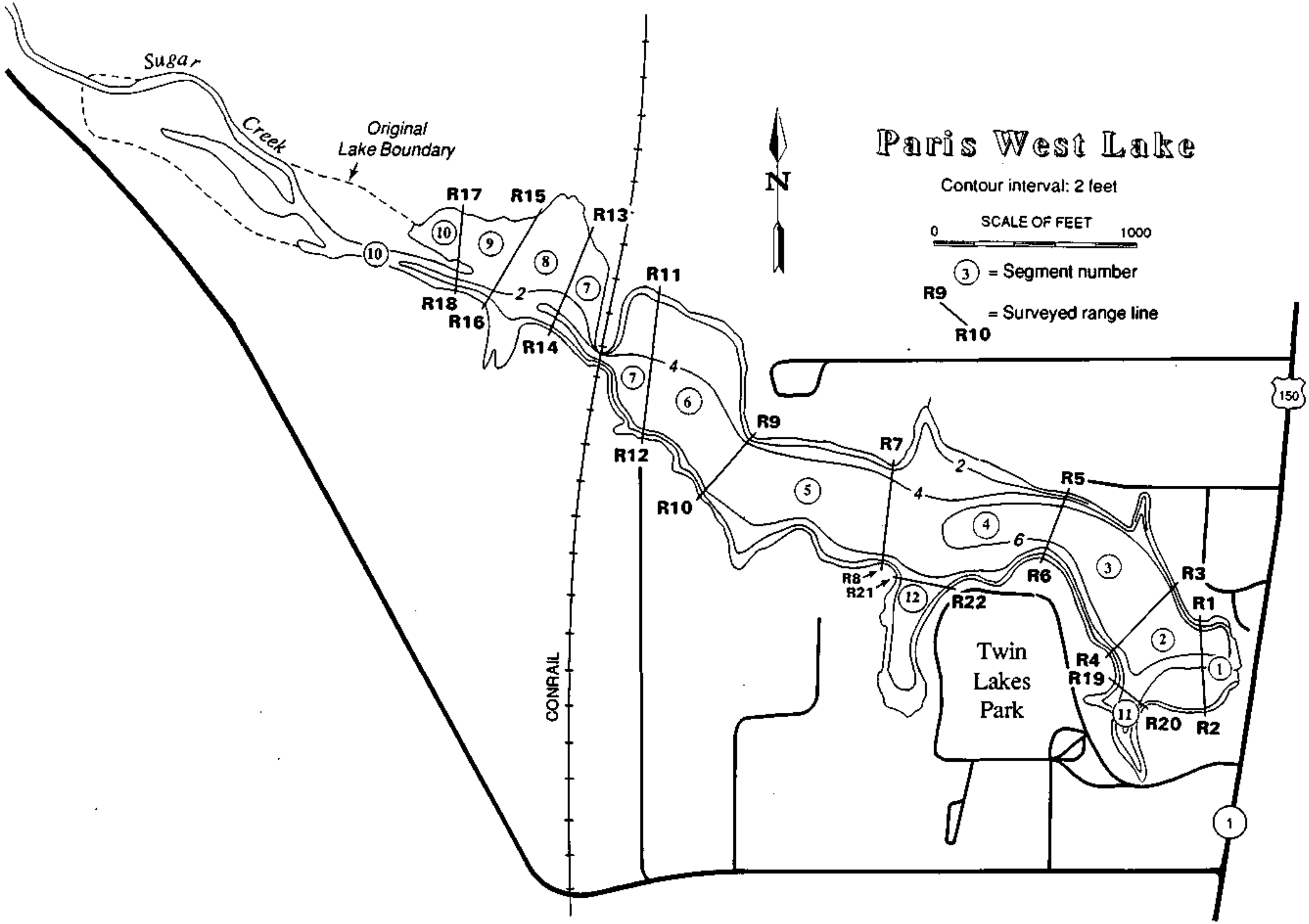


Figure 2. Paris West Lake Survey plan with 1991 bathymetry.

Table 2. Capacity of Paris West Lake and Volume of the Accumulated Sediment

Year of survey	*Intervals since last survey (years)*	*Reservoir storage capacity (ac-ft)*	*(mg)*	*Capacity per square mile of watershed (ac-ft)*	*Deposited sediment since last survey (ac-ft)*
1896		511	166	29.0	
1954	58	281	91.6	16.0	230
Dredging during 1970s				-88	
1991	37	239	77.9	13.6	130
1896-1991	95				360

Notes: Watershed area -17.6 square miles
Reservoir area - 80 acres in 1896 and 71 acres in 1991.

The 1991 water depths were used to generate the bathymetric map in figure 2 and the stage vs. capacity curve in figure 3. Figure 3 can be used to determine the remaining capacity of the reservoir for a given stage below the spillway crest. For example, with the water level drawn down 1 foot as shown in the dashed line in figure 3, the capacity of the reservoir is 160 ac-ft or 59 million gallons. With time and continued sedimentation or the implementation of a. dredging program, the relationship shown in figure 3 will become obsolete.

Dredging Program Impacts

Very little documentation exists for the planning or implementation of the dredging program. Significant difficulty was encountered in analyzing the 1991 sedimentation survey results because no post-dredging survey of the lake was conducted. The following description and evaluation of the dredging operation is summarized from the limited data available from city and Water Survey files.

The dredging operation was initiated in the summer of 1972 in two bayous adjacent to the Twin Lakes Park. Preliminary plans called for documenting the effectiveness of a dredging program under an initial state-supported program. Full authorization for continued state support and management would men be pursued.

Documentation was not maintained on the operation of the dredge or the effectiveness of the dredging. In 1975 the city purchased the dredge from the state and continued the program on its own.

Information available in 1991 indicates mat in addition to the two bayous, the full water area above and below the railroad bridge to the approximate location of transect R9-R10 was dredged to original depths. Volume of sediment removal has been estimated at 88 ac-ft by summing the 1991 sediment volumes in open water areas of segments 6-12.

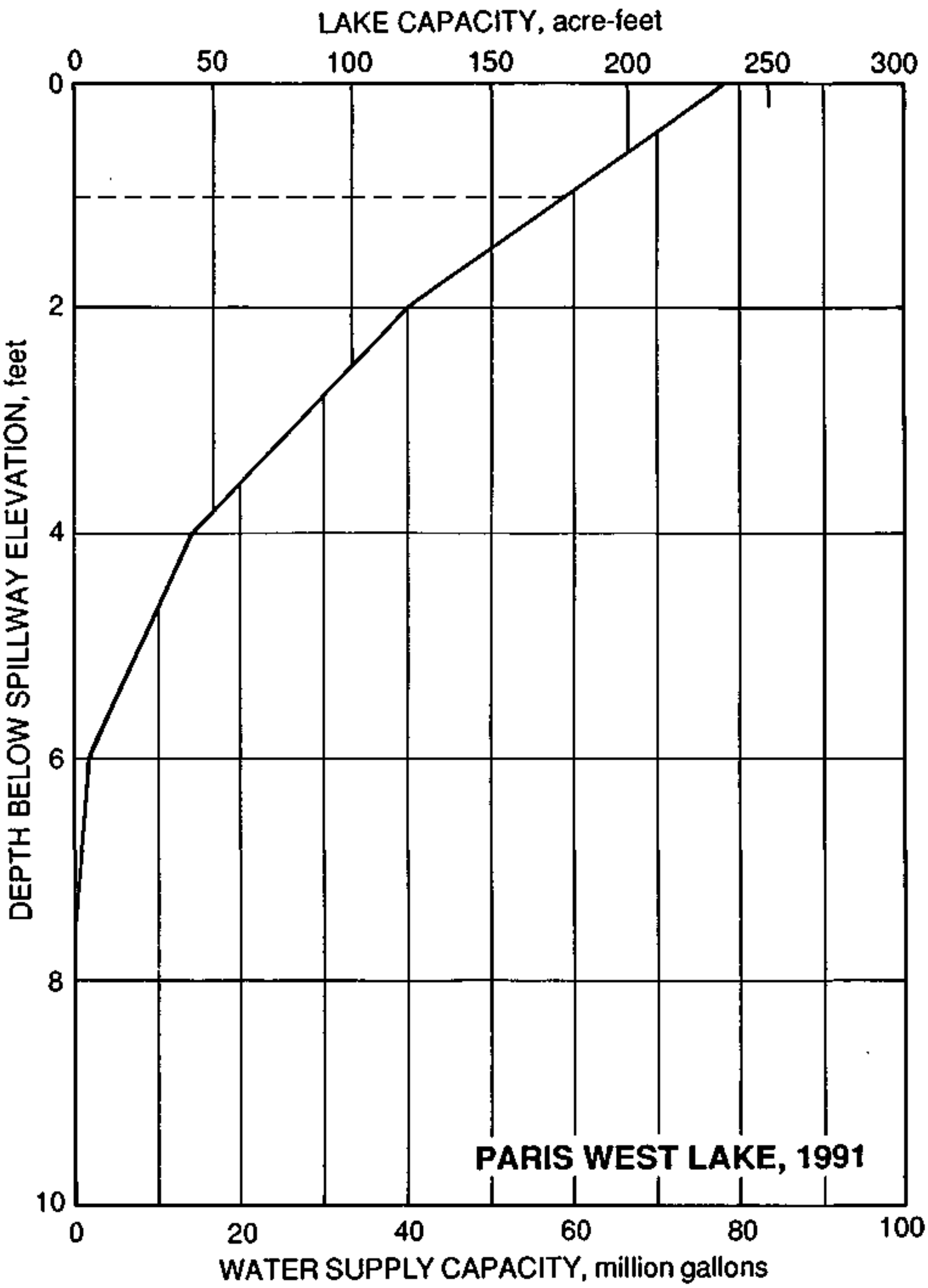


Figure 3. Stage vs. volume for Paris West Lake.

The actual dredging procedure consisted of securing a guide cable on opposite shores of the lake. Following this cable, the dredge would clear a trench 40 feet wide, the width of the lake, to a depth of 15 feet. Following the completion of each dredged trench, the guide cable was reset 40 feet off-line and the procedure was repeated.

In 1991 it was difficult to detect any effects of the dredging. New sediments have accumulated in the dredged areas to approximate pre-dredge conditions. Boating access particularly in the bayou areas does seem to be better due to more water depth.

This reaccumulation of sediment, however, should not be interpreted as a failure of the dredging program. The sediments filled the void left by the dredging instead of entering the downstream sections of West Lake and possibly East Lake.

Sedimentation Rates

This analysis of the sedimentation rates of Paris West Lake was made in terms" of delivery rates from the watershed as well as accumulation rates in the reservoir. The in-lake accumulation rates provide a means of extrapolating from past and present lake conditions to future lake conditions in order to evaluate water supply integrity. The watershed delivery rates are the link between soil erosion processes in the watershed and water supply quantity and quality impacts in the reservoir. These delivery rates show the need for continuing efforts to control soil erosion as a major factor in preventing reservoir sedimentation. Inherent in the accuracy of these sedimentation rates is the accuracy of the volumes determined for the 1954 sedimentation survey and the removal of sediment in the 1970s. The inaccuracy of the 1954 survey results would affect only the comparative analysis of periodic sedimentation rates. The inaccuracy of the dredging volume estimate, however, would affect both the comparative analysis and the long-term analysis.

The sedimentation rates for Paris West Lake and its watershed are given in table 3 for three time intervals: 1896-1954, 1954-1991, and 1896-1991. The values for 1954-1991 and 1896-1991 have been adjusted to remove the impact of dredging on the sedimentation rates.

The data in table 3 indicate that the rate of sedimentation in Paris West Lake was lower during the 1954-1991 period than during the 1896-1954 period. The 1954-1991 volumetric rate (3.5 ac-ft/year) is 92% of the 1896-1991 long-term rate (3.8 ac-ft/year).

Table 3. Annual Sediment Accumulation from the Paris West Lake Watershed

Period	*Sediment deposited (ac-ft)*	*Sediment deposited per square mile of watershed (ac-ft)*	*Sediment deposited per acre of watershed (cubic feet)*	*Sediment deposited per acre of watershed* (tons)*
1896-1954	3.9	0.22	15	
1954-1991	3.5	0.20	14	
1896-1991	3.8	0.22	15	0.28

*Average unit weight of 1991 sediments (38.0 pounds/cubic ft) has also been applied to dredged sediment volume.

The variation of the sedimentation rates between the two survey periods indicates a minor change in the sedimentation rate. Most of this variation may be explained by variables such as streamflow variability, reduced trap efficiency of the reservoir (due to reduced storage capacity), or sediment consolidation rates. This implies a fairly constant rate of sediment yield from the watershed.

Streamflow variability indicated by the U.S. Geological Survey gaging station on the Embarras River at Ste. Marie, Illinois has fluctuated considerably during the life of the lake but has averaged 11.0 inches per year for each period.

Trap efficiency of the reservoir based on a curve developed by Dendy (1974) indicates a reduction in trap efficiency as follows:

Year	*Capacity (ac-ft)*	*Trap efficiency (percent)*
1896	511	77
1954	281	66
1991	239	63

This analysis indicates that on the average 8% less sediment would have been trapped during the 1954-1991 period than the long-term average suggests. This compares closely with the reduced sedimentation rate for me 1954-1991 period.

Finally, the consolidation of the lake sediments with time affects the sedimentation rates of the lake by reducing the volume of accumulated sediments. Sediments accumulate on the bottom of the lake in a very loose, fluid mass. As these sediments are covered by continued sedimentation or are exposed to air by occasional lake drawdown, they are subject to compaction or consolidation. This process reduces the volume of the sediments while increasing the weight per unit volume. Thus the tonnage of the sediments accumulated during a period of time will not change, but the volume of these same sediments may be reduced over time by 25 to 50%. This would also be consistent with a reduced volumetric sedimentation rate over time.

The effects of reduced trap efficiency are sufficient to explain the reduced sediment accumulation rate in Paris West Lake. The effects of sediment compaction on the accumulated rates cannot be determined with available information. The compaction factor itself would indicate a slightly higher sediment input factor for the lake. Dredging of the denser sediments in the bayous and upper reaches of the lake could counteract this compaction factor.

Sediment Distribution

The distribution of sediment within Paris West Lake is shown in table 4. Figure 4 presents the 1991 average sediment thickness for the lake as well as for each segment. These thicknesses range from 1.5 to 9.2 feet for undisturbed main lake sediments. The reduced 1991 water depth in segment 1 is the result of a mound of sediments accumulated on the south end of cross section R1-R2 (figure 2). These sediments originate from treatment plant discharges and are not related to watershed conditions.

Table 4. Paris West Lake Volume

Segment number	*Volume (ac-ft)* *1896*	*1991*
1	21.8	6.8
2	55.9	23.4
3	73.4	39.8
4	100.2	51.3
5	80.0	42.3
6	57.6	34.2
7	37.3	18.8
8	26.6	8.7
9	13.0	2.9
10	27.3	1.8
11	4.5	2.7
12	13.6	6.3
Total	511	239

Sediment unit weights presented in figure 4 indicate the variation of sediment characteristics within the lake. In general, coarser sediments are expected to be deposited in the upstream portion of the lake where the entrainment velocities of the inflowing stream are reduced to the much slower velocities in the lake environment. These coarser sediments tend to be denser when settled and are subject to drying and higher compaction rates due to more frequent drawdown exposure in the shallow water environment.

As the remaining sediment load is transported through the lake, increasingly finer particle sizes and decreasing unit weight are observed. These general trends in unit weight can

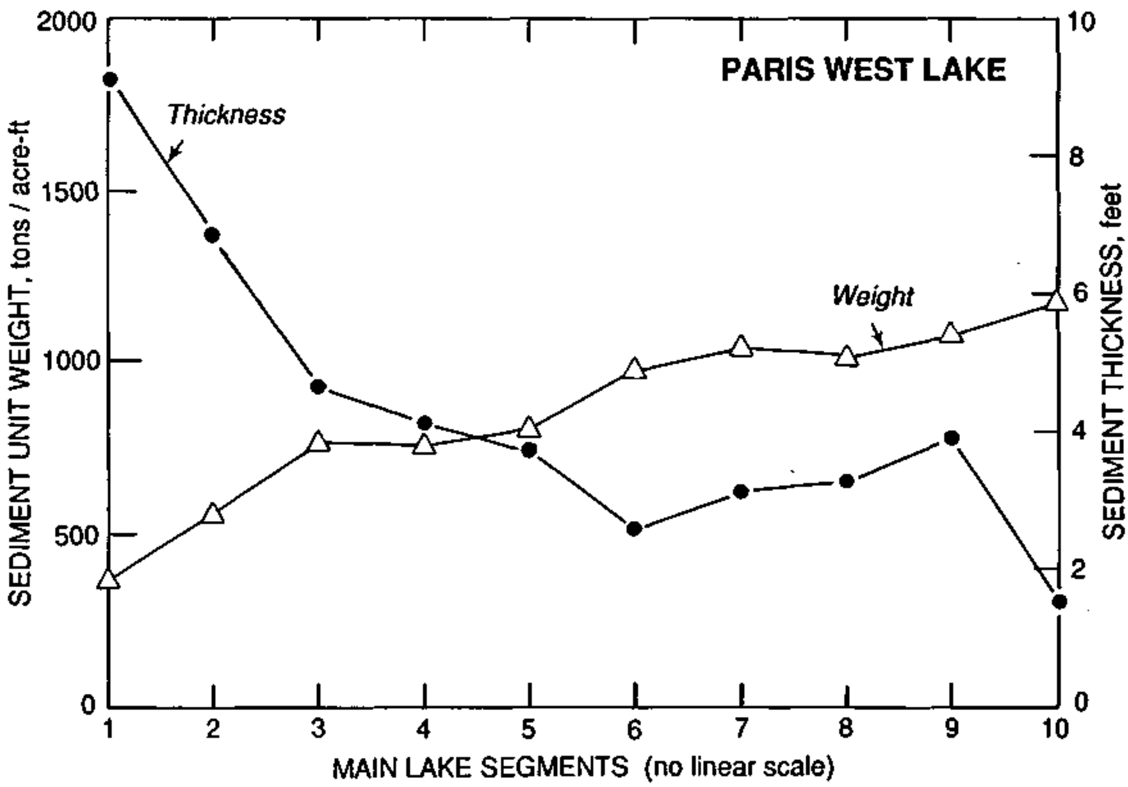


Figure 4. Sediment distribution in Paris West Lake.

be observed in figure 4 where segmented unit weights increase progressively from the dam to the upper end of the lake.

Sediment Grain Size Distribution

A total of 25 lakebed sediment samples were collected for grain size distribution analysis. Field examination of these samples indicated little or no apparent sand size material in the sample set. This would be consistent with general observations concerning sediment distribution in Illinois lakes (Fitzpatrick et al., 1987; Bogner 1986). These and other sources indicate that occurrences of sand exceeding 10 percent are unusual for samples collected from lake sediments.

Fifteen of the samples collected were selected for laboratory analysis. Initial laboratory analysis of Paris West Lake sediments are presented in appendix II. These analyses were made following American Society for Testing and Materials standard D422. These results show high percentages of coarse material which upon final sieving of the sample appeared to be fine organic fibers (decayed wood and leaf).

A second set of sample analyses was made on a selection of samples with an added step of heating the samples to 500°C to burn off organic materials. The results of this set of analyses are presented in appendix HI. With one exception, the results of this analysis are nearly identical to the initial analysis presented in appendix II. These results, however, are not consistent with field observations. Results of the grain size distribution sampling were inconclusive due to the high organic content of the sediments.

EVALUATION AND RECOMMENDATIONS

Paris West Lake remains an important component of the city's recreational and water supply systems. While no water supply intakes are presently installed in the lake, emergency connections could be made if needed to utilize the stored water.

The sedimentation rate of the lake is relatively high at 0.74% per year, but the watershed has a relatively low sediment yield for its size. Table 5 presents comparative data for some other lakes in Illinois. This comparison indicates that watershed sediment yields have been maintained at very reasonable levels due to beneficial watershed geometry.

Table 5. Comparison of Paris West Lake to Other Illinois Lakes

Lake	*County*	*Capacity drainage area ratio (ac-ft/sqmi)*	*Annual rate of volume loss (percent)*	*Annual watershed sediment yield (tons/acre)*
Paris West Lake	Edgar	13.6	0.74	0.28
Lake Springfield	Sangamon	197	0.26	0.79
Lake Decatur	Macon	20.3	0.58	0.27
Lake Pittsfield	Pike	249	0.90	5.6
Pinckneyville City Lake	Perry	382	0.44	3.0
Dawson Lake	McLean	328	0.40	2.7
Lake Carlinville	Macoupin	65	0.73	1.2
Lake of the Woods	Champaign	225	0.42	1.5

Note: Information from Allgire and Bogner (1990), Bogner (1981, 1986, 1987), Fitzpatrick (1987), Fitzpatrick et al. (1985, 1987)

West Lake's most valuable water supply function is in its capacity as a sedimentation basin for East Lake. Approximately 88% of the water and sediment inflows to the Twin Lakes system enter through West Lake. The trap efficiencies presented in this report indicate the effectiveness of West Lake in reducing sediment inputs to East Lake.

The sediment trapping efficiency of West Lake might be augmented by physical modification of the lake including dredging, restricting flow through the area above the railroad bridge, and establishing thicker wetland-type vegetation to enhance sediment filtering.

Another area of concern, which is presently being corrected, is the rerouting of filter backwash water from the filter plant. Direct return of this backwash water to the lake has established a mass of fine sediments along the south shore of the lake by the treatment plant. In addition to reducing storage capacity, these sediments may have negative impacts on water quality at the raw water intakes immediately downstream of the dam. Consideration should be given to the potential benefits of removing these sediments.

The flocculent nature of these sediments suggests that they might be removed with minimal effort. The major benefits would be in the reduction in future water treatment costs.

SUMMARY

The Illinois State Water Survey has conducted a sedimentation survey of Paris West Lake. West Lake and East Lake combined are know as Paris Twin Lakes. Originally constructed in 1896 as the principal source of water for the Paris public water supply, West Lake serves as a recreational resource as well as a sedimentation basin protecting East Lake. Sedimentation has reduced lake capacity from 511 ac-ft (166 million gallons) in 1896 to 239 ac-ft (77.9 million gallons) in 1991. This reduced capacity has also reduced the trap efficiency of

the lake from 77% in 1896 to 63% in 1991. The sediment accumulation rates in the reservoir averaged 3.8 ac-ft per year over the period 1896-1991. Analysis suggests that this rate has been lower since the mid-1950s than it was in the first half of the century.

The high sedimentation rate of the reservoir results primarily from a low capacity to watershed ratio. Under these conditions, watershed treatment is likely to have a low rate of return in comparison to in-lake rehabilitation programs.

ACKNOWLEDGMENTS

This project was conducted by the author as part of his regular duties at the Illinois State Water Survey under the administrative guidance of Richard G. Semonin, Chief; Misganaw Demissie, Director of the Office of Sediment and Wetland Studies; and Nani G. Bhowmik, Director of the Office of Hydraulics and River Mechanics. Jim Slowikowski and Ed Delisio assisted with field data collection and monumentation. Peter Berrini of Cochran & Wilken, Inc. was project director and Rick Craig coordinated assistance from the city of Paris

Illustrations were prepared by John Brother. Eva Kingston edited the report, and Kathleen J. Brown prepared the camera-ready copy.

REFERENCES

Allgire, R.L., and W.C. Bogner. 1990. *Sedimentation Survey of Pinckneyville City Lake, Perry County, Illinois.* Illinois State Water Survey Contract Report 502.

Bogner, W.C. 1981. *Sedimentation Survey of the Lake of the Woods, Mahomet, Illinois.* Illinois State Water Survey Contract Report 281.

Bogner, W.C. 1986. *Sedimentation Survey of Lake Pittsfleld, Pike County, Illinois.* Illinois State Water Survey Contract Report 401.

Bogner, W.C. 1987. *Sedimentation Survey of Lake Carlinville, Macoupin County, Illinois.* Illinois State Water Survey Contract Report 427.

' Dendy, F.E. 1974. *Sediment Trap Efficiency of Small Reservoirs.* Transactions of the American Society of Agricultural Engineers (Vol. 15, No. 5, pp. 898-901).

Fitzpatrick, W.P. 1987. *Sedimentation Survey of Dawson Lake, Moraine View State Park, McLean County, Illinois.* Illinois State Water Survey Contract Report 413.

Fitzpatrick, W.P., W.C. Bogner, and N.G. Bhowmik. 1985. *Sedimentation Investigation of Lake Springfield, Springfield, Illinois.* Illinois State Water Survey Contract Report 363.

Fitzpatrick, W.P., W.C. Bogner, and N.G. Bhowmik. 1987. *Sedimentation and Hydrologic Processes in Lake Decatur and Its Watershed.* Illinois State Water Survey Report of Investigation 107.

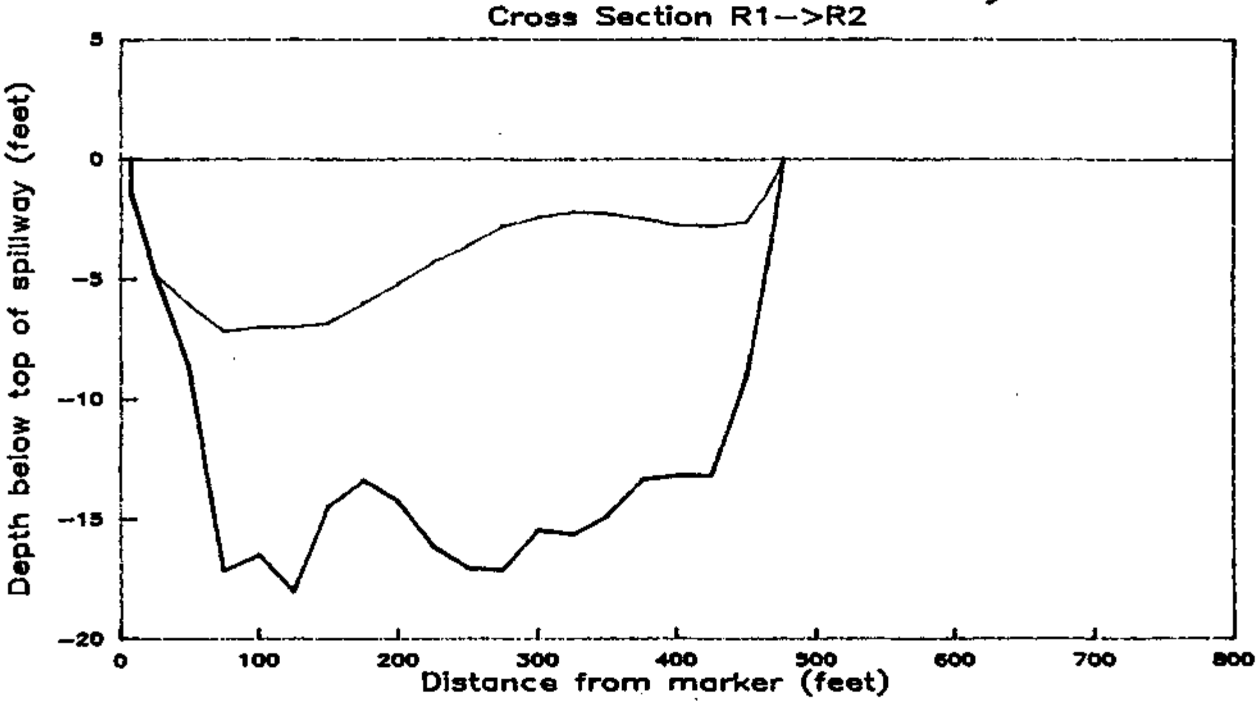
Hopkins, C.G., J.G. Mosier, E. Van Alstine, and F.W. Garrett. 1917. *Edgar County Soils*. University of Illinois Agricultural Experiment Station Soil Report No. 15.

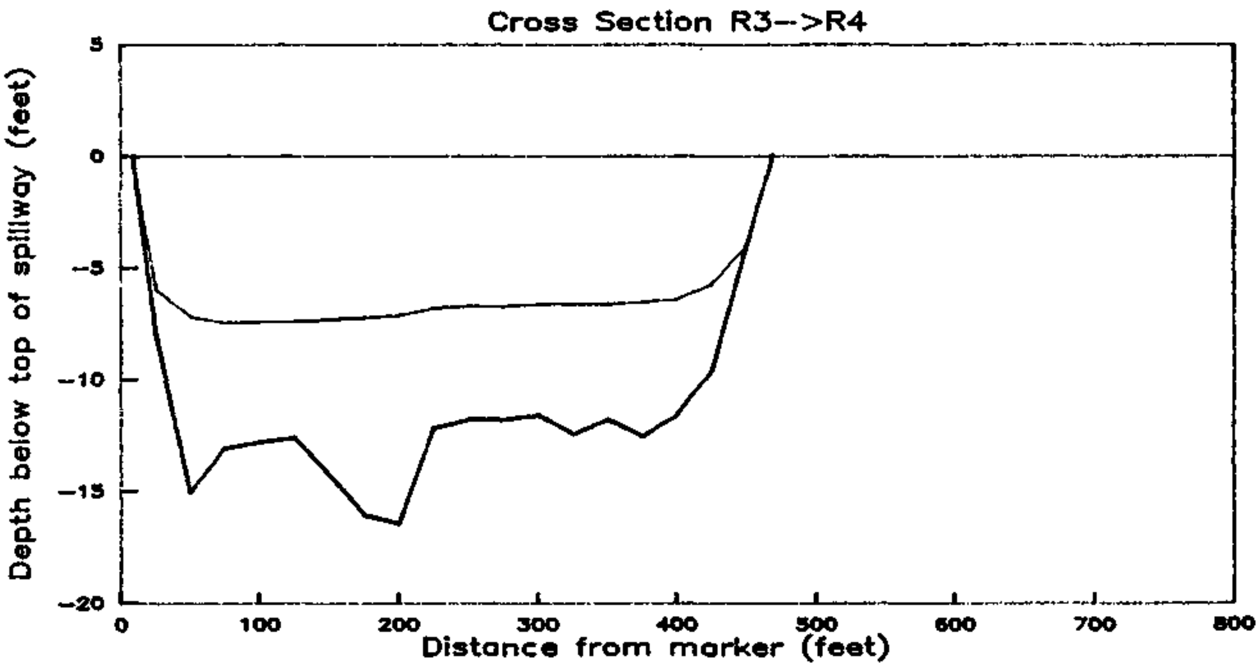
Roberts, W.J., and J.B. Stall. 1967. *Lake Evaporation in Illinois*. Illinois State Water Survey Report of Investigation 57.

USDA-SCS. 1968. *National Engineering Handbook*, Section 3, Sedimentation, Chapters 1, 2, and 7.

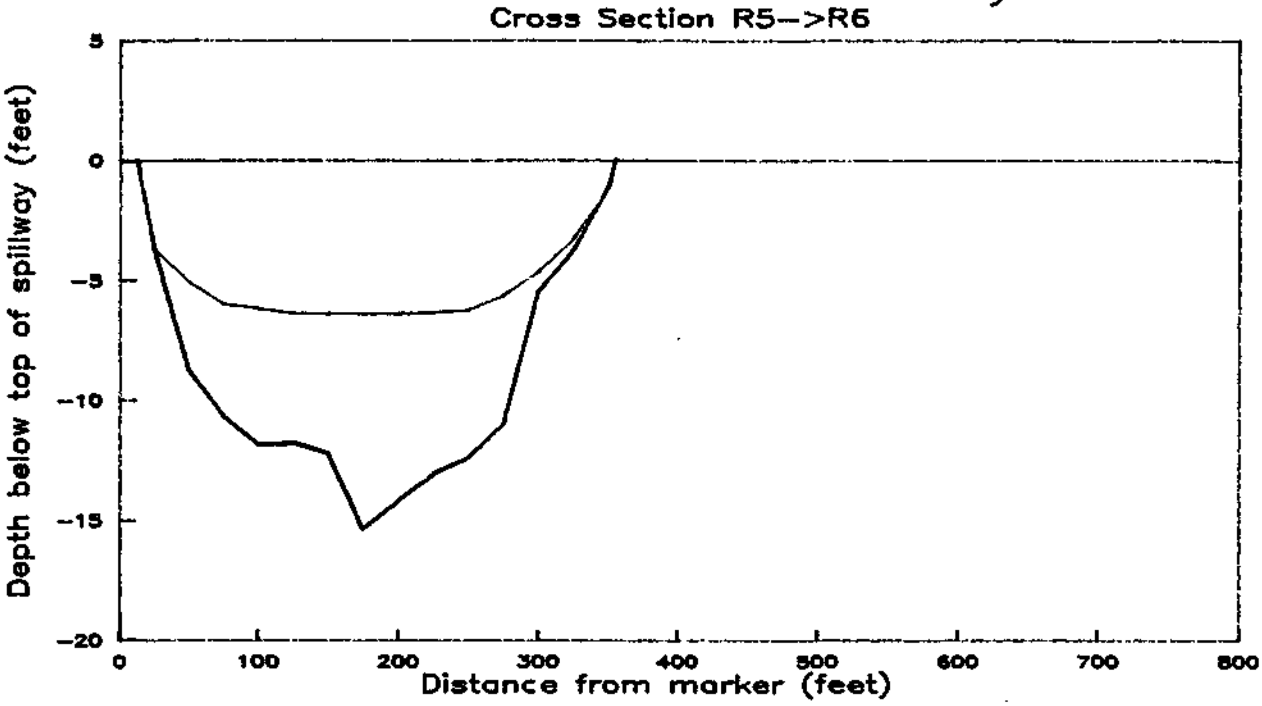
APPENDIX I. SURVEYED CROSS-SECTIONAL PLOTS FOR PARIS WEST LAKE

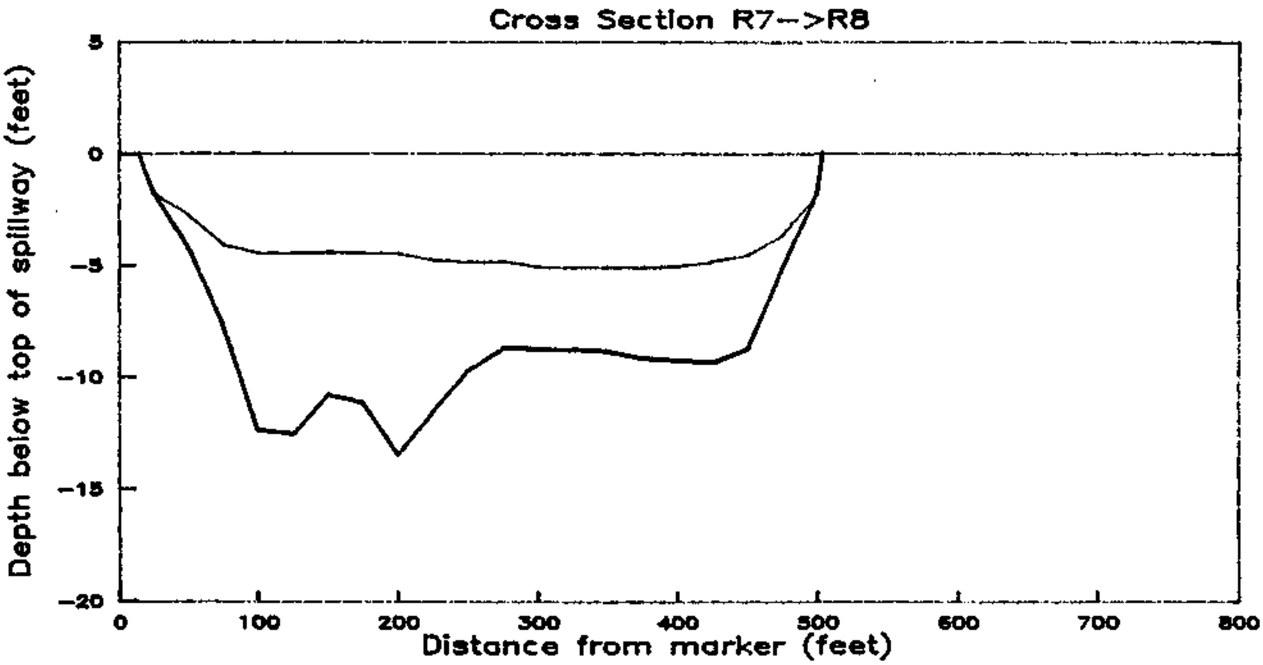
Paris Lake Sedimentation Survey 1991

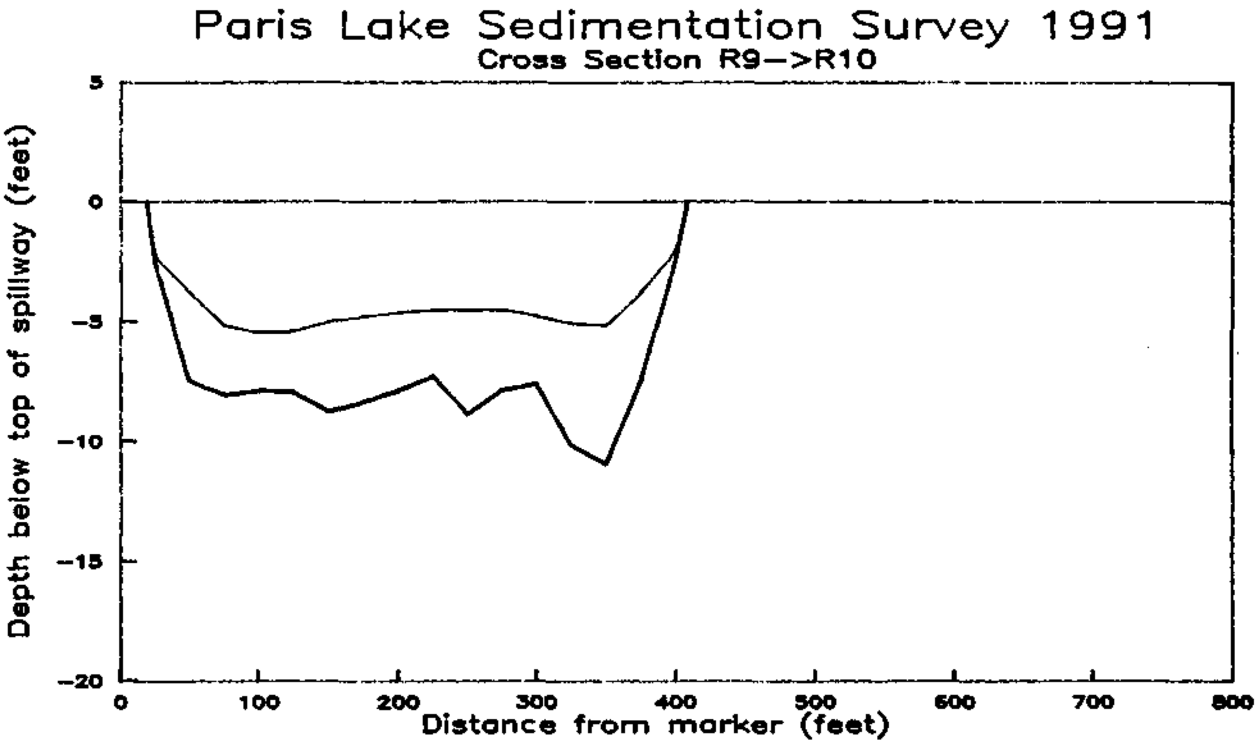




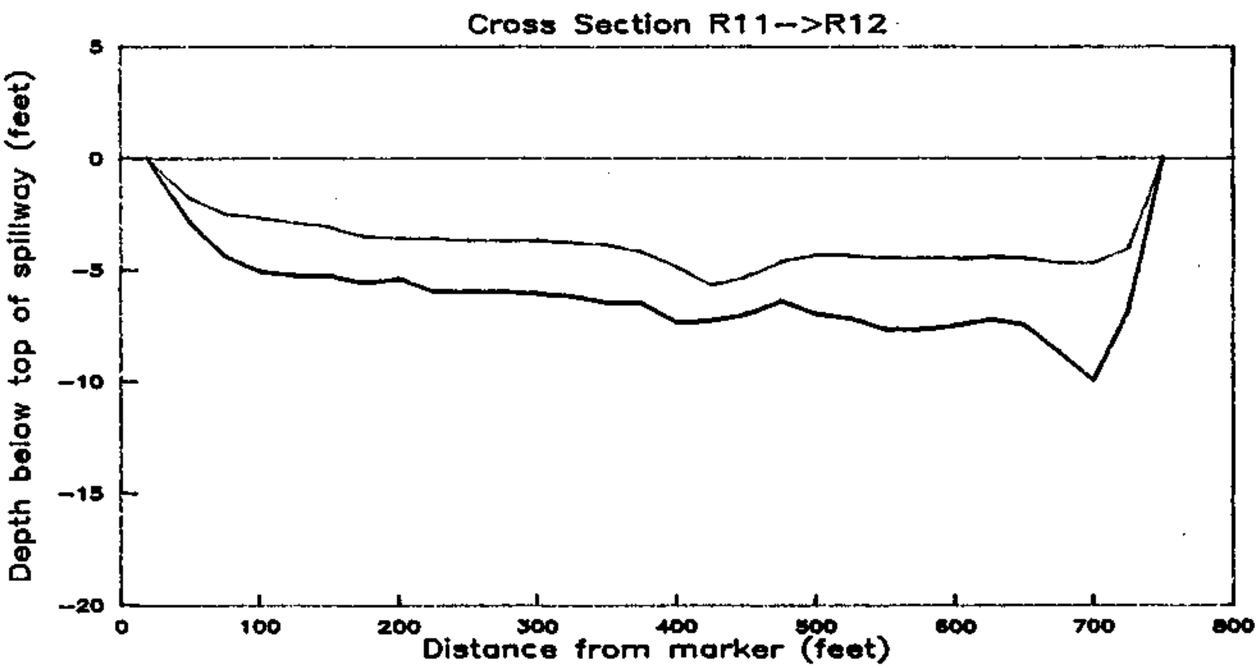
Paris Lake Sedimentation Survey 1991





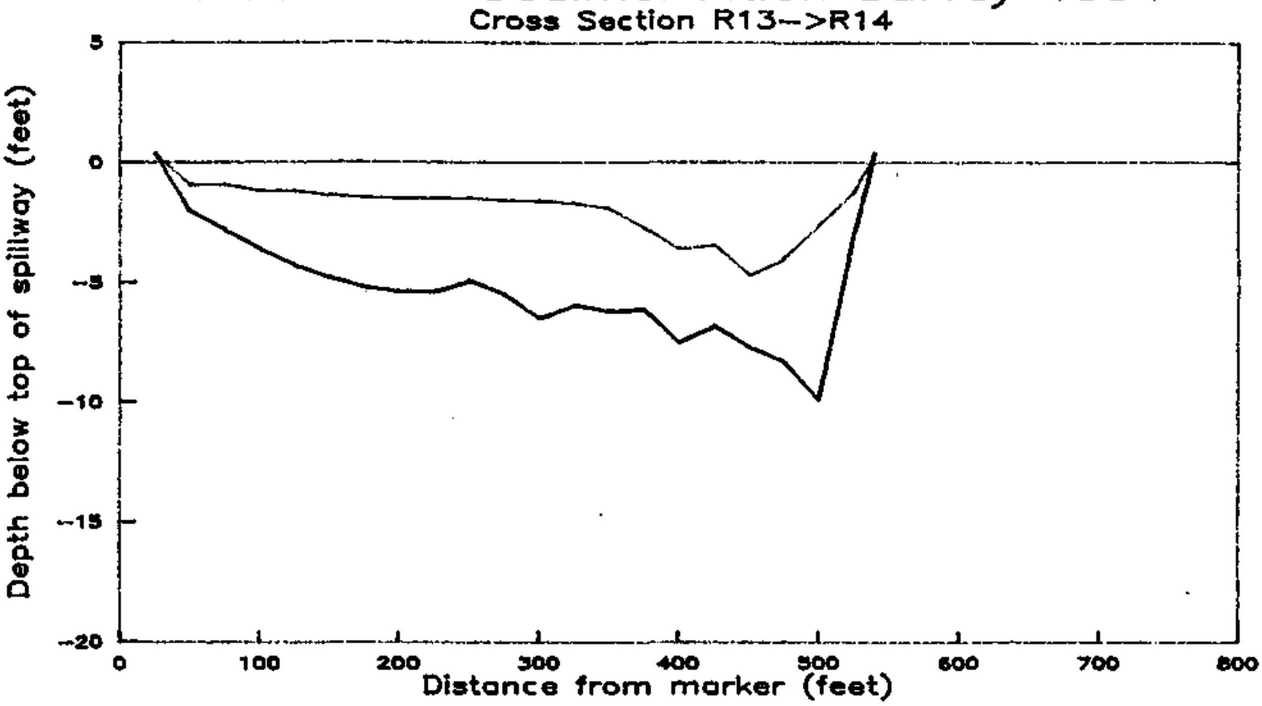


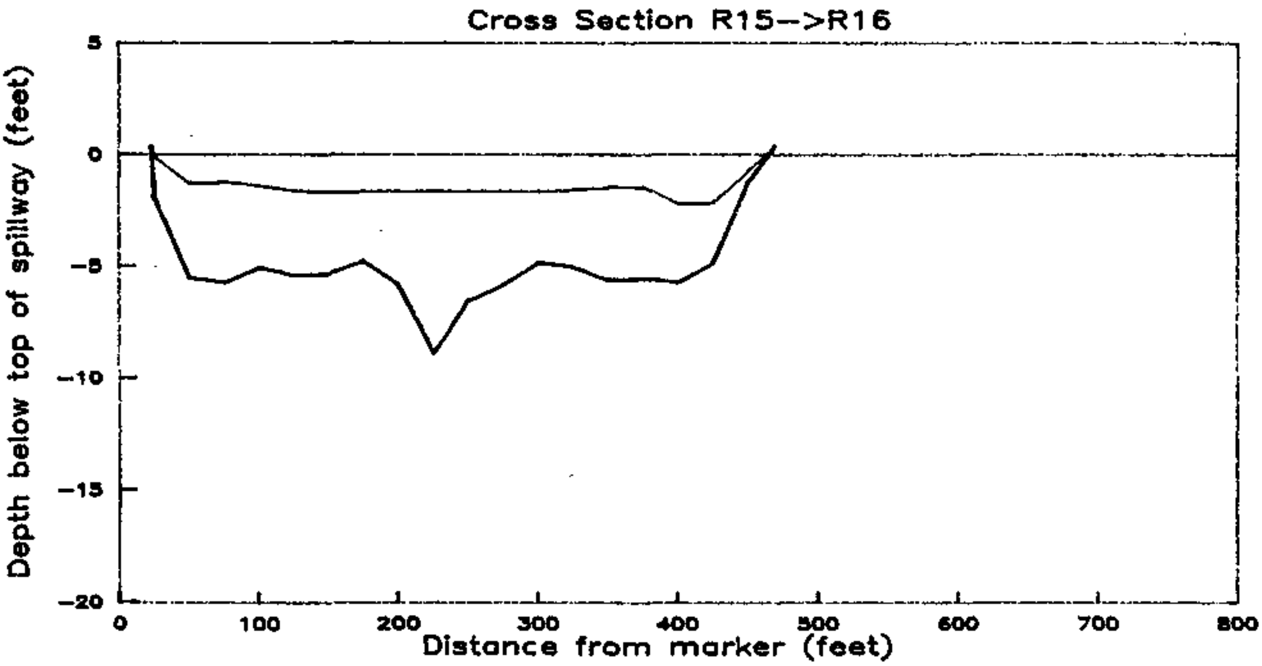
Paris Lake Sedimentation Survey 1991
Cross Section R9—>R10
Depth below top of spillway (feet)
5
0
-5
-10
-15
-20
0
100
200
300
400
500
600
700
800
Distance from marker (feet)



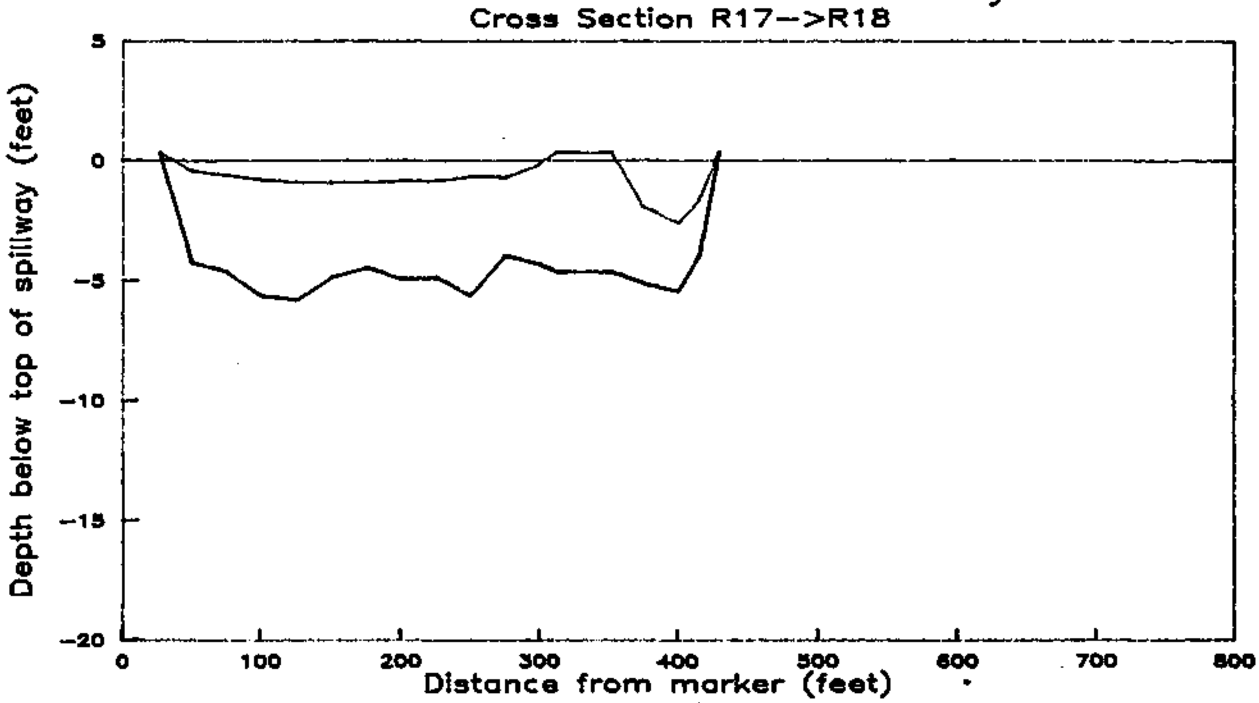
Cross Section R11—>R12
Depth below top of spillway (feet)
5
0
-5
-10
-15
-20
0
100
200
300
400
500
600
700
800
Distance from marker (feet)

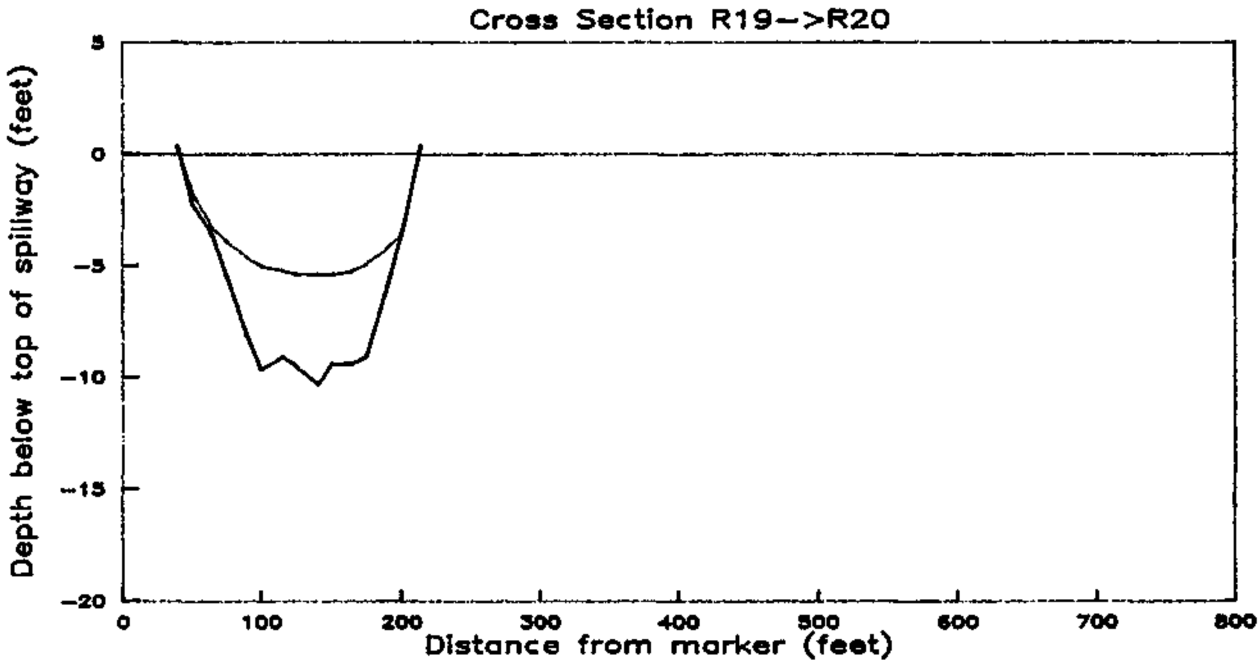
Paris Lake Sedimentation Survey 1991

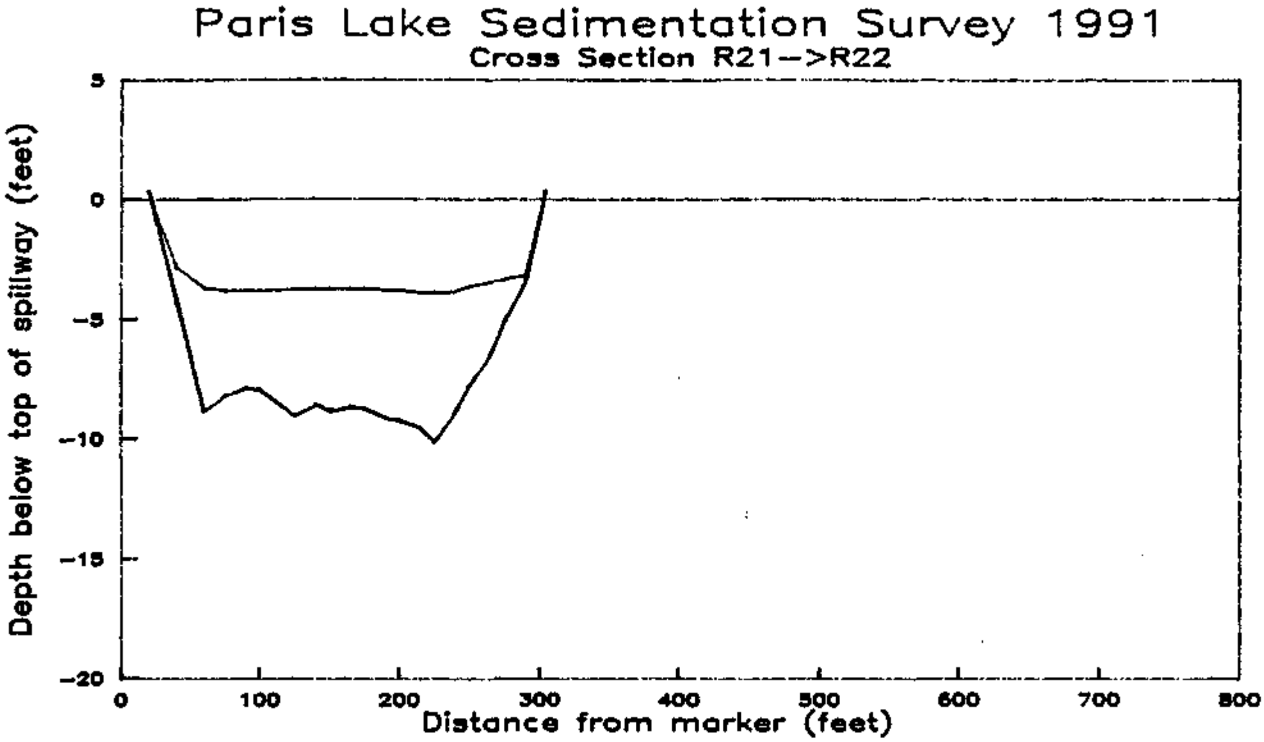




Paris Lake Sedimentation Survey 1991







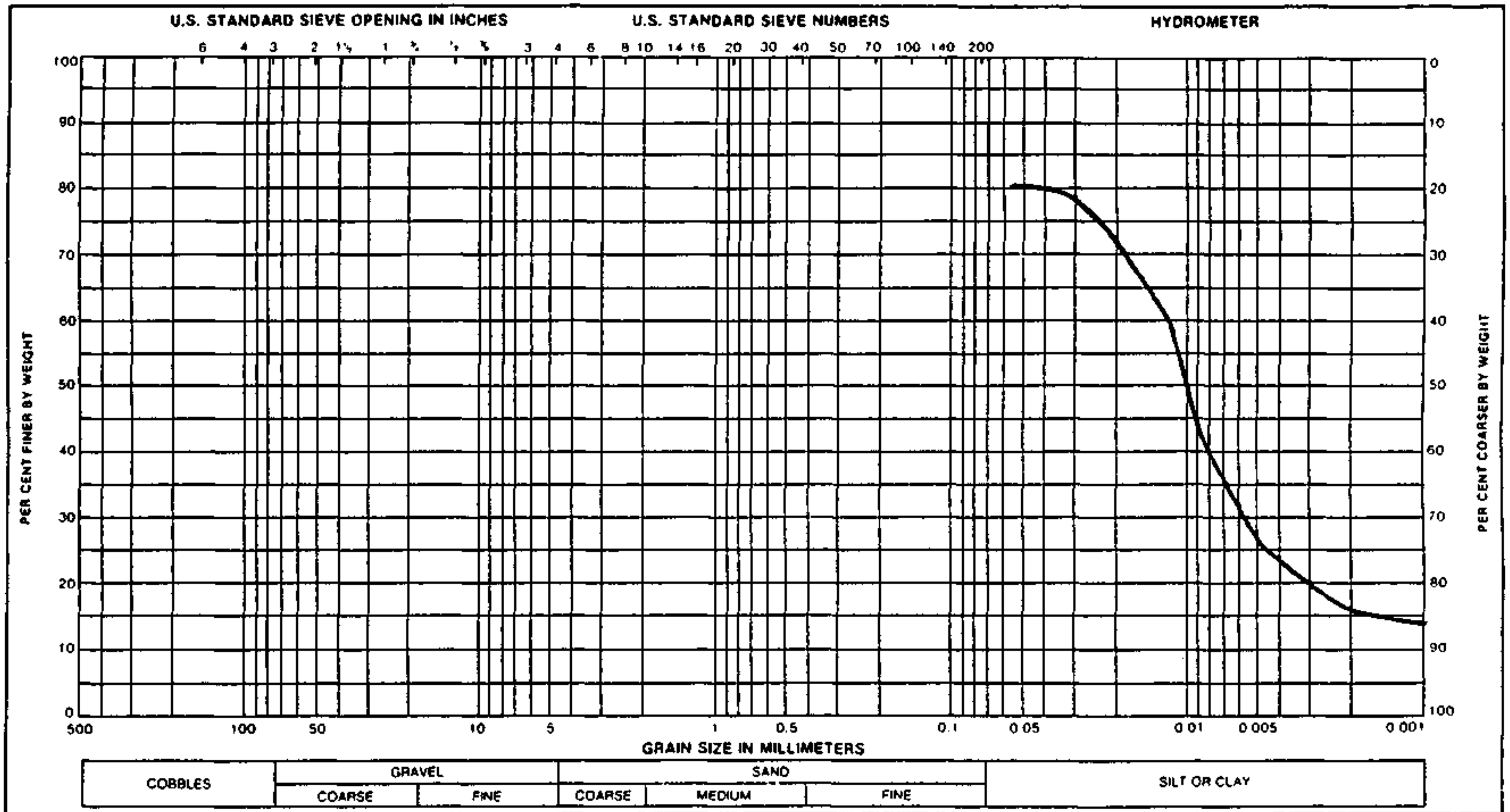
Paris Lake Sedimentation Survey 1991
Cross Section R21->R22
Depth below top of spillway (feet)
5
0
-5
-10
-15
-20
0
100
200
300
400
500
600
700
800
Distance from marker (feet)

APPENDIX II. GRAIN-SIZE DISTRIBUTIONS
(No organic removal)

Sample locations:

1 - R17 - R18, mdpt, surface	
3 - R15 - R16, mdpt, surface	
5 - R15 - R16, mdpt, core	2.1 - 2.3 feet below surface
6 - R13 - R14, mdpt, surface	
8 - R11 - R12, N 1/3 pt, surface	
9 - R11 - R12, N 1/3 pt, core	1.7 -1.8 feet below surface
10 - R1l - R12, S 1/3 pt, surface	
13 - R9 - R10, mdpt, surface	
15 - R5 - R8, mdpt, surface	
17 - R5 - R6, mdpt, surface	
19 - R3 - R4, N 1/3 pt, surface	
21 - R3 - R4, S 1/3 pt, surface	
22 - R3 - R4, S 1/3 pt, core	1.6-1.8 feet below surface
23 - R1 - R2, N 1/3 pt, surface	
24 - Rl - R2, N 1/3 pt, core	1.9-2.1 feet below surface

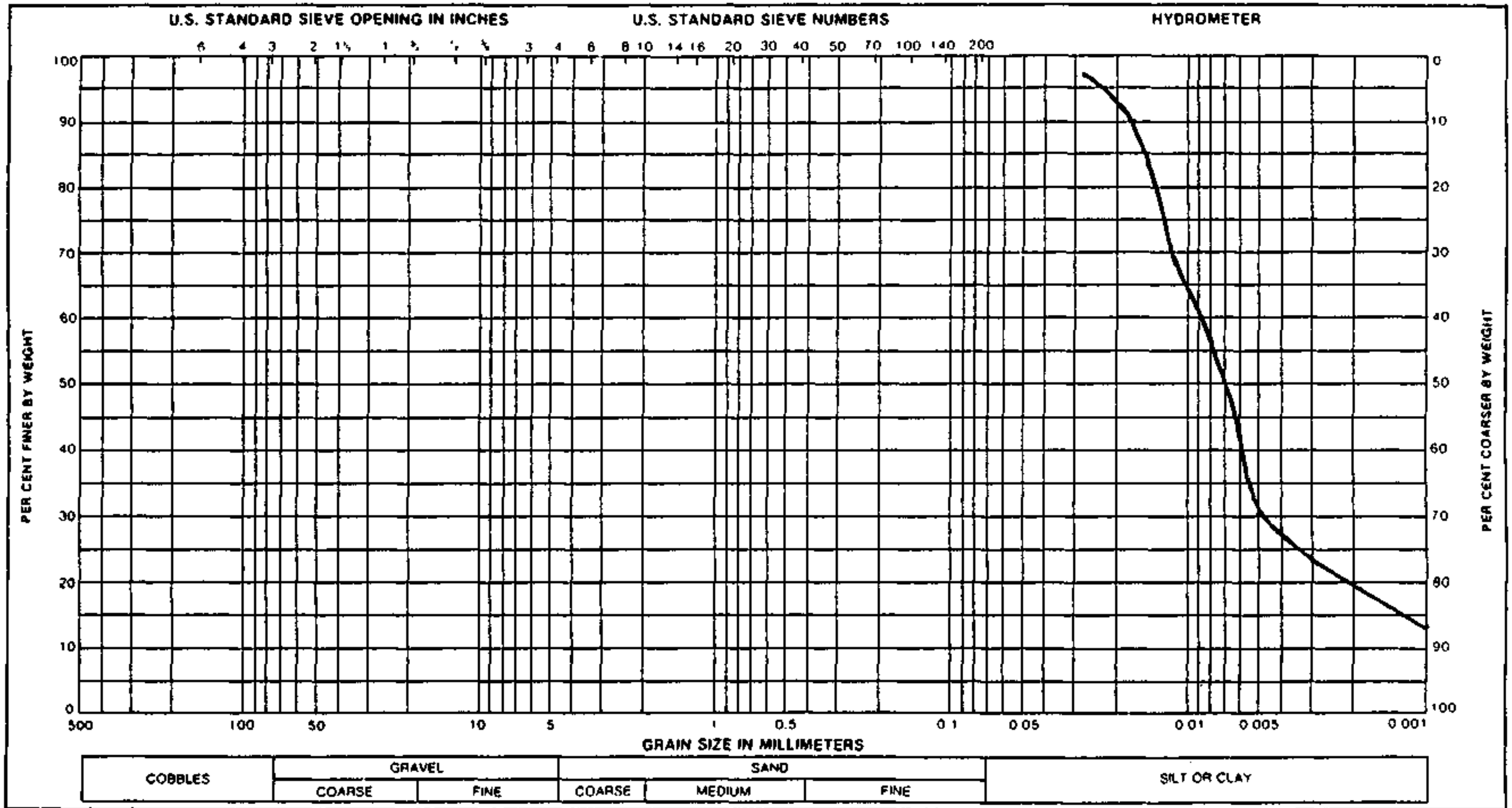
Notes: mdpt = at the midpoint of the transect
N 1/3 pt = at the north 1/3 point of the transect
S 1/3 pt = at the south 1/3 point of the transect



Boring No.	Sample No.	Elev. or Depth		Nat w %	LL	PL	PI	Project
–	PS-1	–	*Retained on #200 = 4.6g	–	–	–	–	Paris-West Lake
								February 19, 1992

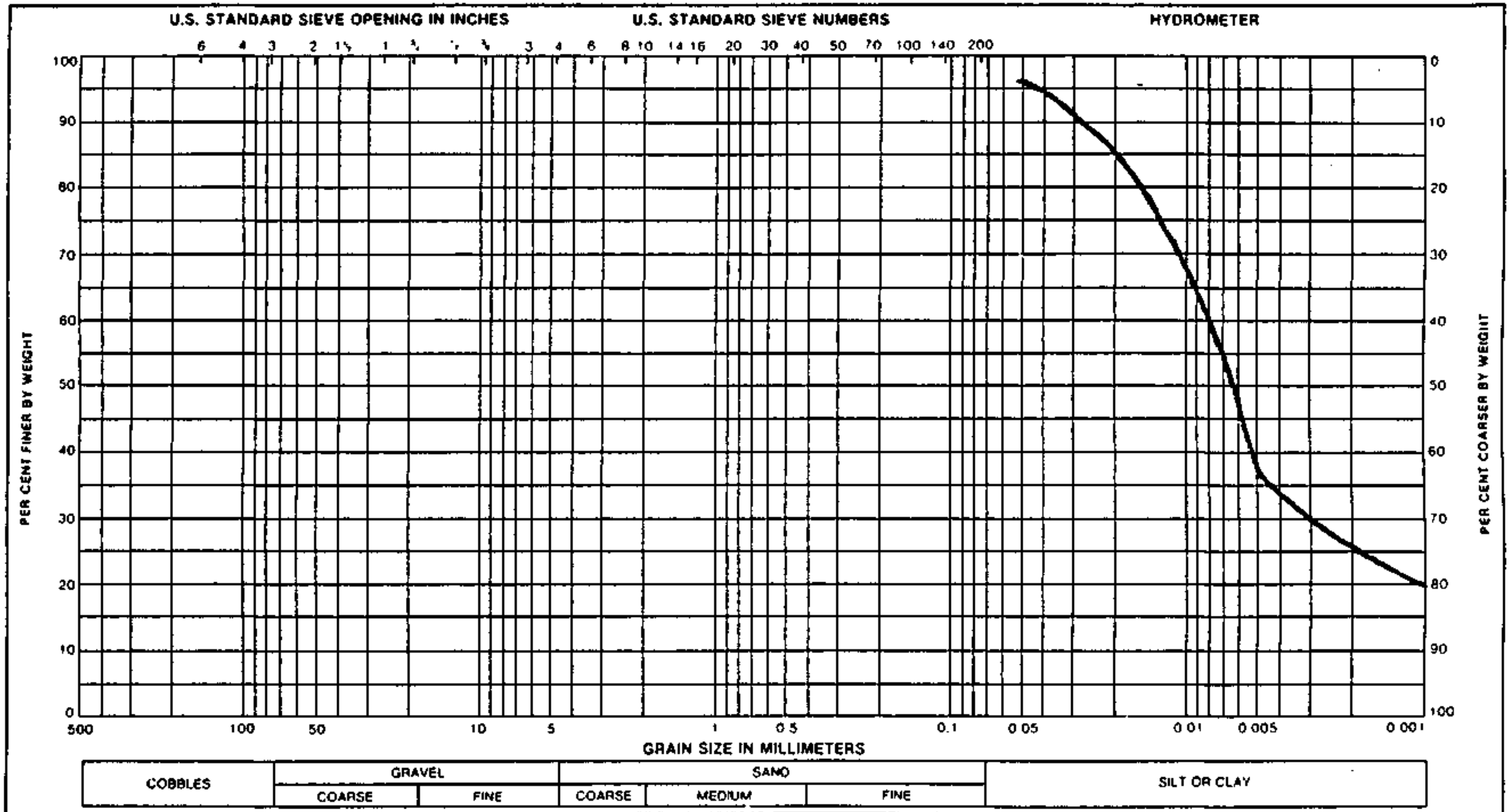
REPORT OF SOIL ANALYSIS — File No. 001-20007

*- weight of material (taken from a 50 gram sample) retained on //200 sieve. Includes organic material.



Boring No.	Sample No.	Elev. or Depth		Nat w %	LL	PL	PI	Project
-	PS-3	-	*Retained on #200 = 0.3g	-	-	-	-	Paris-West Lake
								February 19, 1992
REPORT OF SOIL ANALYSIS								File No. 001-20007

*- weight of material (taken from a 50 gram sample) retained on #200 sieve. Includes organic material.

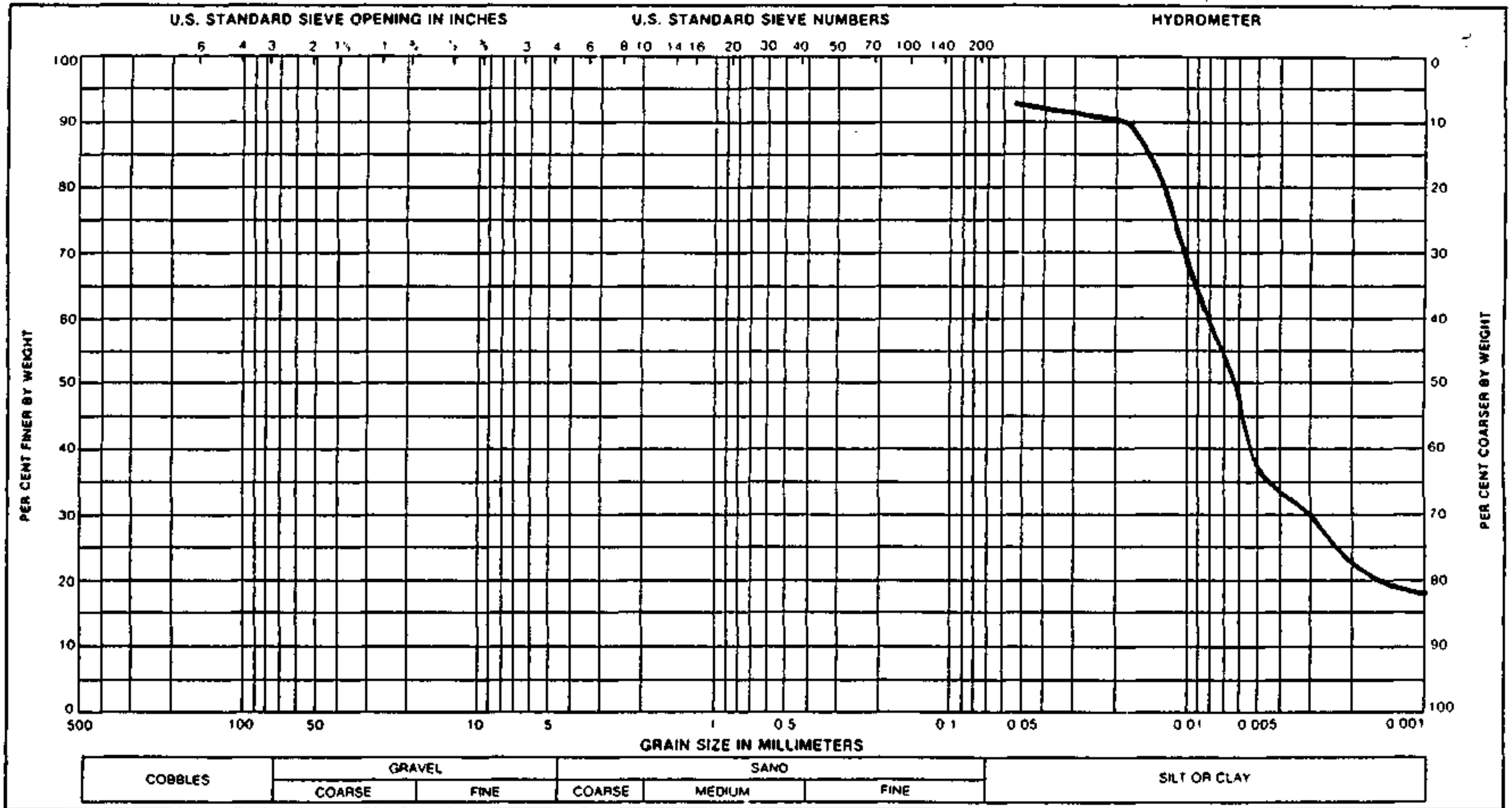


Boring No.	Sample No.	Elev. or Depth		Nat w %	LL	PL	PI	Project
-	PS-5	-	*Retained on #200 = 5.5g	-	-	-	-	Paris-West Lake
								February 19, 1992

REPORT OF SOIL ANALYSIS

File No. 001-20007

*- weight of material (taken from a 50 gram sample) retained on //200 sieve. Includes organic material.

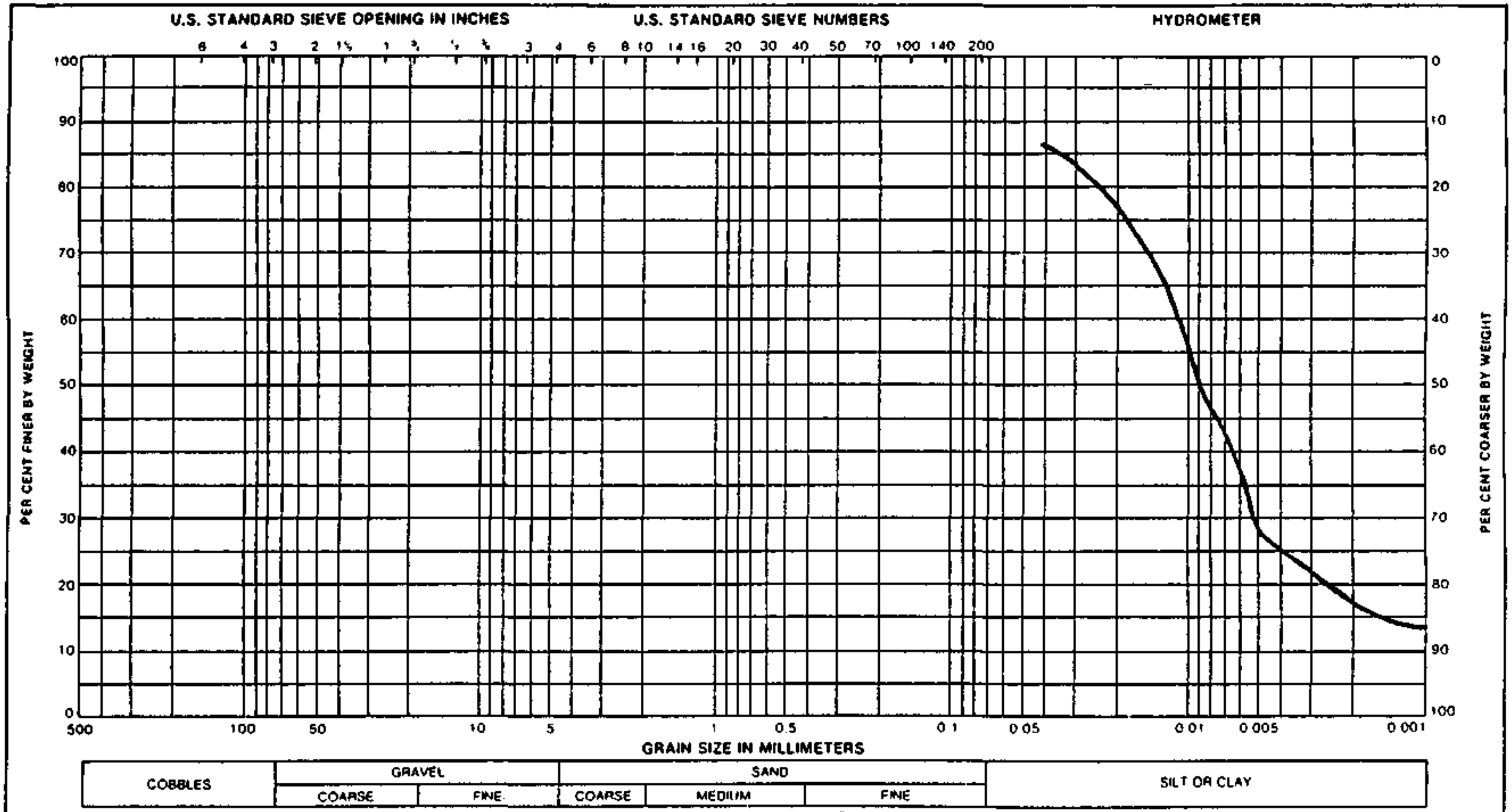


Boring No.	Sample No.	Elev. or Depth		Nat w %	LL	PL	PI	Project
-	PS-6	-	*Retained on #200 = 0.5g	-	-	-	-	Paris-West Lake
								February 19, 1992

REPORT OF SOIL ANALYSIS

File No. 001-20007

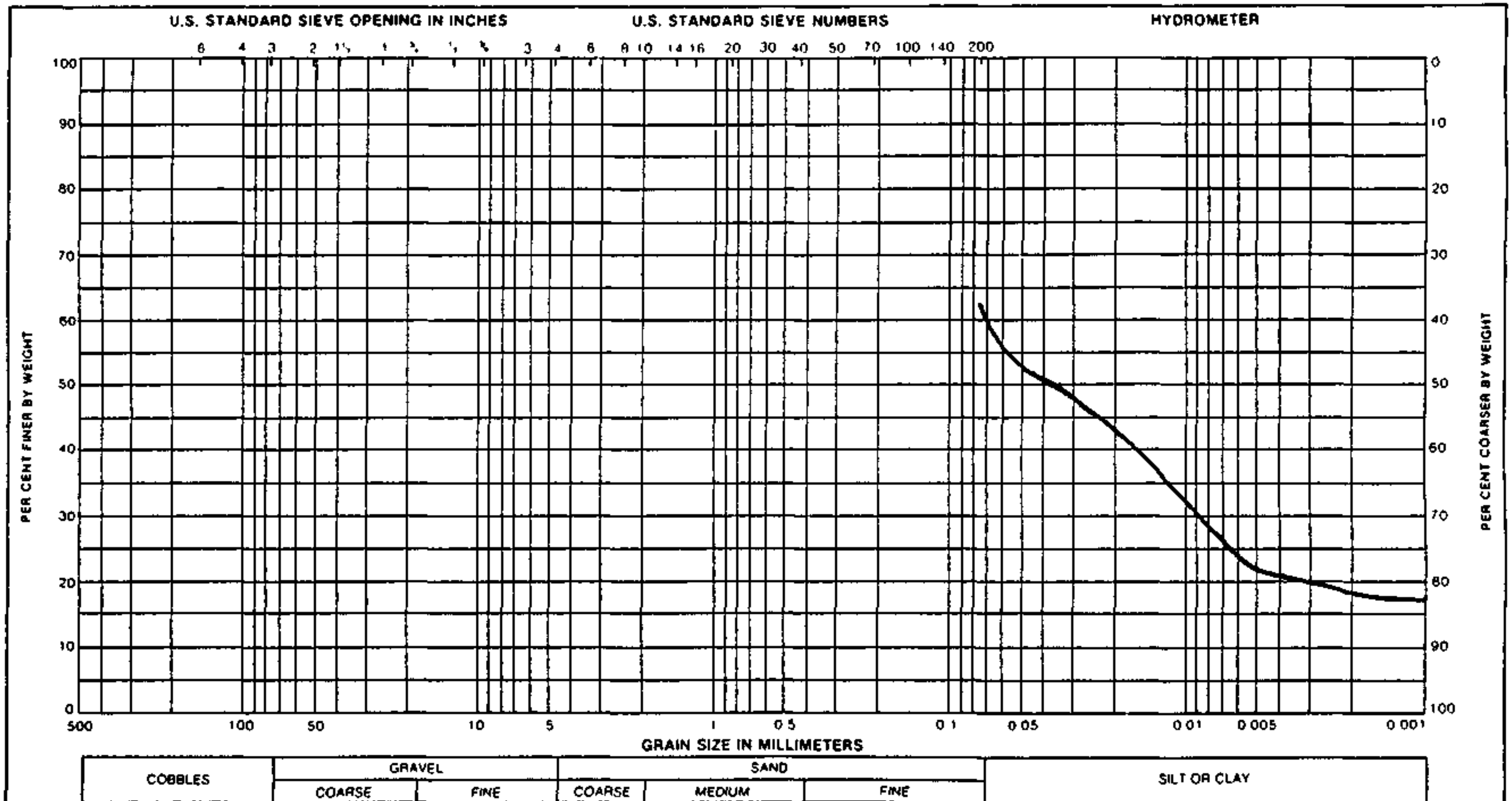
*- weight of material (taken from a 50 gram sample) retained on #200 sieve. Includes organic material.



Boring No.	Sample No.	Elev. or Depth		Nat w %	LL	PL	PI	Project
-	PS-8	-	*Retained on #200 = 0.9g	-	-	-	-	Paris-West Lake
								February 19, 1992

REPORT OF SOIL ANALYSIS	File No. 001-20007

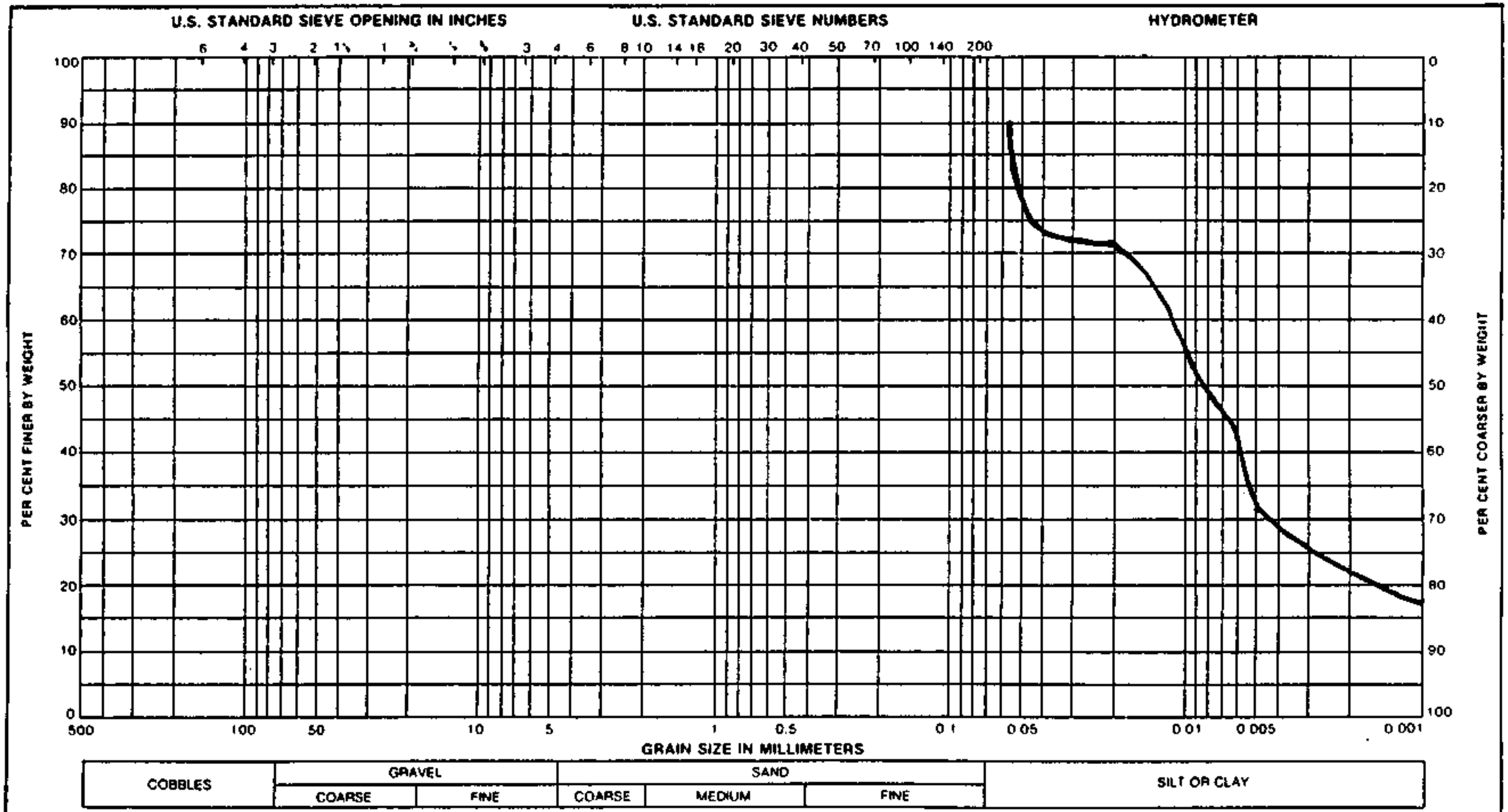
*- weight of material (taken from a 50 gram sample) retained on #200 sieve. Includes organic material.



Boring No.	Sample No.	Elev. or Depth		Nat w %	LL	PL	PI	Project
-	PS-~~A~~ 9	-	*Retained on #200 = 19.1g	-	-	-	-	Paris-West Lake
								February 19, 1992

REPORT OF SOIL ANALYSIS	File No. 001-20007

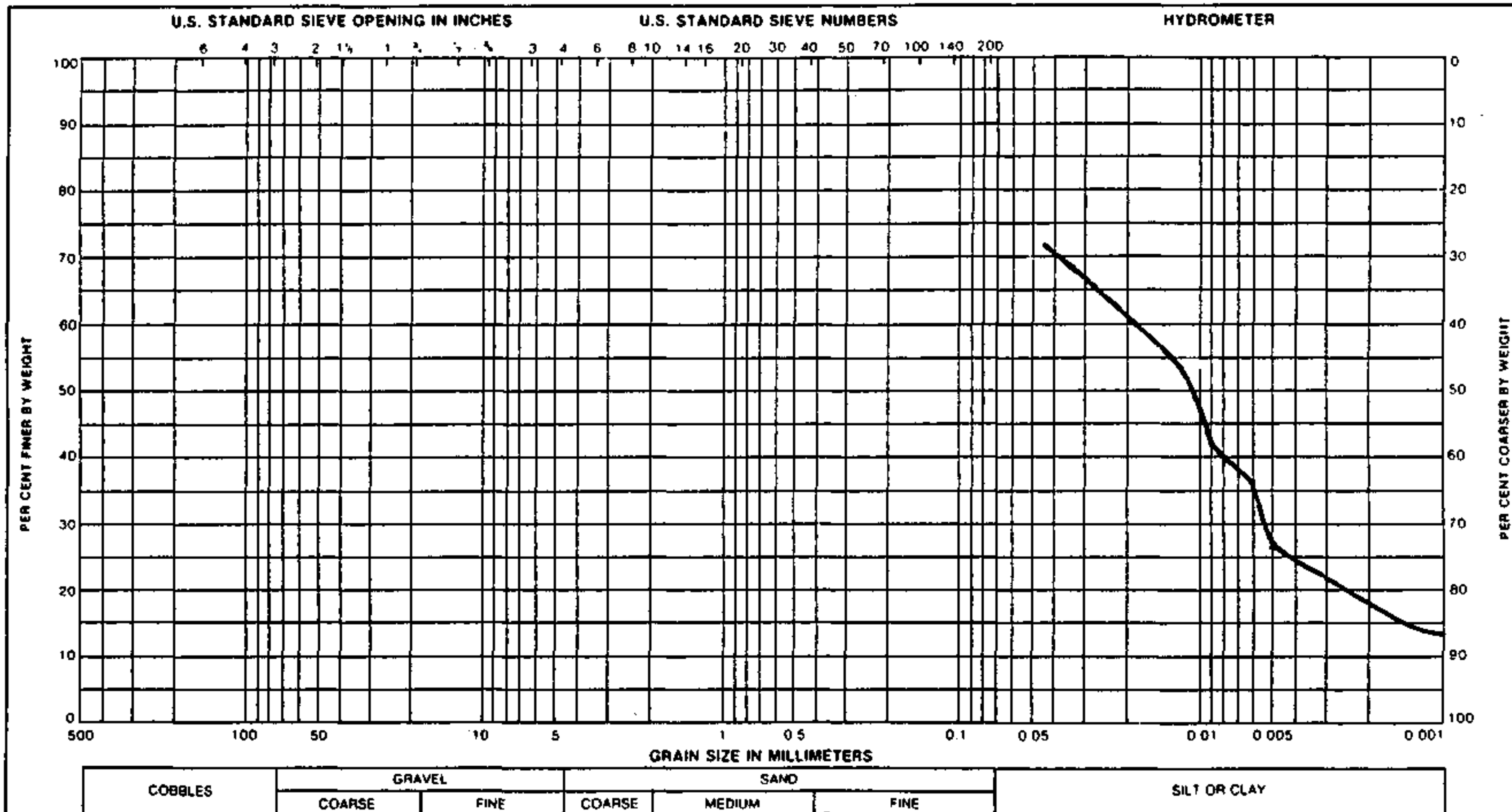
*- weight of material (taken from a 50 gram sample) retained on //200 sieve. Includes organic material.



Boring No.	Sample No.	Elev. or Depth		Nat w %	LL	PL	PI	Project
–	PS-10	–	*Retained on #200 = 3.4g	–	–	–	–	Paris-West Lake
								February 19, 1992

REPORT OF SOIL ANALYSIS — File No 001-20007

*- weight of material (taken from a 50 gram sample) retained on //200 sieve. Includes organic material.

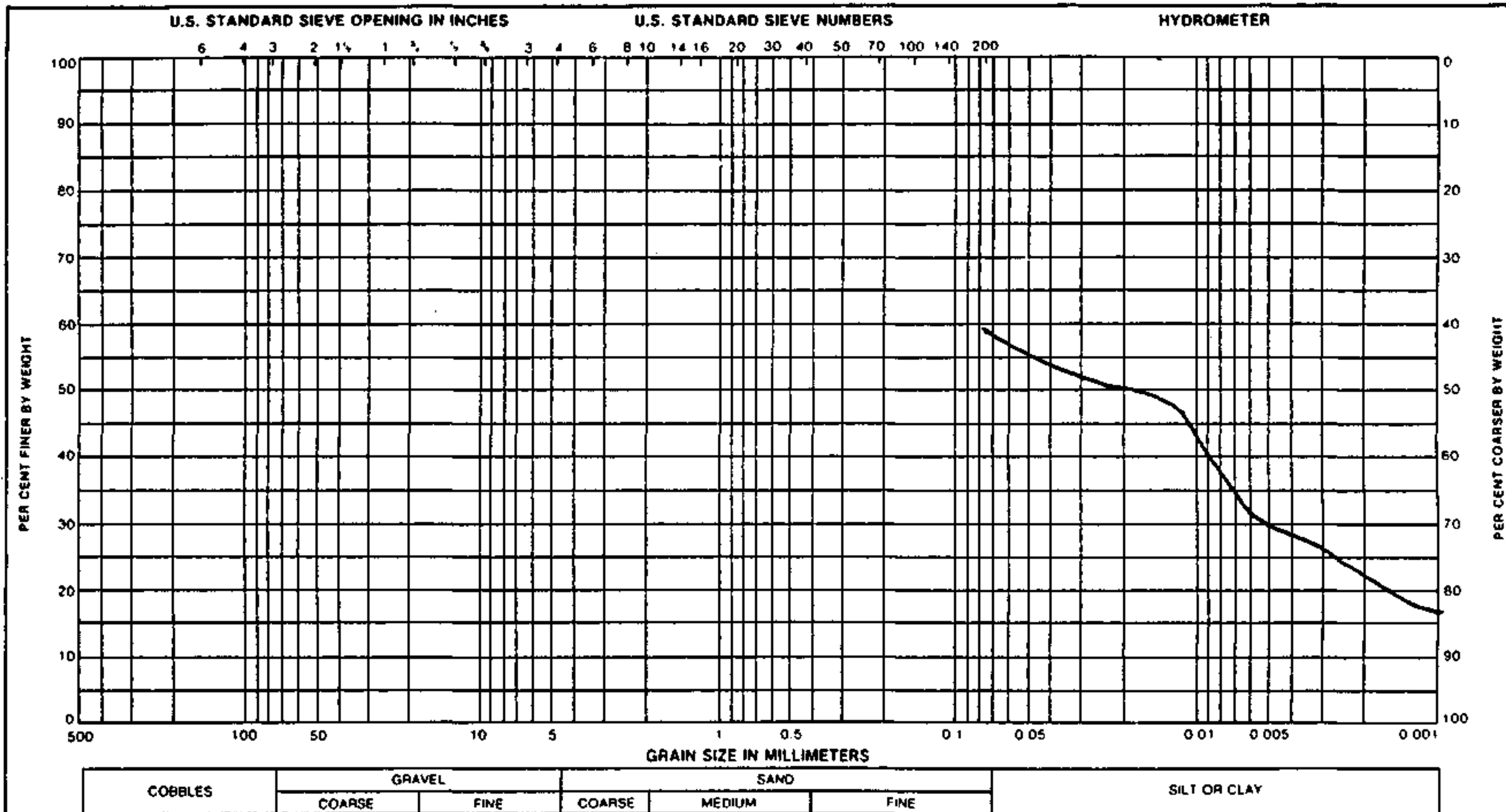


Boring No.	Sample No.	Elev. or Depth		Nat w %	LL	PL	PI	Project
–	PS-13	–	*Retained on #200 = 4.4g	–	–	–	–	Paris-West Lake
		–						
								February 19, 1992

REPORT OF SOIL ANALYSIS

File No 001-20007

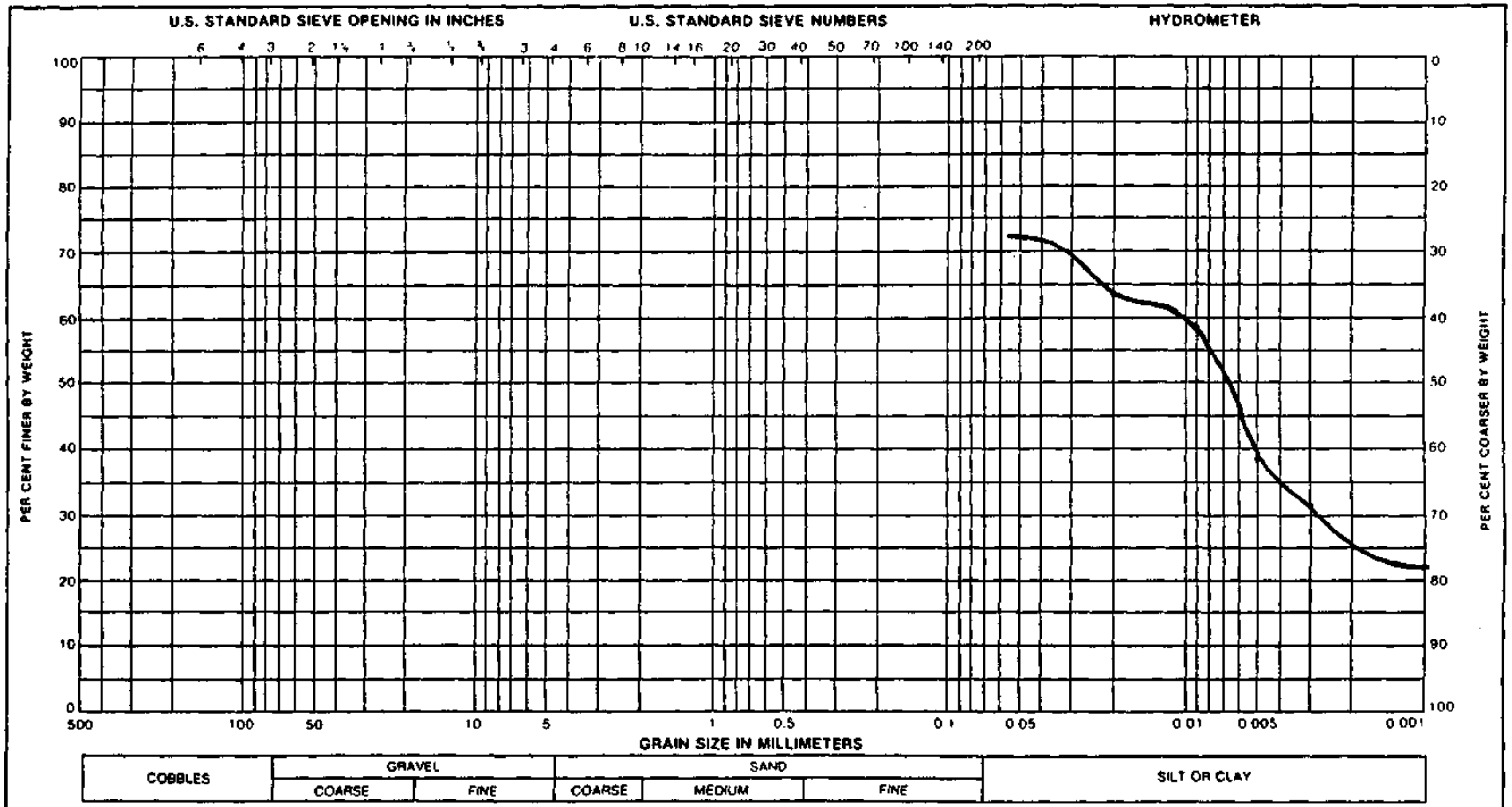
*- weight of material (taken from a 50 gram sample) retained on #200 sieve. Includes organic material.



Boring No.	Sample No.	Elev. or Depth		Nat w %	LL	PL	PI	Project
–	PS-15	–	*Retained on #200 = 19.3g	–	–	–	–	Paris-West Lake
								February 19, 1992

REPORT OF SOIL ANALYSIS — File No. 001-20007

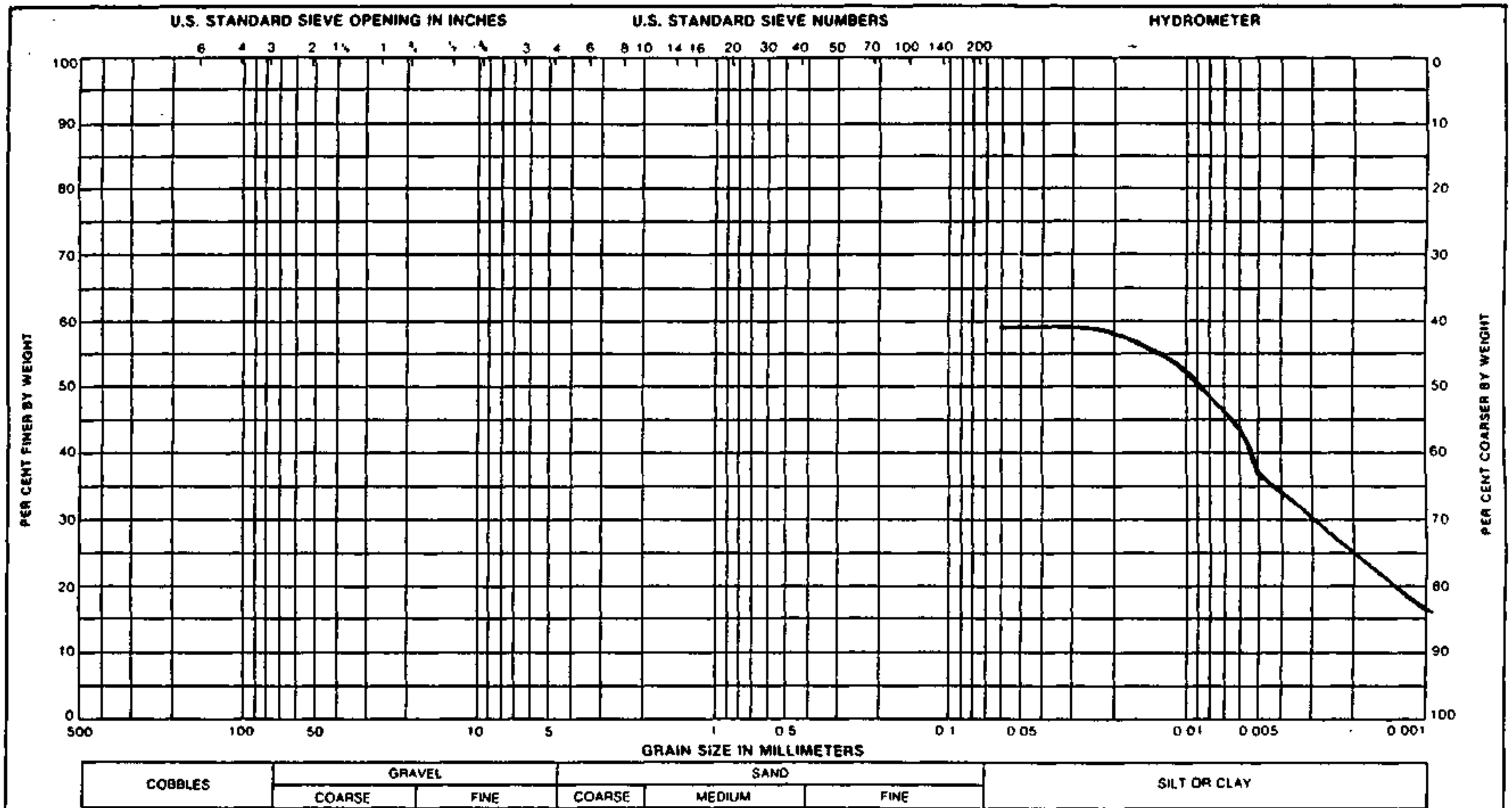
*- weight of material (taken from a 50 gram sample) retained on #200 sieve. Includes organic material.



Boring No.	Sample No.	Elev. or Depth		Nat w %	LL	PL	PI	Project
-	PS-17	-	*Retained on #200 = 8.4g	-	-	-	-	Paris-West Lake
								February 19, 1992

REPORT OF SOIL ANALYSIS | File No. 001-20007

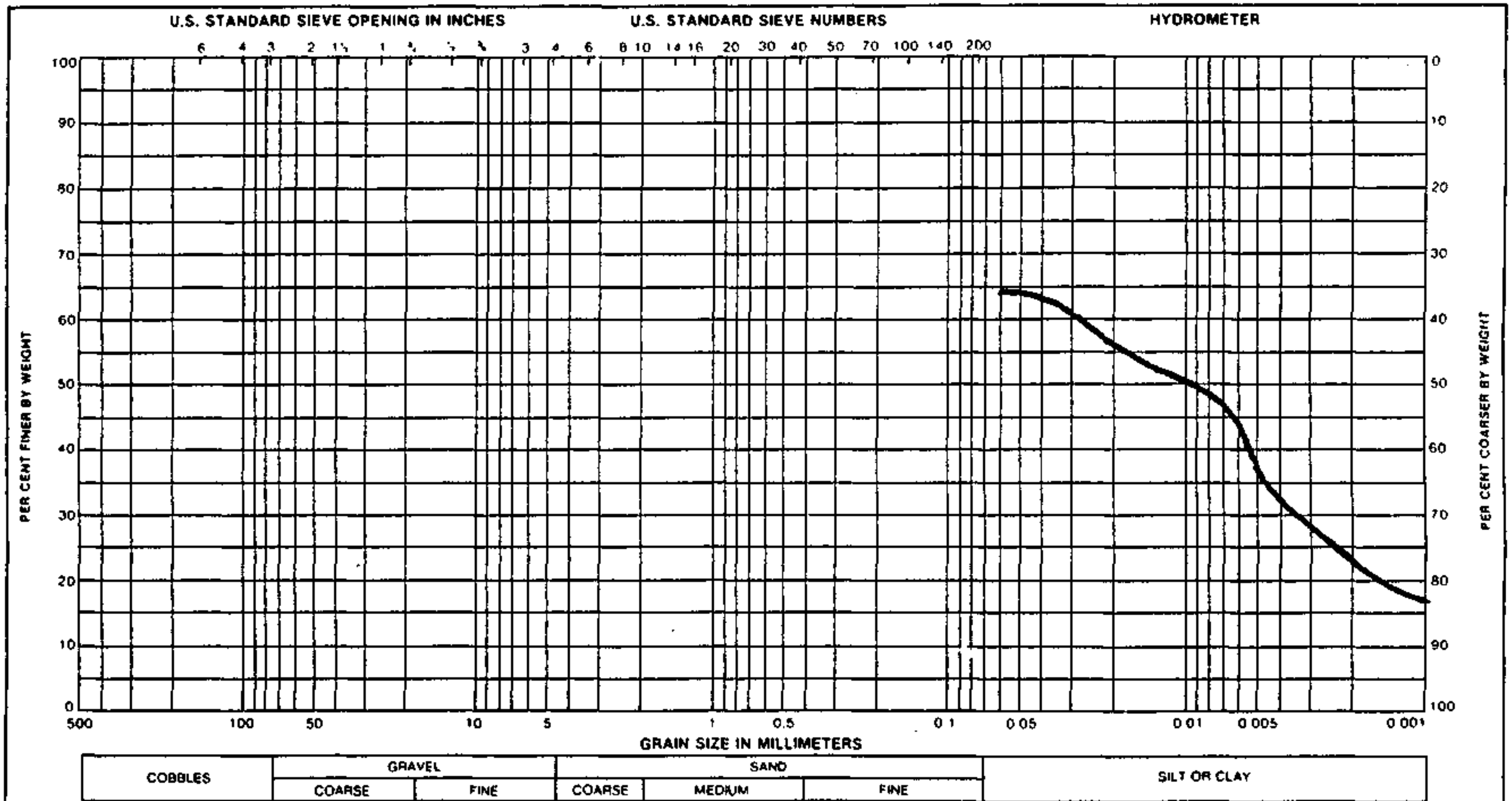
*- weight of material (taken from a 50 gram sample) retained on #200 sieve. Includes organic material.



Boring No.	Sample No.	Elev. or Depth		Nat w %	LL	PL	PI	Project
–	PS-19	–	*Retained on #200 = 17.1g	–	–	–	–	Paris-West Lake
								February 19, 1992

REPORT OF SOIL ANALYSIS — File No. 001-20007

*- weight of material (taken from a 50 gram sample) retained on #200 sieve. Includes organic material.

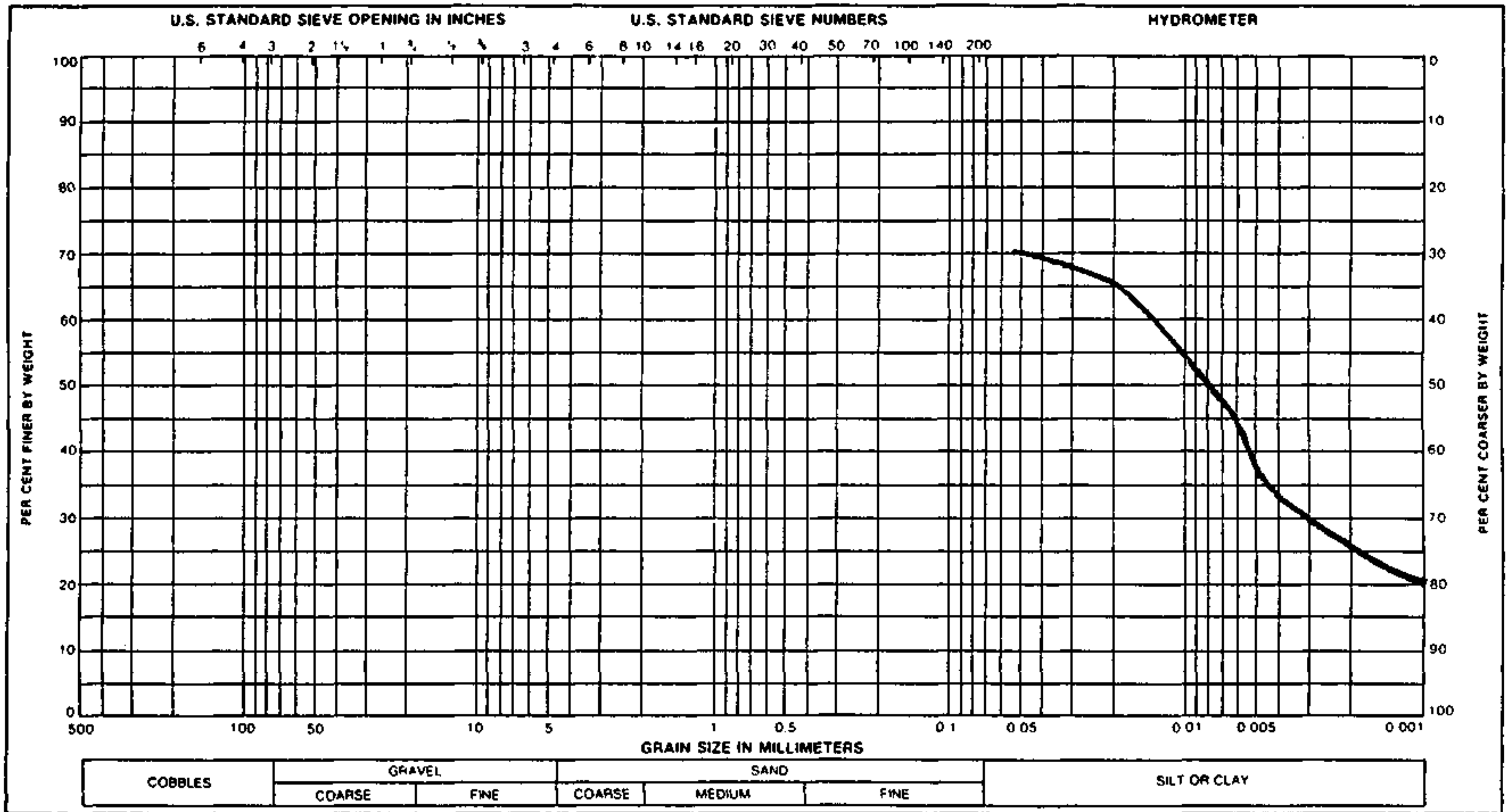


Boring No.	Sample No.	Elev. or Depth		Nat w %	LL	PL	PI	Project
-	PS-21	-	*Retained on #200 = 15.4g	-	-	-	-	Paris-West Lake
								February 19, 1992

REPORT OF SOIL ANALYSIS

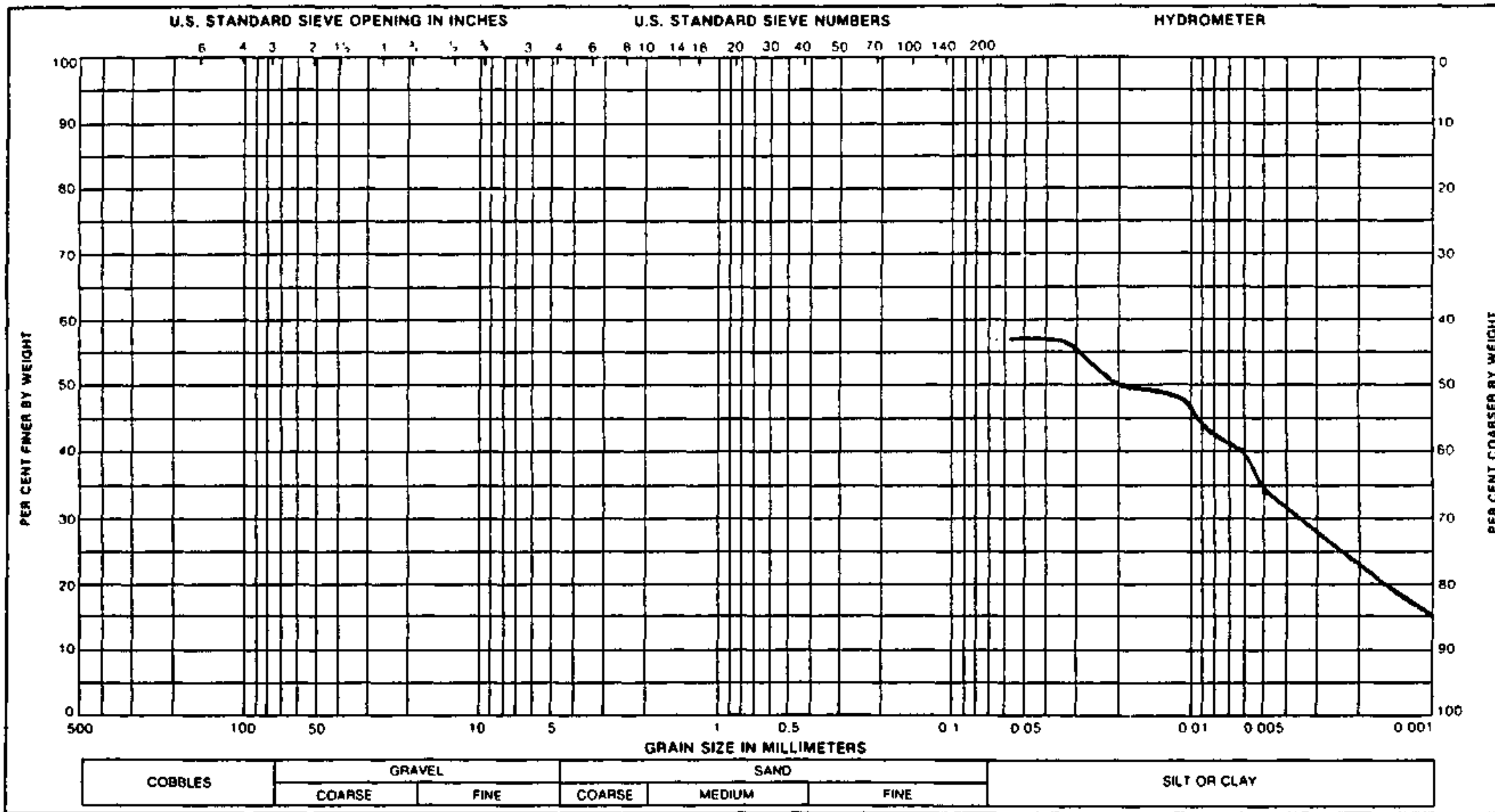
File No 001-20007

*- weight of material (taken from a 50 gram sample) retained on #200 sieve. Includes organic material.



Boring No.	Sample No.	Elev. or Depth		Nat w %	LL	PL	PI	Project
-	PS-22	-	*Retained on #200 = 6.6g	-	-	-	-	Paris-West Lake
								February 19, 1992
REPORT OF SOIL ANALYSIS								File No 001-20007

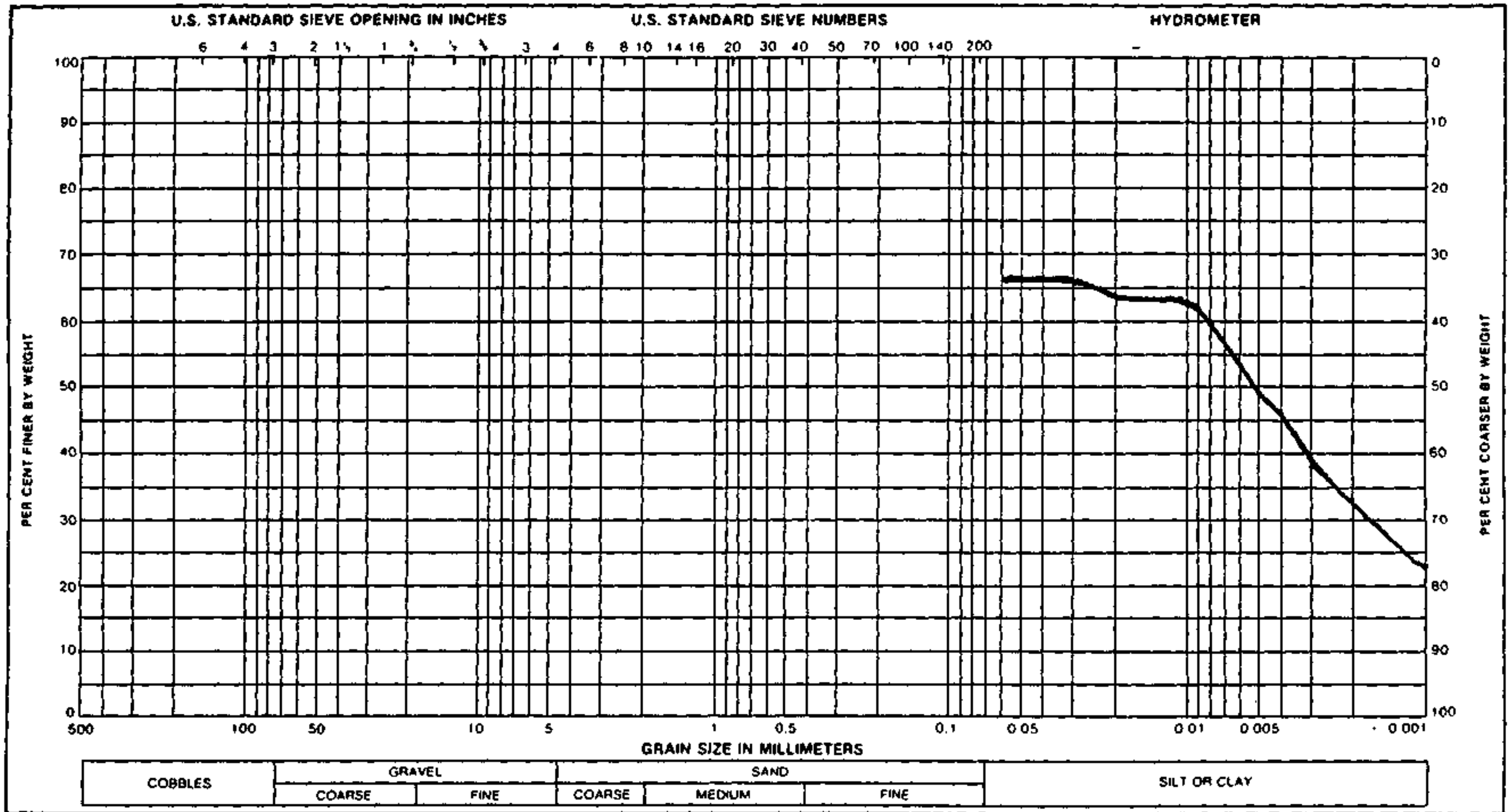
*- weight of material (taken from a 50 gram sample) retained on #200 sieve. Includes organic material.



Boring No.	Sample No.	Elev. or Depth		Nat w %	LL	PL	PI	Project
-	PS-23	-	*Retained on #200 = 20.9g	-	-	-	-	Paris-West Lake
								February 19, 1992

REPORT OF SOIL ANALYSIS — File No. 001-20007

*- weight of material (taken from a 50 gram sample) retained on //200 sieve. Includes organic material.



Boring No.	Sample No.	Elev. or Depth		Nat w %	LL	PL	PI	Project
-	PS-24	-	*Retained on #200 12.9g	-	-	-	-	Paris-West Lake
								February 19, 1992

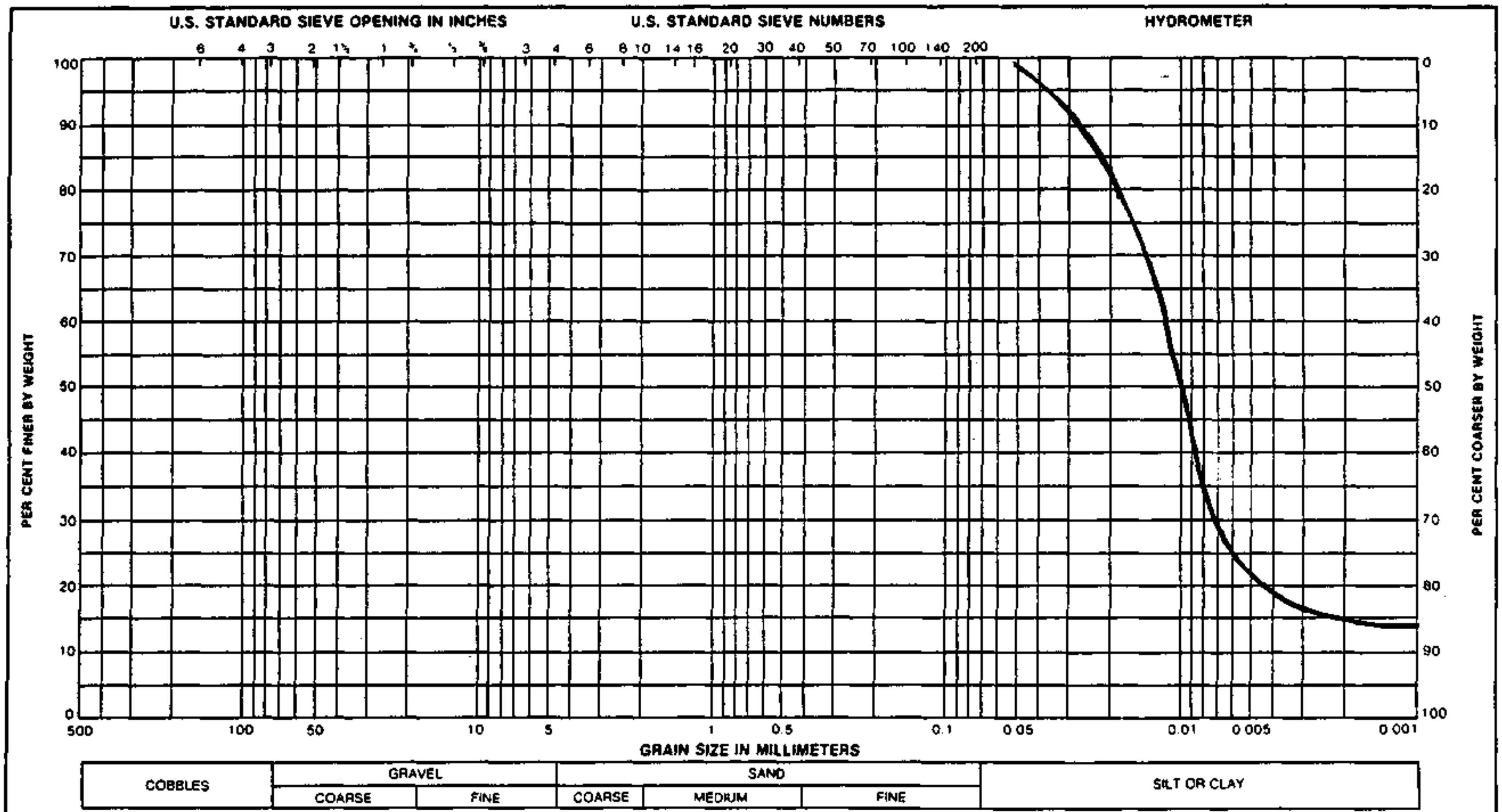
REPORT OF SOIL ANALYSIS

File No 001-20007

*- weight of material (taken from a 50 gram sample) retained on //200 sieve. Includes organic material.

APPENDIX III. GRAIN SIZE DISTRIBUTIONS
(with organics removed)

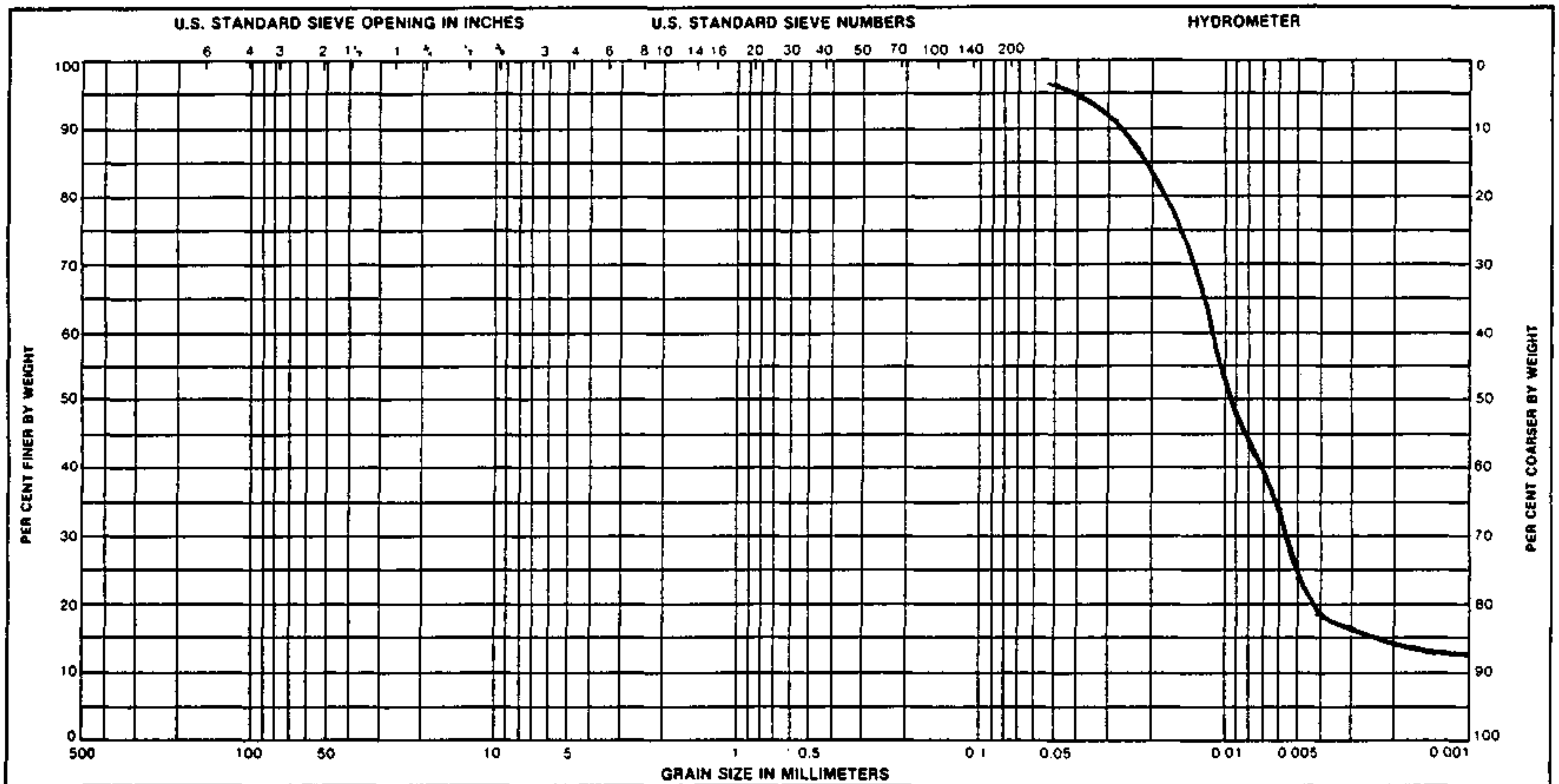
See cover sheet for Appendix II for sample locations



Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI	Project
–	PS-1	–	(after organic burnoff)	–	–	–	–	Paris-West Lake
								March 13, 1992

REPORT OF SOIL ANALYSIS

File No. 001-20007-2

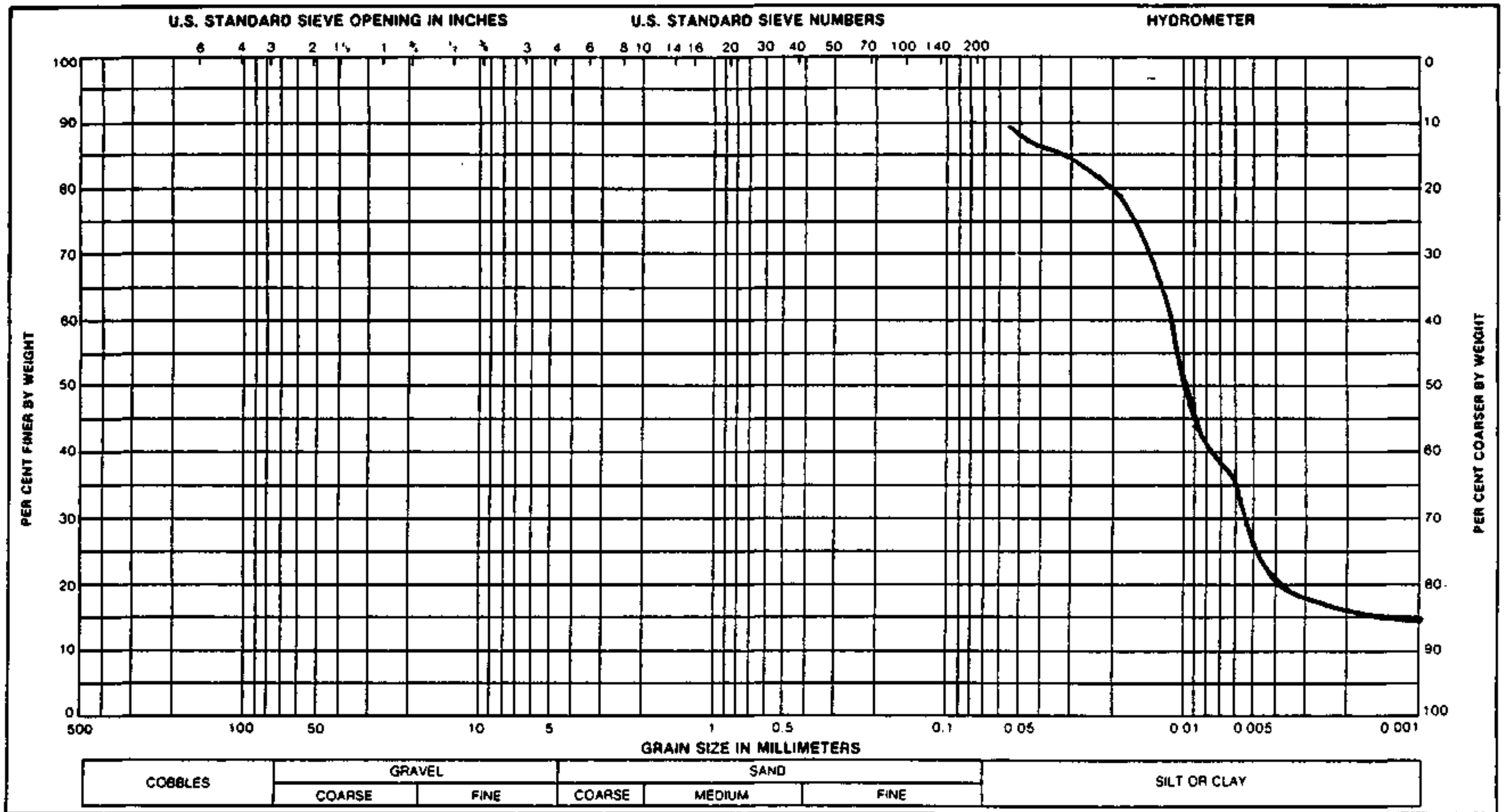


COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI	Project
-	PS-3	-	(after organic burnoff)	-	-	-	-	Paris-West Lake
								March 13, 1992

REPORT OF SOIL ANALYSIS

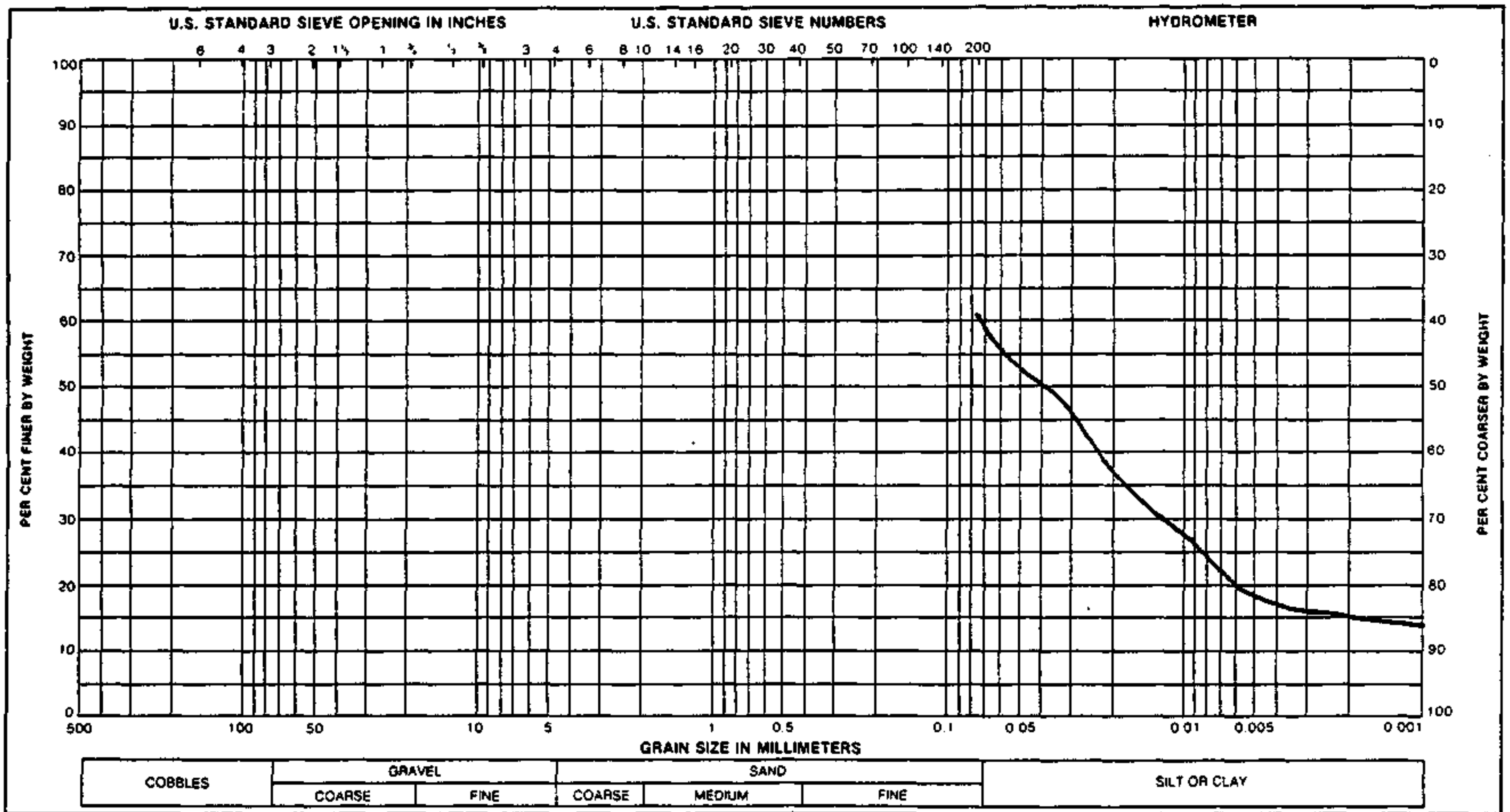
File No. 001-20007-2



Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI	Project
–	PS-8	–	(after organic burnoff)	–	–	–	–	Paris-West Lake
								March 13, 1992

REPORT OF SOIL ANALYSIS

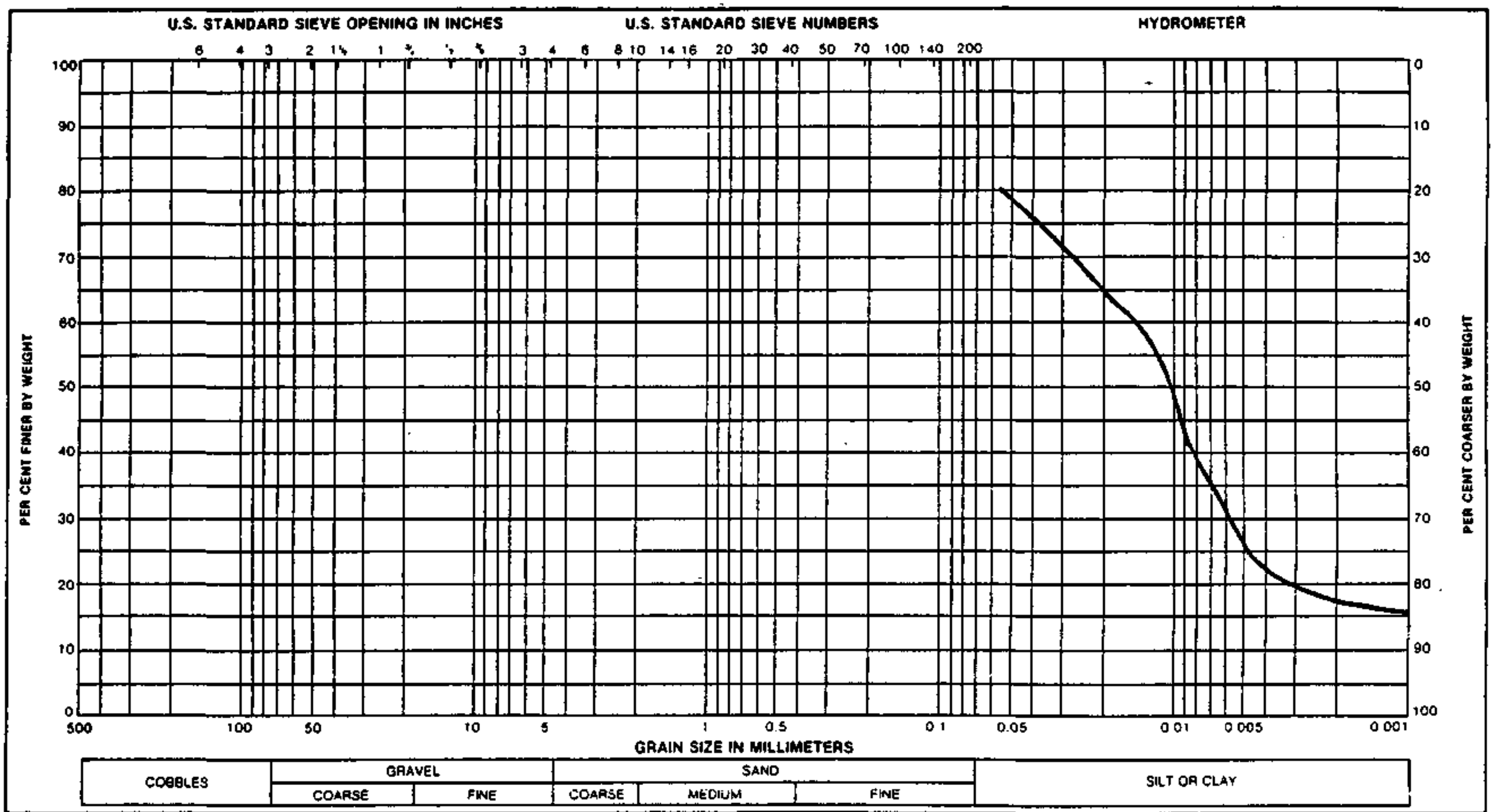
File No. 001-20007-2



Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI	Project
-	PS-9	-	(after organic burnoff)	-	-	-	-	Paris-West Lake
								March 13, 1992

REPORT OF SOIL ANALYSIS

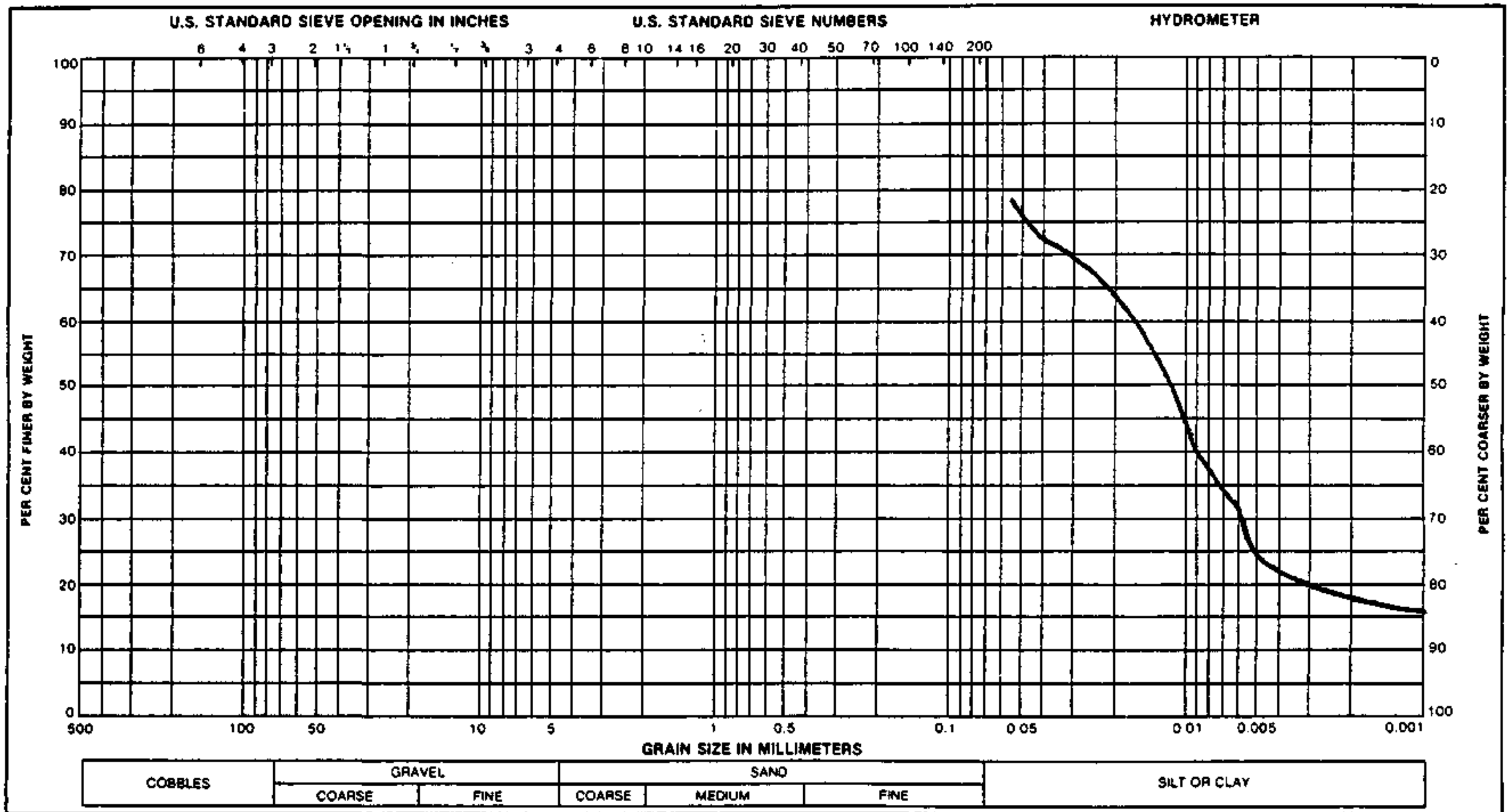
File No. 001-20007-2



Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI	Project
–	PS-10	–	(after organic burnoff)	–	–	–	–	Paris-West Lake
								March 13, 1992

REPORT OF SOIL ANALYSIS

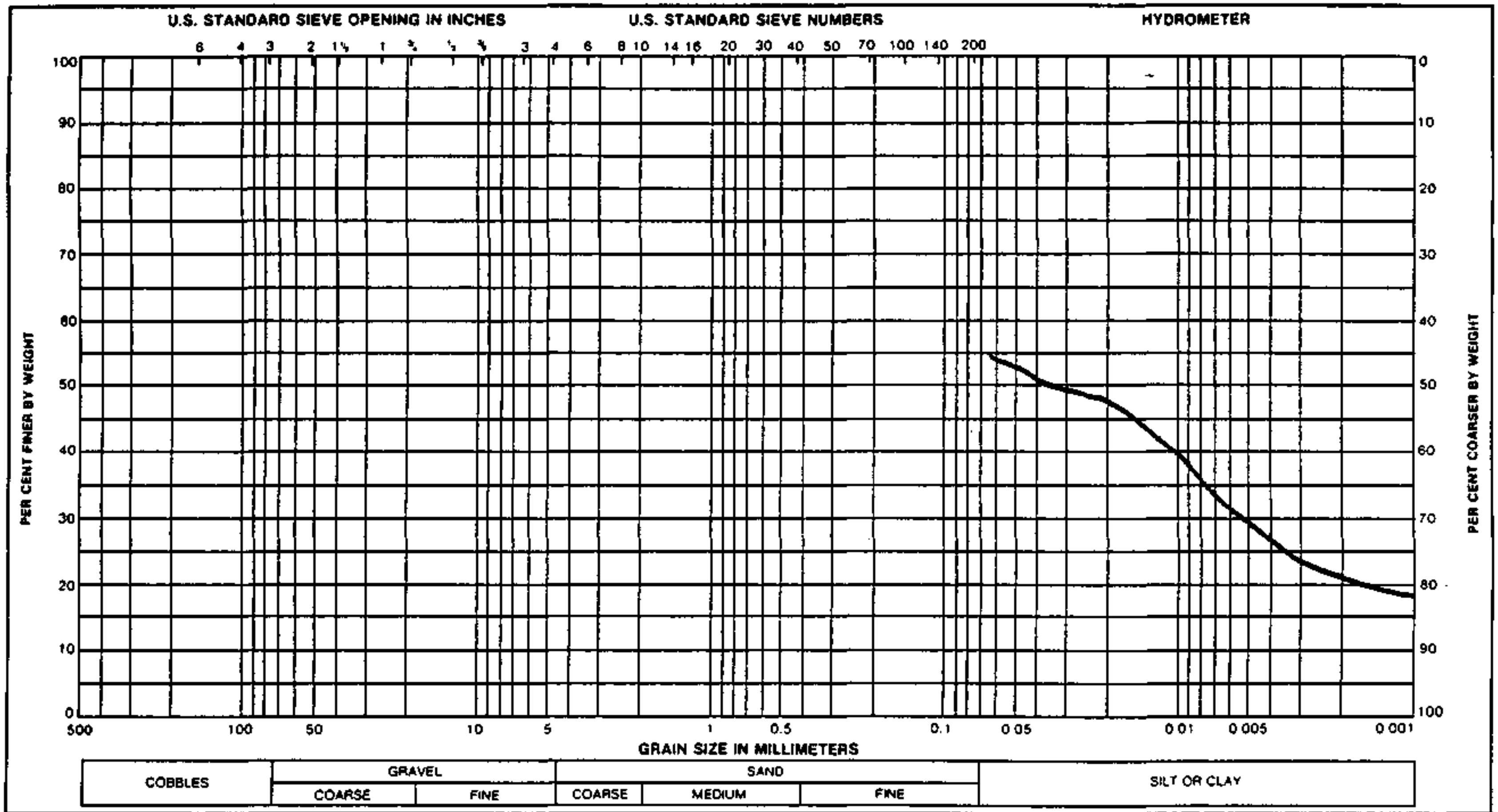
File No. 001-20007-2



Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI	Project
-	PS-13	-	(after organic burnoff)	-	-	-	-	Paris-West Lake
								March 13, 1992

REPORT OF SOIL ANALYSIS

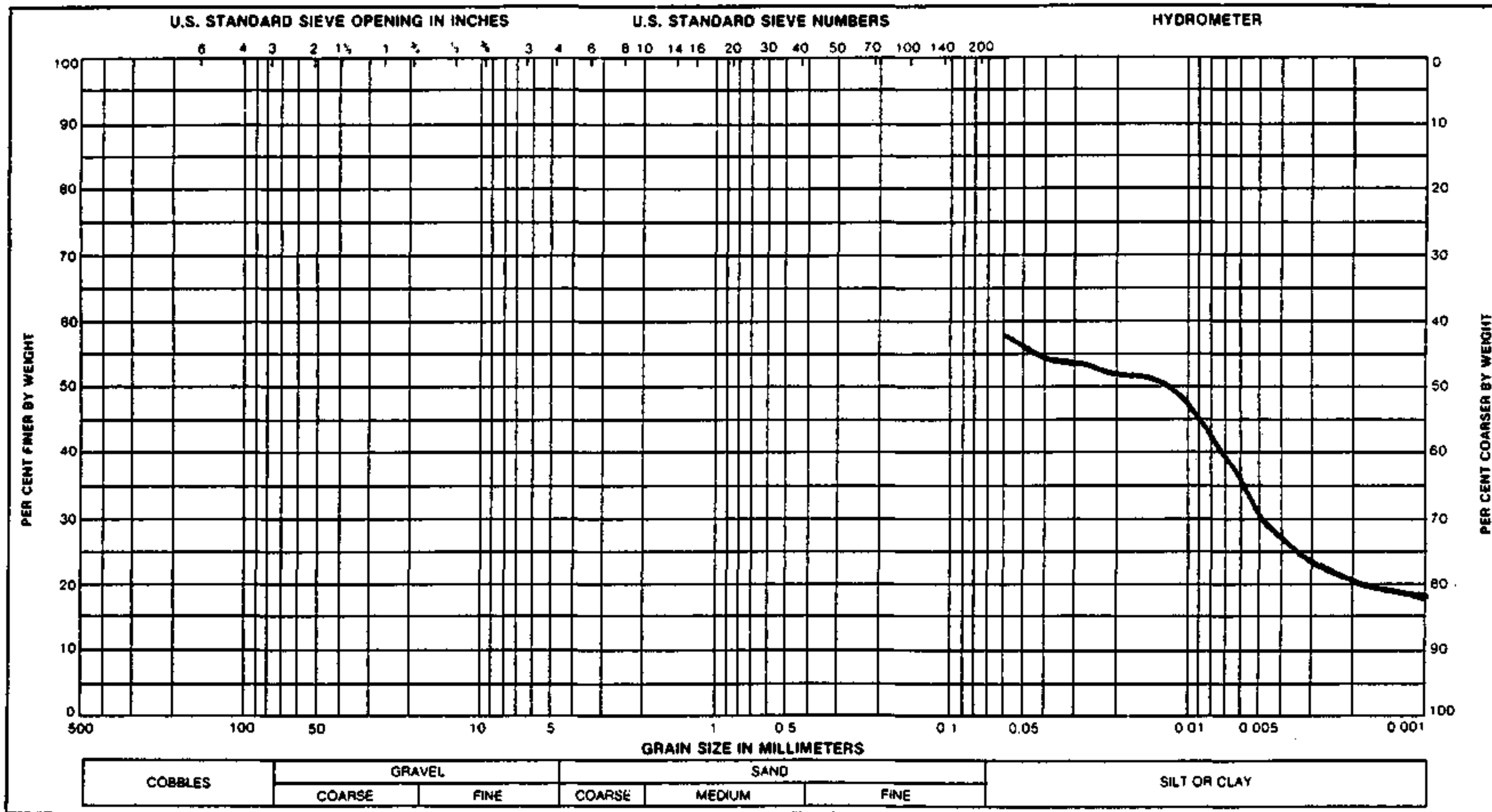
File No. 001-20007-2



Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI	Project
–	PS-15	–	(after organic burnoff)	–	–	–	–	Paris-West Lake
								March 13, 1992

REPORT OF SOIL ANALYSIS

File No. 001-20007-2



Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI	Project
-	PS-19	-	(after organic burnoff)	-	-	-	-	Paris-West Lake
								March 13, 1992

REPORT OF SOIL ANALYSIS

File No. 001-20007-2