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SEWAGE

EFFLUENT DISPOSAL

AKISKINOOK, BRITISH COLUMBIA

for

Land Logistics Western Limited

W. L. Brown, P. Eng.

H. W. Reed, P. Eng.

July 1978

77-046

1.0 INTRODUCTION

1.1 Authorization - Brown, Erdman & Associates Ltd. was authorized by Land Logistics Western Limited (letter dated April 28th, 1978) to conduct a study of a proposed disposal site located to the east of Highway 93/95 at Akiskinook. This study was to elucidate and present the groundwater geologic and hydrologic features of the area to aid in the evaluation of a ground disposal system at the subject site. All work was to be coordinated with the Project Engineers, MecMan Engineering and Testing Ltd. of Cranbrook, British Columbia.

1.2 History - An application dated February 22nd, 1977, was submitted to the Pollution Control Branch for the ground disposal of effluent from a treatment plant in the central part of the Akiskinook property. Studies of the site were conducted by Curtis Engineering & Testing Ltd. of Calgary and Edmonton, Alberta, and by Ground-Water Consultants Group of Edmonton, Alberta. The reports prepared by these firms are entitled

"Curtis, W. E. (August 1976), Foundation Investigation, Akiskinook Resort, Lake Windermere, B. C.",

"Hall, P. L. (June 8th, 1977), Effluent Disposal and its Impact on the Ground-Water Regime, Akiskinook, B. C.".

Our studies conducted in late July 1977 concluded that a disposal site east of Highway 93/95 would be more suitable than the site then planned and that a series of disposal fields for each cluster unit scattered throughout the Akiskinook property would also be more suitable than the single field then planned.

Application was then made in August 1977 to the local health office for a permit for the first cluster. This permit was subsequently issued.

1.0 INTRODUCTION, cont'd.

1.3 Present Study - Sixteen test pits were dug and logged by W. L. Brown of this office on May 9th, 1978. Percolation tests were also run beside nine of these test pits. Four samples of representative sediments were mechanically analyzed by MecMan Engineering and Testing Ltd. Subsequently on May 26th to 28th, 1978, eight test holes were drilled. These were logged by H. W. Reed of this office who also examined the cliffs facing Windermere Lake and pertinent springs in the area.

2.0 DISPOSAL FIELD REQUIREMENTS

2.1 Total ultimate effluent discharge - 25,000 gpd.

2.2 Staging of discharge.

Stage one	5,000 gpd.
Stage two	15,000 gpd.
Stage three	5,000 gpd.

3.0 WEATHER

3.1 Precipitation (1955 - 1977) Cranbrook Airport.

Maximum year (1959) - 578.7 mm (22.78 inches)
Mean year - 437.9 mm (17.24 inches)
Minimum year (1956) - 259.6 mm (10.22 inches)

The precipitation is fairly evenly distributed throughout the year ranging from almost one to slightly over two inches per month. The mean snowfall totals 1,783 millimeters (70.2 inches) with a water equivalent of 178 millimeters (7 inches). Temperature patterns indicate that less than a foot of snow should remain on the ground at any one time (except for drifts).

3.0 WEATHER, cont'd.

3.2 Growing Season - 138 days (May 1st to September 15th).

3.3 Potential Evapotranspiration - 488.9 millimeters (19.25 inches).

4.0 TESTING

4.1 General - The location of the test pits, percolation holes and test holes are shown on the accompanying maps (drawings 1 and 4). Please note that these and the cross-sections all have METRIC SCALES.

4.2 Test Pits - Pits were dug by backhoe to general depths of 11 to 15½ feet. They were logged as digging proceeded and exhibited the following sequence of sediments from surface downwards.

Sandy silt.
Fine sand.
Finely bedded silt and clayey silt.
Fine to coarse sand and gravel.
Pebbly silt.
Glacial till.

Please see cross-sections C-C' and D-D' (drawings 5 and 6) for the interrelationships between these units.

4.2.1 Glacial Till - This is a typical glacial till, hard, compact with "pie crust" structure. Difficult to dig with large backhoe. Till was only observed in Test Pits 5 and 6 which are halfway up slope and on top of a bench above the proposed disposal site.

4.0 TESTING, cont'd.

4.2.2 Pebbly Silt - This is a till-like mixture of silt, sand and pebbles over 2.4 meters thick but is not compact and is without structure. It contains lenses of sands and/or gravels that were noted to be water-bearing in only two of the test pits namely Test Pit 3 and 9. The static water levels were both 12 feet from ground surface or at elevations of 852.2 and 851.3 meters respectively which shows almost a meter drop of the water surface towards the southeast. Please see sample B for grading curves of this sediment. These sediments were probably deposited as slope washes or mud flows of glacial debris.

4.2.3 Fine to Coarse Sand and Gravel - This is usually a loose gravel consisting of well rounded pebbles up to four inches in diameter inter-bedded with medium to coarse grained sand beds. 2.7 meters of gravels showing horizontal bedding was exposed in Test Pit 7 to the elevation of the bottom of the pit at 854.5 meters. The 2.4 meters of sand and gravel encountered in Test Pit 13 exhibited deltaic cross-bedding. It will be noted that a sand or sand and gravel filled channel is present along the back of the disposal site terrace. These sediments occurred in Test Pits 3, 4 and 5; 1 and 7; 8 and 9; and in 13, 14 and 15. The thickness ranged from 0.3 to over 2.7 meters (Test Pit 7 did not encounter the bottom of the sand and gravel section).

4.0 TESTING, cont'd.

4.2.4 Finely Bedded Silt and Clayey Silt - These typically fluvial (lake) sediments consist of well bedded silts with 6.4 millimeters (¼-inch) thick beds and fine grain sand partings between the beds. These silts ranged in thickness from 2.1 to 1.5 meters and were encountered in the southeastern part of the site in Test Pits 11, 14, 15 and 16.

4.2.5 Fine Sand - This is a widespread deposit of fine grained, well rounded and sorted tan coloured sand. Please see samples A and C for grading curves. In places sandy silt to silty sand lenses are present which are uncorrelatable from hole to hole. The sand was present in Test Pits 2, 1 and 7; 8, 9, 10, 11 and 12 and in 14, 15 and 16. The thickest section was found in Test Pit 12 where 3.5 meters were encountered.

4.2.6 Sandy Silt - This is a tan coloured sandy silt that is probably a wind blown (loess) deposit generally present towards the back of the terrace.

4.3 Test Holes - Eight test holes were augered to the west of the proposed disposal site in an effort to correlate the sedimentary sequence seen in the test pits with the sequence seen on the cliffs at Windermere Lake and described in the test holes drilled by Curtis Engineering & Testing Ltd. in 1976. The Curtis test holes are shown as 76-1 to 76-6 and those drilled for the present study as 78-1 to 78-8 on the maps and cross-sections.

The test holes were drilled by power auger to maximum depths of 30.5 meters. In all 233.47 meters (766 feet) of test hole was drilled in three days. When the holes could

4.0 TESTING, cont'd.

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4.0 TESTING, cont'd.

4.3 Cont'd.

be augered into the ground without slippage and then pulled straight out of the ground an excellent exposure of the sediments was obtained. Where, due to ground conditions, slippage did occur the top part of the holes were re-drilled as 78-1A and 78-6A.

The sediments encountered by the auger holes can generally be divided into the following sequence.

Fine sand and sandy silts.
Clayey silt.
Pebbly silt.

Please see cross-sections A-A' and B-B' (drawings 2 and 3) for the relationship of these units.

4.3.1 Pebbly Silts - The till-like mixture of pebbly or stoney silts was encountered in Test Holes 1, 1A, 4, 5 and 6 where it was quite similar to the same type of sediment observed in the test pits. Water-bearing sand and gravel zones within the sequence contained water under artesian pressure (please see cross-sections for the piezometric surface).

The section in Test Hole 3 was more gravelly than usual. The mode of transport and deposition of this sediment would allow for a wide degree of composition and a complex relationship of the various lenses and filled channels.

4.3.2 Clayey Silt - This sequence of clayey silts was not observed in the test pits. It is present lakeward or valleyward of the till-like slope wash material. It was encountered

4.0 TESTING, cont'd.

4.3.2 Cont'd.

in Test Holes 2, 7 and 8 and probably forms the beach at the base of the cliffs on Windermere Lake.

4.3.3 Fine Sand and Sandy Silts - This sequence is similar to the upper sand observed in the test pits. It is best seen on the cliffs overlooking Windermere Lake and is described as a sequence of finely layered silts and fine grained sands with a brown to tan colour. It is impossible to correlate the siltier or sandier sections from one drill hole to another. It appears that the change from sandy to silty zones is gradational and that the zones are lenticular.

5.0 GROUNDWATER

5.1 General - Groundwater was encountered in two of the test pits, in five of the test holes and in one spring. The pertinent features are listed on Table 1.

5.2 Occurrence - It will be noted that all groundwater was encountered 3.81 meters (12½ feet) or more below ground surface in the test pits and wells. It will also be noted that in Test Pit 3, 2.44 meters (8 feet) of pebbly silts were dug through before a water-bearing bed was encountered. Similarly 1.68 meters (5½ feet) of pebbly silts were dug through before a water-bearing bed was encountered in Test Pit 9. The groundwater-bearing lenses are therefore overlain by 1.68 to 2.44 meters (5½ to 8 feet) of impervious beds which in turn lie 2 meters (6½ feet) and 1.5 meters (5 feet) below permeable sediments.

5.0 GROUNDWATER, cont'd.

5.2 Cont'd.

Although the area around Test Holes 1 and 1A is extremely dry at the surface topography is such that groundwater struck in these holes had sufficient artesian pressure to bring it to and almost to the ground surface. This demonstrates that impermeable beds of pebbly silt seal the water-bearing zones as observed in the test pits. The spring located at an approximate elevation of 820 meters (2,690 feet) most probably issued from permeable beds in the pebbly silts.

The following thicknesses of dry permeable sediments are present beneath the proposed drain field area.

T.P.1	2.6 meters (8½ feet)
T.P.7	3.5 meters plus (11½ feet plus)
T.P.8	2.3 meters (7½ feet)
T.P.9	2.0 meters (6½ feet)
T.P.10	2.3 meters (7½ feet)
T.P.11	3.5 meters plus (11½ feet plus)
T.P.15	1.7 meters (5½ feet)
T.P.16	1.5 meters (5 feet)

5.3 Percolation Tests - Standard percolation tests were conducted in 30 centimeter by 30 centimeter square holes 46 centimeters deep (1' x 1' x 1½') beside nine of the test pits. The times to drop from 15.24 centimeters to 12.6 centimeters (6 inches to 5 inches) depth of water was recorded until the times were constant. Please see the Test Pit Logs for records of the percolation rates. The rates ranged from 44 seconds per inch in Test Pit 2 to 6 minutes and 35 seconds in Test Pit 15. Most of the rates were in the 2 to 3½ minutes per inch rate. The design percolate rate was arbitrarily and conservatively picked at 5 minutes per inch.

5.0 GROUNDWATER, cont'd.

5.4 Groundwater Piezometric Surface - The Piezometric Surface slopes towards Windermere Lake at gradients of 1 to 11½ and 1 to 21 (section B-B' and A-A'). If one contours the elevation of the eight points measured on the Piezometric Surface the slope is sub-parallel with the north-eastern leg of section A-A' at a gradient beneath the proposed disposal site of 1 to 12.

5.5 Water Wells - The location of the closest water well to the proposed disposal field is shown on the map (drawing 4). It will be noted that all parts of the proposed drain field and standby drain fields are over 91.5 meters (300 feet) from this well. The well is being used by the Skookum Inn. The exact log of the well is unknown but reports from drillers and local people indicate that it is 18.29 meters (60 feet) deep and that the static water level is 9 meters (30 feet) below ground surface.

Driller reports indicate that a dry hole was drilled approximately 91.5 meters (300 feet) south of Skookum Inn. This hole went through 22.86 meters (75 feet) of fine sands where it hit "blue clays". A well was also recently drilled at least 500 meters (1,650 feet) north of the proposed disposal site. This well drilled through till-like material to a depth of 21 meters (69 feet) where 0.25 litres per second (4 gpm) of groundwater was obtained.

The driller also reports that if water is not obtained before the "blue clay" is encountered the attempt to develop groundwater should be abandoned. The "blue clay" is reportedly over 100 meters (300 feet) thick. It also underlies the beach of Windermere Lake.

5.0 GROUNDWATER, cont'd.

5.5 Cont'd.

The driller's "blue clay" corresponds to the clayey silt sequence of this report.

5.6 Groundwater Occurrence - Available data indicates that the groundwater of the area is to be found in the sand and/or gravel lenses within the slope wash pebbly silt sequence. Beneath the proposed drain field site no water is found on top of the pebbly silts in the overlying sands and/or gravels. No evidence was observed such as an "iron pan" or staining to suggest that an ephemeral perched table ever exists on top of the pebbly silts during the spring thaw.

5.7 Base Permeable Sediments - The topography on the top of the relatively impermeable sediments is roughly sub-parallel with the surface topography. The nose shown by the 854 meter (2,802 foot) surface contour but not by the 856 meter (2,808 foot) surface contour could be more pronounced in the subsurface. Another departure from the surface topography is that there are much steeper slopes on the top of the relatively impermeable sediments to the south and southwest than is shown at ground surface. These steeper falls are shown on cross-sections A-A' and B-B' (drawings 2 and 3).

6.0 DESIGN OF DRAIN FIELD

6.1 General - The drainfield has been designed to accommodate effluent from an aerobic treatment plant with an average BOD level of 45 mg/l and suspended solids level of 60 mg/l. A design percolation rate of five minutes per inch would require a drain field disposing of effluent from a septic tank to cover a total area of 22,300 square meters

6.0 DESIGN OF DRAIN FIELD, cont'd.

6.1 Cont'd.

(240,000 square feet) or 2.23 hectares (5.5 acres). The radius around the Skookum Inn well removes approximately 0.45 hectares (1.1 acres) from the 2.5 hectare (6.2 acre) site (see map drawing 4). Thus there is not sufficient land available to accommodate a septic tank drain field.

A percolation rate of five minutes per inch and a 45/60 aerobic effluent requires a total drain field area of 7,800 square meters (84,000 square feet) or 0.78 hectares (1.9 acres) to accommodate three fields. 1,707 meters (5,600 lineal feet) of drainpipe will be required for the two constructed fields to dispose of the ultimate discharge of 25,000 gallons per day. Please refer to the drain field map (drawing 4) for a proposed layout. This map shows the field to be only 3 meters (10 feet) from the northeastern boundary of the site. We do not at this time know whether or not this will become a parcel boundary. If it does or will become a parcel boundary the field must be shifted another 3 meters (10 feet) away from the boundary to conform to the Pollution Control Guidelines (Draft).

6.2 Piezometric Surface - All permeable sediments are dry beneath the proposed constructed field area to a minimum depth of 2 meters (6.6 feet). The standby field area has a minimum of 1.52 meters (5 feet) of dry permeable material beneath it.

Groundwater was encountered in Test Pit 9 at a depth of 3.8 meters (12½ feet) or 1.83 meters (6 feet) below the top of the pebbly clay. The static water level rose to 3.66

6.0 DESIGN OF DRAIN FIELD, cont'd.

6.2 Cont'd.

meters (12 feet) below ground surface. Reference to section C-C' (drawing 5) will show that the groundwater was most probably in a lens. If any reasonable slope is applied to the piezometric surface in Test Pit 9 water should have been present in at least one if not several of the other test pits.

6.3 Seepage Considerations - The topography at the base of the permeable sediments would force any effluent mound to decay primarily in a southwesterly direction sub-parallel with the northeastern leg of section A-A'.

The slope of the piezometric surface also indicates that the natural groundwater flow is in the same direction.

Permeable sediments are over 1.52 meters (5 feet) thick beneath the proposed drain field and 4 meters (13 feet) or more thick "downstream" of the drain field.

6.4 Sewage Effluent Renovation - The closest water well is over 91.5 meters (300 feet) from the proposed drain field. Water was probably encountered in sand and/or gravel interbeds in the pebbly silt complex with a thick section of relatively impermeable sediments above them. No danger of contaminents of this well by effluent should exist.

The closest spring (unused) is over 330 meters (1,082 feet) away from the proposed drain field and again the water is probably issuing from interbeds or lenses within the pebbly silt complex.

6.0 DESIGN OF DRAIN FIELD, cont'd.

6.4 Cont'd.

The ravine to the southwest of the proposed drain field was dry in early May. The top of the silty clay sequence was encountered in Test Hole 78-7 at a depth of 21.64 meters (71 feet) or close to elevation 820 meters (2,690 feet). The closest part of the 820 meter (2,690 foot) contour lies approximately 500 meters (1,640 feet) from the proposed drain field. No artificial springs will be developed on the slopes of this dry ravine.

6.5 Drain Field Construction - The drain field is to be constructed according to the requirements of section 4.3 of the Pollution Control Guidelines for Municipal Effluent Application to Land.

All work should proceed under complete engineering supervision with casual inspections by personnel of this office at certain stages of the work. All work must proceed in the dry.

The A, B and C distribution boxes should be built as shown with sufficient ports to satisfy the ultimate size of the two completed fields with a third port in the A type box to service the standby field if required.

The drain field can be constructed to suit any stage of development. It would probably be most efficient to construct at least 365 meters (1,200 feet) of trench at a time. This would consist of two fields each containing 183 meters (600 feet) of drain line to accommodate slightly over 5,000 gallons per day.

6.0 DESIGN OF DRAIN FIELD, cont'd.

6.6 Cont'd.

Samples of water from the Skookum Inn and from the spring to the west of the field should be analyzed chemically and for bacteria several times before the effluent is discharged into the disposal field. Once the field goes into operation these two water sources should be analyzed monthly for the first year.

The effluent discharge should be monitored according to Table 5-5 entitled Initial Monitoring Frequency for Effluent Discharges. This Table is on page 30 of the Pollution Control Objectives dated 1975.

7.0 CONCLUSIONS

7.1 Reference to section 4.3 on pages 24 6o 26 inclusive of the Pollution Control Guidelines for Municipal Effluent Application to Land (Draft) will show that the geologic, hydrologic and topographic characteristics of the proposed disposal site meet the Guidelines.

7.2 Available information on the groundwater regime of the general area beneath the proposed disposal site and beneath the lands between the site and Windermere Lake indicates that no free water table exists in the permeable sediments that lie between ground surface and the relatively impermeable pebbly silts, bedded silts, or clayey silts. There is no evidence to suggest that an ephemeral table ever exists even during the spring melt.

7.0 CONCLUSIONS, cont'd.

7.3 An artesian system is present within permeable beds or lens in the pebbly silt slope wash complex. At least 1.83 meters (6 feet) of relatively impermeable materials separates the water-bearing zones from the overlying permeable sediments (Test Pit 9).

7.4 The intervening distances between the proposed disposal fields and the Skookum Inn well and the spring plus the type of sediments, and the mode of occurrence of the groundwater leads us to judge that no contamination of these water sources will occur.

7.5 The disposal of 25,000 gallons per day should not cause instability of any slopes lakewards of the proposed disposal field nor should any artificial springs occur.

T A B L E 1

Observation point	Depth to water-bearing material (m)	Elevation top of water-bearing material (m)	Static water level depth (m)	elevation (m)	Type of sediment
T.P.3	3.96	851.94	3.66	852.24	Gravel interbeds in pebbly silt sequence
T.P.9	3.81	851.19	3.66	851.34	Ditto
T.H.1	18.29	822.71	0.00	841.00	Ditto
T.H.1A	9.75	831.85	0.60	841.00	Ditto
T.H.2	19.51	825.09	14.40	830.20	Interbedded sands and silts
T.H.3	14.02	834.88	11.39	837.51	Sand and gravel
T.H.4	4.34	849.36	4.34	849.36	Gravel interbeds in pebbly silts
Spring	0.00	820.00	0.00	820.00	- - -

T A B L E I I

ELEVATION OF TOP OF PEBBLY SILTS AND BEDDED SILTS

Test Pit	Surface Elevation Meters	Depth of Permeable Sediments Meters	Elevation Top of Silts Meters
1	855.9	4.1	851.8
2	854.1	3.0	851.1
3	855.9	1.5	854.4
4	859.9	2.7	857.2
5	861.3	1.5	859.8
6	875.0	1.2	873.8
7	858.0	3.5 plus	below 854.5
8	855.9	2.3	853.6
9	855.0	2	853.0
10	853.2	2.3	850.9
11	852.5	1.7	850.8
12	850.4	3.2	847.2
13	852.1	3.5 plus	below 848.6
14	852.7	1.5	851.2
15	853.4	1.7	851.7
16	853.5	1.5	852.0
Test Hole			
3	848.9	8.84	840.06
4	853.7	3.96	849.74
5	853.4	4.88	848.52

77-046

Tuesday 9/5/78 W.L.B.

AKISKINOOK

TEST PIT LOGS

T.P.1	Depth feet	Description	Depth meters
	0 - 1	Top soil, dark brown sandy loam (loess?).	0 - 0.3
	1 - 5½	Sand, tan, fine grained well sorted, uniform. Sample A for sieve analysis.	0.3 - 1.7
	5½ - 8½	Gravel, well rounded to 4 inches in diameter.	1.7 - 2.6
	8½ - 13½	Pebbly clay, till-like mixture but not compact or cemented and without till "pie crust" structure. Probably slope wash or mud-flow. Sample B for sieve analysis.	2.6 - 4.1

Percolation test in 1' x 1' x 1½' hole.
Times to drop 6 to 5 inches of water.

Minutes and seconds per inch:

1	0
1	5
1	10
1	15
1	12
1	12
1	12

Hole DRY. Surface elevation 855.9 m.

AKISKINOOK TEST PIT LOGS cont'd.

T.P.2	Depth feet	Description	Depth meters
	0 - 1	Top soil, as above.	0 - 0.3
	1 - 10	Sand, as above. Sample C for sieve analysis.	0.3 - 3
	10 - 13	Silt, clayey, tan. Sample D for sieve analysis.	3 - 4

Percolation tests in 1' x 1' x 1½' hole.

Minutes and seconds per inch:

0	35
0	40
0	45
0	44
0	44

Hole DRY. Surface elevation 854.1 m.

T.P.3	Depth feet	Description	Depth meters
	0 - 1	Top soil, as above.	0 - 0.3
	1 - 5	Gravel, well rounded, up to 4 inches diameter, loose.	0.3 - 1.5
	5 - 13½	Pebbly, silty, clay, till-like mixture with thin (1-2 inch) sand and gravel interbeds. Water at 13 feet. Static water level 12 feet from ground surface after 6 hours.	1.5 - 4.1

Percolation tests in 1' x 1' x 1½' hole.

Minutes and seconds per inch:

2	41
2	54
3	15
3	15
3	15

Surface elevation 855.9 m.

AKISKINOOK TEST PIT LOGS cont'd.

T.P.4	Depth feet	Description	Depth meters
	0 - 1	Soil, as above.	0 - 0.3
	1 - 5½	Silt, sandy, loose possibly loess.	0.3 - 1.7
	5½ - 9	Gravel, as above.	1.7 - 2.7
	9 - 12	Pebbly silt, as above.	2.7 - 3.7
	12 - 13	Till, hard, compact gradational contact with pebbly silt.	3.7 - 4.0

Percolation tests in 1' x 1' x 1½' hole.

Minutes and seconds per inch:

1	20
1	20
1	18
1	17

Hole DRY. Surface elevation 859.9 m.

T.P.5	Depth feet	Description	Depth meters
	0 - 4	Silt, sandy, tan.	0 - 1.2
	4 - 5	Gravel, loose, to 1-inch in diameter, rounded.	1.2 - 1.5
	5 - 7	Pebbly silt, as above.	1.5 - 2.1
	7 - 8	Till, hard, compact.	2.1 - 2.5
	Hole DRY.	Surface elevation 861.3 m.	

AKISKINOOK TEST PIT LOGS cont'd.

T.P.6	Depth feet	Description	Depth meters
	0 - 4	Silt, sandy, tan.	0 - 1.2
	4 - 5	Till, hard, compact.	1.2 - 1.5
	Hole DRY.	Surface elevation 875.0 m.	

T.P.7	Depth feet	Description	Depth meters
	0 - 2½	Sand, very fine grained, silty, tan (loess?).	0 - 0.8
	2½ - 11½	Sand and gravel, interbedded horizontal bedding, well rounded pebbles, loose sand medium grained.	0.8 - 3.5

Percolation tests in 1' x 1' x 1½' hole.

Minutes and seconds per inch:

3	25
3	20
3	22
3	22
3	21

Hole DRY. Surface elevation 858.0 m.

T.P.8	Depth feet	Description	Depth meters
	0 - 2½	Silt, sandy, tan (loess?).	0 - 0.8
	2½ - 4½	Sand, fine grained, well sorted.	0.8 - 1.4
	4½ - 7½	Sand and gravel, interbedded as above.	1.4 - 2.3
	7½ - 13½	Pebbly silt, as above.	2.3 - 4.1

AKISKINOOK TEST PIT LOGS cont'd.

T.P.8 Cont'd.

Percolation tests in 1' x 1' x 1½' hole.

Minutes and seconds per inch:

1	35
1	35
1	40
1	40
1	40

Hole DRY. Surface elevation 855.9 m.

T.P.9	Depth feet	Description	Depth meters
	0 - 5½	Sand, fine grained, as above.	0 - 1.7
	5½ - 6½	Gravel, fine, rounded to 1-inch diameter.	1.7 - 2
	6½ - 12½	Pebbly silt, as above. Water in bottom to depth below ground surface of 12 feet after 3 hours.	2 - 3.8

Surface elevation 855.0 m.

T.P.10	Depth feet	Description	Depth meters
	0 - 7½	Sand, as above.	0 - 2.3
	7½ - 12½	Pebbly silt, as above.	2.3 - 3.8

Hole DRY. Surface elevation 853.2 m.

AKISKINOOK TEST PIT LOGS cont'd.

T.P.11	Depth feet	Description	Depth meters
	0 - 5½	Sand, as above.	0 - 1.7
	5½ - 12½	Silt, clayey, bedded with ¼-inch thick beds, fine grained sand partings on beds.	1.7 - 3.8
	12½ - 15½	Sand, as above.	3.8 - 4.7

Percolation tests in 1' x 1' x 1½' hole.

Minutes and seconds per inch:

1	45
1	50
1	50
1	50

Hole DRY. Surface elevation 852.5 m.

T.P.12	Depth feet	Description	Depth meters
	0 - 10½	Sand, as above.	0 - 3.2
	10½ - 14½	Pebbly clay, as above.	3.2 - 4.4
	Hole DRY.	Surface elevation 850.4 m.	

T.P.13	Depth feet	Description	Depth meters
	0 - 3½	Silt, sandy, tan.	0 - 1.1
	3½ - 11½	Sand, coarse grained, with pea gravel inter-beds, cross-bedded, grey.	1.1 - 3.5

Percolation tests in 1' x 1' x 1½' hole.

Minutes and seconds per inch:

2	30
2	35
2	40
2	40
2	40

Hole DRY. Surface elevation 852.1 m.

AKISKINOOK TEST PIT LOGS cont'd.

T.P.14	Depth feet	Description	Depth meters
	0 - 5	Sand, as above.	0 - 1.5
	5 - 9½	Silt, well bedded, as in T.P.11 with a few pebbles.	1.5 - 2.9
	9½ - 11½	Sand, coarse grained grey.	2.9 - 3.5
	Hole DRY.	Surface elevation 852.7 m.	

T.P.15	Depth feet	Description	Depth meters
	0 - 1½	Silt, sandy.	0 - 0.5
	1½ - 5½	Sand, as above.	0.5 - 1.7
	5½ - 10½	Silt, well bedded, as in T.P.11.	1.7 - 3.2
	10½ - 11½	Sand, coarse grained grey.	3.2 - 3.5
	Percolation tests in 1' x 1' x 1½' hole.		
	Minutes and seconds per inch:		
	6 35		
	6 35		
	6 35		
	6 34		
	Hole DRY.	Surface elevation 853.4 m.	

T.P.16	Depth feet	Description	Depth meters
	0 - 5	Sand, as above.	0 - 1.5
	5 - 10	Silt bedded as in T.P.11.	1.5 - 3.0
	Hole DRY.	Surface elevation 853.5 m.	

FIELD OBSERVATIONS

Cliff - Sequence of finely layered silts and fine grained sands, brown to tan. No seepages from cliff face. Small talus slope at base of cliff above muddy beach. Beach is wet but no streamlets observed. Beach may coincide with silty clays encountered in test holes.

Springs KK - Small arcuate cutbank. No standing or flowing water visible where spring should form.

EE - Small streamlet forms where spring should be. Spring flows from steep bank at less than an estimated one gpm.

77-046

AKISKINOOK

TEST HOLE LOGS

* Hole 1 Elevation 841 m

Depth feet	Description	Depth meters
0 - 30	Tan silty very find sand.	0 - 9.14
30 - 35	Tan medium sand.	9.14 - 10.67
35 - 55	Grey silty clay.	10.67 - 16.76
55 - 60	Stoney clay.	16.76 - 18.29
60 - 70	Silty very fine sand, water-bearing, static water level at surface slight flow.	18.29 21.34
70 - 75	Silty clay, pebbles, till-like.	21.34 - 22.86
75 - 90	Hard silty clay, stoney, till-like.	22.86 - 27.43
90 - 100	Soft silty clay, pebbly, till-like.	27.43 - 30.48

* Hole 1A Elevation 841.6 m

Depth feet	Description	Depth meters
0 - 6	Tan medium sand.	0 - 1.83
6 - 26	Tan silty fine sand.	1.83 - 7.92
26 - 32	Tan silty fine sand, stones.	7.92 - 9.75
32 - 36	Grey silty fine sand, stones. (static water level 0.6 m) water-bearing.	9.75 - 10.97
36 - 40	Grey clayey stoney silt, compact, till-like.	10.97 - 12.19

AKISKINOOK TEST HOLE LOGS cont'd.

* Hole 2 Elevation 844.6 m

Depth feet	Description	Depth meters
0 - 15	Tan silty fine grained sand, some medium grained sand interbeds.	0 - 4.57
15 - 18	Same, few pebbles.	4.57 - 5.49
18 - 25	Tan fine sand.	5.49 - 7.62
25 - 42	Tan silty fine sand, wet.	7.62 - 12.80
42 - 47	Grey silty clay, plastic.	12.80 - 14.33
47 - 58	Grey clayey silt.	14.33 - 17.68
58 - 64	Grey silt, hard.	17.68 - 19.51
64 - 100	Clayey, sandy silt, soft, fine grained sand interbeds water-bearing (static water level 14.40 m).	19.51 - 30.48

* Hole 3 Elevation 848.9 m

Depth feet	Description	Depth meters
0 - 14	Tan silty fine sand.	0 - 4.27
14 - 18	Same, damp.	4.27 - 5.49
18 - 29	Same, wet.	5.49 - 8.84
29 - 38	Tan sandy silt and gravel, wet.	8.84 - 11.58
38 - 46	Tan silty medium sand and gravel, compact.	11.58 - 14.02
46 - 47	Grey silty medium to coarse sand and gravel, wet, (static water level 11.39 m).	14.02 - 14.33

AKISKINOOK TEST HOLE LOGS cont'd.

Hole 3 Cont'd.

Depth feet	Description	Depth meters
47 - 54	Silty gravel, hard.	14.33 - 16.46
54 - 58	Grey silty sand, wet.	16.46 - 17.68
58 - 85	Same, some pebbles, stiff.	17.68 - 25.91
85 - 100	Grey clayey silt, few pebbles, stiff.	25.91 - 30.48
	- Hole bored with very little slippage.	

* Hole 4 Elevation 853.7 m

Depth feet	Description	Depth meters
0 - 13	Tan medium sand to coarse	0 - 3.96
13 - 40	Stoney silt, hard till-like, some fine sand interbeds with water (static water level 4.34 m).	3.96 - 12.19
	- Difficult boring and poor sample recovery.	

* Hole 5 Elevation 853.4 m

Depth feet	Description	Depth meters
0 - 16	Tan silty fine sand.	0 - 4.88
16 - 21	Same, stoney, wet.	4.88 - 6.40
21 - 28	Grey silty fine sand and stones.	6.40 - 8.53
28 - 35	Grey clayey stoney silt.	8.53 - 10.67

AKISKINOOK TEST HOLE LOGS cont'd.

Hole 5 Cont'd.

Depth feet	Description	Depth meters
35 - 44	Clayey silt probably with water-bearing sand interbeds, most of cuttings lost.	10.67 - 13.41
44 - 46	Grey clayey stoney silt, stiff.	13.41 - 14.02

* Hole 6 Elevation 844.3 m

Depth feet	Description	Depth meters
0 - 7	Tan silty fine sand.	0 - 2.13
7 - 12	Grey sandy silt, wet.	2.13 - 3.66
12 - 17	Grey sandy silt, hard.	3.66 - 5.18
17 - 22	Grey sandy silt, soft, some fine water-bearing interbeds.	5.18 - 6.71
22 - 27	Grey stoney silt, hard.	6.71 - 8.23
27 - 32	Clayey silt, poor recovery, water-bearing.	8.23 - 9.75
32 - 37	Grey stoney silt, soft, poor recovery.	9.75 - 11.28
37 - 42	Grey stoney silt, hard.	11.28 - 12.80
42 - 52	Grey stoney silt, soft.	12.80 - 15.85
52 - 72	Grey stoney silt, medium stiff, a few pebbles.	15.85 - 21.95
72 - 77	Same, soft.	21.95 - 23.47
77 - 87	Same, poor recovery.	23.47 - 26.52

AKISKINOOK TEST HOLE LOGS cont'd.

Hole 6 Cont'd.

Depth feet	Description	Depth meters
87 - 92	Same, poor recovery, traces of very fine sand interbeds, water-bearing.	26.52 - 28.04
92 - 100	Stoney silt, stiff. Traces of medium sand interbeds.	28.04 - 30.48

- Hole 6 samples poor in upper section due to auger slipping.
- Log above 11.28 meters should be ignored.

*Hole 6A Elevation 844.6 m

Depth feet	Description	Depth meters
0 - 14	Tan fine sandy silt, loose.	0 - 4.27
14 - 37	Same, compact.	4.27 - 11.28
37 - 40	Dark brown silty fine sand, wet.	11.28 - 12.19

- No distinct layering visible in upper 37'. Hole bored with very little slippage.

*Hole 7 Elevation 841.2 m

Depth feet	Description	Depth meters
0 - 3	Tan silty gravel.	0 - 0.91
3 - 45	Tan sandy silt.	0.91 - 13.72
45 - 66	Tan silty sand, wet.	13.72 - 20.12
66 - 71	Grey brown sandy silt, stiff.	20.12 - 21.64
71 - 100	Grey silty clay, stiff.	21.64 - 30.48

AKISKINOOK TEST HOLE LOGS cont'd.

* Hole 8 Elevation 844.8 m

Depth feet	Description	Depth meters
0 - 28	Tan sandy silt.	0 - 8.53
28 - 30	Tan medium sand, wet.	8.53 - 9.14
30 - 32	Same, stoney.	9.14 - 9.75
32 - 34	Tan clayey silt.	9.75 - 10.36
34 - 37	Tan silty sand.	10.36 - 11.28
37 - 51	Grey clayey silt, soft.	11.28 - 15.54
51 - 78	Grey clayey silt, stiff.	15.54 - 23.77
78 - 100	Grey silty clay, sticky and soft.	23.77 - 30.48

* Please note these test holes are shown as 78-1 to 78-8 on accompanying maps and cross-sections.

MecMan Engineering & Testing Ltd.

GRADATION CURVES

Client Land Logistics Western Limited file number 854I

Type of material Sand order number 1624

Location S.W. Corner D.L. 704 Highway 93/95

Hole #1 sample A depth 1 - 5½'

Sampled by Brown Oliver date 9/5/78

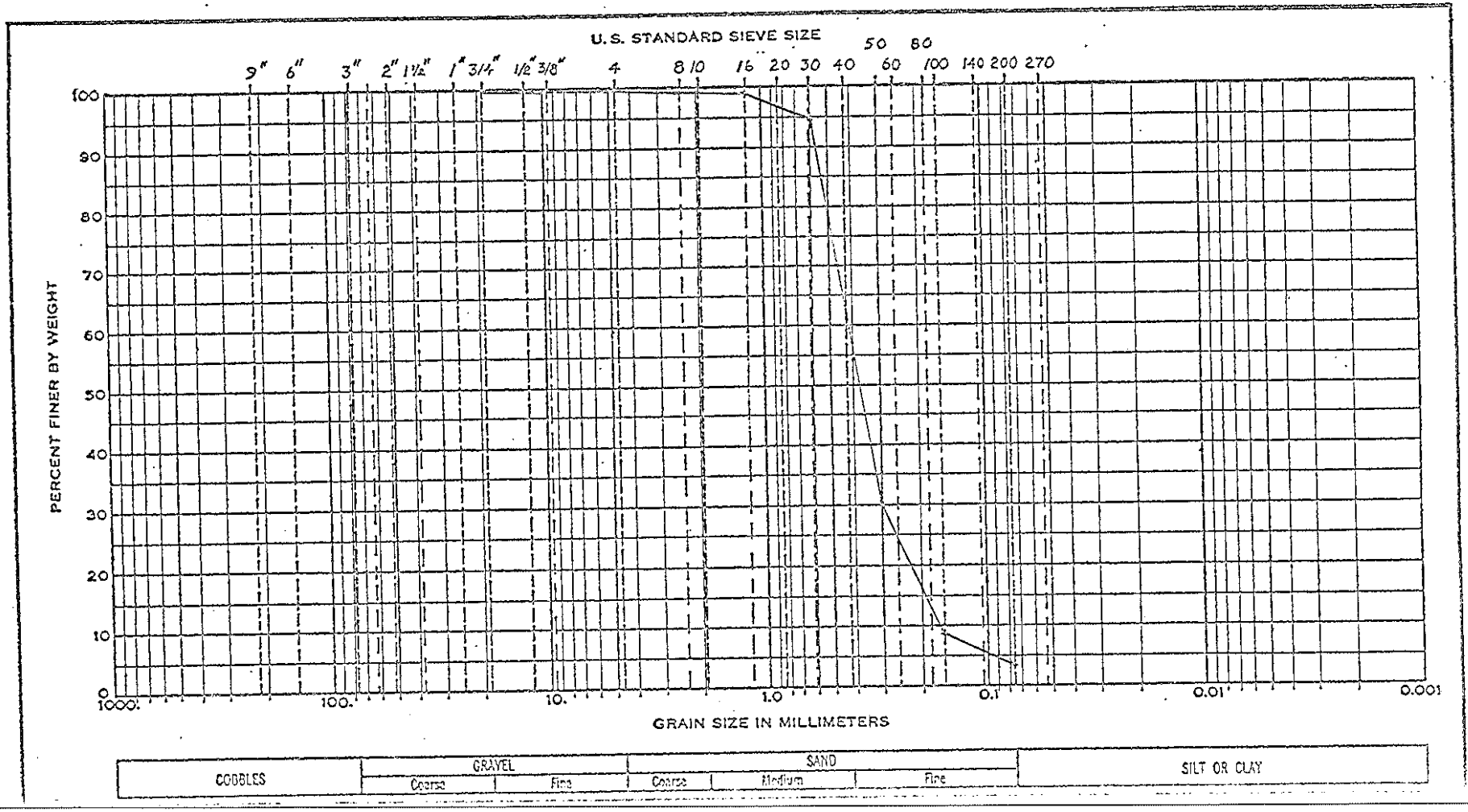
Washed analysis _____ dry analysis _____

D_{10} _____ D_{30} _____ D_{60} _____ Wl _____ PI _____

C_c _____ C_u _____ soil classification _____

Sieve Analysis

Sieve Size	% Passing
3/4	100.0
3/8	99.6
4	99.0
8	98.3
16	97.9
30	95.2
50	29.6
100	8.3
200	3.5



MecMan Engineering & Testing Ltd.

GRADATION CURVES

Client Land Logistics Western Limited file number 8541

Type of material Silty-Clay order number 1624

Location S.W. Corner D.L. 704 Highway 93/95

Hole #1 sample B depth 8½ - 13½'

Sampled by B. Brown & K. Oliver date May 9/78

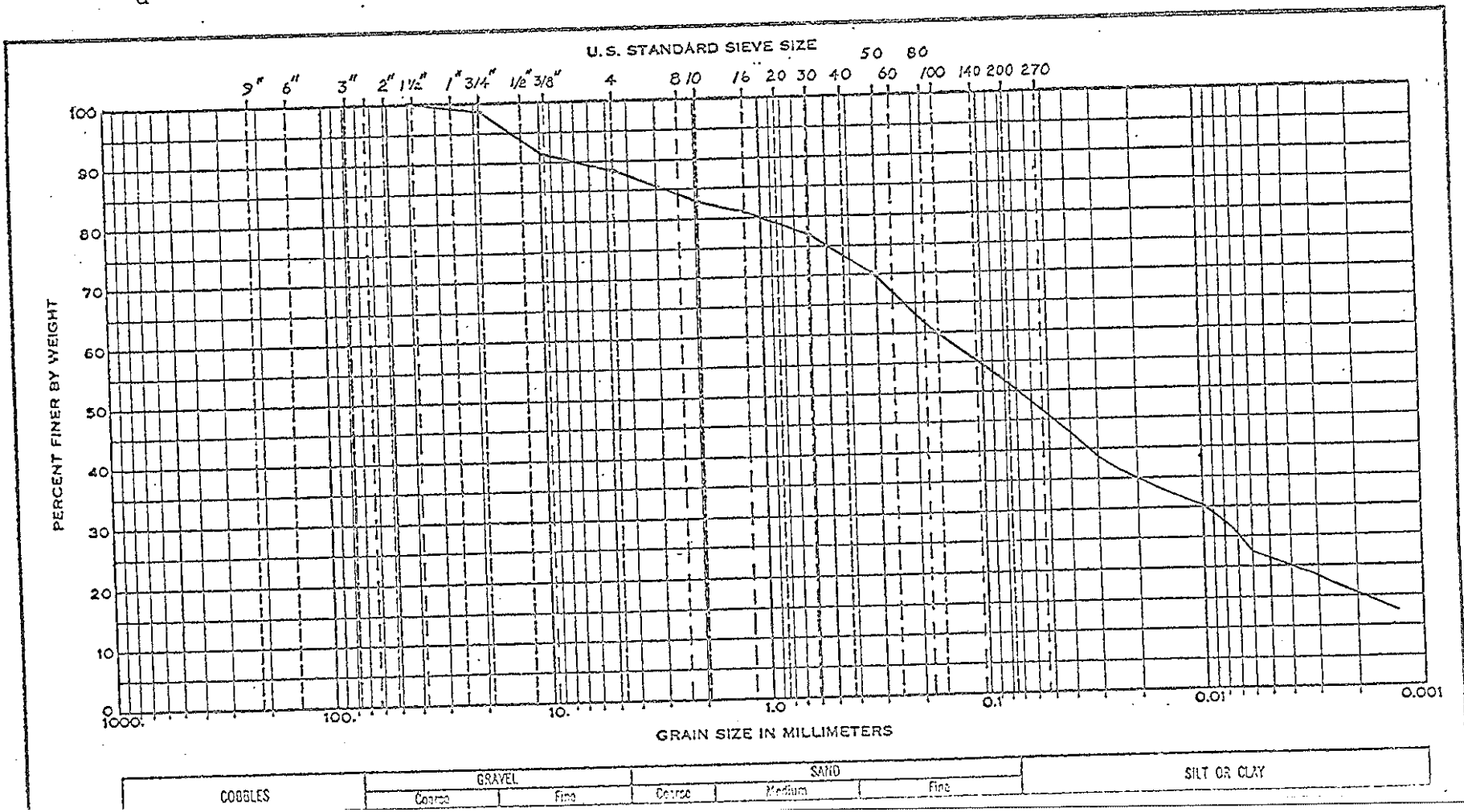
Washed analysis _____ dry analysis _____

D_{10} _____ D_{30} _____ D_{60} _____ W1 _____ PI _____

C_c _____ C_u _____ soil classification _____

Sieve Analysis of Hydrometer Sample

Sieve Size	% Passing
1 1/2	100.0
3/4"	97.9
3/8	92.0
#4	88.0
#10	83.0
#16	80.8
#30	76.7
#50	70.3
#100	60.0
#200	51.7



MecMan Engineering & Testing Ltd.

GRADATION CURVES

Client Land Logistics Western Limited file number 854-I

Type of material Silty-clay order number 1624

Location S. W. Corner D.L. 704 Highway 93/95

Hole #1 sample B depth 8½ - 13½'

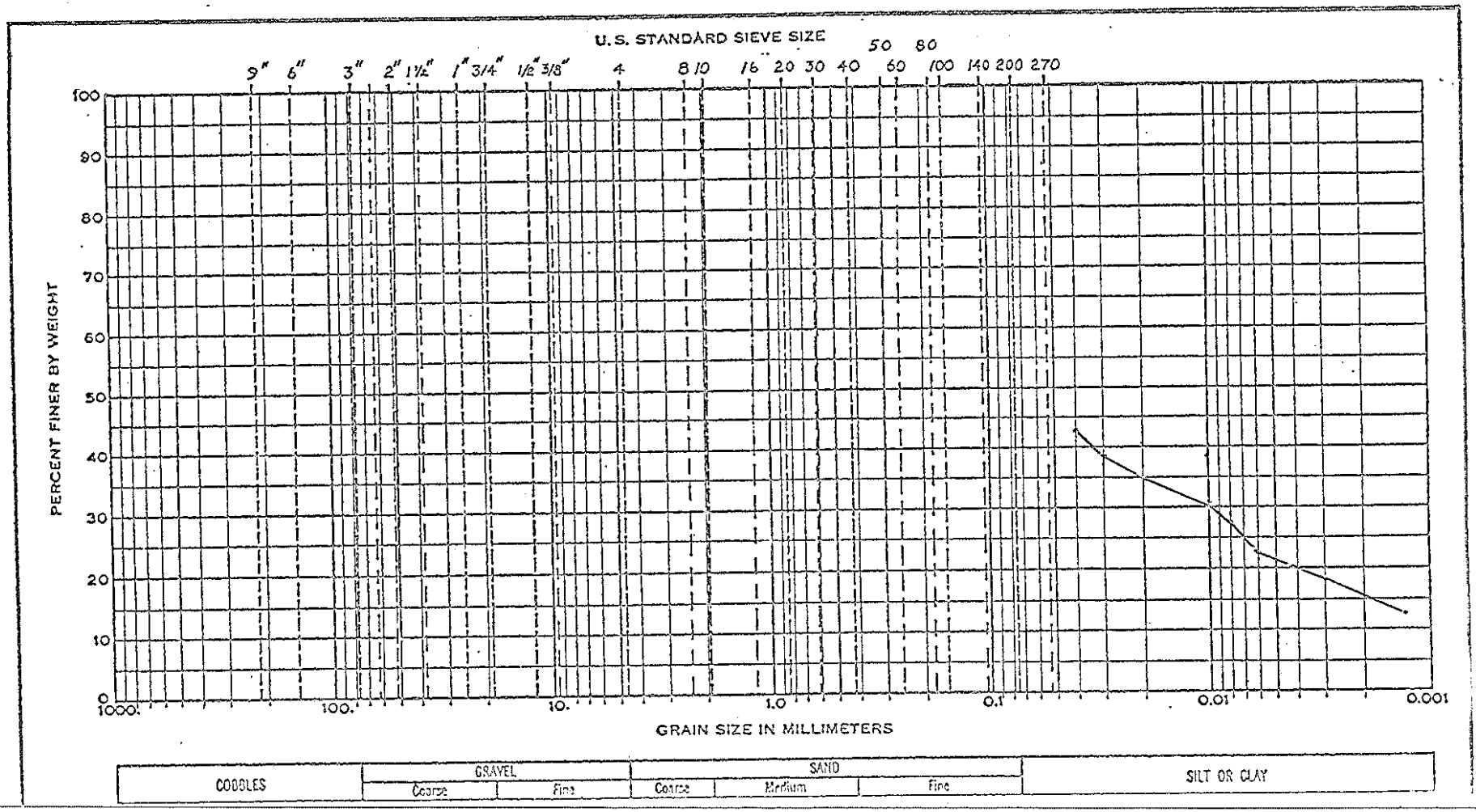
Sampled by B. Brown & K. Oliver date May 9/78

Washed analysis _____ dry analysis _____

D_{10} _____ D_{30} _____ D_{60} _____ Wl _____ PI _____

C_c _____ C_u _____ soil classification _____

Hydrometer Analysis	
Sieve Size	% Passing
0.041	43.0
0.030	38.3
0.019	34.9
0.011	30.2
0.0083	26.7
0.0060	23.2
0.0043	20.3
0.0030	18.0
0.0013	12.8



MecMan Engineering & Testing Ltd.

GRADATION CURVES

Client Land Logistics Western Limited file number 854I

Type of material Sand order number 1624

Location S.W. Corner D.L. 704 Highway 93/95

Hole #2 sample C depth 1 - 10'

Sampled by B. Brown & K. Oliver date May 9/78

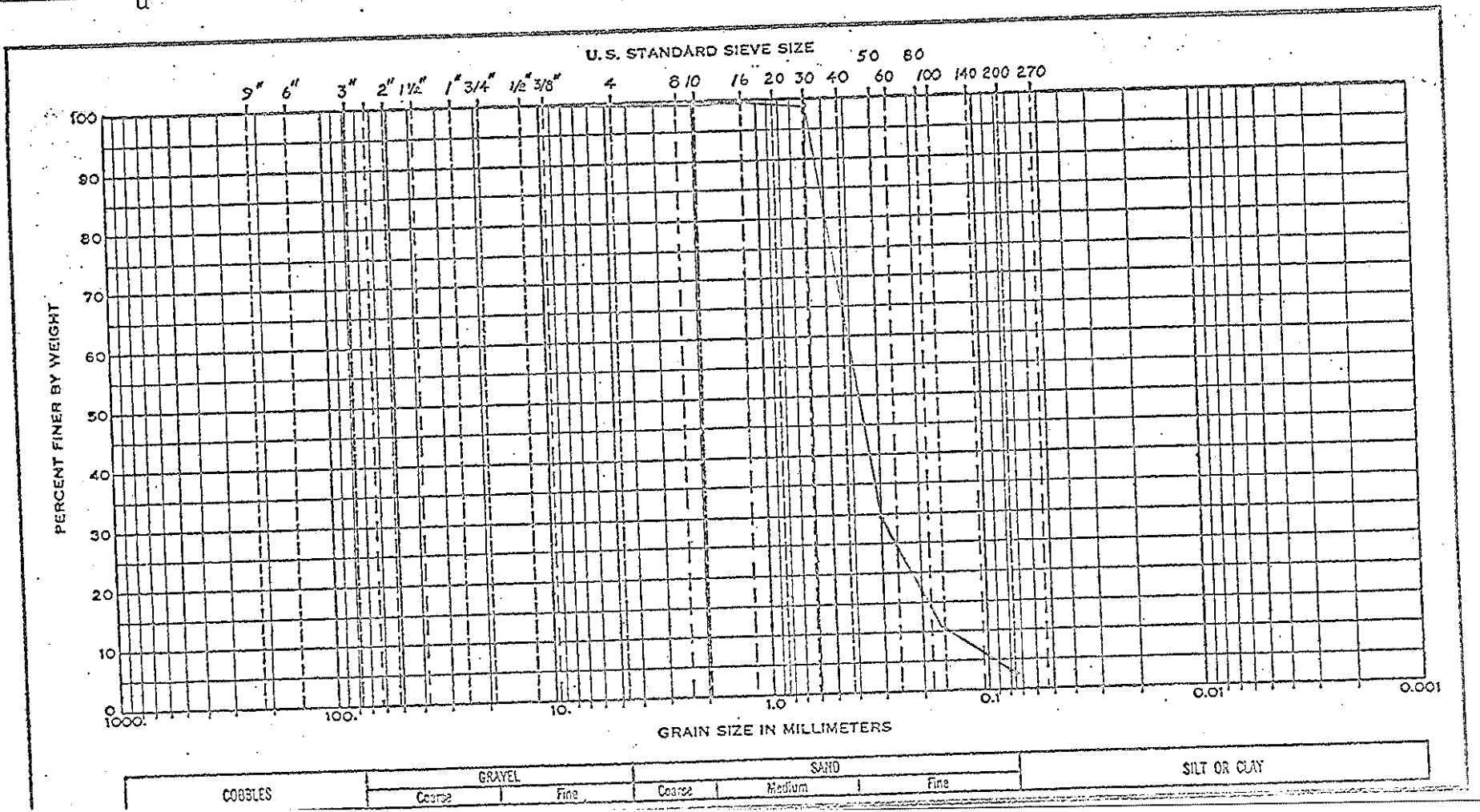
Washed analysis _____ dry analysis _____

D_{10} _____ D_{30} _____ D_{60} _____ Wl _____ PI _____

C_c _____ C_u _____ soil classification _____

Sieve Analysis

Sieve Size	% Passing
3/8	100
4	99.9
8	99.9
16	99.9
30	98.0
50	29.1
100	10.6
200	4.7



MecMan Engineering & Testing Ltd.

GRADATION CURVES

Client Land Logistics Western Limited file number 854I

Type of material Silty-Clay order number 1624

Location S.W. Corner of D.L. 704 Highway 93/95

Hole #2 sample D depth 10 - 13'

Sampled by B. Brown & K. Oliver date May 9/78

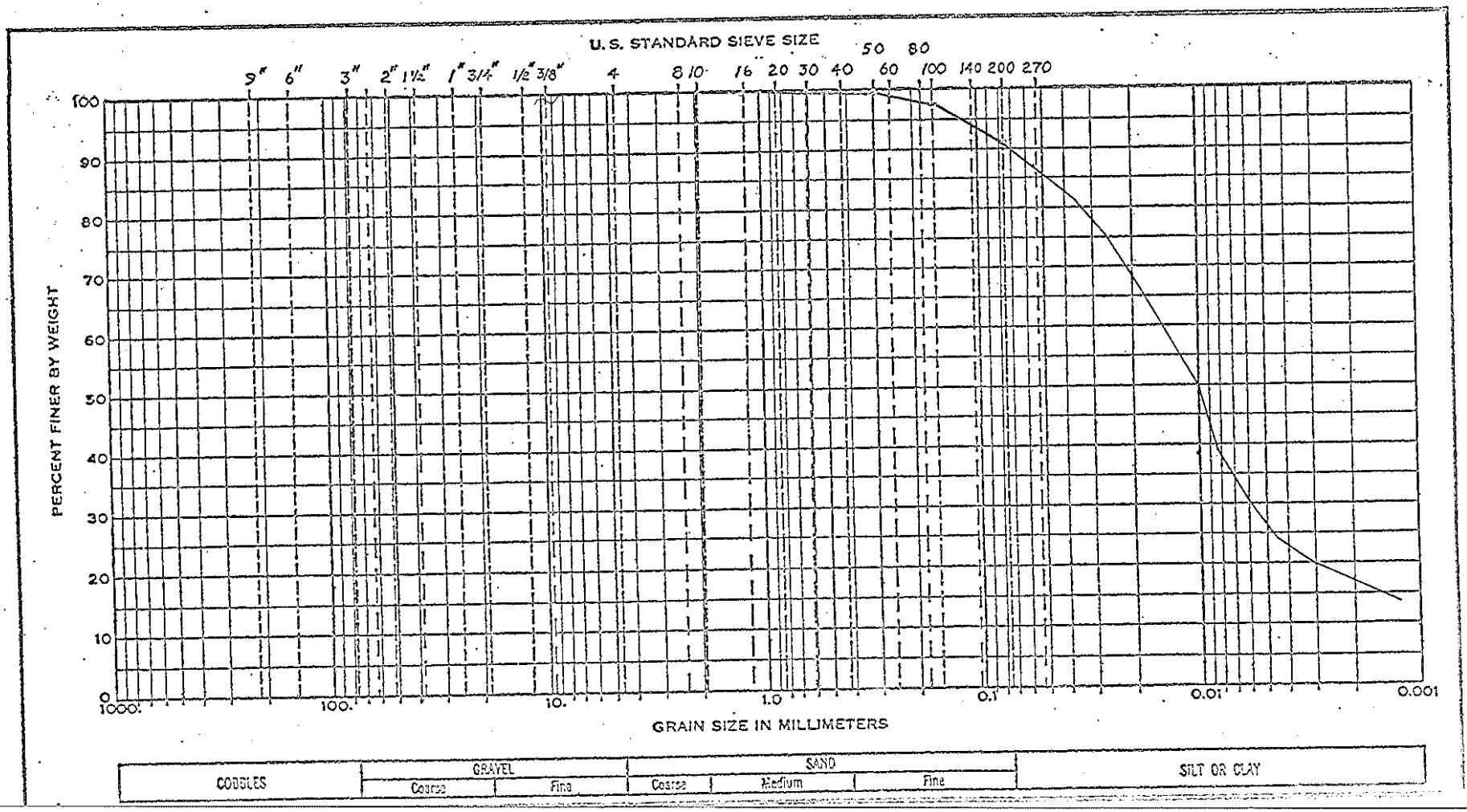
Washed analysis _____ dry analysis _____

D_{10} _____ D_{30} _____ D_{60} _____ Wl _____ PI _____

C_c _____ C_u _____ soil classification _____

Sieve Analysis of Hydrometer Sa

Sieve Size	% Passing
#10	100
#16	100
30	99.8
50	99.5
100	96.7
200	90.9



MecMan Engineering & Testing Ltd.

GRADATION CURVES

Client Land Logistics Western Limited file number 854I

Type of material Silty-Clay order number 1624

Location S.W. Corner D.L. 704 Highway 93/95

Hole #2 sample D depth 10 - 13'

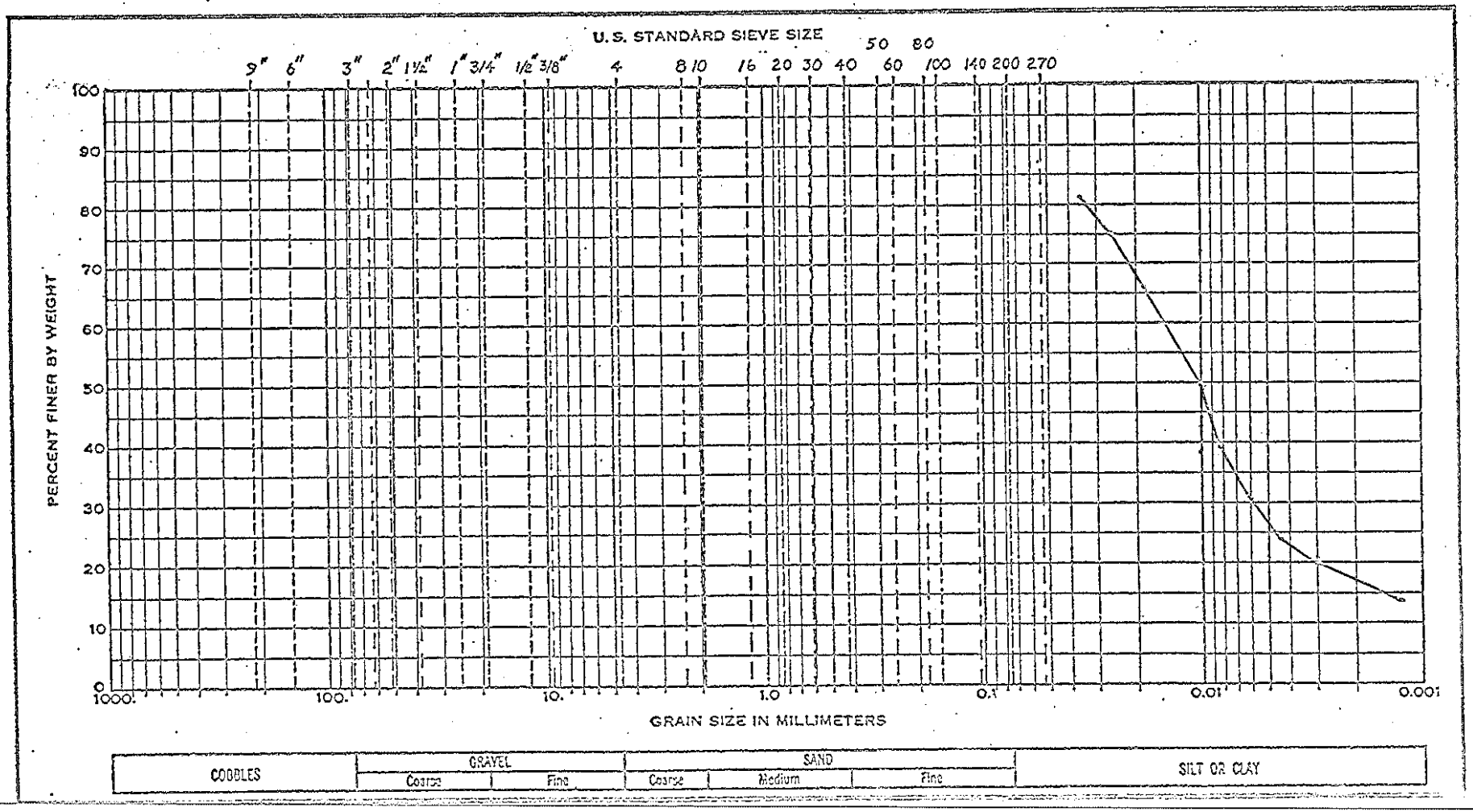
Sampled by B. Brown & K. Oliver date May 9/78

Washed analysis _____ dry analysis _____

D_{10} _____ D_{30} _____ D_{60} _____ Wl _____ PI _____

C_c _____ C_u _____ soil classification _____

Sieve Size	Hydrometer Analysis % Passing
0.036	82.3
0.026	74.7
0.018	66.3
0.011	50.3
0.0084	38.9
0.0061	30.5
0.0044	24.4
0.0031	19.8
0.0013	13.7



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GRADATION CURVES

Client Land Logistics Western Ltd. file number 854I

Type of material Silty-Clay order number 1624

Location S. W. Corner D.L. 704 Highway 93/95

Hole #4 sample E depth 1 - 5½'

Sampled by B. Brown & K. Oliver date May 9/78

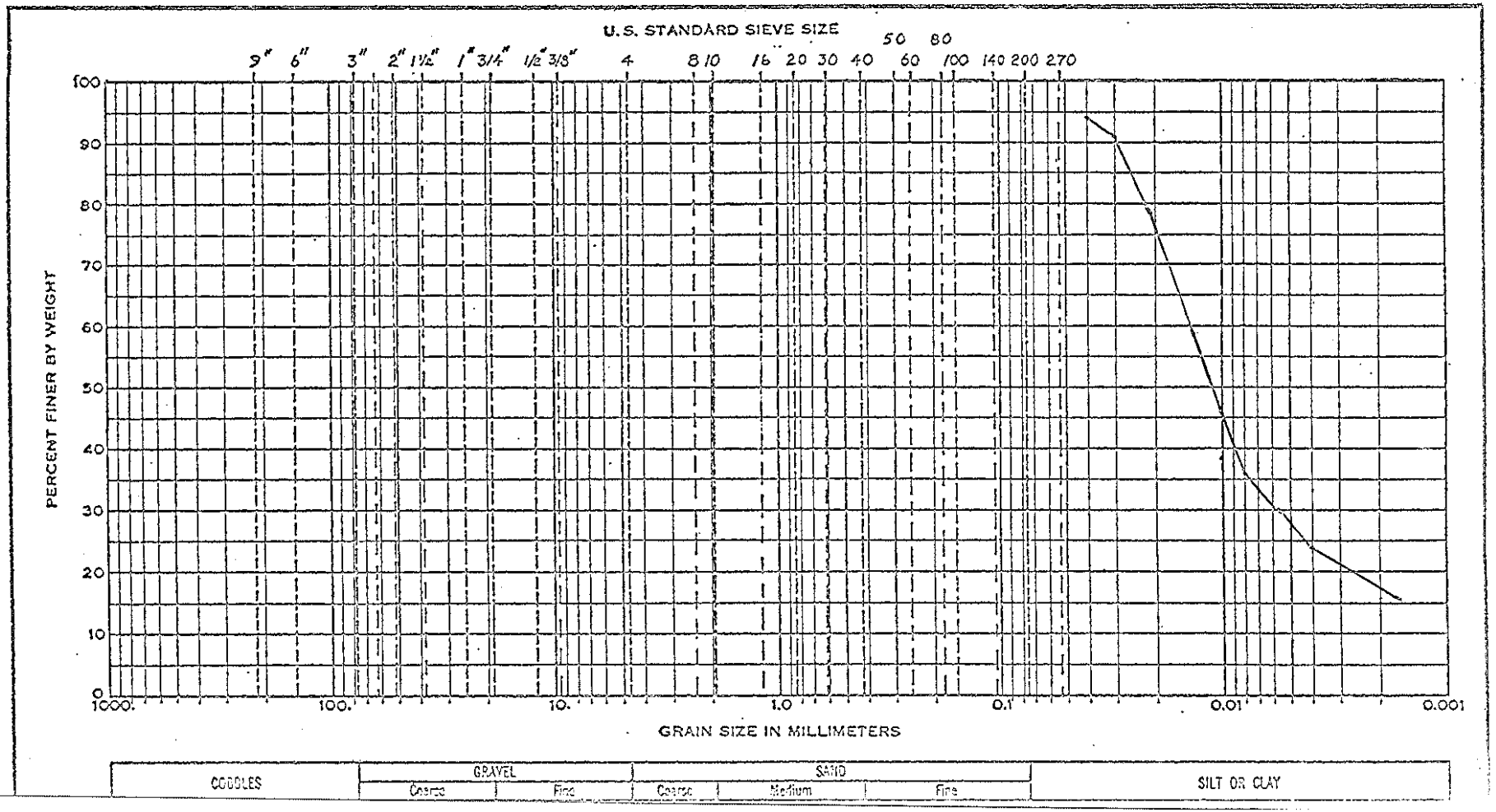
Washed analysis _____ dry analysis _____

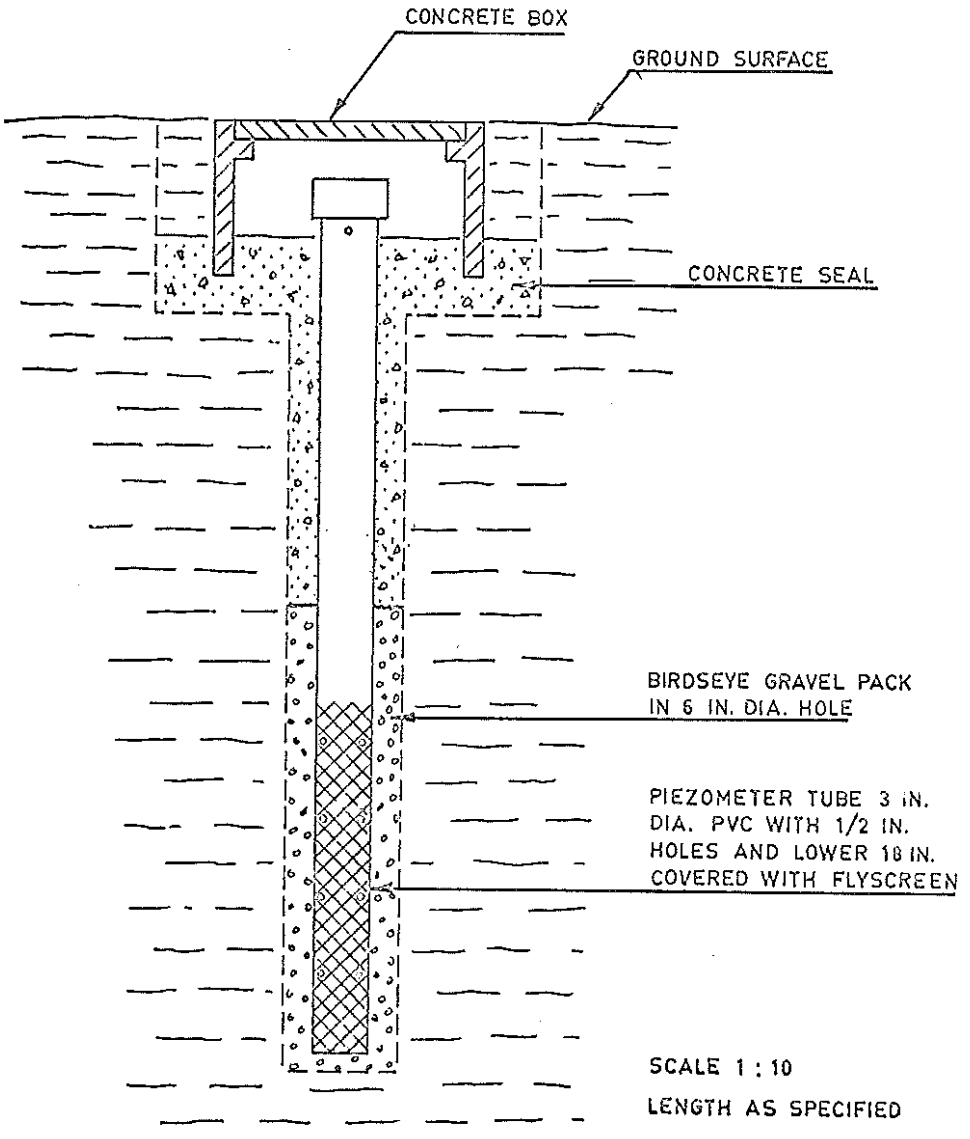
D_{10} _____ D_{30} _____ D_{60} _____ Wl _____ PI _____

C_c _____ C_u _____ soil classification _____

Hydrometer Analysis

Sieve Size	% Passing
0.0421	94.5
0.0308	91.4
0.0213	79.3
0.0141	57.9
0.0106	45.7
0.0079	35.8
0.0057	29.7
0.0040	24.4
0.0017	16.0





PIEZOMETER DETAIL

BROWN, ERDMAN & ASSOCIATES LTD.