Donohue

Investigation of Solvent Contamination in City of Delavan, Wisconsin Well No. 4 Water

Sta-Rite Industries, Inc.
Delavan Operations
Delavan, Wisconsin

May 1983

Donohue & Associates, Inc.
Engineers & Architects

INVESTIGATION OF SOLVENT CONTAMINATION IN CITY OF DELAVAN, WISCONSIN WELL NO. 4

INTRODUCTION

In January, 1983, Sta-Rite Industries, Inc., retained Donohue to investigate chlorinated solvent contamination of City Well No. 4 in Delavan, Wisconsin. The contamination was first found during a monitoring program in 1982. The City of Delavan suspected that the source of the solvent contamination was the Sta-Rite Industries Water Equipment Division Plant located approximately 1,000 feet east to northeast of City Well No. 4. The City retained Warzyn Engineering Company to investigate. With the cooperation of Sta-Rite Industries, Warzyn Engineering obtained soil and groundwater samples on Sta-Rite property. The samples were obtained in areas of potential contamination identified by Sta-Rite and in areas between the potentially contaminated areas and City Well No. 4. Warzyn issued a preliminary report of their findings on February 16, 1983, which indicated solvent contaminated water at the groundwater surface near the southeast wall of Plant No. 1 and soil and near-surface water contamination near the holding tank outside the north wall of Plant No. 2. Groundwater surface samples from wells between the identified contaminated areas and City Well No. 4 showed decreasing amounts of solvents as the distance from the identified contaminated areas near Plants No. 1 and No. 2 increased. Wells near the Sta-Rite property line showed little or no contamination.

Donohue placed additional groundwater monitoring and sampling wells to obtain data covering greater aerial and vertical distances and conducted a pumping test to determine aquifer characteristics. The goals of the work were to determine whether the discharge of solvent on Sta-Rite property could contribute to the contamination of Well No. 4 and to provide data for selecting remedial action if required. This report discusses the physical and chemical mechanisms of solvent movement in groundwater and soils, the results of our hydrogeological and analytical evaluations, and our conclusions and recommendations.

MOVEMENT OF CHLORINATED SOLVENTS IN GROUNDWATER AND SOILS

Federally sponsored surveys over the past ten years including the National Organics Reconnaissance Survey and the National Organics Monitoring Survey have found organic solvent contamination of groundwater supplies in 24 states. The broad distribution of the problem reflects the wide use of chlorinated solvents by industry, commercial establishments, and even households (1,2).

The magnitude of the groundwater contamination problem has encouraged increased research into the mechanisms of movement of chlorinated solvents in soils and groundwater. Numerous chemical and physical mechanisms affect the transport of chlorinated solvents. To date, research has provided better definition of individual mechanisms; however, no one has produced a satisfactory integrated model that combines the individual mechanisms. Nonetheless, it is instructive to review the research literature to provide an intuitive model for evaluating the results of a specific site investigation.

When solvents are spilled on the ground, a portion will evaporate and a portion will flow by gravity through the soil. The fraction that evaporates is a function of solvent volatility and weather conditions. The portion that does not evaporate will flow through the soil at a rate slower than water flow because the solvents have a chemical affinity for organic matter. Several studies indicate that this affinity can be described mathemetically in terms of a partition coefficient. In other words, these solvents appear to dissolve in the organic matter phase of soils and the solubility of solvents in soil organic matter appears to range from 100 to 1,000 times greater than the solubility in water (3-8). Table 1 shows the water solubilities of several chlorinated solvents. This model suggests two important conclusions. First, solvents will not be bound forever in the organic fraction of soils. As rainfall percolates through the soils, the solvents will gradually be released into the groundwater. The term "gradually" is important. If the affinity of the solvent for organic matter in the soil is very strong, the solvents might be held for many years before detectable amounts reach the groundwater. Second, solvents held near the soil surface by organic matter would have a better opportunity to evaporate, therefore, the total amount of solvent reaching the groundwater would be less than it would for a soil system with low solvent affinity. Wilson found that when solutions containing 200 μg/l of various chlorinated solvents were placed on the surface of sand columns 5 feet deep, between 20 and 60 percent of the solvents reached the 5-foot depth. Between 40 and 80 percent was evaporated.

Once these solvents pass through soil strata containing organic matter, the chemical attenuation mechanisms are reduced. The solvents do not tend to absorb strongly on clays, sands, or gravel. It is interesting and important to note that the chlorinated solvents apparently do not rapidly diffuse vertically into the groundwater (2). Studies have shown that the solvents tend to stay at the surface of the groundwater table even though the specific gravities of many of the solvents are greater than that of water. There are apparently a number of forces, including surface tension, that tend to maintain the solvent concentration at the surface. We would expect then that chlorinated solvents spilled on the soil surface would migrate primarily vertically to the surface of the groundwater then move across the surface of the groundwater in the direction of groundwater flow. The movement would not be as fast as the movement of the water because there is small but measurable affinity of the solvents for the material in the formation. The chlorinated solvents could be biologically modified in the near surface soils. Substantial removal by biological mechanisms is not expected however because the kinetics of biodegradation are slow. Once the solvents pass through the surface soils, biological degradation would be virtually nonexistent (9,10).

GEOLOGY/HYDROGEOLOGY

The City of Delavan is located over a bedrock valley which has been filled with glacial drift. This valley was formed when glacial erosion removed easily erodible bedrock. Ground moraine - deposited beneath the ice during advance and retreat of the glacial ice - filled the valley to a depth of approximately 400 feet beneath Delavan. This unconsolidated material consists of unsorted rock debris ranging from clay to boulder size.

TABLE 1

WATER SOLUBILITIES OF SELECTED CHLORINATED SOLVENTS

Solvent	Solubility mg/l	Source
Trichloroethylene	1,100	1
1,1,1 Trichloroethane	720	1
1,1 Dichloroethane	400	1
1,2 Dichloroethane	8,700	2
1,1,2 Trichloroethane	4,500	2
Tetrachloroethylene	150	3

Source: 1 Wilson et al. (1981) J. Environ. Quality 10,4

2 Drilling (1977) ES&T 11,4

3 Love and Eilers (1982) J. AWWA, August

The first encountered and principle aquifer in the area is a sand and gravel aquifer. It is formed by the unconsolidated sand and gravel deposits found in the ground moraine. The saturated thickness of this material is approximately 125 feet beneath Delavan. This thickness includes all saturated, permeable, unconsolidated material from the land surface to the relatively impermeable, finer-grained glacial drift beneath it. Values of the hydraulic conductivity for this sand and gravel aquifer are estimated to be 300 feet per day from the pump test data. This hydraulic conductivity is approximately 50 times greater than the hydraulic conductivity found in the underlying bedrock aquifer.

The water table map in the vicinity of Sta-Rite Industries and of Delavan in general shows the altitude of the water table dipping to the northwest. Recharge to this aquifer is controlled by the permeability of the overlying surface material. Most water in the area circulates through the unconsolidated material and shallow bedrock units and then discharges to the streams. Some groundwater seeps downward and recharges underlying aquifers because of a head difference between the unconsolidated sand and gravel and the bedrock aquifers. However, most flow occurs laterally. It is known that the area around Delavan Lake acts as a recharge area for the shallow groundwater system.

FIELD INVESTIGATIONS

Bore holes were advanced using a truck mounted Central Mine Equipment (CME) 55 Drill rig. Eight-inch hollow stem augers were advanced to a depth of 50 feet. Standard split spoon samples (ASTM Method D-1586) were taken at 5-foot intervals. All samples of soil recovered were visually and manually classified in the field by the drill foreman. Representative samples were enclosed in glass jars, labeled, and returned to the laboratory where they were further examined and reclassified by a soils engineer.

For borings deeper than 50 feet, a 4-1/2-inch tricone roller bit was employed. A grout mixture of two parts cement to one part bentonite powder was used for the wash borings.

All borings were then converted to wells with the installation of a 0.006-inch slotted screen flush threaded to Schedule 40 PVC. A washed sand pack was placed in the annular space surrounding the slotted screen. Above the screen, bentonite pellets and a bentonite grout slurry backfilled the annular space. Steel protector pipe was placed over the PVC well stem and cemented in place. For a detailed description and illustration, see Appendix A.

Following installation of the wells, each well was developed using a submersible pump or bailer. Temperature, pH, and conductivity measurements were taken during development. Before sampling, 2-1/2 standing volumes of water were removed with a bottom filling bailer in all wells except Donohue Well No. 2 where a submersible pump was used.

Using a bottom filling stainless steel bailer, a sample was obtained from the uppermost portion of the water column within the well. The sample was then transferred from the bailer to volatile vials for laboratory analysis. A sample blank (distilled water through samplers; then transferred to volatile vials) was also submitted to the laboratory as a quality assurance measure.

Table 2 shows the depth of the monitoring wells and screens. Figure 1 shows the location of the wells.

RESULTS OF MONITORING AND SAMPLING PROGRAM

Analysis of the groundwater elevation data indicates groundwater movement from southeast to northwest. The formation allows rapid horizontal groundwater movement. A linear velocity of two feet per day is reasonable.

Analysis of the groundwater samples are shown in Table 3. The data support the following statements:

1. The solvents remain near the surface of the groundwater (Donohue Well Nos. 5, 6, 9, and 10).

2. The areas of contaminated groundwater on Sta-Rite property have no affect on the water quality in City Well No. 4. Aquifer characteristics determined during the pumping test indicate the flow paths of water entering City Well No. 4 do not contact identified contaminated areas.

3. A reasonable explanation of the contamination of City Well No. 4 is a point discharge in the immediate vicinity of the well.

4. There is significant contamination of the groundwater at the groundwater table in Donohue Well No. 5. Donohue Well No. 5 is downgradient from the identified point of contamination near Sta-Rite Plant 1. Also, the ratio concentrations of the major solvents identifed are similar in Donohue Well No. 5 and Warzyn Well No. 4. These data strongly suggest that the contaminants originate from the contaminated area near Plant No. 1.

5. Migration of the contaminant plume is to the northwest. Groundwater flow conditions would confine the majority of the contaminant to the very shallow flow paths. The plume would migrate beneath the City of Delavan and eventually discharge to Turtle Creek and Comus Lake. Our initial investigations shows no wells in the area. We are checking further.

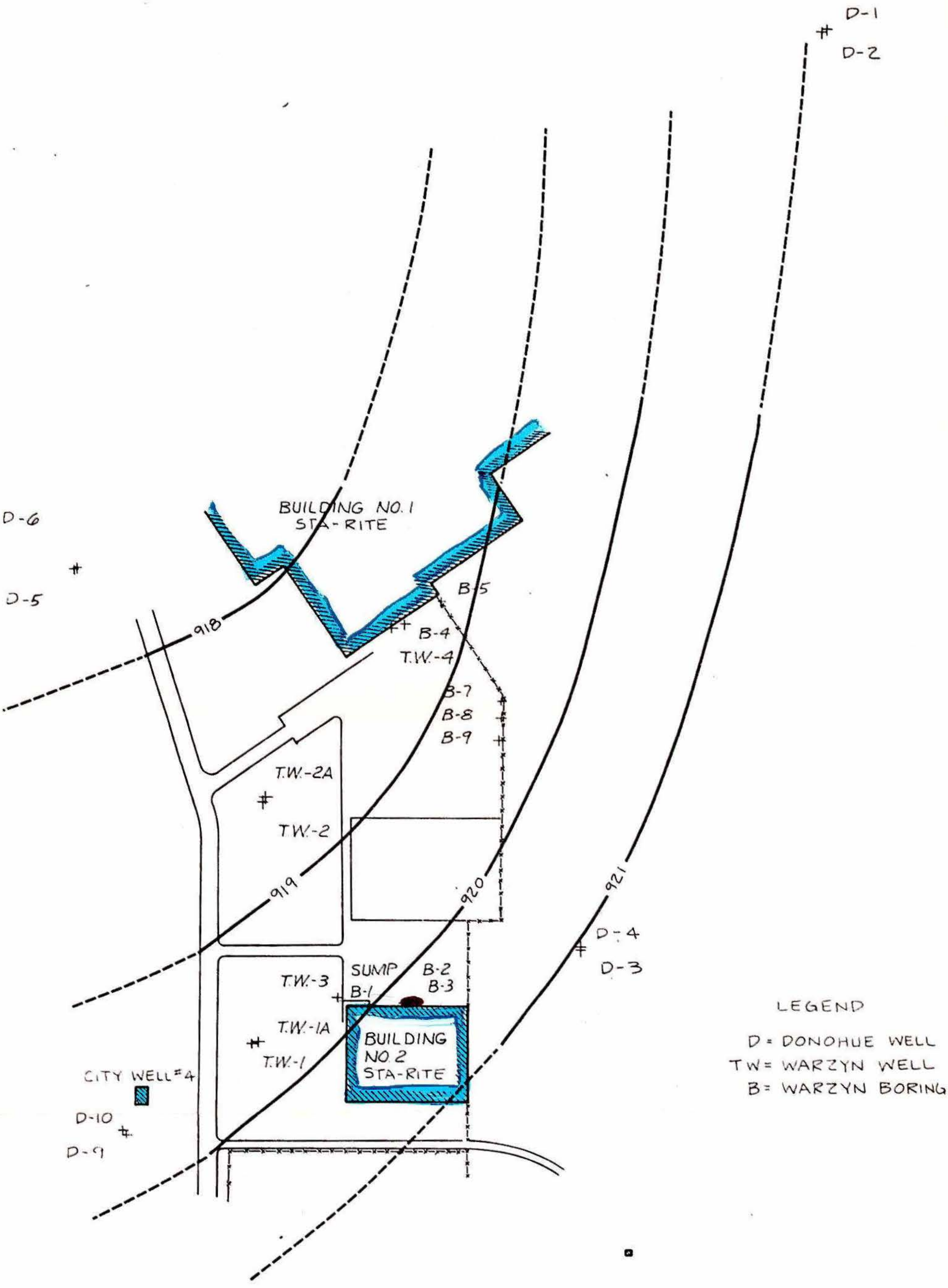
We recommend remedial action relative to soils at Plant 2. Since movement of the plume from Plant 1 does not affect the municipal water supply, additional remedial action might not be warranted with respect to Plant 1. Because there are no longer discharges of solvents from Sta-Rite operations, the remedial actions on plant property should insure steady improvement in groundwater quality downgradient from the site, if there are no off-site sources downgradient. We also recommend continued monitoring of on-site well TW-4 and off site wells D-5 and D-6.

TABLE 2

MONITORING WELL INFORMATION
Delavan, Wisconsin

Well No.	Well Depth	Screen Depth	Depth of Water Table
D-1	50	30 - 50	28.0
D-2	110	100 - 110	27.9
D-3	50	30 - 50	26.3
D-4	80	70 - 80	26.9
D-5	50	30 - 50	26.4
D-6	110	100 - 110	26.3
D-9	50	30 - 50	16.0
D-10	110	100 - 110	16.0
TW-1	44	24 - 44	19.7
TW-1A	85	75 - 85	19.8
TW-2	51	32 - 51	23.8
TW-2A	90	80 - 90	23.3
TW-3	48	29 - 48	24.0
TW-4	50	31 - 50	29.7

D = Donohue well
TW = Warzyn well



Donohue

12894.002
April, 1983

Engineers & Architects

WATER TABLE MAP

FOLEY & LARDNER
INVESTIGATION OF SOLVENT CONTAMINATION

N
0 100 300

FIGURE 1

TABLE 3

WELL WATER ANALYSES
Delavan, Wisconsin

Well Number	Donohue Sample No.	Methylene Chloride	1,1 Dichloro-ethylene	Trans 1,2 Dichloroethylene	1,1,1 Trichloro-ethane	Trichloro-ethylene	Tetrachlo-roethylene	Toluene	Ethylbenzene
D-1	4345	<1	<1	<1	<1	<1	<1	<1	<1
D-2	4306	<1	<1	<1	<1	<1	<1	2	<1
D-3	4346	<1	<1	<1	<1	<1	<1	<1	<1
D-4	4347	<1	<1	<1	<1	<1	<1	<1	<1
D-5	4307	<25	150	19	1,800	500	<1	<1	<1
D-6	4348	<1	<1	<1	<1	<1	<1	<1	<1
D-9	4308	<1	<1	<1	10	2	<1	<1	<1
D-10	4317	<1	<1	<1	<1	<1	<1	<1	<1
TW-1	4311	<1	<1	<1	3	3	<1	2	<1
TW-1A	4312	<1	<1	<1	<1	<1	<1	<1	<1
TW-2	4313	<1	<1	<1	<1	<1	<1	<1	<1
TW-2A	4314	<1	<1	<1	<1	<1	<1	3	<1
TW-3	4315	<1	<1	<1	4	32	<1	<1	<1
TW-4	4316	<100	1,100	<100	12,500	3,400	<100	<100	<100
Pond Well	4309	<1	<1	<1	<1	<1	<1	<1	<1
City 4	4310	<1	<1	<1	<1	56	11	<1	<1

D = Donohue well
TW = Warzyn well

REFERENCES

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2 Borchers, Harry (1983), Northtown Water Authority, Philadelphia, PA, Phone Conversation, February 17.

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6 Chiou, Peters and Freed (1979), A Physical Concept of Soil-Water Equilibria for Nonionic Organic Compounds, Science Vol 206, 16, November.

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12 Love and Eilers (1982), Treatment of Drinking Water Containing Trichloroethylene and Related Industrial Solvents, J AWWA, August, p 413.

13 Edwards (1983), Cleanup of Chemically Contaminated Sites, Chemical Engineering February p 73.

14 McCarty, Sutherland et al. (1979), Volatile Organic Contaminants Removal by Air Stripping, AWWA Seminar Proc, San Francisco.

15 Symons (1979), Removal of Organic Contaminants from Drinking Water Using Techniques Other Than Granular Activated Carbon Alone, EPA Report EP1.2: Or 3/6.

APPENDIX A

TEST BORING AND WELL INSTALLATION REPORT

Test Borings & Well Installation
Sta-Rite Industries
293 South Wright Street
Delavan, Wisconsin

For

Donohue & Associates, Inc.
4738 North 40th Street
P.O. Box 1067
Sheboygan, Wisconsin 53081

By

Wisconsin Testing Laboratories

Job Number S-8315

March 31, 1983

Wisconsin
TESTING LABORATORIES

Testing and Inspection of:
Soils
Concrete
Asphalt
Geotechnical Reports
Soil Borings
Rock Coring

March 31, 1983

Donohue & Associates, Inc.
4738 North 40th Street
P.O. Box 1067
Sheboygan, Wisconsin 53081

Attention: Joan Underwood

Re: Test Borings and Well Installation
Sta-Rite Industries
293 South Wright Street
Delavan, Wisconsin
(S-8315)

Gentlemen:

Submitted herewith in bound form are all field and laboratory data obtained with regard to the referenced project. We are also submitting at this time one loose (stapled) copy of the assembled data. Preliminary copies of the boring logs were submitted earlier. The field and laboratory phases were completed in general accordance with our original agreement and as directed by the client.

Data submitted herewith include the laboratory grain size and Atterberg limits (LL and PL) results, laboratory permeability results, logs of well installations, and logs of soil test borings. The Atterberg limits results can be found on the grain size analysis curve sheets. Included at the rear of the boring logs are descriptions of our field sampling procedures and our soil classification system.

Representative portions of the soil samples are being stored in our laboratory at this time. We ask that you notify us in writing as soon as possible as to when these samples can be discarded, or as to other disposition of them.

We have appreciated the opportunity to be of service to you on this project. If there are any questions, of if we can be of any further assistance, do not hesitate to call our office.

Very truly yours,

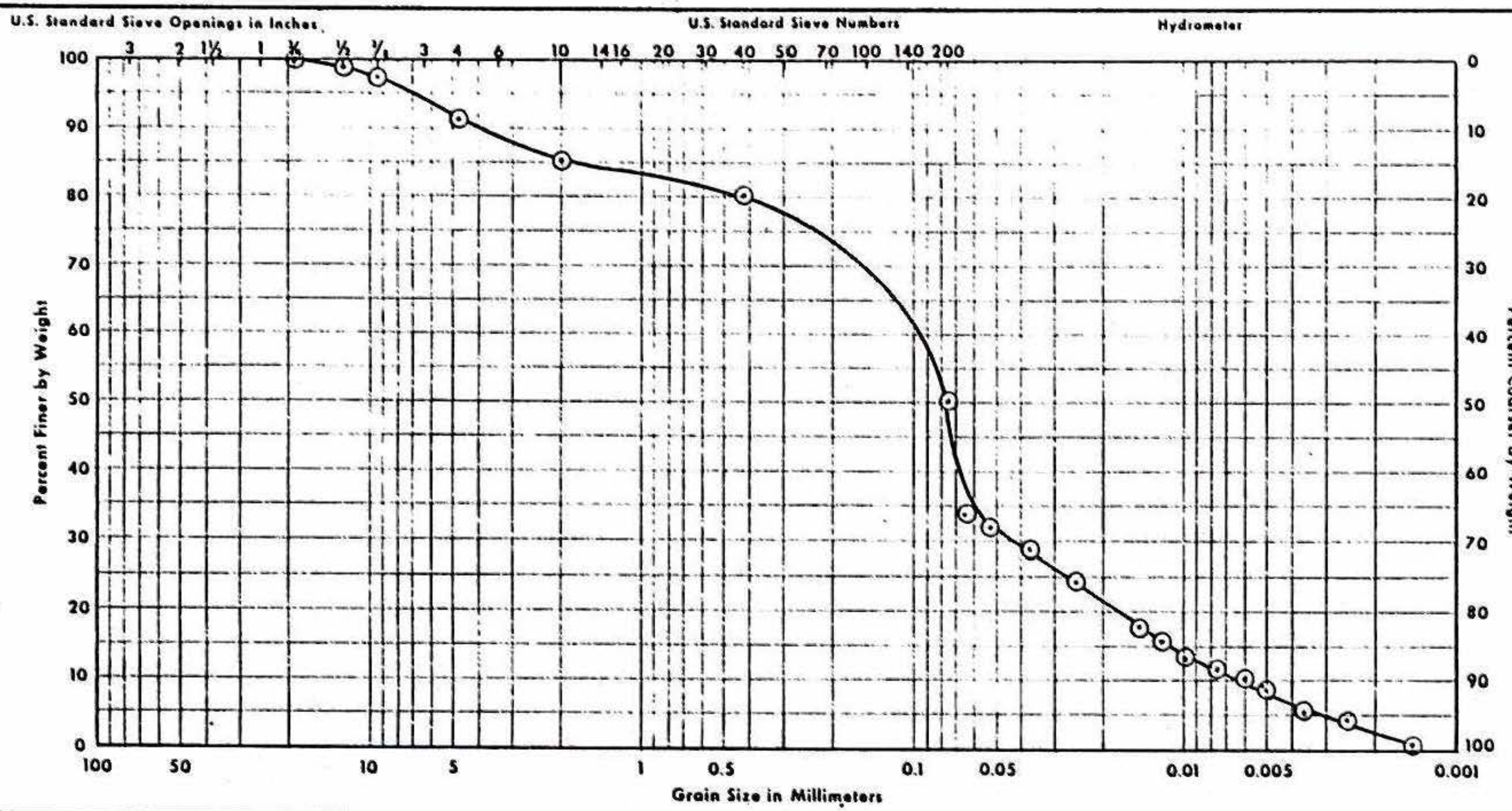
Jeffrey G. Smith
Geotechnical Engineer

JGS/JG

Copies (2) Client

N59 W14176 Kaul Avenue/Menomonee Falls, WI 53051/(414) 252-3300

GRAIN SIZE ANALYSIS



UNIFIED	GRAVEL	SAND		SILT OR CLAY	
AASHO	GRAVEL	COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	w	w_L	w_P	CLASSIFICATION
MW-2	43½-45				Brown clayey sandy silt to clayey silty sand, trace fine to coarse gravel. (ML-SM)

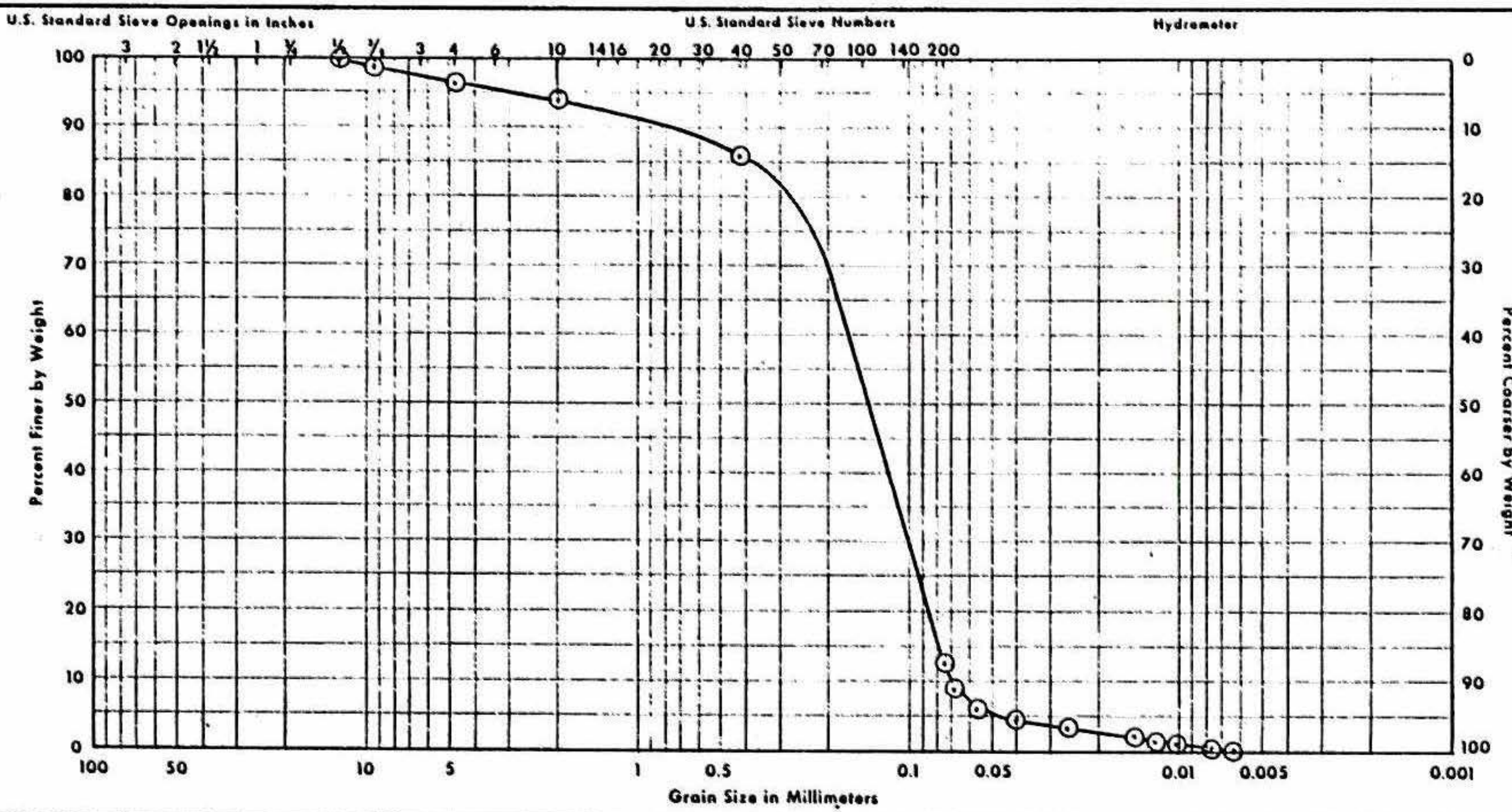
Project: Test Borings and Well Installation
Sta-Rite Industries
Delavan, Wisconsin

Laboratory: Wisconsin Testing Laboratories
Job No.: S-8315
Client: Donohue & Associates, Inc.

Date: 3/19/83

WISCONSIN TESTING LABORATORIES

GRAIN SIZE ANALYSIS



UNIFIED	GRAVEL	SAND		SILT OR CLAY	
AASHO	GRAVEL	COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	w	w_L	w_P	CLASSIFICATION
MW-2	68½-70				Brown fine to coarse sand,
					trace to little silt,
					trace fine to medium gravel.
					(SP-SM)

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Sta-Rite Industries
Delavan, Wisconsin

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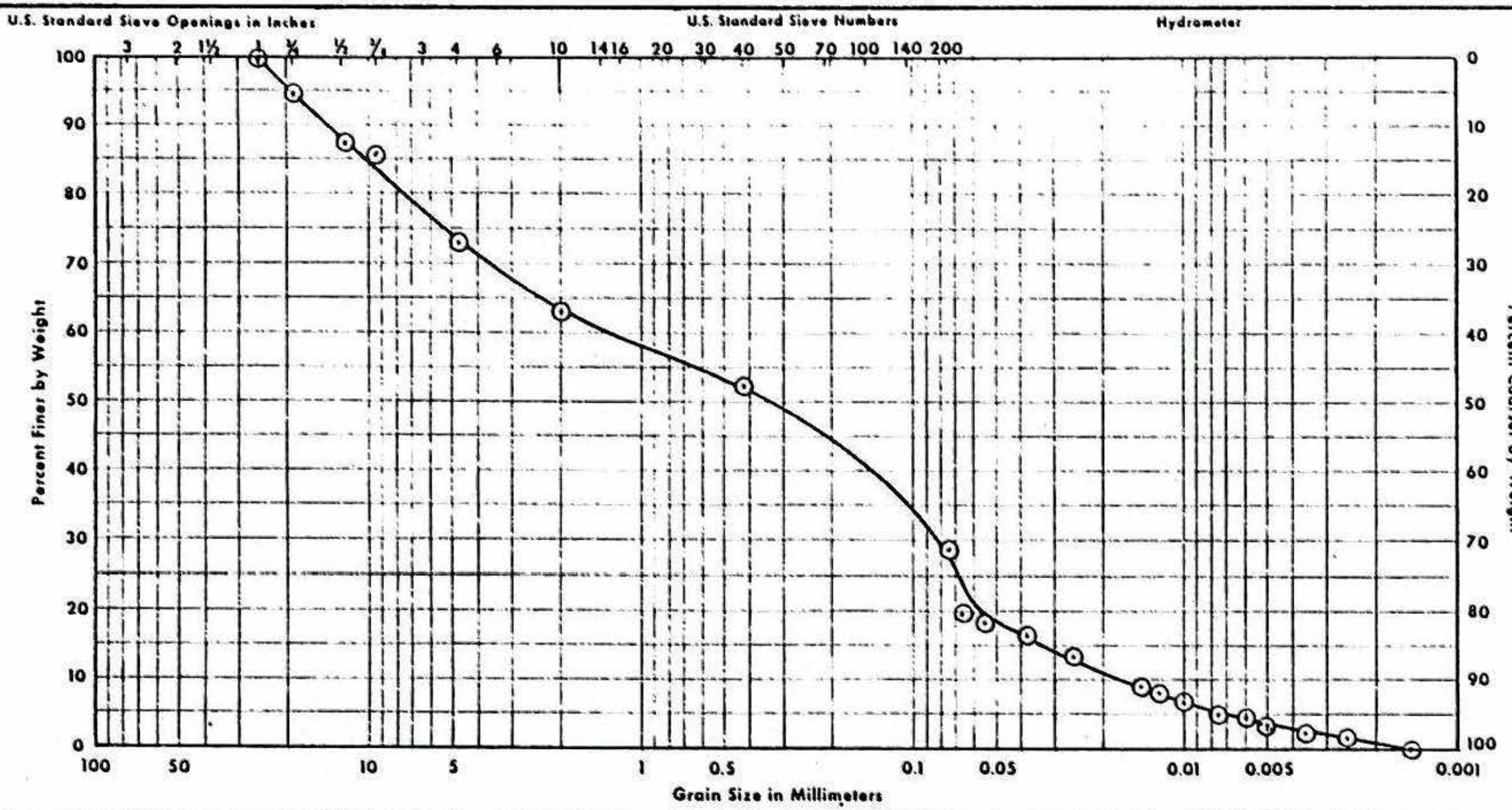
Client: Donohue & Associates, Inc.

Date: 3/19/83

WISCONSIN TESTING LABORATORIES

GRAIN SIZE ANALYSIS



UNIFIED	GRAVEL	SAND		SILT OR CLAY	
AASHO	GRAVEL	COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	w	w_L	w_P	CLASSIFICATION
MW-4	28½-30		13	11	Brown silty fine to coarse sand, trace clay, some fine to coarse gravel. (SM)

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Sta-Rite Industries
Delavan, Wisconsin

Laboratory: Wisconsin Testing Laboratories
Job No.: S-8315
Client: Donohue & Associates, Inc.

Date: 3/19/83

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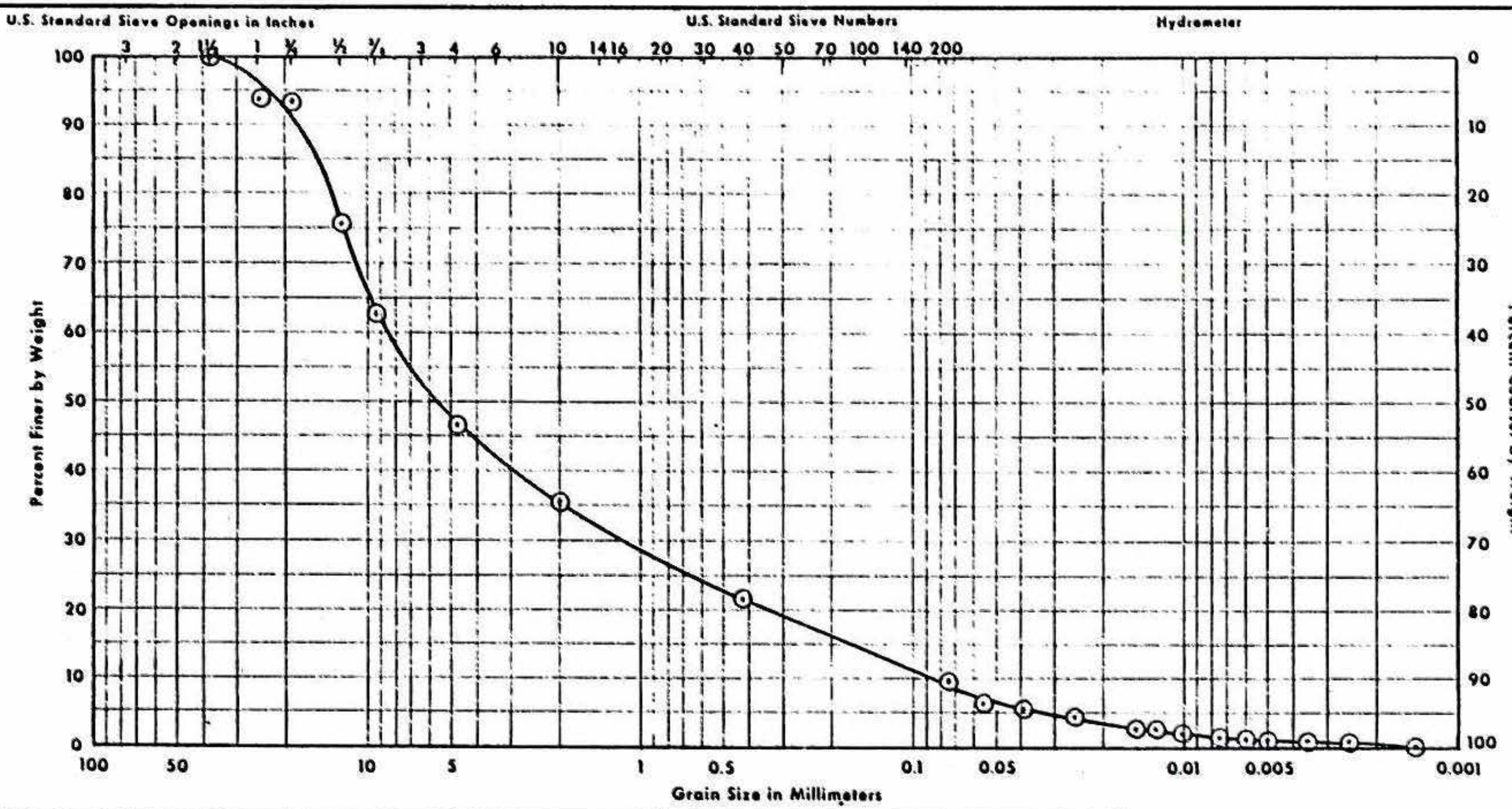

GRAIN SIZE ANALYSIS

UNIFIED	GRAVEL		SAND		SILT OR CLAY	
AASHO	GRAVEL		COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	w	w_L	w_P	CLASSIFICATION
MW-4	53½-55				Brown fine to coarse sand
					and gravel, trace clay,
					trace silt. (SW-GW)

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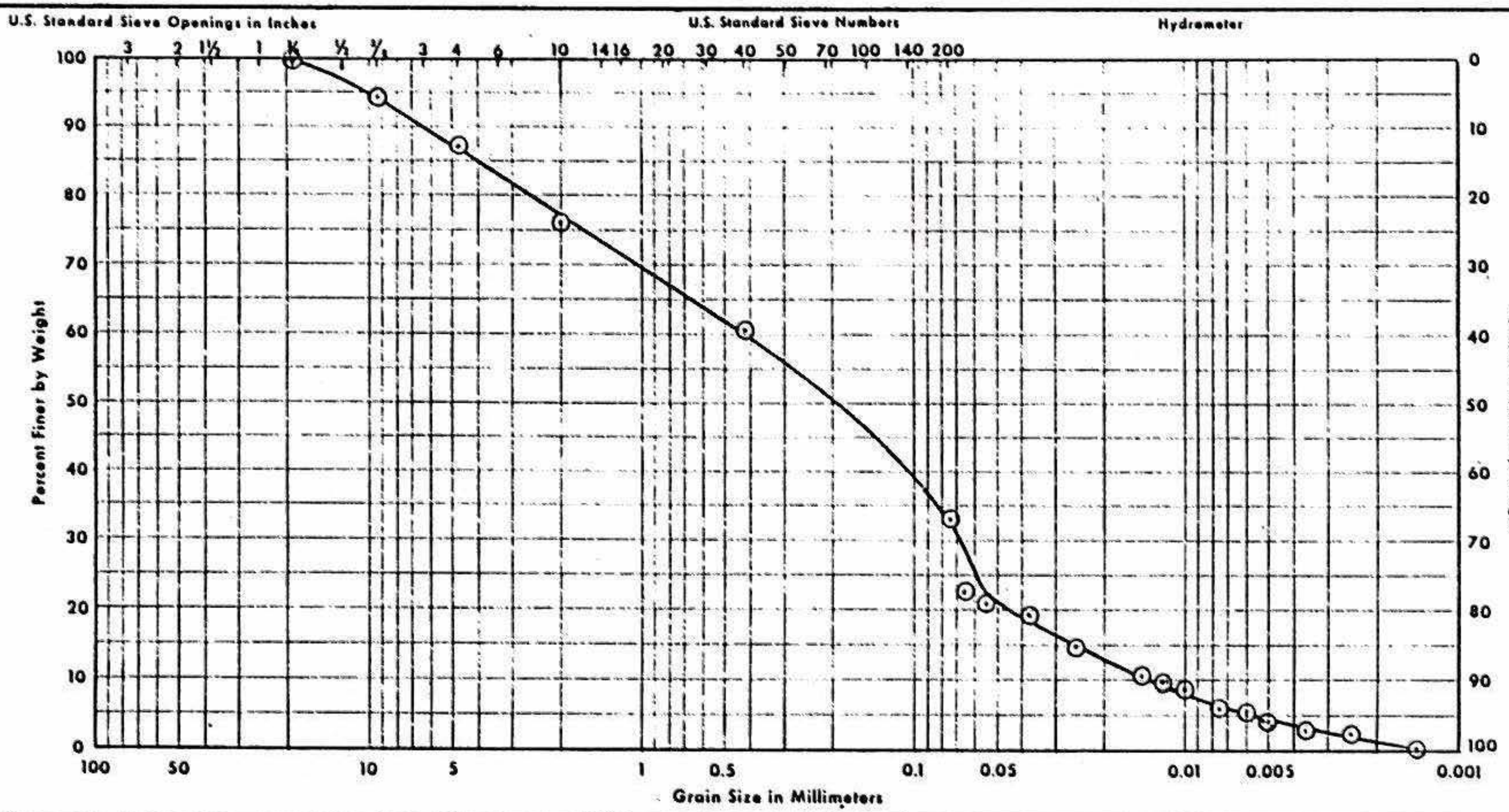
GRAIN SIZE ANALYSIS



UNIFIED	GRAVEL		SAND		SILT OR CLAY	
AASHO	GRAVEL	COARSE	FINE		SILT	CLAY

NUMBER	DEPTH	w	w_L	w_P	CLASSIFICATION
MW-6	8½-10				Brown clayey silty fine to coarse sand, little fine to coarse gravel. (SM)

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Sta-Rite Industries
Delavan, Wisconsin

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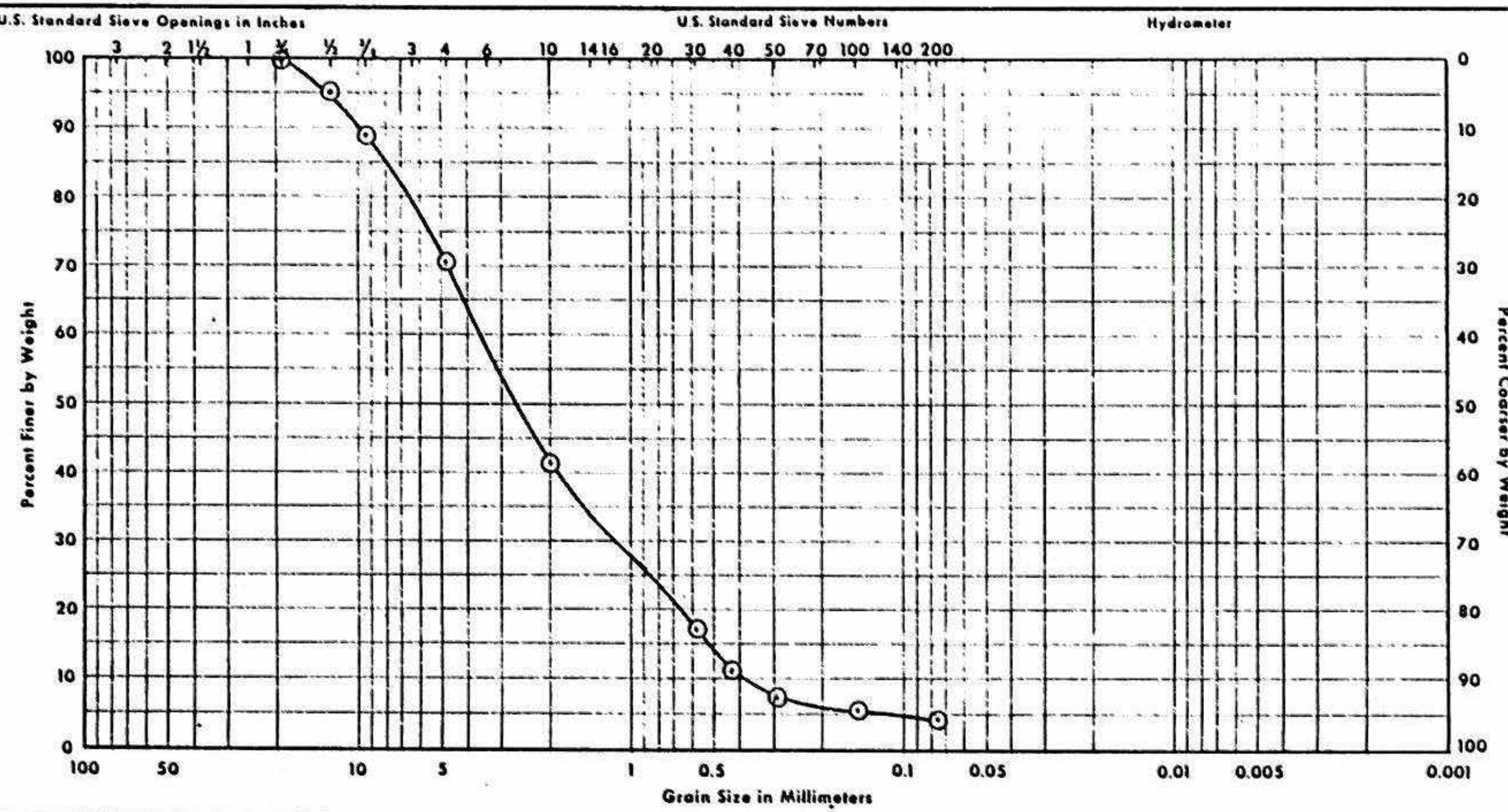


UNIFIED	GRAVEL		SAND		SILT OR CLAY	
AASHO	GRAVEL		COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	w	w_L	w_P	CLASSIFICATION
MW-6	48½-50				Brown fine to coarse sand, trace silt, some fine to coarse gravel. (SW)

Project: Test Borings and Well Installation
Sta-Rite Industries
Delavan, Wisconsin

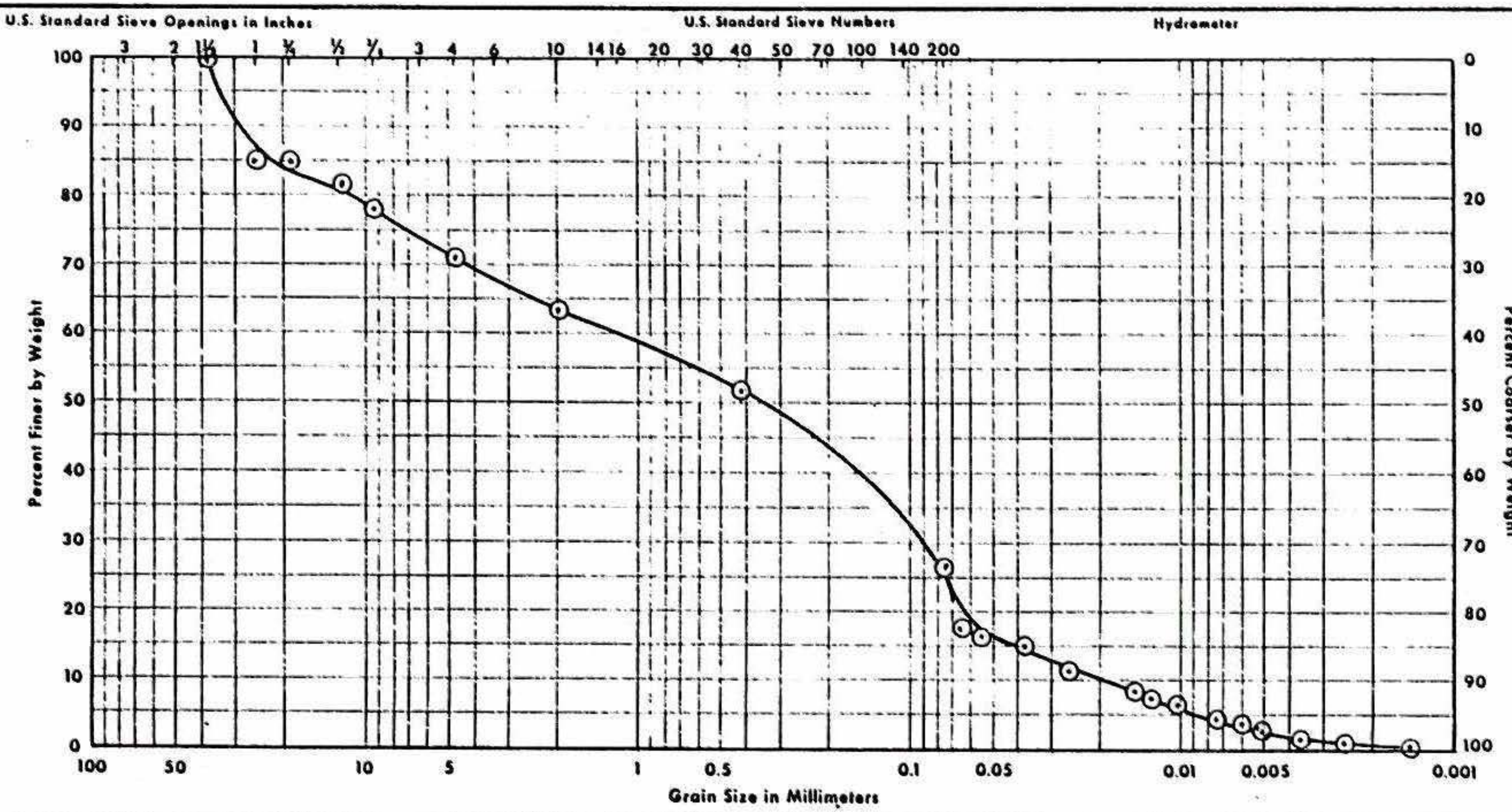
Laboratory: Wisconsin Testing Laboratories
Job No.: S-8315
Client: Donohue & Associates, Inc.

Date: 3/19/83

GRAIN SIZE ANALYSIS

WISCONSIN TESTING LABORATORIES

GRAIN SIZE ANALYSIS



UNIFIED	GRAVEL		SAND		SILT OR CLAY	
AASHO	GRAVEL		COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	w	w_L	w_P	CLASSIFICATION
MW-10	13½-15		15	13	Brown silty fine to coarse sand, trace clay, some fine to coarse gravel. (SM)

Project: Test Borings and Well Installation
Sta-Rite Industries
Delavan, Wisconsin

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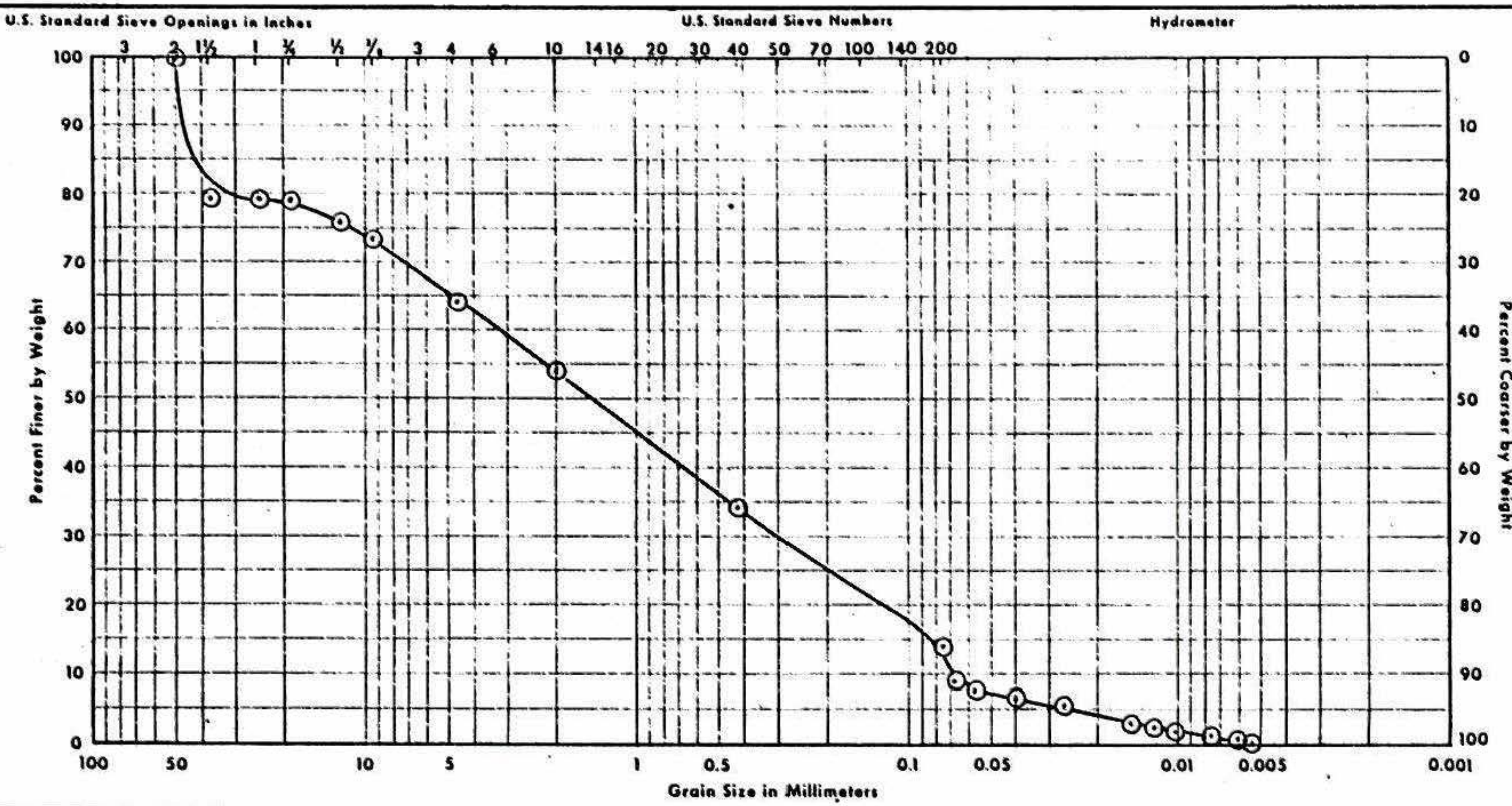

UNIFIED	GRAVEL		SAND		SILT OR CLAY	
AASHO	GRAVEL		COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	w	w_L	w_P	CLASSIFICATION
MW-10	33½-35				Brown fine to coarse sand, trace to little silt, some fine to coarse gravel. (SP-SM)

Project: Test Borings and Well Installation
Sta-Rite Industries
Delavan, Wisconsin

Laboratory: Wisconsin Testing Laboratories
Job No.: S-8315
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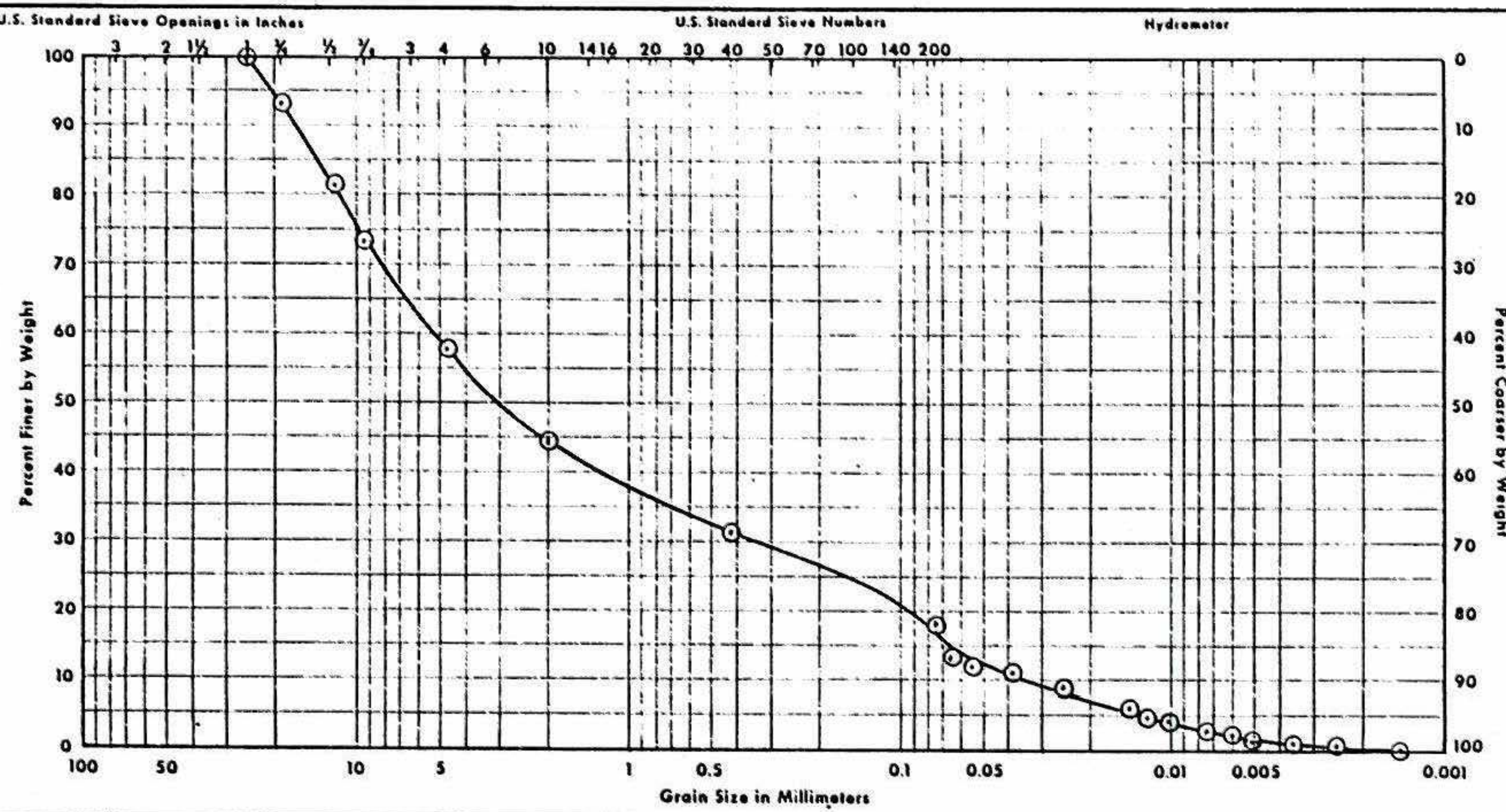
WISCONSIN TESTING LABORATORIES

GRAIN SIZE ANALYSIS



UNIFIED	GRAVEL		SAND		SILT OR CLAY	
AASHO	GRAVEL		COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	w	w_L	w_P	CLASSIFICATION
MW-10	43½-45'		17	14	Brown silty fine to coarse sand, trace clay, some fine to coarse gravel. (SM)

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Sta-Rite Industries
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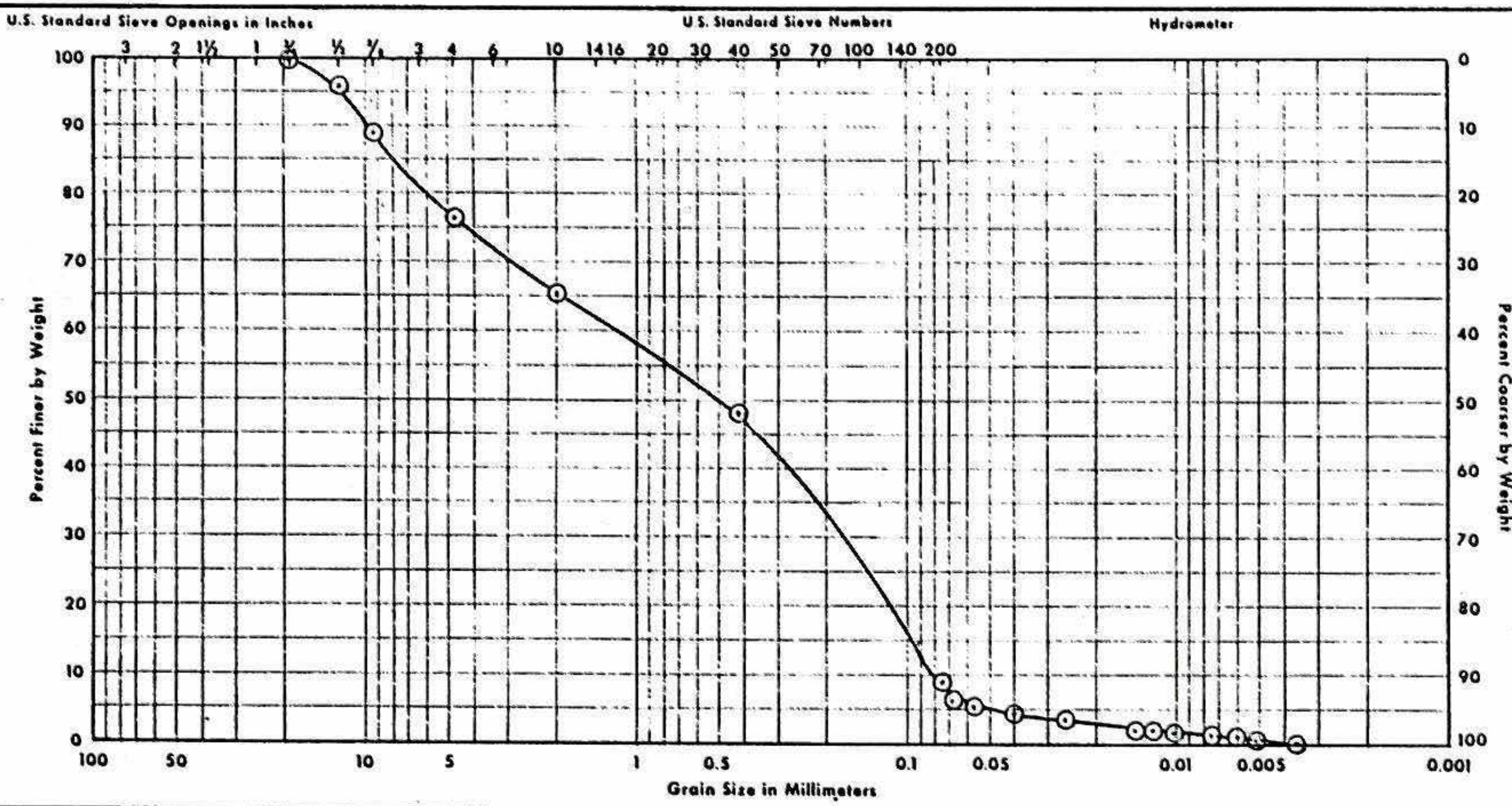
WISCONSIN TESTING LABORATORIES



UNIFIED	GRAVEL		SAND		SILT OR CLAY	
AASHO	GRAVEL		COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	w	w_L	w_P	CLASSIFICATION
MW-10	88½-90'				Brown fine to coarse sand, trace silt, some fine to coarse gravel. (SP)

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Sta-Rite Industries
Delavan, Wisconsin

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Client: Donohue & Associates, Inc.

Date: 3/19/83

GRAIN SIZE ANALYSIS

WISCONSIN TESTING LABORATORIES

SUMMARY OF PERMEABILITY TEST RESULTS

Sta-Rite Industries

Delavan, Wisconsin

Boring Number	Sample Number	Depth Feet	Dry Density PCF	Permeability cm./sec.
MW-4	6	28½-30	136.0*	6.07×10^{-8}
MW-10	3	13½-15	128.8*	8.39×10^{-8}
MW-10	7	33½-35	128.5**	6.39×10^{-7}

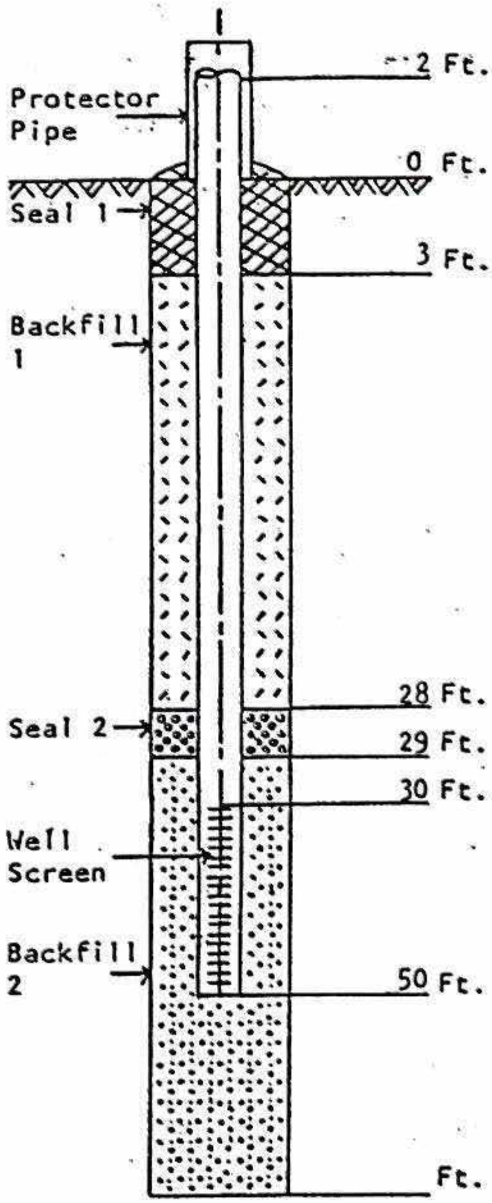
*Remolded density of permeability sample is within estimated natural density range, as based on a natural density determination performed on next lower sample in the same stratum.

**No intact sample from the same stratum was available for natural density determination. Approximate natural density was therefore assumed for remolding purposes.

WTL Job No. S-8315

WISCONSIN TESTING LABORATORIES

WELL DIAGRAM



Boring No: (Well) MW-1

Date Installed 2/15/83

Seal Material

Seal 1 Concrete mixed with Bentonite

Seal 2 Bentonite Pellets

Backfill Material

Backfill 1 Grout - 2 to 1 Cement/ Bentonite Powder

Backfill 2 Washed Torpedo Sand

Auger Hole Diameter 8 In.

Well Material PVC, Sch. 40, FJT

Total Length of Well 52 Ft.

Well I.D. 2 In.

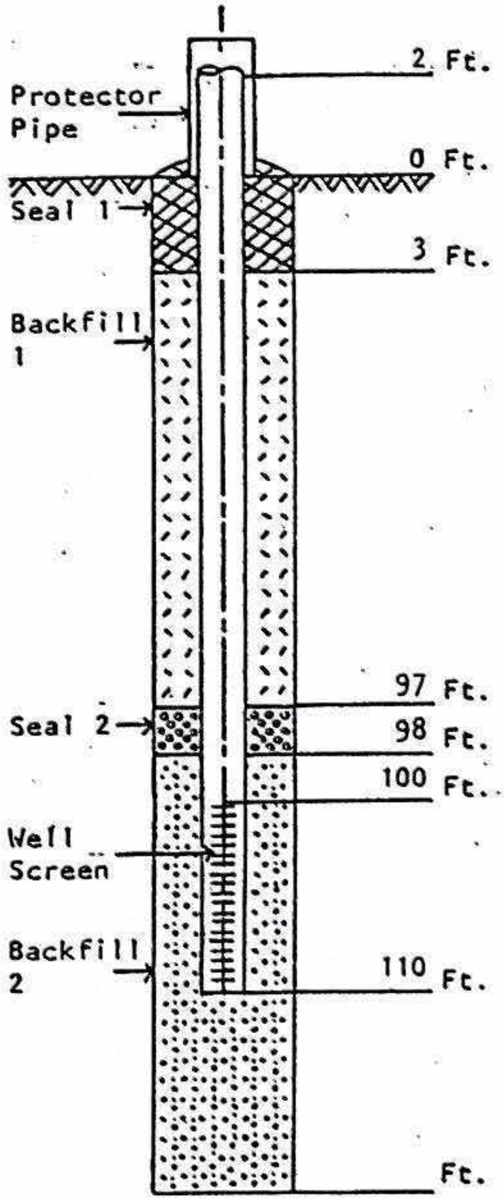
Well Point Slot Size 0.006 In.

Comments Started this boring on 2/9/83. Used hollow stem augers to 25' depth, then used 4½" roller bit to 40' depth, but could not keep hole open even with a very thick Bentonite slurry. Pulled off until we had more hollow stem augers (2/15/83). Finished hole and set well.

WTL Job No. S-8315

WISCONSIN TESTING LABORATORIES

WELL DIAGRAM



Boring No. (Well) MW-2

Date Installed 2/9/83

Seal Material

Seal 1 Concrete

Seal 2 Bentonite Pellets

Backfill Material

Backfill 1 Grout composed of 2 parts cement and 1 part bentonite powder

Backfill 2 Washed Sand

~~Auger~~ Hole Diameter 4½ to 8 In.

Well Material PVC Sch. 40, FJT

Total Length of Well 112 Ft.

Well I.D. 2 In.

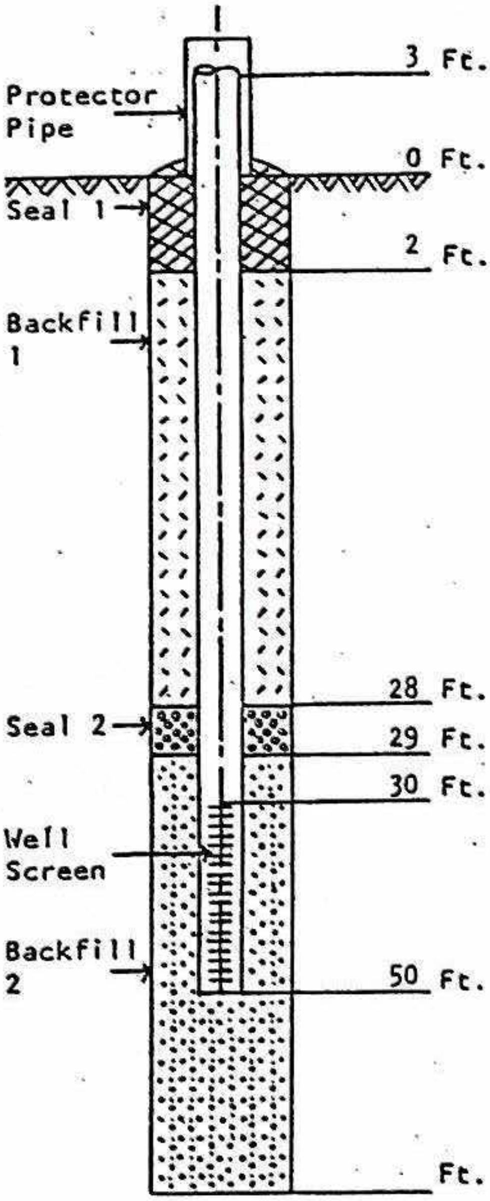
Well Point Slot Size 0.006 In.

Comments

WTL Job No. S-8315

WISCONSIN TESTING LABORATORIES

WELL DIAGRAM



Boring No. (Well) MW-3

Date Installed 2/17/83

Seal Material

Seal 1 Concrete

Seal 2 Bentonite Pellets

Backfill Material

Backfill 1 2 to 1 Grout - Cement/Bentonite Powder

Backfill 2 Washed Sand

Auger Hole Diameter 8 In.

Well Material PVC, Sch. 40, FJT

Total Length of Well 53 Ft.

Well I.D. 2 In.

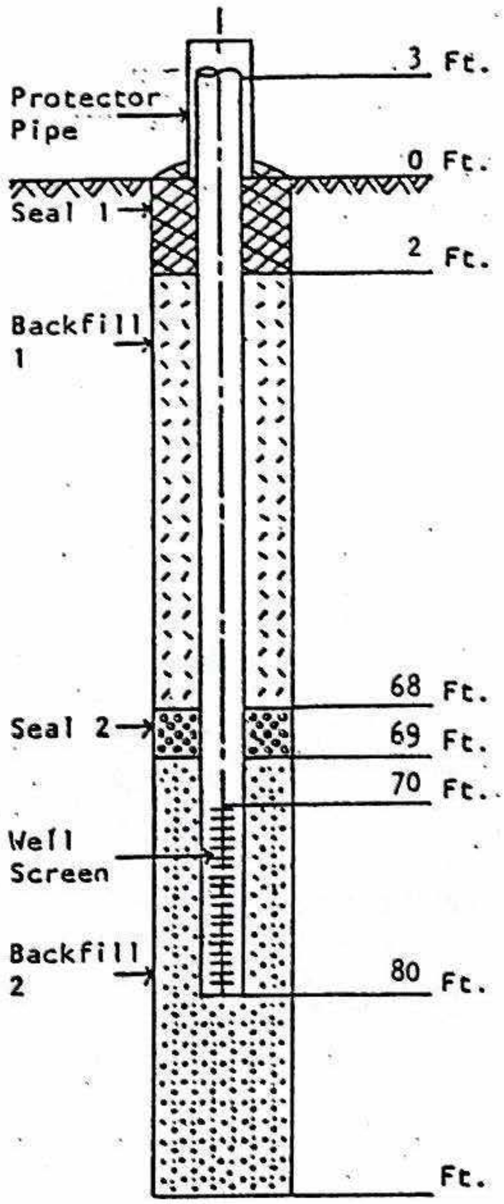
Well Point Slot Size 0.006 In.

Comments

WTL Job No. S-8315

WISCONSIN TESTING LABORATORIES

WELL DIAGRAM



Boring No. (Well) MW-4

Date Installed 2/17/83

Seal Material

Seal 1 Concrete

Seal 2 Bentonite Pellets

Backfill Material

Backfill 1 2 to 1 Grout - Cement/Bentonite Powder

Backfill 2 Washed Sand

~~XXXX~~ Auger Hole Diameter 4½ to 8 In.

Well Material PVC, Sch. 40, FJT

Total Length of Well 83 Ft.

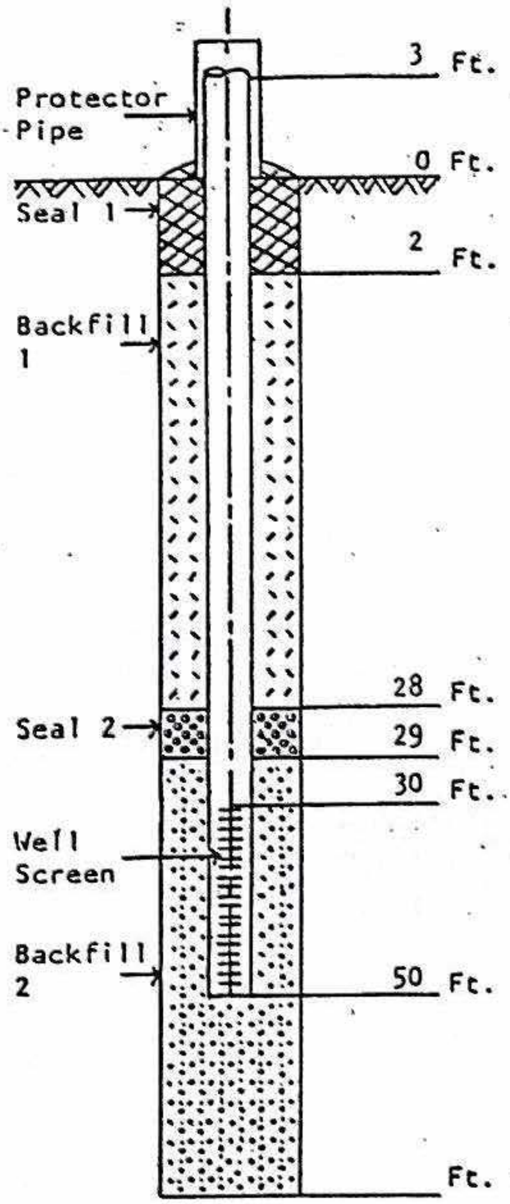
Well I.D. 2 In.

Well Point Slot Size 0.006 In.

Comments

WISCONSIN TESTING LABORATORIES

WELL DIAGRAM



Boring No. (Well) MW-5

Date Installed 2/22/83

Seal Material

Seal 1 Concrete

Seal 2 Bentonite Pellets

Backfill Material

Backfill 1 2/1 Grout - Cement/Bentonite

Backfill 2 Washed Sand

Auger Hole Diameter 8 In.

Well Material PVC, Sch. 40, FJT

Total Length of Well 53 Ft.

Well I.D. 2 In.

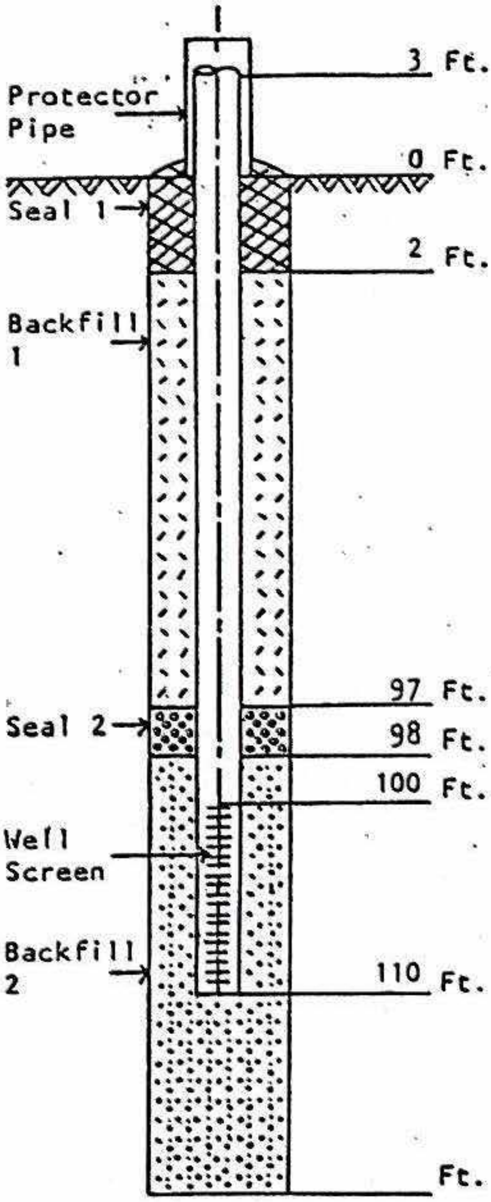
Well Point Slot Size 0.006 In.

Comments While retracting augers to above screen, I believe some large gravels may have fallen in against screen portion of PVC.

WTL Job No. S-8315

WISCONSIN TESTING LABORATORIES

WELL DIAGRAM



Boring No. (Well) MW-6

Date Installed 2/21/83

Seal Material

Seal 1 Concrete

Seal 2 Bentonite Pellets

Backfill Material

Backfill 1 Grout 2/1, Cement/Bentonite Powder

Backfill 2 Washed Sand

~~Auger~~ Hole Diameter 4¼ to 8 In.

Well Material PVC, Sch. 40, FJT

Total Length of Well 113 Ft.

Well I.D. 2 In.

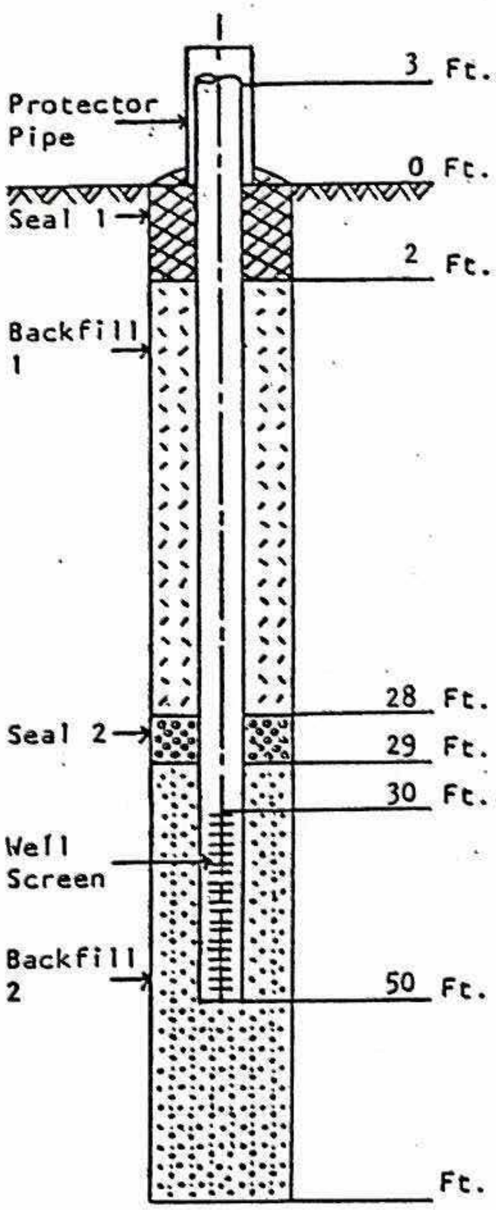
Well Point Slot Size 0.006 In.

Comments

WTL Job No. S-8315

WISCONSIN TESTING LABORATORIES

WELL DIAGRAM



Boring No. (Well) MW-9

Date Installed 2/23/83

Seal Material

Seal 1 Concrete

Seal 2 Bentonite Pellets

Backfill Material

Backfill 1 Grout - Cement/Bentonite (2 to 1)

Backfill 2 Washed Sand

Auger Hole Diameter 8 In.

Well Material PVC, Sch. 40, FJT

Total Length of Well 53 Ft.

Well I.D. 2 In.

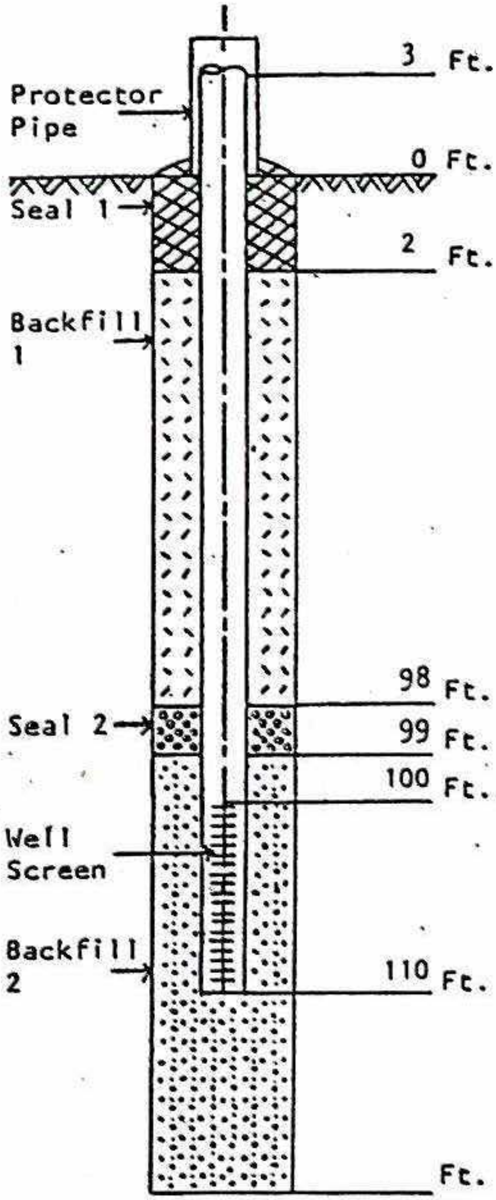
Well Point Slot Size 0.006 In.

Comments

WTL Job No. S-8315

WISCONSIN TESTING LABORATORIES

WELL DIAGRAM



Boring No. (Well) MW-10

Date Installed 3/2/83

Seal Material

Seal 1 Concrete

Seal 2 Bentonite Pellets

Backfill Material

Backfill 1 Grout 2 to 1 - Cement/Bentonite

Backfill 2 Washed Sand

~~Auger~~ Hole Diameter 4½ to 8 In.

Well Material PVC, Sch. 40, FJT

Total Length of Well 113 Ft.

Well I.D. 2 In.

Well Point Slot Size 0.006 In.

Comments

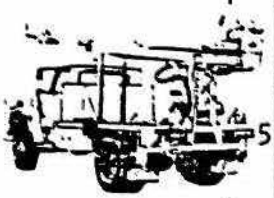
LOG OF BORING

WISCONSIN TESTING LABORATORIES

PROJECT: Test Borings and Well Installation	**JOB NO.:** S-8315
CLIENT: Donohue & Associates, Inc.	**BORING NO.:** MW-2
LOCATION: Sta-Rite Industries, Delavan, Wisconsin	**GROUND ELEVATION:**

BORING STARTED 2/7/83	GROUND WATER: During XX AT DRILLING 60'
BORING COMPLETED 2/8/83	At Completion XXXXX HOURS AFTER DRILLING
TOTAL DEPTH BORING 110'	HOURS AFTER DRILLING

DRILLING DATA: BIT SIZE, TYPE, LOSS OR GAIN OF WATER, CASING SIZE, ETC.	SAMPLE NO.	NUMBER BLOWS	POCKET PENE. TSF	FT. DEPTH	SAMPLE TYPE	SOIL CLASSIFICATION	LABORATORY RESULTS P.S.F. Qu / % Mc / P.C.F. Dd / % S	ELEVATION
8" Hollow stem augers to 25 ft., 4¼" tricone roller bit and wash boring with bentonite for remainder of boring.				0		BLACK CLAYEY TOPSOIL moist.	NOTE: Suspended drilling at 40 ft. on 2/7/83. Next morning hole caved in at 30 ft. depth. Lost 50 gal. slurry. Then mixed heavy slurry and continued with drilling.	
						MEDIUM STIFF BROWN AND GRAY MOTTLED VERY SILTY CLAY moist. (CL)		
	1	3/3/3			Split spoon			
				5		LOOSE TO MEDIUM DENSE BROWN SILTY FINE TO COARSE SAND moist to very moist, trace to little clay, little fine to coarse gravel. (SM)		
	2	3/4/6		10	Split spoon			
	3	7/8/13		15	Split spoon			
	4	6/8/8		20	Split spoon		NOTE: Switched to wash drilling with bentonite and 4¼" roller bit at 25 ft. depth.	
	5	40/10/29		25	Split spoon	See Next Page.		



DRILLING AND SAMPLING INFORMATION:

BORING LOGGED BY H. Steinruck CHECKED BY Soils Engineer CLASSIFICATION SYSTEM WTL

METHOD OF DRILLING Truck Mounted Drill MACHINE MODEL CME 55, Unit 11

PENETRATION TESTS: 2" O.D. × 1-3/8" I.D. SPLIT SPOON SAMPLER DRIVEN 12" WITH 140# PIN GUIDED WEIGHT FREE FALLING 30". NUMBER OF BLOWS REQUIRED SHOWN ON REPORT.

SPLIT SPOON | TUBE SAMPLE | AUGER SAMPLE | WASH SAMPLE

LOG OF BORING

PROJECT: Test Borings and Well Installation
CLIENT: Donohue & Associates, Inc.
LOCATION: Sta-Rite Industries, Delavan, Wisconsin

JOB NO.: S-8315
BORING NO.: MW-2
GROUND ELEVATION:

DRILLING DATA: BIT SIZE, TYPE, LOSS OR GAIN OF WATER, CASING SIZE, ETC.	SAMPLE NO.	NUMBER BLOWS	POCKET PENE. TSF	FT. DEPTH	SAMPLE TYPE	SOIL CLASSIFICATION	LABORATORY RESULTS P.S.F. Qu	% Mc	P.C.F Dd	% S	ELEVATION
				25		DENSE TO VERY DENSE BROWN FINE TO COARSE SAND AND GRAVEL moist to very moist, some small cobbles. (SW-GW)					
	6	28/23/27		30							
	7	15/14/25		35							
	8	20/26/30		40							
	9	17/19/31		45		HARD BROWN CLAYEY SANDY SILT TO CLAYEY SILTY SAND moist, trace fine to coarse gravel. (ML-SM)					
	10	39/61/77		50		VERY DENSE BROWN FINE TO COARSE SAND moist, trace to little silt, little fine to coarse gravel. (SP)					
	11	30/43/76		55		VERY DENSE BROWN CLAYEY SILTY FINE TO COARSE SAND moist, little fine to coarse gravel, few thin to medium seams of sand and gravel. (SM-SC)					
	12	40/45/52		60			NOTE: At 59 ft. depth, lost little slurry (3 to 5 gallons).				

See Next Page.

WISCONSIN TESTING LABORATORIES

LOG OF BORING

PROJECT:	Test Borings and Well Installation	JOB NO.:	S-8315
CLIENT:	Donohue & Associates, Inc.	BORING NO.:	MW-2
LOCATION:	Sta-Rite Industries, Delavan, Wisconsin	GROUND ELEVATION:	

DRILLING DATA: BIT SIZE, TYPE, LOSS OR GAIN OF WATER, CASING SIZE, ETC.	SAMPLE NO.	NUMBER BLOWS	POCKET PENE. TSF	FT. DEPTH	SAMPLE TYPE	SOIL CLASSIFICATION	LABORATORY RESULTS P.S.F. Qu	% Mc	P.C.F. Dd	% S	ELEVATION
				60		VERY DENSE BROWN FINE TO COARSE SAND wet to saturated, trace to little fine to coarse gravel, few thin seams of sandy clay. (SP-SW)					
	13	46/65/72		65							
	14	34/46/62		70							
	15	38/47/50		75							
	16	41/53/63		80							
	17	39/55/61		85							
	18	36/49/60		90							
	19	43/46/48		95							

LOG OF BORING

PROJECT:	Test Borings and Well Installation	JOB NO.:	S-8315
CLIENT:	Donohue & Associates, Inc.	BORING NO.:	MW-2
LOCATION:	Sta-Rite Industries, Delavan, Wisconsin	GROUND ELEVATION:	

DRILLING DATA: BIT SIZE, TYPE, LOSS OR GAIN OF WATER, CASING SIZE, ETC.	SAMPLE NO.	NUMBER BLOWS	POCKET PENE. TSF	FT. DEPTH	SAMPLE TYPE	SOIL CLASSIFICATION	LABORATORY RESULTS P.S.F. Q_u	% Mc	P.C.F. Dd	% S	ELEVATION
				95		VERY DENSE BROWN FINE TO COARSE SAND wet to saturated, trace to little fine to coarse gravel, few thin seams of sandy clay. (SP-SW)					
	20	50/52/50		100							
	21	48/53/58		105							
	22	50/61/64		110		END OF BORING					

WISCONSIN TESTING LABORATORIES

LOG OF BORING

WISCONSIN TESTING LABORATORIES

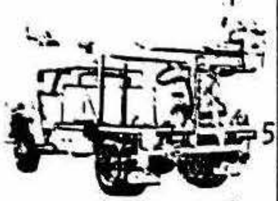
PROJECT: Test Borings and Well Installation
CLIENT: Donohue & Associates, Inc.
LOCATION: Sta-Rite Industries, Delavan, Wisconsin

JOB NO.: S-8315
BORING NO.: MW-4
GROUND ELEVATION:

BORING STARTED 2/16/83
BORING COMPLETED 2/17/83
TOTAL DEPTH BORING 80'

GROUND WATER: During ~~AT~~ DRILLING 39'
At Completion HOURS AFTER DRILLING
HOURS AFTER DRILLING

DRILLING DATA: BIT SIZE, TYPE, LOSS OR GAIN OF WATER, CASING SIZE, ETC.	SAMPLE NO.	NUMBER BLOWS	POCKET PENE. TSF	FT. DEPTH	SAMPLE TYPE	SOIL CLASSIFICATION	LABORATORY RESULTS P.S.F. Qu	% Mc	P.C.F. Dd	% S	ELEVATION
8" Hollow stem augers to 55 ft., 4¼" tricone roller bit and wash boring with bentonite for remainder of boring.				0		BLACK CLAYEY TOPSOIL moist.					
						MEDIUM DENSE TO DENSE BROWN SILTY FINE TO COARSE SAND moist, trace to little clay, some fine to coarse gravel, few small cobbles. (SM)					
	1	7/10/13			Split spoon						
				5							
	2	13/14/17			Split spoon						
				10							
	3	12/15/19			Split spoon						
				15							
	4	21/24/30			Split spoon						
				20							
	5	20/30/36			Split spoon						
				25							



DRILLING AND SAMPLING INFORMATION:

BORING LOGGED BY H. Steinruck CHECKED BY Soils Engineer CLASSIFICATION SYSTEM WTL

METHOD OF DRILLING Truck Mounted Drill MACHINE MODEL CME 55, Unit 11

PENETRATION TESTS: 2" O.D. × 1-3/8" I.D. SPLIT SPOON SAMPLER DRIVEN 12" WITH 140# PIN GUIDED WEIGHT FREE FALLING 30". NUMBER OF BLOWS REQUIRED SHOWN ON REPORT.

SPLIT SPOON | TUBE SAMPLE | AUGER SAMPLE | WASH SAMPLE

LOG OF BORING

PROJECT: Test Borings and Well Installation

CLIENT: Donohue & Associates, Inc.

LOCATION: Sta-Rite Industries, Delavan, Wisconsin

JOB NO.: S-8315

BORING NO.: MW-4

GROUND ELEVATION:

DRILLING DATA: BIT SIZE, TYPE, LOSS OR GAIN OF WATER, CASING SIZE, ETC.	SAMPLE NO.	NUMBER BLOWS	POCKET PENE. TSF	FT. DEPTH	SAMPLE TYPE	SOIL CLASSIFICATION	LABORATORY RESULTS P.S.F. Q_u	% Mc	P.C.F Dd	% S	ELEVATION
				25		MEDIUM DENSE TO DENSE BROWN SILTY FINE TO COARSE SAND moist, trace to little clay, some fine to coarse gravel, few small cobbles. (SM)					
	6	11/13/16		30							
	7	12/13/14		35							
	8	9/11/6		40		MEDIUM DENSE BROWN SILTY FINE TO COARSE SAND wet, little fine to coarse gravel. (SM)					
	9	9/5/12		45							
	10	7/8/10		50		MEDIUM DENSE BROWN FINE TO COARSE SAND wet to saturated, some fine to coarse gravel, trace silt. (SP-SW)	NOTE: At 55 ft. depth, switched over to wash boring with tricone roller bit and bentonite.				
	11	9/12/14		55							
	12	10/13/18		60							

LOG OF BORING

PROJECT: Test Borings and Well Installation	**JOB NO.:** S-8315
CLIENT: Donohue & Associates, Inc.	**BORING NO.:** MW-4
LOCATION: Sta-Rite Industries, Delavan, Wisconsin	**GROUND ELEVATION:**

DRILLING DATA: BIT SIZE, TYPE, LOSS OR GAIN OF WATER, CASING SIZE, ETC.	SAMPLE NO.	NUMBER BLOWS	POCKET PENE. TSF	FT. DEPTH	SAMPLE TYPE	SOIL CLASSIFICATION	LABORATORY RESULTS P.S.F. Qu	% Mc	P.C.F. Dd	% S	ELEVATION
				60		MEDIUM DENSE BROWN FINE TO COARSE SAND wet to saturated, some fine to coarse gravel, trace silt. (SP-SW)					
	13	56/77/102		65		VERY DENSE BROWN FINE TO MEDIUM SAND very moist, trace silt, little fine to coarse gravel. (SP-SW)					
	14	100/3"		70							
	15	100/4"		75							
	16	35/50/63		80		VERY DENSE BROWN FINE TO COARSE SAND saturated, little fine to medium gravel. (SW)					
						END OF BORING					
				85							
				90							
				95							

LOG OF BORING

WISCONSIN TESTING LABORATORIES

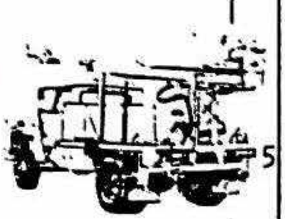
PROJECT: Test Borings and Well Installation
CLIENT: Donohue & Associates, Inc.
LOCATION: Sta-Rite Industries, Delavan, Wisconsin

JOB NO.: S-8315
BORING NO.: MW-6
GROUND ELEVATION:

BORING STARTED 2/18/83
BORING COMPLETED 2/21/83
TOTAL DEPTH BORING 110'

GROUND WATER: During XX DRILLING 27'
At Completion HOURS AFTER DRILLING
HOURS AFTER DRILLING

DRILLING DATA: BIT SIZE, TYPE, LOSS OR GAIN OF WATER, CASING SIZE, ETC.	SAMPLE NO.	NUMBER BLOWS	POCKET PENE. TSF	FT. DEPTH	SAMPLE TYPE	SOIL CLASSIFICATION	LABORATORY RESULTS P.S.F. Qu	% Mc	P.C.F. Dd	% S	ELEVATION
8" Hollow stem augers to 55 ft., 4¼" tricone roller bit and wash boring with bentonite for remainder of boring.				0		BLACK CLAYEY TOPSOIL moist.					
	1	4/5/5				MEDIUM STIFF BROWN SILTY CLAY moist, trace fine to coarse sand, trace fine gravel. (CL)					
				5							
	2	5/7/12				MEDIUM DENSE BROWN CLAYEY SILTY FINE TO COARSE SAND moist, little fine to coarse gravel. (SM)					
				10							
	3	12/29/40				VERY DENSE BROWN FINE TO COARSE SAND AND GRAVEL moist. (SW-GW)					
				15							
	4	16/38/30									
				20							
	5	20/60/94									
				25							



DRILLING AND SAMPLING INFORMATION:

BORING LOGGED BY H. Steinruck CHECKED BY Soils Engineer CLASSIFICATION SYSTEM WTL

METHOD OF DRILLING Truck Mounted Drill MACHINE MODEL CME 55, Unit 11

PENETRATION TESTS: 2" O.D. × 1-3/8" I.D. SPLIT SPOON SAMPLER DRIVEN 12" WITH 140# PIN GUIDED WEIGHT FREE FALLING 30". NUMBER OF BLOWS REQUIRED SHOWN ON REPORT.

SPLIT SPOON | TUBE SAMPLE | AUGER SAMPLE | WASH SAMPLE

LOG OF BORING

PROJECT: Test Borings and Well Installation
CLIENT: Donohue & Associates, Inc.
LOCATION: Sta-Rite Industries, Delavan, Wisconsin

JOB NO.: S-8315
BORING NO.: MW-6
GROUND ELEVATION:

DRILLING DATA: BIT SIZE, TYPE, LOSS OR GAIN OF WATER, CASING SIZE, ETC.	SAMPLE NO.	NUMBER BLOWS	POCKET PENE. TSF	FT. DEPTH	SAMPLE TYPE	SOIL CLASSIFICATION	LABORATORY RESULTS P.S.F. Qu	% Mc	P.C.F Dd	% S	ELEVATION
				25		VERY DENSE BROWN FINE TO COARSE SAND AND GRAVEL moist. (SW-GW)					
						DENSE TO FIRM BROWN FINE TO COARSE SAND saturated, some fine to coarse gravel. (SP-SW)					
	6	15/24/29		30							
	7	8/7/6		35							
	8	7/7/8		40							
	9	6/8/9		45							
	10	7/9/12		50							
	11	8/11/14		55							
						VERY STIFF BROWN VERY SANDY CLAY moist, little fine to medium gravel. (CL)					
	12	6/9/14		60							

LOG OF BORING

PROJECT:	Test Borings and Well Installation	**JOB NO.:**	S-8315
CLIENT:	Donohue & Associates, Inc.	**BORING NO.:**	MW-6
LOCATION:	Sta-Rite Industries, Delavan, Wisconsin	**GROUND ELEVATION:**	

DRILLING DATA: BIT SIZE, TYPE, LOSS OR GAIN OF WATER, CASING SIZE, ETC.	SAMPLE NO.	NUMBER BLOWS	POCKET PENE. TSF	FT. DEPTH	SAMPLE TYPE	SOIL CLASSIFICATION	LABORATORY RESULTS P.S.F. Q_u	% Mc	P.C.F. Od	% S	ELEVATION
				60		VERY STIFF BROWN VERY SANDY CLAY moist, little fine to medium gravel. (CL)					
	13	7/8/10									
				65		VERY DENSE BROWN FINE TO COARSE SAND saturated, some fine to coarse gravel. (SP-SW)					
	14	40/48/53		70							
	15	48/57/61		75							
	16	50/55/58		80							
	17	51/54/59		85							
	18	57/59/60		90							
	19	52/66/69		95							

WISCONSIN TESTING LABORATORIES

LOG OF BORING

PROJECT: Test Borings and Well Installation	JOB NO.: S-8315
CLIENT: Donohue & Associates, Inc.	BORING NO.: MW-6
LOCATION: Sta-Rite Industries, Delavan, Wisconsin	GROUND ELEVATION:

DRILLING DATA: BIT SIZE, TYPE, LOSS OR GAIN OF WATER, CASING SIZE, ETC.	SAMPLE NO.	NUMBER BLOWS	POCKET PENE. TSF	FT. DEPTH	SAMPLE TYPE	SOIL CLASSIFICATION	LABORATORY RESULTS P.S.F. Qu	% Mc	P.C.F. Dd	% S	ELEVATION
				95		VERY DENSE BROWN FINE TO COARSE SAND saturated, some fine to coarse gravel. (SP-SW)					
	20	60/61/67									
				100							
	21	52/60/71									
				105							
	22	48/60/73									
				110		END OF BORING					

LOG OF BORING

WISCONSIN TESTING LABORATORIES

PROJECT: Test Borings and Well Installation

CLIENT: Donohue & Associates, Inc.

LOCATION: Sta-Rite Industries, Delavan, Wisconsin

JOB NO.: S-8315

BORING NO.: MW-10

GROUND ELEVATION:

BORING STARTED 2/24/83

BORING COMPLETED 3/2/83

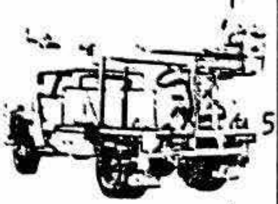
TOTAL DEPTH BORING 110'

GROUND WATER: During ~~AT~~ DRILLING 22'

At Completion ~~HOURS~~ AFTER DRILLING

HOURS AFTER DRILLING

DRILLING DATA: BIT SIZE, TYPE, LOSS OR GAIN OF WATER, CASING SIZE, ETC.	SAMPLE NO.	NUMBER BLOWS	POCKET PENE. TSF	FT. DEPTH	SAMPLE TYPE	SOIL CLASSIFICATION	LABORATORY RESULTS P.S.F Q_u	% Mc	P.C.F. Dd	% S	ELEVATION
8" Hollow stem augers to 55 ft., 4¼" tricone roller bit and wash boring with bentonite for remainder of boring.				0		MEDIUM STIFF BLACK CLAYEY TOPSOIL moist. (OL)					
	1	3/4/5		5	Split spoon	MEDIUM STIFF BROWN SILTY CLAY moist, trace fine to coarse sand. (CL)					
	2	5/5/6		10	Split spoon	FIRM BROWN SILTY FINE TO COARSE SAND moist, little fine to coarse gravel, trace clay. (SM)					
	3	6/7/7		15	Split spoon						
	4	7/8/9		20	Split spoon						
	5	10/14/16		25	Split spoon	DENSE TO VERY DENSE BROWN FINE TO COARSE SAND saturated, some fine to coarse gravel, trace silt. (SP-SW)					



DRILLING AND SAMPLING INFORMATION:

BORING LOGGED BY H. Steinruck CHECKED BY Soils Engineer CLASSIFICATION SYSTEM WTL

METHOD OF DRILLING Truck Mounted Drill MACHINE MODEL CME 55, Unit 11

PENETRATION TESTS: 2" O.D. × 1-3/8" I.D. SPLIT SPOON SAMPLER DRIVEN 12" WITH 140# PIN GUIDED WEIGHT FREE FALLING 30". NUMBER OF BLOWS REQUIRED SHOWN ON REPORT.

SPLIT SPOON | TUBE SAMPLE | AUGER SAMPLE | WASH SAMPLE

LOG OF BORING

PROJECT: Test Borings and Well Installation
JOB NO.: S-8315
CLIENT: Donohue & Associates, Inc.
BORING NO.: MW-10
LOCATION: Sta-Rite Industries, Delavan, Wisconsin
GROUND ELEVATION:

DRILLING DATA: BIT SIZE, TYPE, LOSS OR GAIN OF WATER, CASING SIZE, ETC.	SAMPLE NO.	NUMBER BLOWS	POCKET PENE. TSF	FT. DEPTH	SAMPLE TYPE	SOIL CLASSIFICATION	LABORATORY RESULTS P.S.F. Qu	% Mc	P.C.F Dd	% S	ELEVATION
				25		DENSE TO VERY DENSE BROWN FINE TO COARSE SAND saturated, some fine to coarse gravel, trace silt. (SP-SW)					
	6	13/15/18		30							
	7	17/19/23		35							
	8	20/26/29		40							
	9	27/35/40		45		VERY DENSE BROWN CLAYEY SILTY FINE TO COARSE SAND saturated, some fine to coarse gravel. (SM-SC)					
	10	23/31/39		50			NOTE: Few thin to medium seams of silty sandy clay around the 50 ft. depth level.				
	11	30/38/47		55		VERY DENSE BROWN FINE TO MEDIUM SAND saturated, trace coarse sand, trace fine to medium gravel. (SP)					
	12	34/37/48		60							

LOG OF BORING

PROJECT: Test Borings and Well Installation
CLIENT: Donohue & Associates, Inc.
LOCATION: Sta-Rite Industries, Delavan, Wisconsin
JOB NO.: S-8315
BORING NO.: MW-10
GROUND ELEVATION:

DRILLING DATA: BIT SIZE, TYPE, LOSS OR GAIN OF WATER, CASING SIZE, ETC.	SAMPLE NO.	NUMBER BLOWS	POCKET PENE. TSF	FT. DEPTH	SAMPLE TYPE	SOIL CLASSIFICATION	P.S.F. Qu	% Mc	P.C.F. Dd	% S	ELEVATION
				60		VERY DENSE BROWN FINE TO MEDIUM SAND saturated, trace coarse sand, trace fine to medium gravel. (SP)					
	13	31/33/50		65							
	14	33/40/46		70							
	15	26/31/34		75		VERY DENSE BROWN FINE TO COARSE SAND saturated, trace silt, little fine to coarse gravel. (SP-SW)					
	16	30/24/39		80							
	17	31/33/34		85							
	18	25/31/30		90							
						VERY DENSE BROWN FINE TO COARSE SAND saturated, little fine to coarse gravel. (SP-SW)					
	19	26/30/37		95							

LOG OF BORING

PROJECT: Test Borings and Well Installation
CLIENT: Donohue & Associates, Inc.
LOCATION: Sta-Rite Industries, Delavan, Wisconsin

JOB NO.: S-8315
BORING NO.: MW-10
GROUND ELEVATION:

DRILLING DATA: BIT SIZE, TYPE, LOSS OR GAIN OF WATER, CASING SIZE, ETC.	SAMPLE NO.	NUMBER BLOWS	POCKET PENE. TSF	FT. DEPTH	SAMPLE TYPE	SOIL CLASSIFICATION	LABORATORY RESULTS P.S.F. Qu	% Mc	P.C.F. Dd	% S	ELEVATION
				95		VERY DENSE BROWN FINE TO COARSE SAND saturated, little fine to coarse gravel. (SP-SW)					
	20	28/38/41		100							
	21	23/32/33		105							
	22	30/34/39		110		END OF BORING					

WISCONSIN TESTING LABORATORIES

WISCONSIN TESTING LABORATORIES
FIELD EXPLORATION STANDARD SAMPLING PROCEDURES

The borings were made with a truck mounted Central Mine Equipment model 55 exploration drill rig. Soil sampling was performed in general accordance with ASTM method D-1586. Using this method a 140 lb. weight free falling a distance of 30 in. is used to drive a 2 in. O.D. by 1-3/8 in. I.D. split barrel sampler in the soil. The sampler is first driven 6 in. into the soil for seating purposes. After this has been done the sampler is driven an additional 12 in. The number of blows required to drive the sampler the final 12 in. is known as the penetration resistance or "N" value. The number of hammer blows used in making the test is reported on the drill logs for the final two 6 in. increments of penetration (example: 8/9 where 8 + 9 = 17 is the standard penetration resistance or "N" value). In some cases the initial or "set" blow count is also recorded. "N" values are used to indicate relative densities of cohesionless (sand and gravel soils) and to a lesser degree consistencies of cohesive soils.

All samples of soil recovered were visually and manually classified in the field by the drill foreman. Representative samples were enclosed in glass jars, labeled and returned to the laboratory where they were further examined and reclassified by a soils engineer.

We wish to emphasize that the boring logs show the subsurface conditions at the dates, locations and depths indicated, and it is not warranted that they are representative of subsurface conditions at other locations and times, and to greater depths than penetrated by the borings.

WISCONSIN TESTING LABORATORIES

Field Classification System for Soil Exploration

Non Cohesive Soils
(Silt, Sand, Gravel and Combinations)

Density

Very Loose	5 blows/ft. or less
Loose	6 to 10 blows/ft.
Firm	11 to 15 blows/ft.
Medium Dense	16 to 30 blows/ft.
Dense	31 to 50 blows/ft.
Very Dense	51 blows/ft. or more

Relative Proportions

Descriptive Term	Percent
Trace	1-10
Little	11-20
Some	21-35
And	36-50

Particle Size Identification

Boulders		- 8 inch diameter or more
Cobbles		- 3 to 8 inch diameter
Gravel	Coarse	- Large 1 to 3 inch
	Medium	- 1/2 to 1 inch
	Fine	- 1/4 to 1/2 inch
Sand	Coarse	- 0.6mm to 1/4 inch (dia. of pencil lead)
	Medium	- 0.2mm to 0.6mm (dia. of broom straw)
	Fine	- 0.05mm to 0.2mm (dia. of human hair)
Silt		- 0.06mm to 0.002mm (Cannot see particles)

Cohesive Soils
(Clay, Silt and Combinations)

Consistency

Very Soft	3 blows/ft. or less
Soft	4 to 5 blows/ft.
Medium Stiff	6 to 10 blows/ft.
Stiff	11 to 15 blows/ft.
Very Stiff	16 to 30 blows/ft.
Hard	31 blows/ft. or more

Plasticity

Degree of Plasticity	Plasticity Index
None to Slight	0 - 4
Slight	5 - 7
Medium	8 - 22
High to Very High	Over 22

Classification on logs are made by visual inspection.

Standard Penetration Test - Driving a 2.0 in. O.D., 1-3/8 in. I.D., sampler a distance of 1.0 ft. into undisturbed soil with a 140 lb. hammer free falling a distance of 30.0 in. It is customary for Wisconsin Testing Laboratories to drive the spoon 6.0 in. to seat into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and making the tests are recorded for each 6.0 in. of penetration on the drill log (Example - 6/8/9). The standard penetration test results can be obtained by adding the last two figures (i.e. 8+9 = 17 blows/ft.).

Strata Changes - In the column "Soil Descriptions" on the drill log the horizontal lines represent strata changes. A solid line (——) represents an actually observed change, a dashed line (- - -) represents an estimated change.

Ground Water observations were made at the times indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water levels indicated on the logs.

Supportive Strata Descriptions - Silt and Sand Seams

Very thin seams	- Paper thin to 1/8 in. thick
Thin seams	- 1/8 in. to 1 in. thick
Medium seams	- 1 in. to 6 in. thick
Large seams	- 6 in. to 12 in. thick