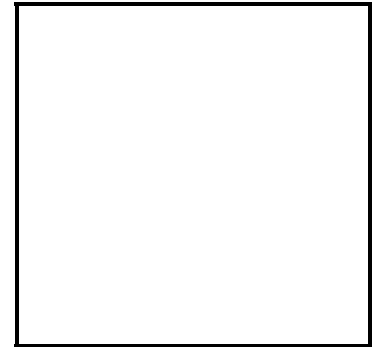


# ND 18 DEEP FOUNDATION RECOMMENDATIONS

TO:	File
FROM:	Geotechnical Section
DATE:	07/05/23
HIGHWAY:	ND 18
PROJECT NUMBER:	8-018(106)064
PCN:	23279
LOCATION:	8 North of Leonard, Maple River
SUBJECT:	ND 18 Deep Foundation Recommendations



## Introduction/Project Description

The geotechnical section was tasked to provide deep foundation recommendations for the proposed lengthening of the bridge structure on ND 18 at approximately RP 64 (Bridge No. 0018-064.955). There is a landslide occurring on the northern bank of the maple river and is affecting the bridge structure that crosses the Maple River. This landslide has been affecting the current structure since the early 2000's and is causing the north pier to lean. Due to the proposed landslide fix that has been developed, the existing north pier and abutment will be removed and replaced, and the bridge will be lengthened on the north side of the Maple River. Soil borings were completed at this location and instrumentation was installed to identify the depth of the landslide movement and the water table characteristics.

This memo will provide the foundation recommendations for the construction of the new pier and abutment. Figure 1 below shows an aerial picture of the project location and the soil borings completed:



Figure 1 – Project Location and Soil Boring Locations

### **Soil Borings**

A total of 5 borings were completed near the proposed structure. See the project location map above for the boring locations.

#### **Boring #1**

Boring #1 has an elevation of approximately 924 feet at the top of the boring and is located near the middle existing pier that is being removed and replaced. This boring extends to a depth of 59 feet.

#### **Boring #2**

Boring #2 has an elevation of approximately 930 feet at the top of the boring and is located near the north abutment that is being replaced with a pier. This boring extends to a depth of 60 feet.

#### **Boring #3**

Boring #3 has an elevation of approximately 933 feet at the top of the boring and is located near the proposed north abutment. This boring extends to a depth of 59 feet.

#### **Boring #4**

Boring #1 has an elevation of approximately 924 feet at the top of the boring and is located near the middle existing pier that is being removed and replaced. This boring extends to a depth of 61 feet.

#### **Boring #5**

Boring #1 has an elevation of approximately 925 feet at the top of the boring and is located near the middle existing pier that is being removed and replaced. This boring extends to a depth of 61 feet.

### **Sampling and Testing Procedures:**

Shelby tube sampling and split spoon sampling were used to extract the samples from a hollow stem auger.

Shelby tube sampling provides an “undisturbed” sample of fine-grained soils for laboratory testing via a thin wall tube that is slowly pushed into the soils to be sampled. Densities were calculated according to AASHTO test method T-296.

Split spoon samplers are utilized during advancement of the boring to perform the Standard Penetration Test (SPT). The samples are considered “disturbed”, due to the driving nature in which they are obtained. The SPT results in an N-value, or number of blows required to drive the split spoon sampler 1 foot. This N-value is used to estimate the friction angle of non-cohesive soils and define the consistency of cohesive soils.

For cohesive soils, the shear strength values were determined from the Unconsolidated Undrained and Consolidated Undrained tests utilizing Shelby tubes samples.

The samples from the split spoon and Shelby tubes are submitted to the laboratory for determination of AASHTO classification, moisture content, dry density, sieve analysis, and Atterberg limits.

### **Test Results**

A summary of the lab analysis has been included in Appendix B.

## Foundation Recommendation

### Steel Piling

Pile recommendations are given as termination elevations. The pile sizes that have been analyzed are HP10x42, HP12x53 and HP14x73. See table 4 below for the recommended termination elevations.

The software "APile" was used in conjunction with engineering judgment and past experience in pile driving in these types of soils to estimate the pile lengths. The output from this analysis is available upon request from the NDDOT Geotechnical Section.

Below are simplified soil profiles for each boring that was used to predict the unfactored nominal geotechnical resistance in APile. A graphical representation of the unfactored nominal geotechnical resistance is also shown below in figures 2-4. The nominal geotechnical resistance is used to help predict the pile termination elevations which can be found in table 4 below.

Table 1 - Boring #1 Simplified Soil Profile-Middle Pier

Layer	Depth (feet)	Elevation (feet)	Cohesion (lb/ft <sup>2</sup> )	Friction Angle	Effective Unit Weight (lb/ft <sup>3</sup> )
Soft to Medium Stiff Gry Clay	0.0-38.0	924.0-886.0	c=524psf	-	47.7
Loose Gry Silt	38.0-42.0	886.0-882.0	-	$\phi=30.0$	47.7
Very Stiff to Hard Glacial Till	42.0-59.0	882.0-865.0	c=4000psf	-	47.7

Table 2 - Boring #2 Simplified Soil Profile-North Pier

Layer	Depth (feet)	Elevation (feet)	Cohesion (lb/ft <sup>2</sup> )	Friction Angle	Effective Unit Weight (lb/ft <sup>3</sup> )
Soft to Medium Stiff Gry Clay	0.0-5.0	930.0-925.0	c=766psf	-	109.6
Soft to Medium Stiff Gry Clay	5.0-38.0	925.0-892.0	c=766psf	-	47.2
Loose Gry Silt	38.0-48.0	892.0-882.0	-	$\phi=30.0$	47.2
Very Stiff to Hard Glacial Till	48.0-60.0	882.0-870.0	c=4000 psf	-	47.2

Table 3 - Boring #3 Simplified Soil Profile-North Abutment & Approach Slab

Layer	Depth (feet)	Elevation (feet)	Cohesion (lb/ft <sup>2</sup> )	Friction Angle	Effective Unit Weight (lb/ft <sup>3</sup> )
Soft to Medium Stiff Gry Clay	0.0-8.0	933.0-925.0	c=1061 psf	-	113.0
Soft to Medium Stiff Gry Clay	8.0-41.0	925.0-892.0	c=1061 psf	-	50.6
Loose Gry Silt	41.0-51.0	892.0-882.0	-	$\phi=27.0$	50.6
Very Stiff to Hard Glacial Till	51.0-59.0	882.0-874.0	c=4000 psf	-	50.6

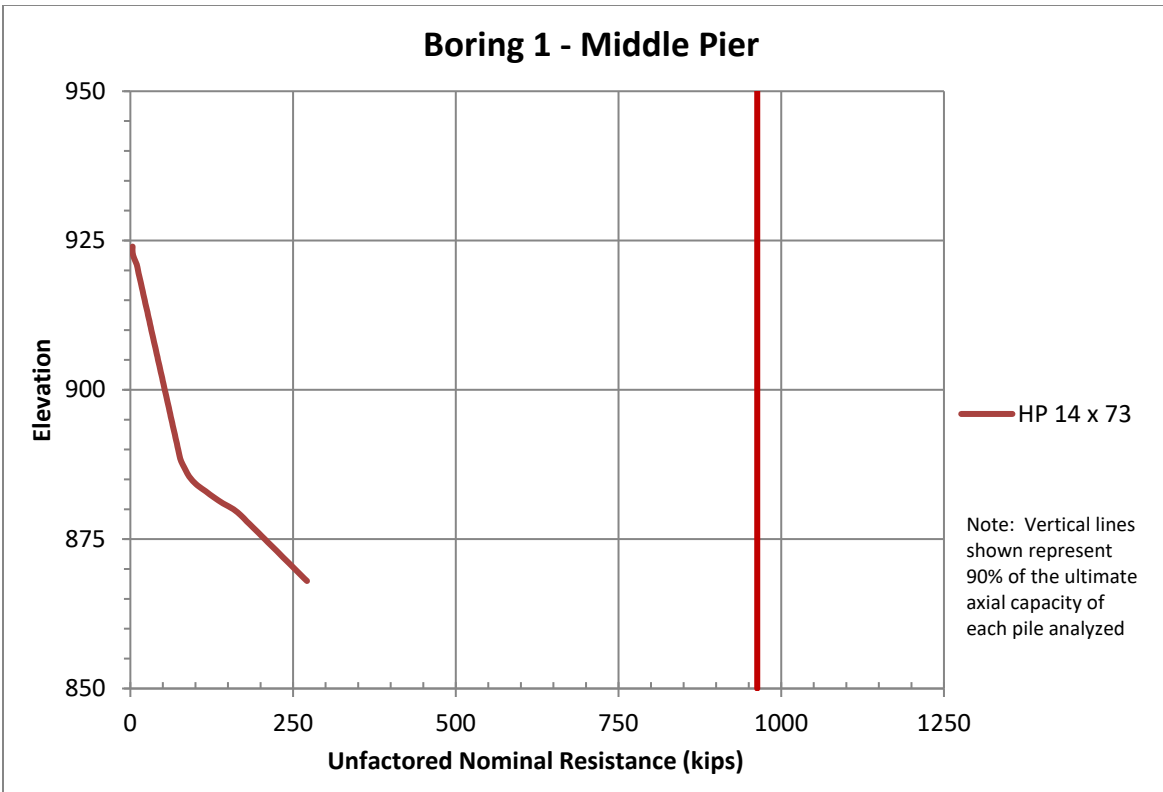


Figure 2: Nominal Resistance for Pile at Middle Pier

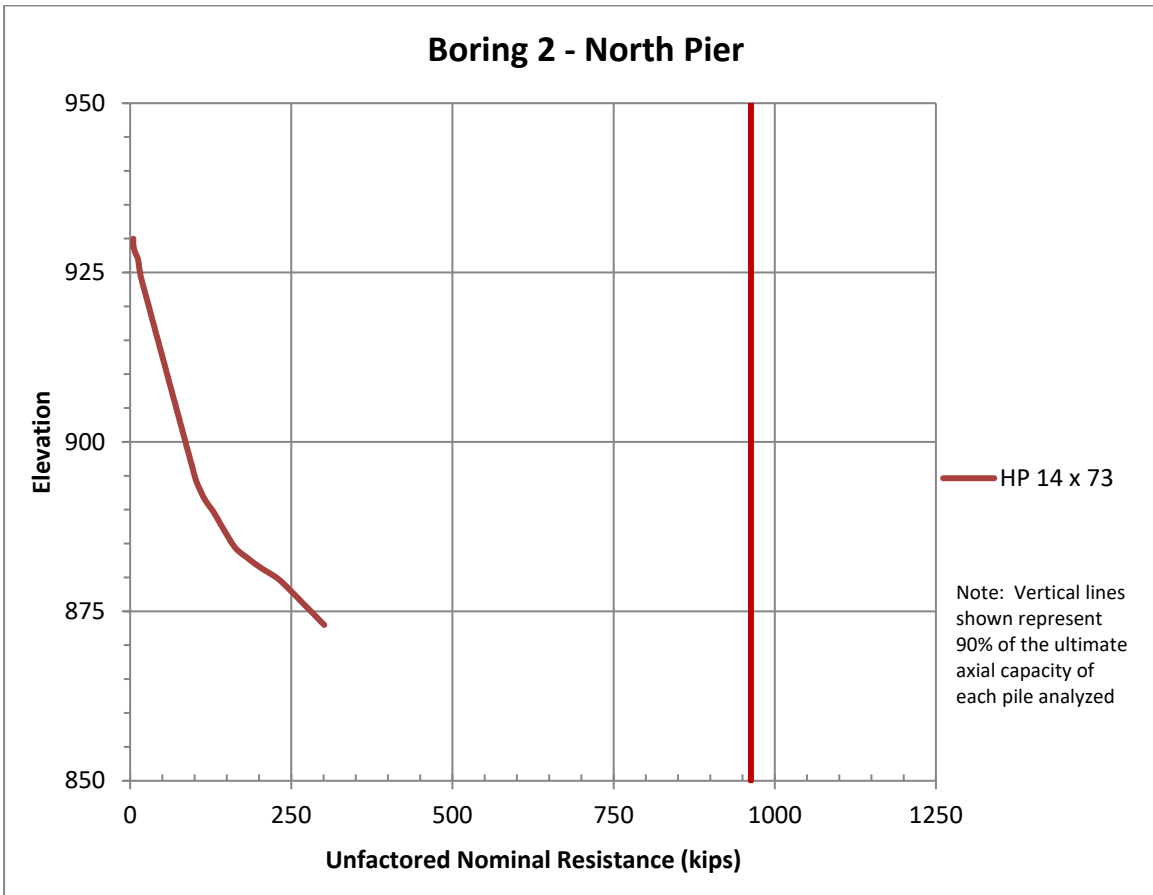


Figure 3: Nominal Resistance for Pile at North Pier

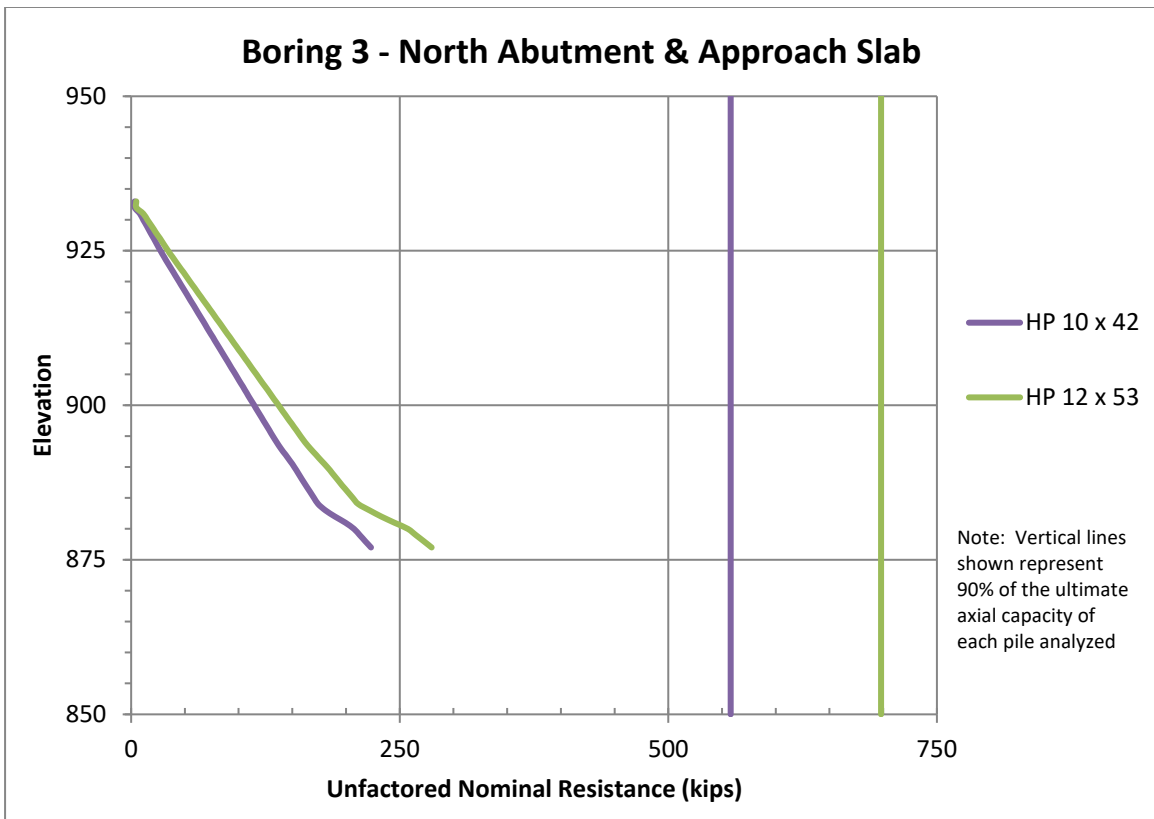


Figure 4: Nominal Resistance for Pile at North Abutment & Pier

Based on the Apile information, past experience and engineering judgement the pile termination elevations were selected as shown in the table below.

Table 4 - Pile Length Information

Pile Type	90% Ultimate Axial Capacity	Middle Pier	North Pier	North Abutment	North Approach Slab
	kips	Termination Elevation	Termination Elevation	Termination Elevation	Termination Elevation
HP10x42	558	-	-	-	872*
HP12x53	698	-	-	872*	-
HP14x73	963	872*	872*	-	-

\*Based on engineering judgement/past experience

**Pile Tips**

It is not anticipated that pile tips will be required for this bridge.

**Scour**

No scour was calculated by the hydraulic section for this structure and so scour was not included.

**Settlement**

Due to no proposed fill there is no anticipated settlement at the structure.

**Downdrag**

Due to no proposed fill downdrag is not applicable at the proposed structure.

**Prebore**

Due to no proposed fill prebore is not applicable at the proposed structure.

If there are any questions or concerns, please contact Jared Loegering [jjloegering@nd.gov](mailto:jjloegering@nd.gov) or Colter Schwagler [cschwagler@nd.gov](mailto:cschwagler@nd.gov) of the NDDOT Geotechnical Section.

# Appendix A

## Soil Boring Logs



PROJECT NUMBER 8-018(106)064 DATE STARTED 8/31/16 COMPLETED 8/31/16

PCN 23279 ELEVATION 924 ft

LOCATION Cass County RP+Feet 64+5062 ft Offset 40 Rt

DRILLED BY Dallan LOGGED BY Jamie DRILLING METHOD \_\_\_\_\_

ENGINEER \_\_\_\_\_

NOTES \_\_\_\_\_

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	AASHTO	USCS	SAMPLE TYPE & NUMBER	RECOVERY (%)	SPT N VALUE	CLAY FRACTION (%)		TESTS & REMARKS
									PL	LL	
920	0	Soft to Medium Stiff Moist Grey to Dark Grey Fat Clay		A-7-6	CL	992	20	7	24	49	UU=601psf
				A-7-6	CL	993	10	9	22	49	
				A-7-6	CH	994	55	4	27	51	
				A-7-6	CH	995	85	4	24	59	
				A-7-5	CH	996	65	5	30	87	
				A-7-6	CH	997	90	5	23	68	
				A-7-5	CH	998	85	3	31	88	
				A-7-6	CH	999	100	3	26	75	
				A-7-6	CH	1000	100	3	29	75	
				A-7-6	CH	1001	100	3	29	72	
				A-7-5	CH	1002	100	3	30	77	
				A-7-6	CH	1003	100	3	28	107	
				A-7-6	CH	1004	100	2	29	86	
				A-7-6	CH	1005	100	2	28	76	
				A-7-5	CH	1006	100	2	31	71	
		A-7-6	CH	1007	100	2	26	63			
		A-7-6	CH	1008	100	3	25	51			
		A-7-6	CL	1009	85	3	24	47			
		A-6	CL	1010	100	7	2038				
880	38.0	886.0 ft		A-4	ML	1011	60	7	235		UU=469psf
		Medium Stiff Wet Grey Silt		A-4	ML	1012	75		232		
		882.0 ft		A-6	SC	1013	75	27	2241		
		Very Stiff to Hard Glacial Till with Clayey Sand, Gravelly Clay, Lean Clay, Silty Sand, and Silt		A-7-6	GC	1014	100	44	1835		
			A-6	CL	1015	75	47	129			
			A-6	CL	1016	75		81	0		
			A-4	SM	1017	100		76	0		
		880		A-4	ML	1018	100		900		
			A-2-4	SM	1019	100		81	128		
			A-6	CL	1020	75		91	131		
		865.0 ft		A-6	CL	1021	25				UU=502psf

Bottom of borehole at 59.0 ft







PROJECT NUMBER 8-018(106)064 DATE STARTED 8/31/16 COMPLETED 8/31/16

PCN 23279 ELEVATION 933 ft

LOCATION Cass County RP+Feet 64+5200 ft Offset 56 Rt

DRILLED BY Dallan LOGGED BY Jamie DRILLING METHOD \_\_\_\_\_

ENGINEER \_\_\_\_\_

NOTES \_\_\_\_\_

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	AASHTO	USCS	SAMPLE TYPE & NUMBER	RECOVERY (%)	SPT N VALUE	CLAY FRACTION (%)		TESTS & REMARKS
									PL	LL	
930	0	Soft to Stiff Moist Brown to Dark Grey Fat Clay		A-4	ML	1052	15	8	26	83	UU=859psf
				A-7-6	CH	1053	70	10	26	89	
				A-7-6	CH	1054	75	5	23	65	
				A-7-6	CH	1055	85	5	25	73	
				A-7-6	CH	1056	85	5	24	76	
				A-7-6	CH	1057	100	5	23	52	
				A-7-6	CH	1058	100	5	24	47	
				A-7-6	CL	1059	100	5	25	76	
				A-7-6	CH	1060	100	6	23	64	
				A-7-6	CH	1061	100	6	25	75	
				A-7-6	CH	1062	100	6	25	74	
				A-7-6	CH	1063	100	6	31	96	
				A-7-5	CH	1064	100	5	31	90	
				A-7-5	CH	1065	100	5	31	82	
				A-7-6	CH	1066	90	3	26	72	
		A-7-6	CH	1067	100	3	28	50			
890	40	892.0 ft	41.0 ft	A-7-6	CH	1068	85	3	30	42	
		Soft Wet Dark Grey Silt		A-7-5	ML	1069	100	3			
				A-4	ML	1070	90	4			
				A-4	ML	1071	100	4			
880	50	882.0 ft	51.0 ft	A-4	ML	1072	100	19	19	37	
		Very Stiff to Hard Glacial Till including Lean Clay and Silty Sand		A-6	CL	1073	100	19			
				A-6	CL	1074	100	71	16	29	
				A-6	CL	1075	100	86	0		
		874.0 ft	59.0 ft	A-2-4	SM	1076	100	86	0		

Bottom of borehole at 59.0 ft

NDDOT LOG - NDDOT\_DATA\TEMP\_20180208\GDT - 6/26/23 12:47 - F:\LAB\PROJECTS\GINT\8-018(088)064.GPJ



PROJECT NUMBER 8-018(106)064 DATE STARTED 8/2/17 COMPLETED 8/2/17

PCN 23279 ELEVATION 924 ft

LOCATION Cass County RP+Feet 64+5100 ft Offset 92 Rt

DRILLED BY Dallan LOGGED BY Jamie DRILLING METHOD \_\_\_\_\_

ENGINEER \_\_\_\_\_

NOTES \_\_\_\_\_

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	AASHTO	USCS	SAMPLE TYPE & NUMBER	RECOVERY (%)	SPT N VALUE	CLAY FRACTION (%)		TESTS & REMARKS
									MC	LL	
920	0	Soft to Medium Stiff Moist Grey to Dark Grey Fat Clay				647	20	6			
						648	20	10			
						A-7-5 MH 649	50	6		30	55
						A-7-6 CH 650	85	6		25	57
						A-7-6 CH 651	65	6		25	75
						A-7-6 CH 652	75	6		28	75
						A-7-6 CL 653	75			22	49
						A-7-6 CH 654	90	3		28	71
						A-7-6 CH 655	100	4		27	69
						A-7-6 CH 656	100	5		24	52
						A-7-6 CH 657	75			21	52
						A-7-5 MH 658	100	3		36	75
						A-7-5 CH 659	100	3		31	65
						A-7-6 CH 660	100	3		28	52
890	34.0					890.0 ft Medium Stiff Wet Grey Silt				A-7-6 ML 661	100
						A-4 ML 662	100			336	
						A-4 ML 663	100			100	
						A-4 ML 664	100				
880	44.0	880.0 ft Very Stiff to Hard Glacial Till including Lean Clay, Silty Lean Clay, and Silty Sand				A-6 CL 665	85	24			20 37
						A-6 CL 666	85	43			14 31
						A-4 ML 667	100	57			0
						A-4 SM 668	90	73			0
						A-4 SM 669	90	87			0
						A-4 SC-SM 670	85				100 227
						A-6 CL 671	85				100 2234

Bottom of borehole at 61.0 ft



PROJECT NUMBER 8-018(106)064 DATE STARTED 8/2/17 COMPLETED 8/2/17

PCN 23279 ELEVATION 925 ft

LOCATION Cass County RP+Feet 64+5049 ft Offset 63 Lt

DRILLED BY Dallan LOGGED BY Jamie DRILLING METHOD \_\_\_\_\_

ENGINEER \_\_\_\_\_

NOTES \_\_\_\_\_

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	AASHTO	USCS	SAMPLE TYPE & NUMBER	RECOVERY (%)	SPT N VALUE	CLAY FRACTION (%)		TESTS & REMARKS
									PL	LL	
0	0	Soft to Medium Stiff Moist Grey to Dark Grey Fat Clay		A-7-6	CH	672	25	8	25	52	
	10					673	25	10	24	54	
920						674	50	23	45		
	4					675	75	25	76		
	4					676	90	23	69		
	5					677	100	23	67		
910						678	90	25	63		
	2					679	100	25	71		
	3					680	100	24	68		
20						681	100	24	65		
	4					682	100	29	76		
900						683	100	29	78		
	3					684	100	27	63		
	2					685	100	25	54		
30						686	100	29	45		
890		687	100	0							
	5	688	100	0							
	7	689	100	0							
40		690	100	22	40						
		691	90	48	17	31					
880		692	90	84	122						
		693	100	100							
50		694	100	100	121						
		695	100	100	121						
870		696	100	100	2	31					
60											

Bottom of borehole at 61.0 ft

NDDOT LOG - NDDOT\_DATATEMP\_20180208.GDT - 6/26/23 12:47 - F:\LAB\PROJECTS\GINT\8-018(088)064.GPJ

# Appendix B

## Lab Analysis



# SUMMARY OF LABORATORY RESULTS

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	AASHTO Classification	USCS Classification	Water Content (%)	Avg. Water Content (%)	Dry Density (pcf)	Saturation (%)	Void Ratio
SB - 1	0.0	49	24	25	4.76	93	A-7-6 (26)	CL	16.1	16.1			
SB - 1	2.0	49	22	27	25	80	A-7-6 (22)	CL	17.5	17.5			
SB - 1	4.0	51	27	24	4.75	91	A-7-6 (25)	CH					
SB - 1	6.0	59	24	35	4.75	97	A-7-6 (39)	CH	32.6	32.6			
SB - 1	8.0	87	30	57	4.75	98	A-7-5 (66)	CH					
SB - 1	10.0	68	23	45	2	100	A-7-6 (52)	CH	42.9	42.9			
SB - 1	12.0	88	31	57	4.75	99	A-7-5 (68)	CH					
SB - 1	14.0	75	26	49	9.5	100	A-7-6 (58)	CH	48.8	48.8			
SB - 1	16.0	75	29	46	4.75	99	A-7-6 (54)	CH					
SB - 1	18.0	72	29	43	4.75	100	A-7-6 (51)	CH	50.5	50.5			
SB - 1	20.0	77	30	47	4.75	99	A-7-5 (56)	CH					
SB - 1	22.0	107	28	79	0.425	98	A-7-6 (91)	CH	67.0	67.0			
SB - 1	24.0	86	29	57	4.75	98	A-7-6 (66)	CH					
SB - 1	26.0	76	28	48	9.5	99	A-7-6 (56)	CH	65.8	65.8			
SB - 1	28.0	71	31	40	9.5	98	A-7-5 (47)	CH					
SB - 1	30.0	63	26	37	9.5	91	A-7-6 (38)	CH	68.2	68.2			
SB - 1	32.0	51	25	26	9.5	94	A-7-6 (28)	CH					
SB - 1	34.0	47	24	23	25	95	A-7-6 (25)	CL	40.8	40.8			
SB - 1	36.0	38	20	18	9.5	72	A-6 (12)	CL					
SB - 1	38.0	NP	NP	NP	9.5	99	A-4 (0)	ML	33.4	33.4			
SB - 1	40.0	35	29	6	25	82	A-4 (6)	ML					
SB - 1	42.0	32	20	12	25	38	A-6 (1)	SC	18.2	18.2			
SB - 1	44.0	41	22	19	25	45	A-7-6 (5)	GC					
SB - 1	45.0	35	18	17	25	62	A-6 (8)	CL	10.9	10.9			
SB - 1	47.0	29	15	14	25	64	A-6 (6)	CL	13.2	13.2			
SB - 1	49.0	NP	NP	NP	9.5	43	A-4 (0)	SM	7.4	7.4			
SB - 1	51.0	NP	NP	NP	25	63	A-4 (0)	ML	8.7	8.7			
SB - 1	53.0	NP	NP	NP	25	30	A-2-4 (0)	SM	13.5	13.5			
SB - 1	55.0	28	17	11	25	54	A-6 (3)	CL	16.6	16.6			
SB - 1	57.0	31	19	12	9.5	54	A-6 (4)	CL	16.7	16.7			
SB - 2	0.0	50	27	23	25	80	A-7-6 (20)	CH	18.9	18.9			
SB - 2	2.0	53	26	27	9.5	88	A-7-6 (26)	CH	23.0	23.0			
SB - 2	4.0	50	26	24	4.75	91	A-7-6 (25)	CH					
SB - 2	6.0	78	24	54	2	99	A-7-6 (62)	CH	35.0	35.0			
SB - 2	8.0	73	25	48	4.75	99	A-7-6 (55)	CH					
SB - 2	10.0	64	31	33	4.75	99	A-7-5 (40)	CH	37.2	37.2			
SB - 2	12.0	96	31	65	4.75	99	A-7-5 (77)	CH					
SB - 2	14.0	78	29	49	4.75	98	A-7-6 (57)	CH	41.0	41.0			
SB - 2	16.0	57	25	32	4.75	99	A-7-6 (37)	CH					
SB - 2	18.0	52	23	29	4.75	100	A-7-6 (33)	CH	33.8	33.8			
SB - 2	20.0	67	29	38	4.75	99	A-7-6 (45)	CH					
SB - 2	22.0	61	26	35	4.75	99	A-7-6 (41)	CH	52.5	52.5			
SB - 2	24.0	64	27	37	9.5	99	A-7-6 (43)	CH					

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# SUMMARY OF LABORATORY RESULTS

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	AASHTO Classification	USCS Classification	Water Content (%)	Avg. Water Content (%)	Dry Density (pcf)	Saturation (%)	Void Ratio
SB - 2	26.0	85	29	56	4.75	98	A-7-6 (65)	CH	61.1	61.1			
SB - 2	28.0	82	39	43	9.5	99	A-7-5 (54)	MH					
SB - 2	30.0	81	38	43	9.5	98	A-7-5 (53)	MH	51.1	51.1			
SB - 2	32.0	69	29	40	4.75	98	A-7-6 (47)	CH					
SB - 2	34.0	69	30	39	9.5	97	A-7-5 (45)	CH	64.2	64.2			
SB - 2	36.0	60	26	34	4.75	97	A-7-6 (38)	CH					
SB - 2	38.0	46	28	18	4.75	97	A-7-6 (21)	ML	40.3	40.3			
SB - 2	40.0	NP	NP	NP	2	98	A-4 (0)	ML					
SB - 2	42.0	NP	NP	NP	9.5	95	A-4 (0)	ML	35.2	35.2			
SB - 2	44.0	NP	NP	NP	2	99	A-4 (0)	ML					
SB - 2	46.0	NP	NP	NP	9.5	94	A-4 (0)	ML	34.5	34.5			
SB - 2	48.0	29	17	12	25	52	A-6 (3)	CL					
SB - 2	50.0	37	21	16	25	59	A-6 (7)	CL	21.7	21.7			
SB - 2	52.0	33	17	16	25	60	A-6 (7)	CL	10.5	10.5			
SB - 2	54.0	18	14	4	25	52	A-4 (0)	CL-ML	13.0	13.0			
SB - 2	56.0	22	15	7	25	54	A-4 (1)	CL-ML	9.1	9.1			
SB - 2	58.0	NP	NP	NP	25	49	A-4 (0)	SM	11.7	11.7			
SB - 3	0.0	NP	NP	NP	25	75	A-4 (0)	ML	21.8	21.8			
SB - 3	2.0	83	26	57	4.75	99	A-7-6 (66)	CH	46.2	46.2			
SB - 3	4.0	89	26	63	4.75	99	A-7-6 (73)	CH					
SB - 3	6.0	65	23	42	4.75	99	A-7-6 (48)	CH	36.1	36.1			
SB - 3	9.0	73	25	48	4.75	100	A-7-6 (56)	CH					
SB - 3	11.0	76	24	52	4.75	100	A-7-6 (60)	CH	48.4	48.4			
SB - 3	14.0	52	23	29	4.75	99	A-7-6 (33)	CH					
SB - 3	16.0	47	24	23	2	100	A-7-6 (26)	CL	32.8	32.8			
SB - 3	19.0	76	25	51	0.425	100	A-7-6 (60)	CH					
SB - 3	21.0	64	23	41	2	100	A-7-6 (47)	CH	39.5	39.5			
SB - 3	24.0	75	25	50	2	100	A-7-6 (58)	CH					
SB - 3	26.0	74	25	49	2	100	A-7-6 (57)	CH	59.6	59.6			
SB - 3	29.0	96	31	65	2	99	A-7-5 (77)	CH					
SB - 3	31.0	90	31	59	2	99	A-7-5 (70)	CH	60.1	60.1			
SB - 3	34.0	82	31	51	2	99	A-7-5 (61)	CH					
SB - 3	36.0	72	26	46	9.5	97	A-7-6 (52)	CH	51.2	51.2			
SB - 3	39.0	50	28	22	9.5	97	A-7-6 (25)	CH					
SB - 3	41.0	42	30	12	9.5	95	A-7-5 (14)	ML	40.1	40.1			
SB - 3	44.0	NP	NP	NP	4.75	99	A-4 (0)	ML					
SB - 3	46.0	NP	NP	NP	9.5	98	A-4 (0)	ML	36.7	36.7			
SB - 3	49.0	NP	NP	NP	2	99	A-4 (0)	ML					
SB - 3	51.0	37	19	18	9.5	66	A-6 (10)	CL	21.0	21.0			
SB - 3	55.0	29	16	13	25	60	A-6 (5)	CL	12.7	12.7			
SB - 3	57.0	NP	NP	NP	25	14	A-2-4 (0)	SM	13.0	13.0			
SB - 4	0.0				9.5	90			14.2				
SB - 4	2.0				9.5	90			17.2				

LAB SUMMARY - 20171219.GDT - 6/27/23 07:01 - F:\LAB\PROJECTS\GINT\8-018(089)064.GPJ





**SUMMARY OF LABORATORY RESULTS**

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	AASHTO Classification	USCS Classification	Water Content (%)	Avg. Water Content (%)	Dry Density (pcf)	Saturation (%)	Void Ratio
SB - 4	4.0	55	30	25	2	94	A-7-5 (28)	MH	33.6				
SB - 4	6.0	57	25	32	2	98	A-7-6 (36)	CH	29.6				
SB - 4	9.0	75	25	50	4.75	98	A-7-6 (57)	CH	33.4				
SB - 4	11.0	75	28	47	2	99	A-7-6 (55)	CH	41.8				
SB - 4	14.0	49	22	27	2	100	A-7-6 (30)	CL	34.2				
SB - 4	16.0	71	28	43	4.75	100	A-7-6 (51)	CH	62.1				
SB - 4	19.0	69	27	42	2	100	A-7-6 (50)	CH	46.6				
SB - 4	21.0	52	24	28	2	100	A-7-6 (32)	CH	40.6				
SB - 4	24.0	52	21	31	2	100	A-7-6 (35)	CH	34.8				
SB - 4	24.8								45.1				
SB - 4	25.3								51.4				
SB - 4	26.0	75	36	39	2	99	A-7-5 (48)	MH	59.7				
SB - 4	29.0	65	31	34	4.75	97	A-7-5 (40)	CH	54.1				
SB - 4	31.0	52	28	24	4.75	97	A-7-6 (28)	CH	43.2				
SB - 4	34.0	42	29	13	4.75	96	A-7-6 (15)	ML	39.5				
SB - 4	36.0	36	30	6	2	99	A-4 (8)	ML	38.2				
SB - 4	39.0	NP	NP	NP	4.75	97	A-4 (0)	ML	33.5				
SB - 4	41.0	NP	NP	NP	9.5	89	A-4 (0)	ML	32.0				
SB - 4	44.0	37	20	17	9.5	64	A-6 (9)	CL	14.0				
SB - 4	46.0	31	14	17	9.5	63	A-6 (8)	CL	2.8				
SB - 4	49.0	NP	NP	NP	9.5	55	A-4 (0)	ML	6.8				
SB - 4	52.0	NP	NP	NP	9.5	36	A-4 (0)	SM	13.4				
SB - 4	54.0	NP	NP	NP	9.5	44	A-4 (0)	SM	18.4				
SB - 4	57.0	27	21	6	25	47	A-4 (0)	SC-SM	16.9				
SB - 4	59.0	34	22	12	9.5	60	A-6 (5)	CL	16.4				
SB - 5	0.0	52	25	27	9.5	92	A-7-6 (28)	CH	16.0	16.0			
SB - 5	2.0	54	24	30	9.5	87	A-7-6 (28)	CH	17.3	17.3			
SB - 5	4.0	45	23	22	9.5	89	A-7-6 (21)	CL	33.1	33.1			
SB - 5	6.0	76	25	51	9.5	97	A-7-6 (57)	CH	31.5	31.5			
SB - 5	9.0	69	23	46	4.75	98	A-7-6 (52)	CH	46.3	46.3			
SB - 5	11.0	67	23	44	4.75	100	A-7-6 (51)	CH	42.9	42.9			
SB - 5	14.0	63	25	38	2	99	A-7-6 (44)	CH	49.2	49.2			
SB - 5	16.0	71	25	46	2	100	A-7-6 (54)	CH	45.8	45.8			
SB - 5	19.0	68	24	44	2	100	A-7-6 (51)	CH	44.3	44.3			
SB - 5	21.0	65	24	41	2	100	A-7-6 (47)	CH	41.1	41.1			
SB - 5	24.0	76	29	47	9.5	99	A-7-6 (55)	CH	68.6	68.6			
SB - 5	26.0	78	29	49	4.75	98	A-7-6 (57)	CH	62.2	62.2			
SB - 5	29.0	63	27	36	9.5	97	A-7-6 (41)	CH	52.3	52.3			
SB - 5	31.0	54	25	29	9.5	94	A-7-6 (31)	CH	47.4	47.4			
SB - 5	34.0	45	29	16	9.5	96	A-7-6 (19)	ML	49.0	49.0			
SB - 5	36.0	NP	NP	NP	4.75	99	A-4 (0)	ML	35.7	35.7			
SB - 5	39.0	NP	NP	NP	9.5	98	A-4 (0)	ML	35.6	35.6			
SB - 5	41.0	NP	NP	NP	9.5	97	A-4 (0)	ML	35.5	35.5			

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NORTH DAKOTA DEPARTMENT OF TRANSPORTATION  
 300 AIRPORT ROAD  
 BISMARCK, ND 58504

# SUMMARY OF LABORATORY RESULTS

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

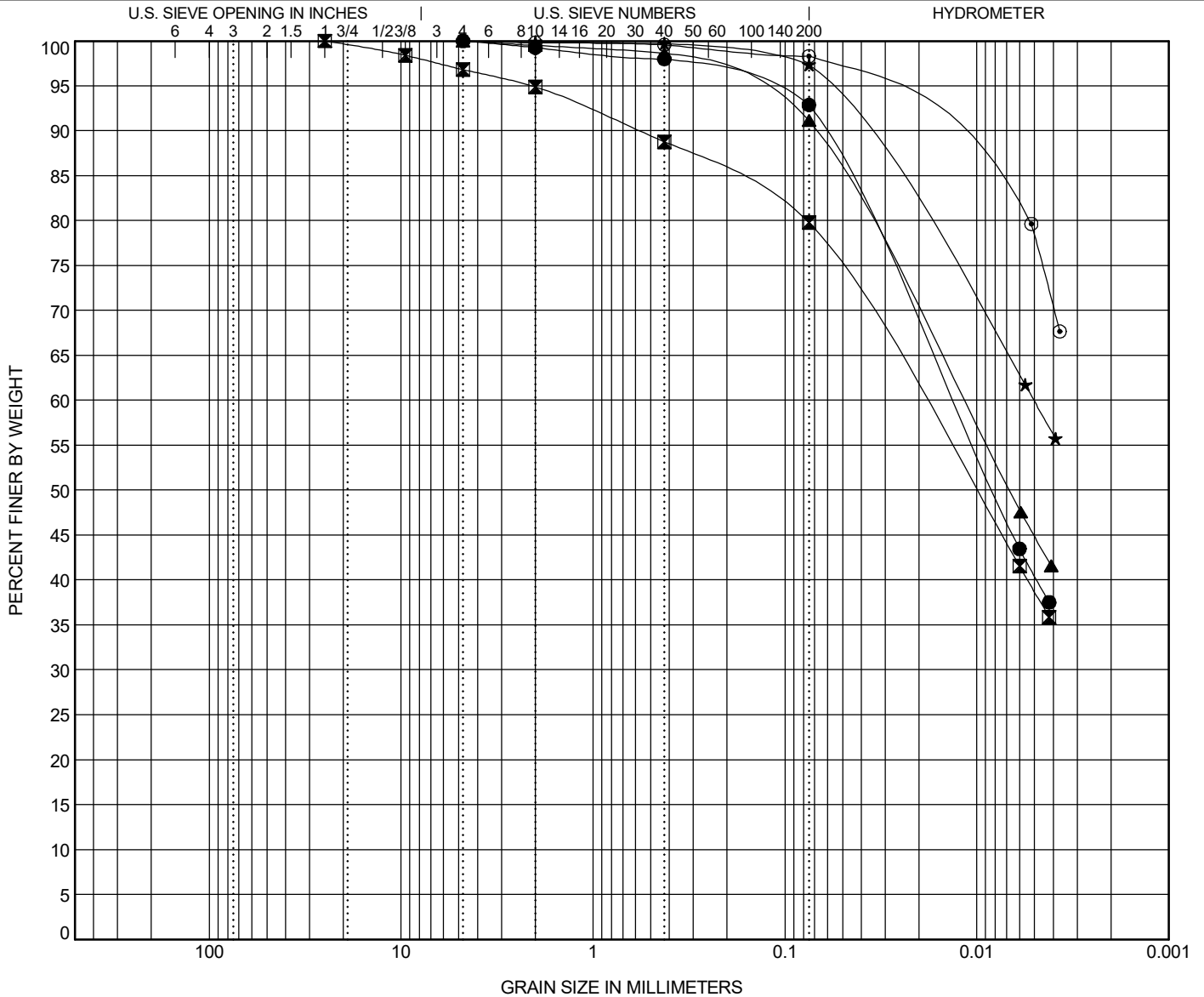
PCN 23279

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	AASHTO Classification	USCS Classification	Water Content (%)	Avg. Water Content (%)	Dry Density (pcf)	Saturation (%)	Void Ratio
SB - 5	44.0	40	22	18	25	62	A-6 (9)	CL	22.6	22.6			
SB - 5	45.0	31	17	14	9.5	60	A-6 (6)	CL	10.7	10.7			
SB - 5	49.0	22	15	7	9.5	58	A-4 (1)	CL-ML	11.2	11.2			
SB - 5	51.0	NP	NP	NP	4.75	46	A-4 (0)	SM	23.4	23.4			
SB - 5	54.0	21	14	7	9.5	40	A-4 (0)	SC-SM	22.5	22.5			
SB - 5	56.0	21	14	7	9.5	54	A-4 (1)	CL-ML	7.6	7.6			
SB - 5	59.0	31	21	10	9.5	49	A-4 (2)	SC	16.1	16.1			

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification		LL	PL	PI	Cc	Cu
● SB - 1	0.0	A-7-6 (26)	CL		49	24	25		
☒ SB - 1	2.0	A-7-6 (22)	CL		49	22	27		
▲ SB - 1	4.0	A-7-6 (25)	CH		51	27	24		
★ SB - 1	6.0	A-7-6 (39)	CH		59	24	35		
◎ SB - 1	8.0	A-7-5 (66)	CH		87	30	57		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 1	0.0	4.76	0.014			0.0	7.1	92.9	
☒ SB - 1	2.0	25	0.02			3.2	17.0	79.8	
▲ SB - 1	4.0	4.75	0.012			0.0	8.9	91.1	
★ SB - 1	6.0	4.75	0.005			0.0	2.6	97.4	
◎ SB - 1	8.0	4.75				0.0	1.7	98.3	

GRAIN SIZE - 20171219.GDT - 6/27/23 06:59 - F:\LAB\PROJECTS\GINT18-018\088\064.GPJ

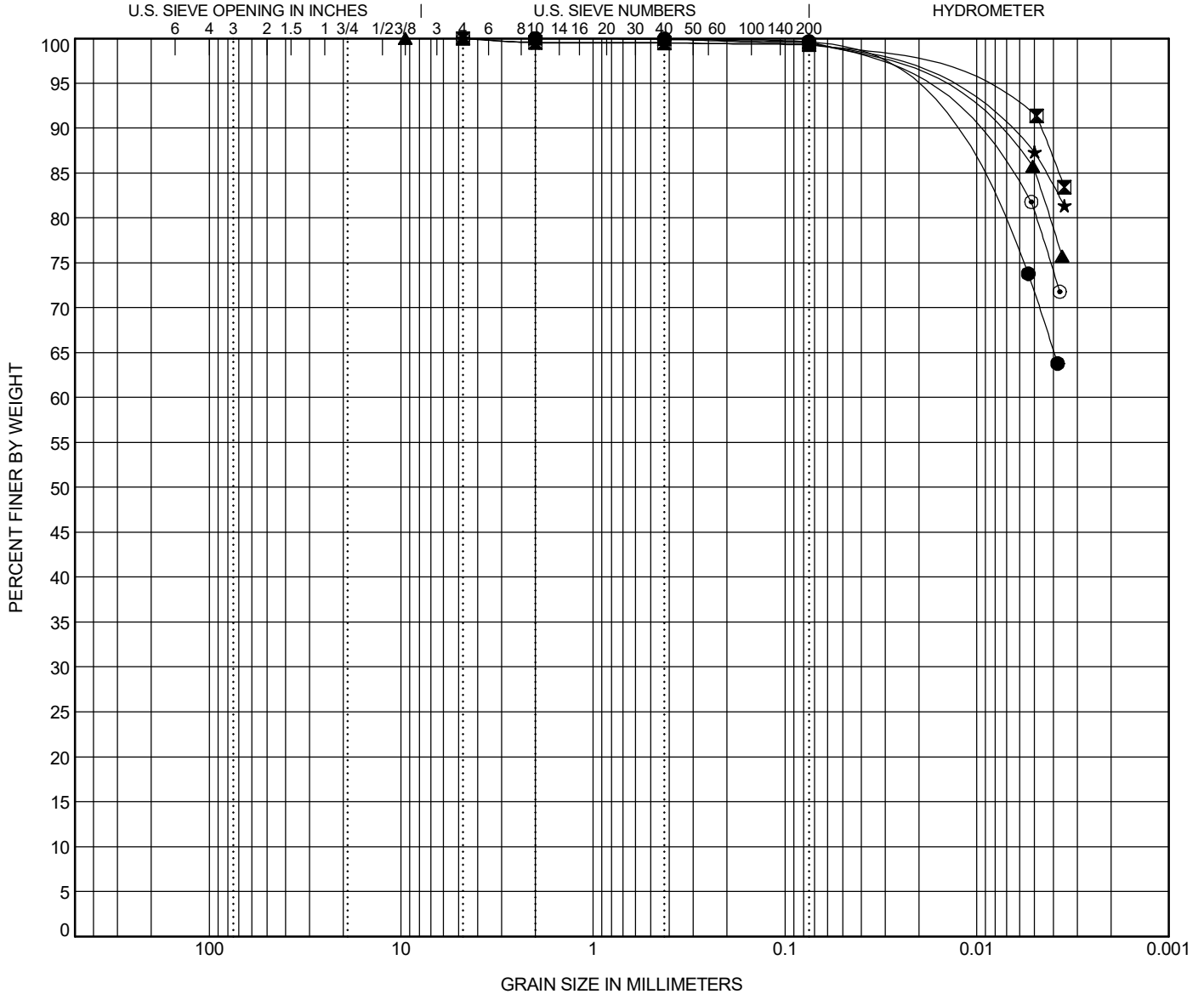


# GRAIN SIZE DISTRIBUTION

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification		LL	PL	PI	Cc	Cu
● SB - 1	10.0	A-7-6 (52)	CH		68	23	45		
■ SB - 1	12.0	A-7-5 (68)	CH		88	31	57		
▲ SB - 1	14.0	A-7-6 (58)	CH		75	26	49		
★ SB - 1	16.0	A-7-6 (54)	CH		75	29	46		
◎ SB - 1	18.0	A-7-6 (51)	CH		72	29	43		

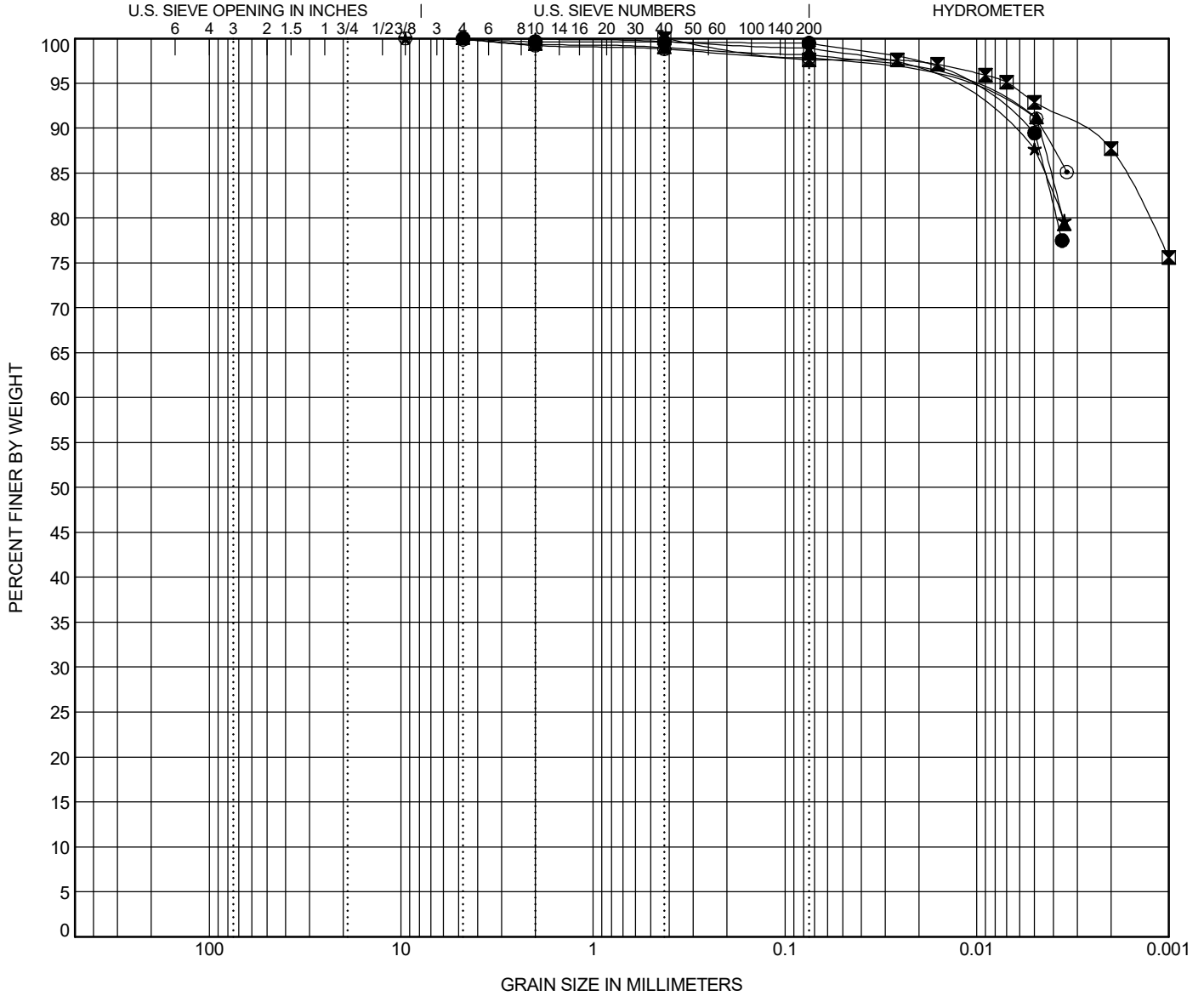
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 1	10.0	2				0.0	0.4	99.6	
■ SB - 1	12.0	4.75				0.0	0.7	99.3	
▲ SB - 1	14.0	9.5				0.0	0.4	99.5	
★ SB - 1	16.0	4.75				0.0	0.6	99.4	
◎ SB - 1	18.0	4.75				0.0	0.3	99.7	

GRAIN SIZE - 20171219.GDT - 6/27/23 06:59 - F:\LAB\PROJECTS\GINT18-018\088\064.GPJ

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification		LL	PL	PI	Cc	Cu
● SB - 1	20.0	A-7-5 (56)	CH		77	30	47		
☒ SB - 1	22.0	A-7-6 (91)	CH		107	28	79		
▲ SB - 1	24.0	A-7-6 (66)	CH		86	29	57		
★ SB - 1	26.0	A-7-6 (56)	CH		76	28	48		
◎ SB - 1	28.0	A-7-5 (47)	CH		71	31	40		

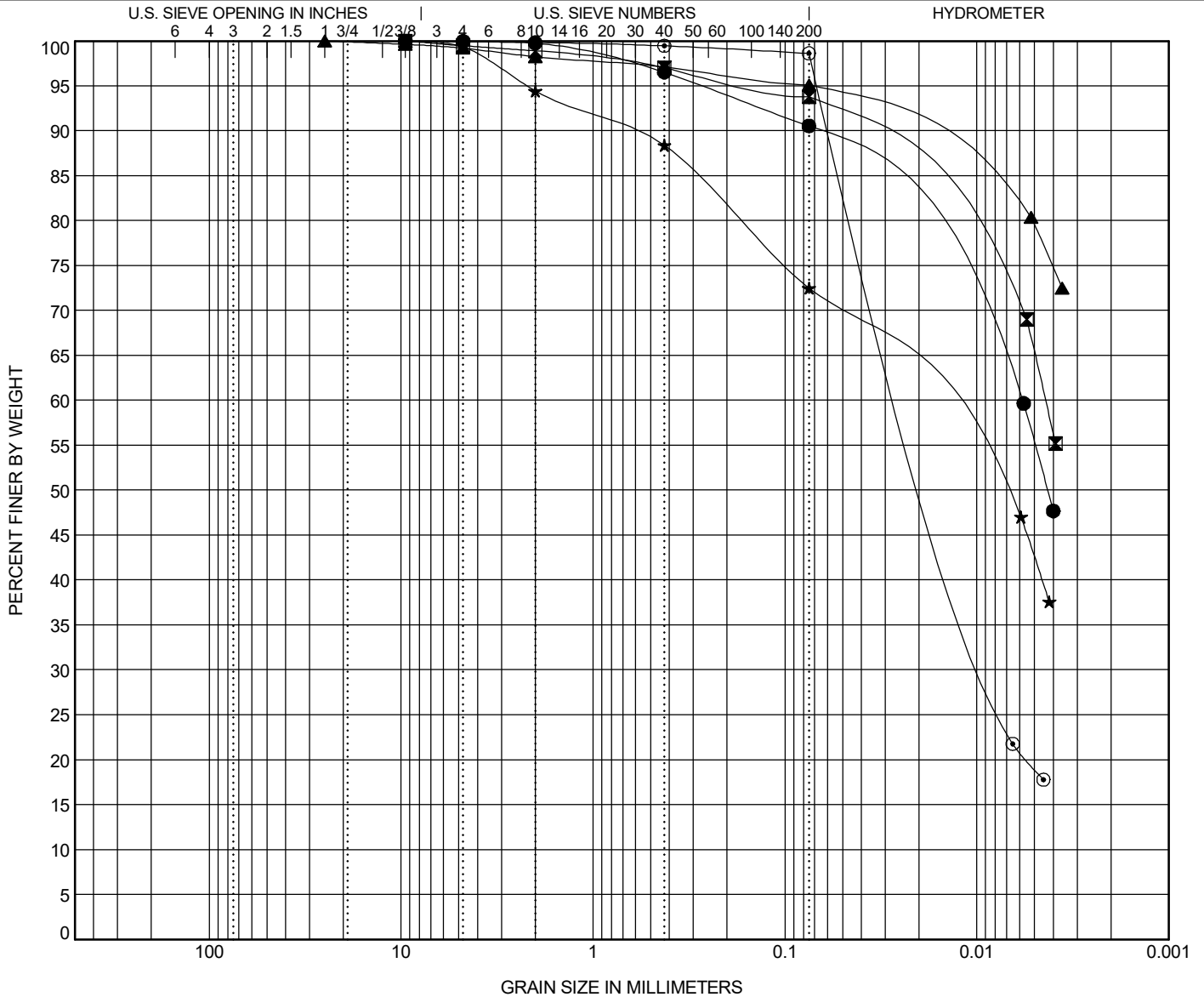
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 1	20.0	4.75				0.0	0.5	99.5	
☒ SB - 1	22.0	0.425				0.0	2.4	9.9	87.7
▲ SB - 1	24.0	4.75				0.0	1.8	98.2	
★ SB - 1	26.0	9.5				0.0	1.0	98.9	
◎ SB - 1	28.0	9.5				0.1	2.0	97.9	

GRAIN SIZE - 20171219.GDT - 6/27/23 06:59 - F:\LAB\PROJECTS\GINT18-018\088\064.GPJ

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification			LL	PL	PI	Cc	Cu
● SB - 1	30.0	A-7-6 (38)	CH			63	26	37		
■ SB - 1	32.0	A-7-6 (28)	CH			51	25	26		
▲ SB - 1	34.0	A-7-6 (25)	CL			47	24	23		
★ SB - 1	36.0	A-6 (12)	CL			38	20	18		
○ SB - 1	38.0	A-4 (0)	ML			NP	NP	NP		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 1	30.0	9.5	0.006			0.0	9.4	90.5	
■ SB - 1	32.0	9.5	0.004			0.5	5.7	93.8	
▲ SB - 1	34.0	25				0.8	4.1	95.1	
★ SB - 1	36.0	9.5	0.022			0.6	26.9	72.5	
○ SB - 1	38.0	9.5	0.022	0.008		0.1	1.3	98.6	

GRAIN SIZE - 20171219.GDT - 6/27/23 06:59 - F:\LAB\PROJECTS\GINT18-018(088)064.GPJ



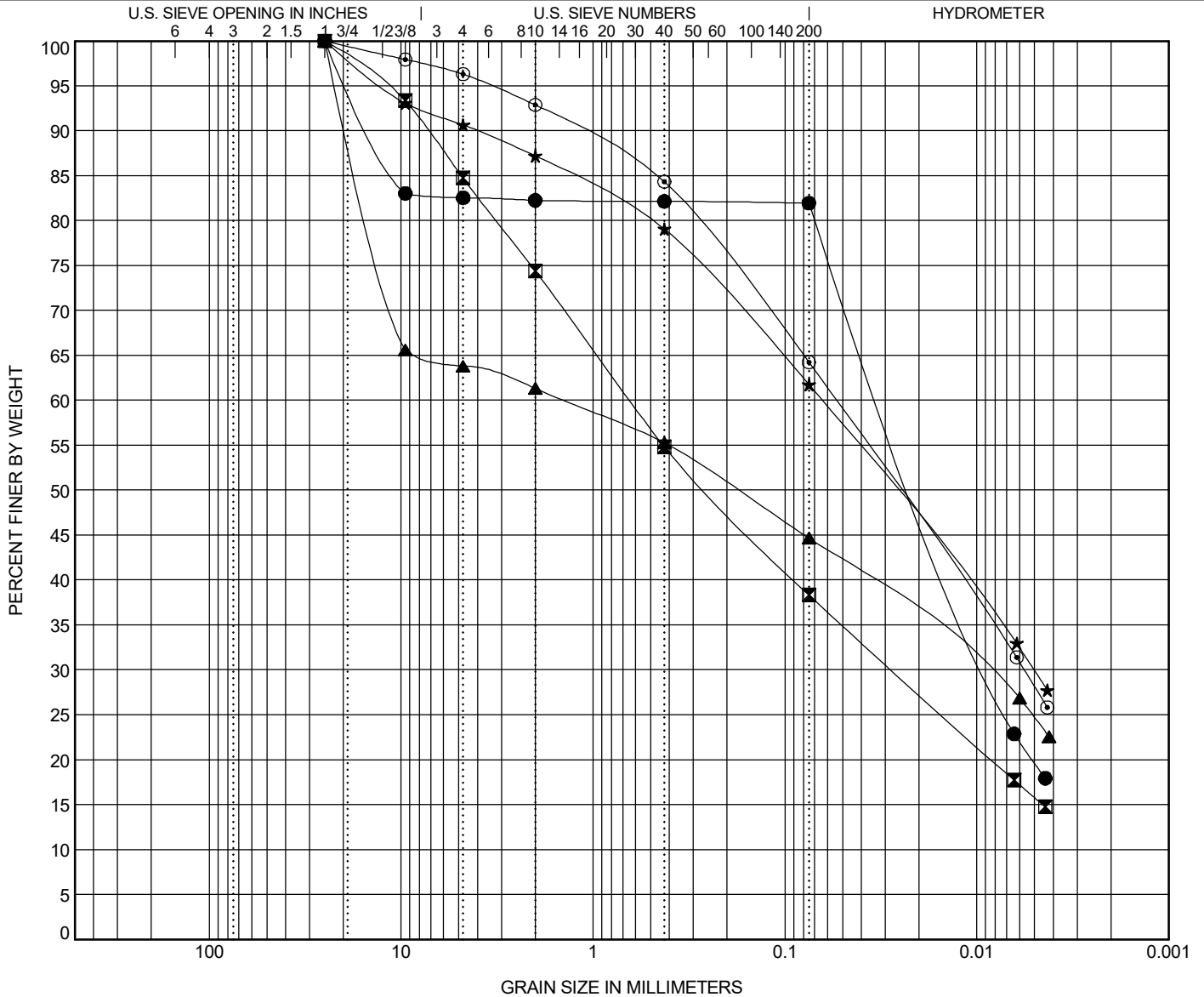
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 300 AIRPORT ROAD  
 BISMARCK, ND 58504

# GRAIN SIZE DISTRIBUTION

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification	LL	PL	PI	Cc	Cu
● SB - 1	40.0	A-4 (6)	ML	35	29	6		
■ SB - 1	42.0	A-6 (1)	SC	32	20	12		
▲ SB - 1	44.0	A-7-6 (5)	GC	41	22	19		
★ SB - 1	45.0	A-6 (8)	CL	35	18	17		
○ SB - 1	47.0	A-6 (6)	CL	29	15	14		

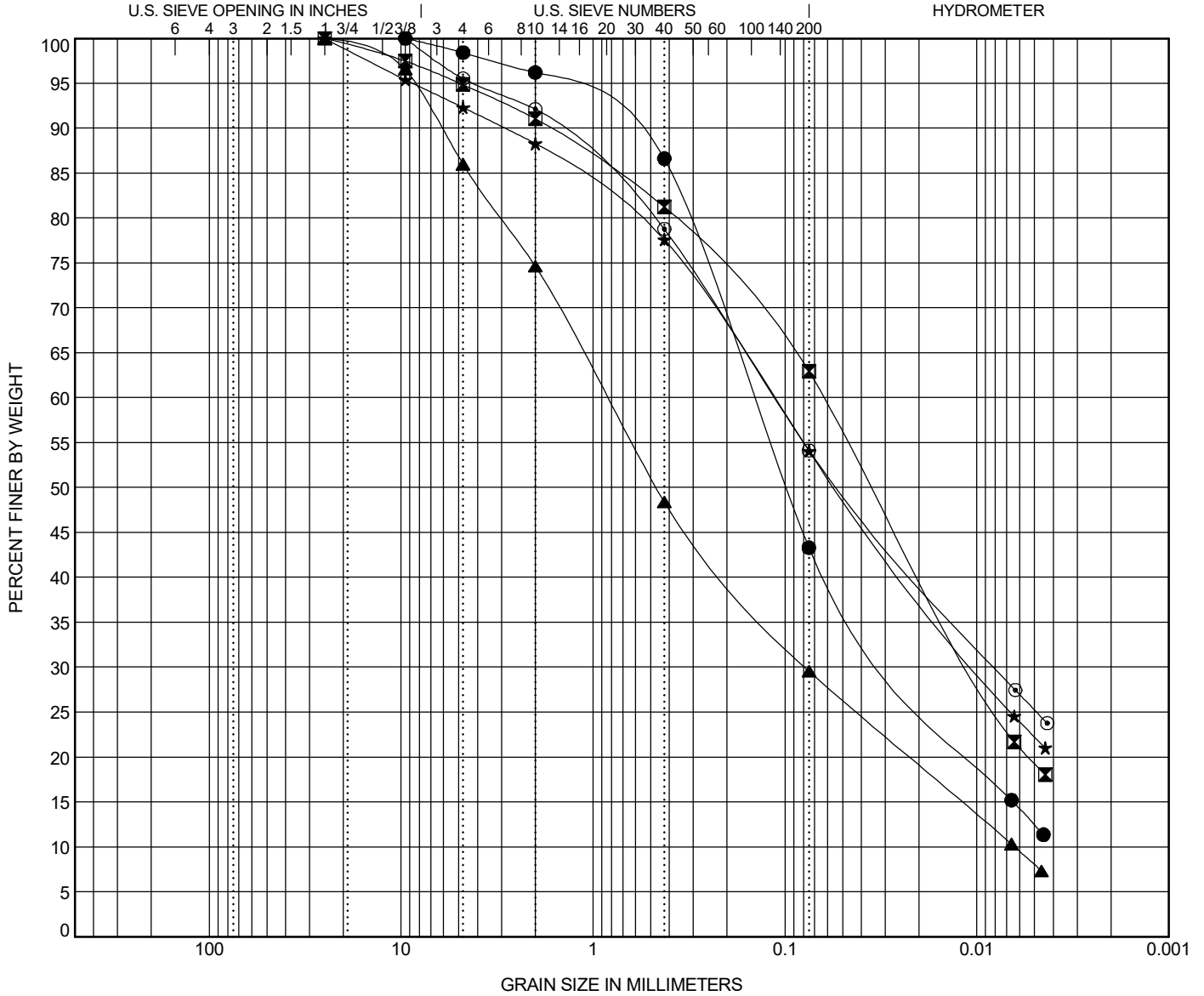
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 1	40.0	25	0.03	0.009		17.5	0.6	81.9	
■ SB - 1	42.0	25	0.639	0.028		15.3	46.4	38.3	
▲ SB - 1	44.0	25	1.426	0.009		36.2	19.1	44.7	
★ SB - 1	45.0	25	0.065	0.005		9.3	28.9	61.7	
○ SB - 1	47.0	25	0.054	0.006		3.7	32.1	64.2	

GRAIN SIZE - 20171219.GDT - 6/27/23 06:59 - F:\LAB\PROJECTS\GINT18-018(088)064.GPJ

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification		USCS Classification			LL	PL	PI	Cc	Cu
● SB - 1	49.0	A-4 (0)		SM			NP	NP	NP		
☒ SB - 1	51.0	A-4 (0)		ML			NP	NP	NP		
▲ SB - 1	53.0	A-2-4 (0)		SM			NP	NP	NP	1.14	132.38
★ SB - 1	55.0	A-6 (3)		CL			28	17	11		
◎ SB - 1	57.0	A-6 (4)		CL			31	19	12		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay		
● SB - 1	49.0	9.5	0.146	0.024		1.6	55.1	43.3			
☒ SB - 1	51.0	25	0.063	0.011		5.1	31.9	62.9			
▲ SB - 1	53.0	25	0.843	0.078	0.006	14.0	56.4	29.5			
★ SB - 1	55.0	25	0.116	0.01		7.7	38.2	54.1			
◎ SB - 1	57.0	9.5	0.113	0.008		4.5	41.4	54.1			



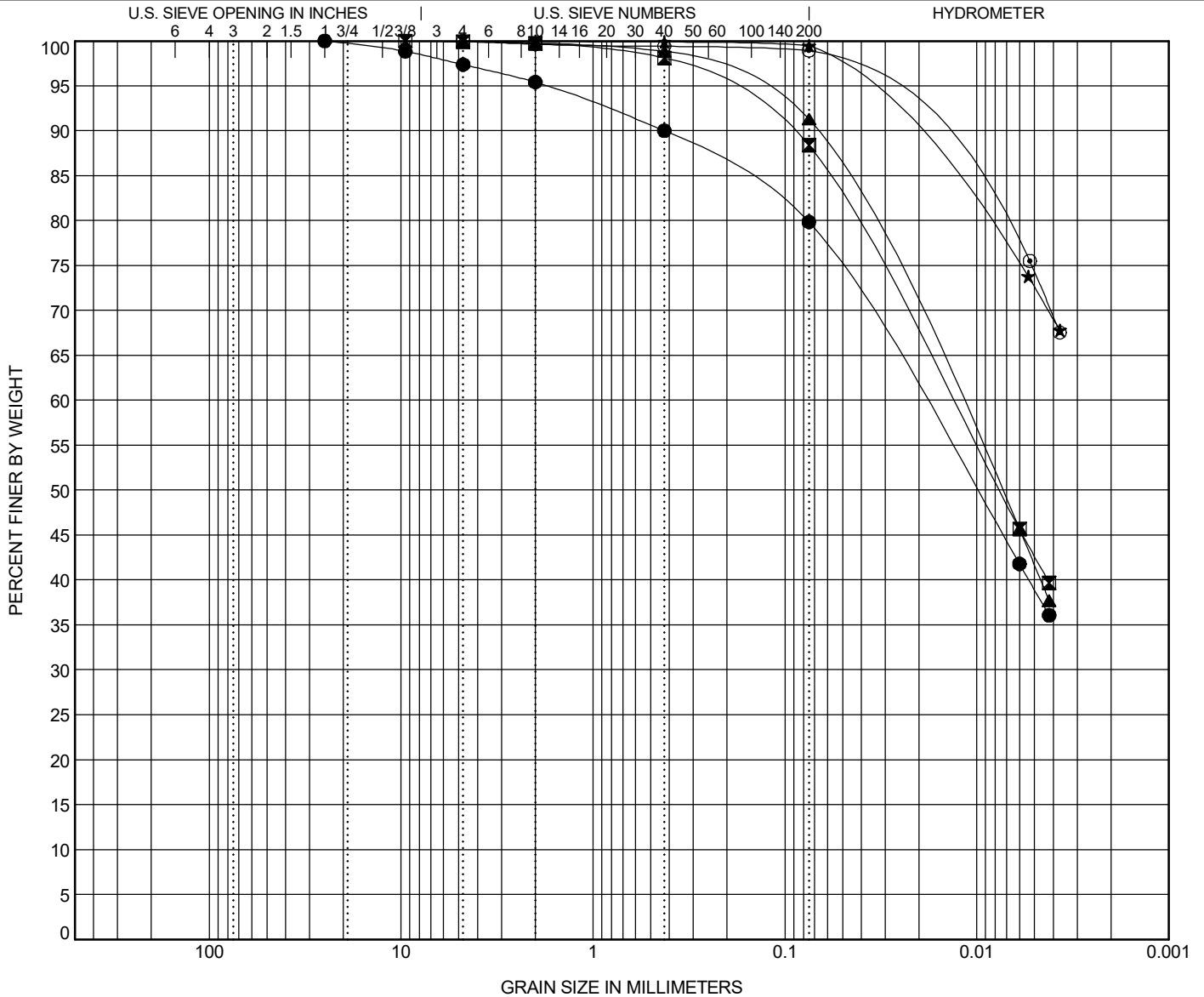
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300 AIRPORT ROAD  
BISMARCK, ND 58504

# GRAIN SIZE DISTRIBUTION

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification	LL	PL	PI	Cc	Cu
● SB - 2	0.0	A-7-6 (20)	CH	50	27	23		
■ SB - 2	2.0	A-7-6 (26)	CH	53	26	27		
▲ SB - 2	4.0	A-7-6 (25)	CH	50	26	24		
★ SB - 2	6.0	A-7-6 (62)	CH	78	24	54		
◎ SB - 2	8.0	A-7-6 (55)	CH	73	25	48		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 2	0.0	25	0.02			2.6	17.5	79.8	
■ SB - 2	2.0	9.5	0.014			0.1	11.5	88.4	
▲ SB - 2	4.0	4.75	0.013			0.0	8.7	91.3	
★ SB - 2	6.0	2				0.0	0.5	99.5	
◎ SB - 2	8.0	4.75				0.0	1.1	98.9	

GRAIN SIZE - 20171219.GDT - 6/27/23 06:59 - F:\LAB\PROJECTS\GINT18-018\088\064.GPJ





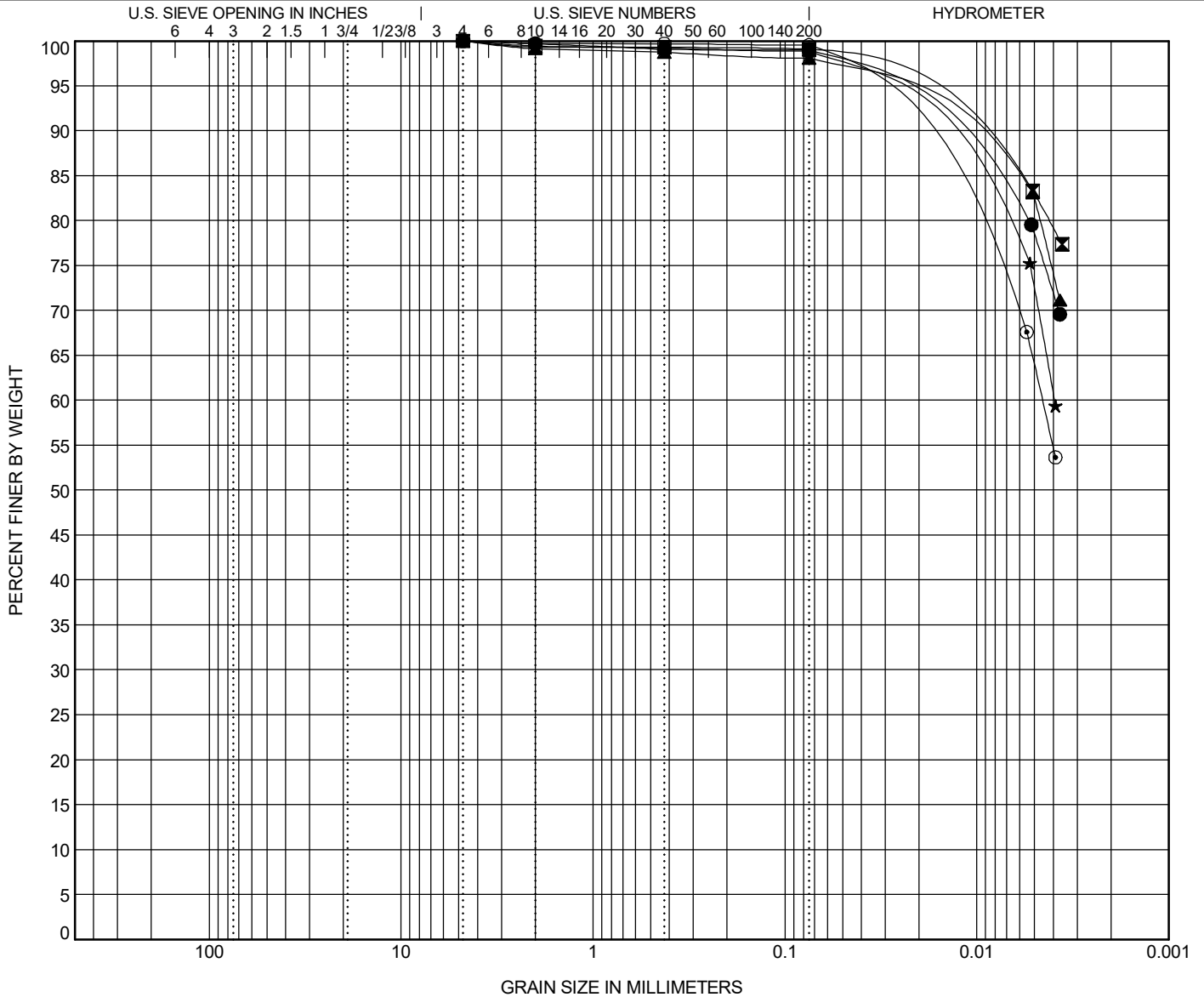
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300 AIRPORT ROAD  
BISMARCK, ND 58504

# GRAIN SIZE DISTRIBUTION

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification		LL	PL	PI	Cc	Cu
● SB - 2	10.0	A-7-5 (40)	CH		64	31	33		
■ SB - 2	12.0	A-7-5 (77)	CH		96	31	65		
▲ SB - 2	14.0	A-7-6 (57)	CH		78	29	49		
★ SB - 2	16.0	A-7-6 (37)	CH		57	25	32		
◎ SB - 2	18.0	A-7-6 (33)	CH		52	23	29		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 2	10.0	4.75				0.0	1.0	99.0	
■ SB - 2	12.0	4.75				0.0	0.9	99.1	
▲ SB - 2	14.0	4.75				0.0	1.9	98.1	
★ SB - 2	16.0	4.75	0.004			0.0	1.1	98.9	
◎ SB - 2	18.0	4.75	0.005			0.0	0.5	99.5	

GRAIN SIZE - 20171219.GDT - 6/27/23 06:59 - F:\LAB\PROJECTS\GINT18-018\088\064.GPJ



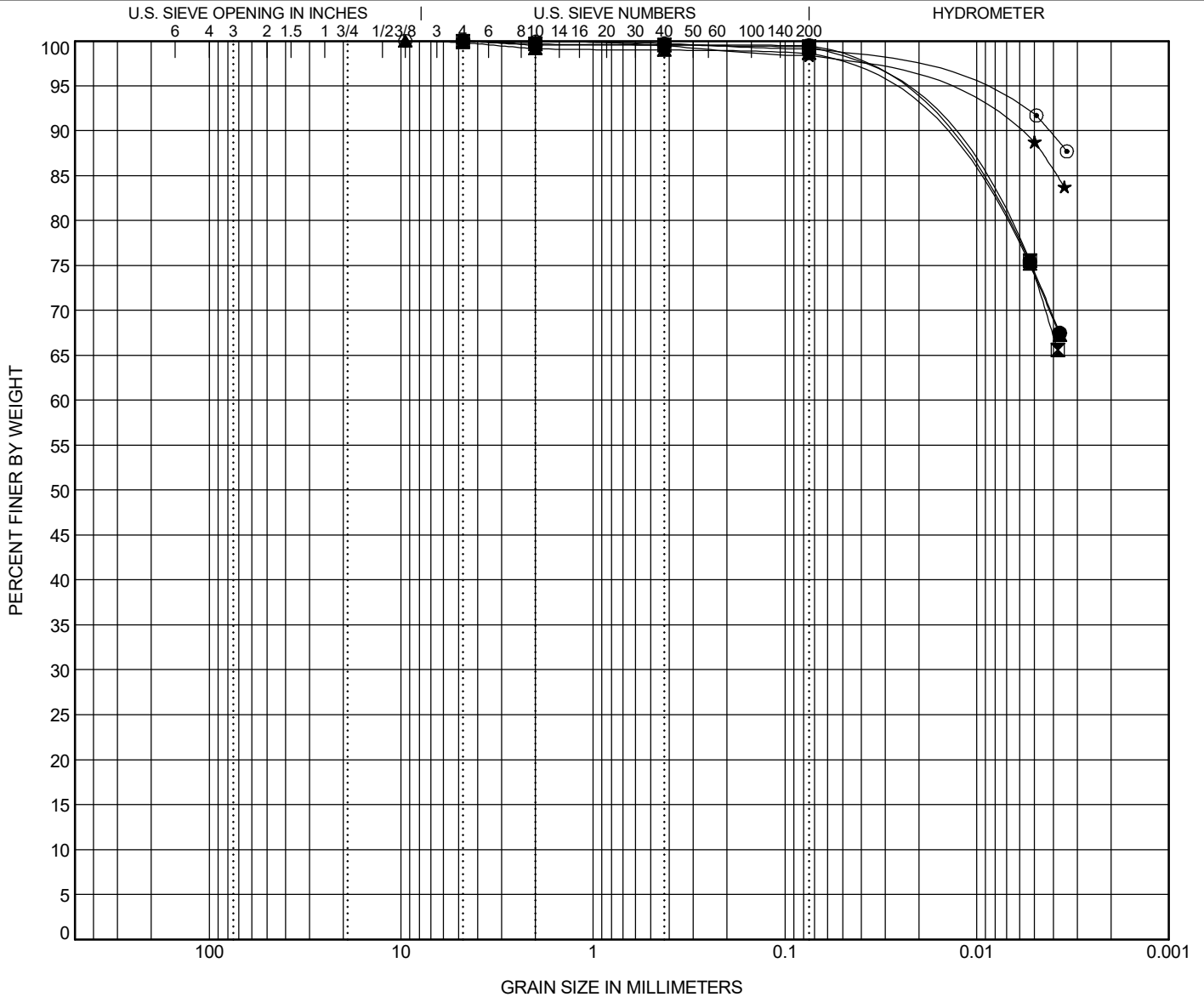
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 300 AIRPORT ROAD  
 BISMARCK, ND 58504

# GRAIN SIZE DISTRIBUTION

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification			LL	PL	PI	Cc	Cu
● SB - 2	20.0	A-7-6 (45)	CH			67	29	38		
☒ SB - 2	22.0	A-7-6 (41)	CH			61	26	35		
▲ SB - 2	24.0	A-7-6 (43)	CH			64	27	37		
★ SB - 2	26.0	A-7-6 (65)	CH			85	29	56		
◎ SB - 2	28.0	A-7-5 (54)	MH			82	39	43		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 2	20.0	4.75				0.0	0.5	99.5	
☒ SB - 2	22.0	4.75				0.0	0.6	99.4	
▲ SB - 2	24.0	9.5				0.2	1.2	98.6	
★ SB - 2	26.0	4.75				0.0	1.6	98.4	
◎ SB - 2	28.0	9.5				0.0	0.8	99.1	

GRAIN SIZE - 20171219.GDT - 6/27/23 06:59 - F:\LAB\PROJECTS\GINT18-018(088)064.GPJ



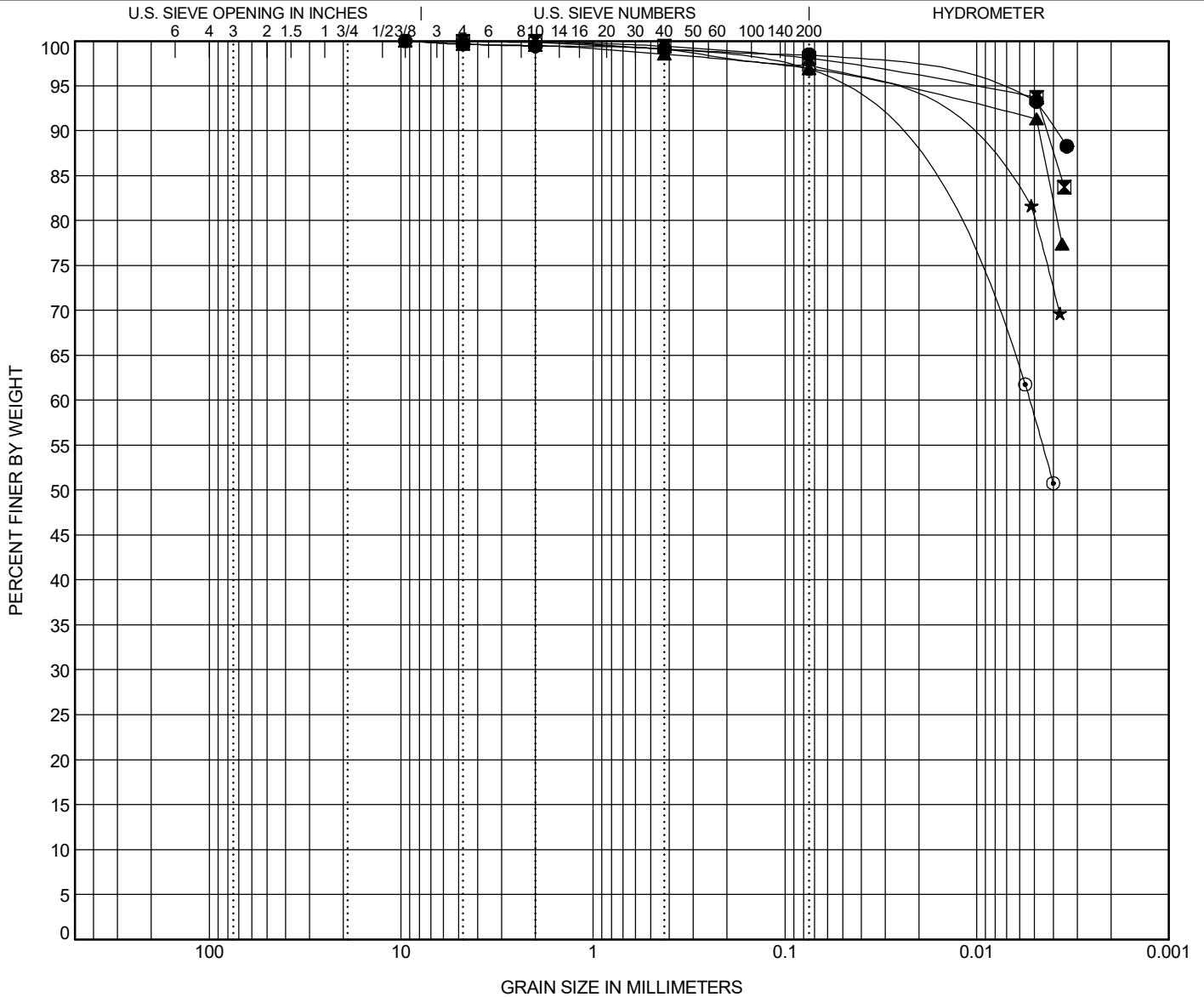
NORTH DAKOTA DEPARTMENT OF TRANSPORTATION  
300 AIRPORT ROAD  
BISMARCK, ND 58504

# GRAIN SIZE DISTRIBUTION

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification			LL	PL	PI	Cc	Cu
● SB - 2	30.0	A-7-5 (53)	MH			81	38	43		
☒ SB - 2	32.0	A-7-6 (47)	CH			69	29	40		
▲ SB - 2	34.0	A-7-5 (45)	CH			69	30	39		
★ SB - 2	36.0	A-7-6 (38)	CH			60	26	34		
◎ SB - 2	38.0	A-7-6 (21)	ML			46	28	18		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 2	30.0	9.5				0.3	1.2	98.5	
☒ SB - 2	32.0	4.75				0.0	1.9	98.1	
▲ SB - 2	34.0	9.5				0.4	2.7	96.9	
★ SB - 2	36.0	4.75				0.0	2.7	97.3	
◎ SB - 2	38.0	4.75	0.005			0.0	3.1	96.9	

GRAIN SIZE - 20171219.GDT - 6/27/23 06:59 - F:\LAB\PROJECTS\GINT18-018\088\064.GPJ



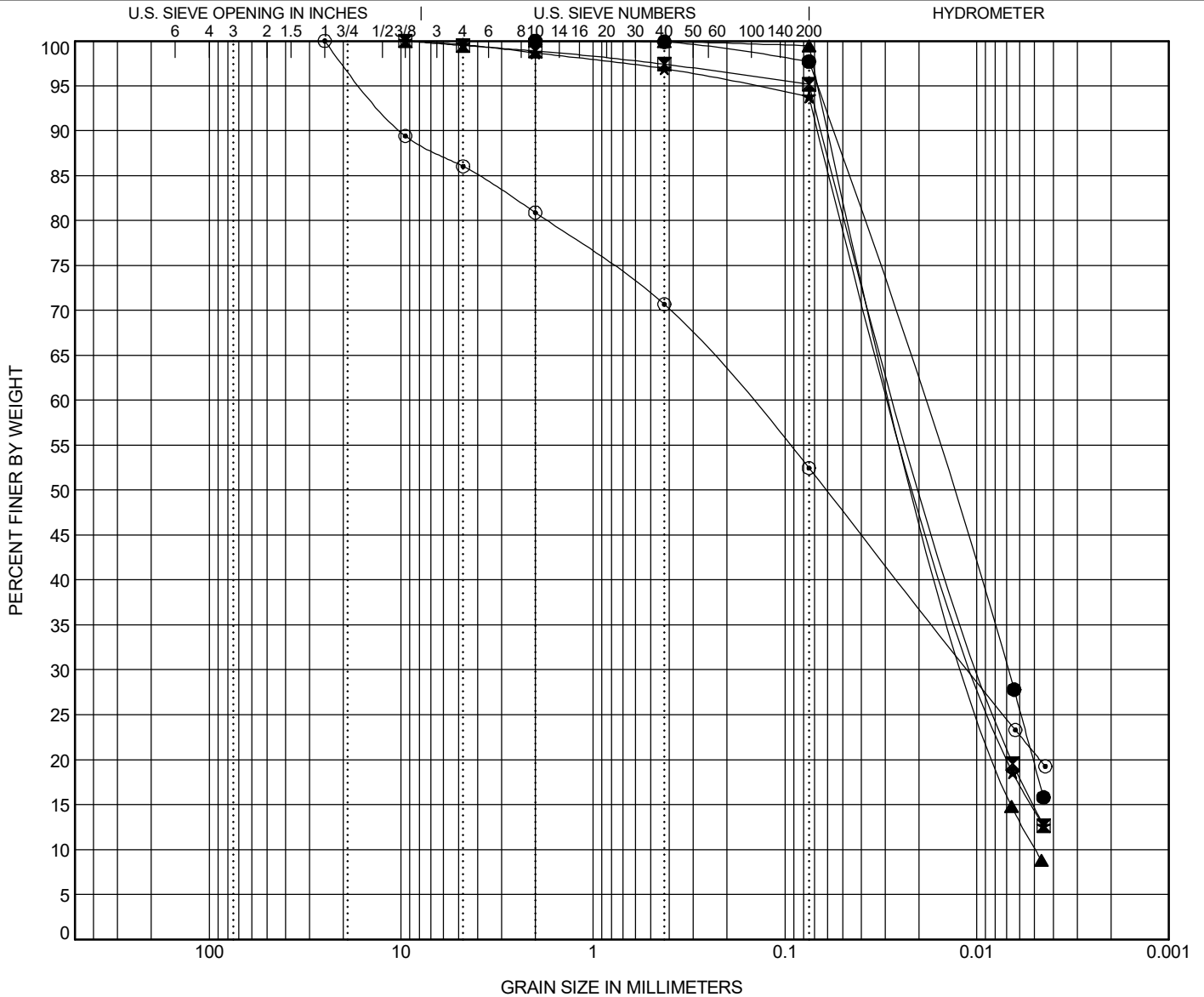
NORTH DAKOTA DEPARTMENT OF TRANSPORTATION  
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BISMARCK, ND 58504

# GRAIN SIZE DISTRIBUTION

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification			USCS Classification			LL	PL	PI	Cc	Cu
● SB - 2	40.0	A-4 (0)			ML			NP	NP	NP		
☒ SB - 2	42.0	A-4 (0)			ML			NP	NP	NP		
▲ SB - 2	44.0	A-4 (0)			ML			NP	NP	NP	0.87	4.88
★ SB - 2	46.0	A-4 (0)			ML			NP	NP	NP		
◎ SB - 2	48.0	A-6 (3)			CL			29	17	12		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay		
● SB - 2	40.0	2	0.02	0.007		0.0	2.3	97.7				
☒ SB - 2	42.0	9.5	0.024	0.009		0.5	4.3	95.2				
▲ SB - 2	44.0	2	0.024	0.01	0.005	0.0	0.5	99.5				
★ SB - 2	46.0	9.5	0.025	0.009		0.4	5.8	93.8				
◎ SB - 2	48.0	25	0.154	0.011		14.0	33.6	52.5				

GRAIN SIZE - 20171219.GDT - 6/27/23 06:59 - F:\LAB\PROJECTS\GINT18-018\088\064.GPJ



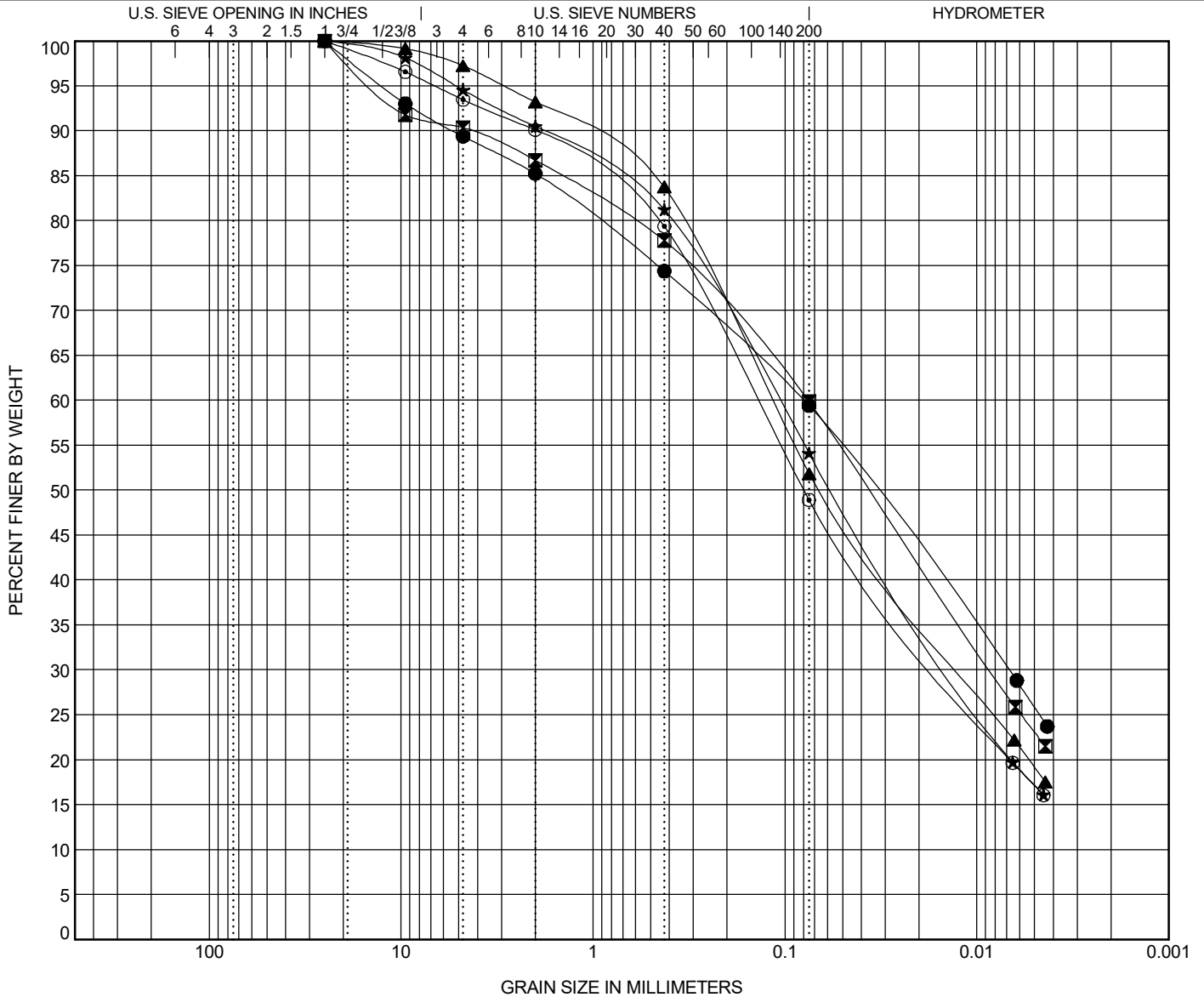
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# GRAIN SIZE DISTRIBUTION

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

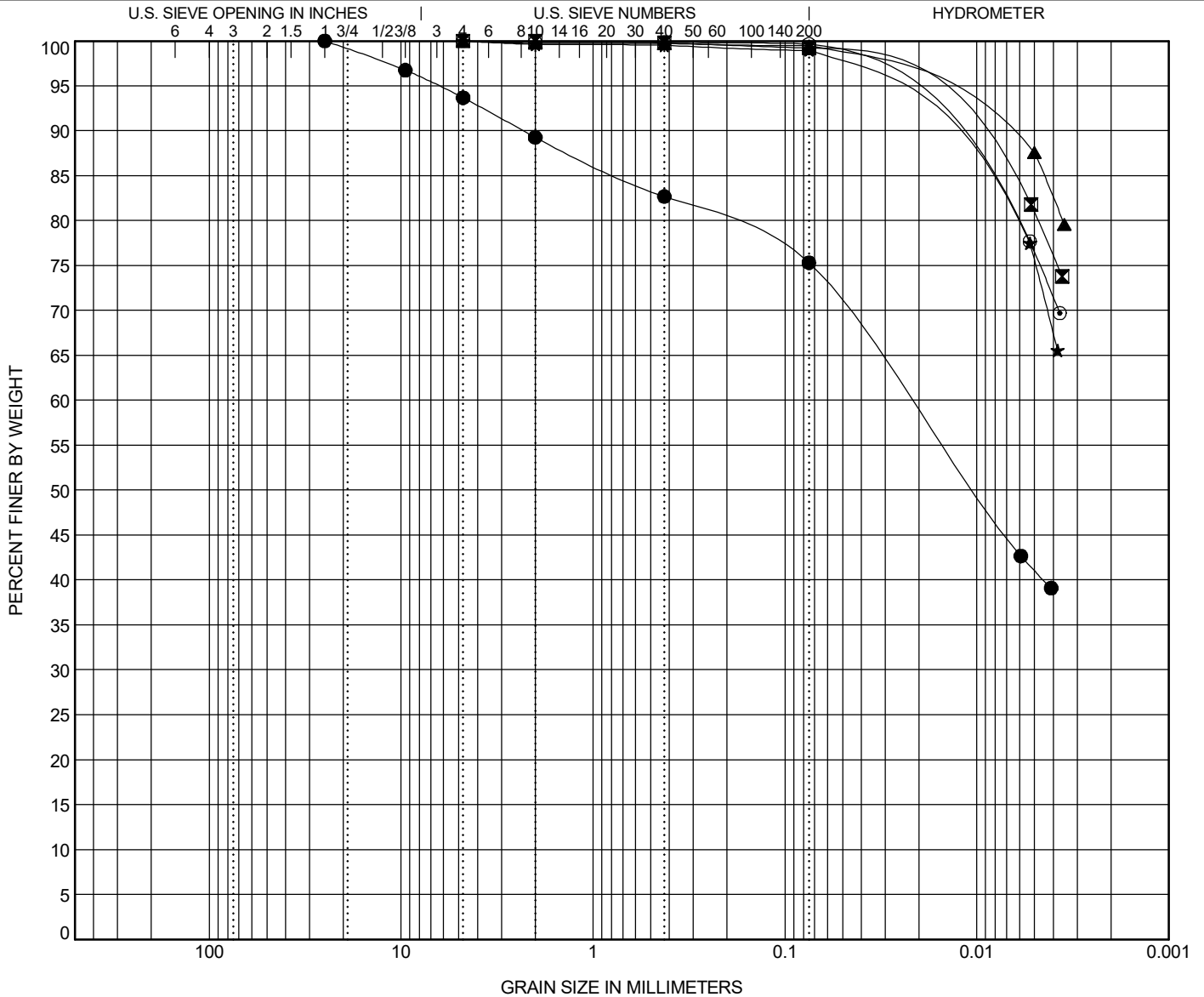
BOREHOLE	DEPTH	AASHTO Classification		USCS Classification		LL	PL	PI	Cc	Cu
● SB - 2	50.0	A-6 (7)		CL		37	21	16		
☒ SB - 2	52.0	A-6 (7)		CL		33	17	16		
▲ SB - 2	54.0	A-4 (0)		CL-ML		18	14	4		
★ SB - 2	56.0	A-4 (1)		CL-ML		22	15	7		
◎ SB - 2	58.0	A-4 (0)		SM		NP	NP	NP		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay	
● SB - 2	50.0	25	0.08	0.007		10.6	30.0	59.4		
☒ SB - 2	52.0	25	0.076	0.009		9.7	30.5	59.9		
▲ SB - 2	54.0	25	0.117	0.012		2.8	45.4	51.8		
★ SB - 2	56.0	25	0.109	0.013		5.5	40.4	54.1		
◎ SB - 2	58.0	25	0.141	0.015		6.5	44.6	48.9		

GRAIN SIZE - 20171219.GDT - 6/27/23 06:59 - F:\LAB\PROJECTS\GINT18-018\088\064.GPJ

PROJECT NUMBER 8-018(106)064

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification	LL	PL	PI	Cc	Cu
● SB - 3	0.0	A-4 (0)	ML	NP	NP	NP		
☒ SB - 3	2.0	A-7-6 (66)	CH	83	26	57		
▲ SB - 3	4.0	A-7-6 (73)	CH	89	26	63		
★ SB - 3	6.0	A-7-6 (48)	CH	65	23	42		
◎ SB - 3	9.0	A-7-6 (56)	CH	73	25	48		

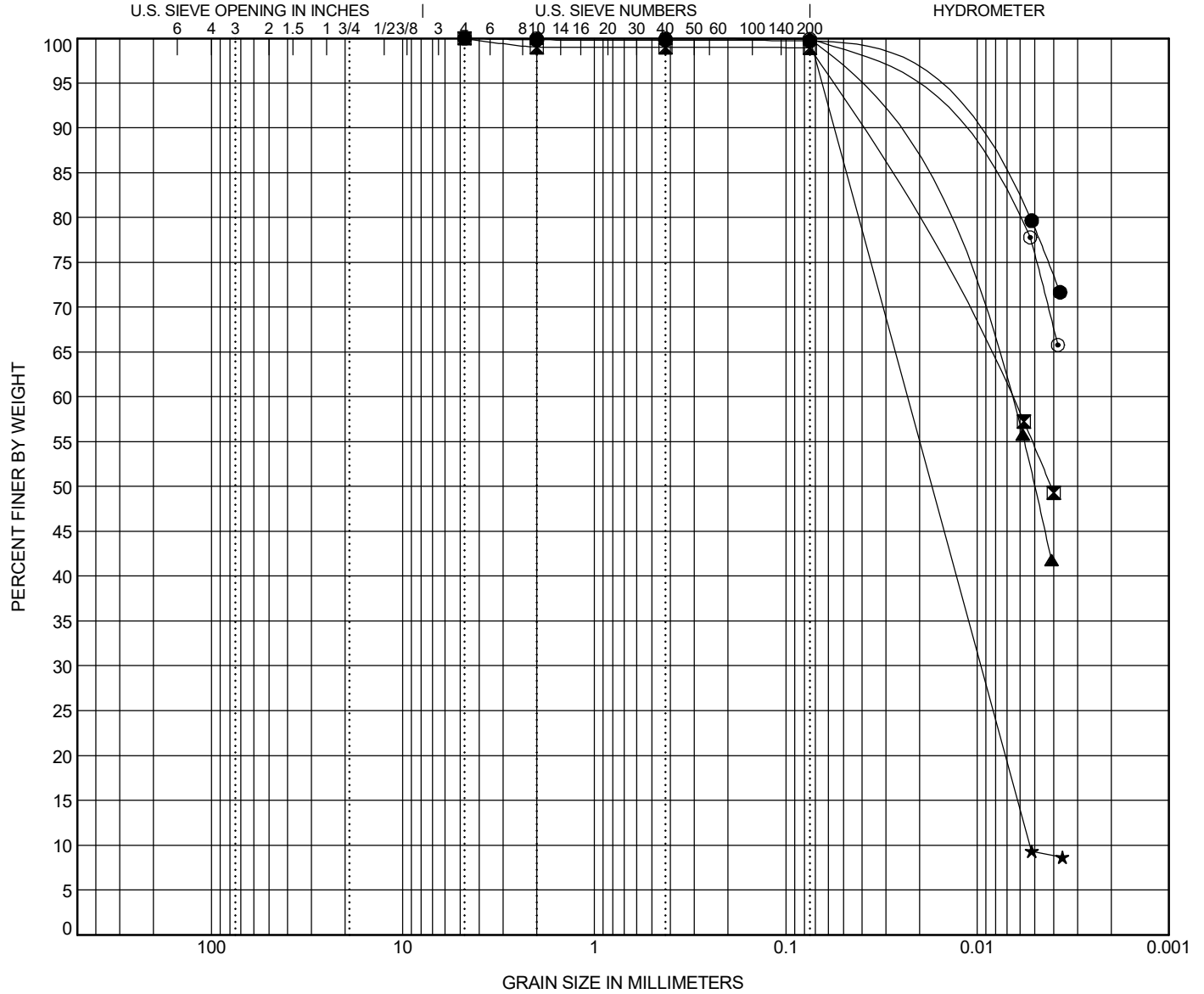
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 3	0.0	25	0.023			6.3	18.4	75.3	
☒ SB - 3	2.0	4.75				0.0	0.8	99.2	
▲ SB - 3	4.0	4.75				0.0	0.5	99.5	
★ SB - 3	6.0	4.75				0.0	1.0	99.0	
◎ SB - 3	9.0	4.75				0.0	0.3	99.7	

GRAIN SIZE - 20171219.GDT - 6/27/23 06:59 - F:\LAB\PROJECTS\GINT18-018\088\064.GPJ

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LOCATION Cass County

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification		LL	PL	PI	Cc	Cu
● SB - 3	11.0	A-7-6 (60)	CH		76	24	52		
☒ SB - 3	14.0	A-7-6 (33)	CH		52	23	29		
▲ SB - 3	16.0	A-7-6 (26)	CL		47	24	23		
★ SB - 3	19.0	A-7-6 (60)	CH		76	25	51	0.74	4.36
◎ SB - 3	21.0	A-7-6 (47)	CH		64	23	41		

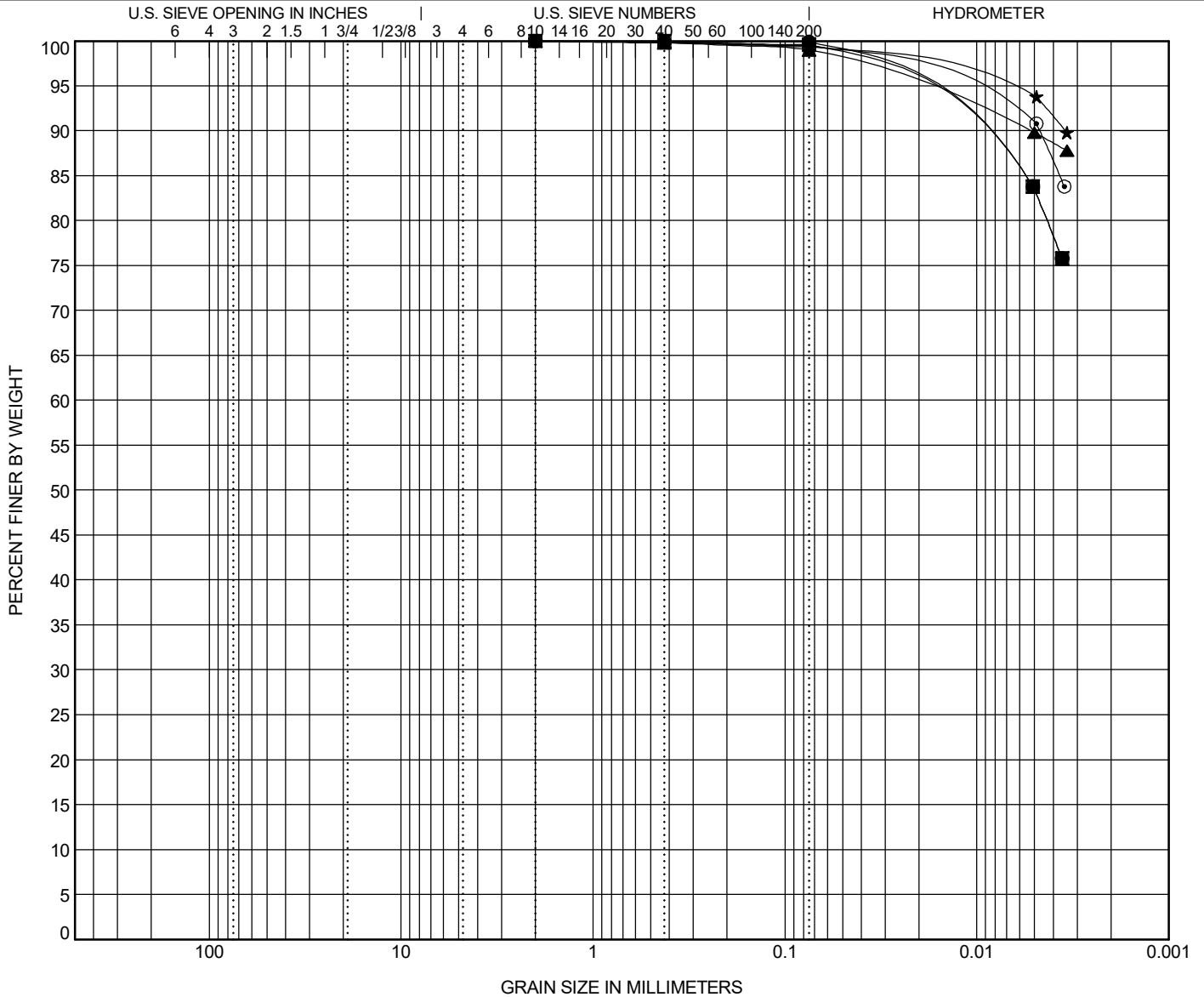
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 3	11.0	4.75				0.0	0.3	99.7	
☒ SB - 3	14.0	4.75	0.007			0.0	1.0	99.0	
▲ SB - 3	16.0	2	0.007			0.0	0.1	99.9	
★ SB - 3	19.0	0.425	0.023	0.01	0.005	0.0	0.0	100.0	
◎ SB - 3	21.0	2				0.0	0.1	99.9	

GRAIN SIZE - 20171219.GDT - 6/27/23 06:59 - F:\LAB\PROJECTS\GINT18-018\088\064.GPJ

PROJECT NUMBER 8-018(106)064

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification	LL	PL	PI	Cc	Cu
● SB - 3	24.0	A-7-6 (58)	CH	75	25	50		
☒ SB - 3	26.0	A-7-6 (57)	CH	74	25	49		
▲ SB - 3	29.0	A-7-5 (77)	CH	96	31	65		
★ SB - 3	31.0	A-7-5 (70)	CH	90	31	59		
◎ SB - 3	34.0	A-7-5 (61)	CH	82	31	51		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 3	24.0	2				0.0	0.1	99.9	
☒ SB - 3	26.0	2				0.0	0.4	99.6	
▲ SB - 3	29.0	2				0.0	1.0	99.0	
★ SB - 3	31.0	2				0.0	0.7	99.3	
◎ SB - 3	34.0	2				0.0	0.5	99.5	





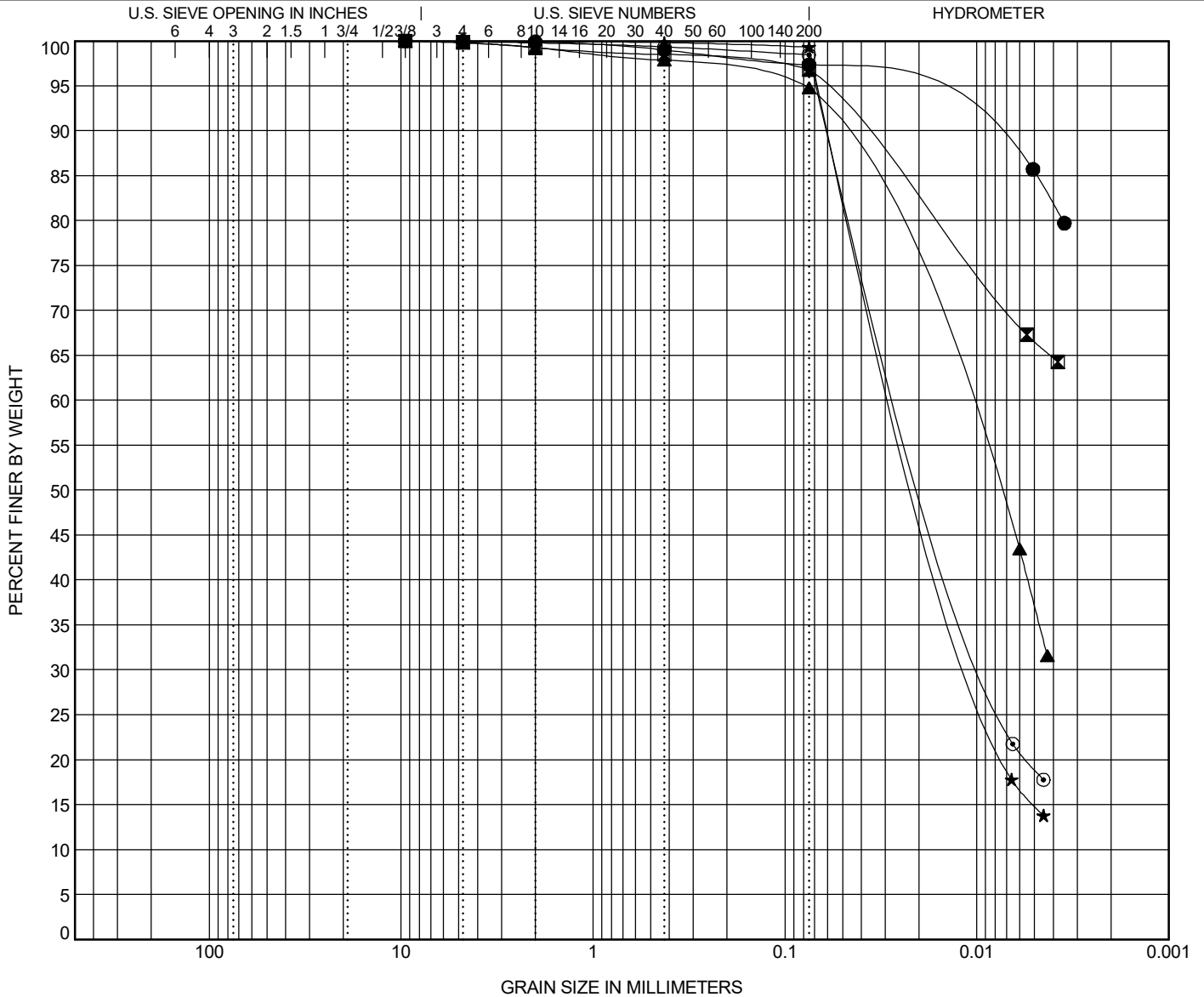
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BISMARCK, ND 58504

# GRAIN SIZE DISTRIBUTION

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification			LL	PL	PI	Cc	Cu
● SB - 3	36.0	A-7-6 (52)	CH			72	26	46		
☒ SB - 3	39.0	A-7-6 (25)	CH			50	28	22		
▲ SB - 3	41.0	A-7-5 (14)	ML			42	30	12		
★ SB - 3	44.0	A-4 (0)	ML			NP	NP	NP		
◎ SB - 3	46.0	A-4 (0)	ML			NP	NP	NP		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 3	36.0	9.5				0.0	2.6	97.3	
☒ SB - 3	39.0	9.5				0.2	3.0	96.8	
▲ SB - 3	41.0	9.5	0.014			0.2	5.0	94.8	
★ SB - 3	44.0	4.75	0.023	0.009		0.0	0.7	99.3	
◎ SB - 3	46.0	9.5	0.022	0.008		0.1	1.5	98.4	

GRAIN SIZE - 20171219.GDT - 6/27/23 06:59 - F:\LAB\PROJECTS\GINT18-018(088)064.GPJ



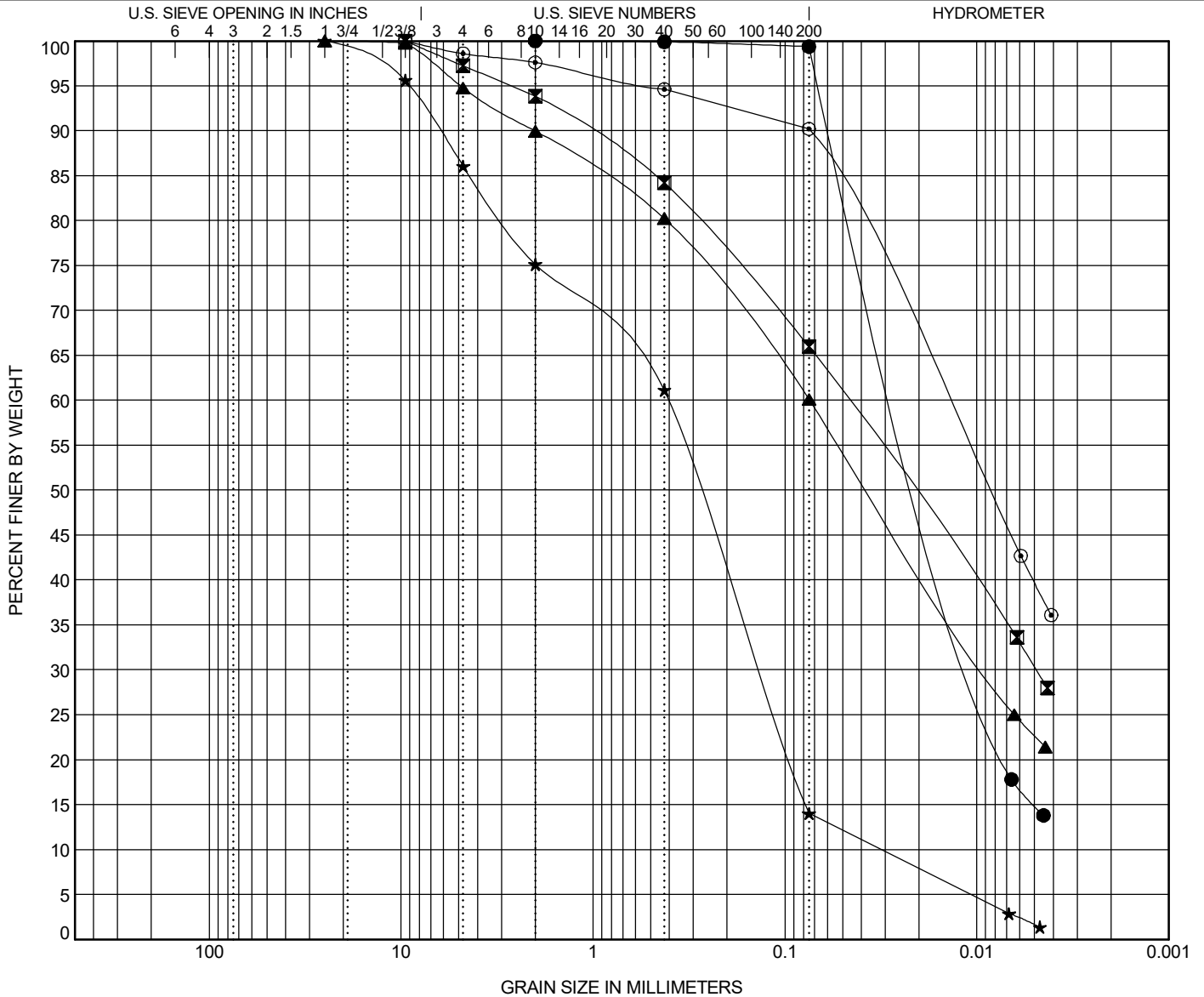
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# GRAIN SIZE DISTRIBUTION

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification	LL	PL	PI	Cc	Cu
● SB - 3	49.0	A-4 (0)	ML	NP	NP	NP		
■ SB - 3	51.0	A-6 (10)	CL	37	19	18		
▲ SB - 3	55.0	A-6 (5)	CL	29	16	13		
★ SB - 3	57.0	A-2-4 (0)	SM	NP	NP	NP	1.41	12.88
○ SB - 4	0.0							

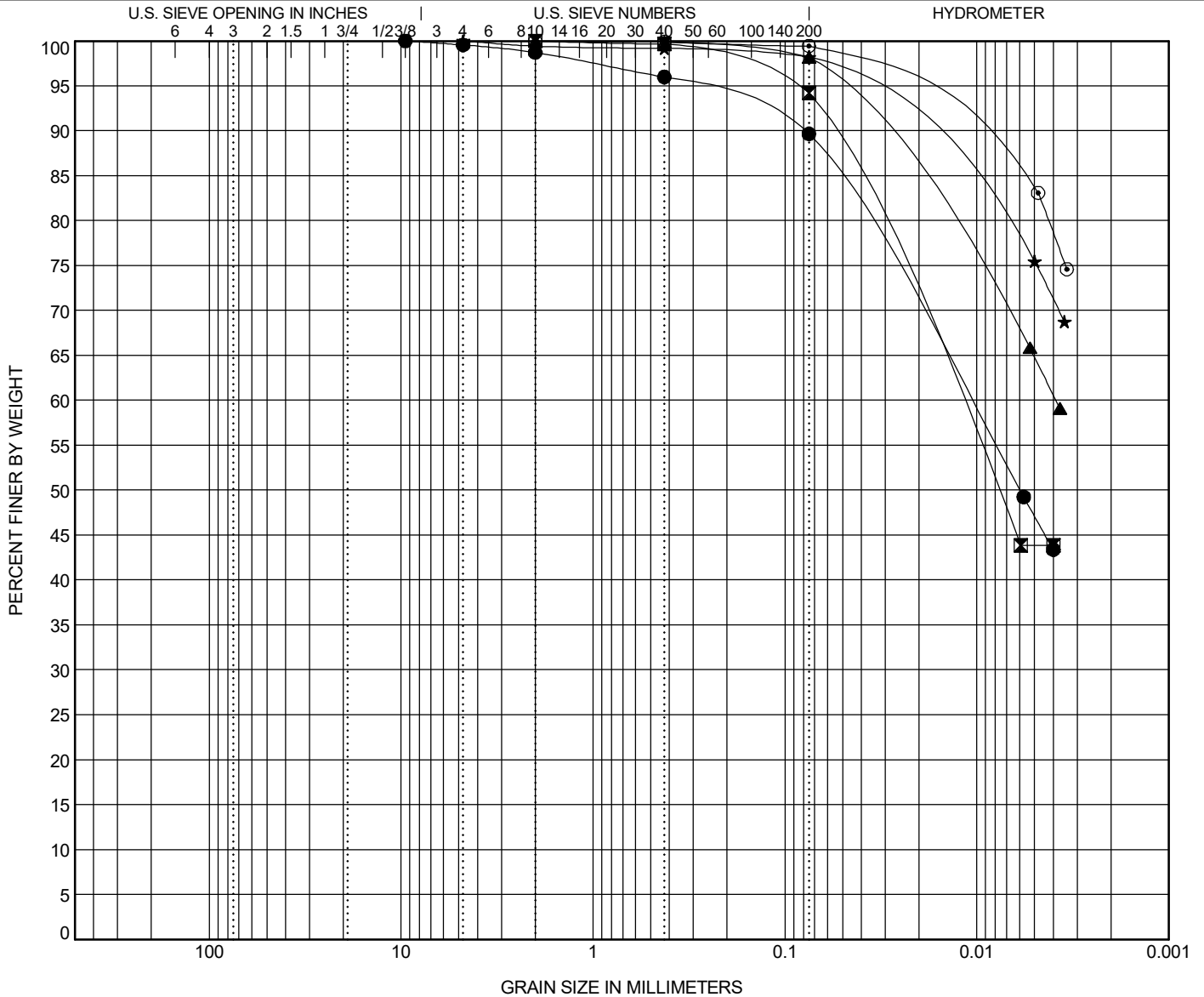
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 3	49.0	2	0.023	0.009		0.0	0.6		99.4
■ SB - 3	51.0	9.5	0.047	0.005		2.8	31.3		66.0
▲ SB - 3	55.0	25	0.075	0.009		5.2	34.7		60.1
★ SB - 3	57.0	25	0.408	0.135	0.032	13.9	72.1		14.0
○ SB - 4	0.0	9.5	0.015			1.4	8.4		90.2

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PROJECT NUMBER 8-018(106)064

LOCATION Cass County

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification		USCS Classification			LL	PL	PI	Cc	Cu
● SB - 4	2.0										
☒ SB - 4	4.0	A-7-5 (28)		MH			55	30	25		
▲ SB - 4	6.0	A-7-6 (36)		CH			57	25	32		
★ SB - 4	9.0	A-7-6 (57)		CH			75	25	50		
◎ SB - 4	11.0	A-7-6 (55)		CH			75	28	47		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay		
● SB - 4	2.0	9.5	0.011			0.4	9.9	89.7			
☒ SB - 4	4.0	2	0.013			0.0	5.8	94.2			
▲ SB - 4	6.0	2	0.004			0.0	1.8	98.2			
★ SB - 4	9.0	4.75				0.0	1.8	98.2			
◎ SB - 4	11.0	2				0.0	0.6	99.4			



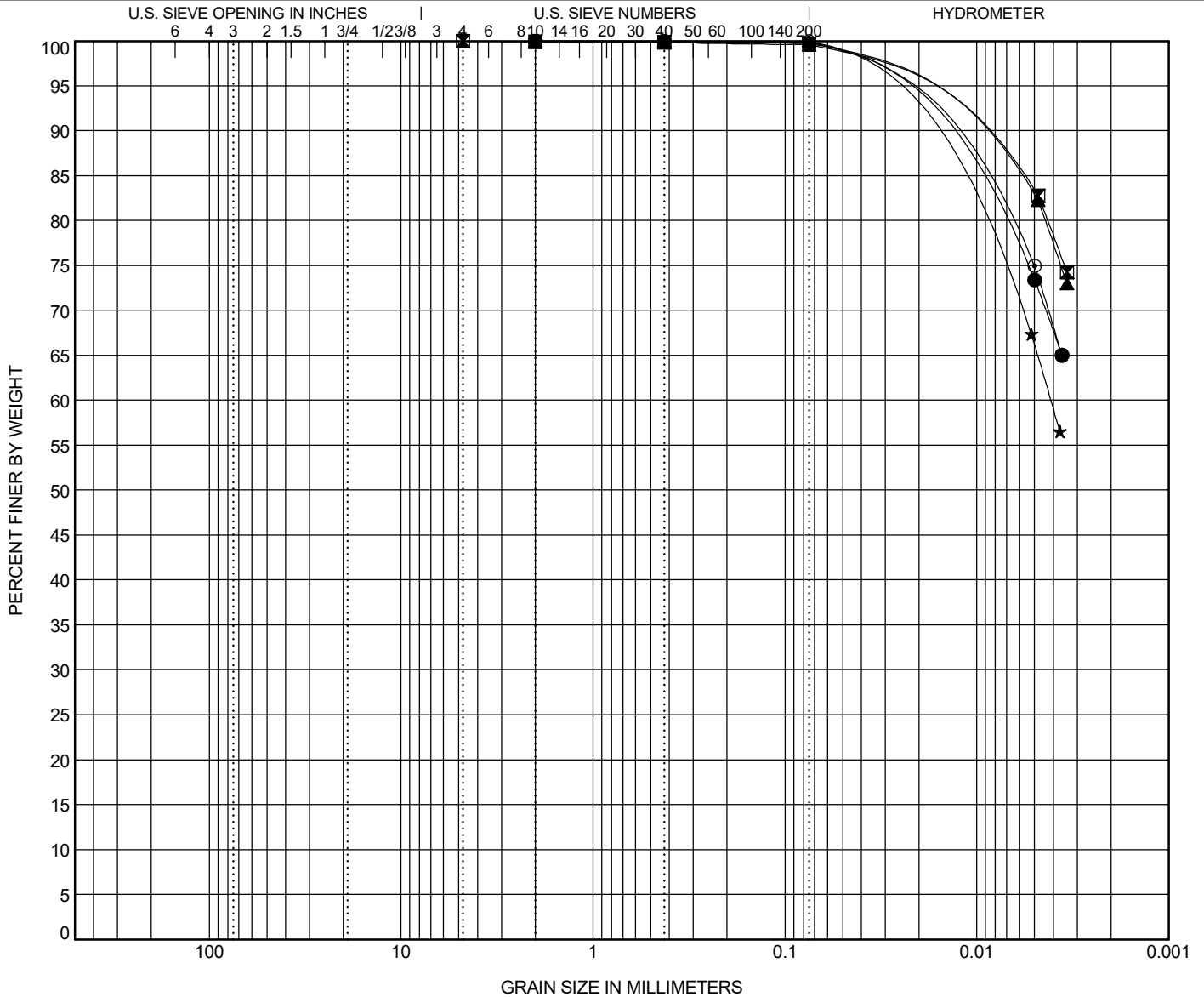
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300 AIRPORT ROAD  
BISMARCK, ND 58504

# GRAIN SIZE DISTRIBUTION

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification	LL	PL	PI	Cc	Cu
● SB - 4	14.0	A-7-6 (30)	CL	49	22	27		
☒ SB - 4	16.0	A-7-6 (51)	CH	71	28	43		
▲ SB - 4	19.0	A-7-6 (50)	CH	69	27	42		
★ SB - 4	21.0	A-7-6 (32)	CH	52	24	28		
◎ SB - 4	24.0	A-7-6 (35)	CH	52	21	31		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 4	14.0	2				0.0	0.3	99.7	
☒ SB - 4	16.0	4.75				0.0	0.4	99.6	
▲ SB - 4	19.0	2				0.0	0.1	99.9	
★ SB - 4	21.0	2	0.004			0.0	0.1	99.9	
◎ SB - 4	24.0	2				0.0	0.0	100.0	

GRAIN SIZE - 20171219.GDT - 6/27/23 07:00 - F:\LAB\PROJECTS\GINT18-018\088\064.GPJ



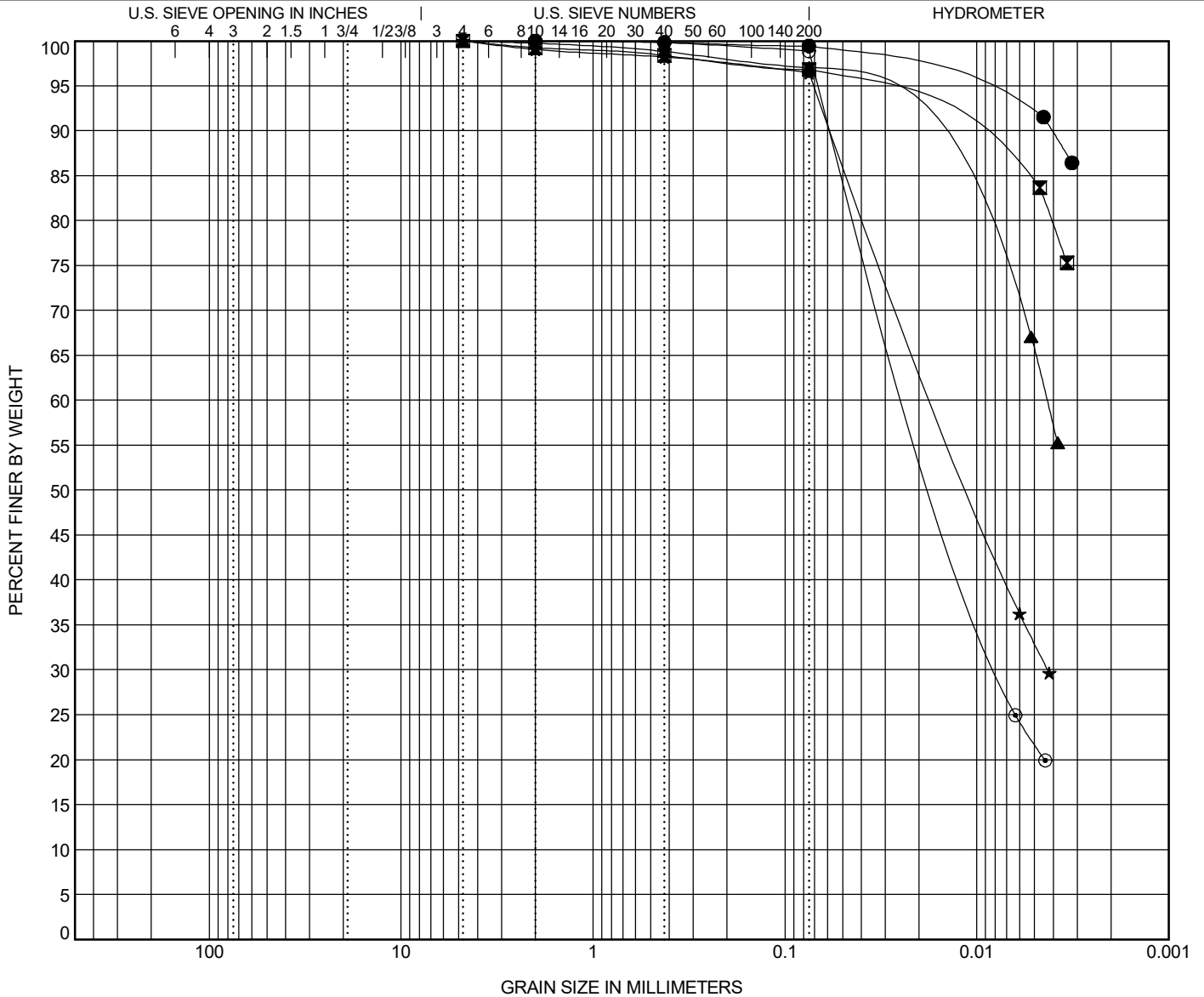
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 300 AIRPORT ROAD  
 BISMARCK, ND 58504

# GRAIN SIZE DISTRIBUTION

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification			LL	PL	PI	Cc	Cu
● SB - 4	26.0	A-7-5 (48)	MH			75	36	39		
☒ SB - 4	29.0	A-7-5 (40)	CH			65	31	34		
▲ SB - 4	31.0	A-7-6 (28)	CH			52	28	24		
★ SB - 4	34.0	A-7-6 (15)	ML			42	29	13		
◎ SB - 4	36.0	A-4 (8)	ML			36	30	6		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 4	26.0	2				0.0	0.6	99.4	
☒ SB - 4	29.0	4.75				0.0	3.2	96.8	
▲ SB - 4	31.0	4.75	0.004			0.0	3.0	97.0	
★ SB - 4	34.0	4.75	0.016	0.004		0.0	3.5	96.5	
◎ SB - 4	36.0	2	0.02	0.007		0.0	1.1	98.9	

GRAIN SIZE - 20171219.GDT - 6/27/23 07:00 - F:\LAB\PROJECTS\GINT18-018\088\064.GPJ



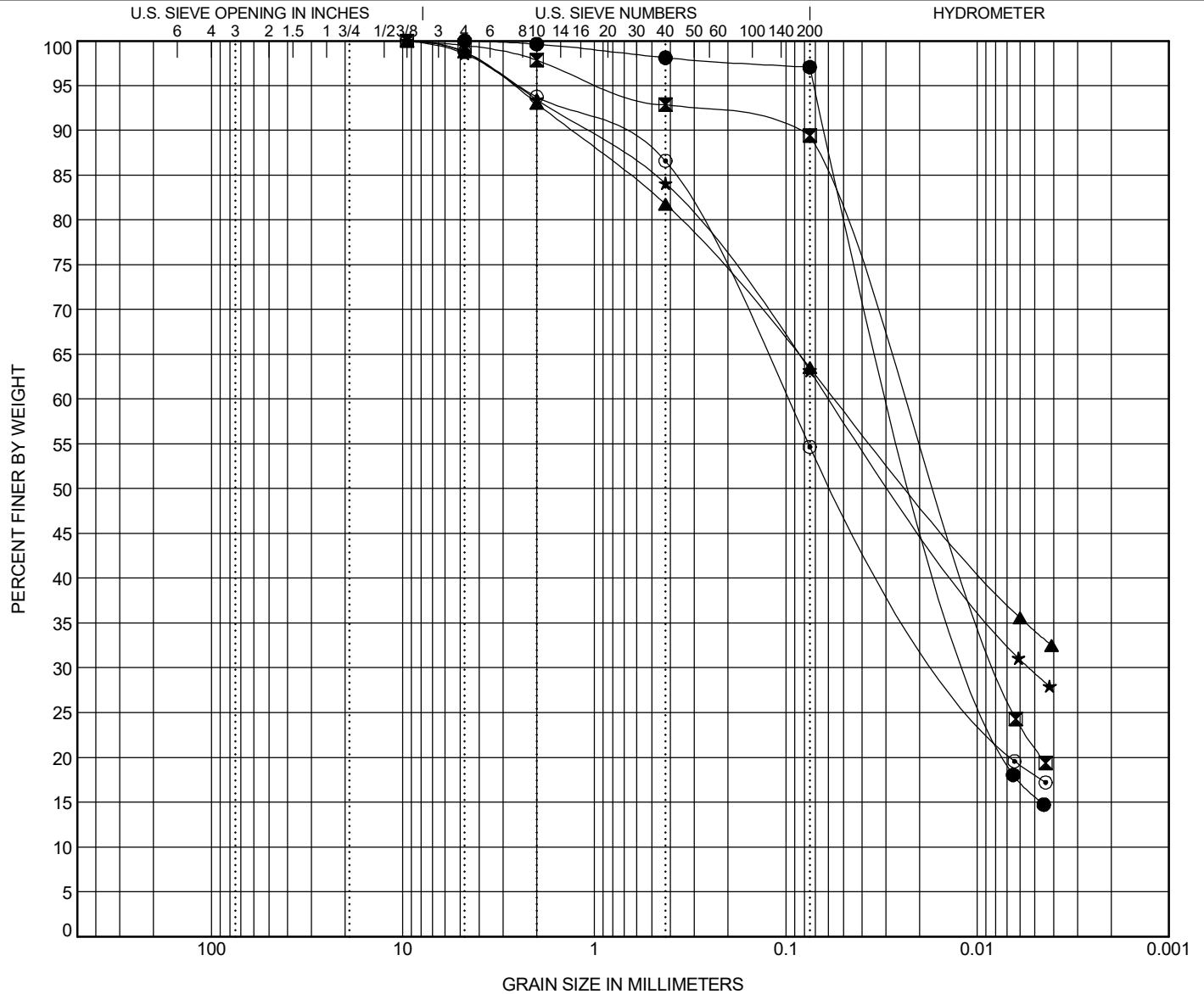
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300 AIRPORT ROAD  
BISMARCK, ND 58504

# GRAIN SIZE DISTRIBUTION

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification			LL	PL	PI	Cc	Cu
● SB - 4	39.0	A-4 (0)	ML			NP	NP	NP		
☒ SB - 4	41.0	A-4 (0)	ML			NP	NP	NP		
▲ SB - 4	44.0	A-6 (9)	CL			37	20	17		
★ SB - 4	46.0	A-6 (8)	CL			31	14	17		
⊙ SB - 4	49.0	A-4 (0)	ML			NP	NP	NP		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 4	39.0	4.75	0.024	0.009		0.0	2.9	97.1	
☒ SB - 4	41.0	9.5	0.025	0.008		0.5	10.0	89.4	
▲ SB - 4	44.0	9.5	0.055			1.2	35.3	63.5	
★ SB - 4	46.0	9.5	0.058	0.005		1.4	35.4	63.2	
⊙ SB - 4	49.0	9.5	0.1	0.013		1.2	44.1	54.7	

GRAIN SIZE - 20171219.GDT - 6/27/23 07:00 - F:\LAB\PROJECTS\GINT18-018\088\064.GPJ



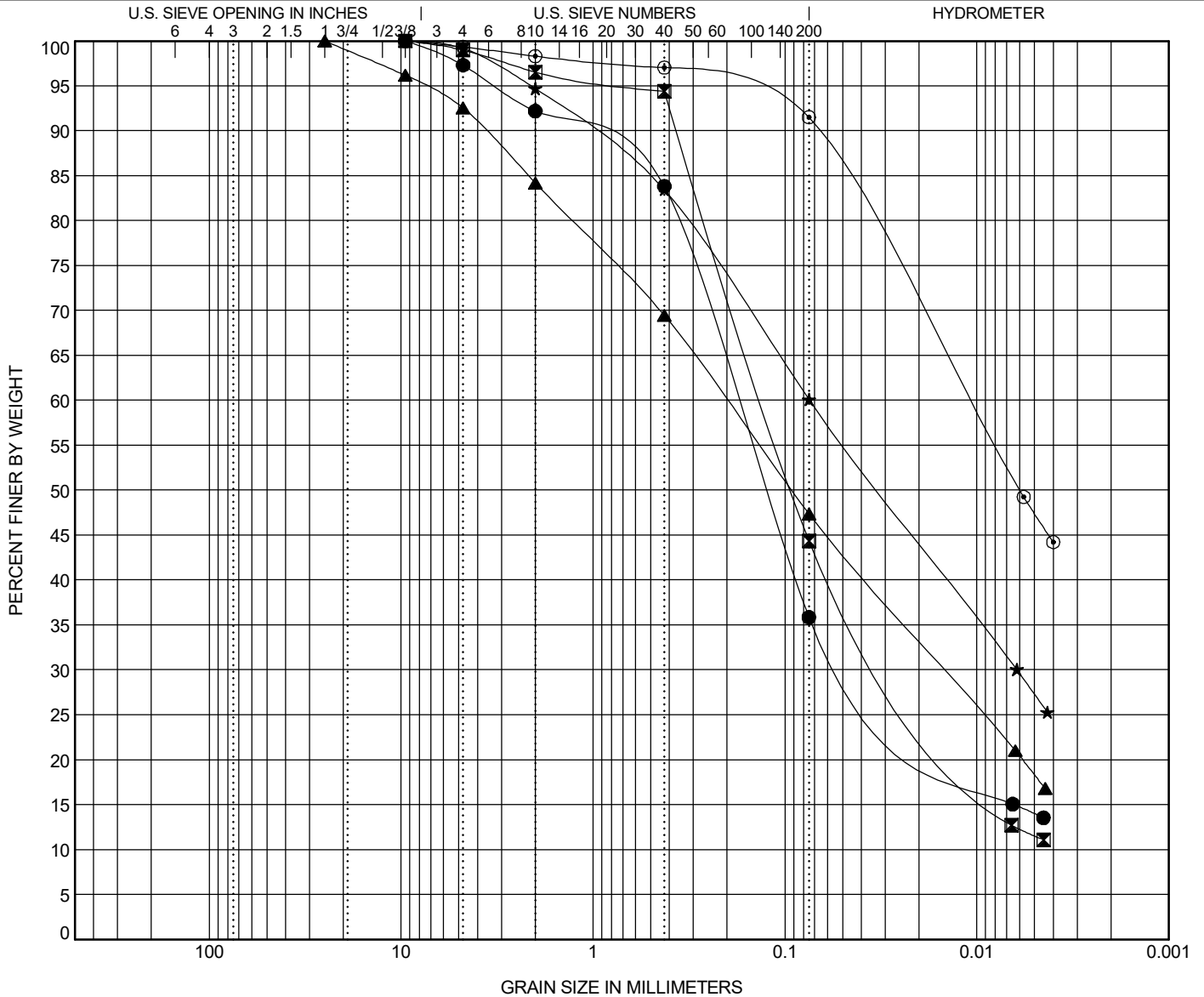
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BISMARCK, ND 58504

# GRAIN SIZE DISTRIBUTION

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification			LL	PL	PI	Cc	Cu
● SB - 4	52.0	A-4 (0)	SM			NP	NP	NP		
■ SB - 4	54.0	A-4 (0)	SM			NP	NP	NP		
▲ SB - 4	57.0	A-4 (0)	SC-SM			27	21	6		
★ SB - 4	59.0	A-6 (5)	CL			34	22	12		
○ SB - 5	0.0	A-7-6 (28)	CH			52	25	27		

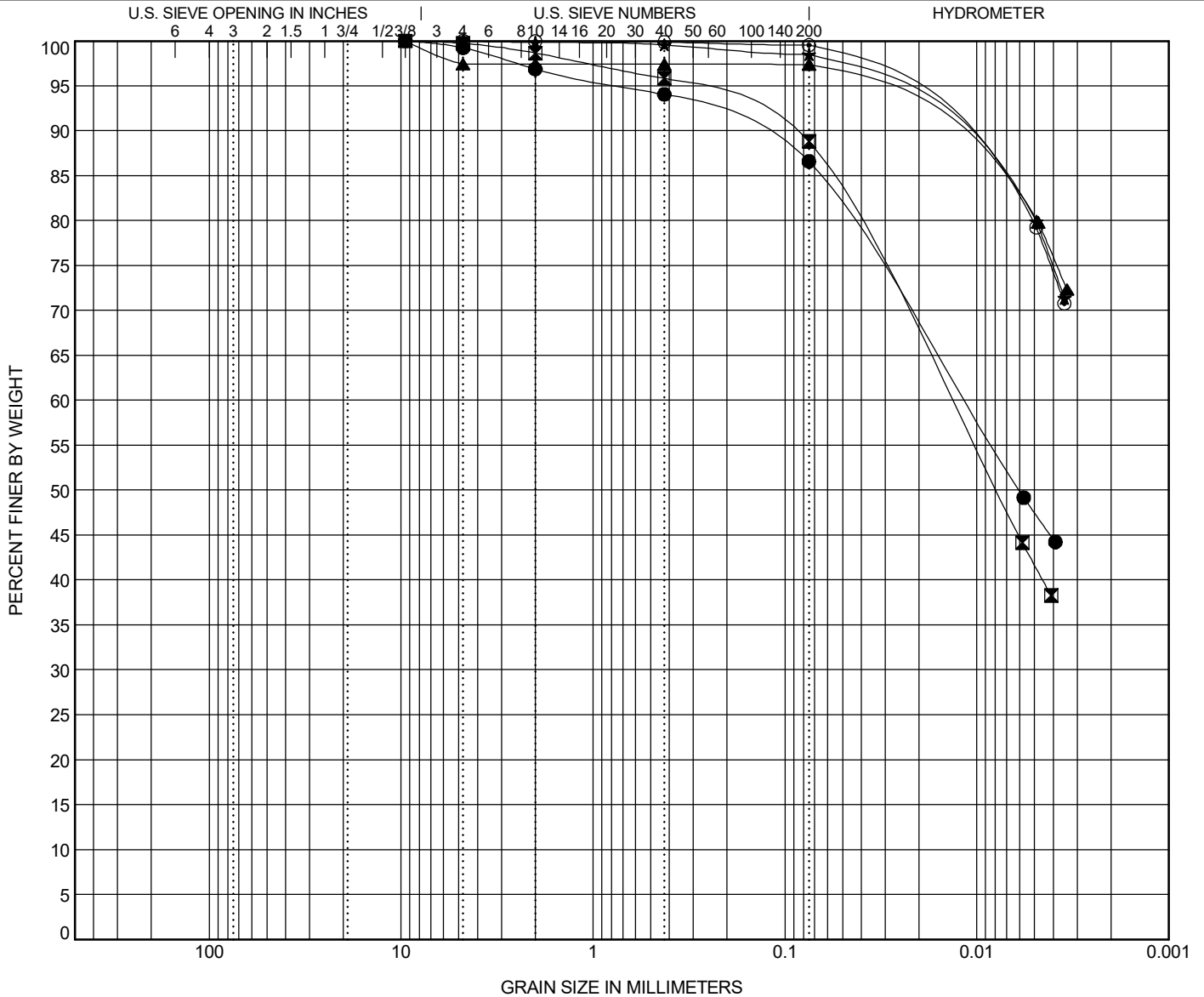
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 4	52.0	9.5	0.18	0.038		2.7	61.5	35.8	
■ SB - 4	54.0	9.5	0.129	0.025		1.0	54.6	44.4	
▲ SB - 4	57.0	25	0.202	0.015		7.5	45.2	47.3	
★ SB - 4	59.0	9.5	0.074	0.006		0.8	39.1	60.1	
○ SB - 5	0.0	9.5	0.011			0.7	7.8	91.5	

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification	LL	PL	PI	Cc	Cu
● SB - 5	2.0	A-7-6 (28)	CH	54	24	30		
☒ SB - 5	4.0	A-7-6 (21)	CL	45	23	22		
▲ SB - 5	6.0	A-7-6 (57)	CH	76	25	51		
★ SB - 5	9.0	A-7-6 (52)	CH	69	23	46		
◎ SB - 5	11.0	A-7-6 (51)	CH	67	23	44		

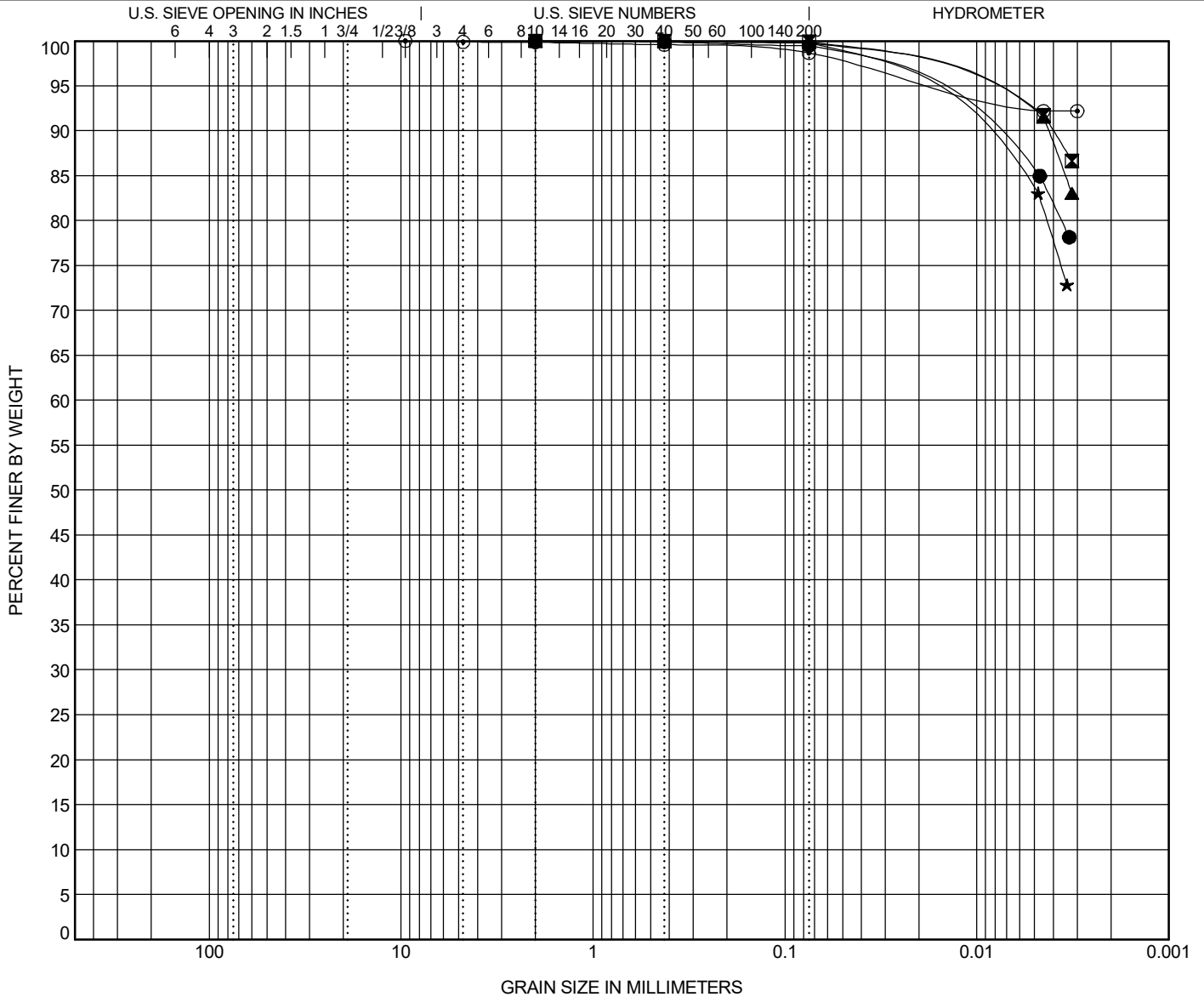
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 5	2.0	9.5	0.012			0.8	12.6	86.6	
☒ SB - 5	4.0	9.5	0.014			0.3	10.9	88.8	
▲ SB - 5	6.0	9.5				2.6	0.0	97.4	
★ SB - 5	9.0	4.75				0.0	1.5	98.5	
◎ SB - 5	11.0	4.75				0.0	0.5	99.5	



PROJECT NUMBER 8-018(106)064

LOCATION Cass County

PCN 23279



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification		LL	PL	PI	Cc	Cu
● SB - 5	14.0	A-7-6 (44)	CH		63	25	38		
☒ SB - 5	16.0	A-7-6 (54)	CH		71	25	46		
▲ SB - 5	19.0	A-7-6 (51)	CH		68	24	44		
★ SB - 5	21.0	A-7-6 (47)	CH		65	24	41		
⊙ SB - 5	24.0	A-7-6 (55)	CH		76	29	47		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 5	14.0	2				0.0	0.5	99.5	
☒ SB - 5	16.0	2				0.0	0.1	99.9	
▲ SB - 5	19.0	2				0.0	0.2	99.8	
★ SB - 5	21.0	2				0.0	0.2	99.8	
⊙ SB - 5	24.0	9.5				0.1	1.2	98.7	

GRAIN SIZE - 20171219.GDT - 6/27/23 07:00 - F:\LAB\PROJECTS\GINT18-018\088\064.GPJ



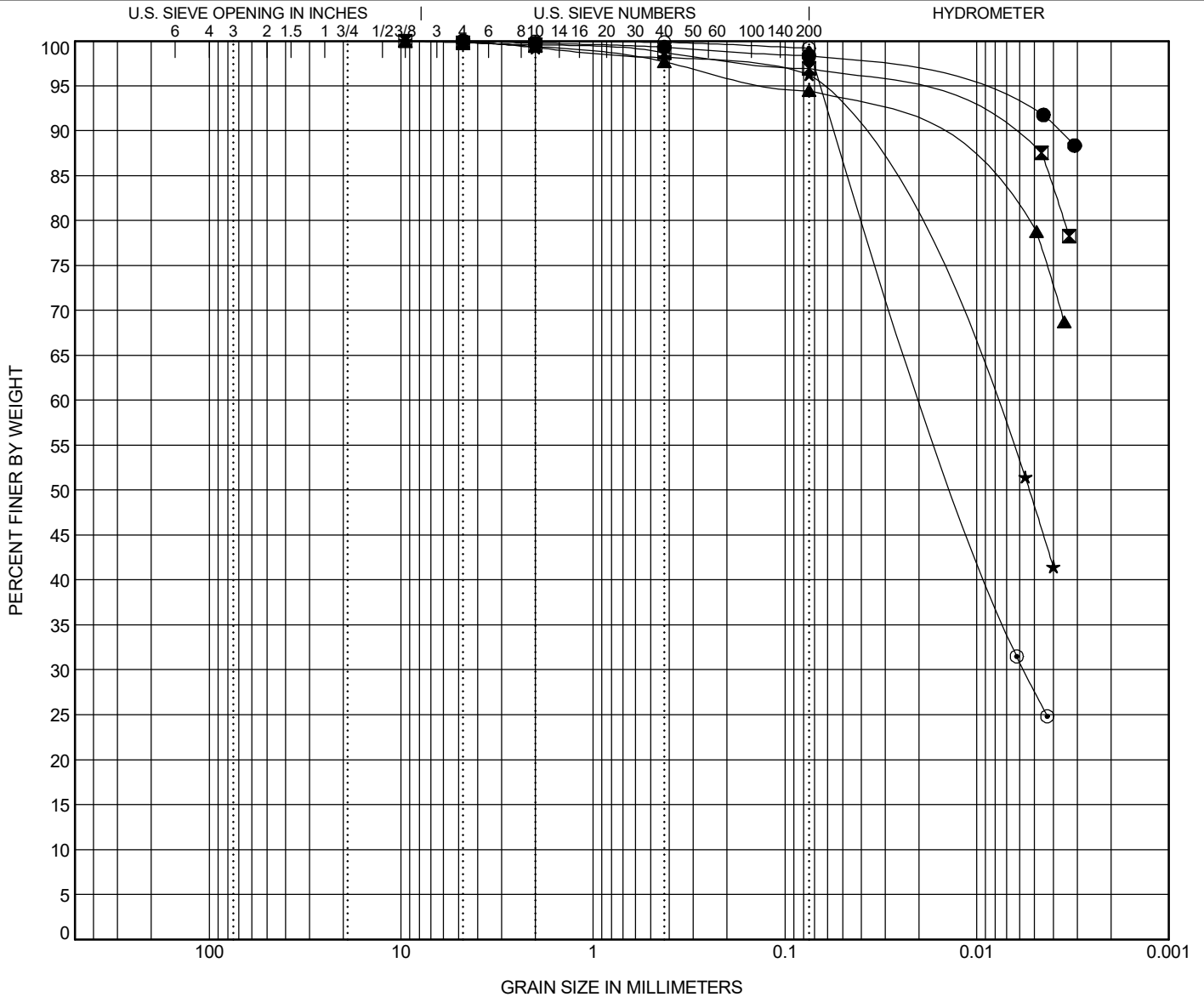
NORTH DAKOTA DEPARTMENT OF TRANSPORTATION  
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 BISMARCK, ND 58504

# GRAIN SIZE DISTRIBUTION

PROJECT NUMBER 8-018(106)064

LOCATION Cass County

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification			LL	PL	PI	Cc	Cu
● SB - 5	26.0	A-7-6 (57)	CH			78	29	49		
☒ SB - 5	29.0	A-7-6 (41)	CH			63	27	36		
▲ SB - 5	31.0	A-7-6 (31)	CH			54	25	29		
★ SB - 5	34.0	A-7-6 (19)	ML			45	29	16		
◎ SB - 5	36.0	A-4 (0)	ML			NP	NP	NP		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 5	26.0	4.75				0.0	1.6	98.4	
☒ SB - 5	29.0	9.5				0.2	2.9	96.9	
▲ SB - 5	31.0	9.5				0.2	5.4	94.5	
★ SB - 5	34.0	9.5	0.009			0.1	3.6	96.3	
◎ SB - 5	36.0	4.75	0.018	0.006		0.0	0.8	99.2	

GRAIN SIZE - 20171219.GDT - 6/27/23 07:00 - F:\LAB\PROJECTS\GINT18-018\088\064.GPJ



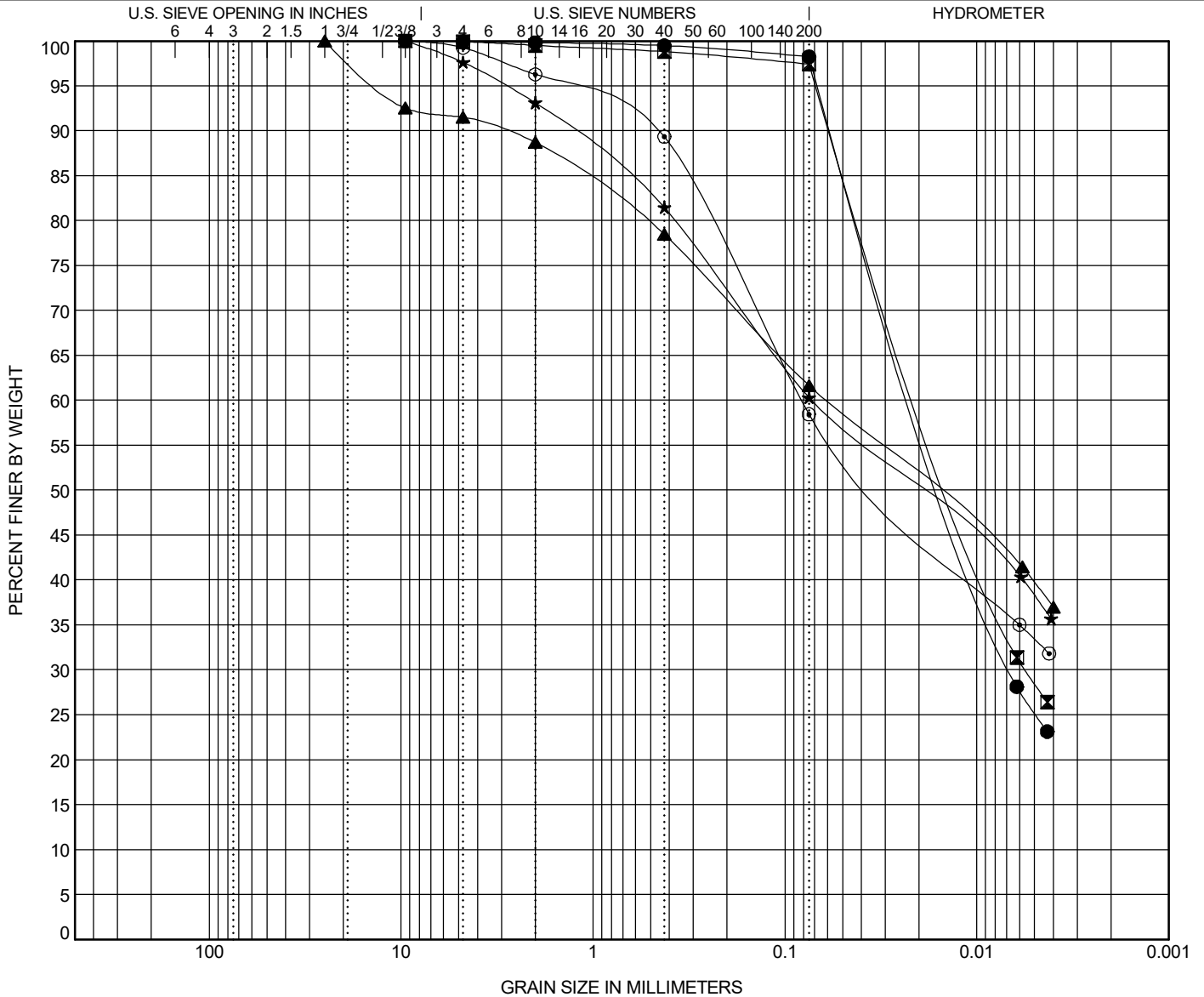
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PROJECT NUMBER 8-018(106)064

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification			USCS Classification		LL	PL	PI	Cc	Cu
● SB - 5	39.0	A-4 (0)			ML		NP	NP	NP		
☒ SB - 5	41.0	A-4 (0)			ML		NP	NP	NP		
▲ SB - 5	44.0	A-6 (9)			CL		40	22	18		
★ SB - 5	45.0	A-6 (6)			CL		31	17	14		
◎ SB - 5	49.0	A-4 (1)			CL-ML		22	15	7		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay		
● SB - 5	39.0	9.5	0.019	0.007		0.1	1.7	98.3			
☒ SB - 5	41.0	9.5	0.018	0.006		0.1	2.5	97.4			
▲ SB - 5	44.0	25	0.061			8.5	29.9	61.6			
★ SB - 5	45.0	9.5	0.072			2.4	37.3	60.3			
◎ SB - 5	49.0	9.5	0.082			0.8	40.8	58.4			

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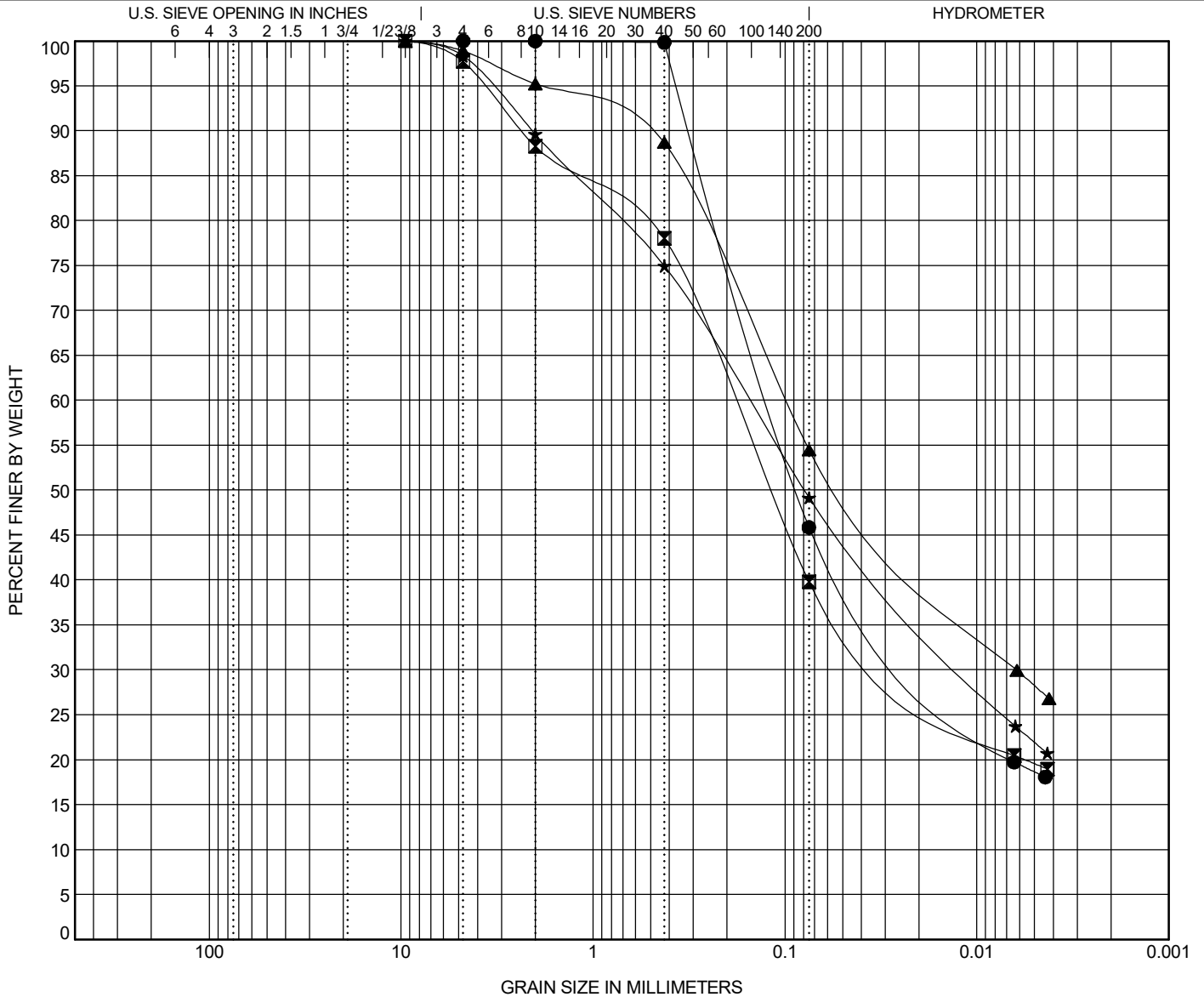
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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification			LL	PL	PI	Cc	Cu
● SB - 5	51.0	A-4 (0)	SM			NP	NP	NP		
■ SB - 5	54.0	A-4 (0)	SC-SM			21	14	7		
▲ SB - 5	56.0	A-4 (1)	CL-ML			21	14	7		
★ SB - 5	59.0	A-4 (2)	SC			31	21	10		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SB - 5	51.0	4.75	0.118	0.017		0.0	54.2	45.8	
■ SB - 5	54.0	9.5	0.188	0.022		2.3	57.9	39.8	
▲ SB - 5	56.0	9.5	0.099	0.006		1.1	44.4	54.5	
★ SB - 5	59.0	9.5	0.155	0.012		1.7	49.2	49.2	

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