US Army Corps
of Engineers
Detroit District

Attachment A

Milwaukee CDF DMMP

Milwaukee, Wisconsin

GEOTECHNICAL DATA

July 2007

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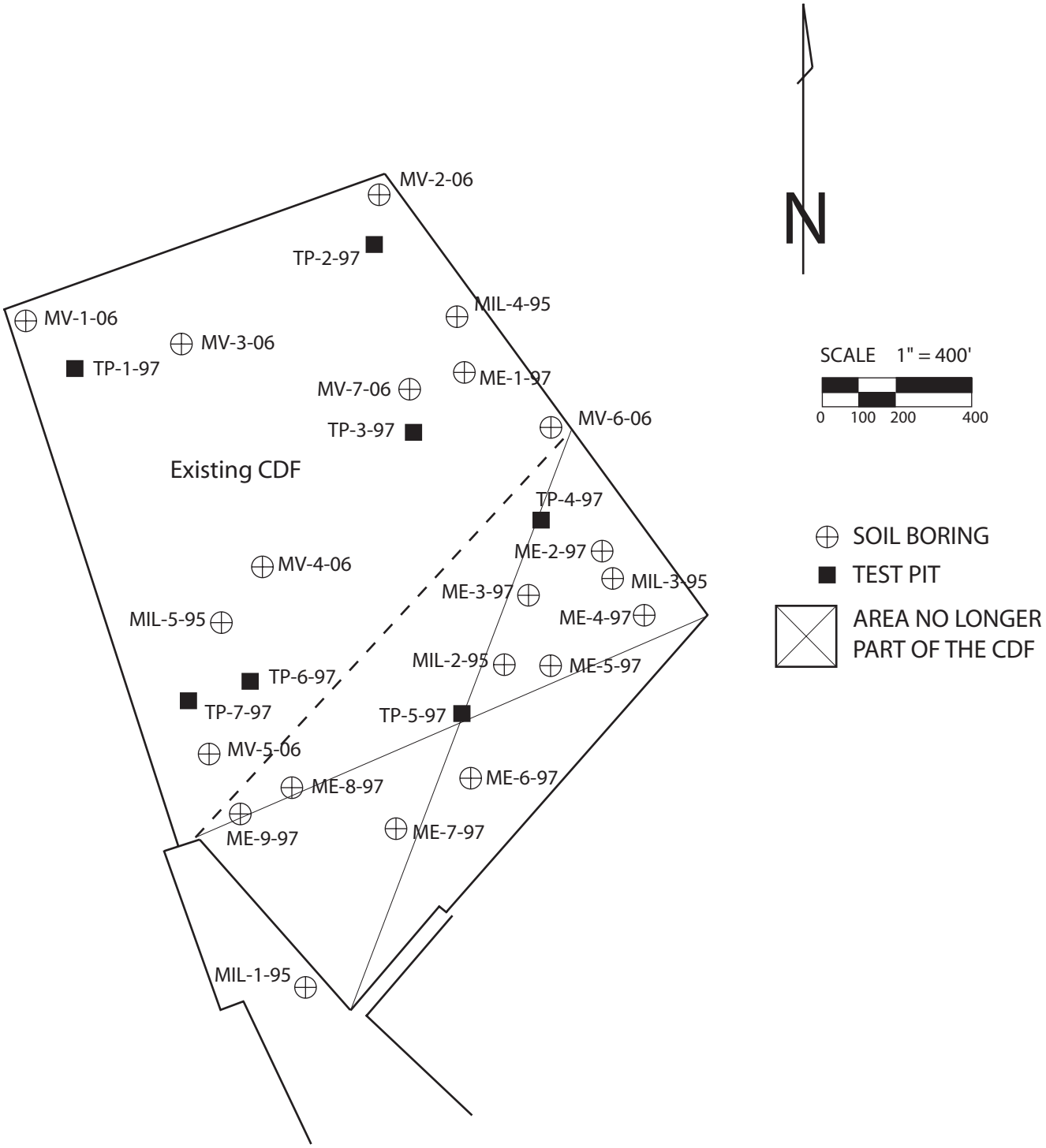
Milwaukee CDF - Approximate Soil Boring Locations



DRILLING LOG

DIVISION	USACE
INSTALLATION	Chicago District
SHEET	1 OF 2 SHEETS
1. PROJECT	Milwaukee CDF Geotech Inv.
2. LOCATION (Coordinates or Station)	Milwaukee, Wisconsin N 374,153.42 E 2,532,492.27
3. DRILLING AGENCY	STS Exploration
4. HOLE NO. *(As shown on drawing title and file number)*	MV-1-06
5. NAME OF DRILLER	Randy/Matt
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	NA
8. DEPTH DRILLED INTO ROCK	NA
9. TOTAL DEPTH OF HOLE	40.0
10. SIZE AND TYPE OF BIT	4" Solid Stem/3 7/8" Rock Bit
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*	IGLD 85
12. MANUFACTURER'S DESIGNATION OF DRILL	Diedrich D-50 ATV
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 17 / UNDISTURBED 3
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	574.0
16. DATE HOLE	STARTED 8/30/2006 / COMPLETED 8/30/2006
17. ELEVATION TOP OF HOLE	+583.1
18. TOTAL CORE RECOVERY FOR BORING	NA %
19. GEOLOGIST	Bryan Bergmann

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+583.1	0.0		Fill: ML, Light brown to brown very loose to medium dense silt, little clay, trace organic matter, aluminum can fragment was observed in Sample No. 1	42	1 0.0 2.0	Blows = WOH,1,2,4 Qp = 2.0 TSF
				63	2 2.0 4.0	Blows = 10,6,6,7 Qp = 1.5 TSF
+579.1	4.0		CL-ML, Brown to dark brown very soft to medium (firm) clayey silt, trace organic matter and shells	100	3 4.0 6.0	Blows = 2,1,2,1 Qp = .75 TSF
				83	4 6.0 8.0	Blows = WOH,WOH,WOH,WOH Qp = .25 TSF
+575.1	8.0		CL, Brownish gray to gray medium (firm) to stiff silty clay, trace to some fine to coarse sand, trace fine gravel 1" Brownish gray silty fine sand seams with shell fragments observed at 9', 10.5' and 11.5' 2" Dark gray to black sandy silt seam observed at 12'	63	5 8.0 10.0	Blows = 3,2,1,9 Qp = 1.25 TSF
				71	6 10.0 12.0	Blows = 3,2,2,3 Qp = 1.5 TSF
				33	7 12.0 14.0	Blows = WOH, WOH, 2,1 Qp = 1.0 TSF
				33	8 14.0 16.0	Blows = 2,2,2,2 Qp = .5 TSF
+567.1	16.0		GP, Brown to gray medium dense to dense fine to medium gravel, little fine to coarse sand Note: Both rounded gravel of various rock types and angular dolomite fragments observed	8	9 16.0 18.0	Blows = 3,2,13,23
				46	10 18.0 20.0	Blows = 18,23,17,10
+563.1	20.0					

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 583.1

Hole No. MV-1-06

PROJECT: Milwaukee CDF Geotech Inv.

INSTALLATION: Chicago District

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			CL, Brown very stiff silty clay, trace fine to coarse sand and fine gravel	71	11 20.0 22.0	Blows = 5,7,9,14 Qp = 3.0 TSF
				100	12 22.0 24.0	3" diameter shelby tube sample from 22.0' - 24.0' Qp = 2.5 TSF
+559.1	24.0					
			ML, Grayish brown to gray medium dense silt, little clay, trace to little fine sand 6" silty clay seam at 28.8'	79	13 24.0 26.0	Blows = 6,7,11,14 Qp = 1.5 TSF
				100	14 26.0 28.0	3" diameter shelby tube sample from 26.0' - 28.0' Qp = 3.5 TSF
				92	15 28.0 30.0	Blows = 9,8,8,17 Qp = 2.25 TSF
+553.1	30.0					
			CL, Brown and slightly reddish brown very stiff silty clay, trace to little fine to coarse sand and fine gravel	100	16 30.0 32.0	Blows = 6,7,12,14 Qp = 2.5 TSF
				50	17 32.0 34.0	3" diameter shelby tube sample from 32.0' - 34.0' Qp = 3.0 TSF
				100	18 34.0 36.0	Blows = 6,7,10,13 Qp = 3.0 TSF
				100	19 36.0 38.0	Blows = 8,8,10,14 Qp = 2.0 TSF
				100	20 38.0 40.0	Blows = 7,9,11,14 Qp = 2.0 TSF
+543.1	40.0					
			END OF BORING - 40.0' Borehole advanced to 12' with with solid stem augers. Borehole advanced from 12' to 38' using a 3 7/8" rock bit and mud rotary drilling methods. 10' of temporary 4" steel casing was installed. Boring was backfilled with bentonite grout and 3/8" bentonite chips. Note: Groundwater was encountered at 9.1' while drilling and before casing installation.			All samples collected with 2" diameter split-spoon sampler; driven with a 140 pound hammer dropped 30", unless otherwise noted. Note: Individual laboratory test results are included on separate data sheets and summarized in the Appendix. STS Project No. 200605402

DRILLING LOG

DIVISION	USACE
INSTALLATION	Chicago District
SHEET	1 OF 2 SHEETS
1. PROJECT	Milwaukee CDF Geotech Inv.
2. LOCATION (Coordinates or Station)	Milwaukee, Wisconsin N 374,526.90 E 2,533,430.66
3. DRILLING AGENCY	STS Exploration
4. HOLE NO. *(As shown on drawing title and file number)*	MV-2-06
5. NAME OF DRILLER	Randy/Matt
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	NA
8. DEPTH DRILLED INTO ROCK	NA
9. TOTAL DEPTH OF HOLE	40.0
10. SIZE AND TYPE OF BIT	4" Solid Stem/3 7/8" Rock Bit
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*	IGLD 85
12. MANUFACTURER'S DESIGNATION OF DRILL	Diedrich D-50 ATV
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 19 / UNDISTURBED 1
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	
16. DATE HOLE	STARTED 8/29/2006 / COMPLETED 8/30/2006
17. ELEVATION TOP OF HOLE	+586.2
18. TOTAL CORE RECOVERY FOR BORING	NA %
19. GEOLOGIST	Bryan Bergmann

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+586.2	0.0		Fill: ML and OH, Light brown, brown and dark brown loose to medium dense silt and organic silt, trace to little clay, fine to coarse sand and fine gravel Note: Gravel encountered while drilling from 6'-8'	38	1 0.0 2.0	Blows = 3,5,5,5
				79	2 2.0 4.0	Blows = 4,6,8,7 Qp = 2.0 TSF
				58	3 4.0 6.0	Blows = 6,4,5,5 Qp = 2.0 TSF
				42	4 6.0 8.0	Blows = 12,15,13,21
+578.2	8.0		OH and OL, Dark brown to gray very soft to medium (firm) organic silt and organic clay, trace to little fine sand and shell fragments	67	5 8.0 10.0	Blows = 8,4,3,5 Qp = .25 TSF
				33	6 10.0 12.0	Blows = WOH,2,2,4 Qp = .25 TSF
				33	7 12.0 14.0	Blows = 3,2,2,2 Qp = .5 TSF
				100	8 14.0 16.0	Blows = WOH,WOH,WOH,WOH Qp = .5 TSF
				33	9 16.0 18.0	3" diameter shelby tube sample from 16.0' - 18.0' No recovery, pushed spoon for disturbed sample
+568.2	18.0		GC, Light gray to tan medium dense sandy gravel, trace to some silt and clay Note: Gravel consisted of angular dolomite fragments		10 18.0 20.0	3" diameter shelby tube sample from 18.0' - 20.0' Poor sample; tube damaged/dented while sampling

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 586.2

Hole No. MV-2-06

PROJECT: Milwaukee CDF Geotech Inv.

INSTALLATION: Chicago District

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			GC, Light gray to tan medium dense sandy gravel, trace to some silt and clay Note: Gravel consisted of angular dolomite fragments *(continued)*	25	11 20.0 22.0	Blows = 12,10,9,9
				17	12 22.0 24.0	Blows = 15,10,14,13
				4	13 24.0 26.0	Blows = 1,6,5,3
					14 26.0 28.0	No sample taken - pounded casing due to gravel
+558.2	28.0					
			GP, Brown to gray loose to medium dense gravel, little fine to coarse sand Note: Gravel consisted of various rounded to subrounded rock types	25	15 28.0 30.0	Blows = 7,7,6,17
				17	16 30.0 32.0	Blows = 3,3,4,4
				21	17 32.0 34.0	Blows = 4,4,5,4
				17	18 34.0 36.0	Blows = 5,4,4,6
+549.7	36.5			67	19 36.0 38.0	Blows = 6,6,5,6
			SM, Brown medium dense silty fine to medium sand with mm-scale varves/bedding, trace to little fine gravel	17	20 38.0 40.0	Blows = 8,6,7,9
+546.2	40.0					
			END OF BORING - 40.0' Borehole advanced to 10' with with solid stem augers. Borehole advanced from 10' to 38' using a 3 7/8" rock bit and mud rotary drilling methods. 28' of temporary 4" steel casing was installed. Boring was backfilled with bentonite grout and 3/8" bentonite chips. Note: Boring dry while drilling and prior to casing installation and introduction of drilling fluids. No groundwater levels were recorded.			All samples collected with 2" diameter split-spoon sampler; driven with a 140 pound hammer dropped 30", unless otherwise noted. Note: Individual laboratory test results are included on separate data sheets and summarized in the Appendix. STS Project No. 200605402

DRILLING LOG

DIVISION	USACE
INSTALLATION	Chicago District
SHEET	1 OF 2 SHEETS
1. PROJECT	Milwaukee CDF Geotech Inv.
2. LOCATION (Coordinates or Station)	Milwaukee, Wisconsin N 374,063.22 E 2,532,974.50
3. DRILLING AGENCY	STS Exploration
4. HOLE NO. *(As shown on drawing title and file number)*	MV-3-06
5. NAME OF DRILLER	Randy/Matt
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	NA
8. DEPTH DRILLED INTO ROCK	NA
9. TOTAL DEPTH OF HOLE	40.0
10. SIZE AND TYPE OF BIT	4" Solid Stem/3 7/8" Rock Bit
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*	IGLD 85
12. MANUFACTURER'S DESIGNATION OF DRILL	Diedrich D-50 ATV
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 17 / UNDISTURBED 3
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	577.4
16. DATE HOLE	STARTED 8/30/2006 / COMPLETED 8/30/2006
17. ELEVATION TOP OF HOLE	+579.6
18. TOTAL CORE RECOVERY FOR BORING	NA %
19. GEOLOGIST	Bryan Bergmann

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+579.6	0.0		Fill: OH, Dark brown to black very soft organic silt, little shell fragments, trace organic matter and plastic	8	1 0.0 2.0	Blows = WOH,2,1,1 Very little recovery; sample disturbed
				29	2 2.0 4.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0 TSF
				100	3 4.0 6.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0 TSF
				75	4 6.0 8.0	3" diameter shelby tube sample from 6.0' - 8.0' Qp = 0.0 TSF
+571.6	8.0		OH, Dark brown to black very soft organic silt and clay, trace to little fine sand 1" fine sand seam observed at 13'	75	5 8.0 10.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0 TSF
				71	6 10.0 12.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0 TSF
				58	7 12.0 14.0	Blows = WOH,1,2,WOH Qp = 0.0 TSF
+565.6	14.0		CH, Gray very soft silty clay, some fine to coarse sand	75	8 14.0 16.0	3" diameter shelby tube sample from 14.0' - 16.0' Poor sample; disturbed due to wood in tube
+563.6	16.0		SM, Dark gray to gray medium dense silty fine sand, trace fine gravel	50	9 16.0 18.0	Blows = 1,3,10,10
				83	10 18.0 20.0	Blows = 7,13,13,12

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 579.6

Hole No. MV-3-06

PROJECT: Milwaukee CDF Geotech Inv.

INSTALLATION: Chicago District

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
+557.6	22.0		SM, Dark gray to gray medium dense silty fine sand, trace fine gravel *(continued)*		11 20.0 22.0	No sample recovered
			ML and CL-ML, Gray to brownish gray loose silt and very soft clayey silt, trace to little fine sand	42	12 22.0 24.0	3" diameter shelby tube sample from 22.0' - 24.0' Qp = 0.0 TSF Poor sample; tube damaged/dented while sampling
				100	13 24.0 26.0	Blows = 7,2,2,1 Qp = 0.0-0.5 TSF
				100	14 26.0 28.0	3" diameter shelby tube sample from 26.0' - 28.0' Qp = .5 TSF No recovery; pushed spoon for disturbed sample
+550.6	29.0			75	15 28.0 30.0	3" diameter shelby tube sample from 28.0' - 30.0' Poor sample (started falling out of tube)
			SM, Brown to gray medium dense silty fine to medium sand, trace to little fine gravel	46	16 30.0 32.0	Blows = 7,6,9,9
				29	17 32.0 34.0	Blows = 9,10,15,13
+543.6	36.0			42	18 34.0 36.0	Blows = 11,10,10,9
			CL, Brown to gray stiff to very stiff silty clay, trace to little fine to medium sand, trace fine gravel	54	19 36.0 38.0	Blows = 10,9,13,17 Qp = 2.0 TSF
+539.6	40.0			38	20 38.0 40.0	Blows = 5,8,7,9 Qp = 1.0 TSF
			END OF BORING - 40.0' Borehole advanced to 10' with with solid stem augers. Borehole advanced from 10' to 38' using a 3 7/8" rock bit and mud rotary drilling methods. 10' of temporary 4" steel casing was installed. Boring was backfilled with bentonite grout and 3/8" bentonite chips. Note: Groundwater was encountered at 2.2' while drilling and before casing installation.			All samples collected with 2" diameter split-spoon sampler; driven with a 140 pound hammer dropped 30", unless otherwise noted. Note: Individual laboratory test results are included on separate data sheets and summarized in the Appendix. STS Project No. 200605402

DRILLING LOG

DIVISION	USACE
INSTALLATION	Chicago District
SHEET	1 OF 2 SHEETS
1. PROJECT	Milwaukee CDF Geotech Inv.
2. LOCATION (Coordinates or Station)	Milwaukee, Wisconsin N 373,576.82 E 2,553,142.05
3. DRILLING AGENCY	STS Exploration
4. HOLE NO. *(As shown on drawing title and file number)*	MV-4-06
5. NAME OF DRILLER	Randy/Matt
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	NA
8. DEPTH DRILLED INTO ROCK	NA
9. TOTAL DEPTH OF HOLE	40.0
10. SIZE AND TYPE OF BIT	4" Solid Stem/3 7/8" Rock Bit
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*	IGLD 85
12. MANUFACTURER'S DESIGNATION OF DRILL	Diedrich D-50 ATV
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 17 / UNDISTURBED 3
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	577.4
16. DATE HOLE	STARTED 8/31/2006 / COMPLETED 8/31/2006
17. ELEVATION TOP OF HOLE	+581.1
18. TOTAL CORE RECOVERY FOR BORING	NA %
19. GEOLOGIST	Bryan Bergmann

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
+581.1	0.0		Fill: OH, Dark brown to black very soft to stiff organic silt, trace to little fine to coarse sand, trace to little organic matter	83	1 0.0 2.0	Blows = 1,2,1,2, Qp = 1.0 TSF
				58	2 2.0 4.0	Blows = WOH,1,1,1 Qp = 0.0 TSF
				83	3 4.0 6.0	Blows = WOH,WOH,WOH,WOH Qp = .25 TSF
				100	4 6.0 8.0	3" diameter shelby tube sample from 6.0' - 8.0' Qp = 0.0 TSF
				50	5 8.0 10.0	Blows = WOH,WOH,WOH,6 Qp = 0.0 TSF
+571.1	10.0		GP, Brown to gray loose to dense gravel, trace to little fine to coarse sand Note: Gravel consisted of various rounded to subrounded rock types	29	6 10.0 12.0	Blows = 4,4,4,6
				13	7 12.0 14.0	Blows = 6,5,7,5
				25	8 14.0 16.0	Blows = 2,4,4,3
				13	9 16.0 18.0	Blows = 13,15,16,10
+563.1	18.0		GP, Tan medium dense gravel Note: Gravel consisted of angular dolomite fragments	8	10 18.0 20.0	Blows = 3,1,15,17
+561.1	20.0					

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 581.1

Hole No. MV-4-06

PROJECT: Milwaukee CDF Geotech Inv.

INSTALLATION: Chicago District

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			SM, Gray medium dense silty fine to coarse sand, trace to some fine gravel	79	11 20.0 22.0	Blows = 9,9,15,14
+558.1	23.0			67	12 22.0 24.0	Blows = 8,9,11,8 Qp = 2.5 TSF
			CL, Brownish gray to gray very stiff silty clay, trace to little fine to coarse sand, trace fine gravel Note: Fine sandy silt seam observed from 39.2' to 39.8'	54	13 24.0 26.0	Blows = 7,7,6,7 Qp = 2.5 TSF
					14 26.0 28.0	3" diameter shelby tube sample from 26.0' - 28.0' No recovery, pushed spoon for disturbed sample
				100	15 28.0 30.0	3" diameter shelby tube sample from 28.0' - 30.0' Qp = 2.5 TSF
				88	16 30.0 32.0	Blows = 3,3,5,8 Qp = 1.75 TSF
				100	17 32.0 34.0	Blows = 5,6,8,11 Qp = 2.25 TSF
				100	18 34.0 36.0	3" diameter shelby tube sample from 34.0' - 36.0' Qp = 2.75 TSF
				100	19 36.0 38.0	Blows = 5,7,9,13 Qp = 2.25 TSF
+541.1	40.0			100	20 38.0 40.0	Blows = 6,8,10,14 Qp = 2.5 TSF
			END OF BORING - 40.0' Borehole advanced to 10' with with solid stem augers. Borehole advanced from 10' to 38' using a 3 7/8" rock bit and mud rotary drilling methods. 28' of temporary 4" steel casing was installed. Boring was backfilled with bentonite grout and 3/8" bentonite chips. Note: Groundwater was encountered at 3.7' while drilling and before casing installation.			All samples collected with 2" diameter split-spoon sampler; driven with a 140 pound hammer dropped 30", unless otherwise noted. Note: Individual laboratory test results are included on separate data sheets and summarized in the Appendix. STS Project No. 200605402

DRILLING LOG

DIVISION	USACE
INSTALLATION	Chicago District
SHEET	1 OF 2 SHEETS
1. PROJECT	Milwaukee CDF Geotech Inv.
2. LOCATION (Coordinates or Station)	Milwaukee, Wisconsin N 373,002.36 E 2,532,972.15
3. DRILLING AGENCY	STS Exploration
4. HOLE NO. *(As shown on drawing title and file number)*	MV-5-06
5. NAME OF DRILLER	Randy/Matt
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	NA
8. DEPTH DRILLED INTO ROCK	NA
9. TOTAL DEPTH OF HOLE	40.0
10. SIZE AND TYPE OF BIT	4" Solid Stem/3 7/8" Rock Bit
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*	IGLD 85
12. MANUFACTURER'S DESIGNATION OF DRILL	Diedrich D-50 ATV
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 18 / UNDISTURBED 2
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	
16. DATE HOLE	STARTED 8/28/2006 / COMPLETED 8/28/2006
17. ELEVATION TOP OF HOLE	+584.3
18. TOTAL CORE RECOVERY FOR BORING	NA %
19. GEOLOGIST	Bryan Bergmann

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+584.3	0.0		Fill: ML and CL-ML, Dark brown to brown loose silt and stiff to hard clayey silt, trace fine sand and organic matter	100	1 0.0 2.0	Blows = 2,5,6,9 Qp = 4.0 TSF
				63	2 2.0 4.0	Blows = 13,3,4,4 Qp = 1.0 TSF
+580.3	4.0					
			Fill: OH, Dark gray very soft to soft organic silt, trace fine sand and organic matter	83	3 4.0 6.0	Blows = 3,3,3,4 Qp = .75 TSF
				100	4 6.0 8.0	Blows = WOH,WOH,2,WOH Qp = .5 TSF
				100	5 8.0 10.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0-.25 TSF
+573.3	11.0			100	6 10.0 12.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0 TSF
			CL, Gray very soft silty clay, trace fine sand			
+571.3	13.0			79	7 12.0 14.0	Blows = 12,9,30,39 Qp = 0.0 TSF
			SM, Black to brownish gray medium dense to dense silty fine to coarse sand, trace to little fine gravel			
				46	8 14.0 16.0	Blows = 7,4,21,50/0.2
				67	9 16.0 18.0	Blows = 20,25,31,36
				46	10 18.0 20.0	Blows = 13,10,9.8
+564.3	20.0					

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 584.3

Hole No. MV-5-06

PROJECT: Milwaukee CDF Geotech Inv.

INSTALLATION: Chicago District

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			CL and CL-ML, Brown to gray soft to stiff silty clay and clayey silt, trace to little fine to medium sand Note: Silty fine to coarse sand seam encountered in Sample No. 11; 1/4" to 1/2" sand seams observed between 24' - 28'	63	11 20.0 22.0	3" diameter shelby tube sample from 20.0' - 22.0'
				25	12 22.0 24.0	Blows = 6,3,4,8 Qp = 1.5 TSF
				63	13 24.0 26.0	Blows = 6,4,7,7 Qp = 1.25 TSF
				100	14 26.0 28.0	Blows = 3,5,5,6 Qp = .75 TSF
				100	15 28.0 30.0	Blows = 4,6,6,7 Qp = 1.5 TSF
				100	16 30.0 32.0	3" diameter shelby tube sample from 30.0' - 32.0' Qp = 1.0 TSF
				100	17 32.0 34.0	Blows = 5,4,5,6 Qp = 1.0 TSF
				83	18 34.0 36.0	Blows = 2,3,3,3 Qp = .5 TSF
				100	19 36.0 38.0	Blows = 2,2,3,4 Qp = .25 TSF
				100	20 38.0 40.0	Blows = 5,8,8,16 Qp = 1.5 TSF
+544.3	40.0					
			END OF BORING - 40.0' Borehole advanced to 10' with with solid stem augers. Borehole advanced from 10' to 38' using a 3 7/8" rock bit and mud rotary drilling methods. 10' of temporary 4" steel casing was installed. Boring was backfilled with bentonite grout and 3/8" bentonite chips. Note: Boring was dry while drilling and prior to casing installation and introduction of drilling fluids. No groundwater levels were recorded.			All samples collected with 2" diameter split-spoon sampler; driven with a 140 pound hammer dropped 30", unless otherwise noted. Note: Individual laboratory test results are included on separate data sheets and summarized in the Appendix. STS Project No. 200605402

DRILLING LOG

DIVISION	USACE
INSTALLATION	Chicago District
SHEET	1 OF 2 SHEETS
1. PROJECT	Milwaukee CDF Geotech Inv.
2. LOCATION (Coordinates or Station)	Milwaukee, Wisconsin N 373,748.68 E 2,534,031.15
3. DRILLING AGENCY	STS Exploration
4. HOLE NO. *(As shown on drawing title and file number)*	MV-6-06
5. NAME OF DRILLER	Randy/Matt
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	NA
8. DEPTH DRILLED INTO ROCK	NA
9. TOTAL DEPTH OF HOLE	40.0
10. SIZE AND TYPE OF BIT	4" Solid Stem/3 7/8" Rock Bit
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*	IGLD 85
12. MANUFACTURER'S DESIGNATION OF DRILL	Diedrich D-50 ATV
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 19 / UNDISTURBED 1
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	579.0
16. DATE HOLE	STARTED 8/29/2006 / COMPLETED 8/29/2006
17. ELEVATION TOP OF HOLE	+586.0
18. TOTAL CORE RECOVERY FOR BORING	NA %
19. GEOLOGIST	Bryan Bergmann

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+586.0	0.0		Fill: ML and CL-ML, Light brown, brown and dark brown very loose to medium dense silt and soft to stiff clayey silt, trace to little fine to medium sand, trace asphalt and slag in Sample No. 2, trace shell fragments and organic matter in Sample Nos. 3 and 4	100	1 0.0 2.0	Blows = 4,5,8,9 Qp = 1.0 TSF
				100	2 2.0 4.0	Blows = 7,6,8,7 Qp = 1.5 TSF
				83	3 4.0 6.0	Blows = 4,5,5,5 Qp = 1.5 TSF
+580.0	6.0					
			Fill: OH, Dark brownish gray soft to medium (firm) organic clayey silt, trace to little fine sand and organic matter	92	4 6.0 8.0	Blows = 1,1,2,2 Qp = .5 TSF
				100	5 8.0 10.0	Blows = 1,1,1,2 Qp = .25-.75 TSF
				100	6 10.0 12.0	Blows = 4,2,1,3 Qp = .5 TSF
+574.0	12.0					
			OL and OH, Dark gray to black soft to medium (firm) organic clay and silt, trace to little shell fragments and organic matter, trace fine sand	100	7 12.0 14.0	Blows = WOH,WOH,WOH,WOH Qp = .25 TSF
				100	8 14.0 16.0	Blows = WOH,WOH,WOH,WOH Qp = .5 TSF
				63	9 16.0 18.0	3" diameter shelby tube sample from 16.0' - 18.0' Qp = .25 TSF
+568.0	18.0					
				4	10 18.0 20.0	Blows = 5,2,1,6

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 586.0

Hole No. MV-6-06

PROJECT: Milwaukee CDF Geotech Inv.

INSTALLATION: Chicago District

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			GP, Tan loose to extremely dense gravel, trace to little fine to coarse sand Note: Gravel consisted of angular dolomite fragments; 100% loss of drilling fluid from 18'-20' and from 20'-22' *(continued)*	8	11 20.0 22.0	Blows = 5,6,4,9
					12 22.0 24.0	Blows = 50/0.1 No recovery
				29	13 24.0 26.0	Blows = 5,30,12,10
					14 26.0 28.0	Blows = 50/0.1 No recovery
					15 28.0 30.0	Blows = 9,4,4,5 No recovery - 2 attempts
+556.0	30.0					
			GP, Brown to gray loose to medium dense fine to coarse sand and fine gravel Note: Gravel consisted of various rounded to subrounded rock types; 100% fluid loss from 36'-38'	8	16 30.0 32.0	Blows = 4,2,4,3
				8	17 32.0 34.0	Blows = 4,4,4,3
				29	18 34.0 36.0	Blows = 3,2,2,2
				13	19 36.0 38.0	Blows = 4,3,2,3
				42	20 38.0 40.0	Blows 6,7,6,5
+546.0	40.0					
			END OF BORING - 40.0' Borehole advanced to 10' with with solid stem augers. Borehole advanced from 10' to 38' using a 3 7/8" rock bit and mud rotary drilling methods. 33' of temporary 4" steel casing was installed. Boring was backfilled with bentonite grout and 3/8" bentonite chips. Note: Groundwater was encountered at 7' while drilling and prior to introduction of drilling fluids.			All samples collected with 2" diameter split-spoon sampler; driven with a 140 pound hammer dropped 30", unless otherwise noted. Note: Individual laboratory test results are included on separate data sheets and summarized in the Appendix. STS Project No. 200605402

DRILLING LOG

DIVISION	USACE
INSTALLATION	Chicago District
SHEET	1 OF 2 SHEETS
1. PROJECT	Milwaukee CDF Geotech Inv.
2. LOCATION (Coordinates or Station)	Milwaukee, Wisconsin N 373,965.30 E 2,533,439.44
3. DRILLING AGENCY	STS Exploration
4. HOLE NO. *(As shown on drawing title and file number)*	MV-7-06
5. NAME OF DRILLER	Randy/Matt
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	NA
8. DEPTH DRILLED INTO ROCK	NA
9. TOTAL DEPTH OF HOLE	40.0
10. SIZE AND TYPE OF BIT	4" Solid Stem/3 7/8" Rock Bit
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*	IGLD 85
12. MANUFACTURER'S DESIGNATION OF DRILL	Diedrich D-50 ATV
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 15 / UNDISTURBED 5
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	
16. DATE HOLE	STARTED 8/31/2006 / COMPLETED 8/31/2006
17. ELEVATION TOP OF HOLE	+583.9
18. TOTAL CORE RECOVERY FOR BORING	NA %
19. GEOLOGIST	Bryan Bergmann

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+583.9	0.0		Fill: SC-SM, Black medium dense organic fine to coarse sand, some silt, little clay, trace shell fragments	63	1 0.0 2.0	Blows = 4,4,6,7 Qp = 2.0 TSF
				100	2 2.0 4.0	Blows = 5,6,7,8 Qp = 1.5 TSF
+579.9	4.0		Fill: OH, Black very soft to stiff organic silt, little to some fine sand, trace fine gravel, shell fragments and organic matter	79	3 4.0 6.0	Blows =5,4,3,3 Qp = .25-1.5 TSF
				83	4 6.0 8.0	Blows = 1,1,1,2 Qp = .25 TSF
				100	5 8.0 10.0	Blows = WOH,WOH,WOH,WOH Qp = .25 TSF
				100	6 10.0 12.0	Blows = WOH,WOH,WOH,WOH Qp = .25 TSF
				17	7 12.0 14.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0 TSF
				71	8 14.0 16.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0 TSF
				100	9 16.0 18.0	3" diameter shelby tube sample from 16.0' - 18.0' Qp = 0.0 TSF
				50	10 18.0 20.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0 TSF

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 583.9

Hole No. MV-7-06

PROJECT: Milwaukee CDF Geotech Inv.

INSTALLATION: Chicago District

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
+561.9	22.0		Fill: OH, Black very soft to stiff organic silt, little to some fine sand, trace fine gravel, shell fragments and organic matter *(continued)*	100	11 20.0 22.0	3" diameter shelby tube sample from 20.0' - 22.0' Qp = 0.0 TSF
			OH, Black very soft to medium (firm) organic silt, trace fine sand and organic matter	75	12 22.0 24.0	Blows = WOH,WOH,WOH,WOH Qp = .25 TSF
+557.9	26.0			75	13 24.0 26.0	3" diameter shelby tube sample from 24.0' - 26.0' Qp = .5 TSF
			CL, Brown to dark brown stiff to very stiff silty clay, trace to little fine to coarse sand Note: 4" Sandy silt seam observed in Sample No. 14; Dark gray fine to medium sand seam observed in Sample No. 15	75	14 26.0 28.0	Blows = WOH,WOH,WOH,1 Qp = .25 TSF
				42	15 28.0 30.0	3" diameter shelby tube sample from 28.0' - 30.0' Qp = 3.5 TSF
				100	16 30.0 32.0	Blows = 5,5,6,7 Qp = 1.5 TSF
				100	17 32.0 34.0	3" diameter shelby tube sample from 32.0' - 34.0' Qp = 1.25 TSF
				100	18 34.0 36.0	Blows = 5,4,8,9 Qp = 1.5 TSF
				75	19 36.0 38.0	Blows = WOH,3,4,8 Qp = 1.25 TSF
+543.9	40.0			100	20 38.0 40.0	Blows = 4,5,6,10 Qp = 1.25 TSF
			END OF BORING - 40.0' Borehole advanced to 10' with with solid stem augers. Borehole advanced from 10' to 38' using a 3 7/8" rock bit and mud rotary drilling methods. 12' of temporary 4" steel casing was installed. Boring was backfilled with bentonite grout and 3/8" bentonite chips. Note: Boring was dry while drilling and prior to casing installation and introduction of drilling fluids. No groundwater levels were recorded.			All samples collected with 2" diameter split-spoon sampler; driven with a 140 pound hammer dropped 30", unless otherwise noted. Note: Individual laboratory test results are included on separate data sheets and summarized in the Appendix. STS Project No. 200605402

DRILLING LOG

DIVISION	North Central
INSTALLATION	Detroit
SHEET	1 OF 1 SHEETS
1. PROJECT	Milwaukee CDF, Milwaukee, WI
2. LOCATION (Coordinates or Station)	
3. DRILLING AGENCY	Coleman Engineering Company
4. HOLE NO. (As shown on drawing title and file number)	-ME-1-97
5. NAME OF DRILLER	Scott Strigel
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	N/A
8. DEPTH DRILLED INTO ROCK	N/A
9. TOTAL DEPTH OF HOLE	10.0
10. SIZE AND TYPE OF BIT	N/A
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	IGLD 55
12. MANUFACTURES'S DESIGNATION OF DRILL	Diedrich D-50
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED N/A; UNDISTURBED N/A
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	
16. DATE HOLE	STARTED OCT 7 97; COMPLETED OCT 7 97
17. ELEVATION TOP OF HOLE	584.8
18. TOTAL CORE RECOVERY FOR BORING	N/A %
19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
584.0	0.8		Medium stiff, brown, organic SILT, occasional garbage (consisting of plastic wrappings), rootlets, dry, slightly plastic 0.8'	80%	1 0.0 2.0	4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop SS sample 0' - 2.0' blows 2-3-4-4 field pen. 2.0 tsf (brown silt) field torvane 0.29 tsf (gray silt) field pen. 1.25 tsf (gray silt)
582.8	2.0		Medium stiff, dark gray, organic SILT, with shells, dry, plastic, occasional garbage (consisting of aluminum foil and plastic wrap) 2.0'			
580.8	4.0		Soft, dark gray, clayey, organic SILT, plastic, moist, occasional garbage (consisting of clear and black plastic wrap), light gray, clayey silt seam 1.3' - 1.5' 4.0'	95%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 1-1-1-2 field torvane 0.22 tsf field pen. 0.5 tsf
578.8	6.0		Soft, dark gray, clayey, organic SILT, occasional garbage (consisting of blue plastic fragments), moist, plastic, thin seam with sand at 0.6' 6.0'	100%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 1-1-2-2 field torvane 0.13 tsf field pen. 0.5 tsf
578.4	6.4		Soft, dark gray, clayey, organic SILT, occasional garbage (consisting of plastic wrap), moist, plastic 6.4'	100%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 1/12"-2-1 field torvane 0.19 tsf (gray, clayey silt) field pen 0.5 tsf (gray, clayey silt)
576.8	8.0		Soft, gray, clayey, organic SILT, moist, medium plastic, trace of sand seam at 1.4' - 1.6' 8.0'			
574.8	10.0		Soft, gray, clayey, organic SILT, moist, plastic, with traces of gravel and sand in last 0.2' 10.0'	70%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 1-1-1-1 field torvane 0.11 tsf field pen. 0.5 tsf water at bottom of boring after 10 minutes
			End of Boring			boring backfilled 60-40 cement-bentonite mix 10' - 2', upper 2' backfilled with native material

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PROJECT Milwaukee CDF, Milwaukee, WI

HOLE NO. -ME-1-97

Hole No. -ME-2-97

DRILLING LOG	DIVISION North Central	INSTALLATION Detroit	SHEET 1 OF 1 SHEETS

1. PROJECT Milwaukee CDF, Milwaukee, WI	10. SIZE AND TYPE OF BIT N/A
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) IGLD 55
	12. MANUFACTURES'S DESIGNATION OF DRILL Diedrich D-50
3. DRILLING AGENCY Coleman Engineering Company	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED N/A; UNDISTURBED N/A
4. HOLE NO. (As shown on drawing title and file number) -ME-2-97	14. TOTAL NUMBER CORE BOXES N/A
5. NAME OF DRILLER Scott Strigel	15. ELEVATION GROUND WATER 579.4
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	16. DATE HOLE — STARTED OCT 1 97; COMPLETED OCT 1 97
7. THICKNESS OF OVERBURDEN N/A	17. ELEVATION TOP OF HOLE 586.8
8. DEPTH DRILLED INTO ROCK N/A	18. TOTAL CORE RECOVERY FOR BORING N/A %
9. TOTAL DEPTH OF HOLE 10.0	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			Medium stiff, dark brown, fine, organic SILT, trace of gravel, friable, dry, some plant matter 2.0'	50%	1 0.0 2.0	4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop boring backfilled 60-40 cement-bentonite mix 10' - SS sample 0' - 2.0' blows 3-4-4-3 2', upper 2'
584.8	2.0		Stiff, dark brown, fine, organic SILT, trace of gravel becoming moist in lower 0.5', with plant material slightly plastic 4.0'	80%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 3-7-4-6
582.8	4.0		Soft, dark brown, fine, organic SILT, trace of gravel, moist, slight to moderately plastic 6.0'	100%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 2-2-1-2 field torvane 0.19 tsf field pen. 0.5 tsf
580.8	6.0		Soft, dark brown, fine, organic SILT, moist, moderately plastic, trace of gravel at 0.9' down 7.0'	100%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 1-2-2-2 field torvane 0.75 tsf field pen 0.33 tsf
579.8	7.0		changes to black, organic SILT, with plant material 8.0'			
578.8	8.0		Soft, dark brown, fine, organic SILT, moderately plastic, moist, at 1.1' down silt becomes black 9.1'	100%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 2-1-2-3 field torvane 0.10 tsf (brown silt) field pen. 0.25 tsf field torvane 0.2 tsf (black silt) field pen. 0.5 tsf (black silt)
577.7	9.1		Soft, black, fine, organic SILT, trace of sand, occasional garbage (consisting of aluminum foil), with plant material, moderately plastic 10.0'			
576.8	10.0		End of Boring			water 7.7' after drilling, 7.4', 10 and 20 minutes later backfilled with native material

DRILLING LOG	DIVISION North Central	INSTALLATION Detroit	SHEET 1 OF 1 SHEETS

1. PROJECT Milwaukee CDF, Milwaukee, WI	10. SIZE AND TYPE OF BIT N/A
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) IGLD 55
3. DRILLING AGENCY Coleman Engineering Company	12. MANUFACTURES'S DESIGNATION OF DRILL Diedrich D-50
4. HOLE NO. (As shown on drawing title and file number) -ME-3-97	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED N/A — UNDISTURBED N/A
5. NAME OF DRILLER Scott Strigel	14. TOTAL NUMBER CORE BOXES N/A
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	15. ELEVATION GROUND WATER 579.3
7. THICKNESS OF OVERBURDEN N/A	16. DATE HOLE — STARTED OCT 1 97 — COMPLETED OCT 1 97
8. DEPTH DRILLED INTO ROCK N/A	17. ELEVATION TOP OF HOLE 585.8
9. TOTAL DEPTH OF HOLE 10.0	18. TOTAL CORE RECOVERY FOR BORING N/A %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			Medium stiff, brown, fine, organic SILT, shell fragments, friable, dry, charcoal and plant bits, slightly plastic — 2.0'	40%	1 0.0 2.0	4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop SS sample 0' - 2.0' blows 2-3-4-5 1st spoon had 0.7' recovery, 2nd spoon taken 1' away
583.8	2.0		Stiff, brown, fine, organic SILT, friable, dry, slightly plastic, with plant matter — 4.0	75%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 3-4-5-6 field torvane 0.3 tsf field pen. 1.75 - 2.0 tsf
581.8	4.0		Stiff, brown, fine, organic SILT, with plant material, shell fragments, cinders, charcoal, slightly plastic, dry — 6.0'	80%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 3-4-5-4 field torvane 0.4 tsf field pen. 1.5 tsf
579.8	6.0		Medium stiff, brown, fine, organic SILT, with cinders — 6.2'	100%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 2-3-2-4 field torvane 0.21 tsf field pen 0.75 tsf
579.6	6.2		at 0.2' down becomes medium stiff, gray, fine, organic SILT, trace of gravel, plus shell fragments, slightly plastic — 8.0'			
577.8	8.0		Soft, gray, fine, organic SILT, plastic, becoming clayey at bottom 0.8', occasional garbage (consisting of plastic wrap) — 10.0'	95%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 1-1-2-2 field torvane 0.26 tsf field pen. 0.5 - 0.75 tsf 40 minutes after drilling, water at 6.5'
575.8	10.0		End of Boring			boring backfilled 60-40 cement-bentonite mix 10' - 2', upper 2' backfilled with native material

Hole No. -ME-4-97

DRILLING LOG	DIVISION North Central	INSTALLATION Detroit	SHEET 1 OF 1 SHEETS

1. PROJECT Milwaukee CDF, Milwaukee, WI	10. SIZE AND TYPE OF BIT N/A
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) IGLD 55
	12. MANUFACTURES'S DESIGNATION OF DRILL Diedrich D-50
3. DRILLING AGENCY Coleman Engineering Company	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
4. HOLE NO. (As shown on drawing title and file number) -ME-4-97	14. TOTAL NUMBER CORE BOXES N/A
5. NAME OF DRILLER Scott Strigel	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	16. DATE HOLE: STARTED OCT 1 97; COMPLETED OCT 1 97
7. THICKNESS OF OVERBURDEN N/A	17. ELEVATION TOP OF HOLE 588.4
8. DEPTH DRILLED INTO ROCK N/A	18. TOTAL CORE RECOVERY FOR BORING N/A %
9. TOTAL DEPTH OF HOLE 10.0	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			Medium, brown, fine to medium SANDY SILT, some gravel, dry 0.7'	65%	1 0.0 2.0	4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop
587.7	0.7		Medium, dark brown, organic SILT, with gravel, dry, friable 2.0'			SS sample 0' - 2.0' blows 7-11-13-14
586.4	2.0		Very stiff, dark brown, fine, organic SILT, friable, dry, with wood pieces, becoming dark brown to black 0.6' down 4.0'	80%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 5-8-9-14 field torvane 0.43 tsf field pen. 2.8 tsf
584.4	4.0		Stiff, dark brown, fine, organic SILT, with cinders, trace of gravel, friable, dry, slightly plastic	100%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 7-7-8-11 field torvane 0.40 tsf, 0.55 tsf field pen. 1.75 tsf
			Stiff, black, fine, organic SILT, with trace of garbage (consisting of cinders, possible small metal fragments), slightly plastic, friable, dry 6.0'			
582.4	6.0		Stiff, black, fine organic SILT, with cinders, moderately plastic, dry 8.0'	100%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 5-4-5-6 field torvane 0.49 tsf, 0.45 tsf field pen 1.25 tsf
580.4	8.0		Medium stiff, fine, organic SILT, with plant parts and cinders, plastic, dry 9.5'	100%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 3-2-4-5 field torvane 0.35 tsf, 0.36 tsf field pen. 1.0 tsf
578.9	9.5		Loose, gray, fine SILTY SAND, dry 10.0'			
578.4	10.0		End of Boring			boring backfilled 60-40 cement-bentonite mix 10' - 2', upper 2' backfilled with native material

Hole No. -ME-5-97

DRILLING LOG	DIVISION North Central	INSTALLATION Detroit	SHEET 1 OF 1 SHEETS

1. PROJECT Milwaukee CDF, Milwaukee, WI	10. SIZE AND TYPE OF BIT N/A
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) IGLD 55
	12. MANUFACTURES'S DESIGNATION OF DRILL Diedrich D-50
3. DRILLING AGENCY Coleman Engineering Company	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED N/A — UNDISTURBED N/A
4. HOLE NO. (As shown on drawing title and file number) -ME-5-97	14. TOTAL NUMBER CORE BOXES N/A
5. NAME OF DRILLER Scott Strigel	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	16. DATE HOLE — STARTED OCT 6 97 — COMPLETED OCT 6 97
7. THICKNESS OF OVERBURDEN N/A	17. ELEVATION TOP OF HOLE 587.9
8. DEPTH DRILLED INTO ROCK N/A	18. TOTAL CORE RECOVERY FOR BORING N/A %
9. TOTAL DEPTH OF HOLE 10.0	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
585.9	2.0		Very stiff, dark brown, organic SILT, crumbly, dry, some gravel, trace of sand, slightly plastic, dry, with cinders — 2.0'	50%	1 0.0 2.0	4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop SS sample 0' - 2.0' blows 6-8-17-16
583.9	4.0		Very stiff, dark brown, organic SILT, crumbly, dry, with glass, metal debris, brick pieces — 4.0'	40%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 9-20-10-7 pocket pen. 2.0 tsf
581.9	6.0		no recovery, refer to boring ME-5A-97 — 6.0'	0%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 4-3-4-5
579.9	8.0		no recovery, refer to boring ME-5A-97 — 8.0'	0%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 3-4-5-5 material was within the auger
577.9	10.0		Medium stiff, gray, organic SILT, moist, plastic, with shell fragments and organic material — 10.0'	100%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 3-2-3-4 field torvane 0.31 tsf field pen. 0.75 tsf
			End of Boring			boring backfilled 60-40 cement-bentonite mix 10' - 2', upper 2' backfilled with native material

ENG FORM 1836 MAR 71 — PREVIOUS EDITIONS ARE OBSOLETE. (modified by GCA 1/94) — PROJECT Milwaukee CDF, Milwaukee, WI — HOLE NO. -ME-5-97

Hole No. -ME-5A-97

DRILLING LOG	DIVISION North Central	INSTALLATION Detroit	SHEET 1 OF 1 SHEETS

1. PROJECT Milwaukee CDF, Milwaukee, WI	10. SIZE AND TYPE OF BIT N/A
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) IGLD 55
3. DRILLING AGENCY Coleman Engineering Company	12. MANUFACTURES'S DESIGNATION OF DRILL Diedrich D-50
4. HOLE NO. (As shown on drawing title and file number) -ME-5A-97	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
5. NAME OF DRILLER Scott Strigel	14. TOTAL NUMBER CORE BOXES N/A
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN N/A	16. DATE HOLE: STARTED OCT 6 97; COMPLETED OCT 6 97
8. DEPTH DRILLED INTO ROCK N/A	17. ELEVATION TOP OF HOLE 587.8
9. TOTAL DEPTH OF HOLE 8.0	18. TOTAL CORE RECOVERY FOR BORING N/A %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			No sampling conducted 0.0' to 4.0'			4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop relocated 6.0' +/- west of boring ME-5-97 to attempt recovery of the 4.0' - 8.0' zone boring augered to 4.0' deep prior to sampling
583.8	4.0		4.0'			
583.6	4.2		Soft, brown, organic SILT, with gravel 4.2'	85%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 2-2-2-2 field torvane 0.19 tsf field pen. 0.75 tsf
			Soft, dark gray to black, organic, clayey SILT, with shells, plastic, moist 6.0'			
581.8	6.0		Medium stiff to stiff, dark gray, organic, clayey SILT, moist, plastic, with shell fragments, occasional garbage (consisting of rubber band fragments) 8.0'	40%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 4-4-4-5 field torvane 0.19 tsf field pen. 0.41 tsf
579.8	8.0		End of Boring			boring backfilled 60-40 cement-bentonite mix 8' - 2', upper 2' backfilled with native material

ENG FORM MAR 71 1836 PREVIOUS EDITIONS ARE OBSOLETE. (modified by GCA 1/94)

PROJECT Milwaukee CDF, Milwaukee, WI | HOLE NO. -ME-5A-97

Hole No. -ME-6-97

DRILLING LOG	DIVISION North Central	INSTALLATION Detroit	SHEET 1 OF 1 SHEETS

1. PROJECT Milwaukee CDF, Milwaukee, WI	10. SIZE AND TYPE OF BIT N/A
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) IGLD 55
3. DRILLING AGENCY Coleman Engineering Company	12. MANUFACTURES'S DESIGNATION OF DRILL Diedrich D-50
4. HOLE NO. (As shown on drawing title and file number) -ME-6-97	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
5. NAME OF DRILLER Scott Strigel	14. TOTAL NUMBER CORE BOXES N/A
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN N/A	16. DATE HOLE: STARTED OCT 6 97; COMPLETED OCT 6 97
8. DEPTH DRILLED INTO ROCK N/A	17. ELEVATION TOP OF HOLE 589.0
9. TOTAL DEPTH OF HOLE 10.0	18. TOTAL CORE RECOVERY FOR BORING N/A %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			Hard, dark brown, organic SILT, with gravel, dry, crumbly, many rootlets (2.0')	80%	1 0.0 2.0	4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop SS sample 0' - 2.0' blows 9-13-19-20
587.0	2.0		Very stiff, dark brown, organic SILT, with woody material and some gravel, dry, crumbly, slightly plastic, between 0.6' - 0.7' large light gray, stone sampled (road gravel) (4.0')	60%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 7-8-10-11
585.0	4.0		Medium stiff, dark brown, organic SILT, dry, crumbly, with gravel, broken glass (4.2')	75%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 4-5-5-5 field torvane 0.29 tsf field pen. 1.5 tsf
584.8	4.2		Stiff, gray, organic SILTY CLAY, moist, plastic, with wood debris (6.0')			
583.0	6.0		Medium stiff, brown, organic SILT, with cinders (6.5')	65%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 3-2-3-3 field torvane 0.39 tsf (brown silt) field pen. 1.5 tsf (brown silt)
582.5	6.5		Medium stiff, gray, organic SILT, with organic material and shells, moist, plastic (8.0')			
581.0	8.0		Medium stiff, gray, clayey, organic SILT, with gravel, moist, plastic (10.0')	60%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 2-3-2-5 field torvane 0.13 tsf field pen. 0.25 tsf
579.0	10.0		End of Boring			boring backfilled 60-40 cement-bentonite mix 10' - 2', upper 2' backfilled with native material

ENG FORM MAR 71 1836	PREVIOUS EDITIONS ARE OBSOLETE. (modified by GCA 1/94)	PROJECT Milwaukee CDF, Milwaukee, WI	HOLE NO. -ME-6-97

Hole No. -ME-7-97

DRILLING LOG	DIVISION North Central	INSTALLATION Detroit	SHEET 1 OF 1 SHEETS

1. PROJECT Milwaukee CDF, Milwaukee, WI	10. SIZE AND TYPE OF BIT N/A
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) IGLD 55
	12. MANUFACTURES'S DESIGNATION OF DRILL Diedrich D-50
3. DRILLING AGENCY Coleman Engineering Company	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED N/A — UNDISTURBED N/A
4. HOLE NO. (As shown on drawing title and file number) -ME-7-97	14. TOTAL NUMBER CORE BOXES N/A
5. NAME OF DRILLER Scott Strigel	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	16. DATE HOLE — STARTED OCT 6 97 — COMPLETED OCT 6 97
7. THICKNESS OF OVERBURDEN N/A	17. ELEVATION TOP OF HOLE 587.8
8. DEPTH DRILLED INTO ROCK N/A	18. TOTAL CORE RECOVERY FOR BORING N/A %
9. TOTAL DEPTH OF HOLE 10.0	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			Very stiff, dark brown, organic SILT, with cinders, friable, dry, slightly plastic, occasional garbage (consisting of cinders, plastic wrap fragments and glass shards) 2.0'	70%	1 0.0 2.0	4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop SS sample 0' - 2.0' blows 7-9-8-8 field pen. 2.75 - 3.0 tsf
585.8	2.0		Stiff, dark brown, organic SILT, with wood material, slight to medium plastic, dry, with black organic silt inclusions in last 0.3' of sample 4.0'	50%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 5-5-7-7 field torvane 1.0 tsf field pen. 0.45 tsf
583.8	4.0					
583.6	4.2		Medium stiff, dark brown, organic SILT, friable, dry 4.2' Soft, dark gray, clayey, organic SILT, moist, plastic, with woody pieces 6.0'	45%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 4-4-3-3 field torvane 0.15 tsf (gray silt layers) field pen. 0.25 tsf (gray silt layers)
581.8	6.0		Medium stiff, dark gray, clayey organic SILT, moist, plastic 8.0'	35%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 2-2-3-3 field torvane 0.15 tsf field pen. 0.25 tsf
579.8	8.0		Soft, dark gray to black, clayey, organic SILT, moist, plastic, with wood debris, occasional garbage (consisting of aluminum foil fragments) 10.0'	70%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 2-1-2-1 field torvane 0.9 tsf field pen. 0.25 tsf
577.8	10.0		End of Boring			boring backfilled 60-40 cement-bentonite mix 10' - 2', upper 2' backfilled with native material

ENG FORM MAR 71 1836 PREVIOUS EDITIONS ARE OBSOLETE. (modified by GCA 1/94) PROJECT Milwaukee CDF, Milwaukee, WI HOLE NO. -ME-7-97

DRILLING LOG

DIVISION	North Central
INSTALLATION	Detroit
SHEET	1 OF 1 SHEETS
1. PROJECT	Milwaukee CDF, Milwaukee, WI
2. LOCATION (Coordinates or Station)	
3. DRILLING AGENCY	Coleman Engineering Company
4. HOLE NO. (As shown on drawing title and file number)	-ME-8-97
5. NAME OF DRILLER	Scott Strigel
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	N/A
8. DEPTH DRILLED INTO ROCK	N/A
9. TOTAL DEPTH OF HOLE	10.0
10. SIZE AND TYPE OF BIT	N/A
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	IGLD 55
12. MANUFACTURES'S DESIGNATION OF DRILL	Diedrich D-50
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED N/A; UNDISTURBED N/A
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	579.4
16. DATE HOLE	STARTED OCT 7 97; COMPLETED OCT 7 97
17. ELEVATION TOP OF HOLE	586.1
18. TOTAL CORE RECOVERY FOR BORING	N/A %
19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			Stiff, brown, organic SILT, with rootlets, cinders 0.6'	90%	1 0.0 2.0	4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop
585.5	0.6		Medium, brown SILTY SAND at 1.2' and 1.4', thin, gray silt seams each about 0.1'			SS sample 0' - 2.0' blows 5-5-5-6
			Loose, brown SAND, with silt 2.2'	75%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 3-2-3-2
583.9	2.2					
583.6	2.5		Soft, gray SILTY SAND, moist, slightly plastic 2.5'			
			Loose, dark gray SILTY SAND, with organics, cinders, siltier from 0.9' to 1.1' down 4.0'			
582.1	4.0		Very soft, dark gray to black, organic SILT, lower 0.4' wet, rest moist, top 0.3' with sand 6.0'	100%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 1/12"-1/12" field torvane 0.12 tsf field pen. 0.25 tsf
580.1	6.0		Very soft, black, organic SILT, wet, plastic, with sand 6.6'	0%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 1/12"-1-3 field torvane 0.04 tsf field pen. 0.5 tsf
579.5	6.6		Very soft, gray, organic SILT, wet, plastic, last 0.2' with silt and shell material 8.0'			
578.1	8.0		Very soft, gray to black SILT, wet, plastic 8.4'	90%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 1-2-2-2
577.7	8.4		Loose, gray SILTY SAND, fine, saturated 10.0'			water at 6.8, 5 minutes after boring
576.1	10.0		End of Boring			boring backfilled 60-40 cement-bentonite mix 10' - 2', upper 2' backfilled with native material

DRILLING LOG	DIVISION North Central	INSTALLATION Detroit	SHEET 1 OF 1 SHEETS

1. PROJECT Milwaukee CDF, Milwaukee, WI	10. SIZE AND TYPE OF BIT N/A
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) IGLD 55
	12. MANUFACTURES'S DESIGNATION OF DRILL Diedrich D-50
3. DRILLING AGENCY Coleman Engineering Company	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED N/A — UNDISTURBED N/A
4. HOLE NO. (As shown on drawing title and file number) -ME-9-97	14. TOTAL NUMBER CORE BOXES N/A
5. NAME OF DRILLER Scott Strigel	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	16. DATE HOLE — STARTED OCT 7 97 — COMPLETED OCT 7 97
7. THICKNESS OF OVERBURDEN N/A	17. ELEVATION TOP OF HOLE 584.6
8. DEPTH DRILLED INTO ROCK N/A	18. TOTAL CORE RECOVERY FOR BORING N/A %
9. TOTAL DEPTH OF HOLE 10.0	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			Stiff, brown, organic SILT, many rootlets, dry, slightly plastic, with gravel	70%	1 0.0 2.0	boring relocated 20' west of staked locating due to ditch and large concrete debris 4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop SS sample 0' - 2.0' blows 5-6-7-8 field pen. 3.0 tsf
582.6	2.0		2.0'			
			Stiff, brown, organic SILT, with fine sand in lower 0.5'	100%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 4-7-7-8 field torvane 0.4 tsf (brown silt) field pen. 2.0 tsf (brown silt) field torvane 0.25 tsf (gray silt) field pen. 2.5 tsf (gray silt)
582.1	2.5		2.5'			
			Stiff, dark gray, organic SILT, moist, plastic, with gravel			
580.6	4.0		4.0'			
			Medium stiff, brown, organic SILT, dry, slightly plastic	95%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 3-2-3-3 field torvane 0.3 tsf field pen. 0.75 tsf - 1.0 tsf
580.3	4.3		4.3'			
			Medium stiff, gray, organic SILT, organics, occasional garbage (consisting of aluminum foil fragments), mottled with black organic inclusions			
578.6	6.0		6.0'			
			Soft, gray, clayey SILT, trace of gravel, moist, plastic, trace of fine sand	105%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 2-1-2-2 field torvane 0.15 tsf field pen. 0.25 tsf
576.6	8.0		8.0'			
			Soft, gray, clayey SILT, moist, plastic	90%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 1/12"-1-1 field torvane 0.07 tsf (clayey silt) field pen. 0.25 tsf (clayey silt)
575.7	8.9		8.9'			
			Very soft, light gray, SILTY CLAY, wet, plastic			
574.6	10.0		10.0'			
			End of Boring			muddy bottom, no water boring backfilled 60-40 cement-bentonite mix 10' - 2', upper 2' backfilled with native material

ENG FORM 1836 MAR 71 — PREVIOUS EDITIONS ARE OBSOLETE. (modified by GCA 1/94) — PROJECT Milwaukee CDF, Milwaukee, WI — HOLE NO. -ME-9-97

Hole No. MIL-1-95

DRILLING LOG

DIVISION

INSTALLATION

SHEET 1 OF 3 SHEETS

1. PROJECT	Milwaukee CDF
2. LOCATION (Coordinates or Station)	N 372,500.000 E 2,564,800.000
3. DRILLING AGENCY	Coleman Engineering Company
4. HOLE NO. (As shown on drawing title and file number)	MIL-1-95
5. NAME OF DRILLER	Scott Strigel
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	Unknown
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	50.0
10. SIZE AND TYPE OF BIT	3-1/4" x 6-1/2" HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	IGLD (LWD 576.8)
12. MANUFACTURES'S DESIGNATION OF DRILL	Diedrich D-50
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 19; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	-
15. ELEVATION GROUND WATER	11.8
16. DATE HOLE	STARTED JUL 20 95; COMPLETED JUL 20 95
17. ELEVATION TOP OF HOLE	13.3' +/-
18. TOTAL CORE RECOVERY FOR BORING	0 %
19. SIGNATURE OF INSPECTOR	David R. Eddleman

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			0.0' to 0.6' +/- 7" Topsoil	78%	SS-1 0.0 1.5	3/9/19 N=28 14/18"
	0.6					
	0.9		0.6' to 1.0' +/- SAND, fine to coarse, medium dense, brown, silty, moist, with gravel			
			1.0' to 3.5' +/- SAND, fine to medium grained, medium dense, brown, silty, moist, with gravel	67%	SS-2 1.5 3.0	21/12/10 N=22 12/18"
			SAND, fine to medium grained, medium dense, brown, silty, moist, with gravel	67%	SS-3 3.0 4.5	11/10/4 N=14 12/18"
	3.5		3.5' to 6.0' +/- CLAY, plastic, soft, sandy, silty, gray, moist			
				67%	SS-4 4.5 6.0	4/3/4 N=7 Penetrometer = 1.5 TSF 12/18" Torvane = 0.70 TSF
	6.0		6.0' to 7.5' +/- SILT, non-plastic, moist, gray, sandy	78%	SS-5 6.0 7.5	2/2/5 14/18" Torvane = 0.75 TSF
	7.5		7.5' to 8.8' +/- CLAY, plastic, medium dense, sandy, moist, brown	89%	SS-6 7.5 9.0	10/15/27 Penetrometer = 3.0 TSF Cobbles and Boulders at 8.2' - 9.7' and 9.7' - 11.8' 16/18" Torvane = 1.05 TSF
	8.8		8.8' to 14.0' +/- GRAVEL, fine to coarse grained, sub-rounded to sub-angular, light brown, sandy, moist	100%	SS-7 9.0 10.0	60/44/50-0" Bouncing 12/12"
						50-0" Bouncing No Sample Recovery
				33%	SS-8 12.0 13.5	12/14/12 6/18"
	14.0		14.0' to 18.5' +/- SAND, fine to coarse grained, very dense, black, silty, gravelly, wet	56%	SS-9 13.5 14.7	40/92/100-3" 10/18"
			SAND, fine to coarse grained, very dense, black, silty, gravelly, wet	56%	SS-10 15.0 16.5	17/42/88 10/18"
			SAND, fine to coarse grained, very dense, black, silty, gravelly, with cinders, slag, wet	67%	SS-11 16.5 18.0	74/85/88 12/18"
	18.5		18.5' to 25.0' +/- SAND, fine to medium grained, dense, black, wet, with gravel, cinders and slag	58%	SS-12 18.0 20.0	24/33/36/33 14/24"

DRILLING LOG

DIVISION

INSTALLATION

Hole No. MIL-1-95

SHEET 2 OF 3 SHEETS

1. PROJECT	Milwaukee CDF
2. LOCATION (Coordinates or Station)	N 372,500.000 E 2,564,800.000
3. DRILLING AGENCY	Coleman Engineering Company
4. HOLE NO. (As shown on drawing title and file number)	MIL-1-95
5. NAME OF DRILLER	Scott Strigel
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	Unknown
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	50.0
10. SIZE AND TYPE OF BIT	3-1/4" x 6-1/2" HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	IGLD (LWD 576.8)
12. MANUFACTURES'S DESIGNATION OF DRILL	Diedrich D-50
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 19 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	-
15. ELEVATION GROUND WATER	11.8
16. DATE HOLE	STARTED JUL 20 95 / COMPLETED JUL 20 95
17. ELEVATION TOP OF HOLE	13.3' +/-
18. TOTAL CORE RECOVERY FOR BORING	0 %
19. SIGNATURE OF INSPECTOR	David R. Edlebeck

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			SAND, fine to medium grained, dense, black, with gravel, cinders, slag, pieces of metal, wet	100%	SS-13 20.0 21.5	35/50/29 18/18"
	25.0		25.0' to 50.0' +/- CLAY, medium plastic, medium stiff, silty, light grayish brown, wet	100%	SS-14 25.0 26.5	3/9/10 Penetrometer = 1.75 TSF 18/18" Torvane = 0.90 TSF
			CLAY, medium plastic, medium stiff, silty, light grayish brown, wet	100%	SS-15 30.0 31.5	8/10/14 Penetrometer = 1.50 TSF 18/18" Torvane = 0.90 TSF
			CLAY, medium plastic, medium stiff, sandy, silty, light grayish brown, wet	100%	SS-16 35.0 36.5	5/8/9 Penetrometer = 0.75 TSF 18/18" Torvane = 0.55 TSF

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (modified by GCA 1/94)

PROJECT Milwaukee CDF

HOLE NO. MIL-1-95

Hole No. MIL-1-95

DRILLING LOG

DIVISION

INSTALLATION

SHEET 3 OF 3 SHEETS

1. PROJECT	Milwaukee CDF
2. LOCATION (Coordinates or Station)	N 372,500.000 E 2,564,800.000
3. DRILLING AGENCY	Coleman Engineering Company
4. HOLE NO. (As shown on drawing title and file number)	MIL-1-95
5. NAME OF DRILLER	Scott Strigel
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	Unknown
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	50.0
10. SIZE AND TYPE OF BIT	3-1/4" x 6-1/2" HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	IGLD (LWD 576.8)
12. MANUFACTURES'S DESIGNATION OF DRILL	Diedrich D-50
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 19 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	-
15. ELEVATION GROUND WATER	11.8
16. DATE HOLE	STARTED JUL 20 95 / COMPLETED JUL 20 95
17. ELEVATION TOP OF HOLE	13.3' +/-
18. TOTAL CORE RECOVERY FOR BORING	0 %
19. SIGNATURE OF INSPECTOR	David R. Ellebeck

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			CLAY, medium plastic, stiff, sandy, silty, some gravel, wet, light grayish brown	100%	SS-17 40.0 41.5	14/14/22 Penetrometer = 2.0 TSF 18/18" Torvane = 1.45 TSF
			CLAY, medium plastic, stiff, sandy, silty, some gravel, wet, light grayish brown	100%	SS-18 45.0 46.5	18/21/26 N=47 Penetrometer = 2.0 TSF 18/18" Torvane = 0.90 TSF
			CLAY, medium plastic, stiff, sandy, silty, some gravel, wet, light grayish brown	100%	SS-19 48.5 50.0	14/20/24 N=44 Penetrometer = 2.0 TSF 18/18" Torvane = 0.90 TSF
	50.0		End of Boring			Borehole Backfilled With Chipped Bentonite 50.0' - 0.0'

Hole No. MIL-2-95

DRILLING LOG

DIVISION

INSTALLATION

SHEET 1 OF 1 SHEETS

1. PROJECT: Milwaukee CDF	10. SIZE AND TYPE OF BIT: 3-1/4" x 6-1/2" HSA
2. LOCATION (Coordinates or Station): N 373,238.000 E 2,565,281.000	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): IGLD (LWD 576.8)
3. DRILLING AGENCY: Coleman Engineering Company	12. MANUFACTURES'S DESIGNATION OF DRILL: Diedrich D-50
4. HOLE NO. (As shown on drawing title and file number): MIL-2-95	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 5; UNDISTURBED 2
5. NAME OF DRILLER: Scott Strigel	14. TOTAL NUMBER CORE BOXES: 0
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	15. ELEVATION GROUND WATER: 17.0
7. THICKNESS OF OVERBURDEN: Unknown	16. DATE HOLE: STARTED JUL 19 95; COMPLETED JUL 19 95
8. DEPTH DRILLED INTO ROCK: 0	17. ELEVATION TOP OF HOLE: 8.5' +/-
9. TOTAL DEPTH OF HOLE: 20.0	18. TOTAL CORE RECOVERY FOR BORING: 0 %
	19. SIGNATURE OF INSPECTOR: David R. Edlebeck

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			0.0' to 20.0' +/- CLAY, plastic, soft, moist, sandy, dark brown, with organics	17%	SS-1 0.0 1.5	Took Auger Sample Due To Low Recovery 4/2/2 3/18"
			CLAY, plastic, very soft, sandy, wet, with organics	11%	SS-2 5.0 6.6	Took Auger Sample Due To Low Recovery 1-12"/1 2/18" Torvane = 0.40 TSF
			CLAY, plastic, soft, sandy, wet, with organics, dark brown	50%	ST-3 8.0 10.0	Pushed Shelby Tube From 8.0' - 10.0' Penetrometer = 1.25 TSF 12/24"
			CLAY, plastic, very soft, sandy, wet, with organics, dark brown	78%	SS-4 10.0 11.5	WH/1-12" 14/18"
			CLAY, plastic, very soft, sandy, dark brown to black, wet, with organics	50%	ST-5 13.0 15.0	Pushed Shelby Tube From 13.0' - 15.0' Penetrometer = 0.0 TSF 12/24"
			CLAY, plastic, very soft, sandy, dark brown to black, wet, occasional sand seams, with organics and plastic	100%	SS-6 15.0 16.5	WH-12"/1 18/18"
			CLAY, plastic, very soft, sandy, dark brown to black, wet, occasional sand seams, with organics	100%	SS-7 18.5 20.0	1-12"/1 Hole Was Backfilled With Chipped Bentonite From 20.0' - 0.0' 18/18"
	20.0		End of Boring			

Hole No. MIL-3-95

DRILLING LOG

DIVISION

INSTALLATION

SHEET 1 OF 1 SHEETS

1. PROJECT: Milwaukee CDF
2. LOCATION (Coordinates or Station): N 373,538.000 E 2,565,469.000
3. DRILLING AGENCY: Coleman Engineering Company
4. HOLE NO. (As shown on drawing title and file number): MIL-3-95
5. NAME OF DRILLER: Scott Strigel
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: Unknown
8. DEPTH DRILLED INTO ROCK: -
9. TOTAL DEPTH OF HOLE: 20.0
10. SIZE AND TYPE OF BIT: 3-1/4' x 6-1/2" HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): IGLD (LWD 576.8)
12. MANUFACTURES'S DESIGNATION OF DRILL: Diedrich D-50
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 9; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: 0
15. ELEVATION GROUND WATER: 6.7
16. DATE HOLE: STARTED JUL 18 95; COMPLETED JUL 18 95
17. ELEVATION TOP OF HOLE: 9.0' +/- LWD
18. TOTAL CORE RECOVERY FOR BORING: 0 %
19. SIGNATURE OF INSPECTOR: Wm R. Eldredge

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			0.0' to 2.5' +/- SAND, fine grained, moist, silty, dark brown, with organics, loose	11%	SS-1 0.0 1.5	Took Auger Sample Due To Low Recovery 2/2/2 N=4 2/18"
	2.5		2.5' to 7.0' +/- CLAY, soft, wet, silty, dark brown to gray, with organics, loose			
				67%	SS-2 5.0 6.5	2/1/2 N=3 12/18"
	7.0		7.0' to 20.0' +/- SAND, fine to medium grained, silty, dark grayish brown, with organics, wet, loose			
				67%	SS-3 10.0 11.5	2/2/2 N=4 12/18"
			SAND, fine to medium grained, silty, dark gray, with organics, wet, loose	89%	SS-4 11.5 13.0	3/2/2 N=4 16/18" Torvane = 0.30 TSF
			SAND, fine to medium grained, silty, dark gray, with organics, wet, loose	100%	SS-5 13.0 14.5	3/3/2 N=5 18/18"
			SAND, fine to medium grained, silty, dark gray, with organics, wet, loose	100%	SS-6 14.5 16.0	2/2/2 N=4 18/18"
			SAND, fine to medium grained, silty, dark gray, wet, with organics and shells, loose	100%	SS-7 16.0 17.5	1/2/2 N=4 18/18"
			SAND, fine to medium grained, silty, dark gray, wet, with organics and shells, loose	100%	SS-8 17.5 19.0	2/1/2 N=3 18/18"
	20.0		SAND, fine to medium grained, silty, dark gray, wet, with organics and shells, loose	100%	SS-9 19.0 20.0	1/2 12/12"
			End of Boring			1-1/4" PVC Well Installed to 20.0' With 10' Screen and 13' of Riser. Borehole Allowed to Cave-in Around Well and Backfilled From 10.0' - 0.0' With Auger Cuttings

Hole No. MIL-4-95

DRILLING LOG

DIVISION

INSTALLATION

SHEET 1 OF 1 SHEETS

1. PROJECT: Milwaukee CDF	10. SIZE AND TYPE OF BIT: 3-1/4" x 6'1/2" HSA
2. LOCATION (Coordinates or Station): N 374,194.000 E 2,565,150.000	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): IGLD (LWD 576.8)
3. DRILLING AGENCY: Coleman Engineering Company	12. MANUFACTURES'S DESIGNATION OF DRILL: Diedrich D-50
4. HOLE NO. (As shown on drawing title and file number): MIL-4-95	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 2; UNDISTURBED 5
5. NAME OF DRILLER: Scott Strigel	14. TOTAL NUMBER CORE BOXES: 0
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	15. ELEVATION GROUND WATER: 16.3
7. THICKNESS OF OVERBURDEN: Unknown	16. DATE HOLE: STARTED JUL 18 95; COMPLETED JUL 18 95
8. DEPTH DRILLED INTO ROCK: 0	17. ELEVATION TOP OF HOLE: 6.5' +/- LWD
9. TOTAL DEPTH OF HOLE: 20.0	18. TOTAL CORE RECOVERY FOR BORING: 0 %
	19. SIGNATURE OF INSPECTOR: David R. Edlebeck

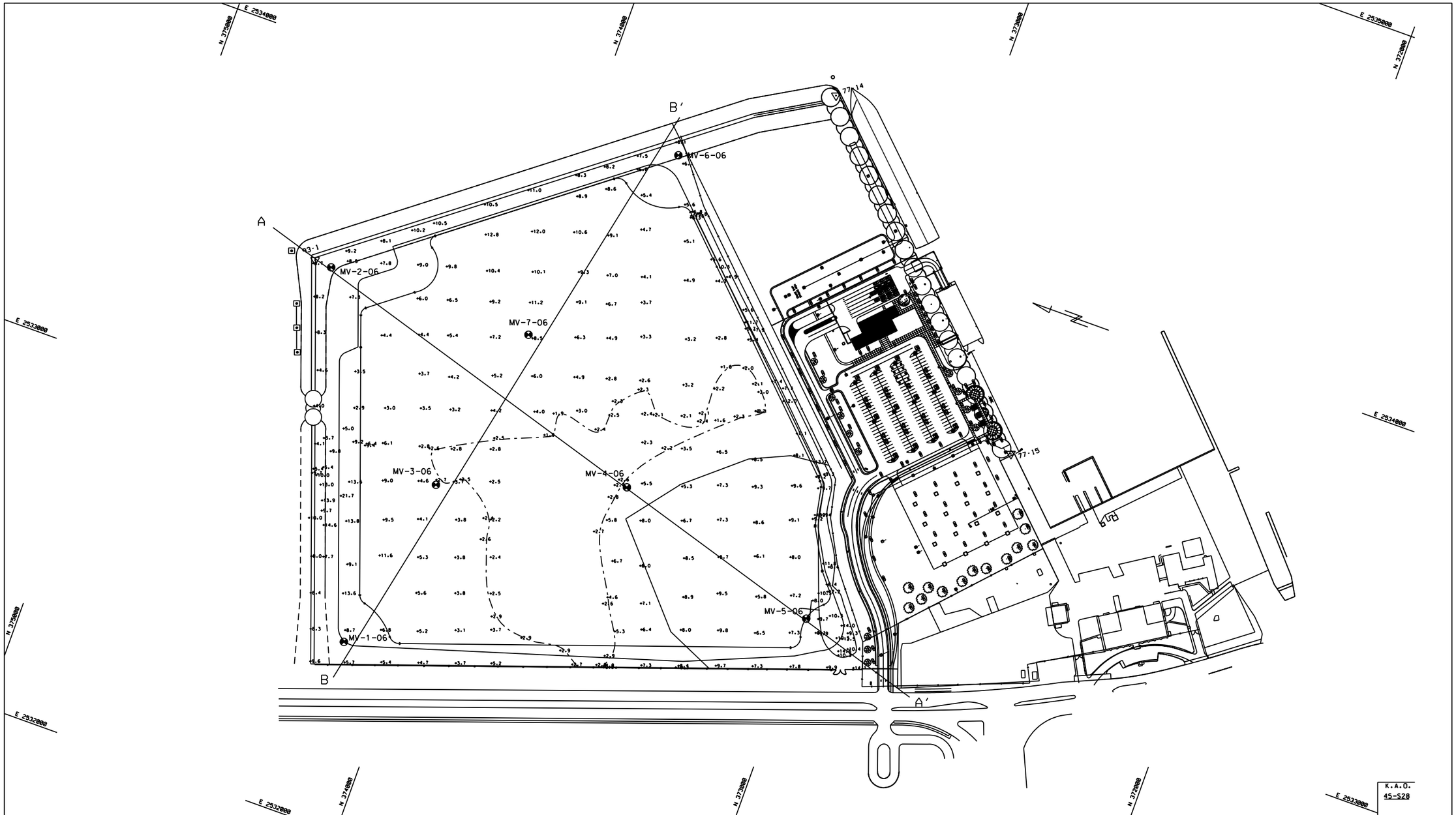
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			0.0' to 3.0' +/- SAND, fine grained, dry, silty, dark brown, with organics	17%	SS-1 0.0 1.5	1/12" N=1 3/18"
	3.0		3.0' to 11.5' +/- CLAY, plastic, very soft, wet, with organics, sandy			
				92%	ST-2 5.0 7.0	Pushed Shelby Tube From 5.0' - 7.0' 22/24"
			CLAY, plastic, very soft, wet, sandy, with organics, dark gray	89%	SS-3 7.0 8.5	1/12" 16/18" Torvane = 0.35 TSF
			CLAY, plastic, very soft, wet, with organics, dark gray	75%	ST-4 10.0 12.0	Pushed Shelby Tube From 10.0' - 12.0' Penetrometer = 0.0 TSF 18/24"
	11.5		11.5' to 14.5' +/- SAND, fine to medium grained, wet, dark gray, with organics, silty	100%	SS-5 12.0 13.5	1/WH/WH 18/18" Torvane = 0.30 TSF
	14.5		14.5' to 20.0' +/- CLAY, slightly plastic, very soft, wet, sandy, dark gray, with organics	78%	SS-6 15.0 16.5	1/WH/1 Penetrometer = 0.25 TSF 14/18" Torvane = 0.25 TSF
			CLAY, slightly plastic, very soft, wet, sandy, dark gray, with organics	78%	SS-7 18.5 20.0	1/2/1 Penetrometer = 0.50 TSF 14/18" Borehole Collapsed to 17.0', Then Backfilled With Chipped Bentonite to the Surface Torvane - 0.50 TSF
	20.0		End of Boring			

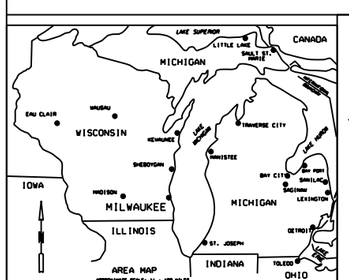
Hole No. MIL-5-95

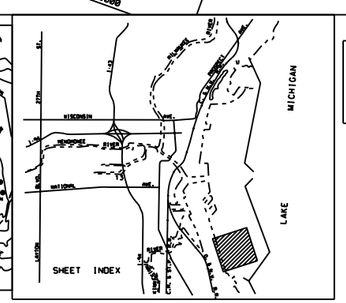
DRILLING LOG

DIVISION	
INSTALLATION	
SHEET 1 OF 1 SHEETS	
1. PROJECT	Milwaukee CDF
2. LOCATION (Coordinates or Station)	N 373,375.000 E 2,565,650.000
3. DRILLING AGENCY	Coleman Engineering Company
4. HOLE NO. (As shown on drawing title and file number)	MIL-5-95
5. NAME OF DRILLER	Scott Strigel
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	Unknown
8. DEPTH DRILLED INTO ROCK	0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	3-1/4" x 6-1/2" HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	IGLD (LWD 576.8)
12. MANUFACTURES'S DESIGNATION OF DRILL	Diedrich D-50
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5; UNDISTURBED 1
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	3.1
16. DATE HOLE	STARTED JUL 19 95; COMPLETED JUL 19 95
17. ELEVATION TOP OF HOLE	6.7' +/-
18. TOTAL CORE RECOVERY FOR BORING	0 %
19. SIGNATURE OF INSPECTOR	David R. Edlebeck

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			0.0' to 1.2' +/- SAND, fine to coarse, with silt, with gravel, light brown, moist	67%	SS-1 0.0 1.5	8/11/10 12/18"
	1.2		1.2' to 4.5' +/- SILT, non-plastic, hard sandy, moist			
	4.5		4.5' to 9.5' +/- CLAY, fine grained, sandy, loose, wet, dark gray, with organics	33%	SS-2 5.0 6.5	2/2/1 6/18" Torvane = 0.075 TSF
				0%	ST 7.5 9.0	Unable to Push Shelby Tube (No Recovery) 0/24"
	9.5		9.5' to 16.0' +/- GRAVEL, fine to medium grained, sub-angular to sub-rounded, sandy, wet, light brown	33%	SS-3 10.0 11.5	4/3/4 6/18"
			GRAVEL, fine to medium grained, sub-angular to sub-rounded, sandy, silty, wet	56%	SS-4 15.0 16.5	10/3/1 10/18"
	16.0		16.0' to 17.5' +/- SAND, fine to medium, silty, loose, dark gray, wet, with organics	75%	ST-5 16.5 18.5	Pushed Shelby Tube From 16.5' - 18.5' 18/24"
	17.5		17.5' to 18.5' +/- CLAY, fine to medium grained, silty, dark gray, wet			
	18.5		18.5' to 20.0' +/- SAND, fine grained, silty, gray, wet, dense, with gravel	100%	SS-6 18.5 20.0	14/16/16 18/18" Borehole Collapsed to 7.4', Then Backfilled With Chipped Bentonite to the Surface
	20.0		End of Boring			







LEGEND

- GPS CONTROL MONUMENT
- BRONZE OR BRASS DISC
- CHANNEL LINE TURNING POINT
- SOIL BORING LOCATION

NOTES:

SURVEY CONTROL AND BENCH MARK DATA IS AVAILABLE FROM THE DETROIT DISTRICT, ENGINEERING & TECHNICAL SERVICES, OPERATIONS TECHNICAL SUPPORT BRANCH, KEWAUNEE AREA OFFICE.

THE COORDINATE GRID SYSTEM SHOWN IS REFERENCED TO THE WISCONSIN STATE PLANE COORDINATE SYSTEM, LAMBERT PROJECTION, SOUTH ZONE (4803), NORTH AMERICAN DATUM 1983 (NAD83), US FOOT.

ALL ELEVATIONS ARE IN FEET AND ARE REFERENCED TO LOW WATER DATUM ELEVATION, 576.8 FEET ABOVE MEAN SEA LEVEL, I.G.L.D. 1955.

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS AT THAT TIME.

THE SURVEY SHOWN WAS CONDUCTED BY THE LAKE MICHIGAN AREA OFFICE - KEWAUNEE SURVEY PARTY ON 24 JANUARY AND 07 FEBRUARY 2006 USING A NIKON TOTAL STATION AND A RANGE POLE WITH A REFLECTOR.

COMBINED GRID SCALE FACTOR = 0.99995570
GRID DIST. DIVIDED BY COMBINED GRID SCALE FACTOR = GROUND DIST.

100 0 100 200 300

1" = 100'

THIS PROJECT WAS DESIGNED BY THE DETROIT DISTRICT OF THE U.S. ARMY CORPS OF ENGINEERS. THE INITIALS OR SIGNATURES AND REGISTRATION DESIGNATIONS OF INDIVIDUALS APPEAR ON THESE PROJECT DOCUMENTS WITHIN THE SCOPE OF THEIR EMPLOYMENT AS REQUIRED BY ER 1110-1-8152.

NO.	DATE	REVISION	BY

U.S. ARMY ENGINEER DISTRICT, DETROIT
CORPS OF ENGINEERS
DETROIT, MICHIGAN

SIGNATURES AFFIXED BELOW INDICATE OFFICIAL RECOMMENDATION AND APPROVAL OF ALL DRAWINGS IN THIS SET AS INDEXED ON THIS SHEET.

MILWAUKEE HARBOR,
WISCONSIN
CONFINED DISPOSAL AREA
DMMP SOIL PROFILE

SUBMITTED BY: _____ P.E.
CHIEF, CCAGE BRANCH

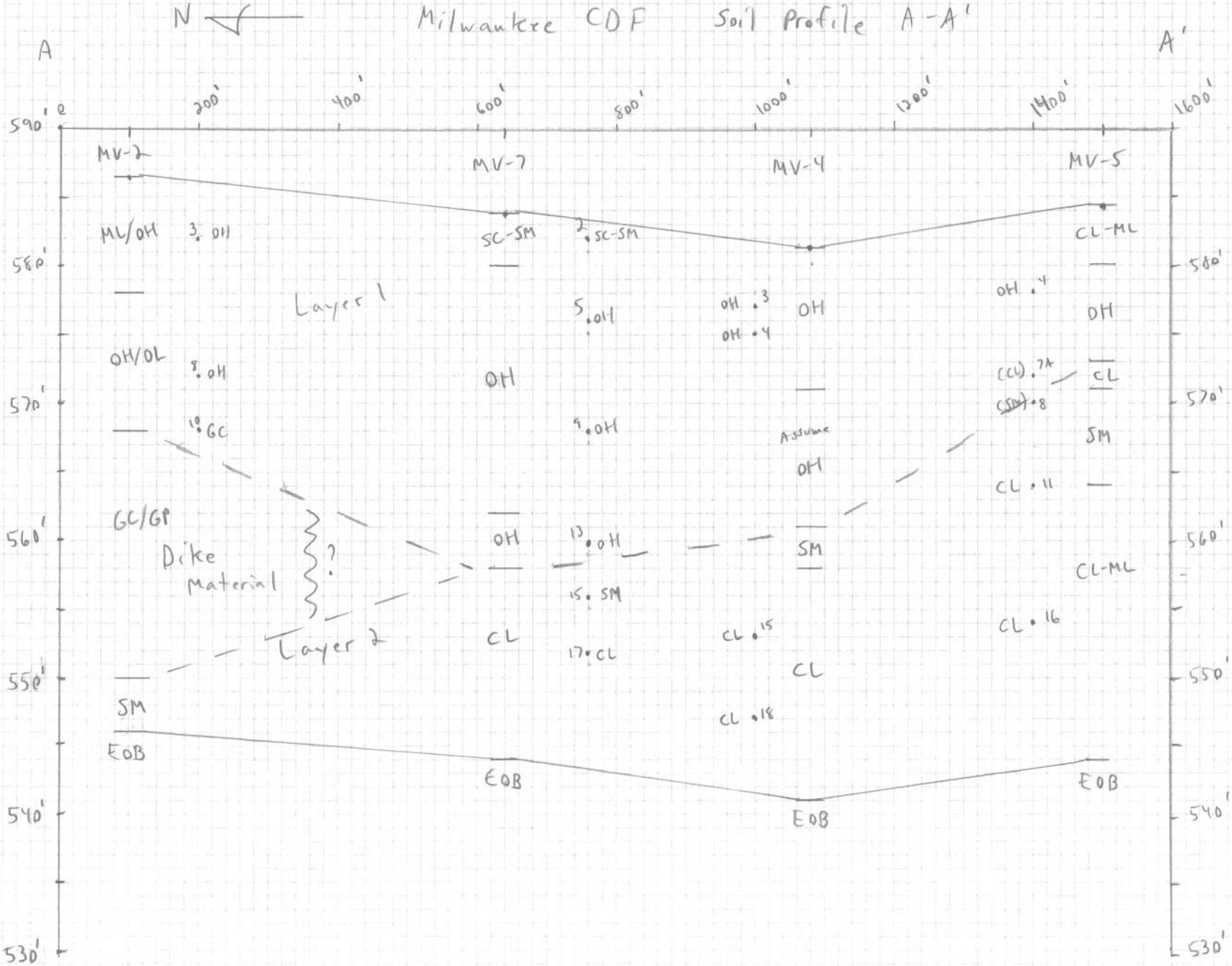
APPROVAL RECOMMENDED: _____ P.E.
CHIEF, ENGINEERING & CONSTRUCTION OFFICE

APPROVED: _____
CHIEF, ENGINEERING & TECHNICAL SERVICES DIVISION

SCALE AS SHOWN

DRAWING NUMBER

SHEET 1 OF 1


N
Milwaukee CDF Soil Profile A-A'
A
A'
0
200'
400'
600'
800'
1000'
1200'
1400'
1600'
590'
580'
570'
560'
550'
540'
530'
MV-2
MV-7
MV-4
MV-5
ML/OH
3. OH
SC-SM
2. SC-SM
CL-ML
Layer 1
5. OH
OH .3
OH .4
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OH .4
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8. OH
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(SM) .8
CL
10. GC
9. OH
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SM
CL .11
GC/GP
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Material
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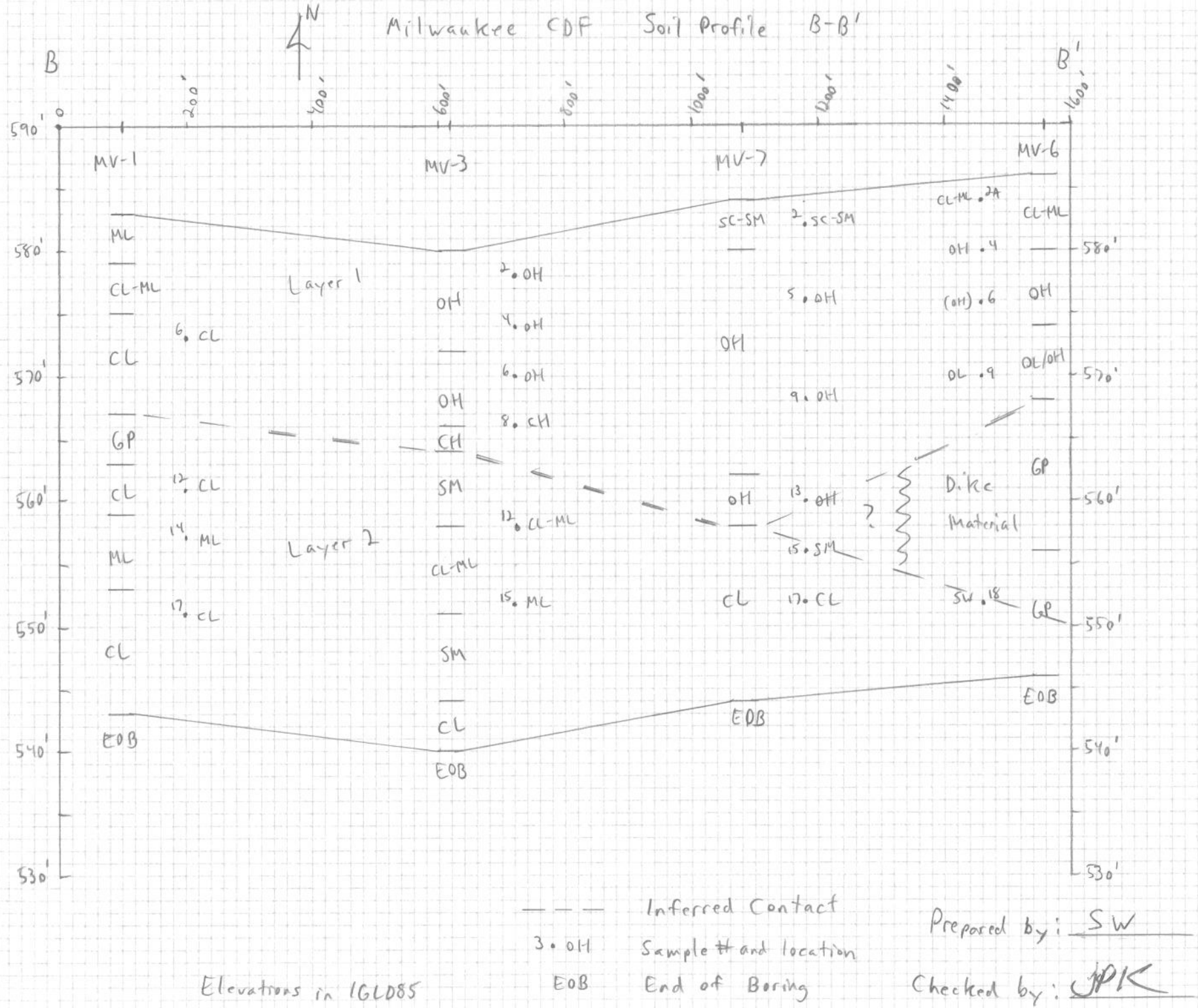
OH
13. OH
SM
CL-ML
15. SM
CL .16
Layer 2
CL
17. CL
CL .15
CL
SM
CL .18
EOB
EOB
EOB
EOB
Inferred Contact
3 • OH Sample # and location
EOB End of Boring
Elevations in IGLD85
Prepared by: SW
Checked by: JPK


Milwaukee CDF Soil Profile B-B'
N
B
B'
0
200'
400'
600'
800'
1000'
1200'
1400'
1600'
590'
580'
570'
560'
550'
540'
530'
MV-1
MV-3
MV-7
MV-6
ML
CL-ML
CL
GP
CL
ML
CL
EOB
Layer 1
Layer 2
6. CL
12. CL
14. ML
17. CL
OH
OH
CH
SM
CL-ML
SM
CL
EOB
2. OH
4. OH
6. OH
8. CH
12. CL-ML
15. ML
SC-SM
2. SC-SM
5. OH
9. OH
13. OH
15. SM
17. CL
OH
CL
EOB
CL-ML 2A
OH 4
(OH) 6
OL 9
SW 18
CL-ML
OH
OL/OH
GP
GP
EOB
Dike Material
?
Inferred Contact
3. OH Sample # and location
EOB End of Boring
Elevations in IGLD85
Prepared by: SW
Checked by: JPK

Lab Results for Milwaukee CDF (2006)

Layer 1 values are shaded

									Standard Proctor		Est. St. Proctor	Compacted @ 90% St. Proctor*									Terzaghi	Skempton
Boring	Spl #	Depth	Soil Type	Clay (%)	PI	SG	w (%)	yd (pcf)	yd_{max} (pcf)	w_{opt} (%)	yd_{max} (pcf)	90% w_{opt}	$yd_{90\%}$ (pcf)	y_{moist} (pcf)	Qu (psf)	phi (deg)	c (psf)	org (%)	Cc	LL	Est Cc	Est Cc
MV-1-06	bulk	2-7				2.69			98	21		0.189	96.0	114.1								
583.1	6	10-12	CL	37.5	10		19				115.7							0.66		21	0.099	0.098
Sect B-B'	12	22-24	CL	61.6	16	2.783	17.9	115.1			109.6					23.5	0		0.146	30	0.18	0.161
	14	26-28	ML	15.2	3		15.8	122.8			116.7					0	2560			18	0.072	0.077
	17	32-34	CL	39.5	11	2.707	15.2	121.6			114.3								0.12	23	0.117	0.112
MV-2-06	bulk	2-6.5				2.7			98.5	17		0.153	96.8	111.6								
586.2	3	4-6	OH	43.2	23						89.7									56	0.414	0.343
Sect A-A'	6	10-12																				
	8	14-16	OH	55.3	23		53.4	74.1			92.2							3.78		53	0.387	0.322
	10	18-20	GC	24.5	10						109.9									28	0.162	0.147
MV-3-06	bulk	2-6.5				2.7			88.5	24		0.216	86.5	105.2								
579.6	2	2-4	OH	39.1	20						88.3									57	0.423	0.35
Sect B-B'	4	6-8	OH	34.1	17		66.7	58.2			93.4					0	88	7.36		50	0.36	0.301
	6	10-12	OH	46.5	25						91.8									54	0.396	0.329
	8	14-16	CH	48.8	30						90.4									57	0.423	0.35
	12	22-24	CL-ML	23.8	6						117.3									18	0.072	0.077
	15	28-30	ML	14.6	NP	2.679					121.0					0	3140		0.075	12	0.018	0.035
MV-4-06	bulk	2-9				2.72			92.5	23.5		0.212	90.8	110.0								
581.1	3	4-6	OH	38.4	22		71.5				87.0							8.05		59	0.441	0.364
Sect A-A'	4	6-8	OH	40	19	2.501	69.5	54.8			87.2								0.55	58	0.432	0.357
	15	28-30	CL	39.1	10	2.728	15.6	119.8			114.9								0.126	22	0.108	0.105
	18	34-36	CL	51.9	15	2.721	19.4	110.6			111.0								0.292	28	0.162	0.147
MV-5-06	bulk	2-6				2.72			101.5	19		0.171	100.5	117.7								
584.3	4	6-8	OH	50.8	19		68.4				88.1							7.68		57	0.423	0.35
Sect A-A'	7A	12-13	(CL)		32						97.3									49	0.351	0.294
	8	14-16	(SM)	2.2																		
	11	20-22	CL	72.2	14						110.8									28	0.162	0.147
	16	30-32	CL	48.1	11	2.749	21.6	108.7			113.4								0.125	24	0.126	0.119
MV-6-06	bulk	2-6.5				2.72			104	15		0.135	103.0	116.9								
586	2A	2-3.5	CL-ML	30.1	6						114.8									21	0.099	0.098
Sect B-B'	4	6-8	OH		17						93.4									50	0.36	0.301
	6	10-12	(OH)		14						92.7									50	0.36	0.301
	7	12-14					78.4											8.39				
	9	16-18	OL	23.3	21	2.549	50.2	66.9			95.0					19	0		0.45	49	0.351	0.294
	18	34-36	SW	0.9																		
MV-7-06	bulk	2-8.5				2.72			105	17		0.153	104.0	119.9								
583.9	2	2-4	SC-SM	19.4	7						109.3									28	0.162	0.147
Sect A-A'	5	8-10	OH	39.6	23		67.2				86.4							7.93		60	0.45	0.371
Sect B-B'	9	16-18	OH	45.9	25	2.549	63.2	61.3			84.4					0	140		0.452	63	0.477	0.392
	11	20-22					59.1	59.4							513	0	256					
	13	24-26	OH	41	22	2.532	75	52.4			82.1								0.71	65	0.495	0.406
	15	28-30	SM	4.7		2.649													0.117			
	17	32-34	CL	42.4	14	2.728	18.2	112.1			112.4								0.163	26	0.144	0.133
				35.8	17	2.6761	45.5	88.4	98.29	19.5	101.01			**113.6**					0.277	40	0.274	0.234

* used for compacted dike

Correlations used:

Est. Standard Proctor yd = 130.8 - (0.82*LL) + (0.21*PI)

Terzaghi estimate of Cc = 0.009*(LL-10)

Skempton estimate of Cc = 0.007*(LL-7)

Moist unit wt. = yd*(1+w)

Milwaukee Confined Disposal Facility DMMP
Stability Analysis for the Raising of Existing Dikes

Introduction

A Stability Analysis was conducted for placing inner dikes to construct a Dredge Material Disposal Facility (DMDF) in Milwaukee, Wisconsin (Figure 1). The concept plan is to excavate the existing CDF material above low water datum (LWD) and use that material to construct an inner dike adjacent to the existing outer dikes to a top elevation of 18 feet above LWD. The elevation of LWD at the site is 577.5 ft International Great Lakes Datum 1985 (IGLD85). In addition, a one foot thick gravel road on top of the dike will be included, therefore bringing the total elevation of the new inner dikes to 19 feet above LWD (596.5 ft IGLD85).

The exterior slopes on the North and East sides of the inner dikes would be protected with a ~2.5 ft thick layer of splash stone. For the planned gravel road on top of the dikes, a design road distributed load of 750 psf (approximately equivalent to a 62.5 lb/ft line load over 12 ft) acting on the top of the structure will be used for the analysis. This design loading was provided by the Design Engineer, Kerry Williams. Two cross-sections, one at 5+00 and one at 26+00, were chosen as the most critical, or "worst case", sections and were examined in this stability analysis. An interior dike that will be constructed to create a cell on the west side of the CDF to contain the Kinnickinnic River dredge material was not analyzed because it is not part of the DMMP project.

Two design cross-sections were selected and analyzed for slope stability on the inner (right) and outer (left) sides. Bearing capacity of the dike foundation was also estimated due to the additional loading from truck traffic on the gravel road. Settlement calculations and results are provided in a separate section of the Geotechnical Appendix.

Material Properties

Soil strength parameters were selected from field and lab test data, several references, and from engineering judgment. Soils in the CDF are primarily high and low plasticity silty/sandy clays (CL and CH) with trace organics. From lab test data, optimum moisture contents range from 15 to 24.0%, and maximum dry densities range from 88.5 to 105 pcf. Analysis parameters chosen for the specific materials are shown in Table 1. Refer to the Soil Profile in the Geotechnical Appendix for additional field and lab test data.

Analysis Assumptions

The computer software SLOPE/W was used to create the cross-sections and determine the factors of safety of the sections for an end of construction (short-term)

condition, and a full capacity (long-term) condition using Spencer's Method. Spencer's Method was utilized because it satisfies all conditions of static equilibrium and provides a factor of safety based on both force and moment equilibrium. For verification of the SLOPE/W results, spreadsheets utilizing the Modified Swedish Method were used as recommended in EM1110-2-1902 to verify the results of the right side, end of construction, analysis of section 26+00 (See attached calculations). Bearing capacity results for sections 5+00 and 26+00 are provided along with the results of the Slope Stability Analysis in Table 2. The bearing capacity cross-section and calculations are also attached.

The assumptions used for this stability analysis are listed below:

1) Layer 1 soil properties were used for the dike and foundation (see Soil Profile for data used to estimate the soil properties). Proctor test data was also used to estimate properties for the dike because it is expected to be compacted.

2) Additional dike foundation material will be placed and graded to ~10 ft above LWD prior to dike construction. Because minimal compaction is assumed, the same soil parameters as the underlying dike foundation (Layer 1) will be used.

3) Dike material will be assumed to be compacted to not less than 90 percent of the maximum Standard Proctor density (ASTM D 698).

4) Full capacity condition is considered the long-term condition for this analysis.

5) For full capacity condition, the average saturated unit weight of Layer 1 was used for dike fill. Cohesion was assumed to be half of what was used for the dike because the material will be initially more loosely consolidated.

6) The firm base (deep foundation) layer of sandy clay ranges from approximately 5 feet to 27 feet below LWD. This depth of this layer increases lake ward. Assuming a worst case condition, the top of the deep foundation will be assumed to be 27 feet below LWD throughout the CDF. See also Layer 2 details in the Soil Profile.

7) Splash stone protection used is assumed to be limestone, γ = 160 pcf.

8) Surcharge load on road on top of slope from truck and excavator traffic is 750 psf. Will also assume this includes any surcharge due to ice loads.

9) Rapid drawdown condition is not anticipated and will not be evaluated in this analysis.

10) Steel sheet pile bulkhead along west end is assumed to be an unyielding structure. The embedment depth of this bulkhead is at least 24 ft below LWD as shown in the CDF as-built drawings.

11) The existing filter cell is no longer used; however, additional site preparation may be necessary at this location.

Results and Conclusions

Analyzed cross-sections from the SLOPE/W software are attached along with slope stability verification and bearing capacity calculations. A summary table of the results of the stability analysis is shown in Table 2. All values shown in Table 2 assume there is no reinforcement of the slope and that a line load of 62.5 lb/ft exists due to road and ice loads. It is assumed that stability of the inner slopes will improve as additional dredge material is placed into the CDF so this side (right side) was not analyzed for the full capacity condition.

All slopes, except for one, are stable under current conditions and design. The end of construction and the full capacity condition for Section 26+00 (left side) did not meet stability criteria for sliding. However, a recommended configuration is shown that meets the criteria for this section for both conditions.

Furthermore, both cross-sections did not meet the recommended bearing capacity factor of safety. Additional reinforcement will be necessary to prevent bearing capacity failure of the dike due to road loads and the weaker foundation material. This will increase project costs, but will provide better long term support of the structure and foundation. The concept alternatives that were evaluated are shown in the following section Foundation Reinforcement.

Foundation Reinforcement

Alternative 1 – Staged Construction

This alternative allows the foundation to gain strength due to dissipation of pore water pressure in the foundation soils. It is expected that the foundation will gain strength as time progresses; however, the gain of strength may not be uniform due to the nature of the in-place soils. Furthermore, the time needed for this strength gain may be excessive therefore increasing costs and schedule duration; so therefore, this alternative will likely be rejected.

Alternative 2 – Excavation and Replacement

This alternative would require that a portion of the weak foundation materials would be replaced with stronger materials. A significant quantity to excavate and replace would be required which reduces available capacity of the CDF and increases construction cost. This alternative is rejected because of the increased costs due to bringing in offsite material, and also the replaced material will have to be disposed of off site or relocated within the CDF.

Alternative 3 – Geogrid System

This alternative provides installation of biaxial geogrid layers within the dike foundation for improved bearing capacity. Due to the nature of the existing foundation soils, multiple layers would most likely be needed. Although this alternative would

require less excavation and replacement of foundation soils, additional costs will be incurred due to the design and installation of the geogrid system. This alternative is considered feasible depending on results of a concept design and cost analysis.

Alternative 4 – Cement Modified Soil

This alternative would require mixing water and Portland cement with existing soil to strengthen the foundation. The use of Portland cement is recommended over lime because of the additional strength requirements and reduced curing time. A small cement content, <5% volume dry weight, would be sufficient to reduce plasticity of the soil and improve bearing strength. Additional costs would be incurred due to addition and mixing of soil cement, and compaction. Also there will be some effect on dike construction schedule because the foundation will have to be prepared prior to dike construction. Like alternative 3, this alternative is considered feasible depending on results of a concept design and cost analysis.

Recommendations

It will be recommended that the top 1 foot of material should be cleared and grubbed and not be used for dike construction because of probable higher organic content and debris. The current design calls for 3 on 1 side slopes but some of the slopes can be changed to 2.5 on 1 side slopes (See Table 2 and cross sections). This is not a requirement but may save some additional quantity of material used for dike construction. Because of the assumed material properties, a 2 on 1 side slope is not recommended for any slope in this CDF.

Woven geotextile (AASHTO Class 2 or equivalent) should be carefully placed on the North and East outer slopes (underneath the splash stone) for filtration and drainage. Also the loading on the dike due to vehicular traffic should be restricted to 750 psf or less. Furthermore, this analysis assumes that the CDF dike material can be placed and compacted as specified. Construction of the dikes in lifts of 8 to 12 inches of loose thickness is also recommended to allow for proper moisture control and compaction.

In order to determine the most feasible foundation reinforcement alternatives, additional evaluation to determine more exact quantities and cost for implementation will be required. If it is determined that other alternatives not discussed in this report may be feasible, additional analysis of these alternatives would also be required. Furthermore, the results of this stability analysis are based on the provided design. Any significant structural changes or additional loads must be re-evaluated to verify that all stability criteria are maintained for the proposed design.

References

1) EM1110-1-1905, Bearing Capacity of Soils, 30 Oct 1992.

2) EM1110-2-1902, Slope Stability, 31 Oct 2003.

3) EM1110-2-5027, Confined Disposal of Dredged Material, 30 Sept 1987.

4) Milwaukee Confined Disposal Facility DMMP Geotechnical Investigation Report, prepared by STS Consultants, Dec 2006.

5) Study Report - Milwaukee Harbor, WI, Increasing Disposal Capacity by Dike Raising, May 1996.

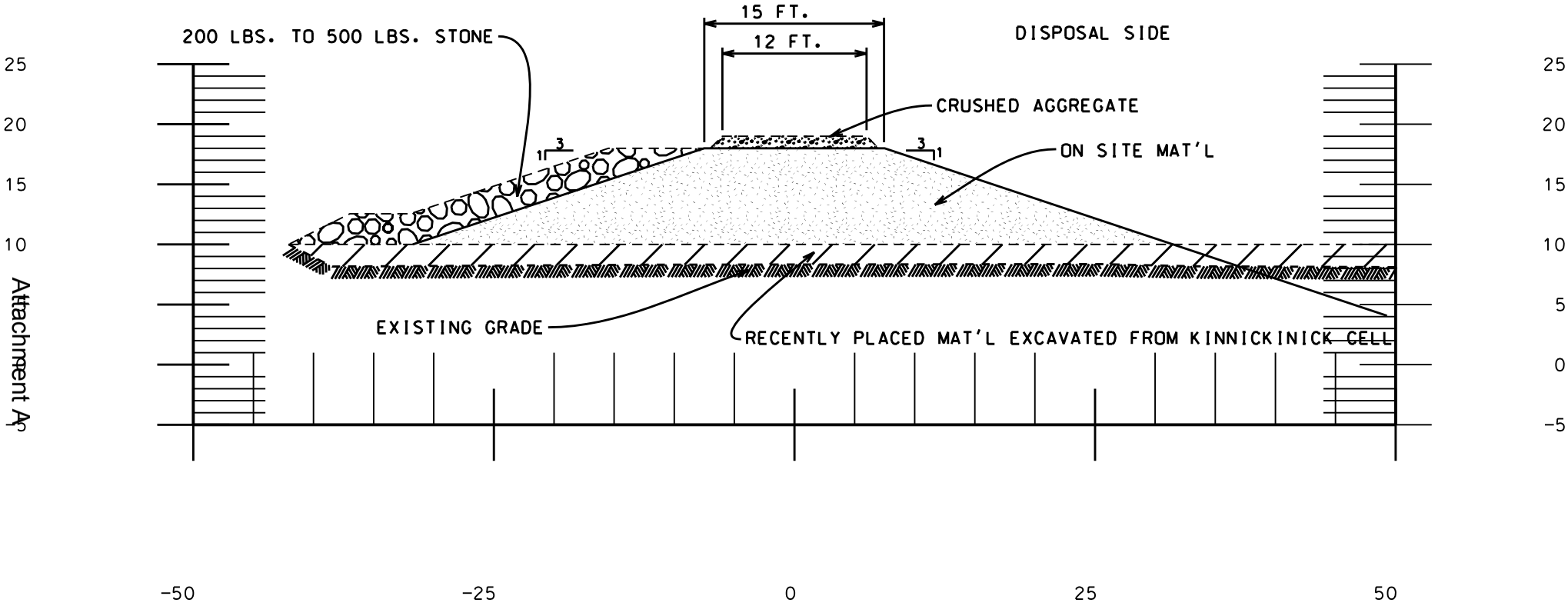
6) Report of Subsurface Investigation for Milwaukee Confined Disposal Facility, Milwaukee, WI, prepared by Coleman Engineering, Nov 1995.

7) Duncan, J. Michael, and Wright, Stephen G., Soil Strength and Slope Stability, John Wiley and Sons, Inc., 2005.

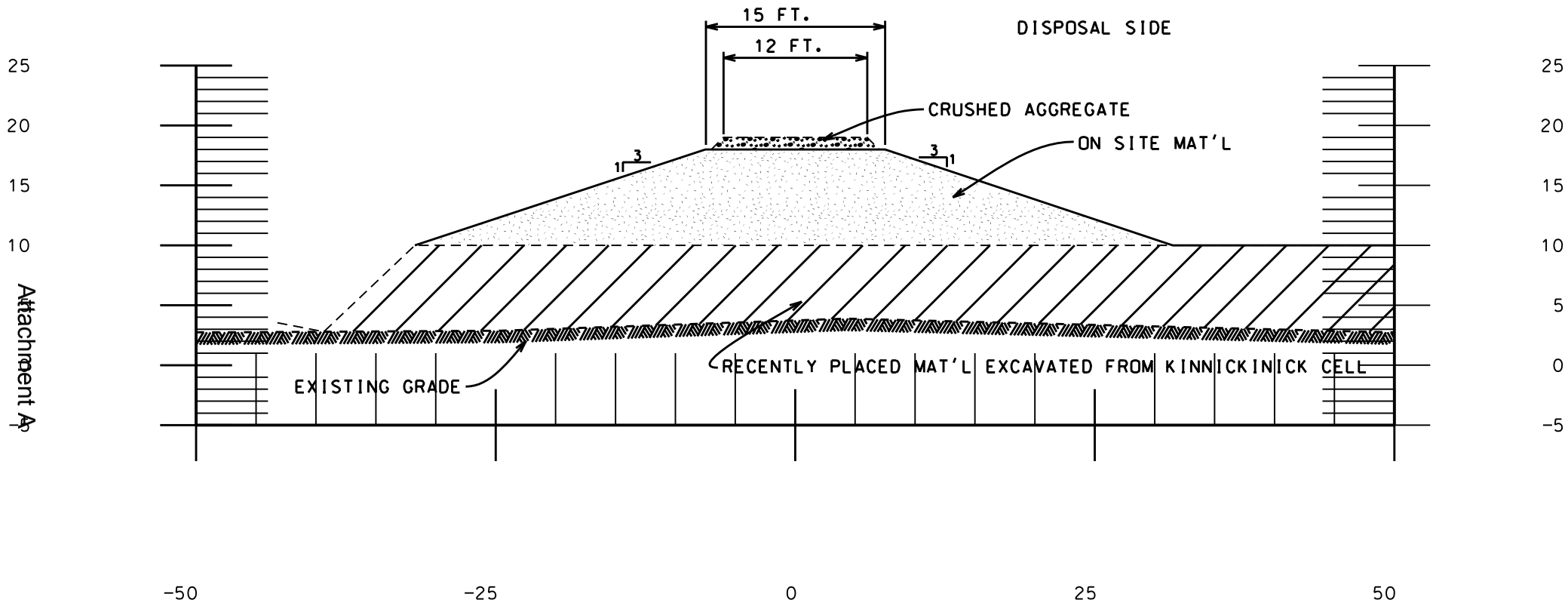
8) "Properties and Uses of Cement-Modified Soil", Portland Cement Association, 2003.

Prepared by: _____
Steven Wyrembelski
Geotechnical and Structural Eng. Branch

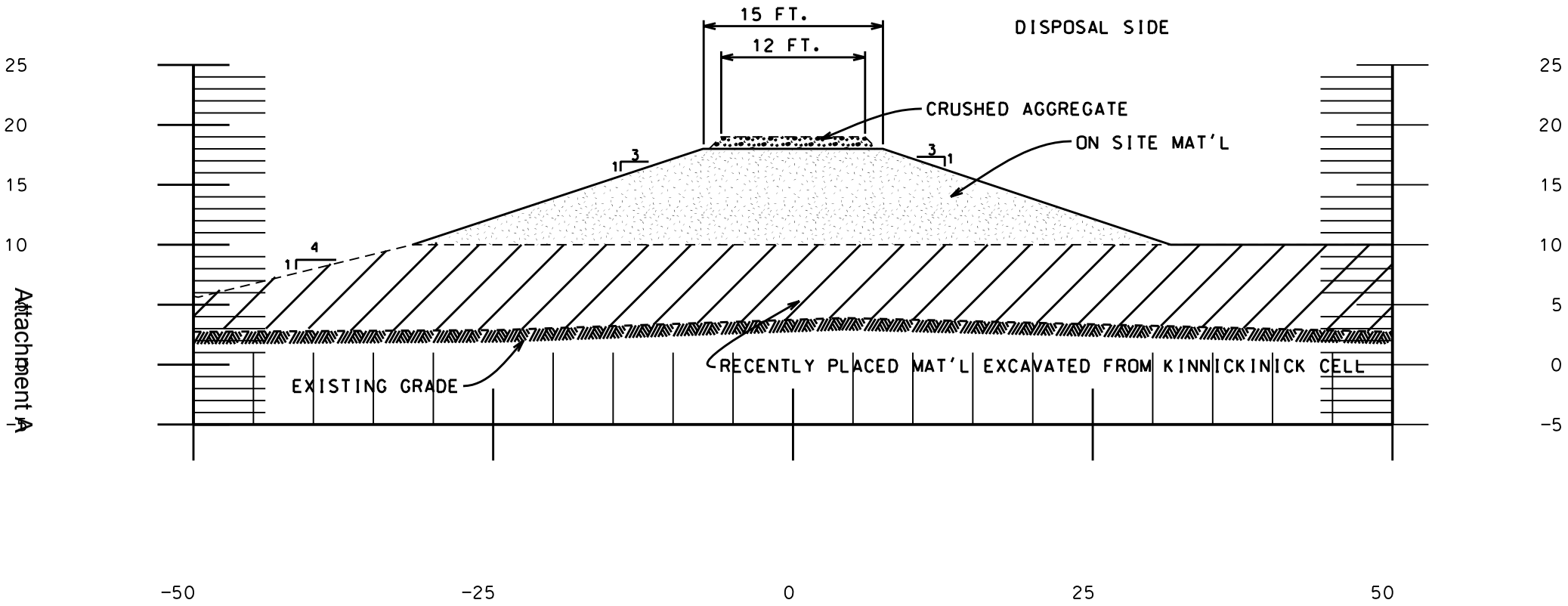
Checked by: _____
Tina Kowitz, P.E.
Geotechnical and Structural Eng. Branch



PROPOSED CROSS-SECTION 5+00



PROPOSED CROSS-SECTION 26+00



RECOMMENDED CROSS-SECTION 26+00

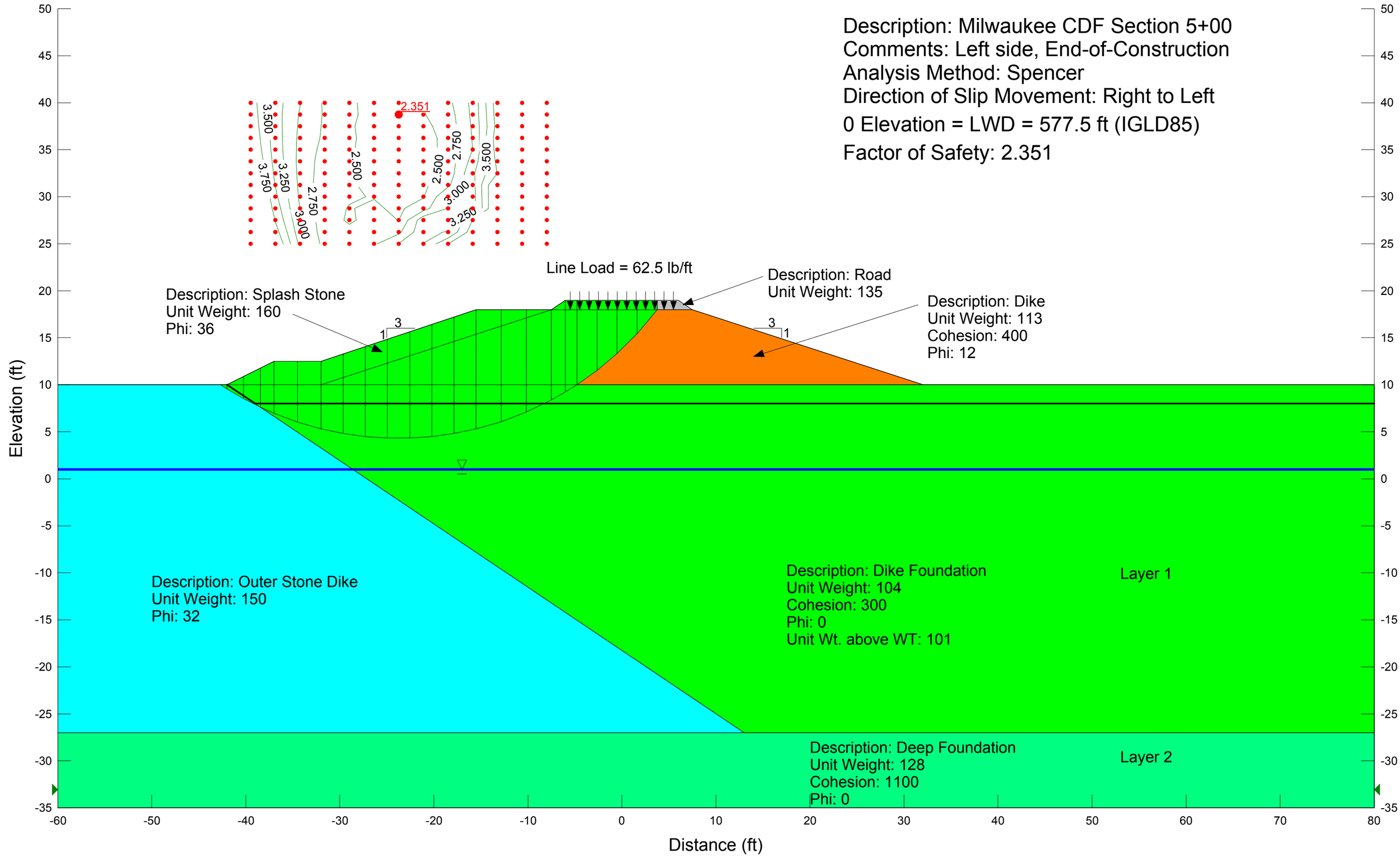
Table 1. Soil Parameters for Milwaukee CDF Dike Raising Stability Analysis
(Refer to Geotech Appendix for Field and Lab Data)

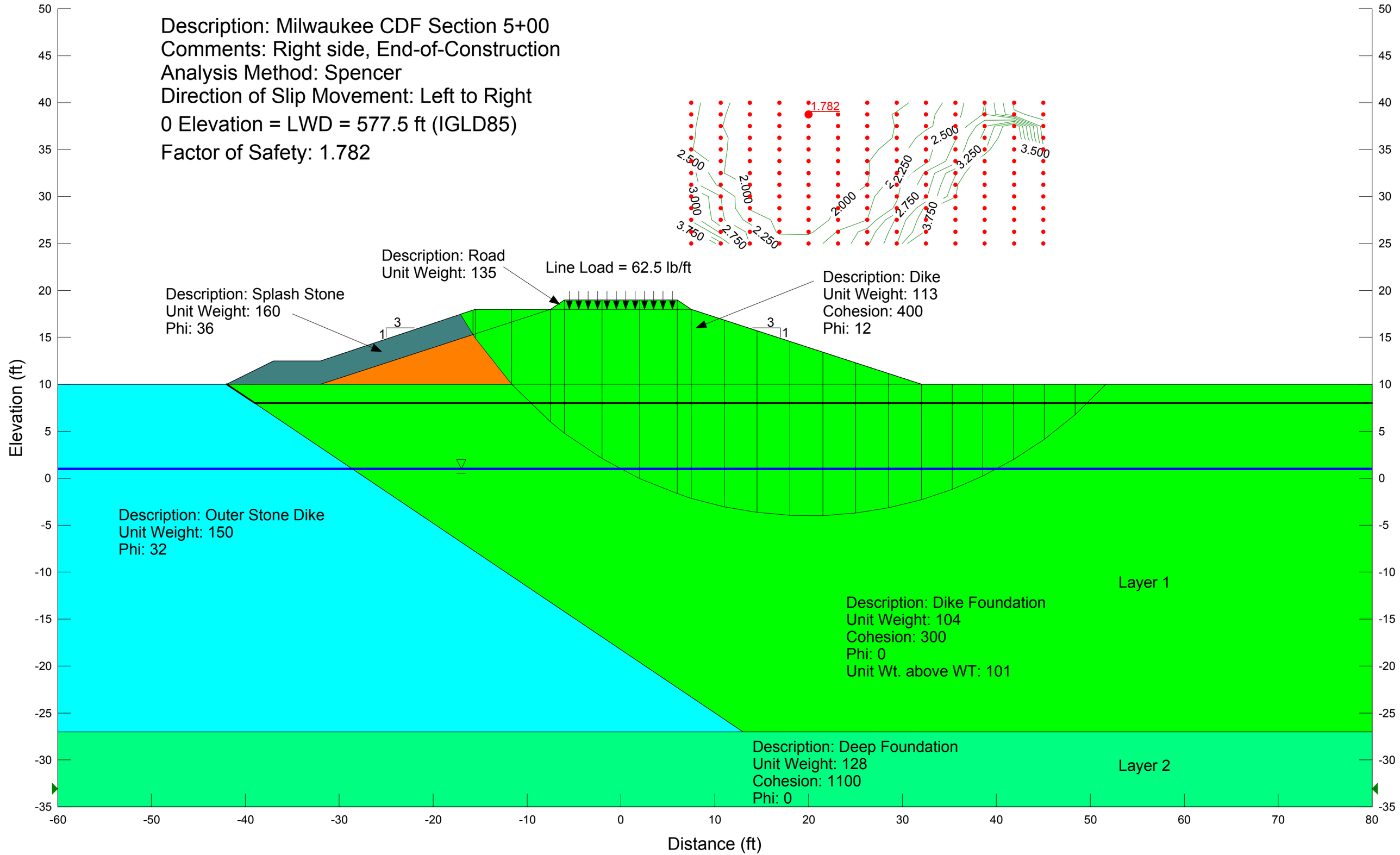
Section 5+00 - Short-term condition (Undrained)			
Material	Unit Weight 'γ' (pcf)	Strength 'Φ' (degrees)	Cohesion 'c' (psf)
Road	135	no strength	
Dike	113	12	400
Foundation (moist)	101	0	300
Foundation (sat.)	104	0	300
Splash Stone	160	36	0
Deep Foundation	128	0	1100
Outer Dike Stone	150	32	0
Section 5+00 - Full capacity condition (outer side only)			
Material	Unit Weight 'γ' (pcf)	Strength 'Φ' (degrees)	Cohesion 'c' (psf)
Road	135	no strength	
CDF Fill (sat.)	104	0	200
Dike	113	25	0
Foundation (moist)	101	27	0
Foundation (sat.)	104	27	0
Splash Stone	160	36	0
Deep Foundation	128	0	1200
Outer Dike Stone	150	32	0
Section 26+00 - Short-term condition (Undrained)			
Material	Unit Weight 'γ' (pcf)	Strength 'Φ' (degrees)	Cohesion 'c' (psf)
Road	135	no strength	
Dike	113	12	400
Foundation (moist)	101	0	300
Foundation (sat.)	104	0	300
Deep Foundation	128	0	1100
Section 26+00 - Full capacity condition (outer side only)			
Material	Unit Weight 'γ' (pcf)	Strength 'Φ' (degrees)	Cohesion 'c' (psf)
Road	135	no strength	
CDF Fill (sat.)	104	0	200
Dike	113	25	0
Foundation (moist)	101	27	0
Foundation (sat.)	104	27	0
Deep Foundation	128	0	1200

Table 2. Summary Results for Milwaukee CDF Dike Raising Stability Analysis

Section 5+00 - Short-term condition (Undrained)			
Scenario	Req. FS (Sliding)	FS (Sliding)	Meets Stability Criteria?
3 on 1 slope - left side	1.3	**2.35**	**Yes**
3 on 1 slope - right side	1.3	**1.78**	**Yes**
2.5 on 1 slope - left side	1.3	**2.10**	**Yes**
2.5 on 1 slope - right side	1.3	**1.74**	**Yes**
Section 5+00 - Full capacity condition (Effective)			
Scenario	Req. FS (Sliding)	FS (Sliding)	Meets Stability Criteria?
3 on 1 slope - left side	1.5	**2.70**	**Yes**
3 on 1 slope - right side	NA	NA	NA
2.5 on 1 slope - left side	1.5	**2.38**	**Yes**
2.5 on 1 slope - right side	NA	NA	NA
Section 26+00 - Short-term condition (Undrained)			
Scenario	Req. FS (Sliding)	FS (Sliding)	Meets Stability Criteria?
3 on 1 slope - left side	1.3	**1.06**	**No**
3 on 1 slope - left, revised	1.3	**1.34**	**Yes**
3 on 1 slope - right side	1.3	**1.84**	**Yes**
2.5 on 1 slope - left side	Not Recommended		NA
2.5 on 1 slope - right side	1.3	**1.80**	**Yes**
Section 26+00 - Full capacity condition (Effective)			
Scenario	Req. FS (Sliding)	FS (Sliding)	Meets Stability Criteria?
3 on 1 slope - left side	1.5	**1.22**	**No**
3 on 1 slope - left, revised	1.5	**1.84**	**Yes**
3 on 1 slope - right side	NA	NA	NA
2.5 on 1 slope - left side	Not Recommended		NA
2.5 on 1 slope - left, revised	Not Recommended		NA
2.5 on 1 slope - right side	NA	NA	NA
Bearing Capacity Results			
Scenario	Req. FS (Bearing)	FS (Bearing)*	Meets Stability Criteria?
Section 5+00	2.5	**1.8**	**No**
Section 26+00	2.5	**1.8**	**No**

*Includes Additional Road Load of 750 psf.


Description: Milwaukee CDF Section 5+00
Comments: Left side, End-of-Construction
Analysis Method: Spencer
Direction of Slip Movement: Right to Left
0 Elevation = LWD = 577.5 ft (IGLD85)
Factor of Safety: 2.351
2.351
3.500
3.750
3.250
2.750
3.000
2.500
2.500
2.750
3.000
3.250
3.500
Line Load = 62.5 lb/ft
Description: Road
Unit Weight: 135
Description: Splash Stone
Unit Weight: 160
Phi: 36
Description: Dike
Unit Weight: 113
Cohesion: 400
Phi: 12
3
1
3
1
Description: Outer Stone Dike
Unit Weight: 150
Phi: 32
Description: Dike Foundation
Unit Weight: 104
Cohesion: 300
Phi: 0
Unit Wt. above WT: 101
Layer 1
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1100
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)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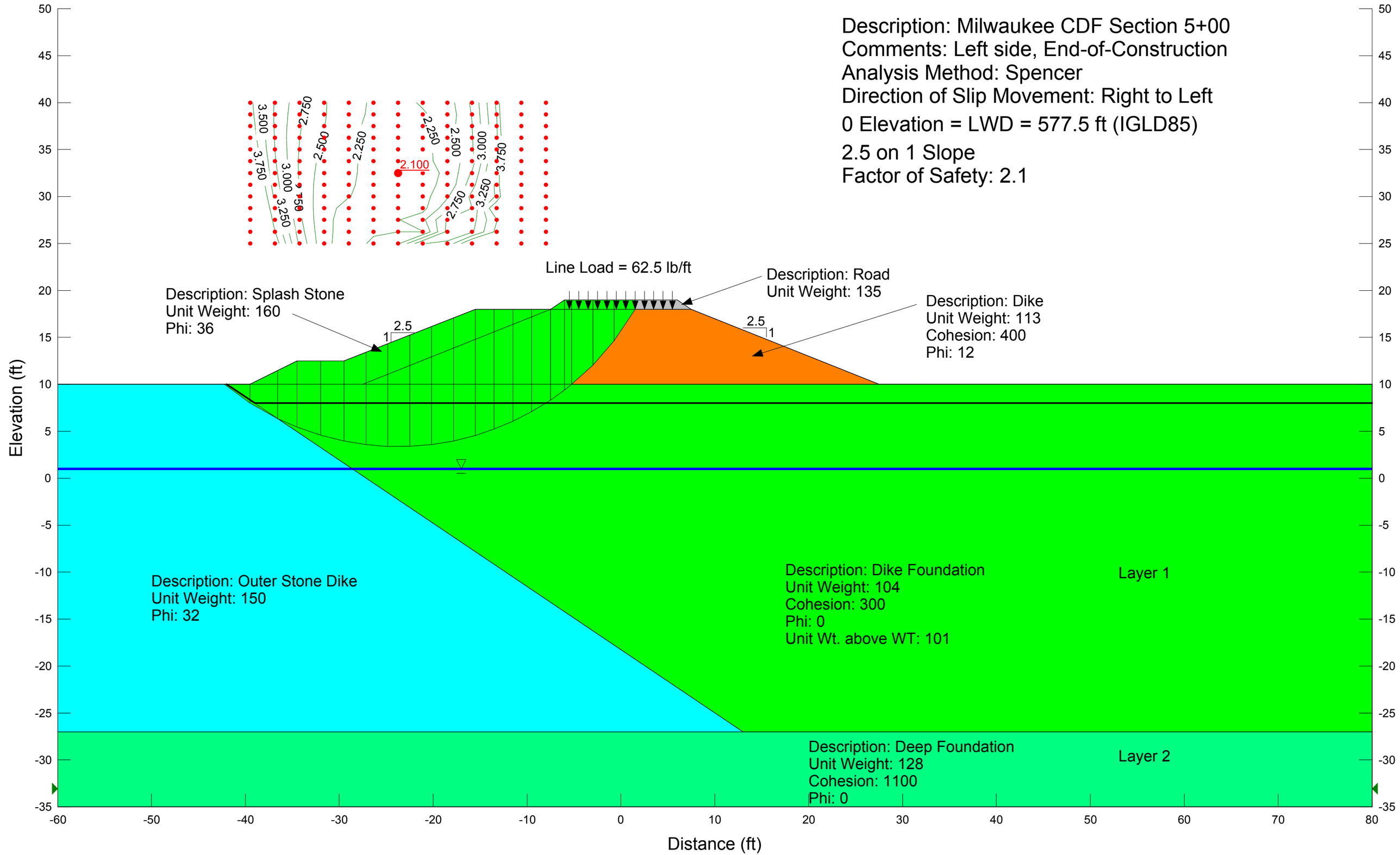
Comments: Right side, End-of-Construction
Analysis Method: Spencer
Direction of Slip Movement: Left to Right
0 Elevation = LWD = 577.5 ft (IGLD85)
Factor of Safety: 1.782
1.782
2.500
3.000
3.750
2.750
2.250
2.000
2.000
2.250
2.750
3.750
2.500
3.250
3.500
Description: Road
Unit Weight: 135
Line Load = 62.5 lb/ft
Description: Splash Stone
Unit Weight: 160
Phi: 36
Description: Dike
Unit Weight: 113
Cohesion: 400
Phi: 12
Description: Outer Stone Dike
Unit Weight: 150
Phi: 32
Layer 1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 300
Phi: 0
Unit Wt. above WT: 101
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1100
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)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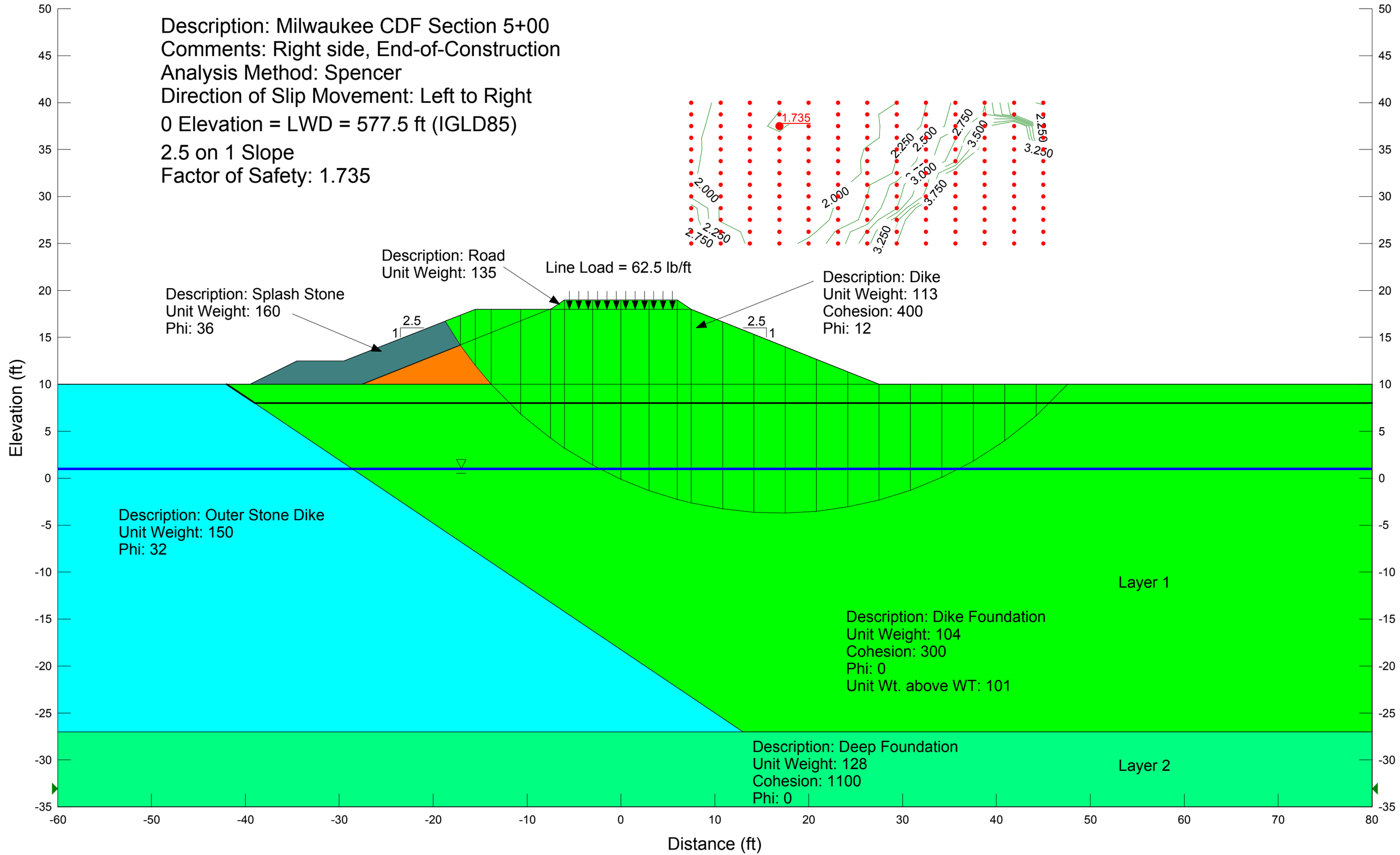
Comments: Left side, End-of-Construction
Analysis Method: Spencer
Direction of Slip Movement: Right to Left
0 Elevation = LWD = 577.5 ft (IGLD85)
2.5 on 1 Slope
Factor of Safety: 2.1
2.100
Line Load = 62.5 lb/ft
Description: Road
Unit Weight: 135
Description: Splash Stone
Unit Weight: 160
Phi: 36
Description: Dike
Unit Weight: 113
Cohesion: 400
Phi: 12
2.5
1
Description: Outer Stone Dike
Unit Weight: 150
Phi: 32
Description: Dike Foundation
Unit Weight: 104
Cohesion: 300
Phi: 0
Unit Wt. above WT: 101
Layer 1
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1100
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)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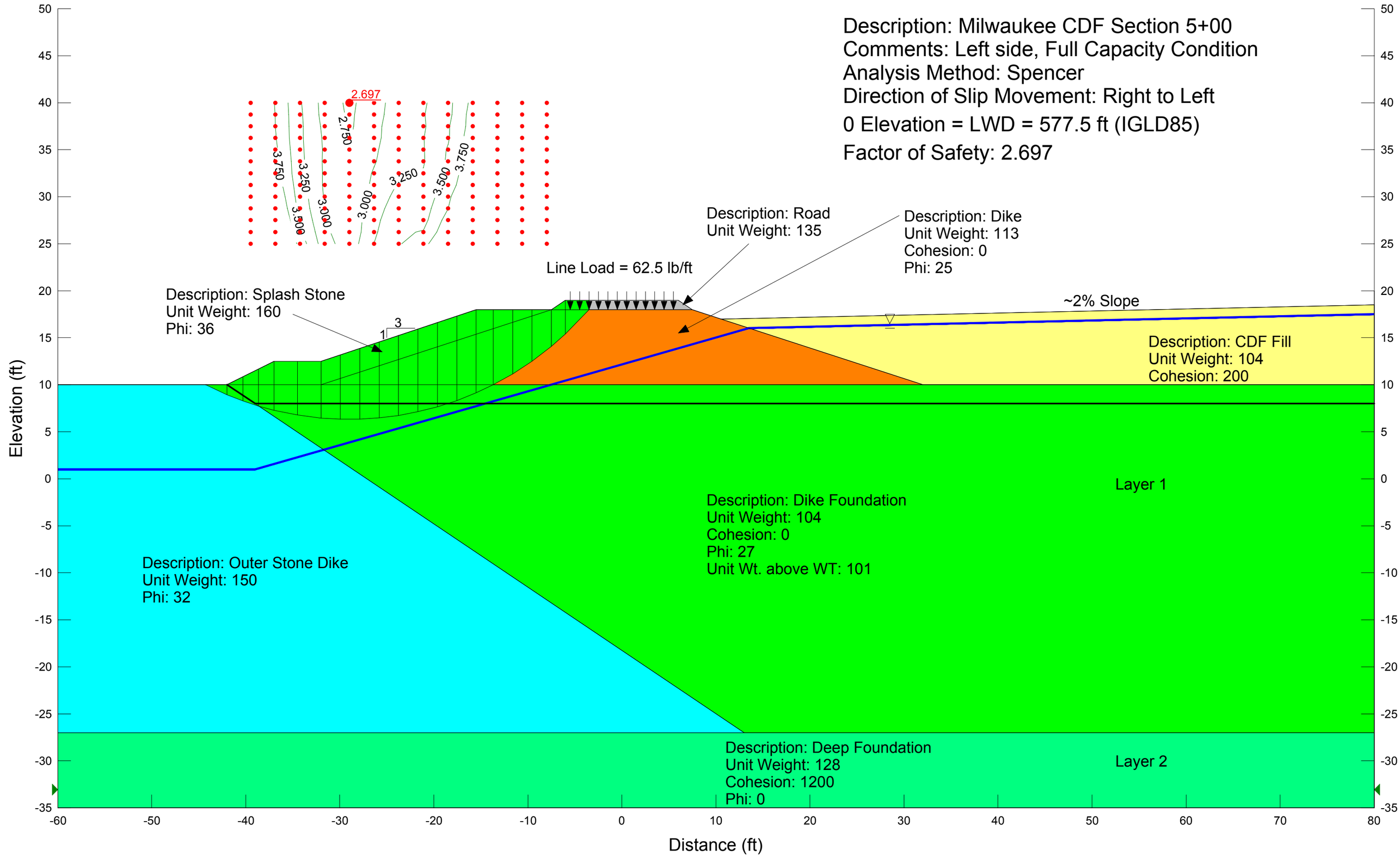
Comments: Right side, End-of-Construction
Analysis Method: Spencer
Direction of Slip Movement: Left to Right
0 Elevation = LWD = 577.5 ft (IGLD85)
2.5 on 1 Slope
Factor of Safety: 1.735
1.735
2.000
2.250
2.750
3.250
3.500
3.750
3.000
2.500
Description: Road
Unit Weight: 135
Line Load = 62.5 lb/ft
Description: Splash Stone
Unit Weight: 160
Phi: 36
Description: Dike
Unit Weight: 113
Cohesion: 400
Phi: 12
2.5
1
Description: Outer Stone Dike
Unit Weight: 150
Phi: 32
Layer 1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 300
Phi: 0
Unit Wt. above WT: 101
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1100
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)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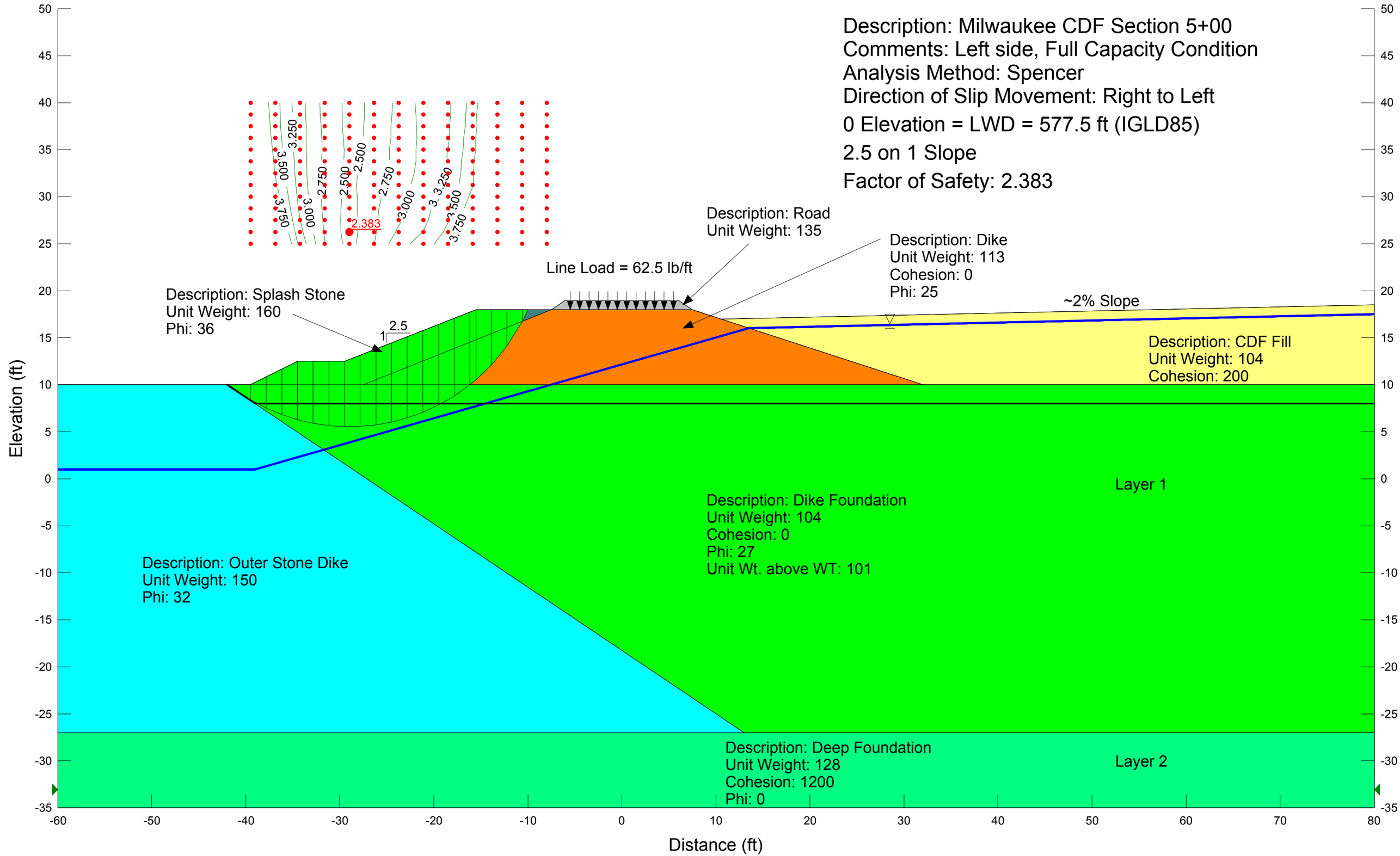
Comments: Left side, Full Capacity Condition
Analysis Method: Spencer
Direction of Slip Movement: Right to Left
0 Elevation = LWD = 577.5 ft (IGLD85)
Factor of Safety: 2.697
2.697
2.750
3.000
3.250
3.500
3.750
Description: Road
Unit Weight: 135
Description: Dike
Unit Weight: 113
Cohesion: 0
Phi: 25
Line Load = 62.5 lb/ft
Description: Splash Stone
Unit Weight: 160
Phi: 36
3
1
~2% Slope
Description: CDF Fill
Unit Weight: 104
Cohesion: 200
Layer 1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 0
Phi: 27
Unit Wt. above WT: 101
Description: Outer Stone Dike
Unit Weight: 150
Phi: 32
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1200
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)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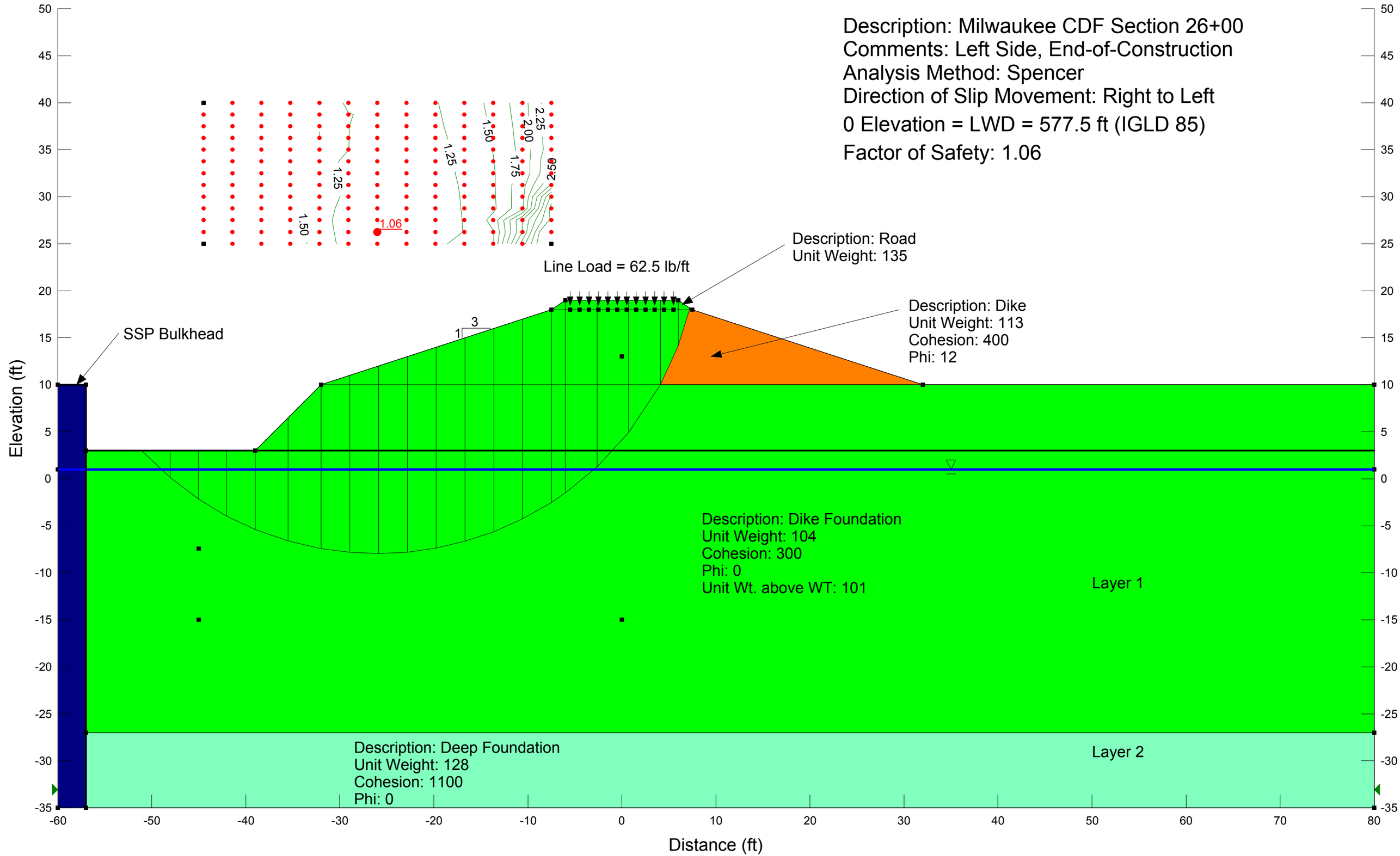
Comments: Left side, Full Capacity Condition
Analysis Method: Spencer
Direction of Slip Movement: Right to Left
0 Elevation = LWD = 577.5 ft (IGLD85)
2.5 on 1 Slope
Factor of Safety: 2.383
2.383
3.250
3.500
3.750
3.000
2.750
2.500
Description: Road
Unit Weight: 135
Line Load = 62.5 lb/ft
Description: Dike
Unit Weight: 113
Cohesion: 0
Phi: 25
~2% Slope
Description: Splash Stone
Unit Weight: 160
Phi: 36
2.5
1
Description: CDF Fill
Unit Weight: 104
Cohesion: 200
Layer 1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 0
Phi: 27
Unit Wt. above WT: 101
Description: Outer Stone Dike
Unit Weight: 150
Phi: 32
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1200
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)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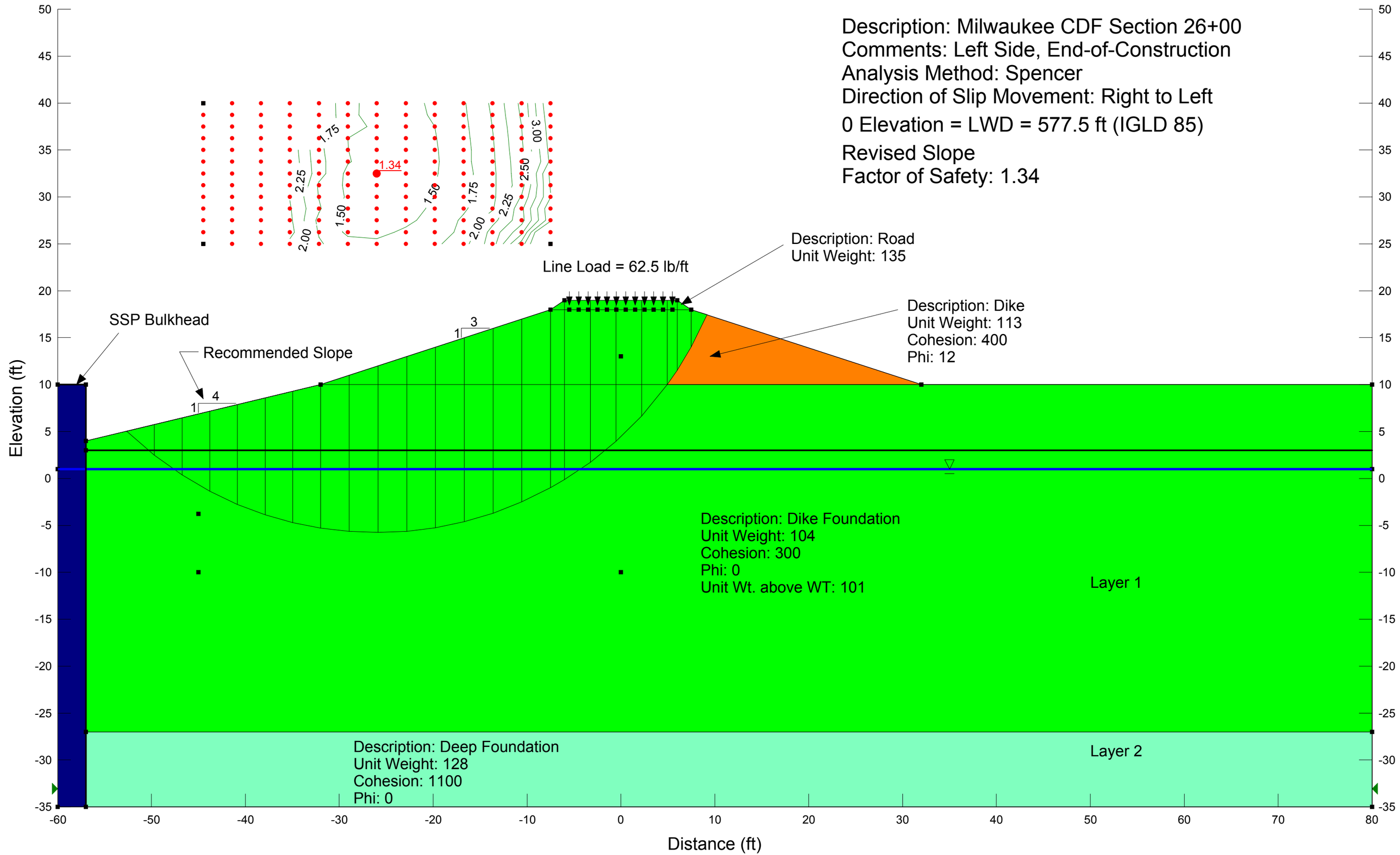
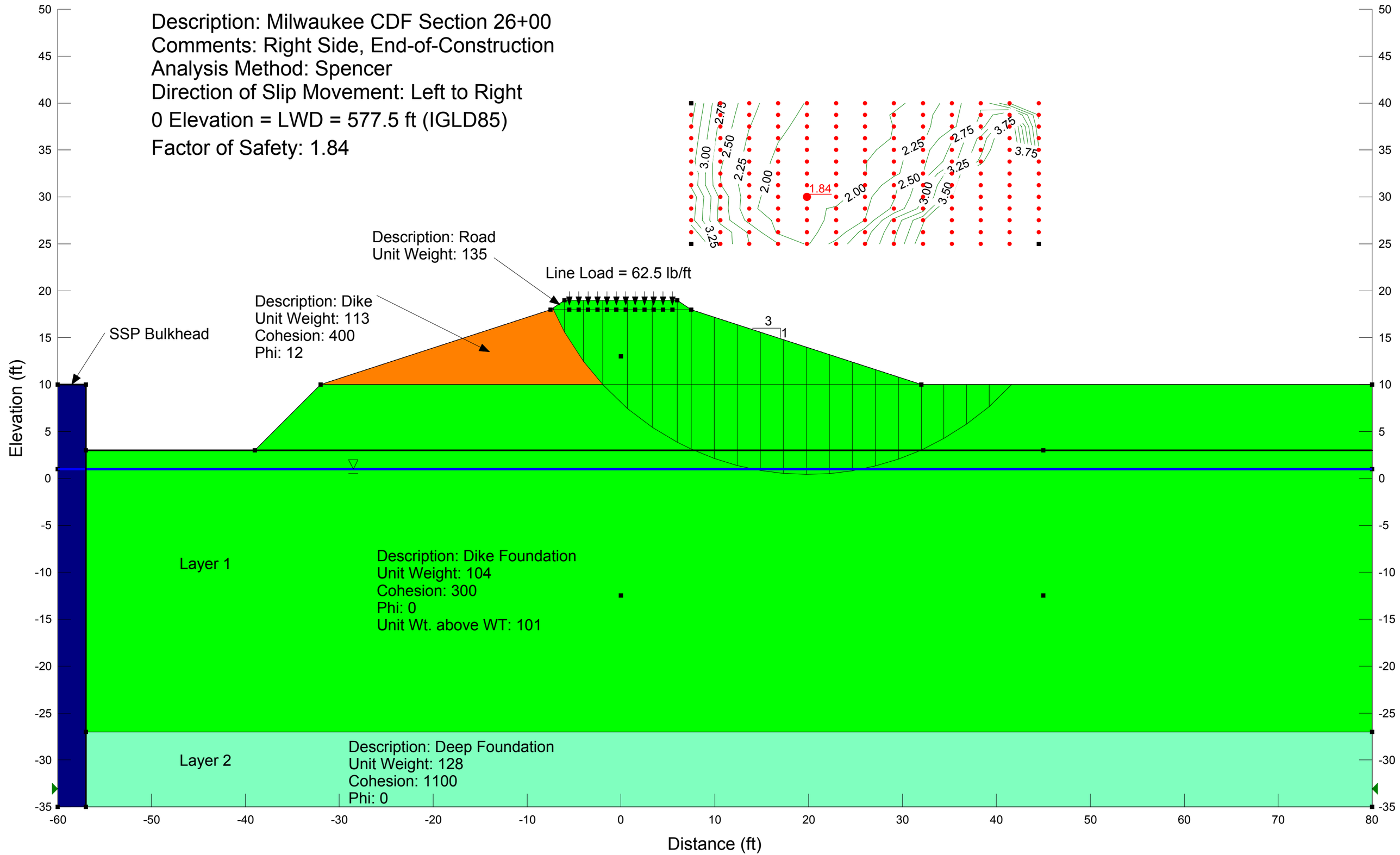
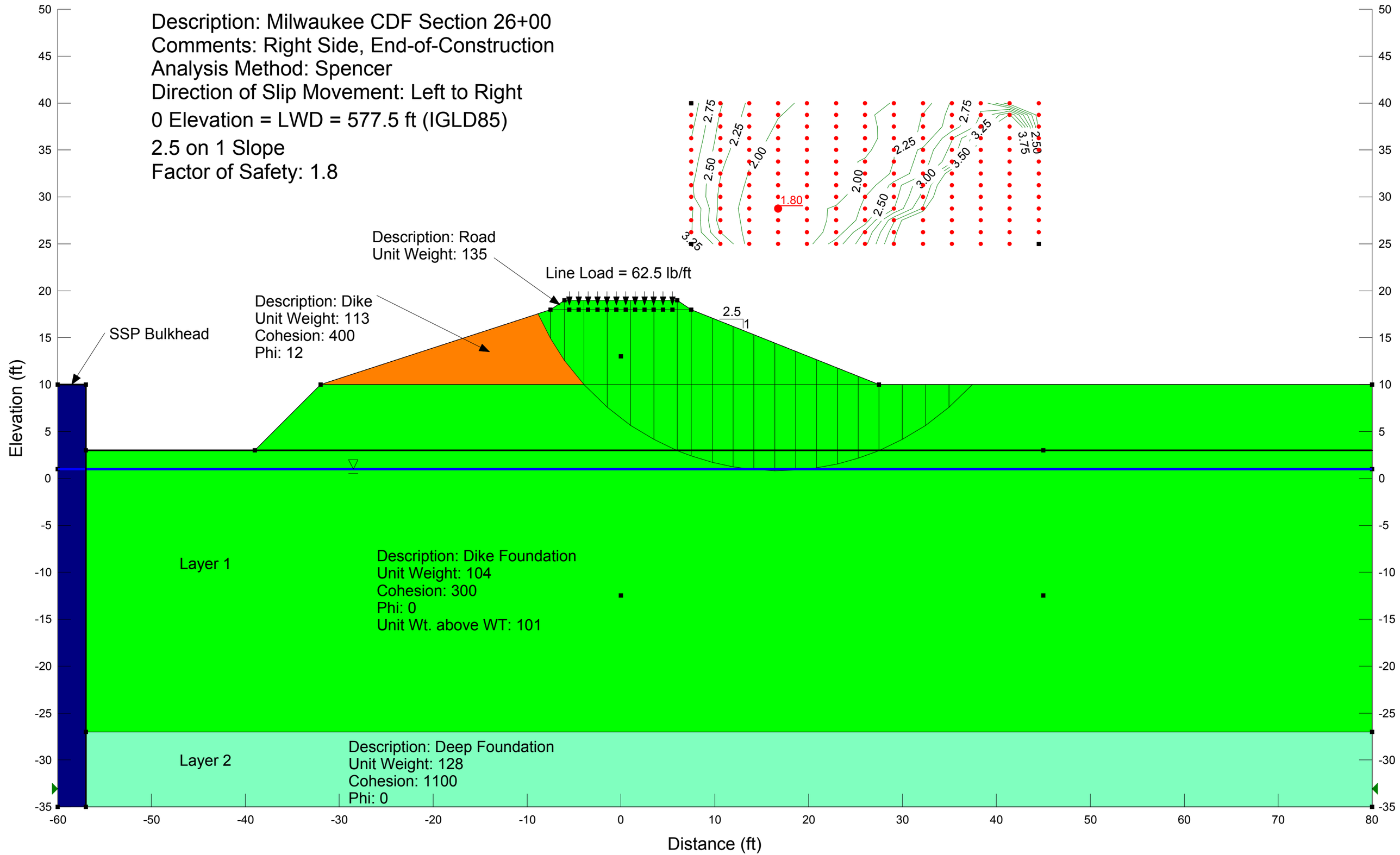
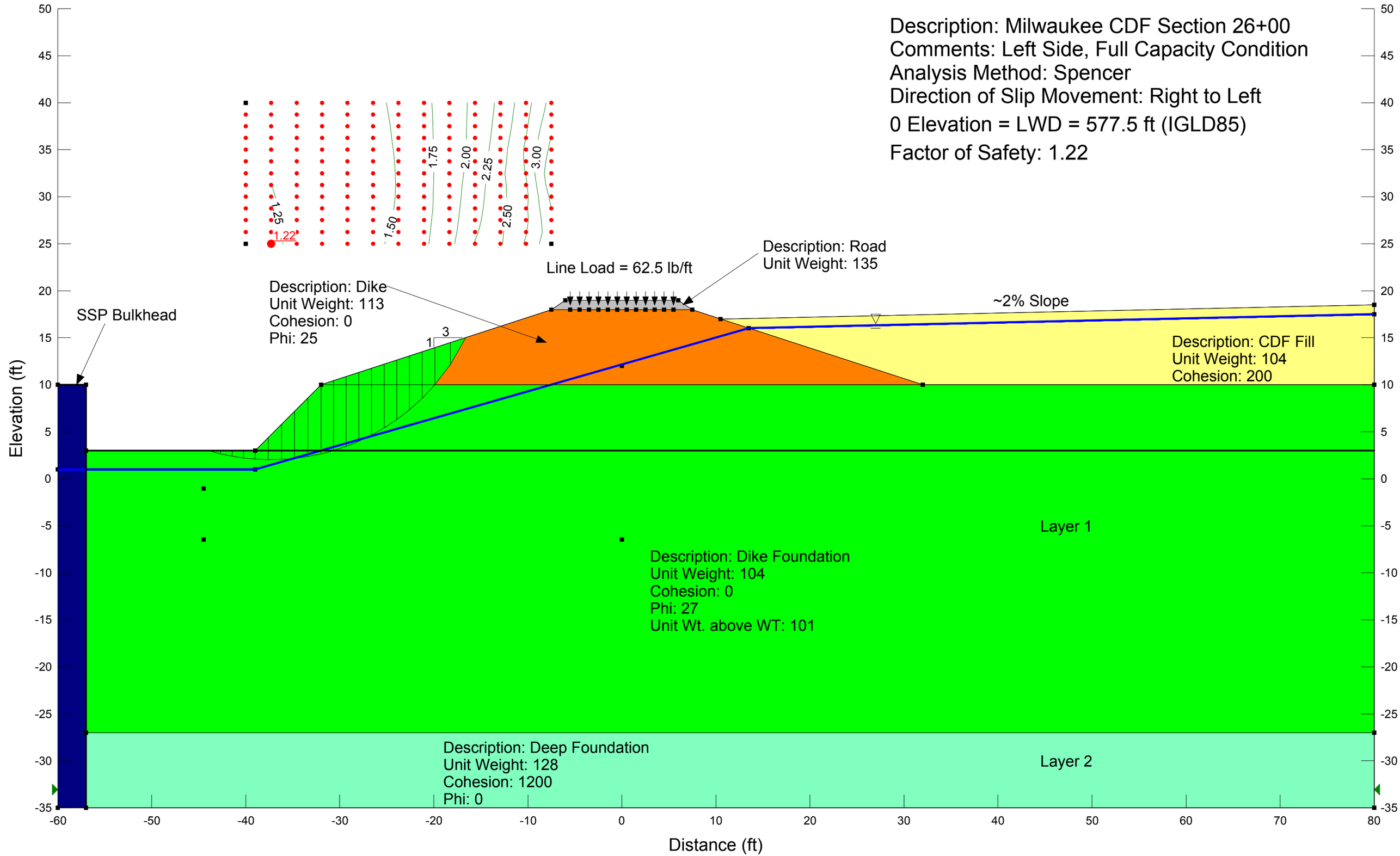
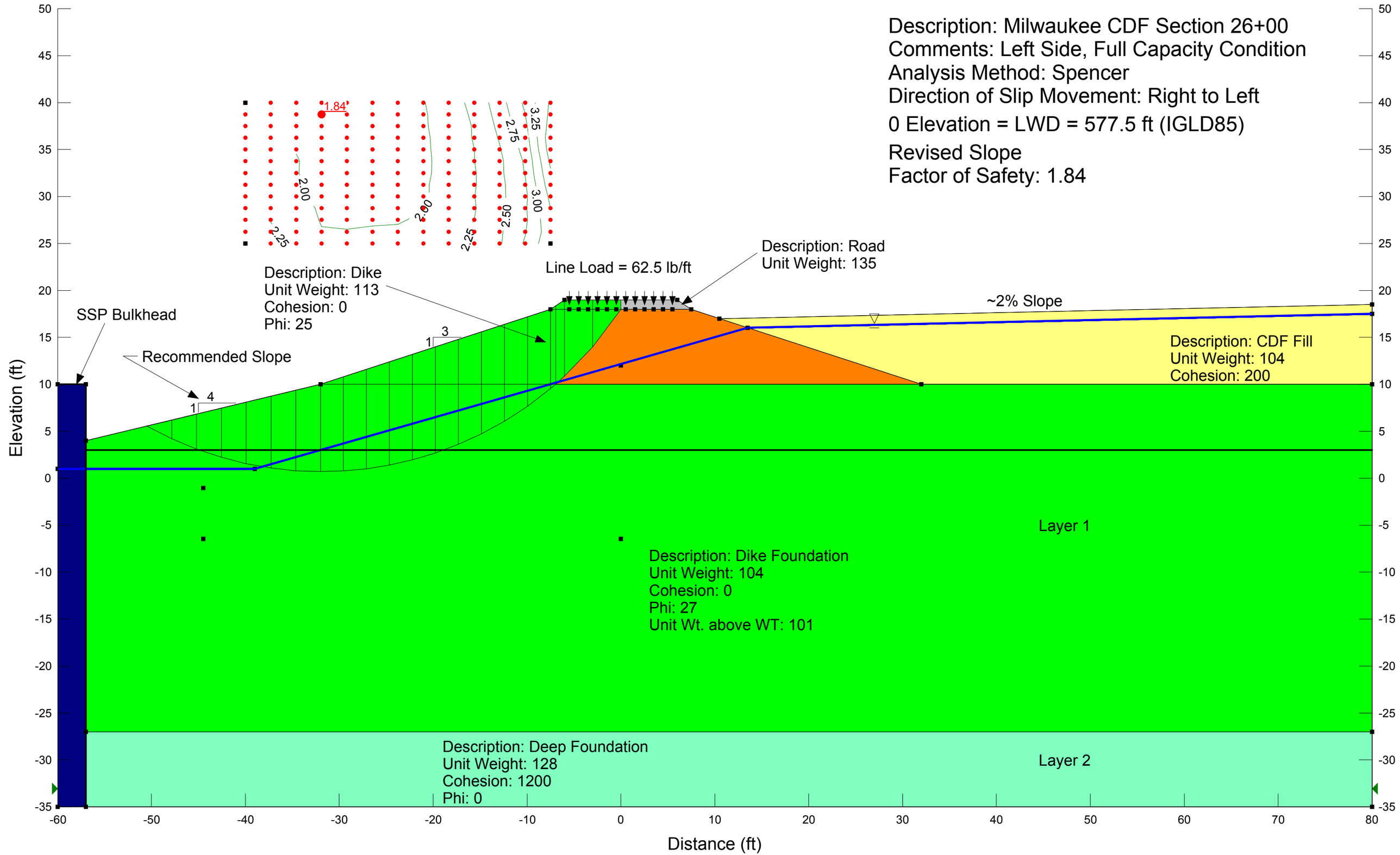
Comments: Left Side, End-of-Construction
Analysis Method: Spencer
Direction of Slip Movement: Right to Left
0 Elevation = LWD = 577.5 ft (IGLD 85)
Factor of Safety: 1.06
1.06
1.50
1.25
1.25
1.50
1.75
2.00
2.25
2.50
Line Load = 62.5 lb/ft
Description: Road
Unit Weight: 135
Description: Dike
Unit Weight: 113
Cohesion: 400
Phi: 12
SSP Bulkhead
3
1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 300
Phi: 0
Unit Wt. above WT: 101
Layer 1
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1100
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)


Description: Milwaukee CDF Section 26+00
Comments: Left Side, End-of-Construction
Analysis Method: Spencer
Direction of Slip Movement: Right to Left
0 Elevation = LWD = 577.5 ft (IGLD 85)
Revised Slope
Factor of Safety: 1.34
1.34
1.75
2.25
2.00
1.50
1.50
1.75
2.00
2.25
2.50
3.00
Line Load = 62.5 lb/ft
Description: Road
Unit Weight: 135
Description: Dike
Unit Weight: 113
Cohesion: 400
Phi: 12
SSP Bulkhead
Recommended Slope
3
1
4
1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 300
Phi: 0
Unit Wt. above WT: 101
Layer 1
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1100
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)

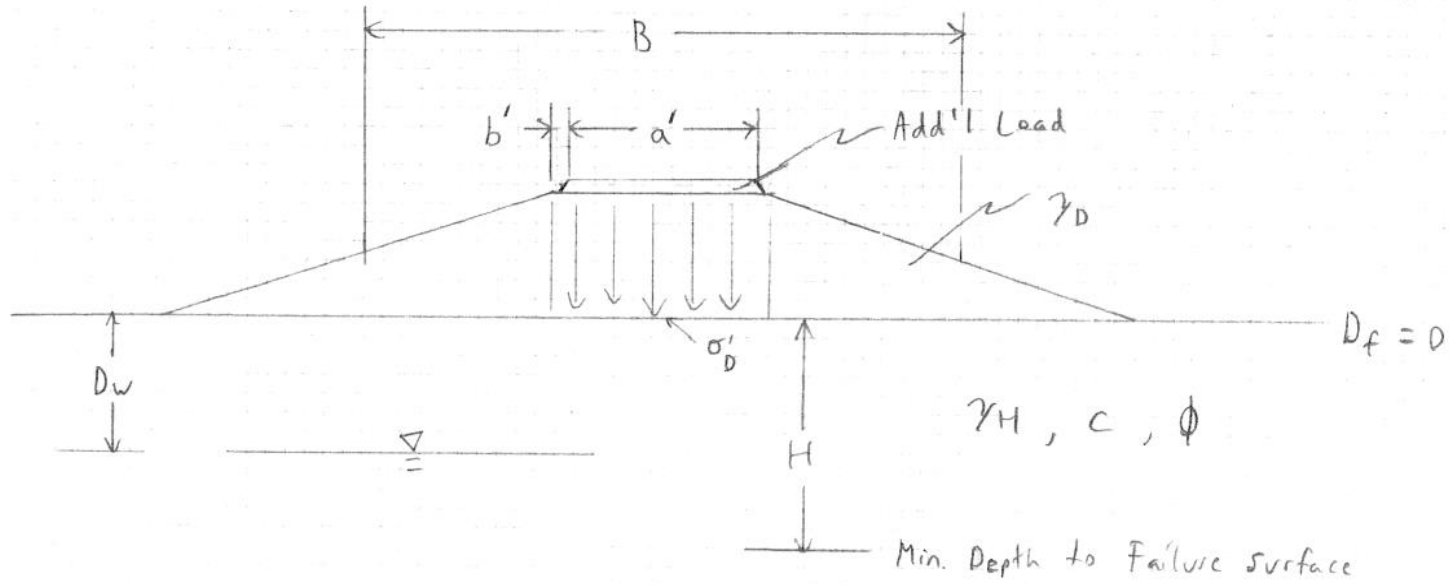

Description: Milwaukee CDF Section 26+00
Comments: Right Side, End-of-Construction
Analysis Method: Spencer
Direction of Slip Movement: Left to Right
0 Elevation = LWD = 577.5 ft (IGLD85)
Factor of Safety: 1.84
Description: Road
Unit Weight: 135
Line Load = 62.5 lb/ft
Description: Dike
Unit Weight: 113
Cohesion: 400
Phi: 12
SSP Bulkhead
3
1
Layer 1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 300
Phi: 0
Unit Wt. above WT: 101
Layer 2
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1100
Phi: 0
1.84
Elevation (ft)
Distance (ft)


Description: Milwaukee CDF Section 26+00
Comments: Right Side, End-of-Construction
Analysis Method: Spencer
Direction of Slip Movement: Left to Right
0 Elevation = LWD = 577.5 ft (IGLD85)
2.5 on 1 Slope
Factor of Safety: 1.8
Description: Road
Unit Weight: 135
Line Load = 62.5 lb/ft
Description: Dike
Unit Weight: 113
Cohesion: 400
Phi: 12
SSP Bulkhead
2.5
1
1.80
Layer 1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 300
Phi: 0
Unit Wt. above WT: 101
Layer 2
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1100
Phi: 0
Elevation (ft)
Distance (ft)


Description: Milwaukee CDF Section 26+00
Comments: Left Side, Full Capacity Condition
Analysis Method: Spencer
Direction of Slip Movement: Right to Left
0 Elevation = LWD = 577.5 ft (IGLD85)
Factor of Safety: 1.22
1.25
1.22
1.50
1.75
2.00
2.25
2.50
3.00
Line Load = 62.5 lb/ft
Description: Road
Unit Weight: 135
Description: Dike
Unit Weight: 113
Cohesion: 0
Phi: 25
SSP Bulkhead
~2% Slope
Description: CDF Fill
Unit Weight: 104
Cohesion: 200
Layer 1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 0
Phi: 27
Unit Wt. above WT: 101
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1200
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)


Description: Milwaukee CDF Section 26+00
Comments: Left Side, Full Capacity Condition
Analysis Method: Spencer
Direction of Slip Movement: Right to Left
0 Elevation = LWD = 577.5 ft (IGLD85)
Revised Slope
Factor of Safety: 1.84
1.84
2.00
2.25
2.50
2.75
3.00
3.25
Description: Dike
Unit Weight: 113
Cohesion: 0
Phi: 25
Line Load = 62.5 lb/ft
Description: Road
Unit Weight: 135
~2% Slope
SSP Bulkhead
Recommended Slope
3
1
4
1
Description: CDF Fill
Unit Weight: 104
Cohesion: 200
Layer 1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 0
Phi: 27
Unit Wt. above WT: 101
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1200
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)

Generalized Cross-Section for Bearing Capacity Calculations



US Army Corps of Engineers
Detroit District

Milwaukee CDF (DMMP)

Soil Foundation Bearing Capacity Calculations
Typical Section, End-of-Construction

Computed by: SW **Date:** 17-Apr-07
Checked by: JPK **Date:** 17 Apr-07

*Refer to attached cross-section for more detail on inputs

Inputs

Height (ft)	9.0	*embankment height*
c (psf)	300	*fdn soil cohesion*
γ_D (pcf)	113	*soil unit weight above foundation*
γ_H (pcf)	104	*soil unit weight below foundation*
γw (pcf)	62.4	*water unit weight*
Φ (deg)	0	*fdn soil friction angle*
Foundation type	strip	*strip, square, or circular*
Df (ft)	0.0	*foundation depth*
Dw (ft)	9.0	*depth to water table*
B (ft)	39.5	*foundation width*
q (psf)	750	*any external loads*

Assumptions

1) Shallow Foundation
2) Strip Footing
3) 750 psf road load
4) Allowable load = Effective surcharge

Bearing Capacity Factors (see table)

Nq	1.00
Nγ	0.00
Nc	5.70

a'	12	*external dist. load width*
b'	1.5	*distance from edge of load to slope edge*

Results

ζq	1.0	*correction factor*
ζγ	1.0	"
ζc	1.0	"
$\sigma_{v(2)}$ (psf)	500	*Add'l surcharge effect*
ψ (deg)	45	
H (ft)	39.50	*approx depth of shear failure beneath fdn base*
L_{sh} (ft)	39.50	*approx horizontal length of failure*
γ_D' (pcf)	113.0	*eff. soil unit weight*
γ_H' or (pcf)	55.8	*eff. soil unit weight below foundation*
σ_D' (psf)	1017.0	*eff. surcharge pressure @ fdn depth*
qa (psf)	1517.0	*eff. surcharge pressure @ fdn depth + load(s)*
qu (psf)	2727.0	*ultimate bearing capacity* ($\sigma_{v(2)}$)
Factor of Safety	**1.80**	*recommended FS = 2.5*
Meets Criteria?	**No**	

Eq. 3.15 from Das, 1990
if 0≤d≤B, where d = Dw

$$\bar{\gamma} = \gamma' + \frac{d}{B}(\gamma - \gamma')$$

Eq. 11.4 from Das, 1990
where z = height = 9'

$$\sigma_{v(2)} = \frac{qa'}{a' + \frac{z}{2} + b'}$$

Equations from EM1110-1-1905 -> $q_a = \frac{q_u}{FS}$ $\quad q_u = cN_c\zeta_c + \frac{1}{2}B\gamma'_H N_\gamma \zeta_\gamma + \sigma'_D N_q \zeta_q$

Terzaghi Dimensionless Bearing Capacity Factors (after Bowles 1988)

ϕ'	N_q	N_c	N_γ
28	17.81	31.61	15.7
30	22.46	37.16	19.7
32	28.52	44.04	27.9
34	36.50	52.64	36.0
35	41.44	57.75	42.4
36	47.16	63.53	52.0
38	61.55	77.50	80.0
40	81.27	95.66	100.4
42	108.75	119.67	180.0
44	147.74	151.95	257.0
45	173.29	172.29	297.5
46	204.19	196.22	420.0
48	287.85	258.29	780.1
50	415.15	347.51	1153.2

ϕ'	N_q	N_c	N_γ
0	1.00	5.70	0.0
2	1.22	6.30	0.2
4	1.49	6.97	0.4
6	1.81	7.73	0.6
8	2.21	8.60	0.9
10	2.69	9.60	1.2
12	3.29	10.76	1.7
14	4.02	12.11	2.3
16	4.92	13.68	3.0
18	6.04	15.52	3.9
20	7.44	17.69	4.9
22	9.19	20.27	5.8
24	11.40	23.36	7.8
26	14.21	27.09	11.7

Milwaukee CDF Stability Analysis Verification
Section 26+00, Right Side, End-of-Construction, 3 on 1 Slope

Computed by: SW
Checked by: JPK

			unit wt.	113				F.S. ->	1.8300	1.8350	1.8351
Slice	Horiz. width "b" (ft)	Ave. Height "h" (ft)	Area "A" (sqft)	Weight "W" (lbs)	Base Inclin. "α" (deg)	Base Length "Δl" (ft)	Cohesion "c" (psf)	Fric. Angle "Φ" (deg)	Z_{i+1} (Trial FS 1)	Z_{i+1} (Trial FS 2)	Z_{i+1} (Trial FS 3)
1	1.20	1.87	2.23	252.55	63.5	2.68	400	12	-676.94	-674.33	-674.30
2	2.02	5.08	10.28	1161.35	57.2	3.74	400	12	-542.00	-535.53	-535.46
3	2.02	7.84	15.86	1792.40	50.5	3.18	400	12	223.92	233.76	233.86
4	2.65	10.35	27.45	3101.56	43.9	3.68	300	0	2370.30	2382.43	2382.55
5	2.65	12.61	33.43	3777.35	37.1	3.32	300	0	4543.61	4557.59	4557.73
6	2.65	14.39	38.16	4311.75	30.9	3.09	300	0	6532.28	6547.87	6548.03
7	1.50	15.02	22.53	2546.40	26.3	1.67	300	0	7483.22	7499.65	7499.81
8	2.45	15.01	36.77	4155.24	22.1	2.64	300	0	8701.46	8719.16	8719.34
9	2.45	15.08	36.94	4174.34	17.0	2.56	300	0	9541.51	9560.40	9560.59
10	2.45	14.92	36.54	4129.22	12.1	2.51	300	0	10008.73	10028.77	10028.97
11	2.45	14.53	35.61	4023.74	7.3	2.47	300	0	10116.47	10137.62	10137.83
12	2.45	13.95	34.17	3860.67	2.5	2.45	300	0	9885.14	9907.39	9907.62
13	2.45	13.15	32.22	3641.13	2.2	2.45	300	0	9623.69	9647.04	9647.27
14	2.45	12.16	29.78	3365.11	-7.0	2.47	300	0	8803.94	8828.39	8828.64
15	2.45	10.95	26.83	3031.78	-11.8	2.50	300	0	7751.45	7777.05	7777.31
16	2.45	9.53	23.35	2638.08	-16.7	2.56	300	0	6522.09	6548.89	6549.15
17	2.45	7.88	19.30	2180.39	-21.7	2.64	300	0	5187.30	5215.36	5215.64
18	2.40	6.38	15.34	1733.79	-26.9	2.70	300	0	3811.70	3841.11	3841.40
19	2.40	5.02	12.06	1363.20	-32.3	2.84	300	0	2399.25	2430.17	2430.47
20	2.40	3.33	8.00	904.21	-38.0	3.05	300	0	1058.38	1091.03	1091.35
21	2.40	1.24	2.97	335.75	-44.2	3.35	300	0	**-35.08**	**-0.35**	**0.00**

Side Force Inclination (θ) ->	**0.0**
SLOPE/W calculated FS ->	**1.844**
FS that satisfies equilibrium ->	**1.835**

Verified? **Yes**

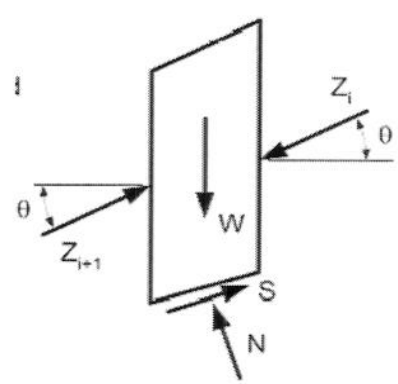
Notes:
1) Input cells are light yellow.
2) Modified Swedish Method used to check Spencer's Method (per EM1110-2-1902).
3) Side Force Inclination is assumed to be equal to that used in SLOPE/W.
4) Verification is for end-of-construction condition.

5) Line loads are not considered.

6) Allowable difference between factors of safety is 2%.

Equation F-7 from EM1110-2-1902

$$Z_{i+1} = Z_i + \frac{W\left[\sin\alpha - \frac{\tan\phi\cos\alpha}{F}\right] - \frac{c\cdot\Delta l}{F}}{\cos(\alpha-\theta) + \frac{\tan\phi\sin(\alpha-\theta)}{F}}$$



Slice Data used for Stability Analysis Verification

Slice	1	2	3	4	5	6	7	8	9	10	11
Factor of Safety	1.844	1.844	1.844	1.844	1.844	1.844	1.844	1.844	1.844	1.844	1.844
Phi Angle	12	12	12	0	0	0	0	0	0	0	0
C (Strength)	400	400	400	300	300	300	300	300	300	300	300
C (Force)	1071.7	1496	1273.4	1103.4	997.06	926.65	501.82	793.2	768.75	751.78	741.02
Pore Water Pressure	0	0	0	0	0	0	0	0	0	0	20.876
Pore Water Force	0	0	0	0	0	0	0	0	0	0	51.564
Pore Air Pressure	0	0	0	0	0	0	0	0	0	0	0
Pore Air Force	0	0	0	0	0	0	0	0	0	0	0
Slice Width	1.1969	2.0236	2.0236	2.6509	2.6509	2.6509	1.5	2.45	2.45	2.45	2.45
Mid-Height	1.8673	5.0788	7.8385	10.354	12.61	14.394	15.023	15.009	15.078	14.915	14.534
Base Length	2.6792	3.74	3.1836	3.6779	3.3235	3.0888	1.6727	2.644	2.5625	2.5059	2.4701
Base Angle	63.465	57.244	50.533	43.883	37.096	30.882	26.268	22.085	17.04	12.129	7.3074
Polygon Closure	8.9299	6.0295	9.509	19.164	21.301	46.792	12.685	20.033	0	38.672	37.519
Weight	268.39	1205.9	1836.9	3116.9	3721	4198.5	2445.5	3937.4	3931.1	3867.2	3751.9
Base Shear Force	535.69	925.59	910.15	598.76	541	502.76	272.18	430.3	417.03	407.82	401.98
Base Normal Force	396.4	986.78	1901.8	3832.9	4260.1	4679.2	2537	4006.6	3938.9	3844.1	3726.9
Left Side Normal Force	2.7557	592.57	266.84	618.76	2841.1	4976.1	6943.3	7820.3	8925.3	9678.1	10084
Left Side Shear Force	592.57	33.777	15.21	35.27	161.95	283.64	395.77	445.76	508.75	551.66	574.82
Right Side Normal Force	33.777	266.84	618.76	2841.1	4976.1	6943.3	7820.3	8925.3	9678.1	10084	10157
Right Side Shear Force		15.21	35.27	161.95	283.64	395.77	445.76	508.75	551.66	574.82	578.96
Line Load		125	125	187.5	125	187.5					

Slice	12	13	14	15	16	17	18	19	20	21
Factor of Safety	1.844	1.844	1.844	1.844	1.844	1.844	1.844	1.844	1.844	1.844
Phi Angle	0	0	0	0	0	0	0	0	0	0
C (Strength)	300	300	300	300	300	300	300	300	300	300
C (Force)	735.72	735.55	740.49	750.86	767.37	791.26	809.03	853.3	915.4	1006.3
Pore Water Pressure	34.035	34.466	22.178	0	0	0	0	0	0	0
Pore Water Force	83.467	84.504	54.743	0	0	0	0	0	0	0
Pore Air Pressure	0	0	0	0	0	0	0	0	0	0
Pore Air Force	0	0	0	0	0	0	0	0	0	0
Slice Width	2.45	2.45	2.45	2.45	2.45	2.45	2.4049	2.4049	2.4049	2.4049
Mid-Height	13.945	13.152	12.155	10.951	9.5289	7.8757	6.38	5.0163	3.3273	1.2355
Base Length	2.4524	2.4518	2.4683	2.5029	2.5579	2.6375	2.6968	2.8443	3.0513	3.3543
Base Angle	2.5377	2.2143	6.9817	11.799	16.702	21.737	26.906	32.275	37.989	44.197
Polygon Closure	35.841	34.128	16.052	14.861	26.935	11.8	20.448	18.257	7.545	16.774
Weight	3584.1	3364.4	3092.8	2768.5	2393.2	1960.6	1549.6	1218.4	808.18	300.09
Base Shear Force	399.1	399.01	401.69	407.32	416.28	429.25	438.9	462.93	496.65	546.01
Base Normal Force	3583.8	3412.8	3210.5	2972.1	2693.5	2360.1	2044.8	1825.7	1509	1038.4
Left Side Normal Force	10157	9914.3	9381.1	8589.5	7580.5	6405	5129.6	3810.2	2441.2	1118.3
Left Side Shear Force	578.96	565.13	534.73	489.61	432.09	365.09	292.39	217.19	139.15	63.742
Right Side Normal Force	9914.3	9381.1	8589.5	7580.5	6405	5129.6	3810.2	2441.2	1118.3	
Right Side Shear Force	565.13	534.73	489.61	432.09	365.09	292.39	217.19	139.15	63.742	
Line Load										

Milwaukee Confined Disposal Facility DMMP
Settlement Calculations

Introduction

Estimates of soil settlement were performed for two areas of the proposed CDF dike construction. The first area involves a maximum thickness of dredge material over the compressible foundation (Figure 1). The second area involves calculating settlement at specified points in the foundation of the proposed dikes (Figure 2). Table 1 lists the lab data used for this analysis, further details on the lab data can be found in the Soil Profile. Table 2 lists the soil properties used for the dredge material settlement analysis. Table 3 lists the soil properties used for the dike foundation settlement analysis. Calculation tables for the dredge material and CDF foundation are shown in Tables 4 and 5 respectively. Separate calculation sheets are attached for the specified depths in the dike foundation settlement analysis. Hand calculations, graphs and correlations are also attached.

Analysis Assumptions

The assumptions used for this settlement analysis for each case are listed below:

Dredge Material and CDF Foundation

1) Uniform dredge material with properties similar to existing fill. Average lab data values will be used for dredge material and foundation.

2) Maximum settlement is determined. Layer thickness used is maximum thickness assuming 1 ft freeboard from top of dike. Height due to road is not included. The top surface of the placed dredge material is assumed to be flat.

3) Foundation is normally consolidated. This may yield higher settlements than actual.

5) Pre consolidation pressure assumed to be equal to initial effective stress for CDF foundation sub layers.

6) Water will not be continuously pumped out, and analysis assumes material settlement. Amount of water displaced due to additional material placement will have to be factored in the available capacity calculations.

7) Void ratios are approximate and were determined from graphical means using existing lab data (see Graph 1).

8) Assume double drainage for dredge material and foundation layers.

9) Graph 2 used to approximate percent consolidation at 20 years.

10) Assume no modification to foundation soil.

Dike Foundation

1) Lab data corresponding to specified depth will be used for this analysis.

2) Minimum coefficient of consolidation used for time rate calculation (realistic, but more conservative).

3) External loads are neglected because they are temporary. Long term effect assumed to be minimal.

4) Graph 2 used to approximate percent consolidation at 20 years.

5) Assume double drainage for dike foundation layers.

6) Assume no modification to dike foundation soil.

Results and Conclusions

Table 6 shows the results for the dredge material settlement calculations and Table 7 shows the results for the dike foundation settlement calculations. The results show the expected settlement for each case using the above assumptions. The difference in total settlement between the CDF foundation and dike foundation is due to differing layer thicknesses, and selected parameters. Actual settlement may be more or less depending on soil type, location in CDF, thickness of layers, method of placement, frequency and quantity of material placement, drainage, etc. As stated in the assumptions, water displacement due to adding dredge material needs to be accounted for in quantity calculations. Estimated settlement will also be reduced due to any foundation treatment for the dikes but this will also reduce long term maintenance of the dikes.

Recommendations

To maximize available capacity of the CDF over the 20 year design life, it is recommended that a long term pump system be considered. Maximum settlement due to consolidation of material in the CDF may be increased by maintaining a low water level before and after placement of dredge material. The removal of water increases the effective vertical pressure on the underlying soil thereby increasing consolidation. Additional analysis would be required to develop an effective long term system. Furthermore, funding would need to be provided throughout the life of the CDF on an annual or as-needed basis to maintain the pump system. A cost analysis should also be conducted to estimate the savings due to the additional available capacity versus the cost of maintaining a pump system.

References

1) EM1110-1-1904, Settlement Analysis, 30 Sept 1990.

2) EM1110-2-5027, Confined Disposal of Dredged Material, 30 Sept 1987.

3) Milwaukee Confined Disposal Facility DMMP Geotechnical Investigation Report, prepared by STS Consultants, Dec 2006.

4) Study Report - Milwaukee Harbor, WI, Increasing Disposal Capacity by Dike Raising, May 1996.

5) Das, Braja M., Principles of Foundation Engineering, 2nd Edition, PWS Publishing division of Wadsworth, Inc., 1990.

Prepared by: _____
Steven Wyrembelski
Geotechnical and Structural Eng. Branch

Checked by: _____
Tina Kowitz, P.E.
Geotechnical and Structural Eng. Branch

Figure 1. Cross-Section for Dredge Material Settlement Analysis

(Not to scale)

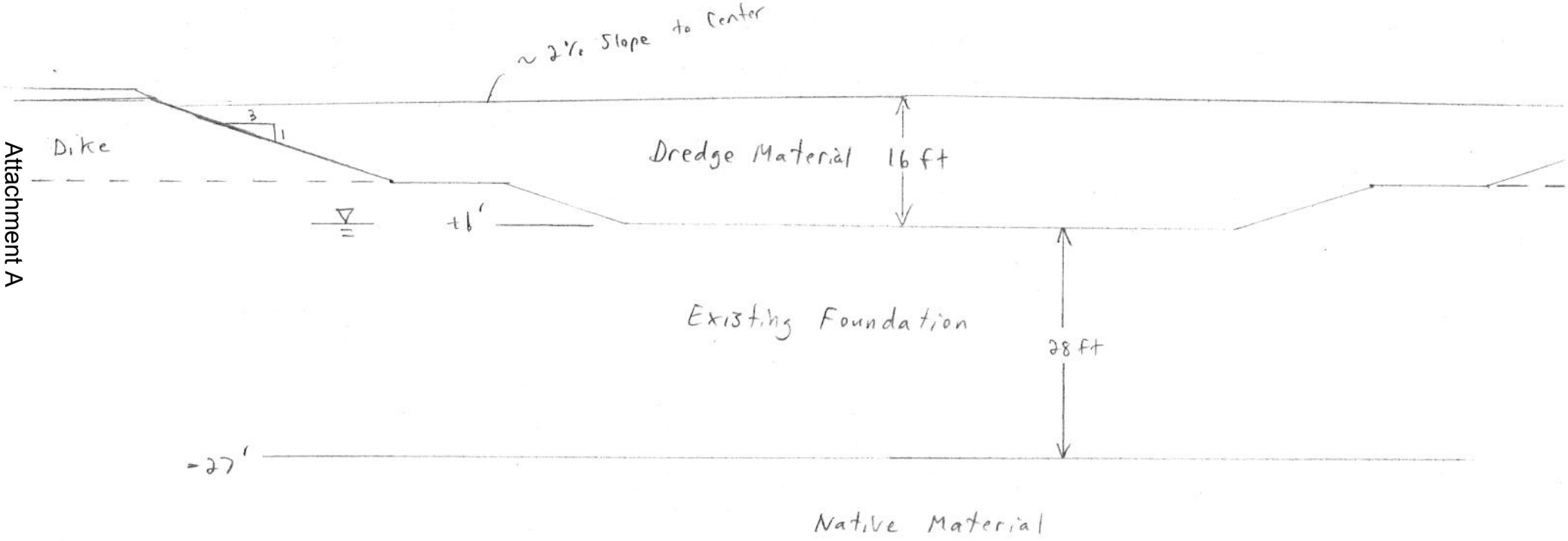
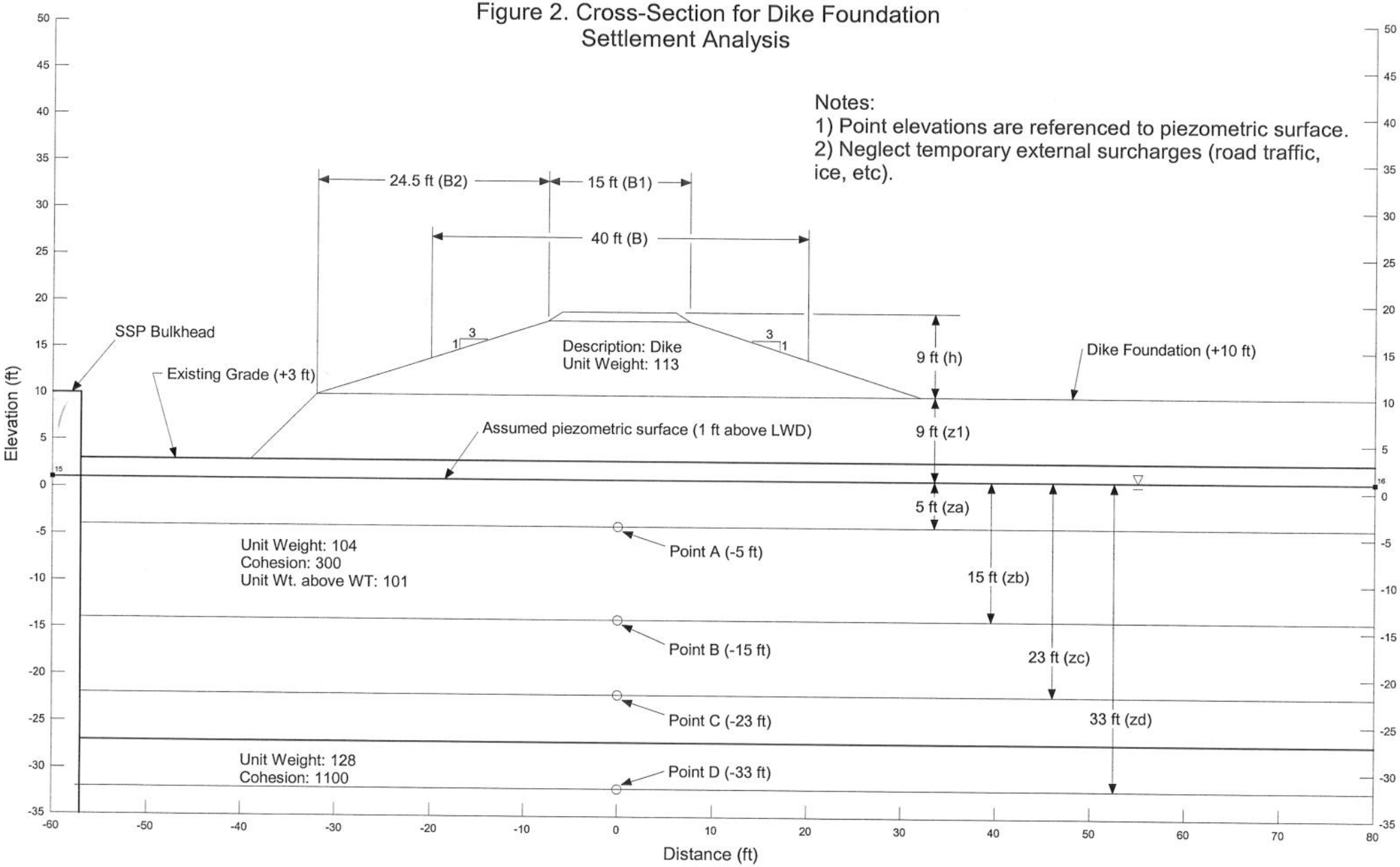


Figure 2. Cross-Section for Dike Foundation Settlement Analysis



Milwaukee CDF Settlement Analysis

Table 1. Summary Lab Test Data*

Water line is assumed to be 1 ft above LWD (577.5 ft), data depths corrected to water line.

Test location	Sample #	Data Depth below water (ft)	Pc (tsf)	Cc	e_o	Cv (in^2/sec)	SG	LL	w	γ_d (pcf)	γ_s (pcf)
MV-1-06	12	18.4	2.6	0.146	0.51	4.37E-05	2.783	30	0.179	115.1	135.7
MV-1-06	17	28.4	2.5	0.12	0.4	2.80E-05	2.707	23	0.152	121.6	140.1
MV-3-06	15	27.9	4	0.075	0.32	2.33E-06	2.679	12	NA	NA	NA
MV-4-06	4	6.4	0.67	0.55	1.82	2.47E-06	2.501	58	0.695	54.8	92.9
MV-4-06	15	26.4	2.9	0.126	0.42	1.73E-05	2.728	22	0.156	119.8	138.5
MV-4-06	18	32.4	4.1	0.292	0.54	1.05E-05	2.721	28	0.194	110.6	132.1
MV-5-06	16	25.2	3.8	0.125	0.58	8.02E-07	2.749	24	0.216	108.7	132.2
MV-6-06	9	9.5	0.63	0.45	1.38	3.19E-06	2.549	49	0.502	66.9	100.5
MV-7-06	9	11.6	1.4	0.452	1.43	4.58E-06	2.549	63	0.632	61.3	100.0
MV-7-06	13	19.6	0.5	0.71	2.01	6.57E-07	2.532	65	0.75	52.4	91.7
MV-7-06	15	23.6	4.1	0.117	0.75	6.06E-07	2.649	NA	NA	NA	NA
MV-7-06	17	27.6	3	0.163	0.52	2.53E-05	2.728	26	0.182	112.1	132.5
					Ave ->	1.16E-05	2.656				

*Refer to Soil Profile for additional details

Table 2. Selected CDF Parameters for Analysis

	Thickness (ft)	Ave Cv (in^2/sec)	SG	γ_t (pcf)*
Dredge Mat'l	16	1.16E-05	2.656	165.8
Foundation	28	1.16E-05	2.656	165.8

*Where γ_t = SG * γ_w and (γ_w = 62.4 pcf)

Table 3. Selected Dike Foundation Parameters for Analysis

Water line is assumed to be 1 ft above LWD, data depths corrected to water line.

	Depth below water (ft)	Data Depth Used	Pc (tsf)	Cc	e_o	Cv (in^2/sec)	SG	LL#	γ_s (pcf)*
Point A	5	6.4	0.67	0.55	1.82	2.47E-06	2.501	58	92.9
Point B	15	11.6	1.4	0.452	1.43	4.58E-06	2.549	63	100.0
	15	18.4	2.6	0.146	0.51	4.37E-05	2.783	30	135.7
	use ->	ave	2.0	0.299	0.97	2.41E-05	2.666	47	118
Point C	23	23.6	4.1	0.117	0.75	6.06E-07	2.649	24	132.2
Point D	33	32.4	4.1	0.292	0.54	1.05E-05	2.721	28	132.1

#LL @ Point C taken from data depth 25.2

*γ_s @ Point C taken from data depth 25.2

Table 4. Dredge Material Ultimate Settlement Calculations

$\gamma_t = \gamma_s$ = 165.8 pcf

i	h_i (ft)	l_i (ft)	σ_i' (psf)	e_i	σ_f' (psf)	e_f	h_f (ft)	δ (ft)
1	1.00	0.131	0	6.65	6.8	5.33	0.83	0.17
2	1.00	0.131	0	6.65	20.3	4.56	0.73	0.27
3	1.00	0.131	0	6.65	33.8	4.21	0.68	0.32
4	1.00	0.131	0	6.65	47.3	3.97	0.65	0.35
5	1.00	0.131	0	6.65	60.8	3.80	0.63	0.37
6	1.00	0.131	0	6.65	74.3	3.66	0.61	0.39
7	1.00	0.131	0	6.65	87.9	3.54	0.59	0.41
8	1.00	0.131	0	6.65	101.4	3.44	0.58	0.42
9	1.00	0.131	0	6.65	114.9	3.36	0.57	0.43
10	1.00	0.131	0	6.65	128.4	3.28	0.56	0.44
11	1.00	0.131	0	6.65	141.9	3.21	0.55	0.45
12	1.00	0.131	0	6.65	155.4	3.15	0.54	0.46
13	1.00	0.131	0	6.65	169.0	3.09	0.53	0.47
14	1.00	0.131	0	6.65	182.5	3.04	0.53	0.47
15	1.00	0.131	0	6.65	196.0	2.99	0.52	0.48
16	1.00	0.131	0	6.65	209.5	2.94	0.52	0.48
	16.00	2.092					9.62	6.38

Where:

i = sublayer number
h_i = initial layer thickness
l_i = initial reduced thickness
σ_i' = initial ave effective stress
γ_s = saturated unit weight
e_i = initial void ratio
σ_f' = final ave effective stress
e_f = final void ratio
h_f = final layer thickness
δ = ultimate settlement

Equations from EM1110-2-5027

F-3

$$\ell_i = \frac{h_{i,o}}{1 + e_{i,o}}$$

F-5

$$\sigma_f' = \sigma'_{1,\infty} = \frac{1}{2}\ell_1 (\gamma_s - \gamma_w)$$

F-2

$$h_f = h_{1,\infty} = \ell_1 (1 + e_{1,\infty})$$

F-4

$$\delta(\infty) = \sum_{i=1}^{m} (e_{i,o} - e_{i,\infty})\, \ell_i$$

where:

$e_i = e_{i,o}$ $\qquad$ $e_f = e_{i,\infty}$

Table 5. CDF Foundation Ultimate Settlement Calculations

$\gamma_t = \gamma_s$ = 165.8 pcf

i	h_i (ft)	l_i (ft)	σ_i' (psf)*	e_i	σ_f' (psf)	e_f	h_f (ft)	δ (ft)
1	10.00	3.771	1340.0	1.65	1556.3	1.55	9.61	0.39
2	10.00	5.283	4000.0	0.89	4216.3	0.86	9.81	0.19
3	8.00	5.738	8200.0	0.39	8416.3	0.38	7.90	0.10
	28.00	14.79					27.31	0.69

*Pc from consolidation tests (see also Table 3)

Milwaukee CDF Settlement Analysis

Table 6. Results of Settlement Calculations for Dredge Material and Foundation

	Dredge Mat'l	Foundation
Ultimate Settlement (ft)	6.38	0.69
Estimated Time for 90% Consolidation (yrs)	21.4	65.6
Time factor at 20 yrs	0.794	0.259
Estimated % Consolidated at 20 years	88	58

Total estimated ultimate settlement of dredge material (ft)	**7.07**
Approx settlement of dredge material @ 20 yrs (ft)	**6.01**

Table 7. Results of Settlement Calculations for Dike Foundation

	Point A	Point B	Point C	Point D
Depth below water (ft)	5	15	23	33
Initial Settlement (in)	0.22	0.43	0.63	0.76
Initial Settlement (ft)	0.02	0.04	0.05	0.06
Consolidation Settlement (in)	5.66	1.28	0.60	0.98
Consolidation Settlement (ft)	0.47	0.11	0.05	0.08
Total Settlement (ft)	0.49	0.15	0.10	0.14
Estimated Time for 90% Consolidation (yrs)	76.8	23.1	1635.8	162.6
Estimated % Consolidated at 20 years	53	86	9	36

Total estimated settlement under center of structure (ft)	**0.88**
Approx settlement under center of structure @ 20 yrs (ft)	**0.55**

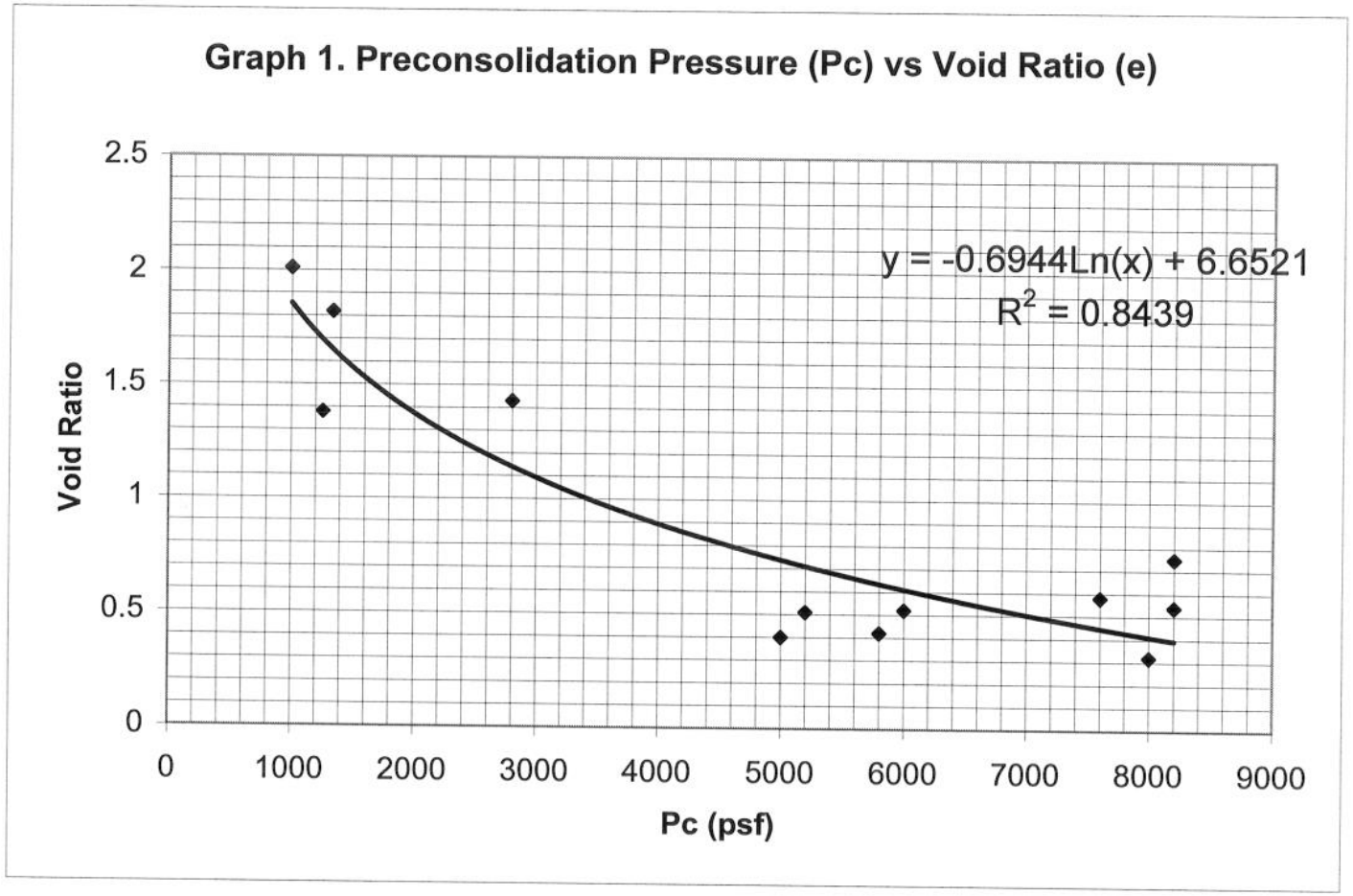
Data from lab tests

Pc (tsf)	Pc (psf)	e_o
2.6	5200	0.51
2.5	5000	0.4
4	8000	0.32
0.67	1340	1.82
2.9	5800	0.42
4.1	8200	0.54
3.8	7600	0.58
0.63	1260	1.38
1.4	2800	1.43
0.5	1000	2.01
4.1	8200	0.75
3	6000	0.52

Equation to determine e:

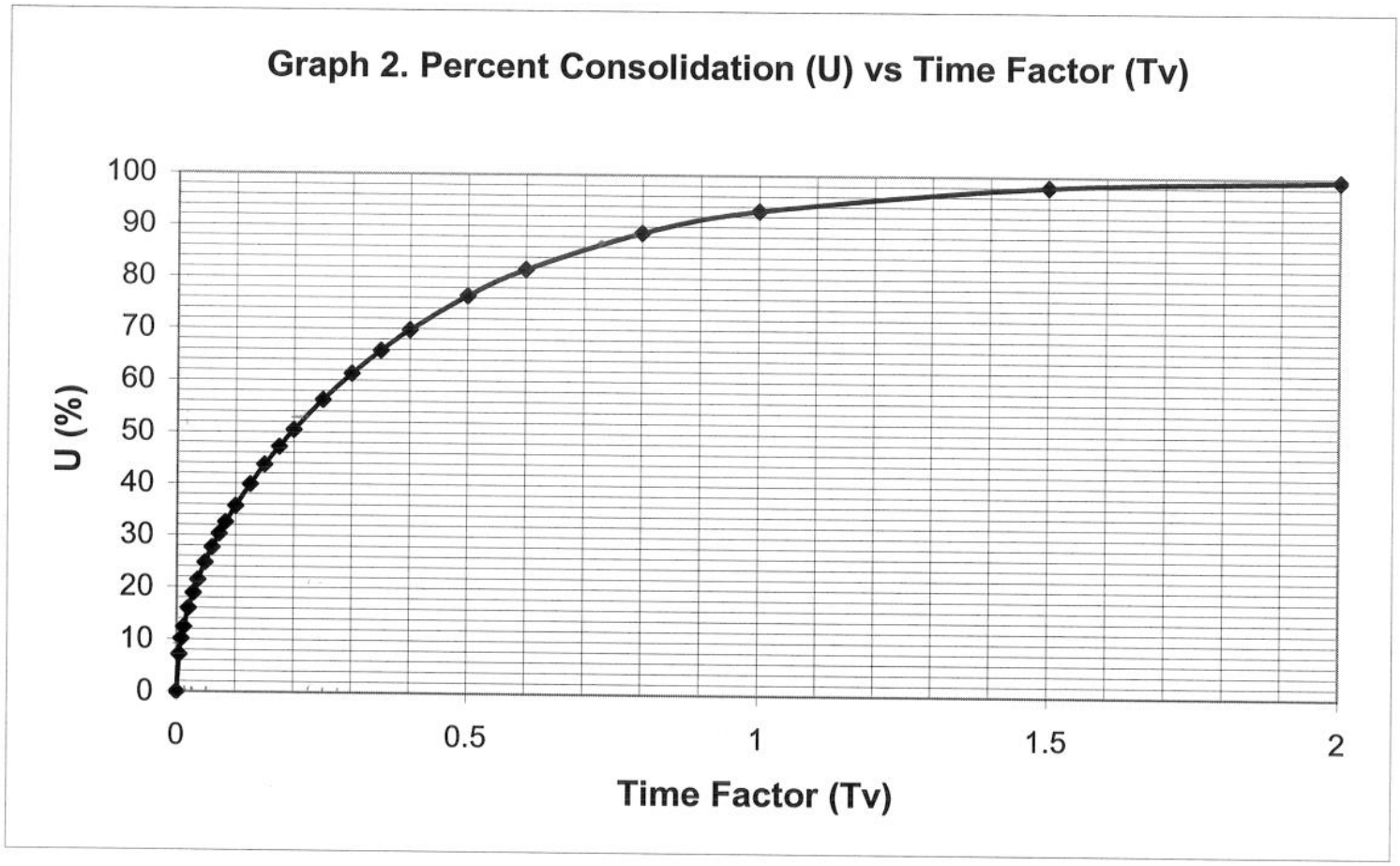
$y = -0.6944Ln(x) + 6.6521$

where:
x = e, void ratio
y = pressure



From EM1110-1-1904
Table 3-10, Case 1

Tv	U (%)
0	0
0.004	7.14
0.008	10.09
0.012	12.36
0.02	15.96
0.028	18.88
0.036	21.4
0.048	24.72
0.06	27.64
0.072	30.28
0.083	32.51
0.1	35.68
0.125	39.89
0.15	43.7
0.175	47.18
0.2	50.41
0.25	56.22
0.3	61.32
0.35	65.82
0.4	69.79
0.5	76.4
0.6	81.56
0.8	88.74
1	93.13
1.5	98
2	99.42



US Army Corps of Engineers
Detroit District

Milwaukee CDF (DMMP)

Soil Foundation Settlement Calculations
Typical Section, End-of-Construction

Computed by: SW **Date:** 23-Apr-07
Checked by: JPK **Date:** 9 May 07

Point A

Inputs

Dike height (ft)	9.0
Dike base eff. length (ft)	40
Dike unit wt. (pcf)	113
Fdn layer above water (ft)	9
Depth to point from water (ft)	5
Fdn unit wt. above water (pcf)	101
Fdn unit wt. above point (pcf)	104
Unit wt. at point (pcf)	93
Estimated cohesion (psf)	300
LL at point	58
Specific Gravity at point	2.50
Initial void ratio (eo) at point	1.82
pc at point (psf)	1340
Cc at point	0.550
Calculated Δp (psf)	876.7
Janbu influence factor μ0	1.0
Janbu influence factor μ1	0.10
Cv (in^2/sec)	2.47E-06
Double drainage?	yes

Results

q (psf)	1017.0
Hc (ft)	14.0
po (psf)	1061.5
OCR	1.3
Overconsolidated?	yes
Young's Modulus (psf)	2.25E+05
Cv (ft^2/day)	1.48E-03
Fdn layer thickness (ft)	14.0
Swell index Cs	0.067
Sc Equation used	1.69
ρ_i (feet)	0.02
ρ_i (inches)	0.22
Sc (feet)	0.47
Sc (inches)	5.66
Total Settlement (inches)	**5.87**
Ave time 90% consolid (yrs)	**76.82**
Time factor at 20 yrs	**0.221**
Approx % Consolid at 20 yrs	**53.0** *

*From Graph 2

Assumptions

1) Water unit wt. of 62.4 pcf
2) Dike length, L, is infinite
3) Point/layer locations and data based on consolidation test results

Equations used:

Immediate Settlement
(EM1110-1-1904, eq 3-17)

$$\rho_i = \mu_0 \cdot \mu_1 \cdot \frac{q \cdot B}{E_s}$$

Consolidation
(Das, 1990, eq 1.65)
(for normally consolidated clays)

$$S_c = \frac{C_c H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_o}$$

(Das, 1990, eq 1.67)
(for overconsolidated clays with $p_o + \Delta p_{av} < p_c$)

$$S_c = \frac{C_s H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_o}$$

(Das, 1990, eq 1.69)
(for overconsolidated clays with $p_o < p_c < p_o + \Delta p_{av}$)

$$S_c = \frac{C_s H_c}{1 + e_o} \log \frac{p_c}{p_o} + \frac{C_c H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_c}$$

(Das, 1990, eq 1.62)

$$C_s = 0.0463 e_L = 0.0463 \left(\frac{LL}{100}\right) G_s$$

(EM1110-1-1904, eq 3-27b)
Taylor square root of time method

$$c_v = \frac{0.848 h_e^2}{t_{90}}$$

US Army Corps of Engineers
Detroit District

Milwaukee CDF (DMMP)

Soil Foundation Settlement Calculations
Typical Section, End-of-Construction

Computed by: SW **Date:** 23-Apr-07
Checked by: JPK **Date:** 9 May 07

Point B

Inputs

Dike height (ft)	9.0
Dike base eff. length (ft)	40
Dike unit wt. (pcf)	113
Fdn layer above water (ft)	9
Depth to point from water (ft)	15
Fdn unit wt. above water (pcf)	101
Fdn unit wt. above point (pcf)	104
Unit wt. at point (pcf)	118
Estimated cohesion (psf)	300
LL at point	47
Specific Gravity at point	2.67
Initial void ratio (eo) at point	0.97
pc at point (psf)	4000
Cc at point	0.299
Calculated Δp (psf)	722.1
Janbu influence factor μ0	1.0
Janbu influence factor μ1	0.20
Cv (in^2/sec)	2.41E-05
Double drainage?	yes

Results

q (psf)	1017.0
Hc (ft)	24.0
po (psf)	1743.0
OCR	2.3
Overconsolidated?	yes
Young's Modulus (psf)	2.25E+05
Cv (ft^2/day)	1.45E-02
Fdn layer thickness (ft)	24.0
Swell index Cs	0.058
Sc Equation used	1.67
ρ_i (feet)	0.04
ρ_i (inches)	0.43
Sc (feet)	0.11
Sc (inches)	1.28
Total Settlement (inches)	**1.71**
Ave time 90% consolid (yrs)	**23.14**
Time factor at 20 yrs	**0.733**
Approx % Consolid at 20 yrs	**86.0** *

*From Graph 2

Assumptions

1) Water unit wt. of 62.4 pcf
2) Dike length, L, is infinite
3) Point/layer locations and data based on consolidation test results

Equations used:

Immediate Settlement
(EM1110-1-1904, eq 3-17)

$$\rho_i = \mu_0 \cdot \mu_1 \cdot \frac{q \cdot B}{E_s}$$

Consolidation
(Das, 1990, eq 1.65)
(for normally consolidated clays)

$$S_c = \frac{C_c H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_o}$$

(Das, 1990, eq 1.67)
(for overconsolidated clays with $p_o + \Delta p_{av} < p_c$)

$$S_c = \frac{C_s H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_o}$$

(Das, 1990, eq 1.69)
(for overconsolidated clays with $p_o < p_c < p_o + \Delta p_{av}$)

$$S_c = \frac{C_s H_c}{1 + e_o} \log \frac{p_c}{p_o} + \frac{C_c H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_c}$$

(Das, 1990, eq 1.62)

$$C_s = 0.0463 e_L = 0.0463\left(\frac{LL}{100}\right) G_s$$

(EM1110-1-1904, eq 3-27b)
Taylor square root of time method

$$c_v = \frac{0.848 h_e^2}{t_{90}}$$

US Army Corps of Engineers
Detroit District

Milwaukee CDF (DMMP)

Soil Foundation Settlement Calculations
Typical Section, End-of-Construction

Computed by: SW **Date:** 23-Apr-07
Checked by: JPR **Date:** 9 May 07

Point C

Inputs

Dike height (ft)	9.0
Dike base eff. length (ft)	40
Dike unit wt. (pcf)	113
Fdn layer above water (ft)	9
Depth to point from water (ft)	23
Fdn unit wt. above water (pcf)	101
Fdn unit wt. above point (pcf)	104
Unit wt. at point (pcf)	132
Estimated cohesion (psf)	300
LL at point	24
Specific Gravity at point	2.65
Initial void ratio (eo) at point	0.75
pc at point (psf)	8200
Cc at point	0.117
Calculated Δp (psf)	602.1
Janbu influence factor μ0	1.0
Janbu influence factor μ1	0.29
Cv (in^2/sec)	6.06E-07
Double drainage?	yes

Results

q (psf)	1017.0
Hc (ft)	32.0
po (psf)	2514.4
OCR	3.3
Overconsolidated?	yes
Young's Modulus (psf)	2.25E+05
Cv (ft^2/day)	3.64E-04
Fdn layer thickness (ft)	32.0
Swell index Cs	0.029
Sc Equation used	1.67
ρ_i (feet)	0.05
ρ_i (inches)	0.63
Sc (feet)	0.05
Sc (inches)	0.60
Total Settlement (inches)	**1.23**
Ave time 90% consolid (yrs)	**1635.76**
Time factor at 20 yrs	**0.010**
Approx % Consolid at 20 yrs	**9.0** *

*From Graph 2

Assumptions

1) Water unit wt. of 62.4 pcf
2) Dike length, L, is infinite
3) Point/layer locations and data based on consolidation test results

Equations used:

Immediate Settlement
(EM1110-1-1904, eq 3-17)

$$\rho_i = \mu_0 \cdot \mu_1 \cdot \frac{q \cdot B}{E_s}$$

Consolidation
(Das, 1990, eq 1.65)
(for normally consolidated clays)

$$S_c = \frac{C_c H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_o}$$

(Das, 1990, eq 1.67)
(for overconsolidated clays with $p_o + \Delta p_{av} < p_c$)

$$S_c = \frac{C_s H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_o}$$

(Das, 1990, eq 1.69)
(for overconsolidated clays with $p_o < p_c < p_o + \Delta p_{av}$)

$$S_c = \frac{C_s H_c}{1 + e_o} \log \frac{p_c}{p_o} + \frac{C_c H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_c}$$

(Das, 1990, eq 1.62)

$$C_s = 0.0463 e_L = 0.0463 \left(\frac{LL}{100}\right) G_s$$

(EM1110-1-1904, eq 3-27b)
Taylor square root of time method

$$c_v = \frac{0.848 h_e^2}{t_{90}}$$

US Army Corps of Engineers
Detroit District

Milwaukee CDF (DMMP)

Soil Foundation Settlement Calculations
Typical Section, End-of-Construction

Computed by: SW **Date:** 23-Apr-07
Checked by: JPR **Date:** 9 May 07

Point D

Inputs

Dike height (ft)	9.0
Dike base eff. length (ft)	40
Dike unit wt. (pcf)	113
Fdn layer above water (ft)	9
Depth to point from water (ft)	33
Fdn unit wt. above water (pcf)	101
Fdn unit wt. above point (pcf)	104
Unit wt. at point (pcf)	132
Estimated cohesion (psf)	300
LL at point	28
Specific Gravity at point	2.72
Initial void ratio (eo) at point	0.54
pc at point (psf)	8200
Cc at point	0.292
Calculated Δp (psf)	528.8
Janbu influence factor μ0	1.0
Janbu influence factor μ1	0.35
Cv (in^2/sec)	1.05E-05
Double drainage?	yes

Results

q (psf)	1017.0
Hc (ft)	42.0
po (psf)	2450.4
OCR	3.3
Overconsolidated?	yes
Young's Modulus (psf)	2.25E+05
Cv (ft^2/day)	6.30E-03
Fdn layer thickness (ft)	42.0
Swell index Cs	0.035
Sc Equation used	1.67
ρ_i (feet)	0.06
ρ_i (inches)	0.76
Sc (feet)	0.08
Sc (inches)	0.98
Total Settlement (inches)	**1.74**
Ave time 90% consolid (yrs)	**162.63**
Time factor at 20 yrs	**0.104**
Approx % Consolid at 20 yrs	**36.0** *

*From Graph 2

Assumptions

1) Water unit wt. of 62.4 pcf
2) Dike length, L, is infinite
3) Point/layer locations and data based on consolidation test results

Equations used:

Immediate Settlement
(EM1110-1-1904, eq 3-17)

$$\rho_i = \mu_0 \cdot \mu_1 \cdot \frac{q \cdot B}{E_s}$$

Consolidation
(Das, 1990, eq 1.65)
(for normally consolidated clays)

$$S_c = \frac{C_c H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_o}$$

(Das, 1990, eq 1.67)
(for overconsolidated clays with $p_o + \Delta p_{av} < p_c$)

$$S_c = \frac{C_s H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_o}$$

(Das, 1990, eq 1.69)
(for overconsolidated clays with $p_o < p_c < p_o + \Delta p_{av}$)

$$S_c = \frac{C_s H_c}{1 + e_o} \log \frac{p_c}{p_o} + \frac{C_c H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_c}$$

(Das, 1990, eq 1.62)

$$C_s = 0.0463 e_L = 0.0463 \left(\frac{LL}{100}\right) G_s$$

(EM1110-1-1904, eq 3-27b)
Taylor square root of time method

$$c_v = \frac{0.848 h_e^2}{t_{90}}$$

COMPUTATION SHEET

PROJECT Milwaukee CDF (DMMP) SHEET NO. 1 OF 7 SHEETS

ITEM Estimated Settlement Calculations DATE

SUBJECT FILE

COMPUTED BY SAW CHECKED BY JPL 9 May 07 REF DRAWING NO.

Assumptions

- Soil layers are uniform, so average values are used
- Disregard external loads (not constant)
- Settlement point/layer locations are based on consolidation test results
- No effect due to dewatering site prior to construction
- Dike foundation @ +10 ft prior to dike construction

References

1) EM 1110-1-1904, Settlement Analysis, 30 Sept 1990.
2) Das, Braja, Principles of Foundation Engineering, Second edition (1990), PWS Publishing Company, Boston.
3) Milwaukee CDF DMMP Geotechnical Investigation Report, prepared by STS Consultants, Dec 2006.

Parameters (Refer to Table 1 and Cross-Section)

Point A Settlement $\gamma_A = 101$ pcf $\gamma_{sat} = 104$ pcf

surcharge from dike $= q = \gamma_{dike} \cdot h = 113 \text{ pcf} \cdot 9 \text{ ft}$ $q = 1017$ psf

present eff. stress $= p_o = \gamma_A z_1 + \gamma_{sat} z_a - \gamma_w z_a$

$p_o = (101 \text{ pcf})(9 \text{ ft}) + (93 \text{ pcf})(5 \text{ ft}) - (62.4 \text{ pcf})(5 \text{ ft})$

909 465 312

$p_o = 1061.5$ psf

COMPUTATION SHEET

PROJECT Milwaukee COF (DMMP) SHEET NO. 2 OF 7 SHEETS

ITEM Estimated Settlement Calculations DATE

SUBJECT FILE

COMPUTED BY SAW CHECKED BY JPK 9May07 REF DRAWING NO.

Determine OCR $OCR = \frac{p_c}{p_o} = \frac{1340 \text{ psf}}{1067.5 \text{ psf}} = 1.26 > 1$ overconsolidated

Estimate Young's Modulus $E_s = 750\,c$ to $1000\,c$ for overconsolidated clay (Das, p. 161)

use conservative value $E_s = 750\,c$ $c = 300$ psf

$E_s = (750)(300 \text{ psf})$ $E_s = 225{,}000$ psf

Immediate Settlement

$S_i = \mu_0 \cdot \mu_1 \cdot \frac{q B}{E_s}$ (eq 3-17 EM 1110-1-1904)

$B = 40$ ft $q = 1017$ psf $E_s = 225{,}000$ psf $H = z_1 + z_2$

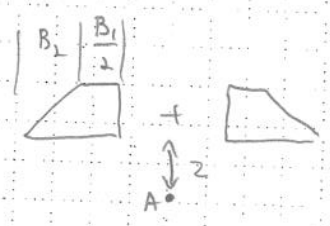
estimate μ_0 and μ_1 from attached Fig 3-8 $H = 14'$, assume $L = \infty$

$\mu_1 = 0.10$ $\mu_0 = 1$ $(D = 0)$ $H/B = 14'/40' = 0.35$

$S_i = 1.0 \cdot 0.10 \cdot \left(\frac{1017 \text{ psf} \cdot 40 \text{ ft}}{225{,}000 \text{ psf}}\right)$ $S_i = 0.018$ ft or 0.22 inches

Consolidation Settlement

$\Delta p = 2 I q$ (2 symmetrical areas)



determine I from attached Fig 3.40

$B_1 = \frac{15'}{2} = 7.5'$ $B_2 = 24.5'$ $z = H = 14'$ $\frac{B_1}{z} = \frac{7.5'}{14'} = 0.535$

$\frac{B_2}{z} = \frac{24.5'}{14'} = 1.75$ $I = 0.431$

COMPUTATION SHEET

PROJECT Milwaukee COF (DMMP) SHEET NO. 3 OF 7 SHEETS

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$\Delta p = 2 \cdot (0.431)(1017 \text{ psf})$ $\Delta p = 876.7$ psf

determine consolidation settlement equation (Das, pg. 168)

$p_o = 1061.5$ psf $p_c = 1340$ psf $\Delta p = 876.7$ psf

$p_o < p_c < p_o + \Delta p$ use eq. 1.69

$$S_c = \frac{C_s H}{1+e_o} \log \frac{p_c}{p_o} + \frac{C_c H}{1+e_o} \log \frac{p_o + \Delta p}{p_c}$$

Swelling index $= C_s = 0.0463 \left(\frac{LL}{100}\right) S.G.$ (Das, eq 1.62)

$C_s = 0.0463 \left(\frac{58}{100}\right) 2.50$ $C_s = 0.067$

$$S_c = \frac{(0.067)(14 \text{ ft})}{1+1.82} \log \frac{1340}{1061.5} + \frac{(0.55)(14 \text{ ft})}{1+1.82} \log \frac{1061.5 + 876.7}{1340}$$

$S_c = 0.333 \log 1.262 + 2.330 \log 1.446$

$S_c = 0.47$ ft or 5.65 inches

Total estimated settlement @ Point A

$S_T = S_i + S_c$ $S_T = 0.22$ in $+ 5.65$ in.

$S_T = 5.87$ inches

COMPUTATION SHEET

PROJECT Milwaukee COF (DMMP) SHEET NO. 4 OF 7 SHEETS

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Estimated time rate of consolidation for Dike Foundation

from EM 1110-1-1904 eq 3.22b @ 90% consolidation $t = \frac{0.848\, H_e^2}{C_v}$

Assume double drainage $H_e = \frac{H}{2} = \frac{14}{2} = 7.0' \rightarrow 84$ inches

C_v from consolidation test data MV-4-06, #S-4)

$$t_{90} = \frac{0.848\,(84\text{ in})^2}{2.47\times10^{-6}\ \text{in}^2/\text{sec}} \cdot \left(1.16\times10^{-5}\ \frac{\text{day}}{\text{sec}} \cdot \frac{1\text{ yr}}{365\text{ day}}\right)$$

$t_{90} = 26.8$ yrs

Time factor @ 20 years (T_v)

$t = 20$ yrs $T_v = \frac{t \cdot c_v}{(H_e)^2} = \frac{20\text{ yr} \cdot 2.47\times10^{-6}\ \frac{\text{in}^2}{\text{sec}} \cdot 86400\ \frac{\text{sec}}{\text{day}} \cdot \frac{365\text{ day}}{\text{yr}}}{(84\text{ in})^2}$

$T_v = 0.221$

Approx % consolidation @ 20 years

From Graph 2

% Consolidated at time factor (T_v) = 0.221

U = 53 % consolidated at 20 years

COMPUTATION SHEET

PROJECT Milwaukee COF (DMMP) SHEET NO. 5 OF 7 SHEETS

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Additional point calculations for Pts B, C, and D inputs

Point B

$H = 24'$ $H/B = 24'/40' = 0.6$, $\mu_1 = 0.2$

$z = H = 24'$ $\frac{B_1}{2} = \frac{2.5}{24} = 0.313$ $\frac{B_2}{2} = \frac{24.5}{24} = 1.02$ $I = 0.355$

$\Delta p = (2)(0.355)(1017 \text{ psf})$ $\Delta p = 722.07 \text{ psf}$

Point C

$H = 32'$ $H/B = 32'/40' = 0.8$ $\mu_1 = 0.29$

$z = H = 32'$ $\frac{B_1}{2} = \frac{2.5}{32} = 0.234$ $\frac{B_2}{2} = \frac{24.5}{32} = 0.766$ $I = 0.296$

$\Delta p = (2)(0.296)(1017 \text{ psf})$ $\Delta p = 602.06 \text{ psf}$

Point D

$H = 42'$ $H/B = 42'/40' = 1.05$ $\mu_1 = 0.35$

$z = H = 42'$ $\frac{B_1}{2} = \frac{2.5}{42} = 0.179$ $\frac{B_2}{2} = \frac{24.5}{42} = 0.583$ $I = 0.26$

$\Delta p = (2)(0.26)(1017 \text{ psf})$ $\Delta p = 528.84 \text{ psf}$

COMPUTATION SHEET

PROJECT Milwaukee CDF (DMMP) SHEET NO. 6 OF 7 SHEETS

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Estimated time rate of consolidation for Dredge Material & Foundation

$t_{90} = \frac{0.848\, h^2}{c_v}$ Assume double drainage $H_e = \frac{H}{2} = \frac{16'}{2} = 8' \rightarrow 96$ inches

$c_v = 1.16 \times 10^{-5}\ in^2/sec$ $t_{90} = \frac{0.848 \cdot (96\ in)^2}{1.16 \times 10^{-5}\ \frac{in^2}{sec}} \left(1.16 \times 10^{-5}\ \frac{day}{sec} \cdot \frac{1\ yr}{365\ day}\right)$

$t_{90} = 21.4$ yrs dredge material

Foundation $H_e = \frac{28}{2} = 14' \rightarrow 168$ inches $c_v = 1.16 \times 10^{-5}\ in^2/sec$

$t_{90} = \frac{0.848\ (168\ in)^2}{1.16 \times 10^{-5}\ in^2/sec} \left(1.16 \times 10^{-5}\ \frac{day}{sec} \cdot \frac{1\ yr}{365\ day}\right)$ $t_{90} = 65.6$ yrs foundation

Time factor @ 20 years

$t = 20$ yrs $T_v = \frac{t \cdot c_v}{(H_e)^2} = \frac{20\ yr \cdot 1.16 \times 10^{-5}\ \frac{in^2}{sec} \cdot 86400\ \frac{sec}{day} \cdot \frac{365\ day}{1\ yr}}{(96\ in)^2} = \frac{7316.4\ in^2}{(96\ in)^2}$

$T_v = 0.794$ dredge material

$T_v = \frac{7316.4\ in^2}{(168\ in)^2} = 0.259$ foundation

Approximate % consolidation @ 20 yrs From Graph 2

dredge material % consolidated at time factor $(T_v) = 0.794$

COMPUTATION SHEET

PROJECT Milwaukee COF (DMMP) SHEET NO. 7 OF 7 SHEETS

ITEM Estimated Settlement Calculations DATE

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U = 88 % dredge material

foundation % consolidated at time factor (T_v) = 0.259

U = 58 % foundation

Approximate settlement of material @ 20 yrs

ultimate settlement dredge material = 6.38 ft

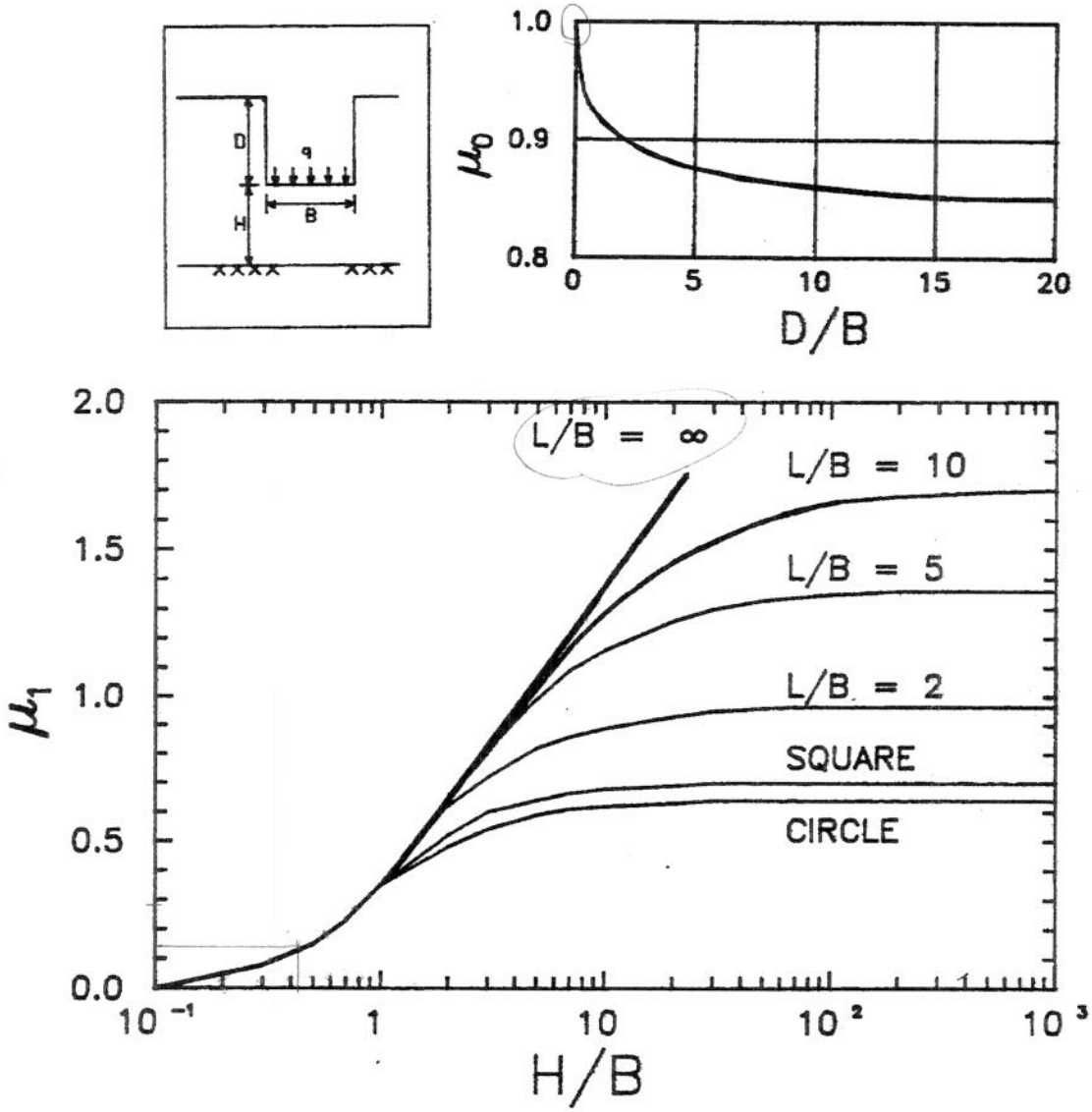
" " foundation = 0.69 ft

Approx. settlement (@ 20 yrs) = $\left(6.38' \cdot \frac{88}{100}\right) + \left(0.69' \cdot \frac{58}{100}\right)$

= 6.01 ft

Total settlement of dredge material + fdn

= 6.38' + 0.69' = 7.07 ft



$$\rho_i = \mu_o \cdot \mu_1 \cdot \frac{q \cdot B}{E_s^*}$$

L = LENGTH, FT
B = WIDTH, FT
E_s^* = EQUIVALENT YOUNG'S SOIL MODULUS, TSF
ν_s = POISSON'S RATIO, 0.5

Figure 3-8. Chart for estimating immediate settlement in cohesive soil. Reprinted by permission of the National Research Council of Canada from Canadian Geotechnical Journal, Vol 15, 1978, "Janbu, Bjerrum, and Kjaernsli's Chart Reinterpreted", by J. T. Christian and W. D. Carrier III, p 127.