Summary for Subcatchment 1S: Subcatchment P-1 (North)

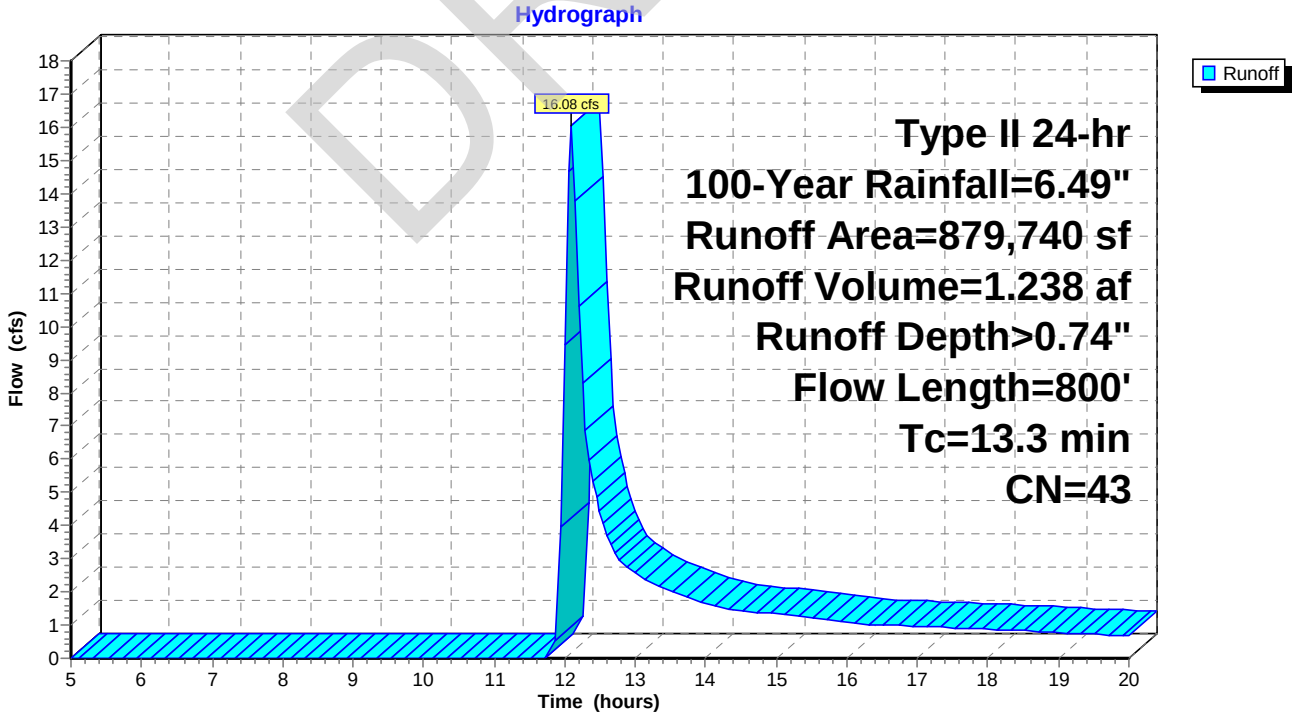
Runoff = 16.08 cfs @ 12.09 hrs, Volume= 1.238 af, Depth> 0.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=6.49"

Area (sf)	CN	Description
194,665	39	>75% Grass cover, Good, HSG A
554,920	43	Woods/grass comb., Fair, HSG A
130,155	48	Brush, Poor, HSG A
879,740	43	Weighted Average
879,740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.7	100	0.0600	0.16		**Sheet Flow, Segment AB** Grass: Dense n= 0.240 P2= 2.37"
1.5	400	0.0750	4.41		**Shallow Concentrated Flow, Segment BC** Unpaved Kv= 16.1 fps
1.1	300	0.0570	4.61	23.05	**Channel Flow, Segment CD** Area= 5.0 sf Perim= 16.3' r= 0.31' n= 0.035 Earth, dense weeds
13.3	800	Total			

Subcatchment 1S: Subcatchment P-1 (North)



Summary for Subcatchment 2S: Subcatchment P-2 (East)

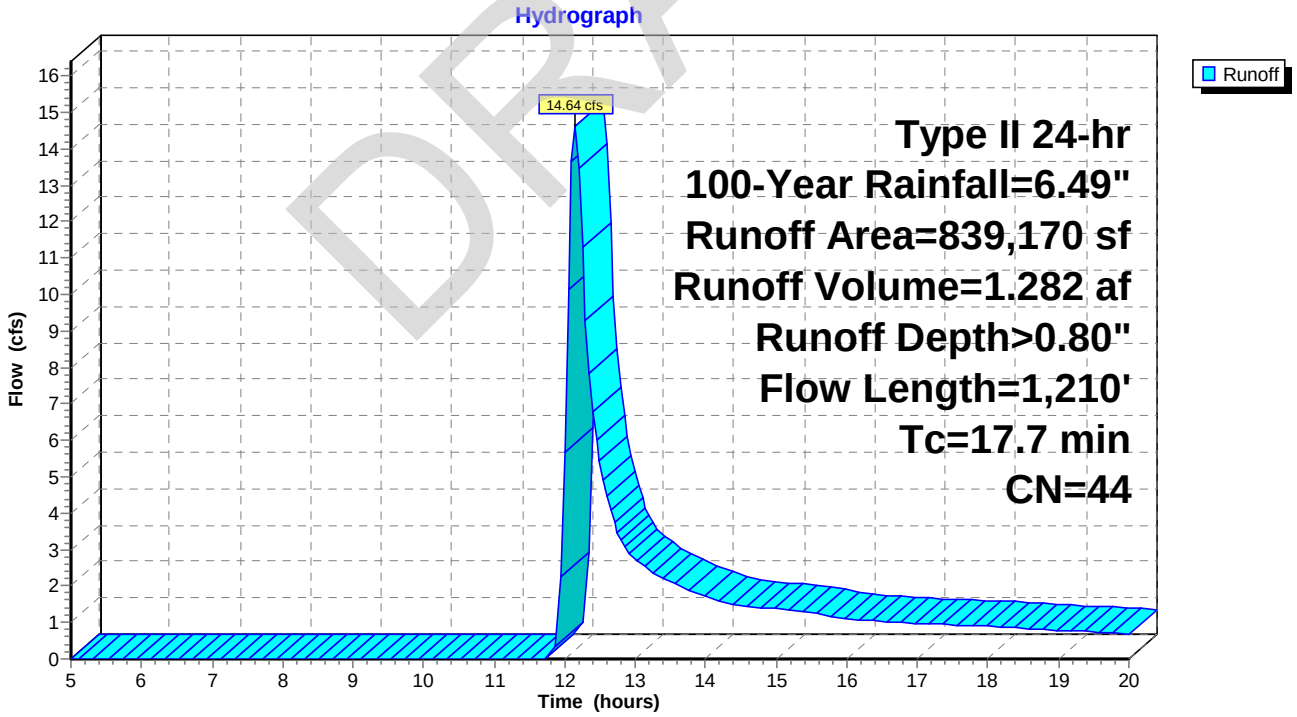
Runoff = 14.64 cfs @ 12.15 hrs, Volume= 1.282 af, Depth> 0.80"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=6.49"

Area (sf)	CN	Description
55,500	39	>75% Grass cover, Good, HSG A
582,650	43	Woods/grass comb., Fair, HSG A
201,020	48	Brush, Poor, HSG A
839,170	44	Weighted Average
839,170		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.6	100	0.0400	0.13		**Sheet Flow, Segment AB** Grass: Dense n= 0.240 P2= 2.37"
5.1	1,110	0.0500	3.60		**Shallow Concentrated Flow, Segment BC** Unpaved Kv= 16.1 fps
17.7	1,210	Total			

Subcatchment 2S: Subcatchment P-2 (East)



Summary for Subcatchment 3S: Subcatchment P-3 (Central)

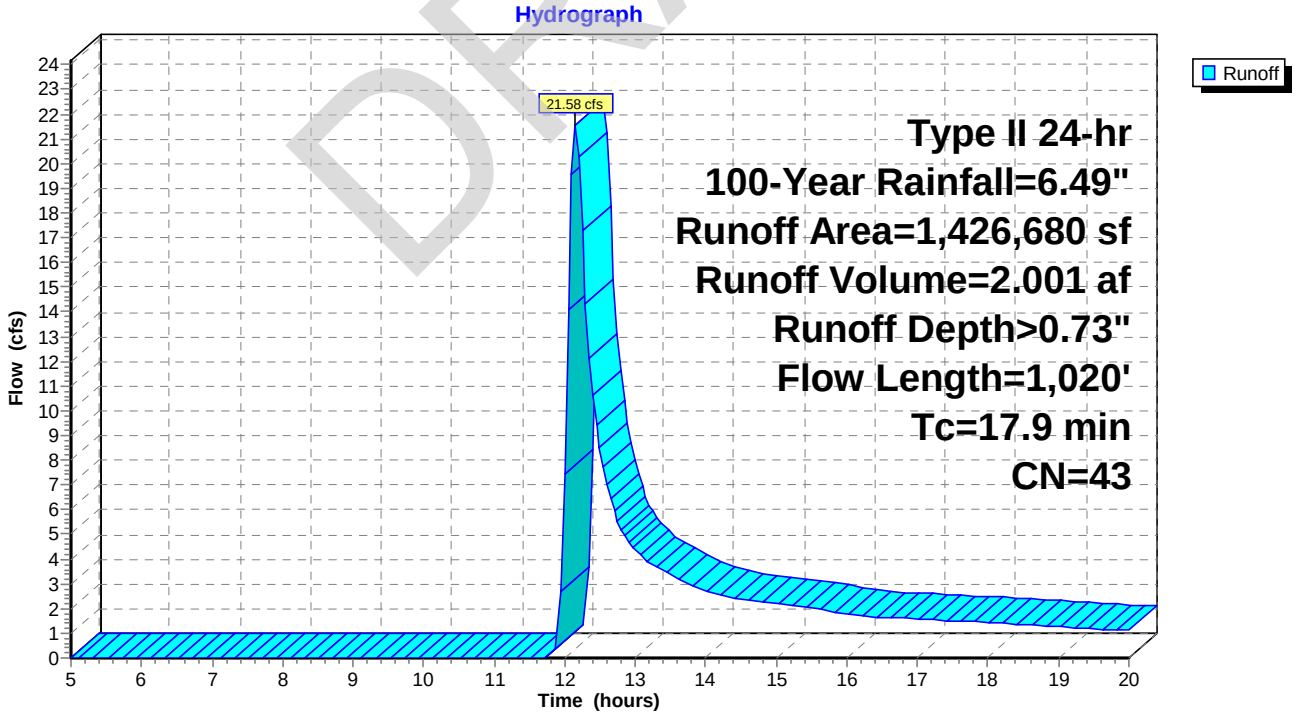
Runoff = 21.58 cfs @ 12.15 hrs, Volume= 2.001 af, Depth> 0.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=6.49"

Area (sf)	CN	Description
755,635	39	>75% Grass cover, Good, HSG A
671,045	48	Brush, Poor, HSG A
1,426,680	43	Weighted Average
1,426,680		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.6	100	0.0400	0.13		**Sheet Flow, Segment AB** Grass: Dense n= 0.240 P2= 2.37"
0.7	170	0.0650	4.10		**Shallow Concentrated Flow, Segment BC** Unpaved Kv= 16.1 fps
4.6	750	0.0430	2.73	32.75	**Channel Flow, Segment CD** Area= 12.0 sf Perim= 20.9' r= 0.57' n= 0.078 Riprap, 12-inch
17.9	1,020	Total			

Subcatchment 3S: Subcatchment P-3 (Central)



Summary for Subcatchment 4S: Subcatchment P-4 (West Central)

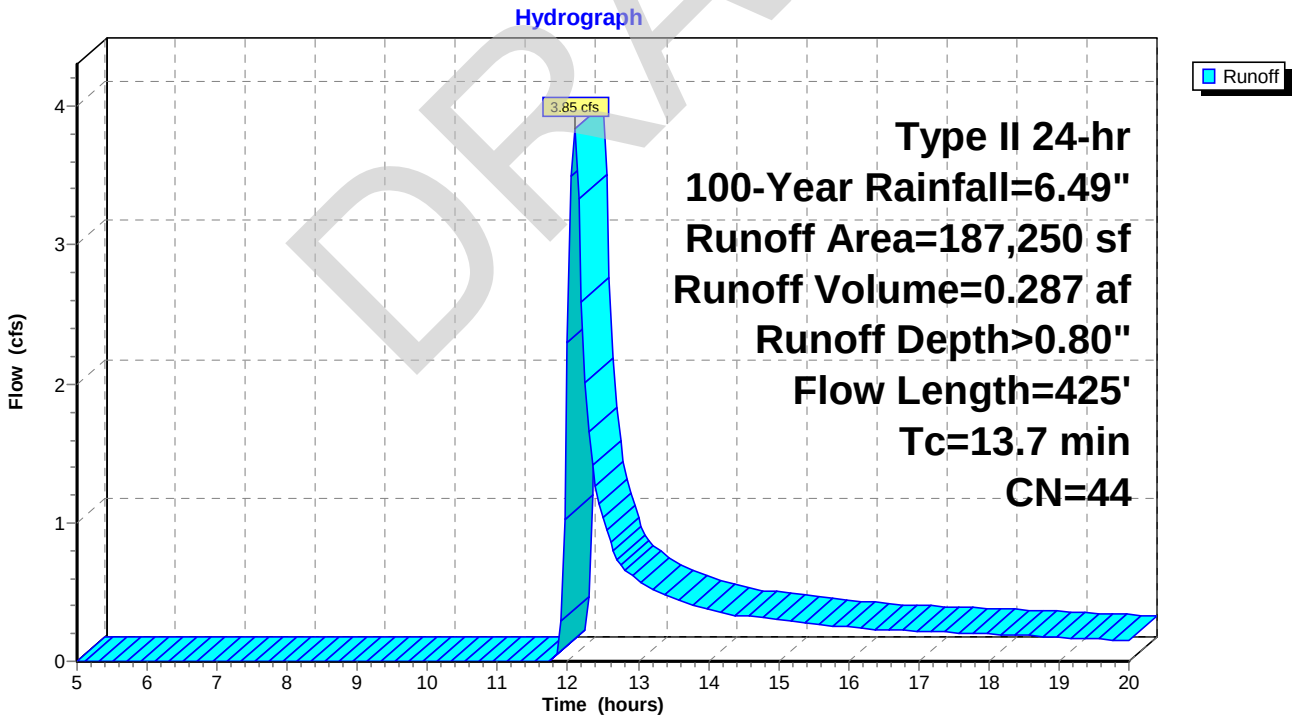
Runoff = 3.85 cfs @ 12.10 hrs, Volume= 0.287 af, Depth> 0.80"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=6.49"

Area (sf)	CN	Description
85,475	39	>75% Grass cover, Good, HSG A
101,775	48	Brush, Poor, HSG A
187,250	44	Weighted Average
187,250		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.6	100	0.0400	0.13		**Sheet Flow, Segment AB** Grass: Dense n= 0.240 P2= 2.37"
1.1	325	0.0920	4.88		**Shallow Concentrated Flow, Segment BC** Unpaved Kv= 16.1 fps
13.7	425	Total			

Subcatchment 4S: Subcatchment P-4 (West Central)



Summary for Pond 1P: Proposed Retention Pond

Inflow Area = 32.752 ac, 0.00% Impervious, Inflow Depth > 0.73" for 100-Year event
Inflow = 21.58 cfs @ 12.15 hrs, Volume= 2.001 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

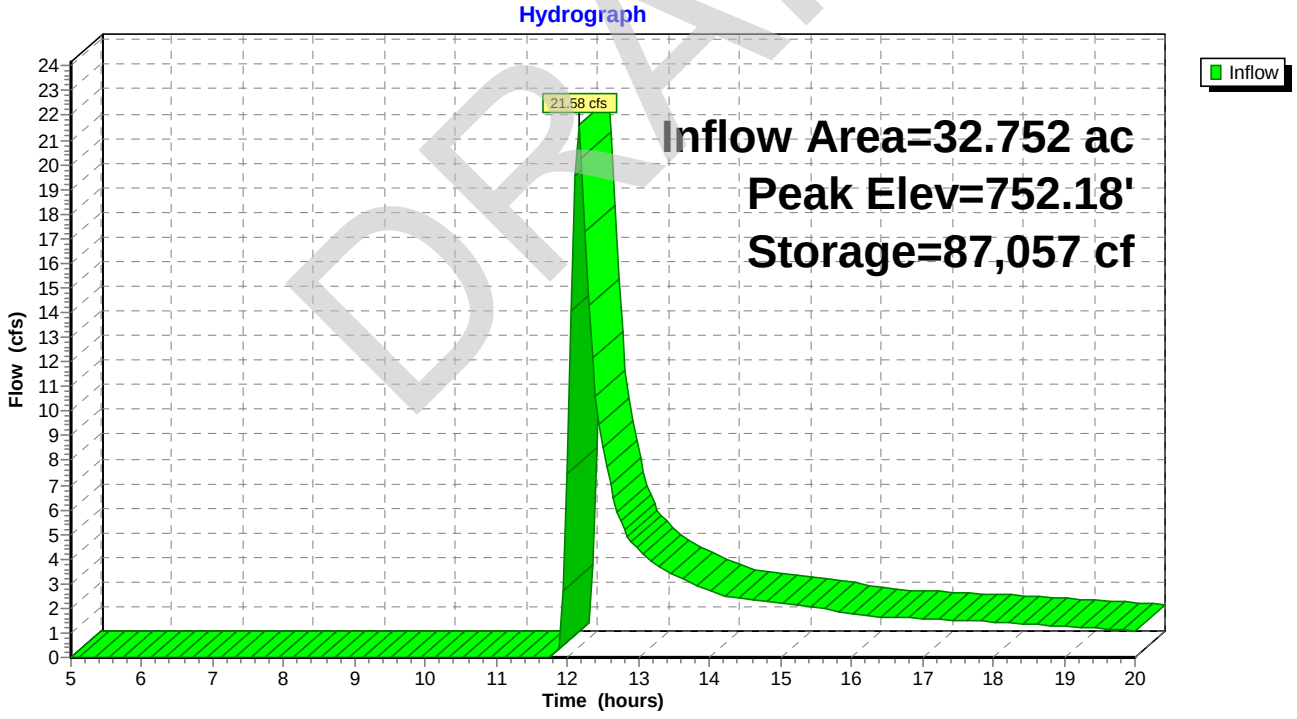
Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 752.18' @ 20.00 hrs Surf.Area= 47,458 sf Storage= 87,057 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	750.00'	669,750 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
750.00	32,350	0	0
760.00	101,600	669,750	669,750

Pond 1P: Proposed Retention Pond



ATTACHMENT A.2

STORMWATER DRAINAGE PIPE CALCULATIONS

(LEFT BLANK IN CASE REQUIRED)

ATTACHMENT A.3

SLOPE STABILITY CALCULATIONS

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JOB House Street Cap - Slope
SHEET NO. 1 OF 5
CALCULATED BY B. Hanna DATE
CHECKED BY DATE
SCALE NTS

Slope Stability Assessment

Upper Soils for use for perimeter berm construction & for caps cover / barrier protection soil.

Soils are either fine sand or silty clay

Standard penetration test "N" values obtained from these two material types (from geotechnical test borings) are:

Sand:	GT-1 average "N" value =	7	Average ~ 12; then assume moist unit weight at 112 pcf & 33° friction angle
	GT-2 =	10	
	GT-3 =	21	
	GT-4 =	13	
	GT-5 =	9	
	GT-6 =	--	
Silty Clay:	GT-1 average "N" value =	3	Average ~ 7; then assume moist unit weight at 120 pcf & shear strength @ 1500 psf.
	GT-1 =	15	
	GT-3 =	6	
	GT-4 =	7	
	GT-5 & GT-6 =	7	

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SHEET NO. 2 OF 5
CALCULATED BY E. Hanna DATE
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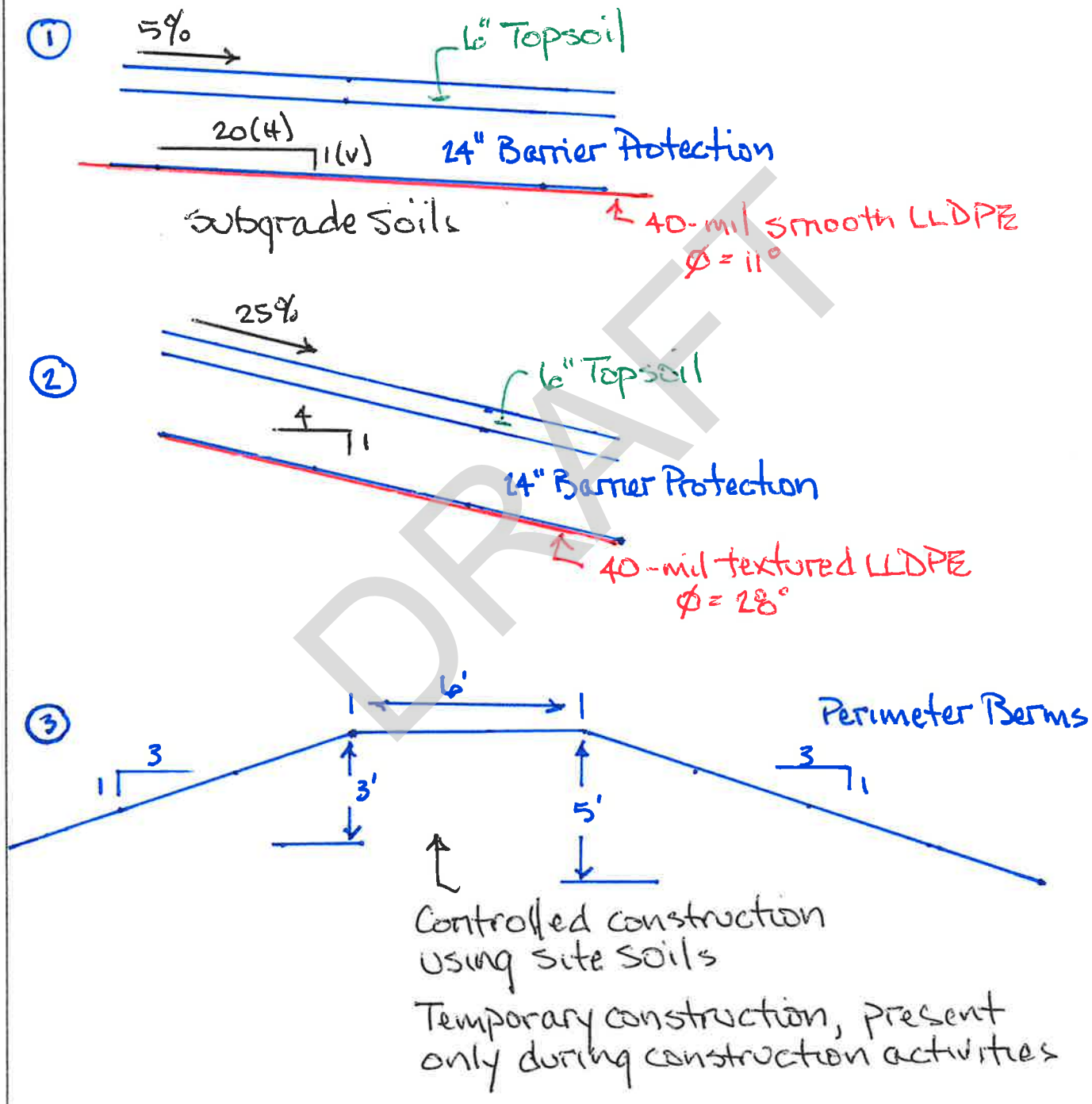
Slopes for Consideration



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By inspection, an infinite slope stability assessment is applicable.

Infinite Slope Factor of Safety (FS) = $\frac{\tan\phi}{\tan\beta}$

Where ϕ = soil angle of internal friction

β = slope angle relative to horizontal

Material Type	Friction Angle (ϕ)	Tangent ϕ
Topsoil	28°	0.53
Sand	33°	0.65
Clay	26°	0.49
Smooth LLDPE	11°	0.19
Textured LLDPE	28°	0.53

Slope Angles	Slope	Angle (β)	
5%	20'(H):1'(V)	3°	0.05
25%	4'(H):1'(V)	14°	0.25
33%	3'(H):1'(V)	18°	0.33

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JOB House Street Cap - Slope
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Infinite Slope Analysis for Various Slope Conditions

$$FS = \frac{\tan \phi}{\tan \beta}$$

Slope Condition	Material	ϕ	Tan ϕ	β	Tan β	FS
①	Topsoil	28°	0.53	3°	.05	10.6
	Barrier Protection	33°	0.65	3°	.05	13
	Smooth LLDPE	11°	0.19	3°	.05	3.8
	Subgrade	26°	0.49	3°	.05	9.8
②	Topsoil	28°	0.53	14°	.25	2.1
	Barrier Protection	33°	0.65	14°	.25	2.6
	Textured LLDPE	28°	0.53	14°	.25	2.1
	Subgrade	26°	0.49	14°	.25	2
③	Barrier Protection or Site Soils	26°	0.49	18°	.33	1.5

FS for slope conditions are greater than 1.5 ✓ Check

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SHEET NO. 5 OF 5
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Also check for seepage conditions at slope condition ① and ② with seepage acting along / above LLDPE surface

Infinite Slope with Seepage Consideration analysis is:

$$FS = \left(\frac{\gamma'_b}{\gamma_s}\right)\left(\frac{\tan\phi}{\tan\beta}\right)$$

where γ'_b = buoyant unit weight of soil

γ_s = saturated unit weight of soil

Consider both Sand & Clay soils

Sand: $\gamma_s = 120$ pcf $\quad \phi = 33°$

$\gamma'_b = 58$ pcf

Clay: $\gamma_s = 125$ pcf $\quad \phi = 26°$

$\gamma'_b = 63$ pcf

@ 5% Slope: Sand $FS = \left(\frac{58}{120}\right)\frac{\tan 33°}{\tan 3°} = 6$

Clay $FS = \left(\frac{63}{125}\right)\frac{\tan 26°}{\tan 3°} = 4.7$ ✓

@ 25% Slope: Clay $FS = \left(\frac{63}{125}\right)\frac{\tan 26°}{\tan 14°} = 1$

Safety Factor at 1 or greater ✓ OK

ATTACHMENT A.4

GEOSYNTHETIC CALCULATIONS

(LEFT BLANK IN CASE REQUIRED)

ATTACHMENT A.5

SETTLEMENT CALCULATIONS

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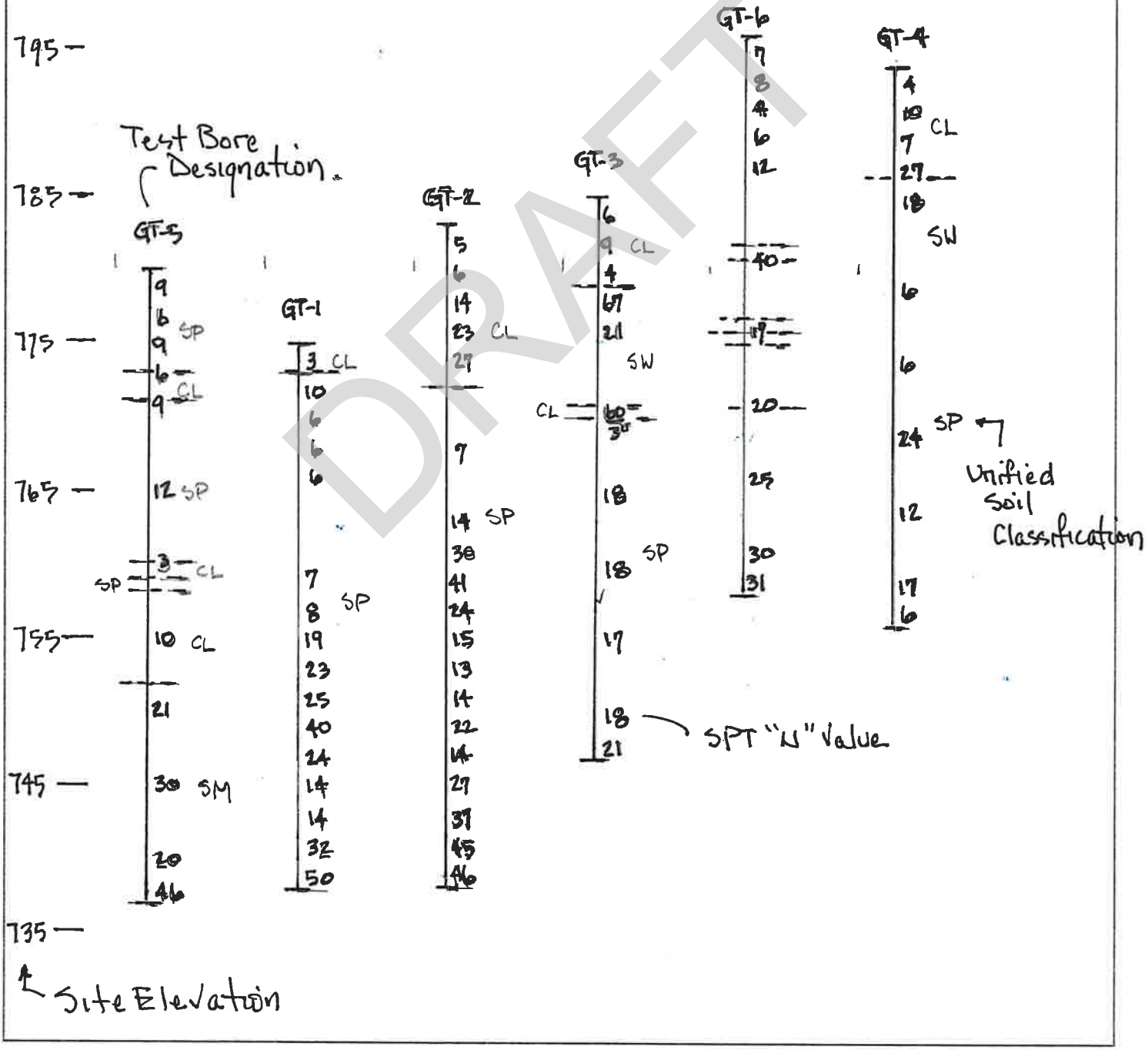
SETTLEMENT ASSESSMENT

Six Soil Borings done for geotechnical purposes and are summarized below in stick figure format

From South to North



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JOB House Street Cap - Settlement
SHEET NO. 2 OF 7
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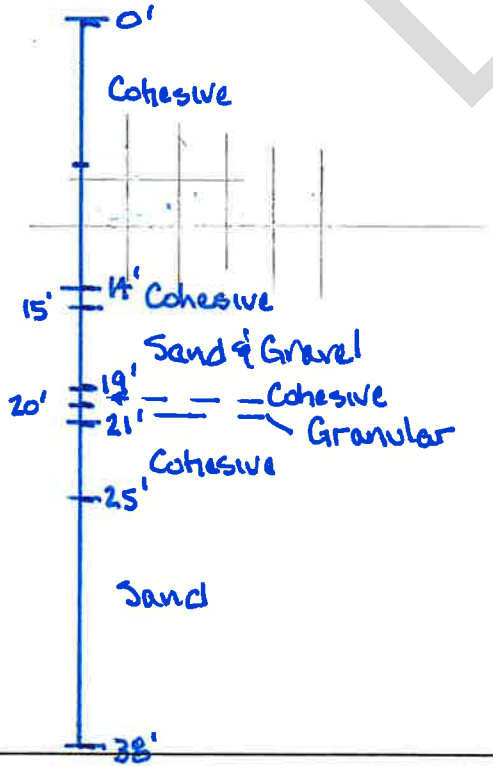
SCALE

Consider first the subgrade Bearing Capacity

Test Boring Designation	Sum of SPT "N" Values in Upper 10-ft.	Average SPT "N" Value
GT-1	31	6
2	75	15
3	107	21
4	66	13
5	39	8
6	37	7

Average = 12
Median = 8

Use GT-6 Profile with Cohesive soils at surface



Consider 2 cases:

① 5' Additional Load over infinite area

② 12' Additional load at base of depression

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JOB House Street Cap - Settlement
SHEET NO. 3 OF 7
CALCULATED BY E. Hanna DATE
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Section 1806
Allowable Load Bearing Values of Soils

TABLE 1806.2
ALLOWABLE FOUNDATION AND LATERAL PRESSURE

CLASS OF MATERIALS	ALLOWABLE FOUNDATION PRESSURE (psf)[d]	LATERAL BEARING (psf/f below natural grade)[d]	LATERAL SLIDING	
			Coefficient of friction[a]	Resistance (psf)[b]
1. Crystalline bedrock	12,000	1,200	0.70	—
2. Sedimentary and foliated rock	4,000	400	0.35	—
3. Sandy gravel and/or gravel (GW and GP)	3,000	200	0.35	—
4. Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	2,000	150	0.25	—
5. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH)	1,500[c]	100	—	130

For SI: 1 pound per square foot = 0.0479 kPa, 1 pound per square foot per foot = 0.157 kPa/m.
a. Coefficient to be multiplied by the dead load.
b. Lateral sliding resistance value to be multiplied by the contact area, as limited by Section 1804.3.
c. Where the building official determines that in-place soils with an allowable bearing capacity of less than 1,500 psf are likely to be present at the site, the allowable bearing capacity shall be determined by a soils investigation.
d. An increase of one-third is permitted when using the alternate load combinations in Section 1605.3.2 that include wind or earthquake loads.

Consider 5' to 12' of soil load, with soil weight at 120 to 125 lbs/ft³ equals 600 lbs/ft² to 1,500 lbs/ft².

Allowable presumptive load bearing values from Building Code at 1500 lbs/ft² or greater; therefore, suitable at House St cap.

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SHEET NO. 4 OF 7
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From Additional Fill, consider stress change at mid-point of cohesive soil layer

$\Delta\sigma_v = I * q_o$

where I is a function of

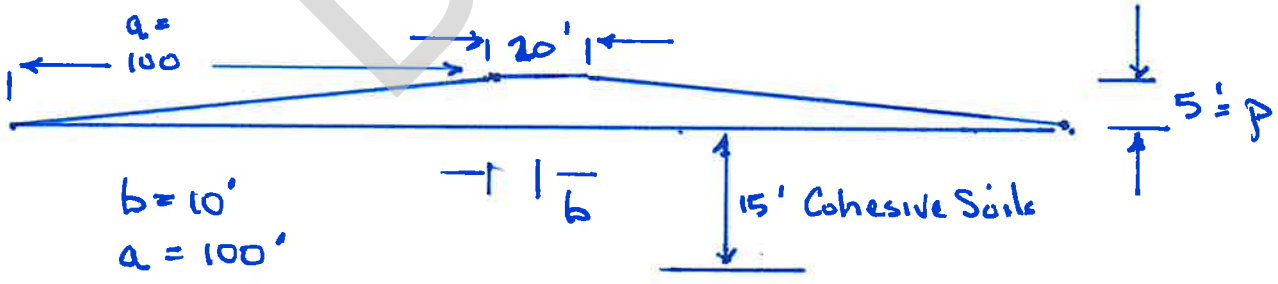
$m = \frac{X}{Z}$

$n = \frac{Y}{Z}$

X = width of loaded area
Y = length of loaded area
Z = depth to point of interest

q_o = Applied vertical stress

For infinite slope embankments, the influence factor can be determined using the following chart.



b = 10'
a = 100'
p = 5'
Z = $7\frac{1}{2}$' = 15'

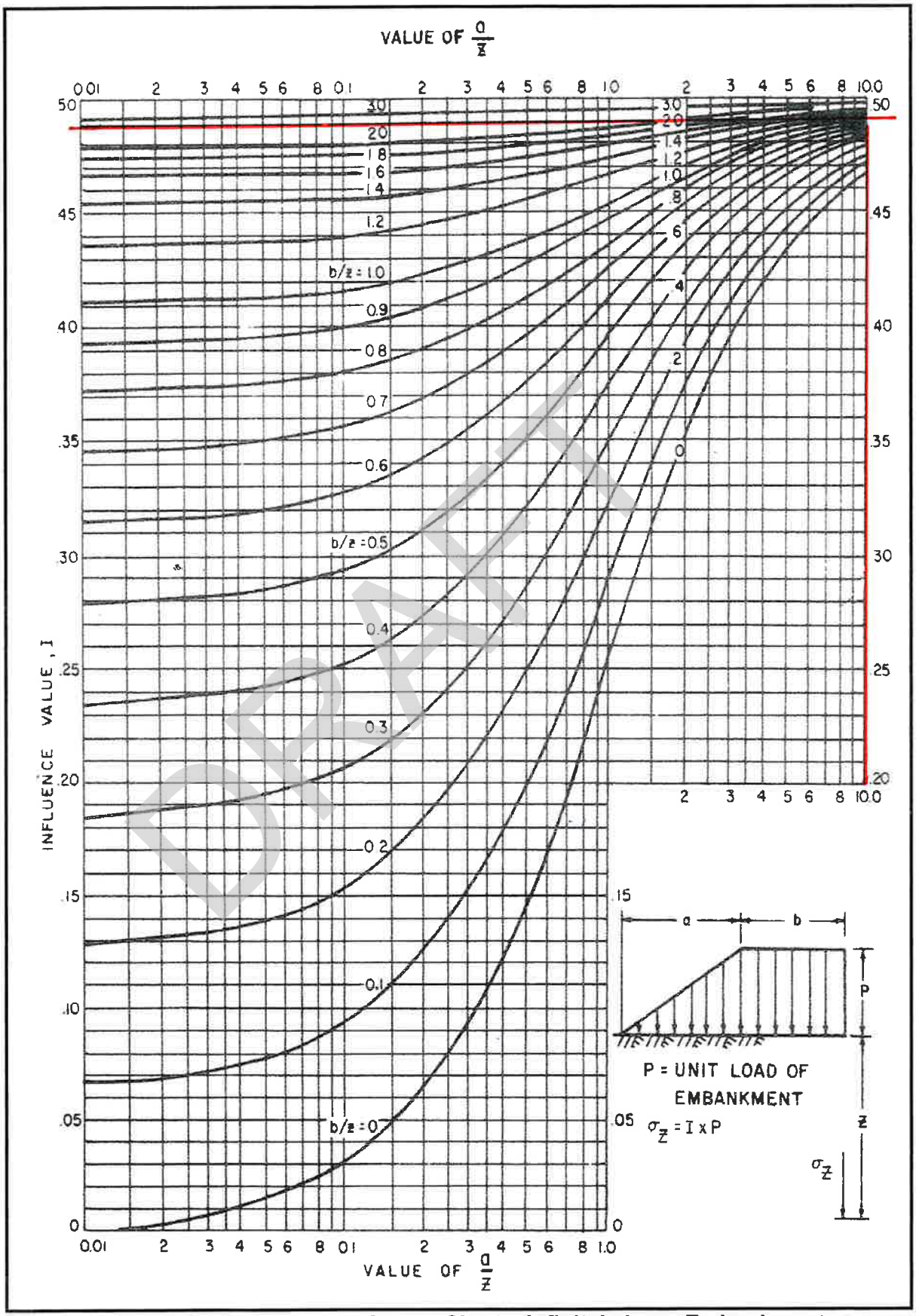
$\frac{a}{Z} = \frac{100}{7\frac{1}{2}} = 13$

$\frac{b}{Z} = \frac{10}{7\frac{1}{2}} = 1.3$

I = 0.49

$\sigma_Z = I \times P = .49 * 600 \frac{lbs}{ft^2}$

$= 300 \frac{lbs}{ft^2}$



Influence Factor Chart – Infinitely Long Embankments
(DOD (NAVFAC DM 7.1) (1982))

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SHEET NO. 6 OF 7
CALCULATED BY _____ DATE _____
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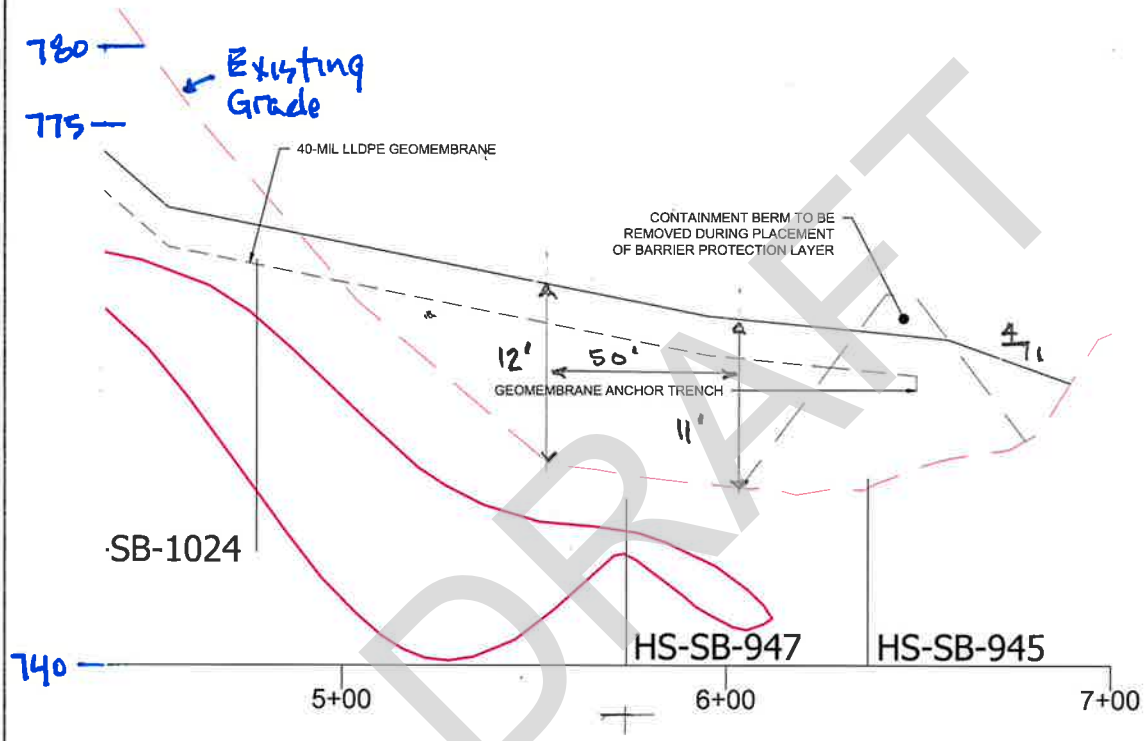
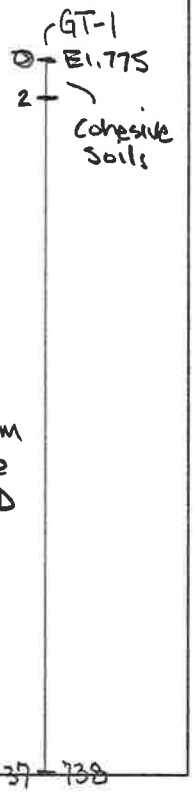
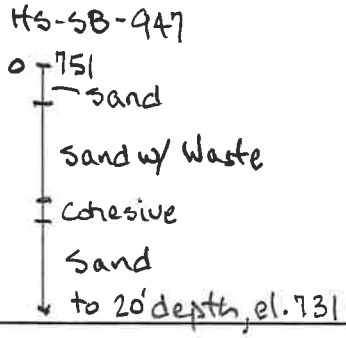
For condition ② where up to 12' of fill is placed in the depressed area, the evaluated cross-section is:



Ref: Southwest Cap: Profile B-B





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SHEET NO. 7 OF 7
CALCULATED BY E. Hanna DATE
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SCALE

Using the Influence Factor chart and the following

$b = 25'$
$a = 70'$
$\rho = 11\frac{1}{2}'$
$z = 7\frac{1}{2}'$

$\frac{a}{z} = 9.3$ $\quad \frac{b}{z} = \frac{25}{7\frac{1}{2}} = 3.3$

$I = 0.5$

$\sigma_z = (0.5)\left(1500 \frac{lbs}{ft^2}\right) = 750 \frac{lbs}{ft^2}$

Estimated Settlement

$$S_i = \frac{5 q_o}{(N-1.5)(C_B)}$$

where q_o = applied vertical stress = σ_z (tons/ft²)

N = SPT "N" Value = 7

C_B = Width Correction = 0.8

S_i = Settlement (inches)

Case ①

$$S_i = \frac{(5)\left(0.3 \frac{tons}{ft^2}\right)}{(7-1.5)(.8)} = \frac{1.5}{(5.5)(.8)} = \frac{1.5}{4.4} = 0.3 \text{ in}$$

✓

Case ②

$$S_i = \frac{(5)\left(0.75 \frac{tons}{ft^2}\right)}{(7-1.5)(.8)} = \frac{3.75}{(5.5)(.8)} = 0.9 \text{ in}$$

ATTACHMENT A.6

SOIL EROSION LOSS

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JOB House Street Cap - Soil Loss
SHEET NO 1 OF ____
Calculated By E. Hanna Date ____
Checked By ____ Date ____
Scale ____

SOIL LOSS ESTIMATION

REF. ① "Predicting Rainfall Erosion Losses", USDA Agriculture Handbook No. 537, December 1978

② Guidelines for Use of the Universal Soil Loss Equation in Michigan; from various internet locations (http://www.iwr.msu.edu)

Soil Loss is estimated using: $A = R \times K \times L \times S \times C \times P$

where:

A = Soil Loss (tons/acre/year)

R = Rainfall Erosion Index = 95 for Kent County

K = Soil Erodibility Index, Udipsamments = 0.15

L = Slope Length Factor

Slopes range from 75'+/- to about 600'

S = Slope Steepness, Slope varies from 4% to 25%

LS Estimated based on longer flowpaths on Southwest mound; selected value of 1.69 based on 600-ft length and average slope of 6%.

C = .005 for continuous grass

P = Erosion Control Practice = 1 for no Practice post construction

Therefore:

Soil Loss Estimation = $A = (95)(0.15)(1.69)(.005)(1)$

$= 0.12$ tons/acre/year

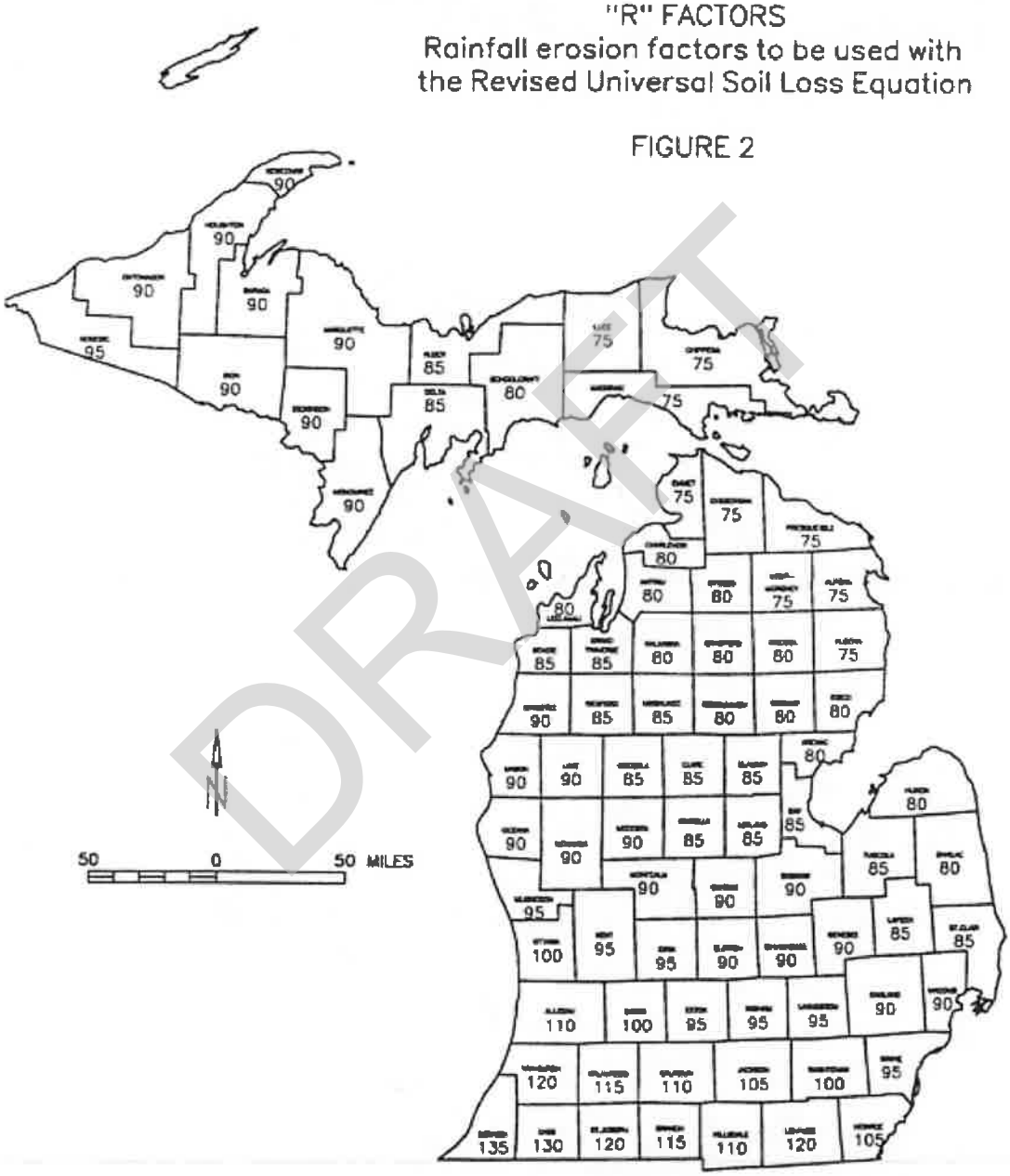
< 2 tons/acre/year ✓ ok

MICHIGAN

TECHNICAL GUIDE
SECTION IC
State–wide
WATER–11

"R" FACTORS
Rainfall erosion factors to be used with
the Revised Universal Soil Loss Equation

FIGURE 2



(Notice 116 – 5/95)

TABLE 2 - CROPLAND
Values for Topographic Factor, LS, for Moderate Ratio of Rill to Interrill Erosion 1/

	Horizontal Slope Length (ft)																
Slope (%)	**<3**	**6**	**9**	**12**	**15**	**25**	**50**	**75**	**100**	**150**	**200**	**250**	**300**	**400**	**600**	**800**	**1,000**
0.2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06
0.5	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10
1.0	0.11	0.11	0.11	0.11	0.11	0.12	0.13	0.14	0.14	0.15	0.16	0.17	0.17	0.18	0.19	0.20	0.20
2.0	0.17	0.17	0.17	0.17	0.17	0.19	0.22	0.25	0.27	0.29	0.31	0.33	0.35	0.37	0.41	0.44	0.47
3.0	0.22	0.22	0.22	0.22	0.22	0.25	0.32	0.36	0.39	0.44	0.48	0.52	0.55	0.60	0.68	0.75	0.80
4.0	0.26	0.26	0.26	0.26	0.26	0.31	0.40	0.47	0.52	0.60	0.67	0.72	0.77	0.86	0.99	1.10	1.19
5.0	0.30	0.30	0.30	0.30	0.30	0.37	0.49	0.58	0.65	0.76	0.85	0.93	1.01	1.13	1.33	1.49	1.63
6.0	0.34	0.34	0.34	0.34	0.34	0.43	0.58	0.69	0.78	0.93	1.05	1.16	1.25	1.42	1.69	1.91	2.11
8.0	0.42	0.42	0.42	0.42	0.42	0.53	0.74	0.91	1.04	1.26	1.45	1.62	1.77	2.03	2.47	2.83	3.15
10.0	0.46	0.48	0.50	0.51	0.52	0.67	0.97	1.19	1.38	1.71	1.98	2.22	2.44	2.84	3.50	4.06	4.56
12.0	0.47	0.53	0.58	0.61	0.64	0.84	1.23	1.53	1.79	2.23	2.61	2.95	3.26	3.81	4.75	5.56	6.28
14.0	0.48	0.58	0.65	0.70	0.75	1.00	1.48	1.86	2.19	2.76	3.25	3.69	4.09	4.82	6.07	7.15	8.11
16.0	0.49	0.63	0.72	0.79	0.85	1.15	1.73	2.20	2.60	3.30	3.90	4.45	4.95	5.86	7.43	8.79	10.02
20.0	0.52	0.71	0.85	0.96	1.06	1.45	2.22	2.85	3.40	4.36	5.21	5.97	6.68	7.97	10.23	12.20	13.99
25.0	0.56	0.80	1.00	1.16	1.30	1.81	2.82	3.65	4.39	5.69	6.83	7.88	8.86	10.65	13.80	16.58	19.13
30.0	0.59	0.89	1.13	1.34	1.53	2.15	3.39	4.42	5.34	6.98	8.43	9.76	11.01	13.30	17.37	20.99	24.31
40.0	0.65	1.05	1.38	1.68	1.95	2.77	4.45	5.87	7.14	9.43	11.47	13.37	15.14	18.43	24.32	29.60	34.48
50.0	0.71	1.18	1.59	1.97	2.32	3.32	5.40	7.17	8.78	11.66	14.26	16.67	18.94	23.17	30.78	37.65	44.02
60.0	0.76	1.30	1.78	2.23	2.65	3.81	6.24	8.33	10.23	13.65	16.76	19.64	22.36	27.45	36.63	44.96	52.70

1/ Such as for row-cropped agricultural and other moderately consolidated soil conditions with little to moderate cover (not applicable to thawing soil).

TABLE 4 EXCERPTS

MI0573	TOOGOOD	S	220	0.15	0.15	5	33.3	33.3
MI0573	TOOGOOD	LS	134	0.17	0.17	5	29.4	29.4
MI0168	TRENARY	VFSL	86	0.24	0.24	5	20.8	20.8
MI0168	TRENARY	FSL	86	0.24	0.24	5	20.8	20.8
MI0329	TRENARY	VFSL	86	0.24	0.24	5	20.8	20.8
MI0329	TRENARY	FSL SL	86	0.24	0.24	5	20.8	20.8
MI0366	TRENARY	STV-FSL	0	0.17	0.24	5	29.4	20.8
MI0630	TRENARY	ST-FSL ST-VFSL	86	0.17	0.24	5	29.4	20.8
MI0553	TRIMOUNTAIN	CB-LFS	134	0.1	0.17	4	40.0	23.5
MI0553	TRIMOUNTAIN	GR-FSL GR-SL GR-LFS	86	0.15	0.24	4	26.7	16.7
MI0553	TRIMOUNTAIN	CB-FSL CB-VFSL	86	0.17	0.24	4	23.5	16.7
MI0554	TRIMOUNTAIN	CB-FSL CB-VFSL	0	0.17	0.24	4	23.5	16.7
MI0554	TRIMOUNTAIN	GR-FSL GR-SL GR-LFS	0	0.17	0.24	4	23.5	16.7
MI0554	TRIMOUNTAIN	CB-LFS	0	0.1	0.17	4	40.0	23.5
MI0116	TULA	CB-VFSL CB-FSL	86	0.28	0.37	4	14.3	10.8
MI0169	TULA	CB-VFSL CB-FSL	86	0.28	0.37	4	14.3	10.8
MI0009	TUSCOLA	LFS	134	0.17	0.17	5	29.4	29.4
MI0009	TUSCOLA	SIL L	56	0.32	0.32	5	15.6	15.6
MI0009	TUSCOLA	FSL SL VFSL	86	0.24	0.24	5	20.8	20.8
MI0488	TUSCOLA	L	56	0.32	0.32	5	15.6	15.6
WI0069	TUSTIN	LFS LS	134	0.17	0.17	5	29.4	29.4
WI0069	TUSTIN	FS S	250	0.15	0.15	5	33.3	33.3
MI0223	TWINING	SL	86	0.24	0.24	5	20.8	20.8
MI0223	TWINING	L	56	0.32	0.32	5	15.6	15.6

Table 4

K, T, T/K, and I Values for Soil Series used in Michigan for use in the Revised Universal Soil Loss Equation and Wind Erosion Equation

Record	Series or Family	Surface Texture	I	K	Kf	T	T/K	T/Kf
MI5004	TYPIC DYSTROCHREPTS	SL FSL	86	0.24	0.24	5	20.8	20.8
MI5004	TYPIC DYSTROCHREPTS	SIL L	56	0.37	0.37	5	13.5	13.5
MI5005	TYPIC DYSTROCHREPTS	SL FSL	86	0.24	0.24	4	16.7	16.7
MI5005	TYPIC DYSTROCHREPTS	SIL L	56	0.37	0.37	4	10.8	10.8
MI5007	TYPIC DYSTROCHREPTS	SL FSL	86	0.24	0.24	4	16.7	16.7
MI5007	TYPIC DYSTROCHREPTS	SIL L	56	0.37	0.37	4	10.8	10.8
MI5047	TYPIC FRAGIAQUODS	SIL L	56	0.32	0.32	3	9.4	9.4
MI5047	TYPIC FRAGIAQUODS	FSL SL	86	0.24	0.24	3	12.5	12.5
MI5047	TYPIC FRAGIAQUODS	VFSL	86	0.37	0.37	3	8.1	8.1
MI5073	TYPIC HAPLAQUODS	MK-S	220	0.15	0.15	5	33.3	33.3
MI5073	TYPIC HAPLAQUODS	S	220	0.15	0.15	5	33.3	33.3
MI6020	TYPIC HAPLAQUODS	MK-S	220	0.15	0.15	5	33.3	0.0
MI5069	TYPIC HAPLAQUOLLS	MUCK	134	NONE	NONE	5	0.0	0.0
MI5018	TYPIC HAPLORTHODS	S LS	220	0.15	0.15	5	33.3	33.3
MI5018	TYPIC HAPLORTHODS	SL FSL	86	0.2	0.24	5	25.0	20.8
MI6022	TYPIC HAPLORTHODS	S	220	0.15	0.15	5	33.3	33.3
MI6024	TYPIC HAPLORTHODS	S	220	0.15	0.15	5	33.3	33.3
MI5051	TYPIC UDIPSAMMENTS	S	220	0.15	0.15	5	33.3	33.3
MI5052	TYPIC UDIPSAMMENTS	S	220	0.15	0.15	5	33.3	33.3
MI5053	TYPIC UDIPSAMMENTS	S	220	0.15	0.15	5	33.3	33.3
MI5054	TYPIC UDIPSAMMENTS	S	220	0.15	0.15	5	33.3	33.3

TABLE 4 EXCERPTS

MI6026	TYPIC UDIPSAMMENTS	S	220	0.15	0.15	5	33.3	33.3
MI6027	TYPIC UDIPSAMMENTS	S	220	0.15	0.15	5	33.3	33.3
MI6028	TYPIC UDIPSAMMENTS	S	220	0.15	0.15	5	33.3	33.3
MI6029	TYPIC UDIPSAMMENTS	S	220	0.15	0.15	5	33.3	33.3
MI0207	TYRE	LS	134	0.17	0.17	3	17.6	17.6
MI0207	TYRE	S	220	0.15	0.15	3	20.0	20.0
MI0200	UBLY	LS	134	0.17	0.17	5	29.4	29.4
MI0200	UBLY	SL	86	0.24	0.24	5	20.8	20.8
MI0298	UBLY	LS	134	0.17	0.17	5	29.4	29.4
MI0298	UBLY	SL	86	0.24	0.24	5	20.8	20.8
MI0447	UBLY	VFSL	86	0.37	0.37	4	10.8	10.8
MI8007	UDIPSAMMENTS	S COS LS	220	0.12	0.15	5	41.7	33.3
NE0523	UDIPSAMMENTS	COS GR-S	134	0.02	0.02	5	250.0	250.0
NE0523	UDIPSAMMENTS	LFS LS VFS	134	0.1	0.02	5	50.0	50.0
NE0523	UDIPSAMMENTS	FS S LCOS	310	0.02	0.02	5	250.0	250.0
MI8001	UDORTHENTS	GR-SL L SL	86	0.24	0.24	5	20.8	20.8
MI8001	UDORTHENTS	SCL SICL CL	86	0.32	0.32	5	15.6	15.6
MI8001	UDORTHENTS	C SIC	86	0.32	0	5	15.6	15.6
NE0524	UDORTHENTS	FSL L VFSL	86	0.24	0.28	5	20.8	17.9
NE0524	UDORTHENTS	SCL SICL CL	48	0.32	0.37	5	15.6	13.5
MI0631	VANRIPER	CB-VFSL	86	0.28	0.37	5	17.9	13.5
MI0631	VANRIPER	CBV-VFSL	0	0.28	0.37	5	17.9	13.5
MI0715	VANRIPER	BYV-SIL	0	0.28	0.37	5	17.9	13.5
MI0341	VELVET	STV-LS	0	0.1	0.15	3	30.0	20.0
MI0456	VELVET	GRV-LS GR-LFS GRV-S	0	0.1	0.17	3	30.0	17.6
MI0456	VELVET	STV-LS CB-LFS CBV-S	0	0.1	0.17	3	30.0	17.6

Table 4

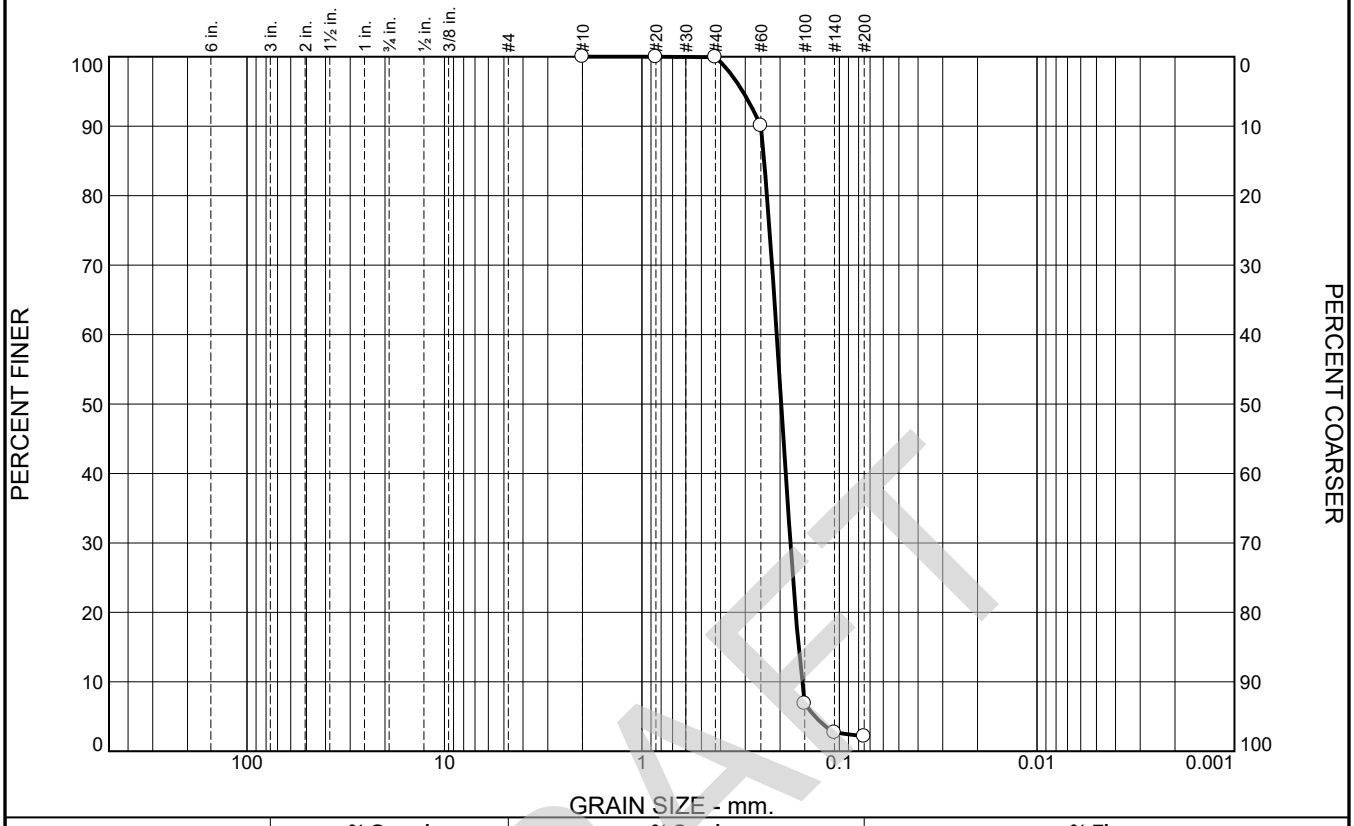
K, T, T/K, and I Values for Soil Series used in Michigan for use in the Revised Universal Soil Loss Equation and Wind Erosion Equation

Record	Series or Family	Surface Texture	I	K	Kf	T	T/K	T/Kf
MI0270	VESTABURG	LS	134	0.17	0.17	5	29.4	29.4
MI0270	VESTABURG	SL	86	0.24	0.24	5	20.8	20.8
MI0270	VESTABURG	S	220	0.15	0.15	5	33.3	33.3
MI0494	VESTABURG	MK-S	220	0.15	0.15	5	33.3	33.3
MI0494	VESTABURG	MK-LS	134	0.17	0.17	5	29.4	29.4
WI0242	VILAS	S	250	0.15	0.15	5	33.3	33.3
WI0242	VILAS	LS	134	0.17	0.17	5	29.4	29.4
WI0493	VILAS	S	250	0.15	0.15	5	33.3	33.3
WI0493	VILAS	LS	134	0.17	0.17	5	29.4	29.4
WI0340	WABENO	SIL	56	0.37	0.37	4	10.8	10.8
WI0341	WABENO	ST-FSL	56	0.24	0.24	4	16.7	16.7
WI0341	WABENO	ST-SIL	48	0.37	0.37	4	10.8	10.8
WI0394	WABENO	SIL	56	0.37	0.37	4	10.8	10.8
WI0418	WABENO	SIL	56	0.37	0.37	4	10.8	10.8
WI0418	WABENO	FSL	86	0.24	0.24	4	16.7	16.7
MI0729	WABUN	S	220	0.15	0.15	4	26.7	26.7
MI0729	WABUN	MK-S	134	0.15	0.15	4	26.7	26.7
MI0212	WAINOLA	LFS	134	0.17	0.17	5	29.4	29.4
MI0212	WAINOLA	FS	250	0.15	0.15	5	33.3	33.3

ATTACHMENT A.7

SUBSURFACE EXPLORATION DATA

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.1	97.7	2.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	99.9		
#60	90.1		
#100	6.9		
#140	2.7		
#200	2.2		

* (no specification provided)

Material Description

light brown poorly graded SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2499 D_{85}= 0.2405 D_{60}= 0.2077
D_{50}= 0.1972 D_{30}= 0.1772 D_{15}= 0.1611
D_{10}= 0.1547 C_u= 1.34 C_c= 0.98

Classification

USCS= SP AASHTO=

Remarks

Lab No.: 167

Location: GT-1
Sample Number: S-4 **Depth:** 6.0' - 8.0' **Date:** 4/1/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/1/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-1
Depth: 6.0' - 8.0'
Sample Number: S-4
Material Description: light brown poorly graded SAND
Date: 4/1/22
USCS Classification: SP
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
357.91	15.85	0.00	#10	0.00	100.0	0.0
100.72	0.00	0.00	#20	0.02	100.0	0.0
			#40	0.08	99.9	0.1
			#60	10.00	90.1	9.9
			#100	93.79	6.9	93.1
			#140	97.99	2.7	97.3
			#200	98.54	2.2	97.8

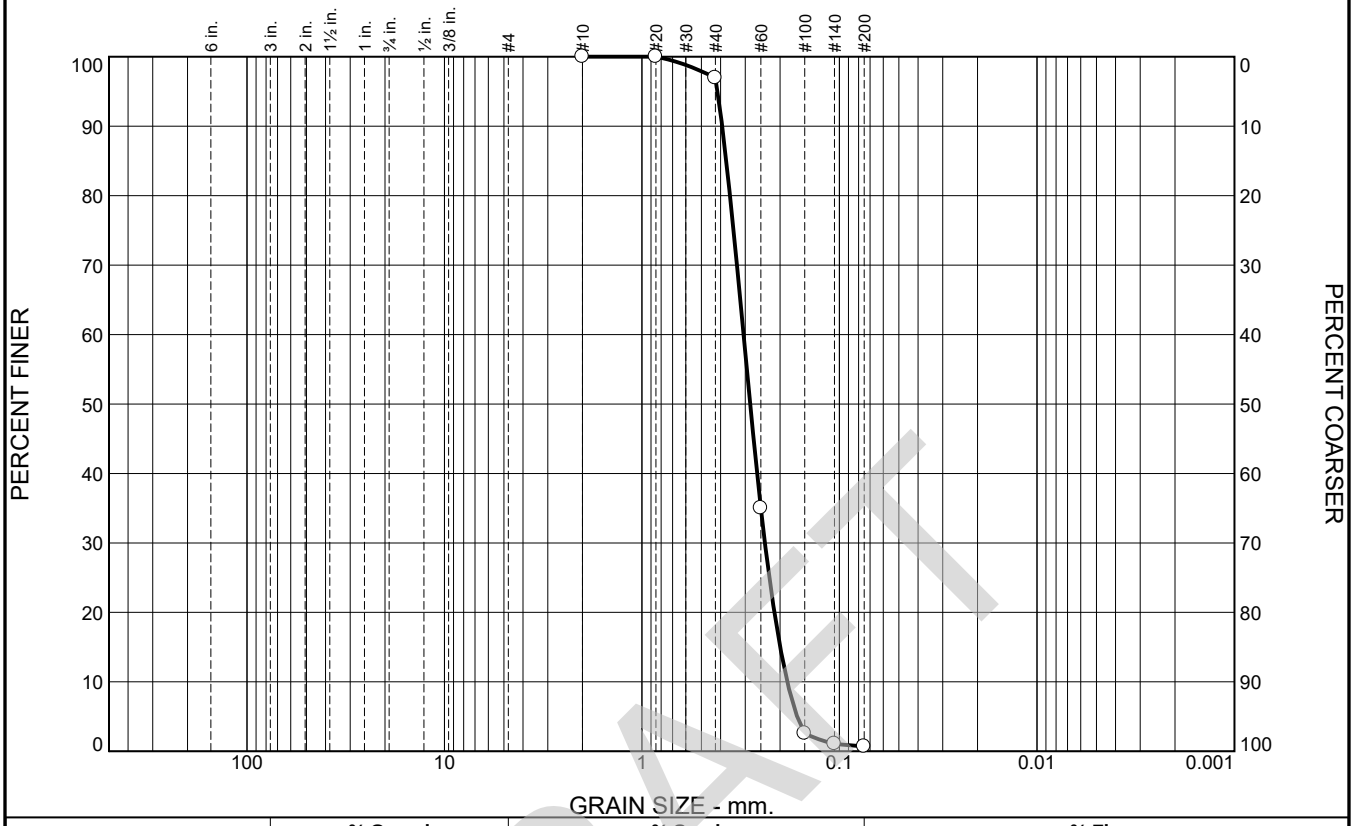
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.1	97.7	97.8			2.2

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1328	0.1547	0.1611	0.1668	0.1772	0.1871	0.1972	0.2077	0.2327	0.2405	0.2499	0.3086

Fineness Modulus	C_u	C_c
0.99	1.34	0.98

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	3.1	96.2	0.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	96.9		
#60	35.0		
#100	2.6		
#140	1.1		
#200	0.7		

* (no specification provided)

Material Description

light brown poorly graded SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.3925 D_{85}= 0.3741 D_{60}= 0.3057
D_{50}= 0.2831 D_{30}= 0.2385 D_{15}= 0.1996
D_{10}= 0.1838 C_u= 1.66 C_c= 1.01

Classification

USCS= SP AASHTO=

Remarks

Lab No.: 167

Location: GT-1
Sample Number: S-7 **Depth:** 17.0' - 19.0' **Date:** 4/1/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/1/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-1
Depth: 17.0' - 19.0'
Sample Number: S-7
Material Description: light brown poorly graded SAND
Date: 4/1/22
USCS Classification: SP
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
349.10	13.95	0.00	#10	0.00	100.0	0.0
107.70	0.00	0.00	#20	0.00	100.0	0.0
			#40	3.31	96.9	3.1
			#60	70.00	35.0	65.0
			#100	104.91	2.6	97.4
			#140	106.54	1.1	98.9
			#200	106.96	0.7	99.3

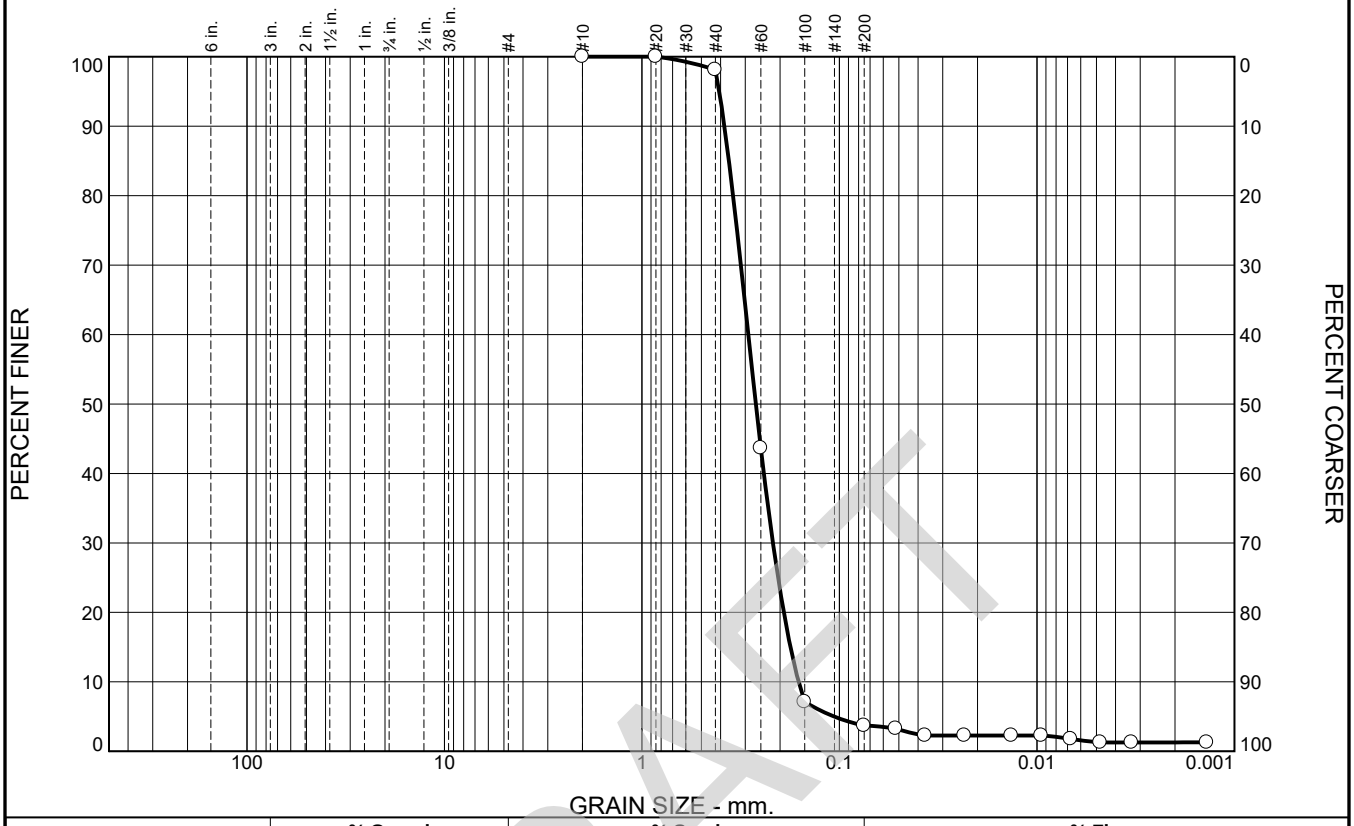
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	3.1	96.2	99.3			0.7

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1638	0.1838	0.1996	0.2136	0.2385	0.2611	0.2831	0.3057	0.3581	0.3741	0.3925	0.4147

Fineness Modulus	C_u	C_c
1.41	1.66	1.01

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.9	94.4	2.4	1.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	98.1		
#60	43.6		
#100	7.1		
#200	3.7		

* (no specification provided)

Material Description

brown poorly graded SAND

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.3823 D_{85}= 0.3625 D_{60}= 0.2892
D_{50}= 0.2650 D_{30}= 0.2171 D_{15}= 0.1771
D_{10}= 0.1611 C_u= 1.80 C_c= 1.01

Classification

USCS= SP AASHTO= A-3

Remarks

Lab No.: 167

Location: GT-1
Sample Number: S-10 **Depth:** 23.0' - 25.0' **Date:** 4/8/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/8/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-1
Depth: 23.0' - 25.0'
Sample Number: S-10
Material Description: brown poorly graded SAND
Date: 4/8/22 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: SP
AASHTO Classification: A-3
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
358.92	15.85	0.00	#10	0.00	100.0	0.0
101.67	0.00	0.00	#20	0.00	100.0	0.0
			#40	1.92	98.1	1.9
			#60	57.30	43.6	56.4
			#100	94.44	7.1	92.9
			#200	97.90	3.7	96.3

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =101.67
Hygroscopic moisture correction:
Moist weight and tare = 127.28
Dry weight and tare = 127.24
Tare weight = 30.81
Hygroscopic moisture = 0.0%
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5.0
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	21.6	8.0	3.3	0.0134	8.0	15.0	0.0518	3.3	96.7
2.00	21.6	7.0	2.3	0.0134	7.0	15.1	0.0368	2.3	97.7
5.00	21.6	7.0	2.3	0.0134	7.0	15.1	0.0233	2.3	97.7
15.00	21.6	7.0	2.3	0.0134	7.0	15.1	0.0134	2.3	97.7
30.00	21.6	7.0	2.3	0.0134	7.0	15.1	0.0095	2.3	97.7
60.00	21.6	6.5	1.8	0.0134	6.5	15.2	0.0067	1.8	98.2
120.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0048	1.3	98.7
250.00	21.5	6.0	1.3	0.0134	6.0	15.3	0.0033	1.3	98.7
1440.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0014	1.3	98.7

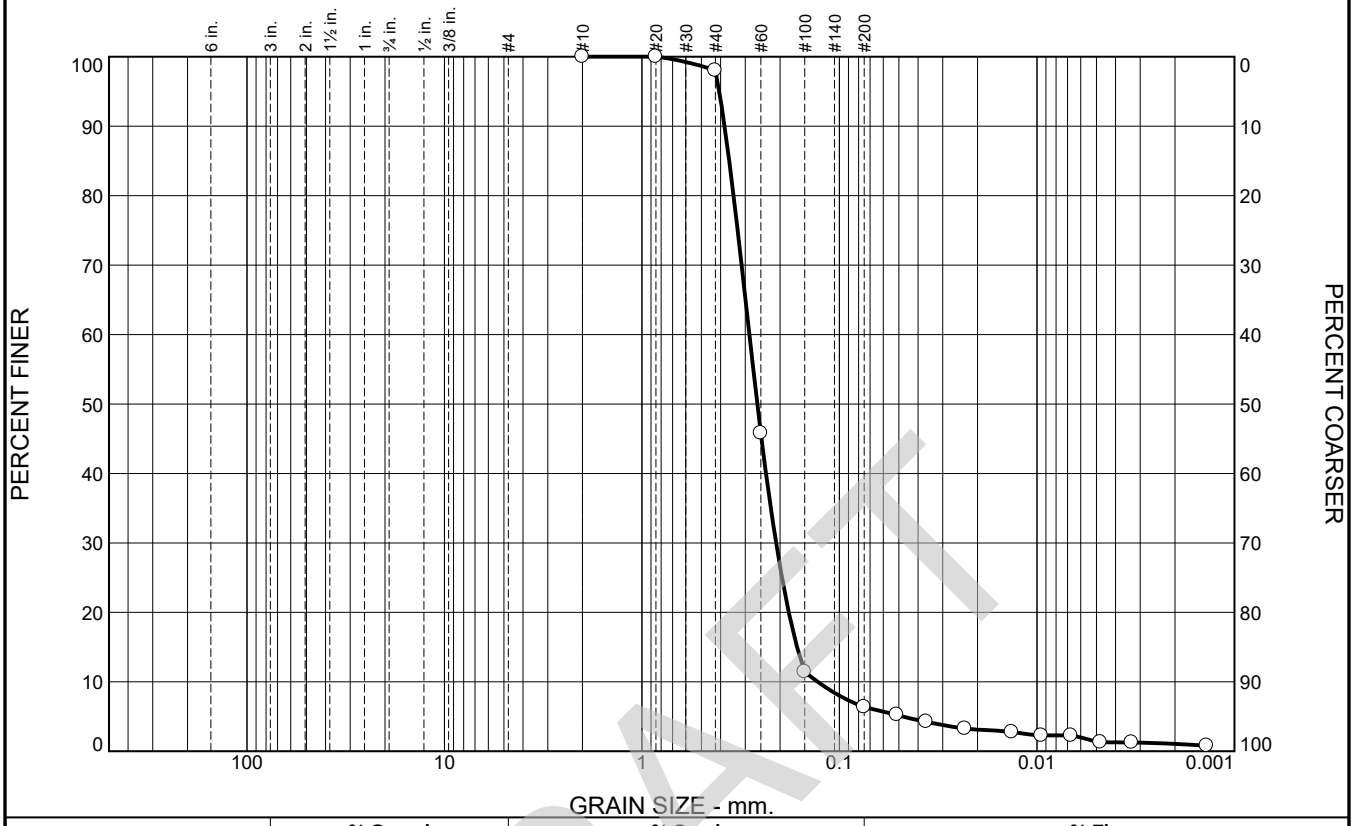
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	1.9	94.4	96.3	2.4	1.3	3.7

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1062	0.1611	0.1771	0.1913	0.2171	0.2414	0.2650	0.2892	0.3452	0.3625	0.3823	0.4062

Fineness Modulus	C_u	C_c
1.29	1.80	1.01

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	2.0	91.6	5.0	1.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	98.0		
#60	45.8		
#100	11.5		
#200	6.4		

* (no specification provided)

Material Description

brown poorly graded SAND with silt (visual)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.3814 D_{85}= 0.3611 D_{60}= 0.2856
D_{50}= 0.2605 D_{30}= 0.2093 D_{15}= 0.1640
D_{10}= 0.1288 C_u= 2.22 C_c= 1.19

Classification

USCS= AASHTO=

Remarks

Lab No.: 167

Location: GT-1
Sample Number: S-11 **Depth:** 25.0' - 27.0' **Date:** 4/8/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/8/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-1
Depth: 25.0' - 27.0' **Sample Number:** S-11
Material Description: brown poorly graded SAND with silt (visual)
Date: 4/8/22
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
373.94	14.57	0.00	#10	0.00	100.0	0.0
101.17	0.00	0.00	#20	0.00	100.0	0.0
			#40	2.00	98.0	2.0
			#60	54.84	45.8	54.2
			#100	89.58	11.5	88.5
			#200	94.72	6.4	93.6

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =101.17
Hygroscopic moisture correction:
Moist weight and tare = 128.28
Dry weight and tare = 128.23
Tare weight = 29.73
Hygroscopic moisture = 0.1%
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5.0
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	21.6	10.0	5.3	0.0134	10.0	14.7	0.0512	5.3	94.7
2.00	21.6	9.0	4.3	0.0134	9.0	14.8	0.0364	4.3	95.7
5.00	21.6	8.0	3.3	0.0134	8.0	15.0	0.0232	3.3	96.7
15.00	21.6	7.5	2.8	0.0134	7.5	15.1	0.0134	2.8	97.2
30.00	21.6	7.0	2.3	0.0134	7.0	15.1	0.0095	2.3	97.7
60.00	21.6	7.0	2.3	0.0134	7.0	15.1	0.0067	2.3	97.7
120.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0048	1.3	98.7
250.00	21.5	6.0	1.3	0.0134	6.0	15.3	0.0033	1.3	98.7
1440.00	21.6	5.5	0.8	0.0134	5.5	15.4	0.0014	0.8	99.2

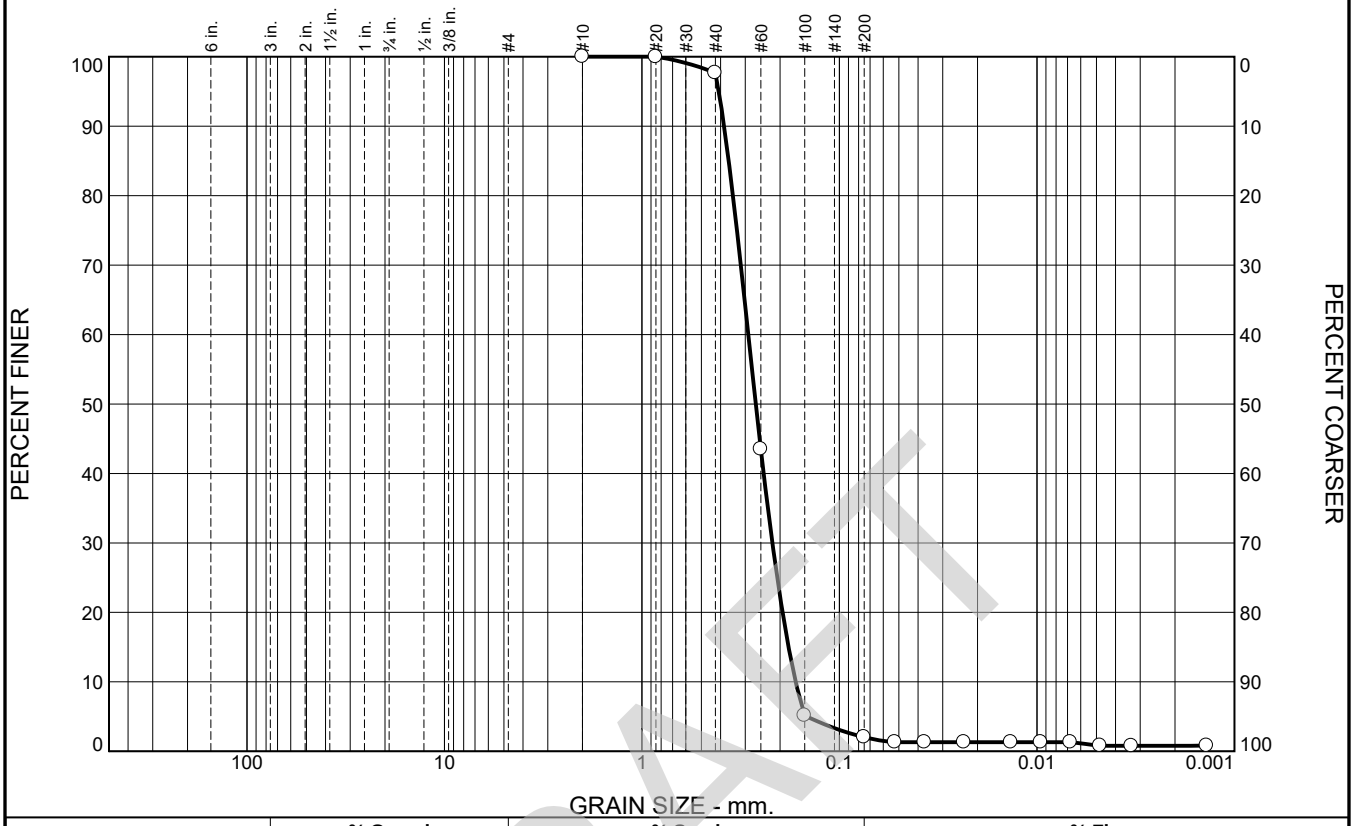
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	2.0	91.6	93.6	5.0	1.4	6.4

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.0477	0.1288	0.1640	0.1806	0.2093	0.2354	0.2605	0.2856	0.3433	0.3611	0.3814	0.4061

Fineness Modulus	C_u	C_c
1.24	2.22	1.19

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	2.3	95.7	1.1	0.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	97.7		
#60	43.5		
#100	5.2		
#200	2.0		

* (no specification provided)

Material Description

brown poorly graded SAND

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.3837 D_{85}= 0.3634 D_{60}= 0.2893
D_{50}= 0.2652 D_{30}= 0.2185 D_{15}= 0.1810
D_{10}= 0.1667 C_u= 1.74 C_c= 0.99

Classification

USCS= SP AASHTO= A-3

Remarks

Lab No.: 167

Location: GT-1
Sample Number: Bucket **Depth:** 25.0' - 35.0' **Date:** 4/8/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/8/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-1
Depth: 25.0' - 35.0'
Sample Number: Bucket
Material Description: brown poorly graded SAND
Date: 4/8/22 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: SP
AASHTO Classification: A-3
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
546.25	13.81	0.00	#10	0.00	100.0	0.0
100.62	0.00	0.00	#20	0.01	100.0	0.0
			#40	2.34	97.7	2.3
			#60	56.86	43.5	56.5
			#100	95.42	5.2	94.8
			#200	98.56	2.0	98.0

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =100.62
Hygroscopic moisture correction:
Moist weight and tare = 121.46
Dry weight and tare = 121.41
Tare weight = 31.02
Hygroscopic moisture = 0.1%
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5.0
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0523	1.3	98.7
2.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0370	1.3	98.7
5.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0234	1.3	98.7
15.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0135	1.3	98.7
30.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0096	1.3	98.7
60.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0068	1.3	98.7
120.00	21.6	5.5	0.8	0.0134	5.5	15.4	0.0048	0.8	99.2
250.00	21.5	5.5	0.8	0.0134	5.5	15.4	0.0033	0.8	99.2
1440.00	21.6	5.5	0.8	0.0134	5.5	15.4	0.0014	0.8	99.2

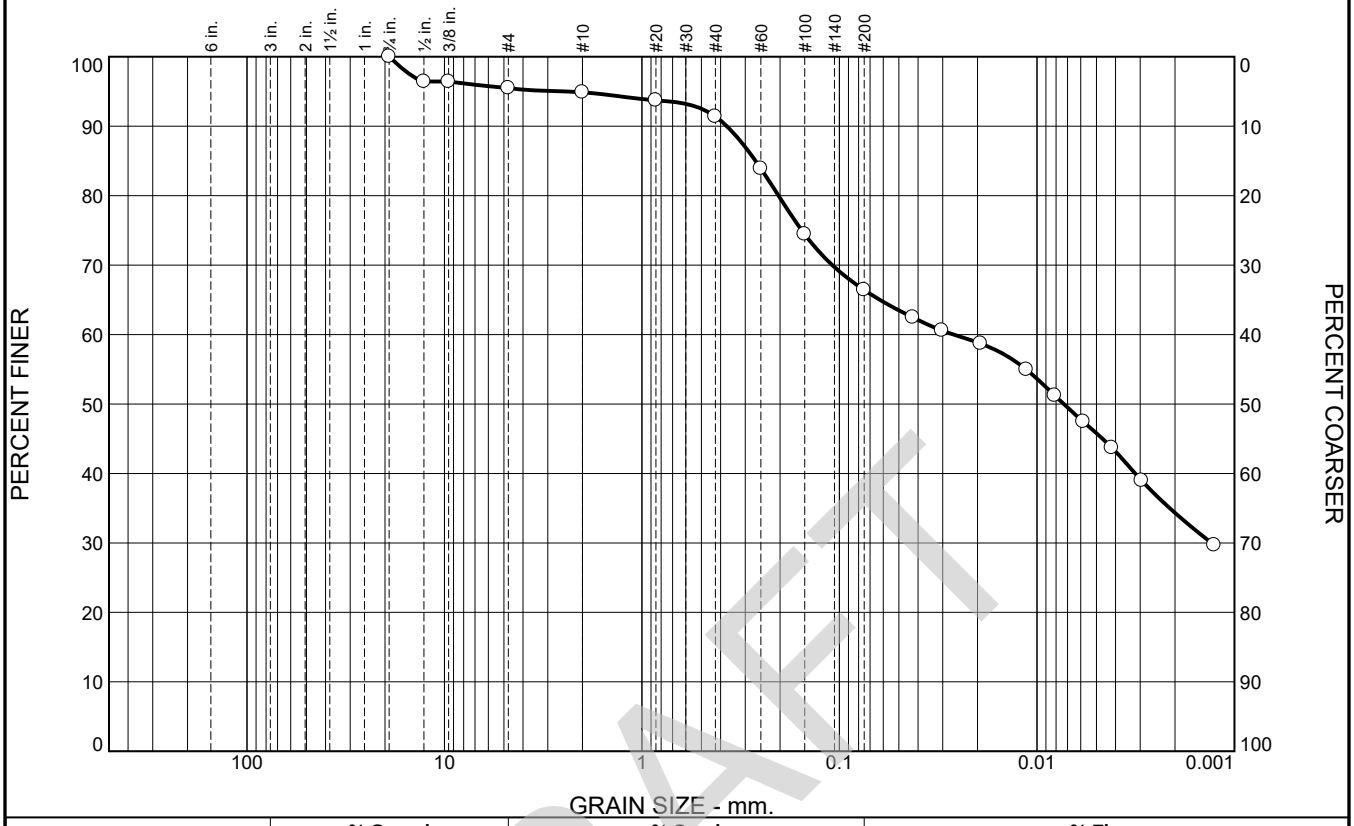
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	2.3	95.7	98.0	1.1	0.9	2.0

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1459	0.1667	0.1810	0.1941	0.2185	0.2419	0.2652	0.2893	0.3458	0.3634	0.3837	0.4084

Fineness Modulus	C_u	C_c
1.32	1.74	0.99

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	4.5	0.6	3.5	25.0	20.6	45.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.75	100.0		
0.5	96.4		
0.375	96.4		
#4	95.5		
#10	94.9		
#20	93.7		
#40	91.4		
#60	83.9		
#100	74.4		
#200	66.4		

* (no specification provided)

Material Description

brown sandy lean CLAY

Atterberg Limits

PL= 13 LL= 34 PI= 21

Coefficients

D_{90}= 0.3720 D_{85}= 0.2660 D_{60}= 0.0265
D_{50}= 0.0073 D_{30}= 0.0013 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(11)

Remarks

Lab No.: 167

Location: GT-2
Sample Number: S-4 **Depth:** 6.0' - 8.0' **Date:** 4/8/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/8/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-2
Depth: 6.0' - 8.0' **Sample Number:** S-4
Material Description: brown sandy lean CLAY
Date: 4/8/22 **PL:** 13 **LL:** 34 **PI:** 21
USCS Classification: CL **AASHTO Classification:** A-6(11)
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
255.42	15.86	0.00	0.75	0.00	100.0	0.0
			0.5	8.58	96.4	3.6
			0.375	8.58	96.4	3.6
			#4	10.83	95.5	4.5
			#10	12.33	94.9	5.1
51.33	0.00	0.00	#20	0.62	93.7	6.3
			#40	1.88	91.4	8.6
			#60	5.93	83.9	16.1
			#100	11.05	74.4	25.6
			#200	15.39	66.4	33.6

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 94.9
Weight of hydrometer sample =51.33
Hygroscopic moisture correction:
Moist weight and tare = 53.29
Dry weight and tare = 52.99
Tare weight = 32.34
Hygroscopic moisture = 1.5%
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5.0
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	21.6	38.0	33.3	0.0134	38.0	10.1	0.0424	62.5	37.5
2.00	21.6	37.0	32.3	0.0134	37.0	10.2	0.0303	60.6	39.4
5.00	21.6	36.0	31.3	0.0134	36.0	10.4	0.0193	58.7	41.3
15.00	21.6	34.0	29.3	0.0134	34.0	10.7	0.0113	55.0	45.0
30.00	21.6	32.0	27.3	0.0134	32.0	11.0	0.0081	51.2	48.8
60.00	21.6	30.0	25.3	0.0134	30.0	11.4	0.0058	47.5	52.5
120.00	21.6	28.0	23.3	0.0134	28.0	11.7	0.0042	43.7	56.3
250.00	21.5	25.5	20.8	0.0134	25.5	12.1	0.0029	39.0	61.0

Hydrometer Test Data (continued)

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1440.00	21.7	20.5	15.8	0.0134	20.5	12.9	0.0013	29.7	70.3

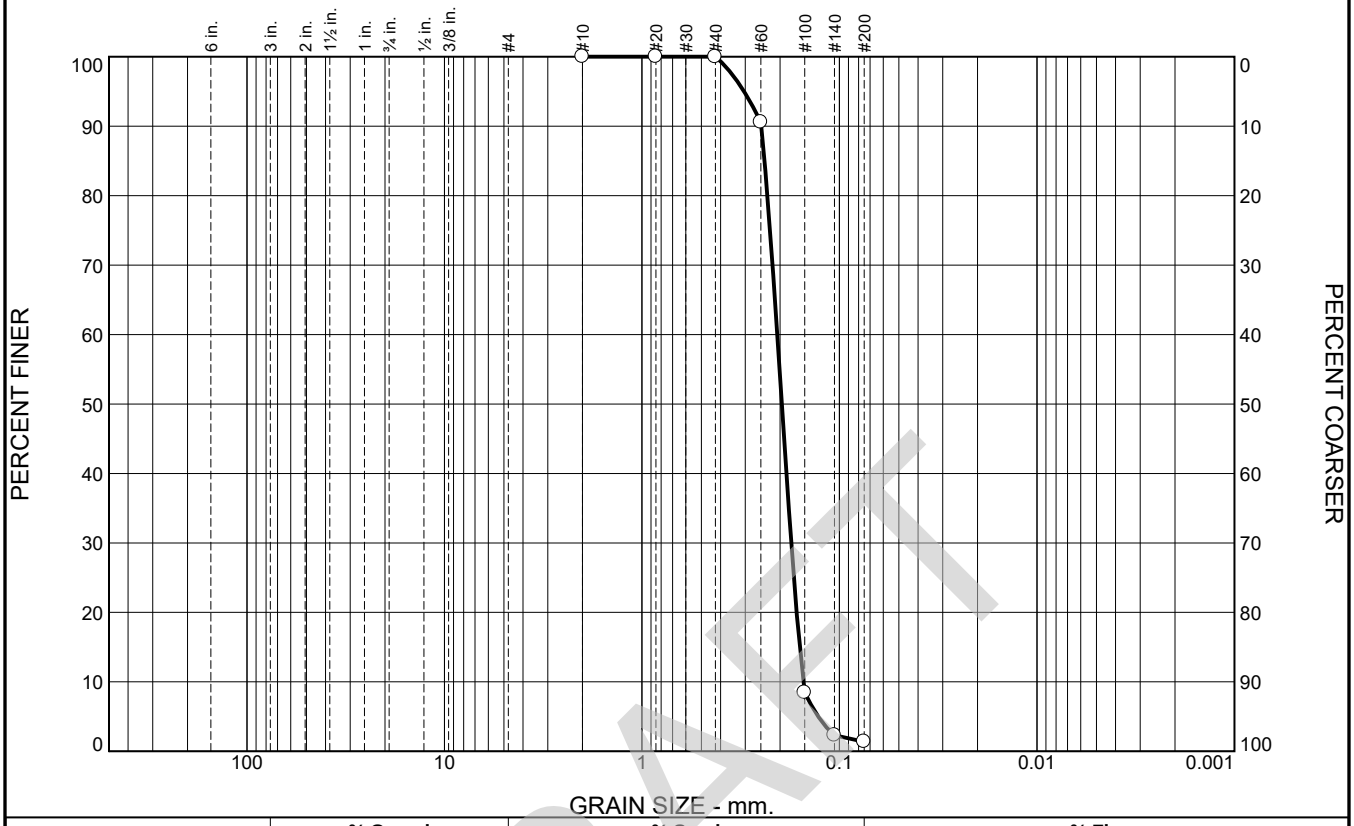
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	4.5	4.5	0.6	3.5	25.0	29.1	20.6	45.8	66.4

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
				0.0013	0.0032	0.0073	0.0265	0.2035	0.2660	0.3720	2.5333

Fineness Modulus
0.64

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	98.6	1.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	100.0		
#60	90.6		
#100	8.5		
#140	2.3		
#200	1.4		

* (no specification provided)

Material Description

light brown poorly graded SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2488 D_{85}= 0.2395 D_{60}= 0.2064
D_{50}= 0.1957 D_{30}= 0.1755 D_{15}= 0.1590
D_{10}= 0.1524 C_u= 1.35 C_c= 0.98

Classification

USCS= SP AASHTO=

Remarks

Lab No.: 167

Location: GT-2
Sample Number: S-6 **Depth:** 14.0' - 16.0' **Date:** 4/1/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/1/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-2
Depth: 14.0' - 16.0'
Sample Number: S-6
Material Description: light brown poorly graded SAND
Date: 4/1/22
USCS Classification: SP
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
326.54	13.92	0.00	#10	0.00	100.0	0.0
101.14	0.00	0.00	#20	0.00	100.0	0.0
			#40	0.02	100.0	0.0
			#60	9.54	90.6	9.4
			#100	92.58	8.5	91.5
			#140	98.80	2.3	97.7
			#200	99.74	1.4	98.6

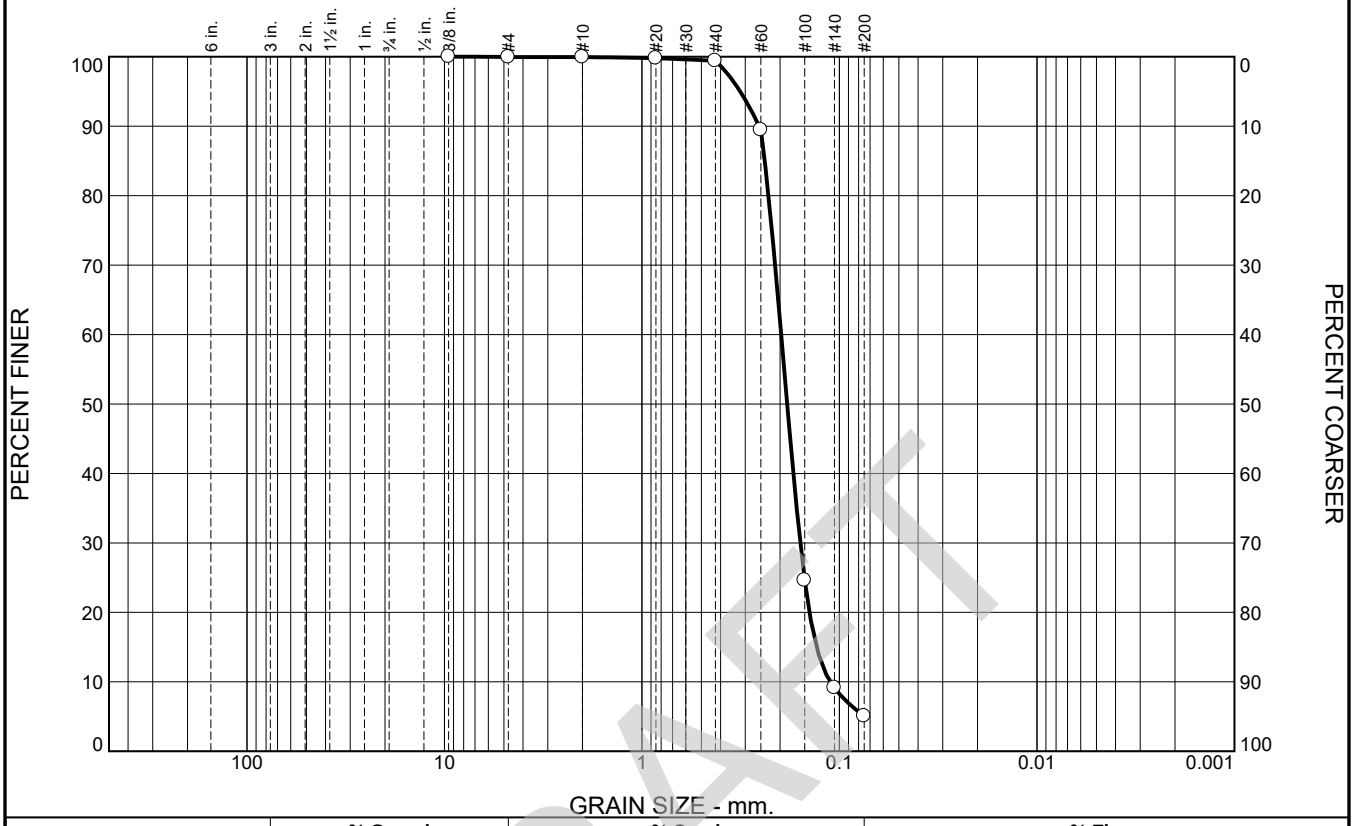
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.0	98.6	98.6			1.4

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1280	0.1524	0.1590	0.1649	0.1755	0.1856	0.1957	0.2064	0.2315	0.2395	0.2488	0.3042

Fineness Modulus	C_u	C_c
0.97	1.35	0.98

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.0	0.5	94.3	5.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	99.9		
#10	99.9		
#20	99.8		
#40	99.4		
#60	89.5		
#100	24.6		
#140	9.1		
#200	5.1		

* (no specification provided)

Material Description

light brown poorly graded SAND with silt (visual)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2551 D_{85}= 0.2389 D_{60}= 0.1972
D_{50}= 0.1840 D_{30}= 0.1580 D_{15}= 0.1305
D_{10}= 0.1112 C_u= 1.77 C_c= 1.14

Classification

USCS= AASHTO=

Remarks

Lab No.: 167

Location: GT-2
Sample Number: S-8 **Depth:** 21.0' - 23.0' **Date:** 4/1/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/1/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-2
Depth: 21.0' - 23.0' **Sample Number:** S-8
Material Description: light brown poorly graded SAND with silt (visual)
Date: 4/1/22
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
346.81	13.76	0.00	0.375	0.00	100.0	0.0
			#4	0.24	99.9	0.1
			#10	0.24	99.9	0.1
108.93	0.00	0.00	#20	0.17	99.8	0.2
			#40	0.59	99.4	0.6
			#60	11.40	89.5	10.5
			#100	82.08	24.6	75.4
			#140	98.96	9.1	90.9
			#200	103.38	5.1	94.9

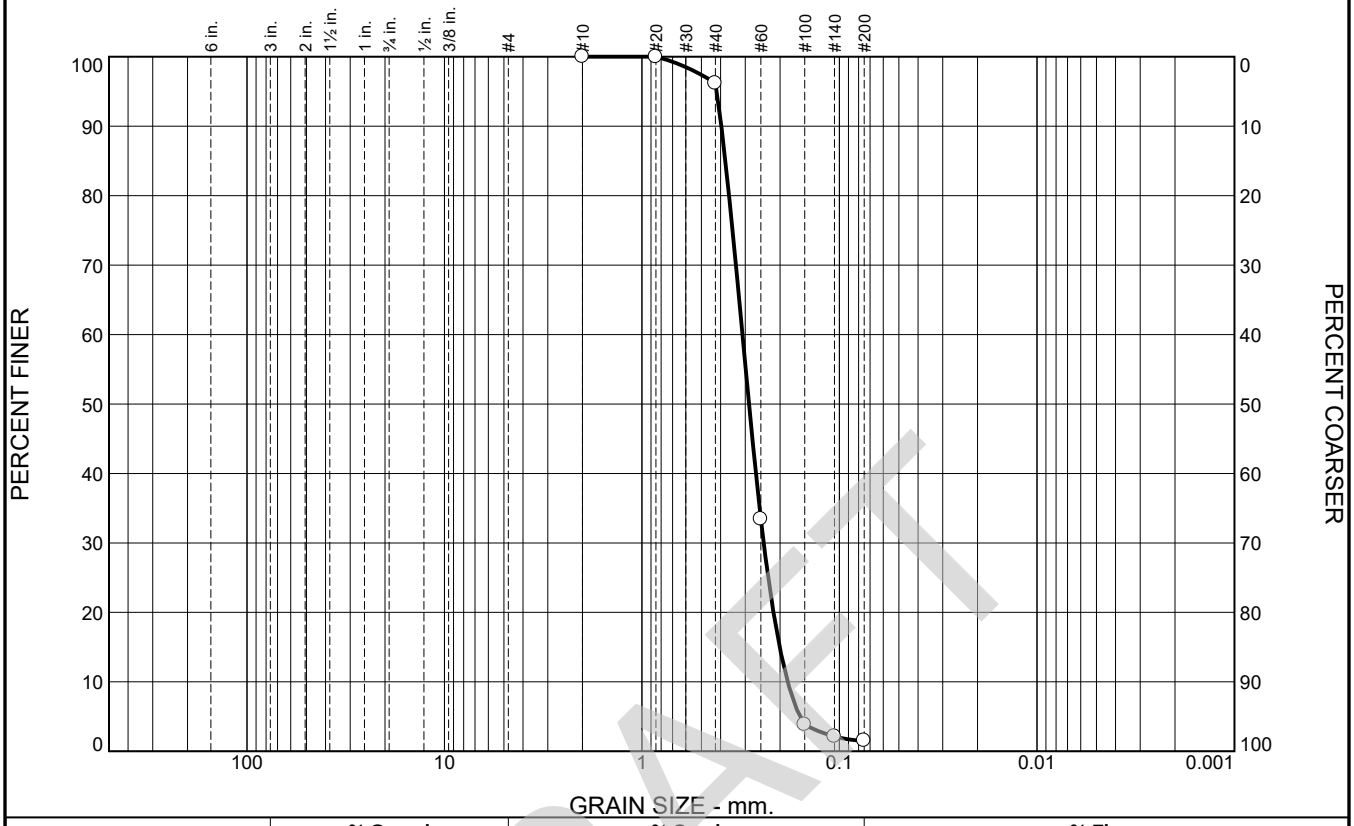
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.1	0.1	0.0	0.5	94.3	94.8			5.1

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.1112	0.1305	0.1419	0.1580	0.1712	0.1840	0.1972	0.2286	0.2389	0.2551	0.3180

Fineness Modulus	C_u	C_c
0.82	1.77	1.14

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	3.8	94.7	1.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	96.2		
#60	33.4		
#100	3.8		
#140	2.1		
#200	1.5		

* (no specification provided)

Material Description

light brown poorly graded SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.3964 D_{85}= 0.3780 D_{60}= 0.3096
D_{50}= 0.2869 D_{30}= 0.2419 D_{15}= 0.2007
D_{10}= 0.1829 C_u= 1.69 C_c= 1.03

Classification

USCS= SP AASHTO=

Remarks

Lab No.: 167

Location: GT-2
Sample Number: S-11 **Depth:** 27.0' - 29.0' **Date:** 4/1/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/1/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-2
Depth: 27.0' - 29.0'
Sample Number: S-11
Material Description: light brown poorly graded SAND
Date: 4/1/22
USCS Classification: SP
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
341.48	15.77	0.00	#10	0.00	100.0	0.0
102.82	0.00	0.00	#20	0.01	100.0	0.0
			#40	3.93	96.2	3.8
			#60	68.45	33.4	66.6
			#100	98.88	3.8	96.2
			#140	100.62	2.1	97.9
			#200	101.24	1.5	98.5

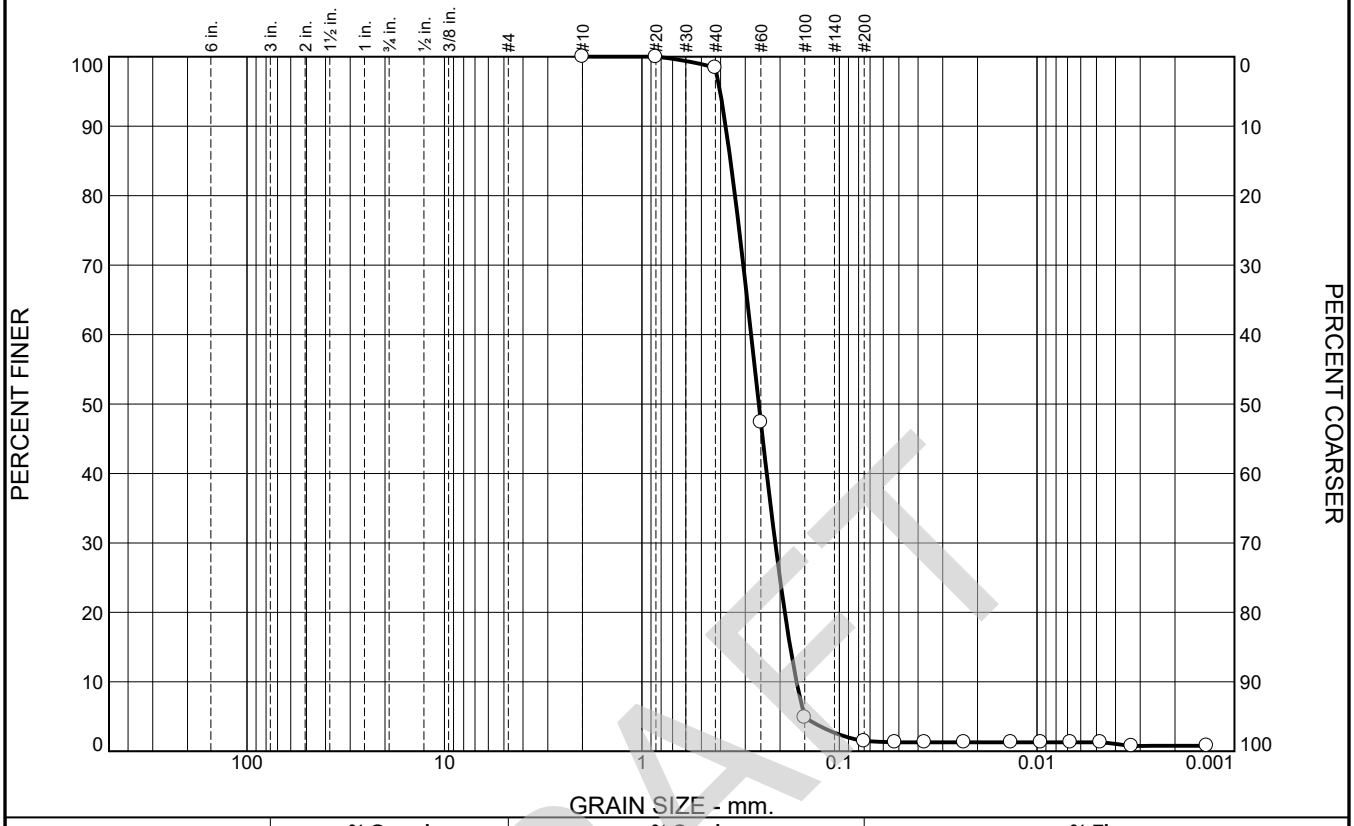
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	3.8	94.7	98.5			1.5

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1585	0.1829	0.2007	0.2159	0.2419	0.2649	0.2869	0.3096	0.3619	0.3780	0.3964	0.4188

Fineness Modulus	C_u	C_c
1.42	1.69	1.03

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.6	96.9	0.2	1.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	98.4		
#60	47.4		
#100	4.9		
#200	1.5		

* (no specification provided)

Material Description

brown poorly graded SAND

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.3766 D_{85}= 0.3556 D_{60}= 0.2800
D_{50}= 0.2560 D_{30}= 0.2113 D_{15}= 0.1775
D_{10}= 0.1650 C_u= 1.70 C_c= 0.97

Classification

USCS= SP AASHTO= A-3

Remarks

Lab No.: 167

Location: GT-2
Sample Number: Bucket **Depth:** 30.0' - 40.0' **Date:** 4/8/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/8/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-2
Depth: 30.0' - 40.0'
Sample Number: Bucket
Material Description: brown poorly graded SAND
Date: 4/8/22 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: SP
AASHTO Classification: A-3
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
536.09	13.76	0.00	#10	0.00	100.0	0.0
101.19	0.00	0.00	#20	0.01	100.0	0.0
			#40	1.60	98.4	1.6
			#60	53.23	47.4	52.6
			#100	96.26	4.9	95.1
			#200	99.69	1.5	98.5

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =101.19
Hygroscopic moisture correction:
Moist weight and tare = 124.78
Dry weight and tare = 124.72
Tare weight = 32.55
Hygroscopic moisture = 0.1%
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5.0
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0523	1.3	98.7
2.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0370	1.3	98.7
5.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0234	1.3	98.7
15.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0135	1.3	98.7
30.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0096	1.3	98.7
60.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0068	1.3	98.7
120.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0048	1.3	98.7
250.00	21.5	5.5	0.8	0.0134	5.5	15.4	0.0033	0.8	99.2
1440.00	21.6	5.5	0.8	0.0134	5.5	15.4	0.0014	0.8	99.2

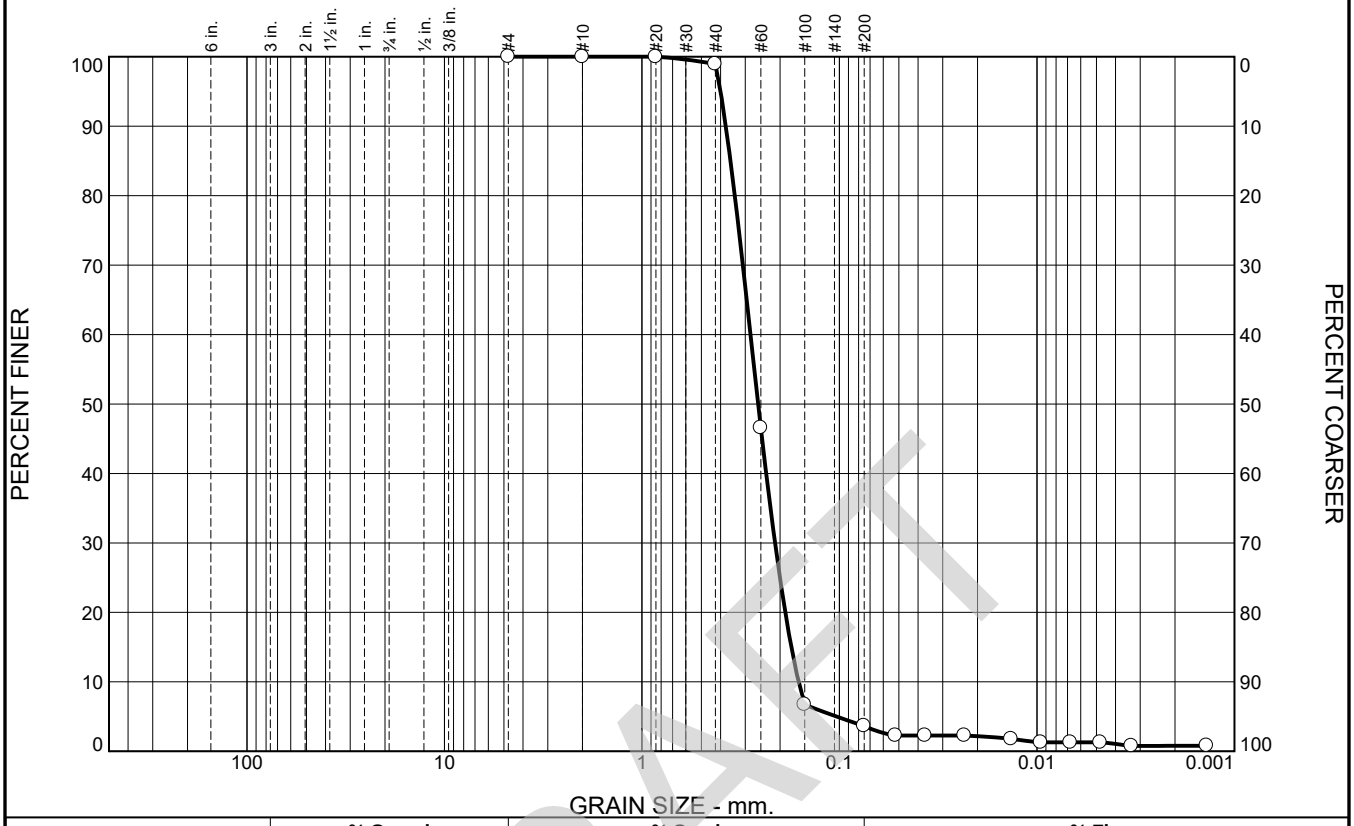
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	1.6	96.9	98.5	0.2	1.3	1.5

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1504	0.1650	0.1775	0.1891	0.2113	0.2334	0.2560	0.2800	0.3375	0.3556	0.3766	0.4023

Fineness Modulus	C_u	C_c
1.28	1.70	0.97

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.1	95.2	2.4	1.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	100.0		
#40	98.9		
#60	46.6		
#100	6.7		
#200	3.7		

* (no specification provided)

Material Description

brown poorly graded SAND

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.3759 D_{85}= 0.3558 D_{60}= 0.2820
D_{50}= 0.2580 D_{30}= 0.2119 D_{15}= 0.1753
D_{10}= 0.1611 C_u= 1.75 C_c= 0.99

Classification

USCS= SP AASHTO= A-3

Remarks

Lab No.: 167

Location: GT-2
Sample Number: S-14 **Depth:** 33.0' - 35.0' **Date:** 4/8/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/8/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-2
Depth: 33.0' - 35.0'
Sample Number: S-14
Material Description: brown poorly graded SAND
Date: 4/8/22
PL: NP
LL: NV
PI: NP
USCS Classification: SP
AASHTO Classification: A-3
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
366.99	13.80	0.00	#4	0.00	100.0	0.0
			#10	0.03	100.0	0.0
101.75	0.00	0.00	#20	0.00	100.0	0.0
			#40	1.07	98.9	1.1
			#60	54.36	46.6	53.4
			#100	94.90	6.7	93.3
			#200	98.03	3.7	96.3

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =101.75
Hygroscopic moisture correction:
Moist weight and tare = 124.21
Dry weight and tare = 124.17
Tare weight = 30.44
Hygroscopic moisture = 0.0%
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5.0
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	21.6	7.0	2.3	0.0134	7.0	15.1	0.0521	2.3	97.7
2.00	21.6	7.0	2.3	0.0134	7.0	15.1	0.0368	2.3	97.7
5.00	21.6	7.0	2.3	0.0134	7.0	15.1	0.0233	2.3	97.7
15.00	21.6	6.5	1.8	0.0134	6.5	15.2	0.0135	1.8	98.2
30.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0096	1.3	98.7
60.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0068	1.3	98.7
120.00	21.6	6.0	1.3	0.0134	6.0	15.3	0.0048	1.3	98.7
250.00	21.5	5.5	0.8	0.0134	5.5	15.4	0.0033	0.8	99.2
1440.00	21.6	5.5	0.8	0.0134	5.5	15.4	0.0014	0.8	99.2

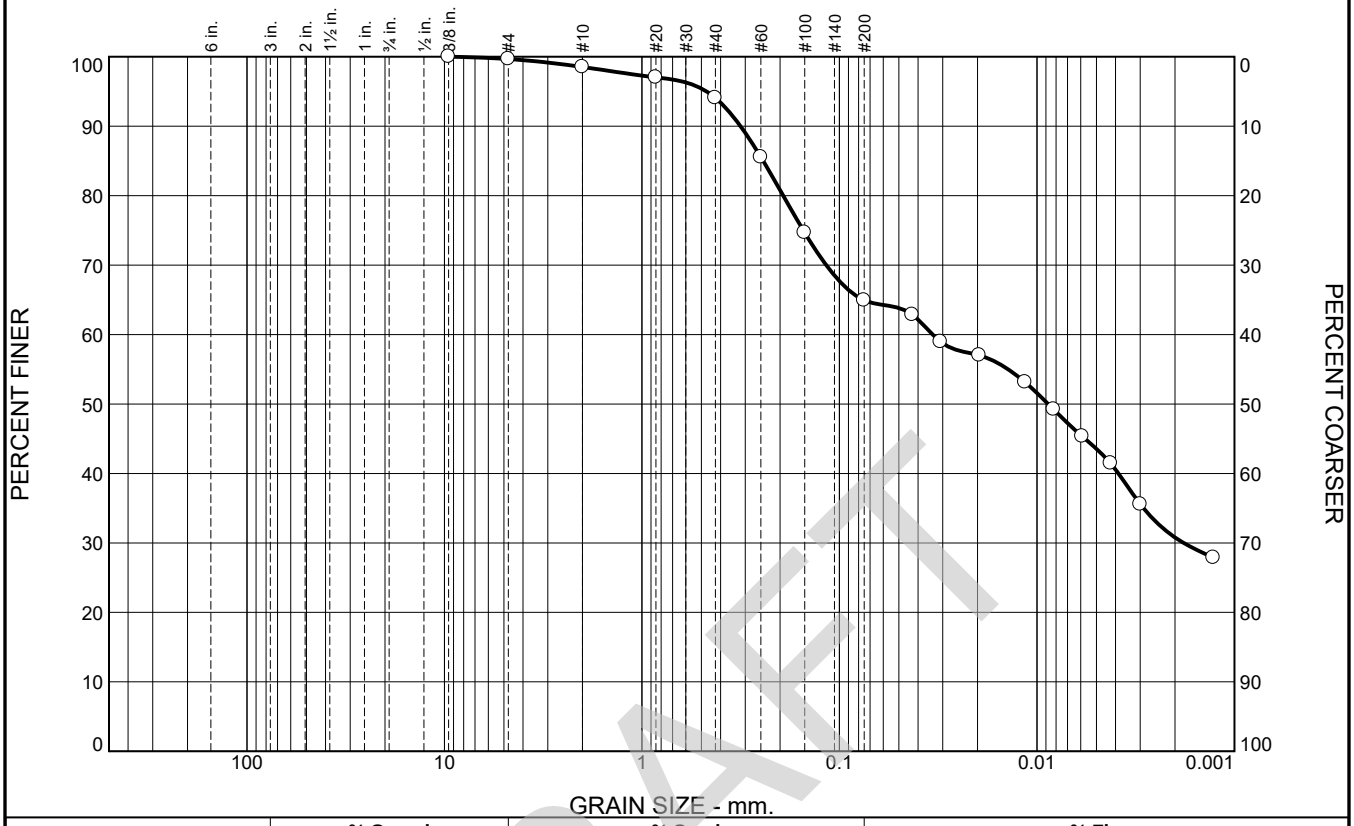
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	1.1	95.2	96.3	2.4	1.3	3.7

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1032	0.1611	0.1753	0.1881	0.2119	0.2349	0.2580	0.2820	0.3383	0.3558	0.3759	0.4002

Fineness Modulus	C_u	C_c
1.27	1.75	0.99

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.3	1.2	4.4	29.2	21.3	43.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	99.7		
#10	98.5		
#20	97.0		
#40	94.1		
#60	85.6		
#100	74.7		
#200	64.9		

* (no specification provided)

Material Description

brown sandy lean CLAY

Atterberg Limits

PL= 12 LL= 31 PI= 19

Coefficients

D_{90}= 0.3167 D_{85}= 0.2433 D_{60}= 0.0338
D_{50}= 0.0088 D_{30}= 0.0018 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(9)

Remarks

Lab No.: 167

Location: GT-3
Sample Number: S-3 **Depth:** 4.0' - 6.0' **Date:** 4/8/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/8/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-3
Depth: 4.0' - 6.0'
Sample Number: S-3
Material Description: brown sandy lean CLAY
Date: 4/8/22 **PL:** 12 **LL:** 31 **PI:** 19
USCS Classification: CL
AASHTO Classification: A-6(9)
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
306.07	13.67	0.00	0.375	0.00	100.0	0.0
			#4	1.00	99.7	0.3
			#10	4.35	98.5	1.5
51.40	0.00	0.00	#20	0.78	97.0	3.0
			#40	2.32	94.1	5.9
			#60	6.76	85.6	14.4
			#100	12.44	74.7	25.3
			#200	17.52	64.9	35.1

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 98.5
Weight of hydrometer sample =51.40
Hygroscopic moisture correction:
Moist weight and tare = 52.44
Dry weight and tare = 52.11
Tare weight = 29.80
Hygroscopic moisture = 1.5%
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5.0
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	21.6	37.0	32.3	0.0134	37.0	10.2	0.0428	62.8	37.2
2.00	21.6	35.0	30.3	0.0134	35.0	10.6	0.0307	59.0	41.0
5.00	21.6	34.0	29.3	0.0134	34.0	10.7	0.0196	57.0	43.0
15.00	21.6	32.0	27.3	0.0134	32.0	11.0	0.0115	53.1	46.9
30.00	21.6	30.0	25.3	0.0134	30.0	11.4	0.0082	49.2	50.8
60.00	21.6	28.0	23.3	0.0134	28.0	11.7	0.0059	45.3	54.7
120.00	21.6	26.0	21.3	0.0134	26.0	12.0	0.0042	41.5	58.5
250.00	21.5	23.0	18.3	0.0134	23.0	12.5	0.0030	35.6	64.4
1440.00	21.7	19.0	14.3	0.0134	19.0	13.2	0.0013	27.9	72.1

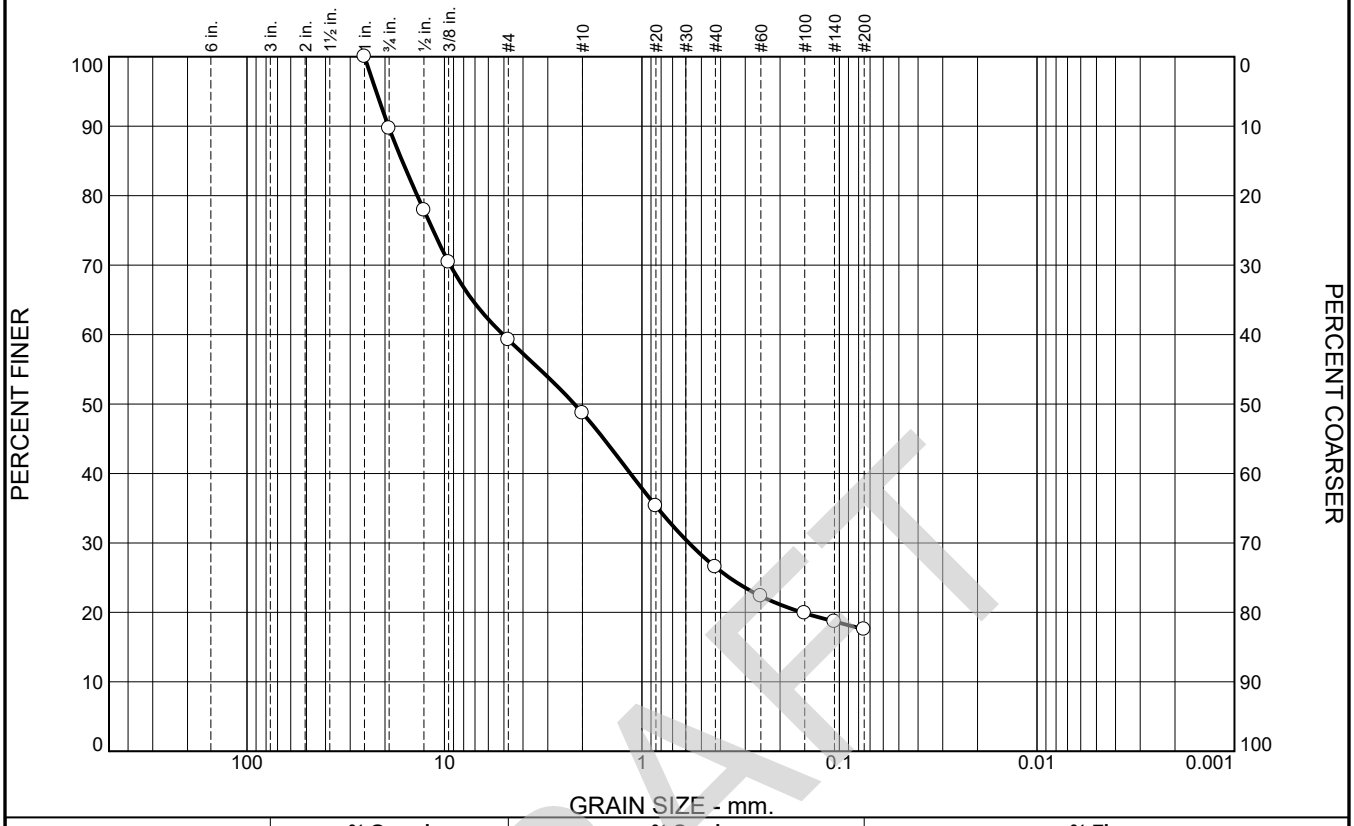
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.3	0.3	1.2	4.4	29.2	34.8	21.3	43.6	64.9

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
				0.0018	0.0039	0.0088	0.0338	0.1927	0.2433	0.3167	0.4716

Fineness Modulus
0.44

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	10.3	30.4	10.6	22.2	8.9	17.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.0	100.0		
0.75	89.7		
0.5	77.9		
0.375	70.4		
#4	59.3		
#10	48.7		
#20	35.3		
#40	26.5		
#60	22.3		
#100	19.9		
#140	18.7		
#200	17.6		

* (no specification provided)

Material Description

gray sility, sandy CLAY with gravel (visual)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 19.2252 D_{85}= 16.3765 D_{60}= 5.0514
D_{50}= 2.1989 D_{30}= 0.5785 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Lab No.: 167
*Sample Size is not representative

Location: GT-3
Sample Number: S-4 (Bottom) **Depth:** 6.0'-8.0' **Date:** 4/8/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/8/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-3
Depth: 6.0'-8.0' **Sample Number:** S-4 (Bottom)
Material Description: gray silty, sandy CLAY with gravel (visual)
Date: 4/8/22
Testing Remarks: Lab No.: 167
*Sample Size is not representative

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
227.61	13.89	0.00	1.0	0.00	100.0	0.0
			0.75	22.02	89.7	10.3
			0.5	47.24	77.9	22.1
			0.375	63.22	70.4	29.6
			#4	87.07	59.3	40.7
			#10	109.65	48.7	51.3
98.87	0.00	0.00	#20	27.15	35.3	64.7
			#40	45.01	26.5	73.5
			#60	53.52	22.3	77.7
			#100	58.50	19.9	80.1
			#140	60.94	18.7	81.3
			#200	63.23	17.6	82.4

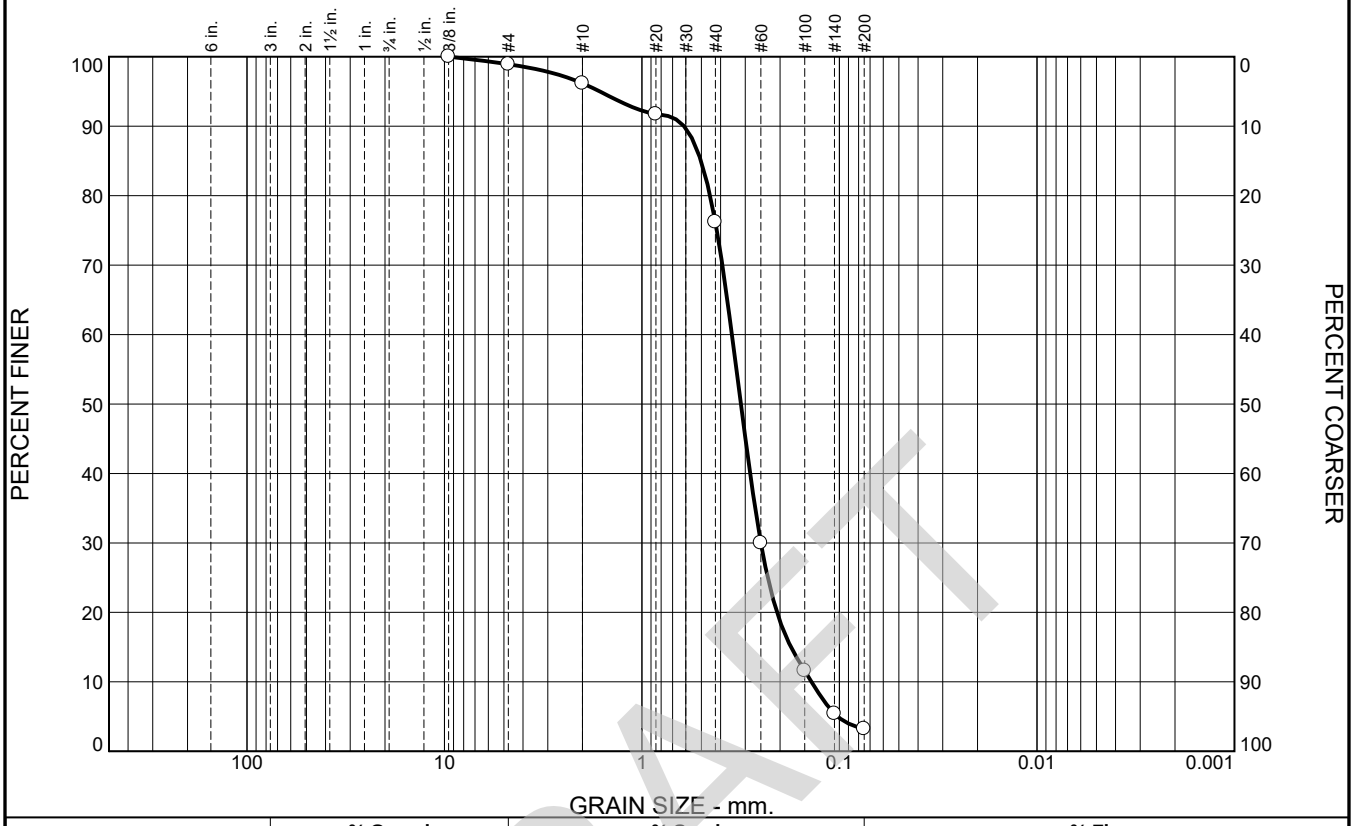
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	10.3	30.4	40.7	10.6	22.2	8.9	41.7			17.6

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
			0.1546	0.5785	1.1442	2.1989	5.0514	13.7169	16.3765	19.2252	22.1822

Fineness Modulus
4.15

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.1	2.7	20.0	73.0	3.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	98.9		
#10	96.2		
#20	91.7		
#40	76.2		
#60	30.0		
#100	11.6		
#140	5.4		
#200	3.2		

* (no specification provided)

Material Description

light brown poorly graded SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6124 D_{85}= 0.5025 D_{60}= 0.3501
D_{50}= 0.3153 D_{30}= 0.2500 D_{15}= 0.1761
D_{10}= 0.1385 C_u= 2.53 C_c= 1.29

Classification

USCS= SP AASHTO=

Remarks

Lab No.: 167

Location: GT-3
Sample Number: S-7 **Depth:** 19.0' - 21.0' **Date:** 4/1/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/1/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-3
Depth: 19.0' - 21.0'
Sample Number: S-7
Material Description: light brown poorly graded SAND
Date: 4/1/22
USCS Classification: SP
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
365.90	13.70	0.00	0.375	0.00	100.0	0.0
			#4	3.86	98.9	1.1
			#10	13.54	96.2	3.8
102.83	0.00	0.00	#20	4.73	91.7	8.3
			#40	21.35	76.2	23.8
			#60	70.76	30.0	70.0
			#100	90.42	11.6	88.4
			#140	97.03	5.4	94.6
			#200	99.37	3.2	96.8

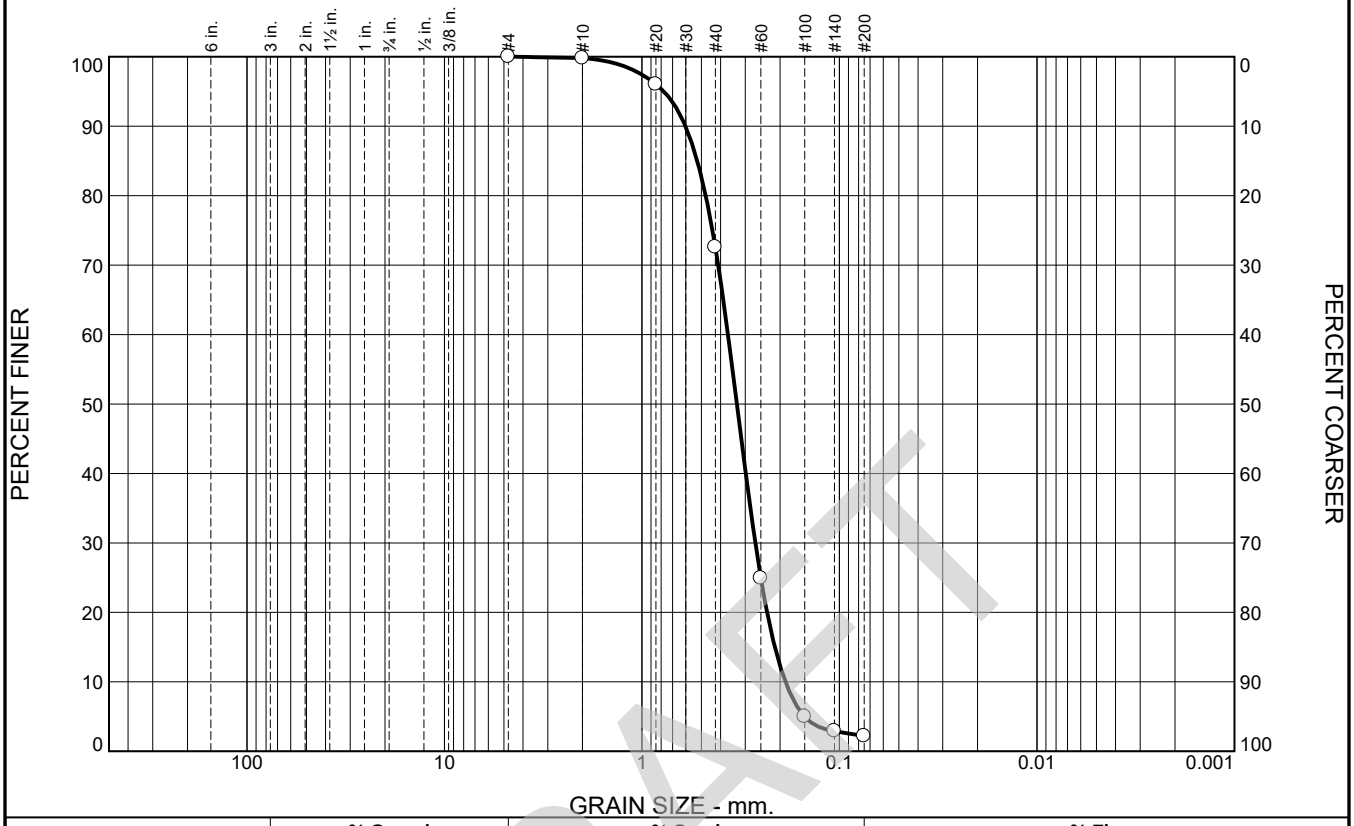
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	1.1	1.1	2.7	20.0	73.0	95.7			3.2

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1021	0.1385	0.1761	0.2072	0.2500	0.2832	0.3153	0.3501	0.4518	0.5025	0.6124	1.6400

Fineness Modulus	C_u	C_c
1.65	2.53	1.29

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	27.2	70.4	2.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.8		
#20	96.0		
#40	72.6		
#60	24.9		
#100	5.0		
#140	2.9		
#200	2.2		

* (no specification provided)

Material Description

light brown poorly graded SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6020 D_{85}= 0.5247 D_{60}= 0.3668
D_{50}= 0.3304 D_{30}= 0.2666 D_{15}= 0.2124
D_{10}= 0.1878 C_u= 1.95 C_c= 1.03

Classification

USCS= SP AASHTO=

Remarks

Lab No.: 167

Location: GT-3
Sample Number: S-10 **Depth:** 34.0' - 36.0' **Date:** 4/1/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/1/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-3
Depth: 34.0' - 36.0'
Sample Number: S-10
Material Description: light brown poorly graded SAND
Date: 4/1/22
USCS Classification: SP
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
368.70	13.91	0.00	#4	0.00	100.0	0.0
			#10	0.73	99.8	0.2
106.10	0.00	0.00	#20	4.01	96.0	4.0
			#40	28.93	72.6	27.4
			#60	79.62	24.9	75.1
			#100	100.80	5.0	95.0
			#140	103.00	2.9	97.1
			#200	103.77	2.2	97.8

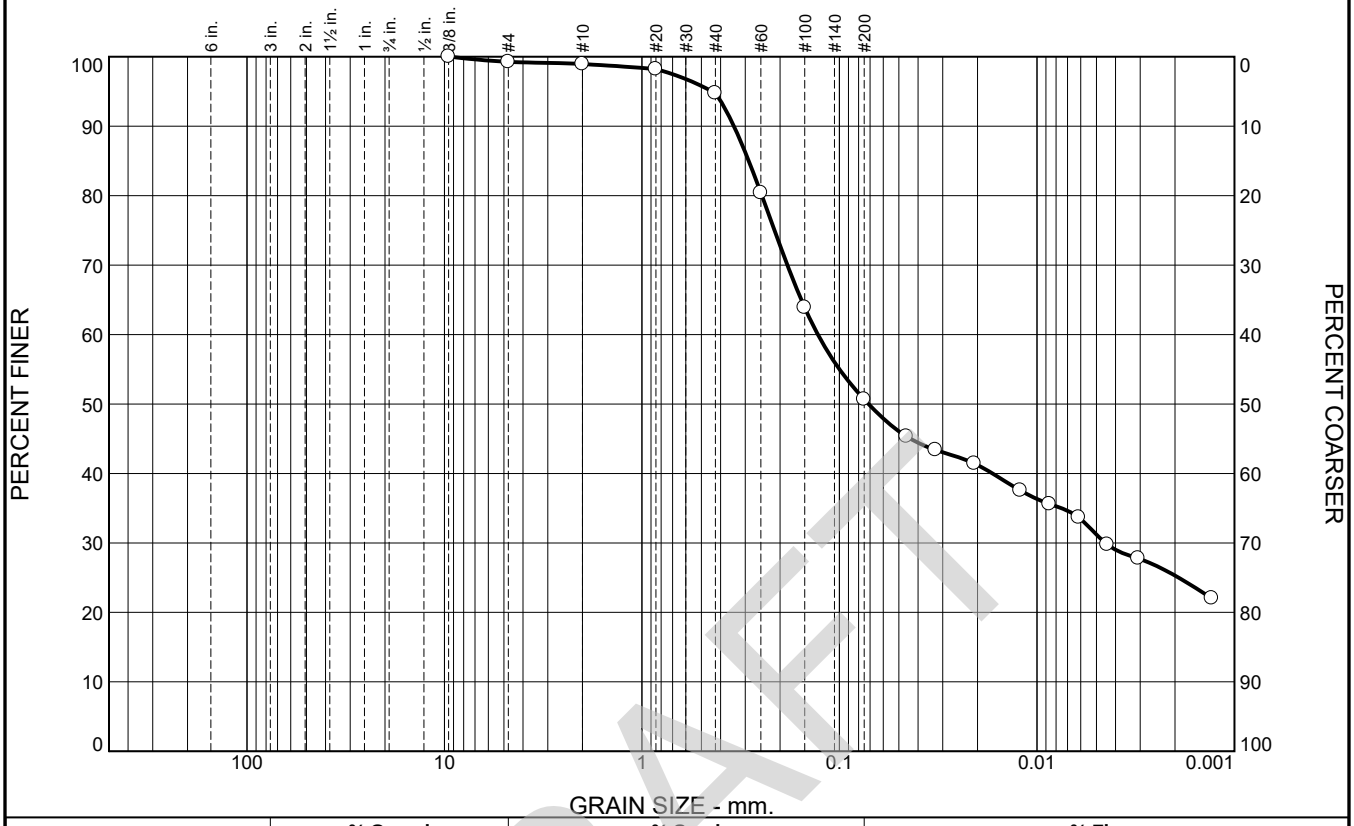
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.2	27.2	70.4	97.8			2.2

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1502	0.1878	0.2124	0.2326	0.2666	0.2979	0.3304	0.3668	0.4755	0.5247	0.6020	0.7753

Fineness Modulus	C_u	C_c
1.66	1.95	1.03

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.7	0.4	4.2	44.0	19.5	31.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	99.3		
#10	98.9		
#20	98.2		
#40	94.7		
#60	80.4		
#100	63.9		
#200	50.7		

* (no specification provided)

Material Description

brown sandy lean CLAY

Atterberg Limits

PL= 12 LL= 27 PI= 15

Coefficients

D_{90}= 0.3421 D_{85}= 0.2879 D_{60}= 0.1286
D_{50}= 0.0713 D_{30}= 0.0045 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(4)

Remarks

Lab No.: 167

Location: GT-4
Sample Number: S-1 **Depth:** 0.0' - 2.0' **Date:** 4/8/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/8/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-4
Depth: 0.0' - 2.0'
Sample Number: S-1
Material Description: brown sandy lean CLAY
Date: 4/8/22 **PL:** 12 **LL:** 27 **PI:** 15
USCS Classification: CL
AASHTO Classification: A-6(4)
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
281.12	13.72	0.00	0.375	0.00	100.0	0.0
			#4	2.00	99.3	0.7
			#10	2.86	98.9	1.1
51.55	0.00	0.00	#20	0.38	98.2	1.8
			#40	2.18	94.7	5.3
			#60	9.65	80.4	19.6
			#100	18.26	63.9	36.1
			#200	25.15	50.7	49.3

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 98.9
Weight of hydrometer sample =51.55
Hygroscopic moisture correction:
Moist weight and tare = 52.37
Dry weight and tare = 52.10
Tare weight = 31.55
Hygroscopic moisture = 1.3%
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5.0
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	21.6	28.0	23.3	0.0134	28.0	11.7	0.0458	45.3	54.7
2.00	21.6	27.0	22.3	0.0134	27.0	11.9	0.0326	43.4	56.6
5.00	21.6	26.0	21.3	0.0134	26.0	12.0	0.0208	41.4	58.6
15.00	21.6	24.0	19.3	0.0134	24.0	12.4	0.0121	37.6	62.4
30.00	21.6	23.0	18.3	0.0134	23.0	12.5	0.0086	35.6	64.4
60.00	21.6	22.0	17.3	0.0134	22.0	12.7	0.0062	33.7	66.3
120.00	21.6	20.0	15.3	0.0134	20.0	13.0	0.0044	29.8	70.2
250.00	21.5	19.0	14.3	0.0134	19.0	13.2	0.0031	27.8	72.2
1440.00	21.7	16.0	11.3	0.0134	16.0	13.7	0.0013	22.0	78.0

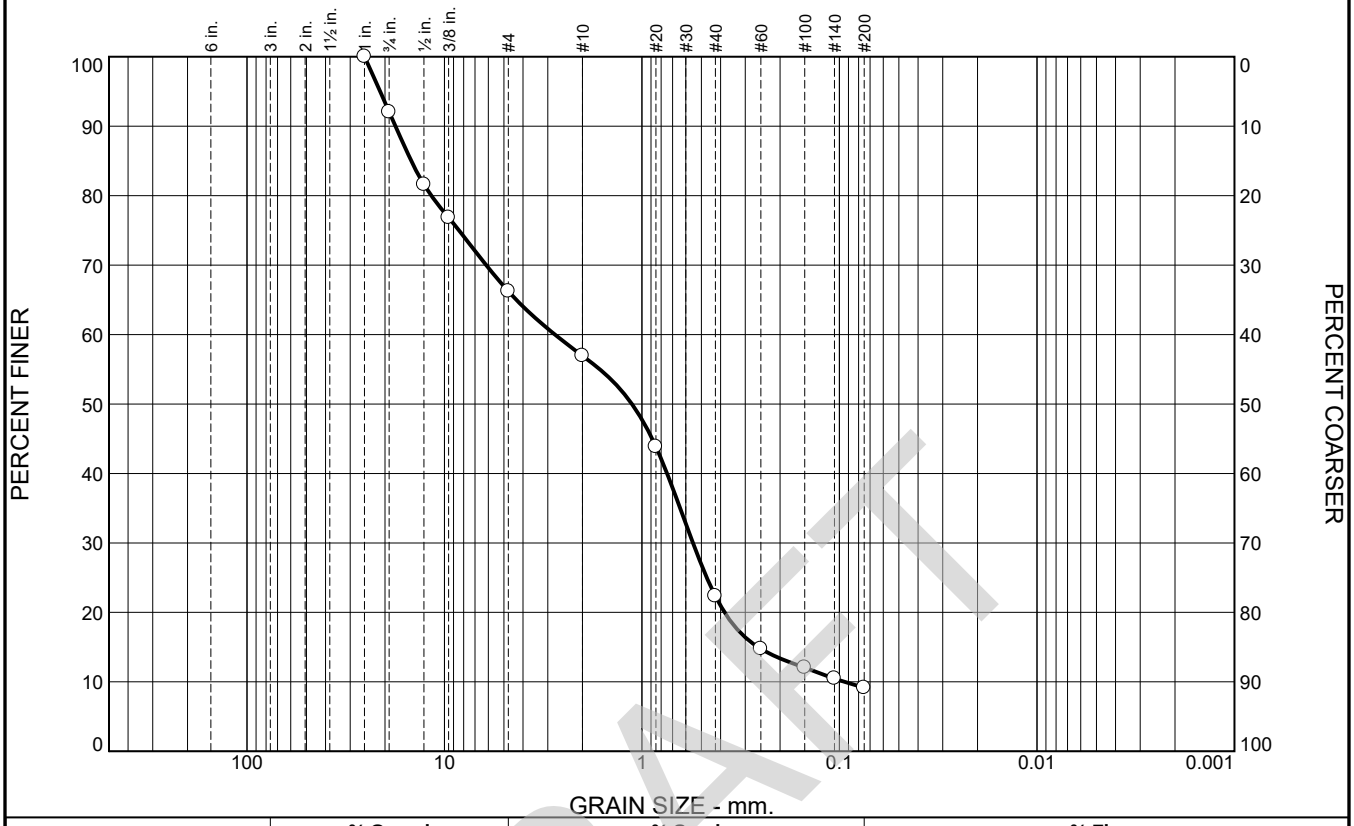
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.7	0.7	0.4	4.2	44.0	48.6	19.5	31.2	50.7

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
				0.0045	0.0168	0.0713	0.1286	0.2470	0.2879	0.3421	0.4413

Fineness Modulus
0.56

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	8.0	25.8	9.3	34.6	13.1	9.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.00	100.0		
0.75	92.0		
0.50	81.6		
0.375	76.8		
#4	66.2		
#10	56.9		
#20	43.9		
#40	22.3		
#60	14.8		
#100	12.0		
#140	10.5		
#200	9.2		

* (no specification provided)

Material Description

brown well graded SAND with silt and gravel (visual)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 17.7149 D_{85}= 14.7264 D_{60}= 2.7600
D_{50}= 1.1236 D_{30}= 0.5517 D_{15}= 0.2581
D_{10}= 0.0942 C_u= 29.30 C_c= 1.17

Classification

USCS= AASHTO=

Remarks

Lab No.: 167

Location: GT-4
Sample Number: S-5 **Depth:** 8.0' - 10.0' **Date:** 4/1/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/1/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-4
Depth: 8.0' - 10.0' **Sample Number:** S-5
Material Description: brown well graded SAND with silt and gravel (visual)
Date: 4/1/22
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
305.57	0.00	0.00	1.00	0.00	100.0	0.0
			0.75	24.31	92.0	8.0
			0.50	56.27	81.6	18.4
			0.375	70.80	76.8	23.2
			#4	103.18	66.2	33.8
			#10	131.60	56.9	43.1
133.39	0.00	0.00	#20	30.62	43.9	56.1
			#40	81.05	22.3	77.7
			#60	98.82	14.8	85.2
			#100	105.16	12.0	88.0
			#140	108.84	10.5	89.5
			#200	111.95	9.2	90.8

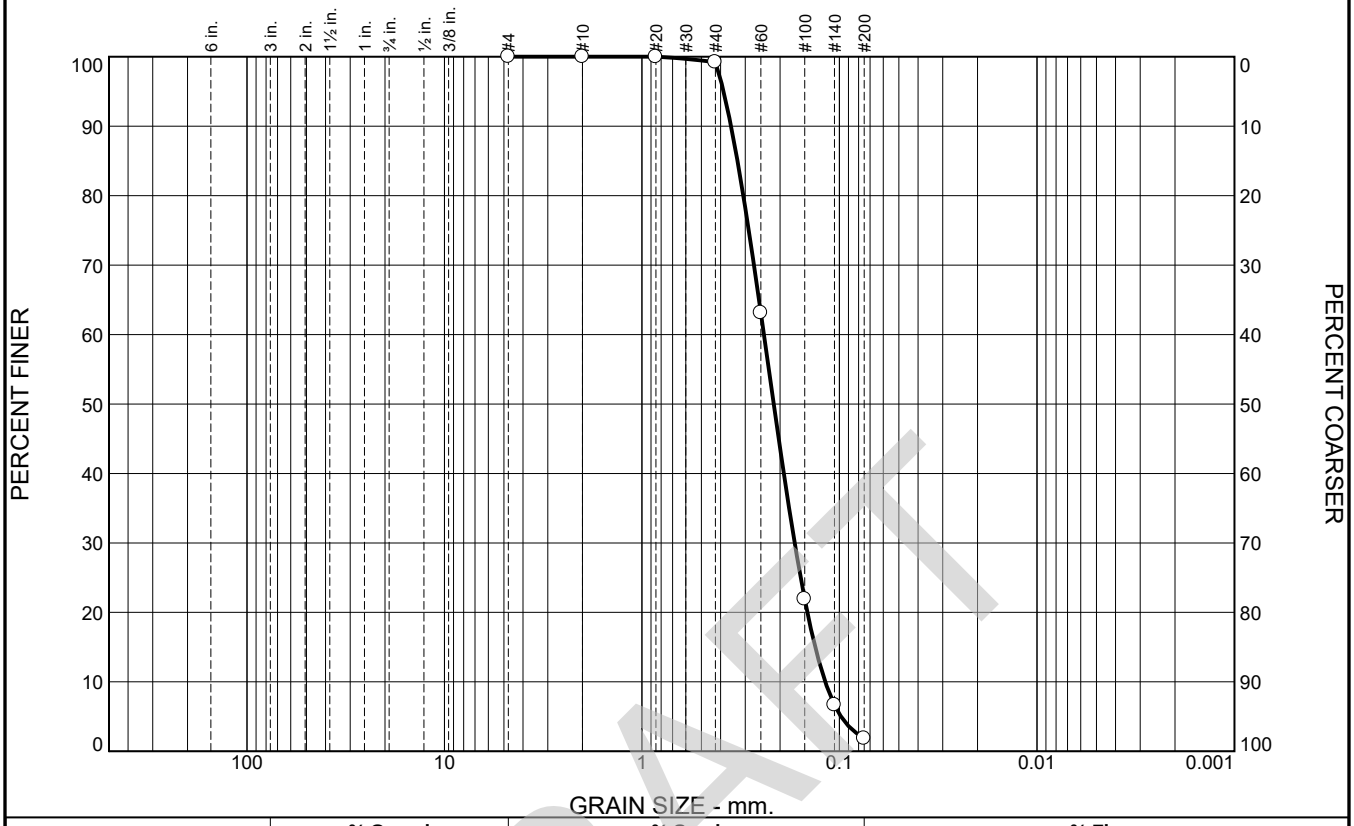
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	8.0	25.8	33.8	9.3	34.6	13.1	57.0			9.2

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0942	0.2581	0.3817	0.5517	0.7458	1.1236	2.7600	11.6696	14.7264	17.7149	21.1811

Fineness Modulus	C_u	C_c
3.94	29.30	1.17

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.8	97.4	1.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	100.0		
#40	99.2		
#60	63.1		
#100	21.9		
#140	6.7		
#200	1.8		

* (no specification provided)

Material Description

light brown poorly graded SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.3536 D_{85}= 0.3281 D_{60}= 0.2412
D_{50}= 0.2151 D_{30}= 0.1686 D_{15}= 0.1326
D_{10}= 0.1180 C_u= 2.04 C_c= 1.00

Classification

USCS= SP AASHTO=

Remarks

Lab No.: 167

Location: GT-4
Sample Number: S-7 **Depth:** 19.0' - 21.0' **Date:** 4/1/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/1/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-4
Depth: 19.0' - 21.0'
Sample Number: S-7
Material Description: light brown poorly graded SAND
Date: 4/1/22
USCS Classification: SP
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
354.08	13.76	0.00	#4	0.00	100.0	0.0
			#10	0.02	100.0	0.0
102.83	0.00	0.00	#20	0.01	100.0	0.0
			#40	0.82	99.2	0.8
			#60	37.91	63.1	36.9
			#100	80.30	21.9	78.1
			#140	95.97	6.7	93.3
			#200	100.93	1.8	98.2

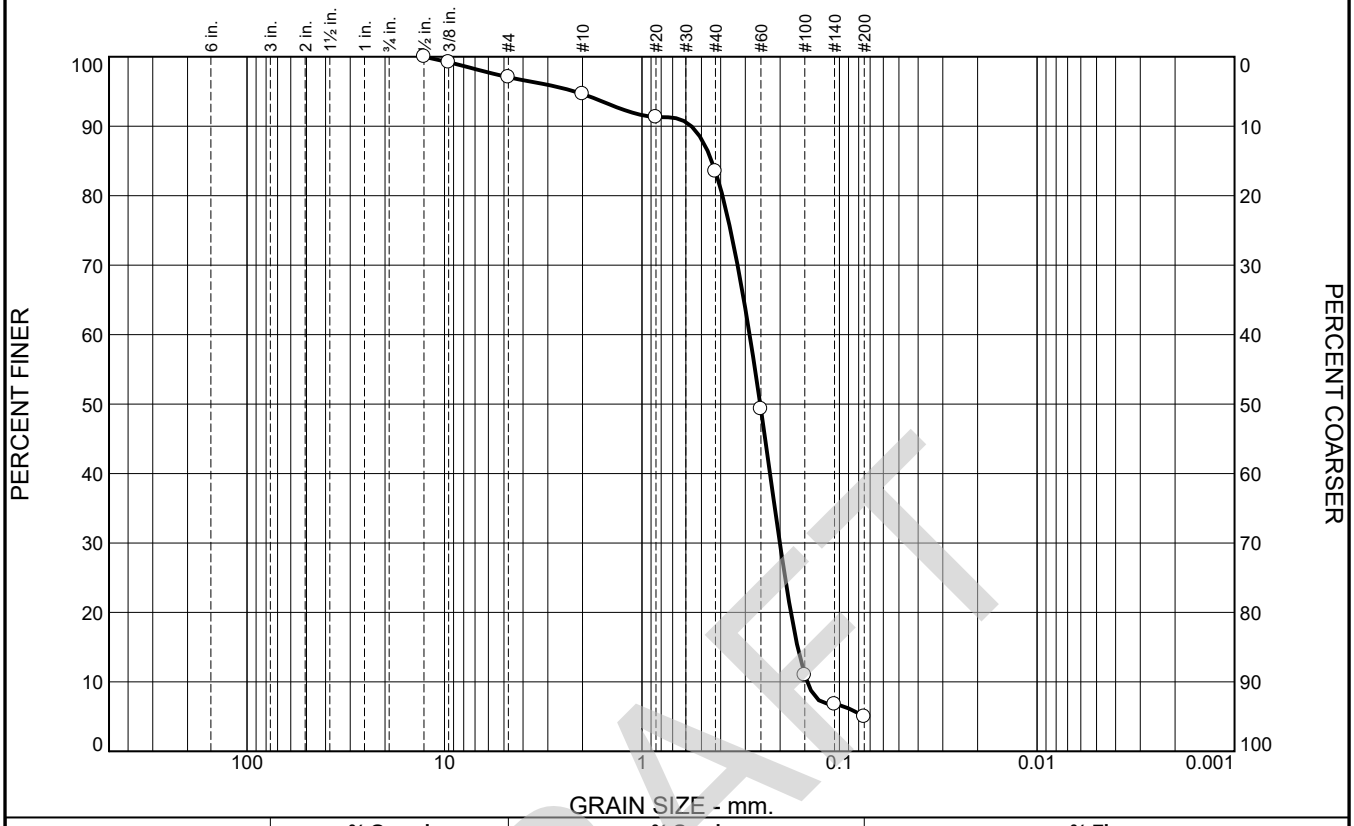
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.8	97.4	98.2			1.8

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.0983	0.1180	0.1326	0.1454	0.1686	0.1913	0.2151	0.2412	0.3066	0.3281	0.3536	0.3861

Fineness Modulus	C_u	C_c
1.00	2.04	1.00

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.9	2.5	11.1	78.5	5.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.50	100.0		
0.375	99.2		
#4	97.1		
#10	94.6		
#20	91.3		
#40	83.5		
#60	49.3		
#100	11.0		
#140	6.8		
#200	5.0		

* (no specification provided)

Material Description

light brown poorly graded SAND with silt (visual)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.5624 D_{85}= 0.4437 D_{60}= 0.2851
D_{50}= 0.2521 D_{30}= 0.2005 D_{15}= 0.1631
D_{10}= 0.1459 C_u= 1.95 C_c= 0.97

Classification

USCS= AASHTO=

Remarks

Lab No.: 167

Location: GT-5
Sample Number: S-2 **Depth:** 2.0' - 4.0' **Date:** 4/1/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/1/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-5
Depth: 2.0' - 4.0' **Sample Number:** S-2
Material Description: light brown poorly graded SAND with silt
Date: 4/1/22
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
379.46	15.82	0.00	0.50	0.00	100.0	0.0
			0.375	2.94	99.2	0.8
			#4	10.71	97.1	2.9
			#10	19.53	94.6	5.4
106.44	0.00	0.00	#20	3.73	91.3	8.7
			#40	12.53	83.5	16.5
			#60	51.00	49.3	50.7
			#100	94.09	11.0	89.0
			#140	98.81	6.8	93.2
			#200	100.81	5.0	95.0

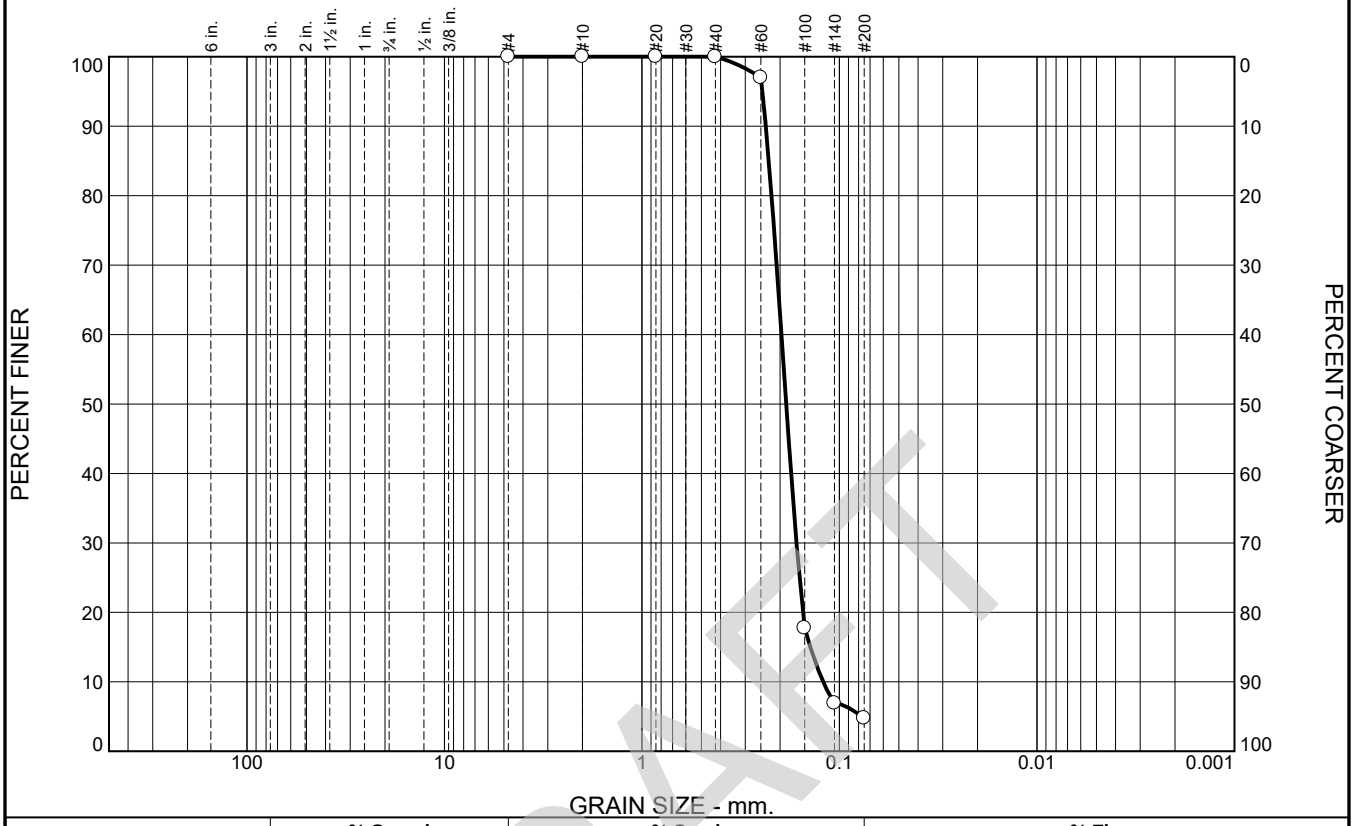
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	2.9	2.9	2.5	11.1	78.5	92.1			5.0

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.1459	0.1631	0.1764	0.2005	0.2249	0.2521	0.2851	0.3915	0.4437	0.5624	2.1981

Fineness Modulus	C_u	C_c
1.51	1.95	0.97

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	95.2	4.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	100.0		
#40	100.0		
#60	97.0		
#100	17.7		
#140	6.9		
#200	4.8		

* (no specification provided)

Material Description

light brown poorly graded SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2359 D_{85}= 0.2278 D_{60}= 0.1967
D_{50}= 0.1861 D_{30}= 0.1652 D_{15}= 0.1404
D_{10}= 0.1209 C_u= 1.63 C_c= 1.15

Classification

USCS= SP AASHTO=

Remarks

Lab No.: 167

Location: GT-6
Sample Number: S-9 **Depth:** 29.0' - 31.0' **Date:** 4/1/22

7NT

Client: GZA
Project: House Street RAP - House Street, Michigan

Project No: L193-MI **File**

GRAIN SIZE DISTRIBUTION TEST DATA

4/1/2022

Client: GZA
Project: House Street RAP - House Street, Michigan
Project Number: L193-MI
Location: GT-6
Depth: 29.0' - 31.0'
Sample Number: S-9
Material Description: light brown poorly graded SAND
Date: 4/1/22
USCS Classification: SP
Testing Remarks: Lab No.: 167

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer	Percent Retained
361.39	13.58	0.00	#4	0.00	100.0	0.0
			#10	0.00	100.0	0.0
101.96	0.00	0.00	#20	0.00	100.0	0.0
			#40	0.01	100.0	0.0
			#60	3.07	97.0	3.0
			#100	83.87	17.7	82.3
			#140	94.90	6.9	93.1
			#200	97.10	4.8	95.2

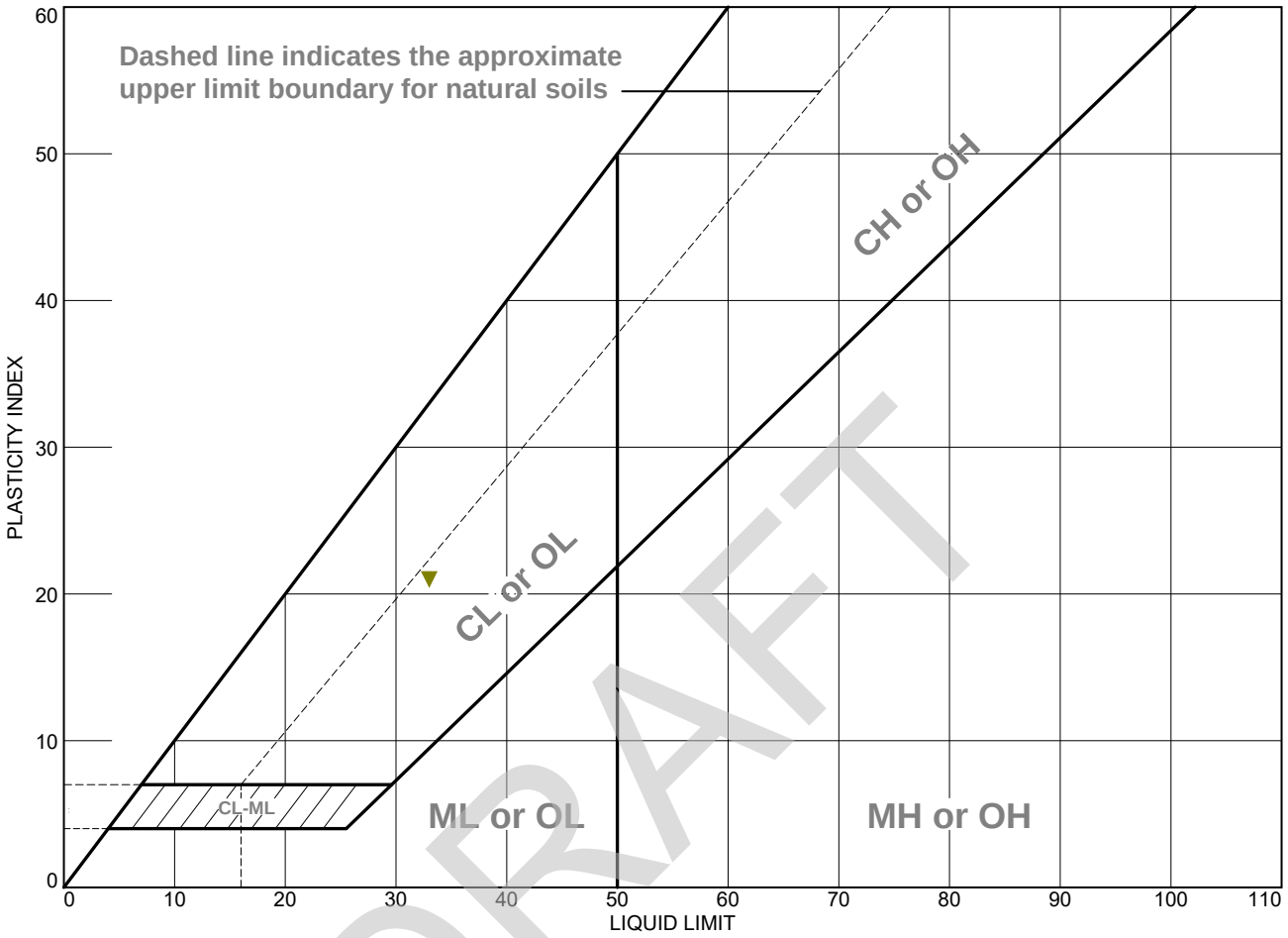
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.0	95.2	95.2			4.8

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.0770	0.1209	0.1404	0.1532	0.1652	0.1758	0.1861	0.1967	0.2206	0.2278	0.2359	0.2455

Fineness Modulus	C_u	C_c
0.84	1.63	1.15

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	light brown poorly graded SAND	NV	NP	NP	99.9	2.2	SP
■	light brown poorly graded SAND	NV	NP	NP	96.9	0.7	SP
▲	brown poorly graded SAND	NV	NP	NP	98.1	3.7	SP
◆	brown poorly graded SAND	NV	NP	NP	97.7	2.0	SP
▼	brown lean CLAY (visual)	33	12	21			

Project No. L193-MI **Client:** GZA

Project: House Street RAP - House Street, Michigan

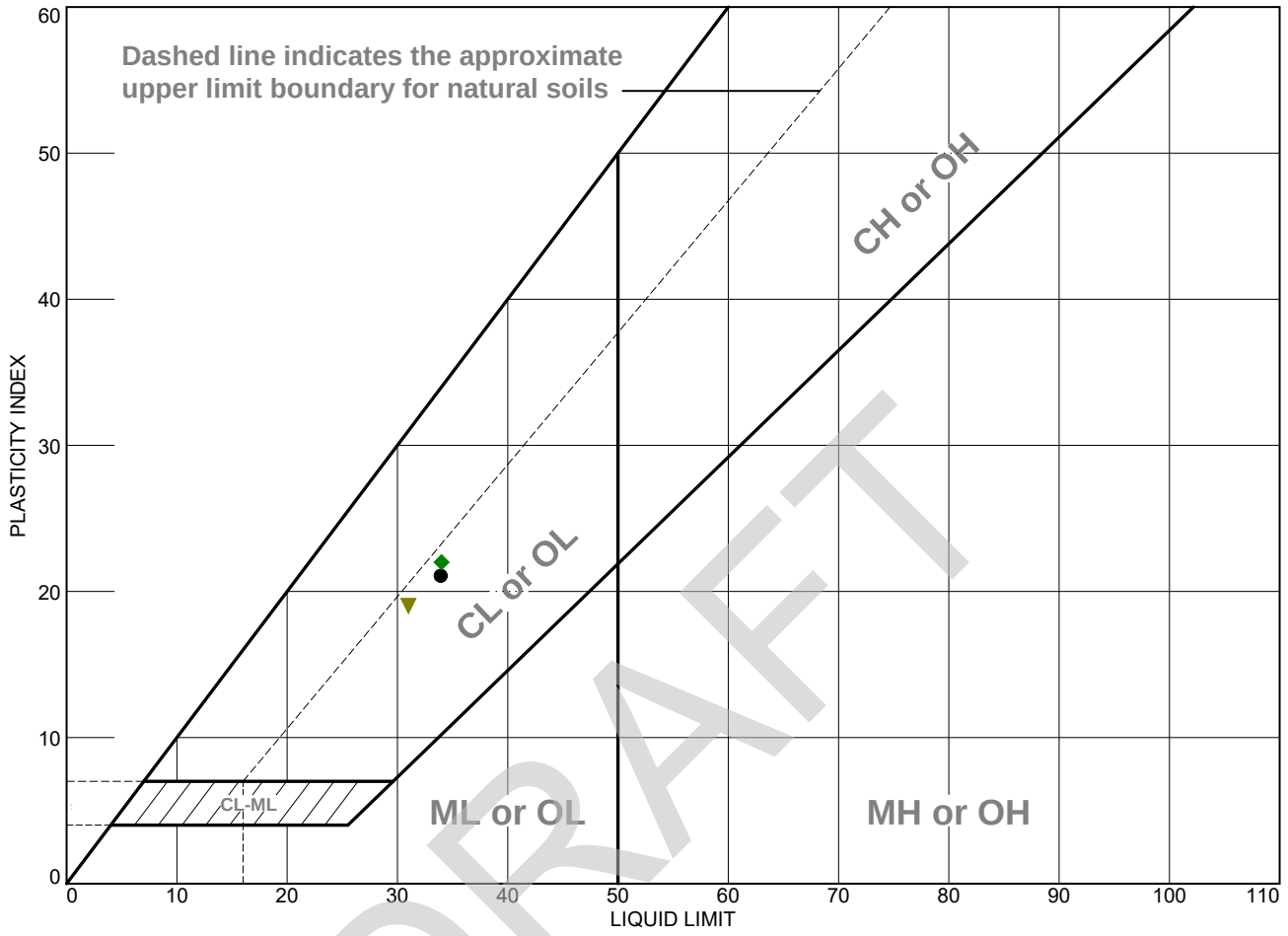
●**Location:** GT-1 **Depth:** 6.0' - 8.0' **Sample Number:** S-4
■**Location:** GT-1 **Depth:** 17.0' - 19.0' **Sample Number:** S-7
▲**Location:** GT-1 **Depth:** 23.0' - 25.0' **Sample Number:** S-10
◆**Location:** GT-1 **Depth:** 25.0' - 35.0' **Sample Number:** Bucket
▼**Location:** GT-2 **Depth:** 2.0' - 4.0' **Sample Number:** S-2

7NT

Remarks:
▼Lab No.: 167

File

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	brown sandy lean CLAY	34	13	21	91.4	66.4	CL
■	brown poorly graded SAND	NV	NP	NP	98.4	1.5	SP
▲	brown poorly graded SAND	NV	NP	NP	98.9	3.7	SP
◆	brown lean CLAY (visual)	34	12	22			
▼	brown sandy lean CLAY	31	12	19	94.1	64.9	CL

Project No. L193-MI **Client:** GZA

Project: House Street RAP - House Street, Michigan

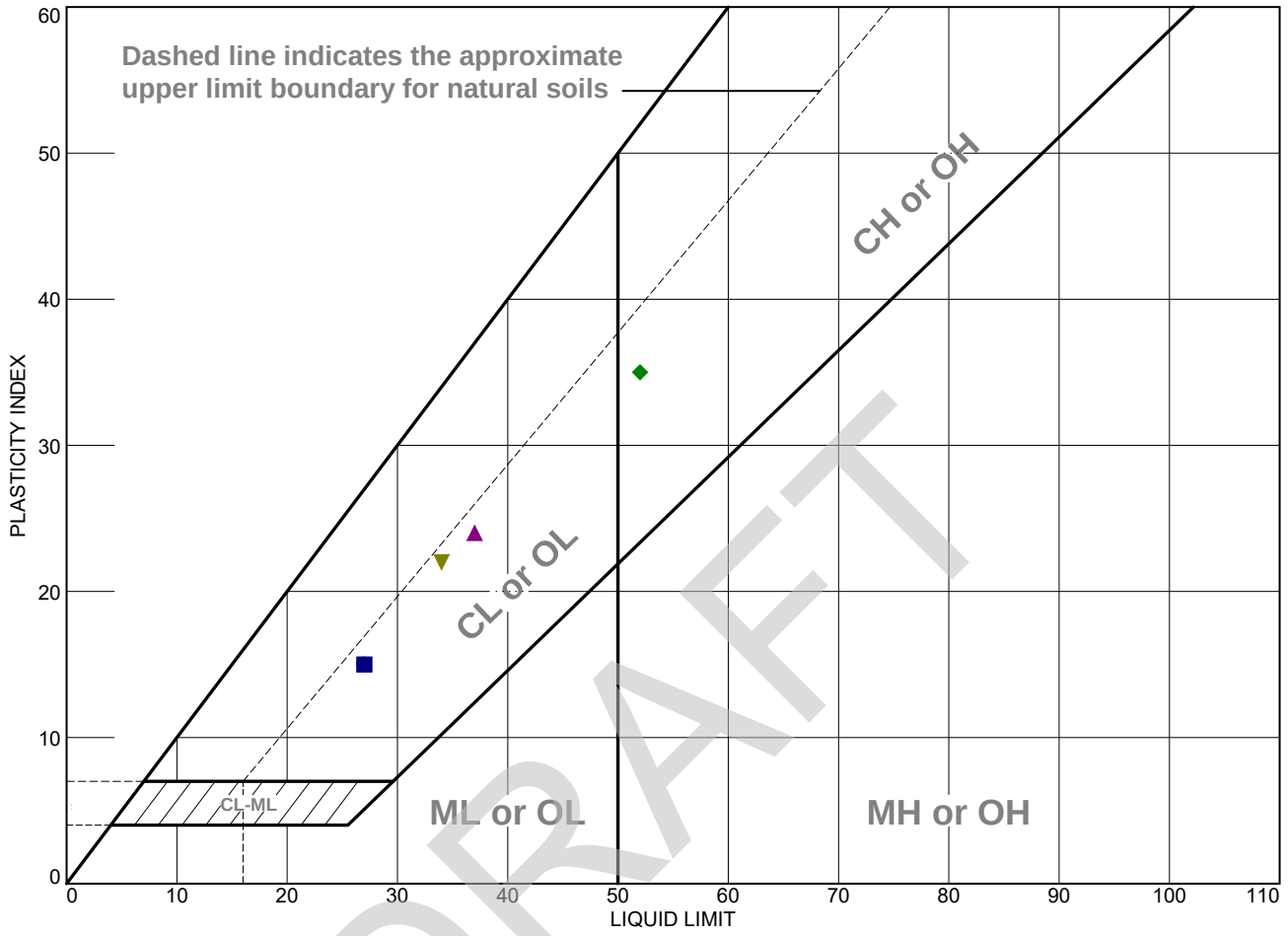
●**Location:** GT-2 **Depth:** 6.0' - 8.0' **Sample Number:** S-4
■**Location:** GT-2 **Depth:** 30.0' - 40.0' **Sample Number:** Bucket
▲**Location:** GT-2 **Depth:** 33.0' - 35.0' **Sample Number:** S-14
◆**Location:** GT-3 **Depth:** 2.0' - 4.0' **Sample Number:** S-2
▼**Location:** GT-3 **Depth:** 4.0' - 6.0' **Sample Number:** S-3

7NT

Remarks:
●Lab No.: 167
◆Lab No.: 167
▼Lab No.: 167

File

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	brown lean CLAY (visual)	27	12	15			
■	brown sandy lean CLAY	27	12	15	94.7	50.7	CL
▲	brown lean CLAY (visual)	37	13	24			
◆	brown fat CLAY (visual)	52	17	35			
▼	brown lean CLAY (visual)	34	12	22			

Project No. L193-MI **Client:** GZA

Project: House Street RAP - House Street, Michigan

●	**Location:** GT-3	**Depth:** 6.0' - 8.0'	**Sample Number:** S-4 (Top)
■	**Location:** GT-4	**Depth:** 0.0' - 2.0'	**Sample Number:** S-1
▲	**Location:** GT-4	**Depth:** 4.0' - 6.0'	**Sample Number:** S-3
◆	**Location:** GT-5	**Depth:** 24.0' - 26.0'	**Sample Number:** S-8
▼	**Location:** GT-6	**Depth:** 4.0' - 6.0'	**Sample Number:** S-3

7NT

Remarks:

●Lab No.: 167
Top 7" of Sample
■Lab No.: 167
▲Lab No.: 167
◆Lab No.: 167
▼Lab No.: 167

File

7NT

ASTM D2216 - Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

Client: GZA
Project: House Street RAP - House Street, Michigan

Lab No.: 167
Project No.: L193-MI
Date: 4/8/2022

Boring Number	Sample Number	Depth (ft)	Depth (m)	Moisture Content (%)	Comments
GT-1	S-4	6.0 - 8.0	1.8 - 2.4	7.9	
GT-1	S-7	17.0 - 19.0	5.2 - 5.8	6.2	
GT-1	S-10	23.0 - 25.0	7.0 - 7.6	3.4	
GT-1	S-11	25.0 - 27.0	7.6 - 8.2	15.2	
GT-2	S-2	2.0 - 4.0	0.6 - 1.2	14.5	
GT-2	S-4	6.0 - 8.0	1.8 - 2.4	12.0	
GT-2	S-6	14.0 - 16.0	4.3 - 4.9	4.0	
GT-2	S-8	21.0 - 23.0	6.4 - 7.0	2.8	
GT-2	S-11	27.0 - 29.0	8.2 - 8.8	1.9	
GT-2	S-14	33.0 - 35.0	10.1 - 10.7	19.3	
GT-3	S-2	2.0 - 4.0	0.6 - 1.2	17.1	
GT-3	S-3	4.0 - 6.0	1.2 - 1.8	16.9	
GT-4	S-1	0.0 - 2.0	0.0 - 0.6	13.7	
GT-4	S-3	4.0 - 6.0	1.2 - 1.8	16.6	
GT-5	S-8	24.0 - 26.0	7.3 - 7.9	24.7	
GT-6	S-3	4.0 - 6.0	1.2 - 1.8	19.7	

ATTACHMENT B

CONSTRUCTION QUALITY ASSURANCE AND QUALITY CONTROL PLAN

Rose & Westra
A Division of GZA

GEOTECHNICAL
ENVIRONMENTAL
ECOLOGICAL
WATER
CONSTRUCTION MANAGEMENT

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HOUSE STREET FINAL REMEDY
CQA PLAN

1855 HOUSE STREET NE
Plainfield Township, Kent County, Michigan

April 2022
File No. 16.0062961.81

PREPARED FOR:
Wolverine World Wide, Inc.
Rockford, Michigan

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ACRONYMS

ASTM	American Society for Testing and materials
CQA	Construction Quality Assurance
CQAP	Construction Quality Assurance And Quality Control Plan
cy	Cubic Yards
EGLE	Michigan Department of Environment, Great Lakes and Energy
FE	Field Engineer/Technician
HSP	House Street Property, also referred to as Site
LLDPE	Linear Low-Density Polyethylene
LM	Laboratory Manager
MDOT	Michigan Department of Transportation
mph	Miles Per Hour
PIC	Principal-In-Charge
PM	Project Manager
psi	pounds per square inch
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
RAP	Remedial Action Plan
R&W/GZA	Rose & Westra, a Division of GZA GeoEnvironmental, Inc.
USACOE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency

1.0 INTRODUCTION

This Construction Quality Assurance (CQA) Plan has been prepared for the House Street Property (HSP) Cap final remedy construction estimated to be completed from 2023 through 2026 . The plan presents the CQA Program, which has been developed and will be implemented under the direction of a CQA Officer who is a registered professional engineer. This CQA Plan presents the staffing organization for monitoring construction of this project, the reporting chain-of-command, and the project and experience requirements of individuals. The plan also addresses the CQA requirements for each material/component in the cap or final cover system design planned as the final remedy. Testing and sampling frequency, test methods (field and laboratory), equipment calibration standards, and criteria for satisfactory test performance are discussed.

2.0 STAFF ORGANIZATION

This section describes the CQA staff organization and reporting procedures for monitoring the final remedy construction of the HSP Cap. The responsibilities and typical experience backgrounds of the CQA staff are described below.

2.1 PRINCIPAL-IN-CHARGE (PIC)

The Principal-in-Charge, also referred to generically as the Engineer in this document, is responsible for technical and administrative aspects of the construction monitoring program. The PIC reviews work done by the project manager and consults with the project manager regularly. This individual must be experienced in capping and remedial action engineering projects. The PIC is required to be a civil engineer with over 20 years of experience and hold a license to practice engineering in the State of Michigan.

2.2 PROJECT MANAGER (PM)

The Project Manager manages the day-to-day technical and administrative aspects of the project and reports directly to the PIC. The PM directly supervises the field (QA/QC) testing and sampling, coordinates the sub-consultant activities (if any) and monitors the laboratory testing. The PM is also the primary contact with the Owner, Contractor, and the State of Michigan, Department of Environment, Great Lakes, and Energy (EGLE). The PM performs in-house quality control for the CQA staff by reviewing the technical issues presented in reports and designs and recommendations presented in correspondence. This individual must have demonstrated experience in engineering and construction aspects related to remedial action and/or capping engineering projects.

2.3 CONSTRUCTION QUALITY ASSURANCE ENGINEER

This individual is the lead field representative responsible for implementing the field CQA program and coordinating CQA for laboratory testing. The Construction Quality Assurance (CQA) Engineer reports directly to the PM, with at least daily updates. The individual's duties vary depending on the construction activities occurring. Where there are several construction activities occurring concurrently, the project engineer may at times supervise several field engineers/technicians. The CQA staff is responsible for assigning these individuals to the various construction activities, supervising field tests, collecting soil and geomembrane samples for laboratory testing and delivering samples to the laboratory. This individual is also required to prepare daily field summary reports that describe each day's construction and construction monitoring activities. The CQA staff coordinates sub-consultant field activities and is responsible for reporting field test data to the Owner and the sub-consultant's field representative, if

applicable. If the project has only one construction activity in progress that requires field testing, this individual will perform the duties of a field engineer/technician described below.

The CQA staff will be a Professional Engineer licensed in the State of Michigan or under the direction of a Professional Engineer licensed in the State of Michigan, experienced with remedial action engineering and construction.

2.4 FIELD ENGINEER/TECHNICIAN (FE)

This individual is responsible for implementing the QA/QC program in the field by making in-place measurements and collecting soil and geomembrane destructive samples at the specified frequency. The FE prepares daily field reports summarizing the construction activity and the field test results. The FE reports directly to the Project Engineer and submits a copy of the field test data to the Contractor's Representative.

This individual is typically a civil engineer, an engineering technician, or other personnel with appropriate experience.

2.5 SOILS LABORATORY

All laboratory tests on soil samples for this project are expected to be done in a qualified independent geotechnical laboratory. Tests will be completed in general accordance with the American Society for Testing and Materials (ASTM) standards listed below.

Test Designation	Standard No.
Method for Particle Size Analysis of Soils	ASTM D422
Test Method for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-pound (4.54 kg) Rammer and 18-inch (457 mm) Drop	ASTM D1557
Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures	ASTM D2216
Practice for Wet Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants	ASTM D2217
Test Method for Permeability of Granular Soils (Constant Head)	ASTM D2434
Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils	ASTMD4318
Test Method Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter	ASTM D5084

Equipment used for the above listed tests will be calibrated in accordance with the applicable, accepted standards. Scales used in the tests will be calibrated annually using weights traceable to the National Bureau of Standards. Pressure gauges and transducers are typically calibrated annually.

Soil tests in the laboratory will be performed by or supervised by the laboratory manager (LM), who will have 5 or more years of soils laboratory testing experience. The LM reports the data and testing status to the Project Manager.

Geomembrane samples are to be tested by a subcontracted testing laboratory. The testing laboratory must have documented experienced with geomembrane testing and testing must be performed by experienced technicians. Test procedures generally follow ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.

3.0 WASTE GRADE PREPARATION AND EXCAVATION

3.1. WASTE GRADE PREPARATION

The Contractor is responsible for completing all Site work necessary to comply with the project design and specifications. This work includes but is not limited to: filling and grading the waste material mounds to their approximate design grades and slopes prior to construction of the cover system; working the final surface to match the design grades; and removing any protrusions, sharp objects, and irregularities to provide a stable, uniform surface to construct the cover system. The CQA staff will monitor the waste material mound grade preparation to verify through periodic spot checks that the surface appears stable and uniform and that irregularities and other unsuitable materials have been removed from the surface.

3.2. EXCAVATION

The Contractor is required to perform all necessary excavation to construct the cover system, anchor trenches, drainage structures and other Site improvements. The CQA staff, or designee, will observe the condition of the subgrade surface following excavation and before placement of overlying fill. Excavation subgrades will be verified by survey for proper dimensions and subgrade conditions for tie-in of the cover system to the existing Site grades. Areas that reveal deleterious materials or disturbed or weathered (softened and/or desiccated) subgrade conditions will be identified by CQA staff to the Contractor so that these areas can be properly excavated before fill placement.

3.3. SURVEY MEASUREMENTS

An independent, Michigan-licensed professional Surveyor will make pre-construction survey measurements prior to construction activities, then again after the Site mounds have been re-graded to the final waste material grades, but before final cover system construction begins. The Surveyor will establish a grid or baseline system to take ground surface elevation measurements at a 50-foot grid or less. Measurements will also be made at changes in slope and angle points. These data shall be compared to post-construction data to assist in determining compliance with the general intent of the RAP. Survey measurements will also be conducted following placement of cover soil and topsoil to document the cap component thicknesses. Auger probes, survey standpipes, or other suitable methods may be necessary to measure final cover system component thicknesses if survey measurements indicate settlement has occurred. The Contractor will be required to complete all auger probes, standpipe installations and any other methods used to supplement optical survey measurements in the presence of the Project Engineer and/or the Surveyor.

In addition, the Surveyor will survey the limits of excavations of waste material outside of the mound limits to document the waste relocation that occurs. These measurements will be compared to pre-construction survey data to estimate the quantity of waste relocated. Waste relocation will occur prior to survey measurements of the final top-of-waste / bottom-of-cap surface.

Locations not within design tolerances shall be re-graded and re-measured.

4.0 GAS VENT RISER INSTALLATION

4.1. EXCAVATION

The CQA staff will monitor installation of the gas venting risers (and associated piezometers, as applicable) to check that the bottom of the riser pipe extends as shown and specified.

4.2. GAS VENT PIPE

The CQA staff will observe the pipe used for the gas vents and collection/transfer lines and the installation procedures and compare those to the plans and specifications. Additional QA/QC requirements for the gas venting pipes are presented in Section 7.00, Pipes.

4.3. SURVEY MEASUREMENTS

The Surveyor will stake the locations of the gas vents and the CQA staff will verify that the bottom of the gas vent riser extends a sufficient depth below the top of waste to the design depth. Following construction of the gas vent riser pipes, the Surveyor will measure the location of each gas vent riser, with bottom of gas vent riser depth/elevation and record all gas vent riser pipe locations and elevations on the Project Record Drawings.

5.0 SOIL MATERIALS

5.1 REFERENCE STANDARDS

Test methods for all soil materials will be carried out in accordance with procedures developed by the ASTM, United States Army Corps of Engineers (USACOE) and United States Environmental Protection Agency (USEPA), as applicable. **Table 1** lists the tests that may be required during this project and the appropriate test method reference. Substitution of a method other than that specified in **Table 1** for a particular test is subject to the approval of the Engineer. Also, the use of test methods for those tests not listed in **Table 1** that are deemed necessary for the work during construction are subject to the approval of the Engineer.

TABLE 1
ACCEPTED REFERENCES FOR TESTING OF CONSTRUCTION MATERIALS

Test Designation	Reference
Particle-Size Analysis of Soils, Combined Sieve and Hydrometer Analysis	ASTM D-422
Moisture-Density-Relations of Soil and Soil-Aggregate Using 5.5lb Rammer and 12-inch Drop (Standard Proctor)	ASTM D-698
Moisture-Density-Relations of Soil and Soil-Aggregate mixtures using 10-pound. Rammer and 18-inch Drop-(Modified Proctor)	ASTM D-1557
Specific Gravity of Soils	ASTM D-854
Amount of Material in Soils Finer than the No. 200 Sieve	ASTM D-1140
Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil- Aggregate Mixtures	ASTM D-2216
Permeability of Granular Soils (Constant Head)	ASTM D-2434
Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)	ASTM D-2922
Moisture Content of Soil and Soil-Aggregate in-Place by Nuclear Methods(Shallow Depth)	ASTM D-3017
Maximum Index Density of Soils Using a Vibratory Table	ASTM D-4253
Minimum Index Density of Soils and Calculation of Relative Density	ASTM D-4254
Liquid Limit, Plastic Limit and Plasticity Index of Soils	ASTMD-4318
Consolidated Drained and Consolidated Undrained Triaxial Compressive Strength	USACOE EM 1110-2-1906
Permeability Test (Constant Head in Triaxial cell with Back Pressure Saturation)	ASTM D-5084
Organic Content of Soils	ASTM D-2974
pH of Soils	ASTM D-4972

5.2 GAS VENT RISER STONE

5.2.1 Pre-Construction Material Evaluation

It is expected that gas vent riser stone shall be obtained from a Michigan Department of Transportation (MDOT) approved source. If a non-approved source is proposed, then the Contractor shall be required to provide additional pre-construction laboratory test data to demonstrate that the proposed source meets MDOT standards, as specified.

The CQA staff will collect one sample of the gas vent riser stone from the proposed source before construction. The gradation of the sample and its permeability shall be measured to estimate the material conformance to specifications.

5.2.2 Construction Quality Evaluation

5.2.2.1 Sampling

The CQA staff will observe and document the particle size distribution of the gas vent riser stone as it is placed and estimate its compliance with specifications. If it appears that the particle size distribution has changed, the CQA staff will be required to collect a sample for testing. One sample of the gas vent riser stone is to be collected as a minimum during construction for laboratory testing. It is estimated that under 50 cubic yards (cy) of gas vent riser stone are required during HSP Cap installation. Therefore, 3 samples will be collected for grain size analysis and one sample collected for permeability testing.

5.2.2.2 Laboratory Testing

Collected samples of the gas vent riser stone will be tested for gradation and permeability prior to installation. If gas vent riser stone/coarse aggregate particle size distribution data fail to meet the required criteria, the CQA staff will notify the Contractor to replace the stone with material that satisfies the project specifications.

5.2.3 Measurements

The CQA staff will verify that the gas vent riser stone is generally placed to the design lines and grades.

5.3 BARRIER PROTECTION LAYER

5.3.1 Preconstruction Material Evaluation

The Contractor will collect one sample of the barrier protection layer material from the proposed source before construction and deliver it to the soil's laboratory for testing. The particle size distribution and Atterberg limits of the sample will be measured to estimate the material's conformance to specifications. If the sample satisfies the specifications, then the soil will be tested for the moisture-density relationship using the modified Proctor test to establish parameters for field control. Reconstituted permeability testing will also be done.

5.3.2 Construction Quality Evaluation

5.3.2.1 Field Tests and Sampling

The CQA staff is responsible to collect one (1) bulk sample of barrier protection layer material for each 10,000 cy placed during construction. If significant changes in the material are visually noticed, then additional samples will be collected.

The CQA staff will observe the barrier protection layer material being placed to check that the material is placed in a manner that does not damage the underlying geosynthetics. The CQA staff will measure the in-place dry density and moisture content of the compacted barrier protection layer at a rate of nine tests per lift per acre of material placed to assess conformance with the specifications. If a test fails to satisfy the specified dry density or moisture criteria, the CQA staff will require additional tests be made around the location having the failing test data to identify the extent of material that is not in compliance with the specifications.

The Contractor will make additional compactor passes and adjusting the moisture content as needed to remediate the non-compliant area. Verification that the remedial efforts were successful will depend upon the in-place dry density and moisture content measurements obtained by the CQA staff.

5.3.2.2 Laboratory Testing

Each bulk sample collected will be tested for Atterberg limits, gradation, modified Proctor and reconstituted permeability. If the test results are comparable to preconstruction test results, no further action is needed. However, should the test results indicate the soil properties have changed, the field control parameters will be reviewed, modified and additional samples will be collected for further testing.

5.3.3 Survey Measurements

The Surveyor will measure the elevation of the top of the barrier protection layer following construction in the same horizontal location that measurements were made after final grading of the top of waste was completed, to calculate the thickness of the barrier protection layer. Hand auger methods and/or standpipes may be used to supplement the layer thickness measurements for reasons described previously. Any excavation method used to supplement optical survey measurements will be done by the Contractor in the presence of the CQA staff or the Surveyor. Locations not within design tolerances shall be re-graded and locations re-measured.

5.4 TOPSOIL

5.4.1 Preconstruction Material Evaluation

No pre-construction testing is necessary for topsoil used from an on-Site soil since this material was successfully used previously on Site for vegetative cover. If an off-Site source is used, three samples for laboratory testing from the proposed topsoil source(s) will be collected and analyzed. Each sample will be tested for PFAS, gradation, pH, and organic content to evaluate the suitability of each proposed source to satisfy the project specifications.

5.4.2 Construction Quality Evaluation

For off-Site borrow, one (1) sample of topsoil material for each 5,000 cy placed will be collected during construction and tested for gradation, pH and organic content. Additional samples will be collected if the CQA staff visually observes that the material is not likely to meet the specifications. Should the soil laboratory test results not meet the required criteria, The CQA staff will notify the Owner and Contractor and recommend procedures to remediate the situation. Only topsoil that meets the specified criteria will be placed.

5.4.3 Survey Measurements

The Surveyor will measure the elevation of the topsoil following construction in the same locations that measurements were made after the barrier protection layer construction was completed to calculate the thickness of the topsoil layer. Hand auger methods and/or standpipes may be used to supplement the layer thickness

measurements for reasons described previously. Locations not within design tolerances shall be regraded and the locations remeasured. Excavation methods used to supplement optical survey measurements will be done by the Contractor in the presence of the CQA staff and/or Surveyor. The Surveyor will also measure the limit and thickness of topsoil placed outside the limit of the final cover system.

5.5 COARSE AGGREGATE

5.5.1 Pre-Construction Material Evaluation

It is expected that coarse aggregate will be obtained from a MDOT-approved source. If a non-approved source is proposed, then the Contractor is required to provide additional pre-construction laboratory test data to demonstrate that the proposed source meets MDOT standards, as specified.

The CQA staff will collect one sample of the coarse aggregate from the proposed source before construction to estimate the material conformance to specifications.

5.5.2 Pre-Construction Material Evaluation

5.5.2.1 Sampling

The CQA staff will visually observe the particle size distribution of the coarse aggregate as it is placed and estimate its compliance with specifications. If it appears that the particle size distribution has changed, The CQA staff will collect a sample for testing. One sample of the coarse aggregate will be collected at a minimum during construction for laboratory testing.

5.5.2.2 Laboratory Testing

The coarse aggregate sample collected will be tested for gradation. If coarse aggregate particle size distribution data fail to meet the required criteria, the Contractor will be notified, and no additional material placed until material is supplied which meets the specified requirements.

5.5.3 Measurements

The CQA staff, or designee, will document the locations of the coarse aggregate following construction and compare them to the design. Locations not within design compliance will be re-graded and the locations re-measured as appropriate.

5.6 CRUSHED STONE

5.6.1 Pre-Construction Material Evaluation

Crushed stone will be obtained from a MDOT-approved source. No pre-construction samples are required.

5.6.2 Construction Quality Evaluation

No construction samples are required.

5.6.3 Measurements

The CQA staff will verify that the crushed stone is generally placed to meet the design intent.

5.7 RIP RAP

5.7.1 Pre-Construction Material Evaluation

It is expected that riprap will be supplied by a MDOT-approved source. The Contractor will provide a certificate of compliance from the riprap supplier, along with gradation test data to confirm the supplied riprap meets the project specifications. If a non-approved source is proposed, then the Contractor will be required to provide additional laboratory test data to demonstrate that the proposed source meets the MDOT standards, as specified.

5.7.2 Construction Quality Evaluation

5.7.2.1 Field Tests and Sampling

The CQA staff will visually observe the riprap as it is unloaded at the Site and compare the visual observations to the appropriate gradation specification. The QA Engineer will require additional samples of riprap be tested for gradation during construction if visual observations suggest that the riprap is not in compliance with the specifications.

6.0 GEOSYNTHETICS

6.1. GEOTEXTILE

6.1.1 Preconstruction Material Evaluation

Prior to product delivery to the Site, the geotextile supplier will furnish certificates of compliance for the geotextile delivered to the Site. The geotextile supplier/ manufacturer will provide copies of manufacturer's conformance test data, and Independent Laboratory test data of the Geotextile for the parameters specified, at the sample rates shown in the specifications.

The CQA staff will review the test data and compare them to the specifications. Rolls not meeting specifications will be identified and the CQA staff will notify the Contractor that those rolls are not to be installed. The CQA staff will observe the storage of rolls delivered to the Site and the procedures used to shelter them from sunlight, storm water and construction traffic.

6.1.2 Construction Quality Evaluation

The CQA staff will observe the deployment of each geotextile roll and will advise the Contractor of observed defects, punctures, and tears so that repairs can be made. The CQA staff will also observe seams/overlaps and check them against specifications. Defective seams/overlaps and patches will be identified to the Contractor so that repairs can be made before covering.

6.1.3 Measurements

The CQA staff, or designee, will document the extents of the separation geotextile placement for pay quantity measurements.

6.2. GEOMEMBRANE

6.2.1 Pre-Construction Material Evaluation

The geomembrane supplier will test the 40-mil linear low-density polyethylene (LLDPE) liner for the parameters specified and will provide copies of manufacturer's conformance test data, and Independent Laboratory test data of the geomembrane for the parameters specified, at the sample rates shown in the specifications. The data will be provided to The CQA staff for review prior to delivery of material to the Site.

The liner installer will be required to submit a liner deployment plan for review before beginning deployment.

6.2.2 Construction Quality Evaluation

The CQA staff will monitor construction of the geomembrane liner to check for conformance to the project specifications. Additional construction QA/QC requirements are as follows.

6.2.3 Responsibilities of the Liner Installer

- Observe the surface of the subgrade to check for stones, clumps of dry clayey soil, and wet areas before deploying the roll of liner.
- Observe that the geomembrane liner subgrade is free of ruts (track made by wheels of passing vehicles with a depth of 1 inch or greater).
- Notify the Engineer that the subgrade surface is not satisfactory for covering with the LLDPE liner, if applicable.
- Submit a certificate to the Engineer stating that the subgrade surface was checked and that its condition is satisfactory for covering with liner.
- Check the condition of each roll for defects and imperfections as it is deployed and repair or remove defects to the satisfaction of the Engineer.
- Geomembrane seams will be oriented parallel to slopes (perpendicular to the contour lines), as often as practical.
- Ensure that fueling/refueling of equipment and vehicles, of any type, are not allowed on the liner.
- Ensure that personnel working on the geomembrane do not smoke or wear damaging shoes or engage in other activities that could damage the geomembrane.
- Repair or replace any liner damaged by equipment, material handling, trafficking, leakage of hydrocarbons, or any other means, to the satisfaction of the Engineer.
- Check seaming equipment daily by destructive-testing seam specimens with a tensiometer. Three specimens will be tested for both peel and shear. The seams should not fail in the weld for both peel and shear with the minimum test values stated below under destructive sample requirements (elongation measurements are not required for field tests). Seaming equipment will be checked:
    - In the morning before beginning work;
    - After extended breaks;
    - After five hours of continuous seaming;
    - After lunch;
    - After equipment changes;
    - After operator changes; and

- After significant changes in ambient or geomembrane temperatures.
- Ensure that seaming is done under the approved seaming conditions noted below.
- Ensure that non-destructive testing and destructive testing in conformance with project specification is completed.

6.2.4 Responsibilities of the Field CQA Staff

- Observe the subgrade surface and inform the installer of areas that, in the Field CQA Staff's opinion, are unsatisfactory for covering.
- Advise the earthwork contractor of unsatisfactory subgrade conditions so that the areas can be repaired before deploying the liner. The prepared surface underlying the geomembrane will not be allowed to deteriorate after acceptance and will remain acceptable during and after geomembrane placement.
- Observe the condition of each sheet as it is being deployed; defects will be marked on the sheet and will be noted in field reports. Each defect will be patched, and the patch seam will be non-destructively tested, as described below. The date of the successful non-destructive test will be marked on the liner and will be noted in field reports.
- Observe geomembrane placement and seam orientation for conformance with permit requirements.
- Observe the destructive testing of test specimens and record the results in field reports.
- Check that destructive and non-destructive testing is completed in accordance with the operation/construction permit and record observations/measurements on the daily field reports.
- Have the Surveyor record the location of each sheet as each sheet is deployed and its respective seams.

6.2.5 Approved Seaming Conditions

- The geomembrane liner will be seamed only when air temperatures are greater than or equal to 32°F and less than or equal to 120°F and when the sheet temperature is less than or equal to 158oF and in accordance with Manufacturer Certification Requirements. Temperatures will be recorded at a minimum frequency of twice a day. If temperatures approach the lower or higher limits, the temperature will be monitored more frequently using an on-Site thermometer.
- All seaming will be done during daylight hours or will be done under artificial light if done at night.
- The geomembrane liner will not be seamed if there is precipitation unless tents are used to direct precipitation away from the seaming area. The manufacturer or installer, to its satisfaction, will wipe and heat the seam dry prior to welding.
- The geomembrane liner will not be seamed if winds exceed 20 miles per hour (mph), measured on-Site using a hand-held anemometer, unless the seaming is done in tents or behind wind screens. Wind speed behind the screen or within the tents will be monitored at the liner surface to verify that the wind speed has been reduced to below 20 mph.

6.2.6 Non-Destructive Testing

Non-destructive testing will be done on all field seams to measure the integrity of the seam. Seams made by extrusion welding will be tested with a vacuum box (ASTM D4437) and seams made with a double hot wedge will be either pressure tested or tested with a vacuum box. The results of each test will be recorded in daily field reports

and the results (with the test date) will be marked on the liner next to the seam to allow a visual inspection of the liner upon completion. Seams where leaks are detected by the non-destructive test method will be re-seamed and retested until non-destructive test results are satisfactory, as specified.

Air Pressure Tests of Fusion-Welded Seams: Following a 2-minute pressurized stabilization period, pressure losses over a measurement period of 5 minutes will not exceed 2 pounds per square inch (psi). At no time during the test will the pressure drop below 30 psi to be considered a passing test. At end of the test, air pressure will be released from the end of the test seam opposite the pressure source. If air is not released through this point, the seam will be checked to identify any clogging, then repaired and retested.

If a pressure loss greater than 2 psi occurs during the test and it is determined that the pressure loss is not due to testing apparatus malfunction, the seam will be pressurized, and a soap solution will be applied to the seam. The seam will be observed by the geomembrane installer and Engineer to check for leaks. Where a leak is observed, the geomembrane installer will repair the leak by placement of a cap strip and retest the seam by pressure test.

If a leak is determined to be on the underneath side of the seam, a progressive search of the seam will be made until that portion of the leaking seam is found. The leaking section of seam will be repaired with a cap strip. The remaining section of seam not capped will be documented to pass the air pressure test. Sections of the seam damaged by the leak search will be repaired with cap strips.

Extrusion Welded Seams: Seams that are not accessible for vacuum testing, such as those used for welding the geomembrane pipe boot to the gas vent riser pipes, will be visually inspected to the satisfaction of the CQA staff. Spark testing will not be done due to explosion/flammability concerns from off-gassing.

6.2.7 Destructive Seam Testing

Destructive seam samples will be collected at the rate of one sample per every 1,000 feet of seam or at least one sample for each seaming unit on each day seaming takes place at locations selected by the CQA staff The location of each sample will be measured by the Surveyor and will be plotted on the geomembrane record drawings.

Each sample will be split into three pieces, each 18 inches long (parallel to the seam) and 12 inches wide. One piece will be field-tested by the Contractor, one piece will be tested by the QA Engineer (or a subcontracted independent laboratory) and one piece will be retained by Engineer If the Contractor's field test meets the strength requirements listed below, then the QA Engineer will send its' sample piece to the independent lab for testing. If the Contractor's field test does not meet the strength requirements listed below, the liner seam will be investigated and repaired as described below, with no independent lab test done for follow-up of the failed field sample test. Test samples will be cut into ten l-inch wide strips perpendicular to the seam orientation. Five strips will be tested for peel strength and five for shear strength (ASTM D4437). All five strips must satisfy the strength and peel separation and elongation requirements listed below.

OT WEDGE SEAMS	
TEST	**REQUIRED VALUE**
Seam Shear Strength (lbs/in.)	60 min.
Seam Shear Elongation [(1)] (%)	50 min.
Seam Peel Strength (lbs/in.)	50 min.
Seam Peel Separation (%)	25 max.

EXTRUSION FILLET SEAMS	
TEST	**MINIMUM VALUE**
Seam Shear Strength (lbs/in.)	60 min.
Seam Shear Elongation (1) (%)	50 min.
Seam Peel Strength (lbs/in.)	44 min.
Seam Peel Separation (%)	25 max.

Note: (1) Elongation measurements omitted for field testing.

Remediation is required for any failing destructive test sample. The installer will:

- Patch the seam over the non-conforming destructive test sample location and extend the patch to the nearest adjacent conforming destructive test sample location, or
- Collect and destructive test an additional sample a minimum 10 feet from each side of the failing destructive test sample location to identify the limits of the defective seam. A patch would then be placed over the seam between the two passing destructive test locations.

The repair locations and locations of destructive test samples will be located on the geomembrane record drawings produced by the Surveyor.

6.2.8 Post-Construction

The Geomembrane Contractor will be required to submit a certification following construction that the liner was installed according to specifications and all QC testing was done. The certification statement will be included in the construction monitoring report. The Surveyor will measure and record the limits of LLDPE deployment, locations of LLDPE liner seams, destructive test samples, and all leak and patch locations for installation of the LLDPE liner on top of the landfill. The Surveyor will measure all patch locations for any necessary repairs of the existing high density polyethylene landfill base liner along the containment berms. The Surveyor will also provide a record drawing of the geomembrane installation for inclusion in the construction monitoring report.

7.0 PIPES

7.1 GAS VENT RISERS

7.1.1 Pre-Construction Material Evaluation

The gas vent risers, piezometer screens, and pipe supplier(s) will furnish copies of manufacturer's conformance test data and certificates of compliance for the pipe and fittings delivered to the Site. The CQA Engineer will review the above data and compare them to the specifications. Pipe and fittings which do not meet the specifications will be identified, and the Contractor will not be permitted to use those materials.

7.1.2 Construction Quality Evaluation

The CQA staff will observe the storage and handling of the pipe and fittings. Any damaged material will not be permitted to be used. The CQA staff will also observe the joining of the pipe and fittings and the backfilling of the pipe. The CQA staff will check that all required fittings and components have been supplied and installed. Pipe that is improperly joined or damaged during backfilling will be repaired or replaced.

7.1.3 Survey Measurements

The Surveyor will measure the location of the gas vent riser pipes as they are being installed. The Surveyor will measure and record the location of the gas vent riser pipes.

8.0 SEEDING AND MULCH

8.1 PRE-CONSTRUCTION MATERIAL EVALUATION

The suppliers of seed and fertilizer will be required to submit documentation showing that the seed and fertilizer mixes conform to the project specifications. Mixes that do not meet the specifications will be identified and the Contractor will not be permitted to use those materials.

8.2 CONSTRUCTION QUALITY EVALUATION

The CQA staff will observe the areas to be seeded and will evaluate their suitability for seeding. The Contractor will be notified of areas requiring additional harrowing or disking, or of low areas which may hold water and require re-grading. The CQA staff will observe that fertilizer, seed, and mulch are applied as specified and evenly distributed. The CQA staff will check that erosion protection devices are in place. Areas which erode or where a uniform stand of grass does not develop will be repaired and reseeded as specified. The Owner, Engineer's Representative, and Contractor will observe the seeded areas six to nine months following initial seeding and will determine if areas require repair and/or additional seeding as specified.

ATTACHMENT C

PRELIMINARY DRAWINGS

WOLVERINE WORLD WIDE, INC.

Grand Rapids, Michigan

CAPPING SYSTEM DESIGN DRAWINGS

DWG. NO.	TITLE
62961.81-PE-001	COVER SHEET AND DRAWING INDEX
62961.81-PE-002	SITE PLAN
62961.81-PE-003	GENERAL EXISTING SITE CONDITIONS / SOIL EROSION & CONTROL PLAN
62961.81-PE-004	BORING LOCATION PLAN
62961.81-PE-005	EXCAVATION / WASTE RELOCATION PLAN
62961.81-PE-006	TOP OF PREPARED SUBGRADE / BOTTOM OF CAPPING MATERIALS (NORTHWEST MOUND)
62961.81-PE-007	TOP OF PREPARED SUBGRADE / BOTTOM OF CAPPING MATERIALS (NORTHEAST MOUND)
62961.81-PE-008	TOP OF PREPARED SUBGRADE / BOTTOM OF CAPPING MATERIALS (SOUTHWEST MOUND)
62961.81-PE-009	TOP OF PREPARED SUBGRADE / BOTTOM OF CAPPING MATERIALS (SOUTHEAST MOUND)
62961.81-PE-010	DRAWING BLANK, RESERVED FOR FUTURE USE
62961.81-PE-011	TOP OF PREPARED SUBGRADE / BOTTOM OF CAPPING MATERIALS
62961.81-PE-012	LIMITS OF 40-MIL LLDPE GEOMEMBRANE
62961.81-PE-013	DRAWING BLANK, RESERVED FOR FUTURE USE
62961.81-PE-014	TOP OF FINISH GRADE (CAPPING TOPSOIL AND DRAINAGE SWALE)
62961.81-PE-015	FINAL COVER SYSTEM TYPICAL CROSS SECTION A-A' AND B-B'
62961.81-PE-016	CAPPING SYSTEM TYPICAL PROFILE C-C'
62961.81-PE-017	CAPPING SYSTEM TYPICAL PROFILE D-D' & E-E'
62961.81-PE-018	CAPPING SYSTEM TYPICAL PROFILE F-F' & G-G'
62961.81-PE-019	CAPPING SYSTEM TYPICAL PROFILE H-H' & I-I'
62961.81-PE-020	TYPICAL FINAL CAPPING SYSTEM SECTIONS
62961.81-PE-021	TYPICAL CAP SYSTEM DETAILS
62961.81-PE-022	TYPICAL WASTE EXCAVATION DETAILS

SITE LOCATION PLAN

NOTE: BASE MAP ADAPTED AUTOCAD CIVIL 3D 2018

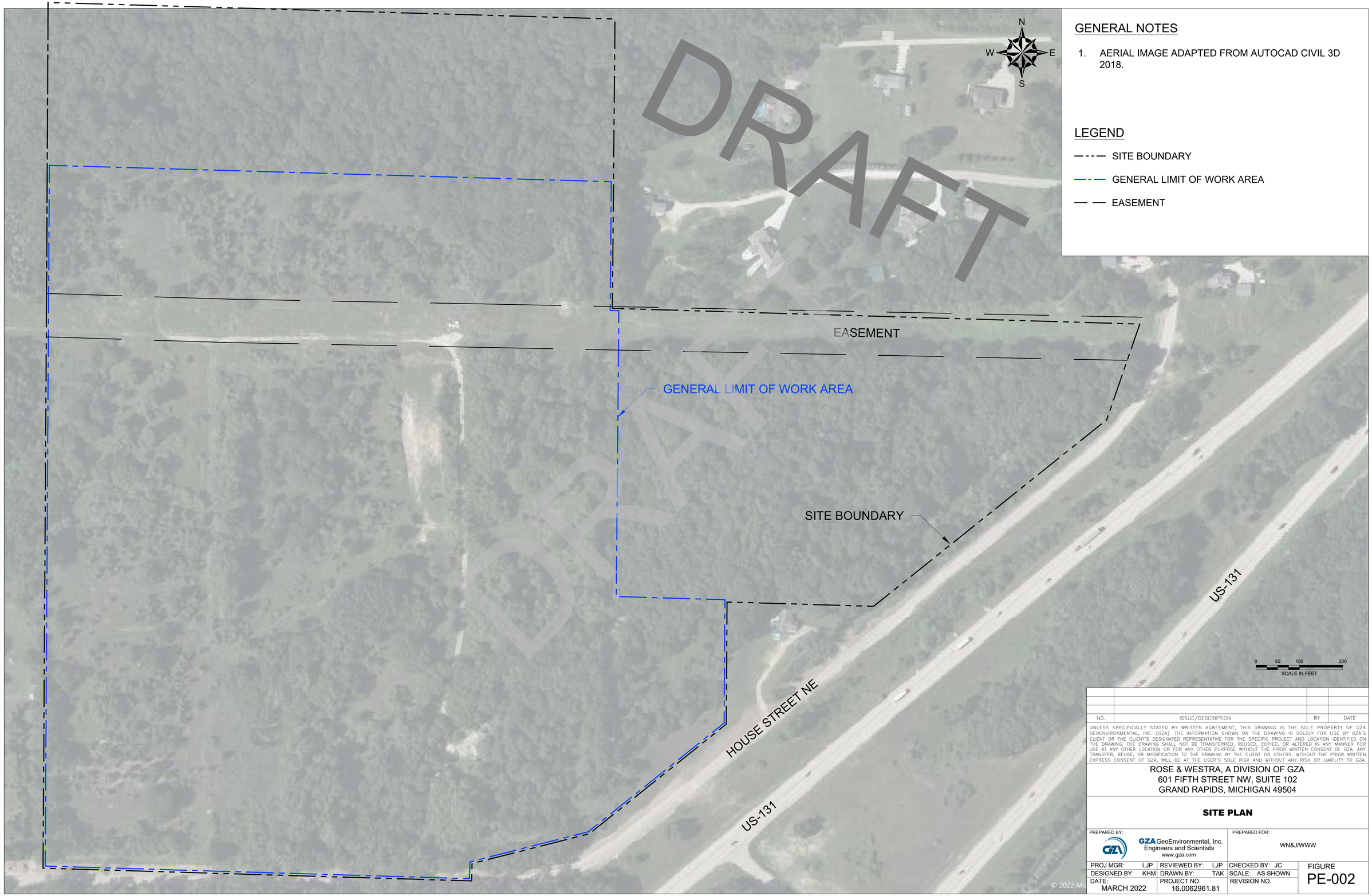
NO.	ISSUE/DESCRIPTION	BY	DATE

ROSE & WESTRA, A DIVISION OF GZA
601 FIFTH STREET NW, SUITE 102
GRAND RAPIDS, MICHIGAN 49504

COVER SHEET AND DRAWING INDEX

PREPARED BY:		PREPARED FOR:	
GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: LJP	FIGURE PE-001
DESIGNED BY: JC	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: APRIL 2022	PROJECT NO. 16.0062961.81	REVISION NO.	

GZA GeoEnvironmental



GENERAL NOTES

1. AERIAL IMAGE ADAPTED FROM AUTOCAD CIVIL 3D 2018.

LEGEND

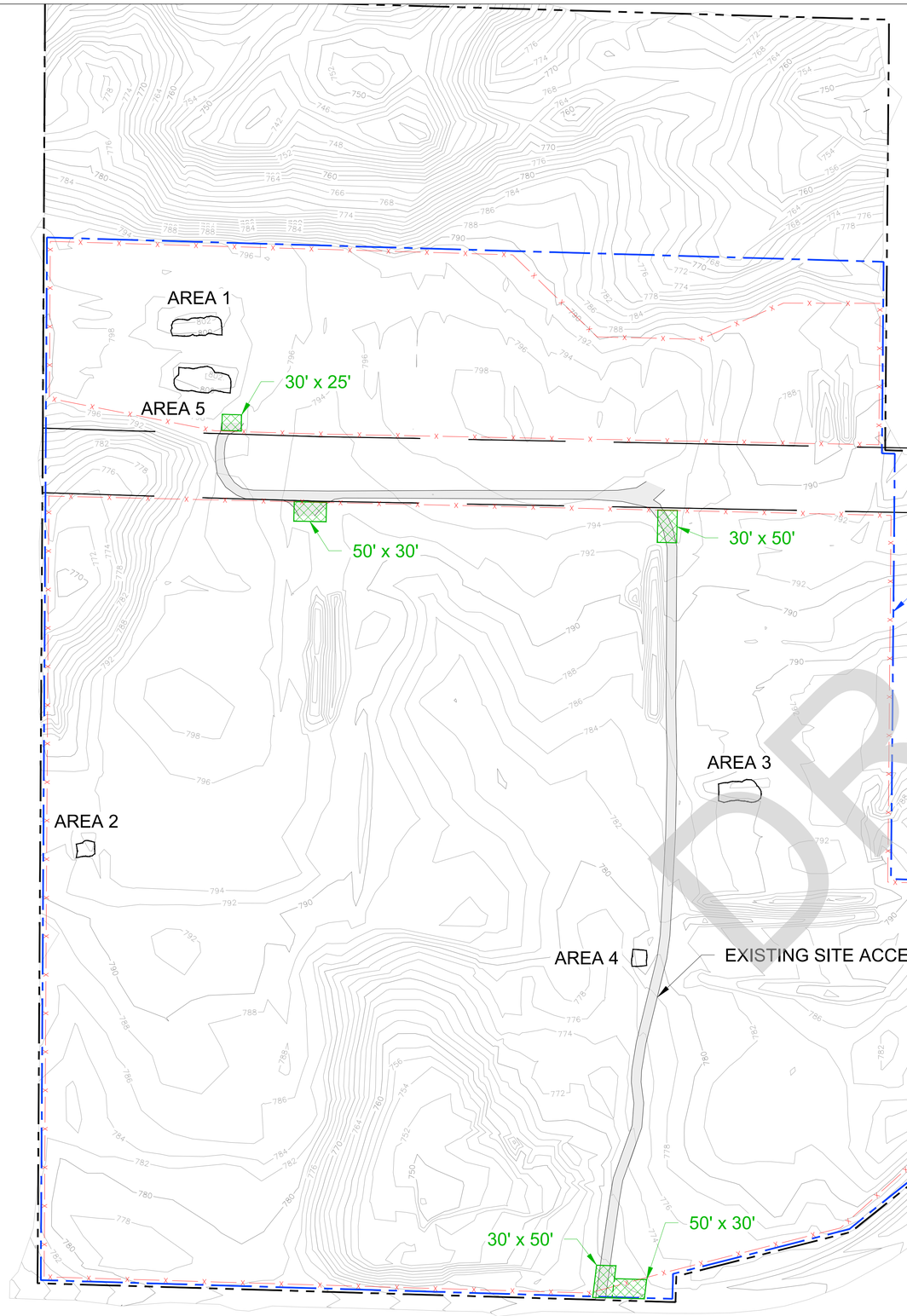
- SITE BOUNDARY
- GENERAL LIMIT OF WORK AREA
- EASEMENT

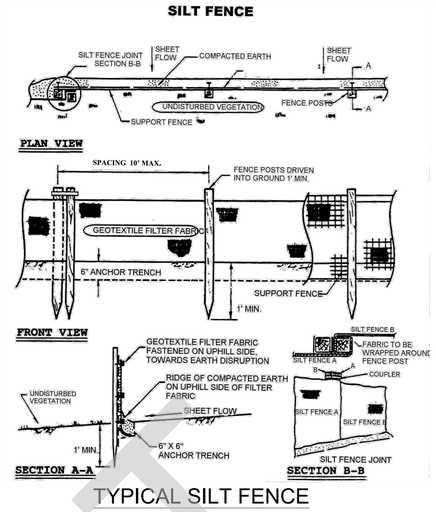
NO.	ISSUE/DESCRIPTION	BY	DATE

ROSE & WESTRA, A DIVISION OF GZA
601 FIFTH STREET NW, SUITE 102
GRAND RAPIDS, MICHIGAN 49504

SITE PLAN

PREPARED BY:		PREPARED FOR:	
GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE PE-002
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: MARCH 2022	PROJECT NO. 16.0062961.81	REVISION NO.	





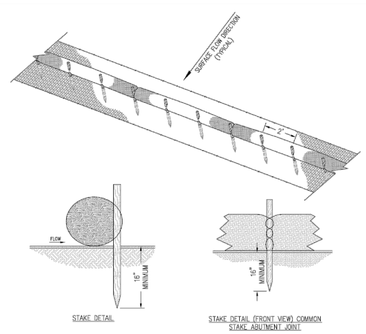
TYPICAL SILT FENCE

LEGEND

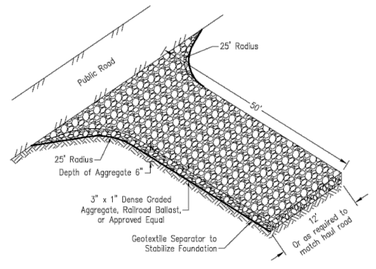
- SITE BOUNDARY
- GENERAL LIMIT OF WORK AREA
- EASEMENT
- EXISTING SITE ACCESS ROAD
- 760 EXISTING GROUND CONTOURS
- AREA 5 EXISTING EPA CAPPED AREA
- APPROXIMATE SILT FENCE PLACEMENT
- STABILIZED CONSTRUCTION ENTRANCE

GENERAL NOTES

1. BASE MAP TOPOGRAPHY PROVIDED BY EXXEL ENGINEERING, INC DATED OCTOBER 6, 2020.
2. STATION DATUM IS NAVD88, BASED ON GPS OBSERVATIONS USING MDOT CORS.



TYPICAL WADDLE SETTLEMENT LOG



TYPICAL CONSTRUCTION ENTRANCE

NO.	ISSUE/DESCRIPTION	BY	DATE

ROSE & WESTRA, A DIVISION OF GZA
601 FIFTH STREET NW, SUITE 102
GRAND RAPIDS, MICHIGAN 49504

EXISTING CONDITIONS AND GENERALIZED EROSION & SEDIMENT CONTROL PLAN

PREPARED BY:		PREPARED FOR:	
GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE PE-003
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: APRIL 2022	PROJECT NO. 16.0062961.81	REVISION NO.	

LEGEND

- 400 FT GRID SYSTEMATIC SAMPLE LOCATION
- ADDITIONAL BIASED SAMPLE LOCATION
- TIERED OR TRENCH SOIL BORING LOCATION
- WASTE MATERIAL OBSERVED
- XRF INDICATED ELEVATED CHROMIUM IN SOIL, NO WASTE MATERIAL OBSERVED
- NO WASTE MATERIAL OBSERVED
- NO WASTE MATERIAL OBSERVED, NOT SAMPLED
- BORING NOT COMPLETED
- PRESUMED TO CONTAIN WASTE MATERIAL, NO SOIL BORING/SAMPLING
- PREVIOUS SOURCE AREA SAMPLE LOCATION
- 1966 PROPOSED SITE PLAN
- APPROXIMATE HOUSE ST SITE BOUNDARY
- 400 FT GRID BLOCK

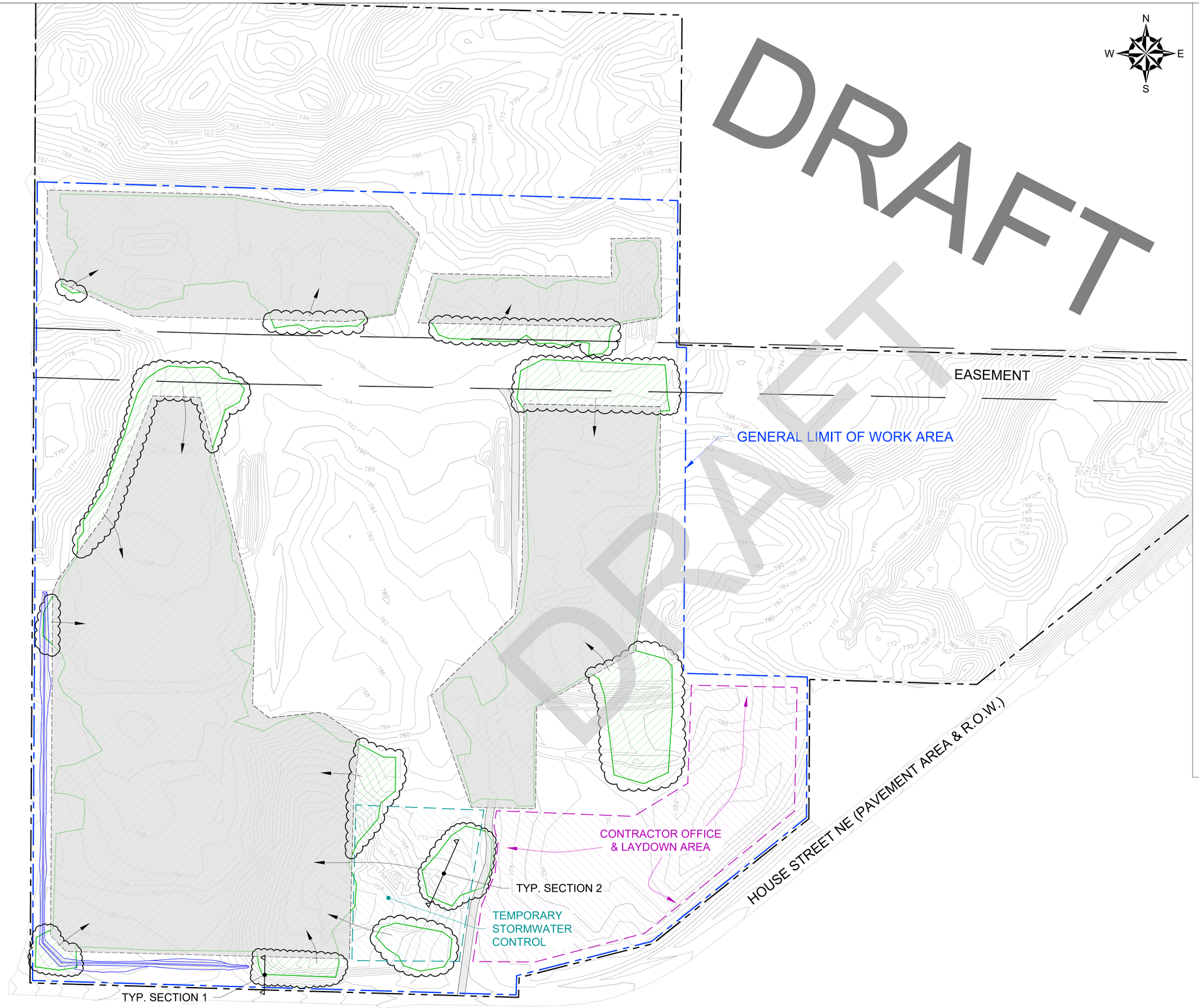
100 50 0 100
Scale in Feet

NO.	ISSUE/DESCRIPTION	BY	DATE

ROSE & WESTRA, A DIVISION OF GZA
601 FIFTH STREET NW, SUITE 102
GRAND RAPIDS, MICHIGAN 49504

TEST BORING LOCATION PLAN

PREPARED BY:		PREPARED FOR:	
GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: LJP	FIGURE
DESIGNED BY: JC	DRAWN BY: JC/JMG	SCALE: AS SHOWN	PE-004
DATE: APRIL 2022	PROJECT NO. 16.0062961.81	REVISION NO.	



GENERAL NOTES

1. BASE MAP TOPOGRAPHY PROVIDED BY EXXEL ENGINEERING, INC DATED OCTOBER 6, 2020.
2. STATION DATUM IS NAVD88, BASED ON GPS OBSERVATIONS USING MDOT CORS.
3. SEE TYPICAL DETAIL OF WASTE EXCAVATION FROM OUTSIDE MOUND AREAS.

LEGEND

- SITE BOUNDARY
- GENERAL LIMIT OF WORK AREA
- EASEMENT
- EXISTING SITE ACCESS ROAD
- 760 EXISTING GROUND CONTOURS
- ESTIMATED EXTENT OF WASTE
- PERIMETER SWALE BREAKLINES (SW CORNER)
- 40-MIL LLDPE GEOMEMBRANE
- AREA OF IDENTIFIED WASTE MATERIAL TO BE RELOCATED TO MOUND AREAS AND CAPPED

0 50 100 200
SCALE IN FEET

NO.	ISSUE/DESCRIPTION	BY	DATE

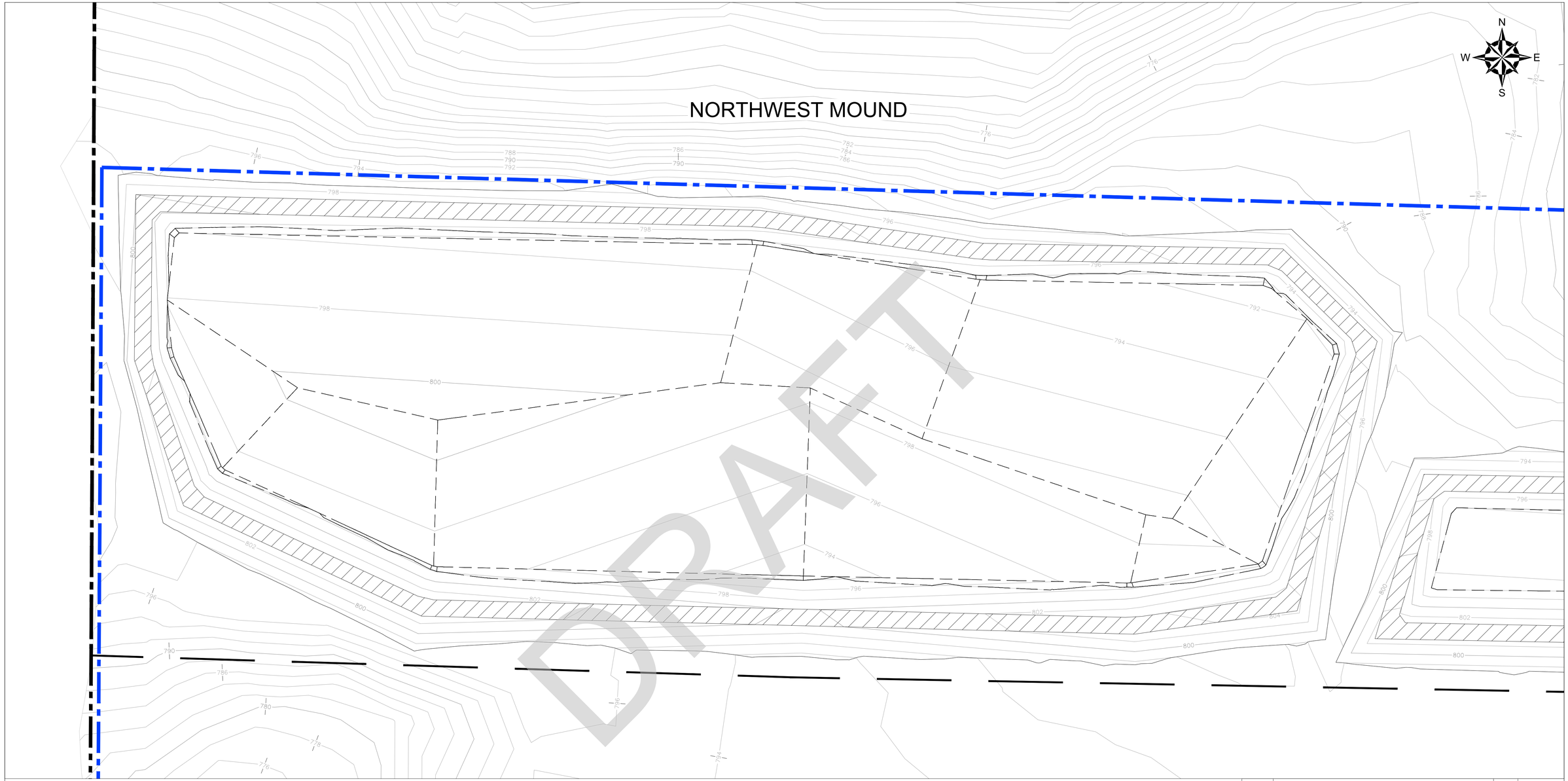
ROSE & WESTRA, A DIVISION OF GZA
601 FIFTH STREET NW, SUITE 102
GRAND RAPIDS, MICHIGAN 49504

EXCAVATION / WASTE RELOCATION PLAN

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:
WN&J/WWW

PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	PE-005
DATE: APRIL 2022	PROJECT NO. 16.0062961.81	REVISION NO.	



LEGEND

- SITE BOUNDARY
- GENERAL LIMIT OF WORK AREA
- EASEMENT
- EXISTING SITE ACCESS ROAD
- 760 EXISTING GROUND CONTOURS
- PERIMETER SWALE BREAKLINES (SW CORNER)
- BERM DESIGN BREAKLINES
- TOP OF IMPACTED MATERIAL BREAKLINES

DRAFT

0 15 30 60
SCALE IN FEET

GENERAL NOTES

1. BASE MAP TOPOGRAPHY PROVIDED BY EXXEL ENGINEERING, INC DATED OCTOBER 6, 2020.
2. STATION DATUM IS NAVD88, BASED ON GPS OBSERVATIONS USING MDOT CORS.

NO.	ISSUE/DESCRIPTION	BY	DATE

ROSE & WESTRA, A DIVISION OF GZA
601 FIFTH STREET NW, SUITE 102
GRAND RAPIDS, MICHIGAN 49504

TOP OF PREPARED SUBGRADE / BOTTOM OF CAPPING MATERIALS (NORTHWEST MOUND)

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE PE-006
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: APRIL 2022	PROJECT NO. 16.0062961.81	REVISION NO.	

LEGEND

- SITE BOUNDARY
- GENERAL LIMIT OF WORK AREA
- EASEMENT
- EXISTING SITE ACCESS ROAD
- 760 EXISTING GROUND CONTOURS
- PERIMETER SWALE BREAKLINES (SW CORNER)
- BERM DESIGN BREAKLINES
- TOP OF IMPACTED MATERIAL BREAKLINES

0 10 20 40
SCALE IN FEET

GENERAL NOTES

1. BASE MAP TOPOGRAPHY PROVIDED BY EXXEL ENGINEERING, INC DATED OCTOBER 6, 2020.
2. STATION DATUM IS NAVD88, BASED ON GPS OBSERVATIONS USING MDOT CORS.

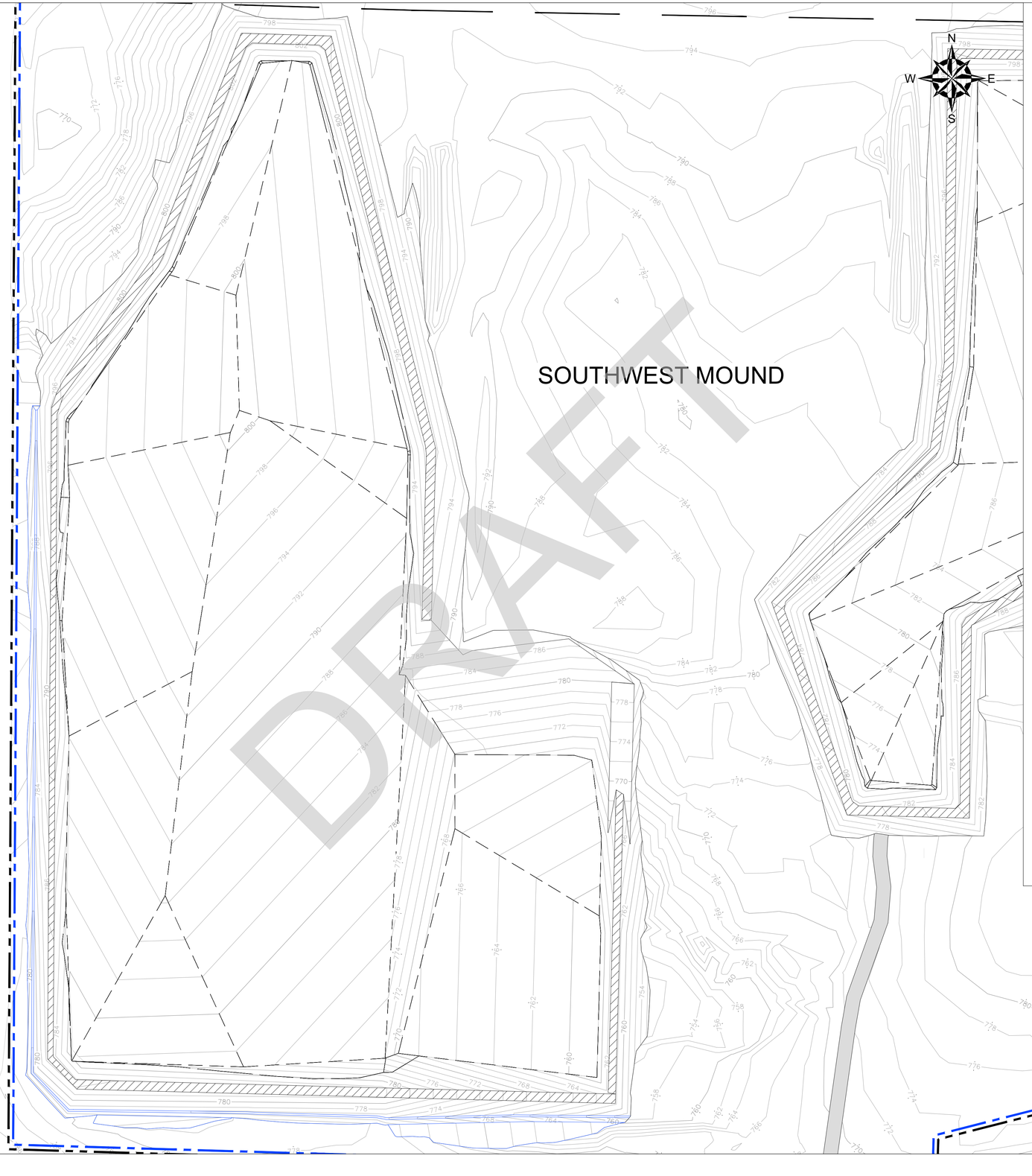
NO.	ISSUE/DESCRIPTION	BY	DATE

ROSE & WESTRA, A DIVISION OF GZA
601 FIFTH STREET NW, SUITE 102
GRAND RAPIDS, MICHIGAN 49504

TOP OF PREPARED SUBGRADE / BOTTOM OF CAPPING MATERIALS (NORTHEAST MOUND)

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com
PREPARED FOR: WN&J/WWW

PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	PE-007
DATE: APRIL 2022	PROJECT NO. 16.0062961.81	REVISION NO.	



GENERAL NOTES

1. BASE MAP TOPOGRAPHY PROVIDED BY EXXEL ENGINEERING, INC DATED OCTOBER 6, 2020.
2. STATION DATUM IS NAVD88, BASED ON GPS OBSERVATIONS USING MDOT CORS.

LEGEND

- SITE BOUNDARY
- GENERAL LIMIT OF WORK AREA
- EASEMENT
- EXISTING SITE ACCESS ROAD
- 760 EXISTING GROUND CONTOURS
- PERIMETER SWALE BREAKLINES (SW CORNER)
- BERM DESIGN BREAKLINES
- TOP OF IMPACTED MATERIAL BREAKLINES

0 30 60 120
SCALE IN FEET

NO.	ISSUE/DESCRIPTION	BY	DATE

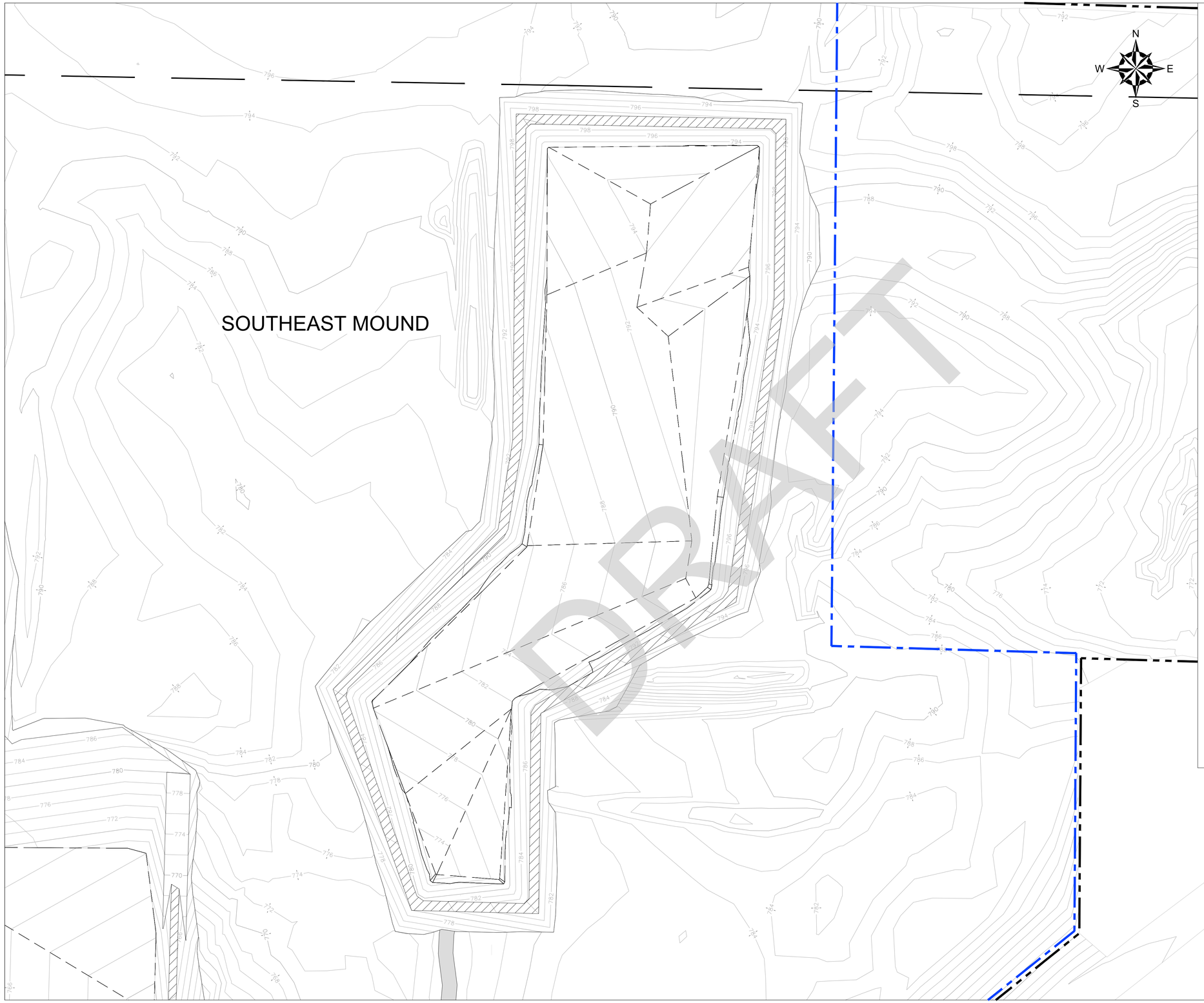
ROSE & WESTRA, A DIVISION OF GZA
601 FIFTH STREET NW, SUITE 102
GRAND RAPIDS, MICHIGAN 49504

TOP OF PREPARED SUBGRADE / BOTTOM OF CAPPING MATERIALS (SOUTHWEST MOUND)

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:
WN&J/WWW

PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE PE-008
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: APRIL 2022	PROJECT NO. 16.0062961.81	REVISION NO.	



GENERAL NOTES

1. BASE MAP TOPOGRAPHY PROVIDED BY EXXEL ENGINEERING, INC DATED OCTOBER 6, 2020.
2. STATION DATUM IS NAVD88, BASED ON GPS OBSERVATIONS USING MDOT CORS.

LEGEND

- SITE BOUNDARY
- GENERAL LIMIT OF WORK AREA
- EASEMENT
- EXISTING SITE ACCESS ROAD
- 760 EXISTING GROUND CONTOURS
- PERIMETER SWALE BREAKLINES (SW CORNER)
- BERM DESIGN BREAKLINES
- TOP OF IMPACTED MATERIAL BREAKLINES

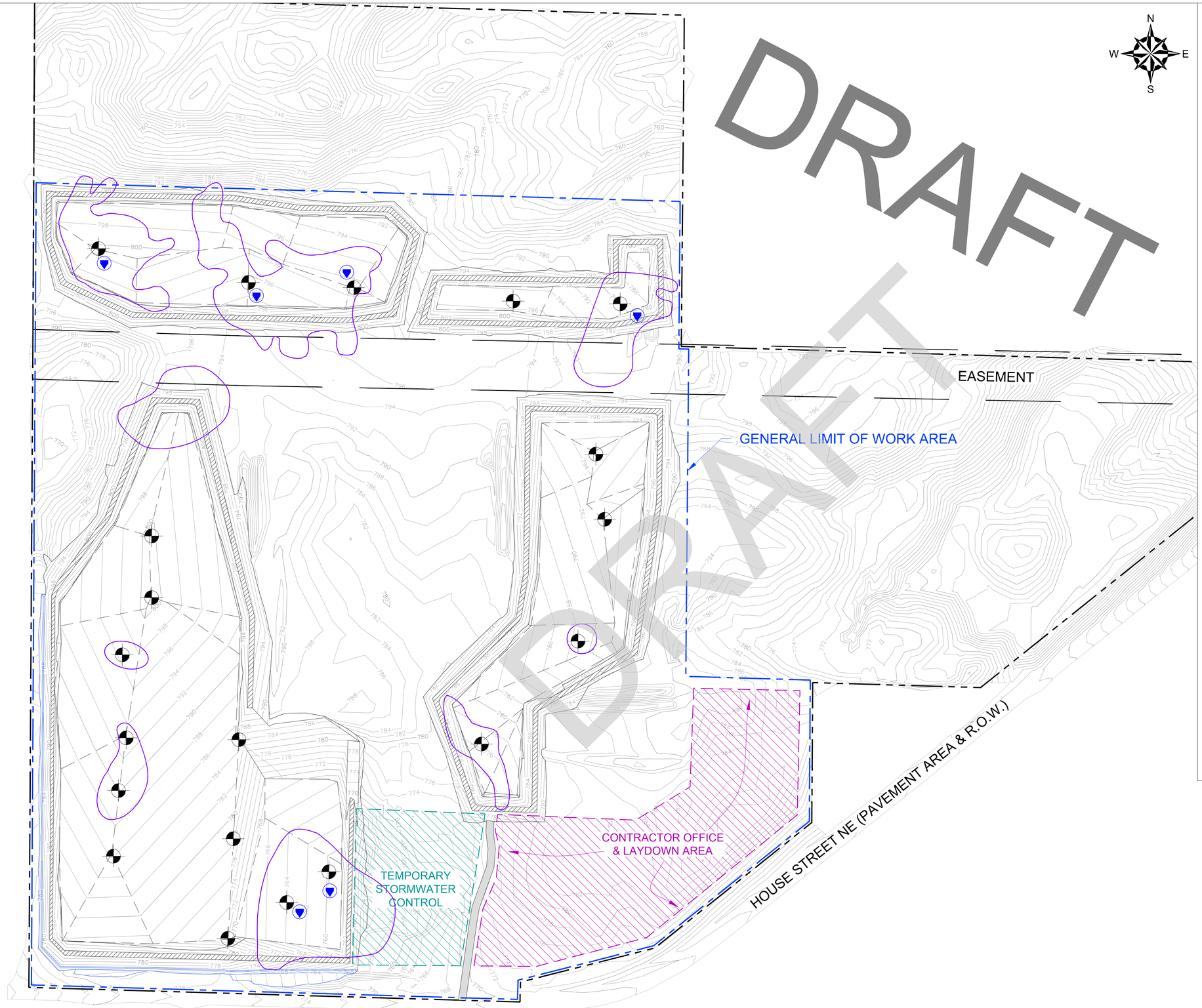
0 25 50 100
SCALE IN FEET

NO.	ISSUE/DESCRIPTION	BY	DATE

ROSE & WESTRA, A DIVISION OF GZA
601 FIFTH STREET NW, SUITE 102
GRAND RAPIDS, MICHIGAN 49504

TOP OF PREPARED SUBGRADE / BOTTOM OF CAPPING MATERIALS (SOUTHEAST MOUND)

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE PE-009
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: APRIL 2022	PROJECT NO. 16.0062961.81	REVISION NO.	



GENERAL NOTES

1. BASE MAP TOPOGRAPHY PROVIDED BY EXXEL ENGINEERING, INC DATED OCTOBER 6, 2020.
2. STATION DATUM IS NAVD88, BASED ON GPS OBSERVATIONS USING MDOT CORS.
3. PROPOSED GAS VENT AND PIEZOMETER SHALL E CO-LOCATED, SHOWN HERE AS SEPARATE FOR CLARITY.

LEGEND

- SITE BOUNDARY
- GENERAL LIMIT OF WORK AREA
- EASEMENT
- EXISTING SITE ACCESS ROAD
- 760 EXISTING GROUND CONTOURS
- PERIMETER SWALE BREAKLINES (SW CORNER)
- BERM DESIGN BREAKLINES
- TOP OF IMPACTED MATERIAL BREAKLINES
- PROPOSED GAS VENT LOCATION
- PROPOSED PIEZOMETER IN HOUSE ST. CAP
- ESTIMATED EXTENT OF PERCHED GROUNDWATER OBSERVED IN 2018-2019

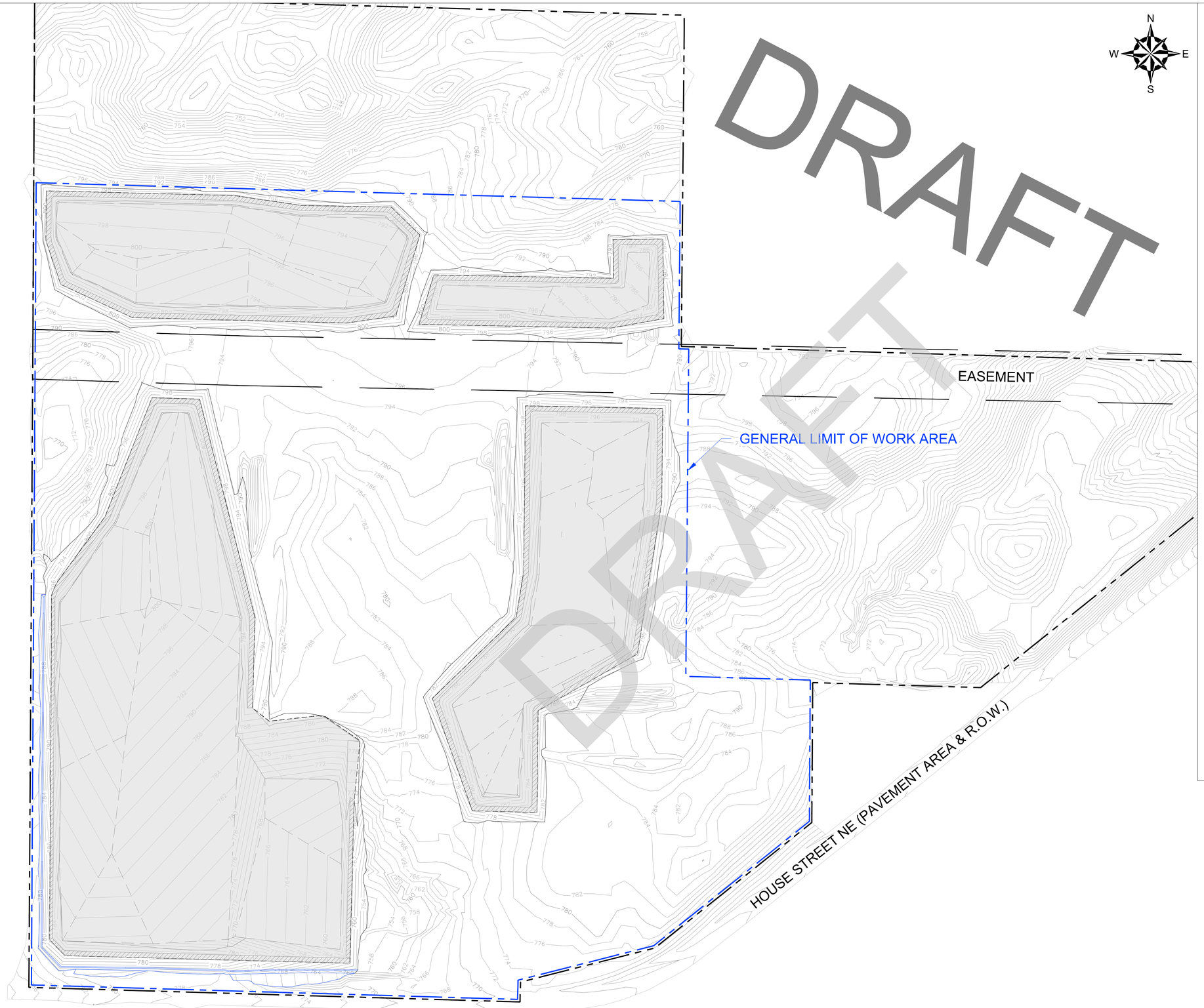
0 50 100 200
SCALE IN FEET

NO.	ISSUE/DESCRIPTION	BY	DATE

ROSE & WESTRA, A DIVISION OF GZA
601 FIFTH STREET NW, SUITE 102
GRAND RAPIDS, MICHIGAN 49504

TOP OF PREPARED SUBGRADE / BOTTOM OF CAPPING MATERIALS

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	PE-011
DATE: APRIL 2022	PROJECT NO. 16.0062961.81	REVISION NO.	



GENERAL NOTES

1. BASE MAP TOPOGRAPHY PROVIDED BY EXXEL ENGINEERING, INC DATED OCTOBER 6, 2020.
2. STATION DATUM IS NAVD88, BASED ON GPS OBSERVATIONS USING MDOT CORS.

LEGEND

- SITE BOUNDARY
- GENERAL LIMIT OF WORK AREA
- EASEMENT
- EXISTING SITE ACCESS ROAD
- 760 EXISTING GROUND CONTOURS
- PERIMETER SWALE BREAKLINES (SW CORNER)
- BERM DESIGN BREAKLINES
- TOP OF IMPACTED MATERIAL BREAKLINES
- 40-MIL LLDPE GEOMEMBRANE

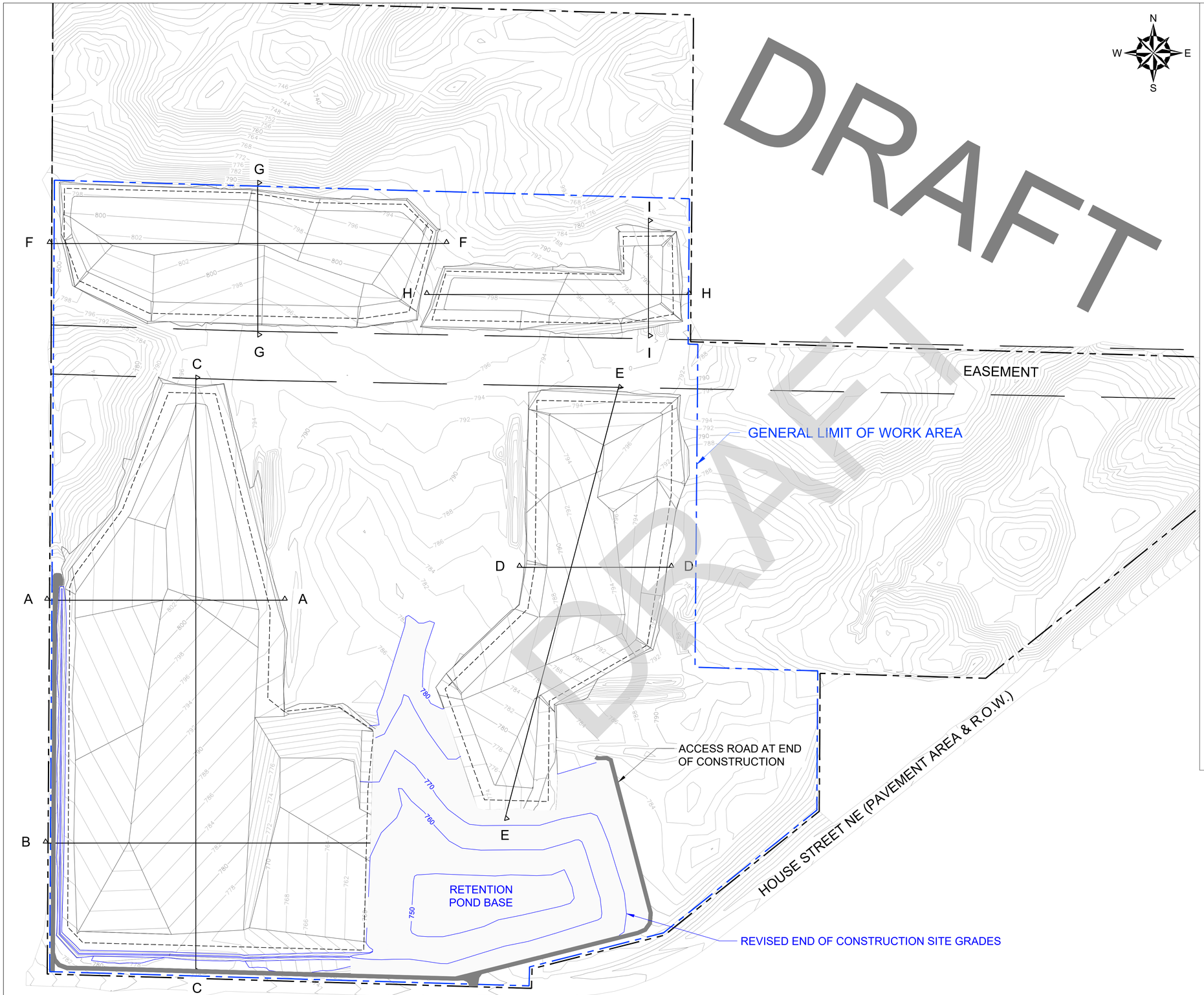
0 50 100 200
SCALE IN FEET

NO.	ISSUE/DESCRIPTION	BY	DATE

ROSE & WESTRA, A DIVISION OF GZA
601 FIFTH STREET NW, SUITE 102
GRAND RAPIDS, MICHIGAN 49504

LIMITS OF 40-MIL LLDPE GEOMEMBRANE

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	PE-012
DATE: MARCH 2022	PROJECT NO. 16.0062961.81	REVISION NO.	



GENERAL NOTES

1. BASE MAP TOPOGRAPHY PROVIDED BY EXXEL ENGINEERING, INC DATED OCTOBER 6, 2020.
2. STATION DATUM IS NAVD88, BASED ON GPS OBSERVATIONS USING MDOT CORS.

LEGEND

- SITE BOUNDARY
- GENERAL LIMIT OF WORK AREA
- EASEMENT
- PROPOSED SITE ACCESS ROAD
- 760 CONTOUR LINES
- PERIMETER SWALE BREAKLINES (SW CORNER)
- TOP OF CAP BREAKLINES
- TOP OF IMPACTED MATERIAL BREAKLINES
- LIMITS OF 40-MIL LLDPE GEOMEMBRANE

0 50 100 200
SCALE IN FEET

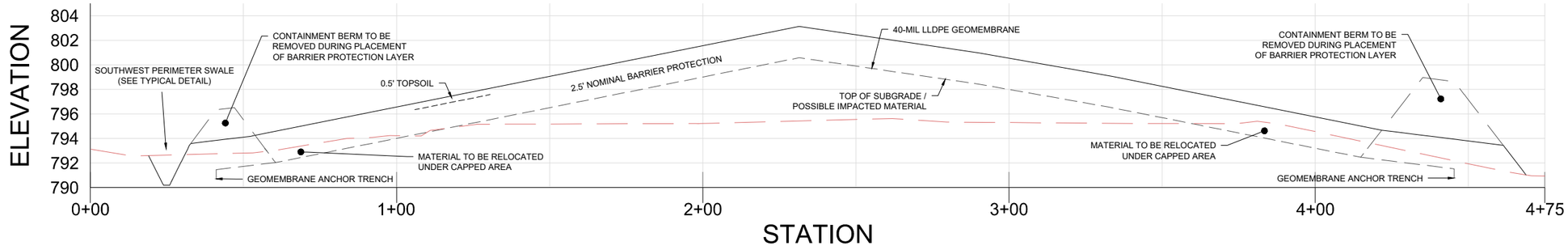
NO.	ISSUE/DESCRIPTION	BY	DATE

ROSE & WESTRA, A DIVISION OF GZA
601 FIFTH STREET NW, SUITE 102
GRAND RAPIDS, MICHIGAN 49504

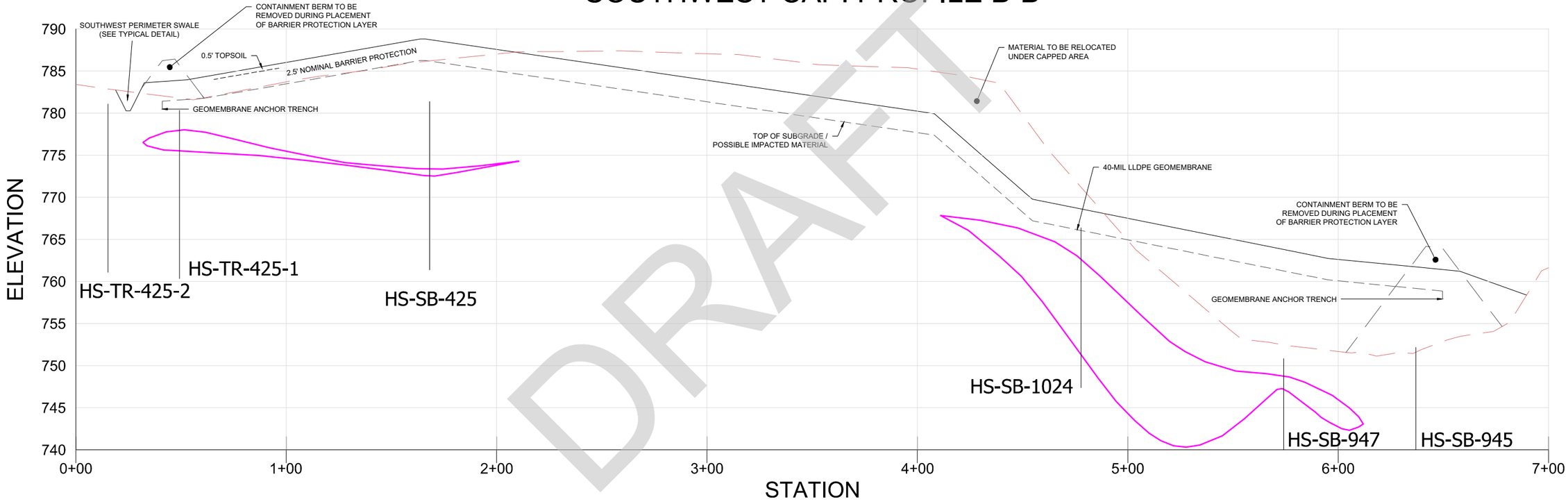
TOP OF FINISH GRADE (CAPPING TOPSOIL AND DRAINAGE SWALE)

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE PE-014
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: APRIL 2022	PROJECT NO. 16.0062961.81	REVISION NO.	

SOUTHWEST CAP: PROFILE A-A



SOUTHWEST CAP: PROFILE B-B



LEGEND

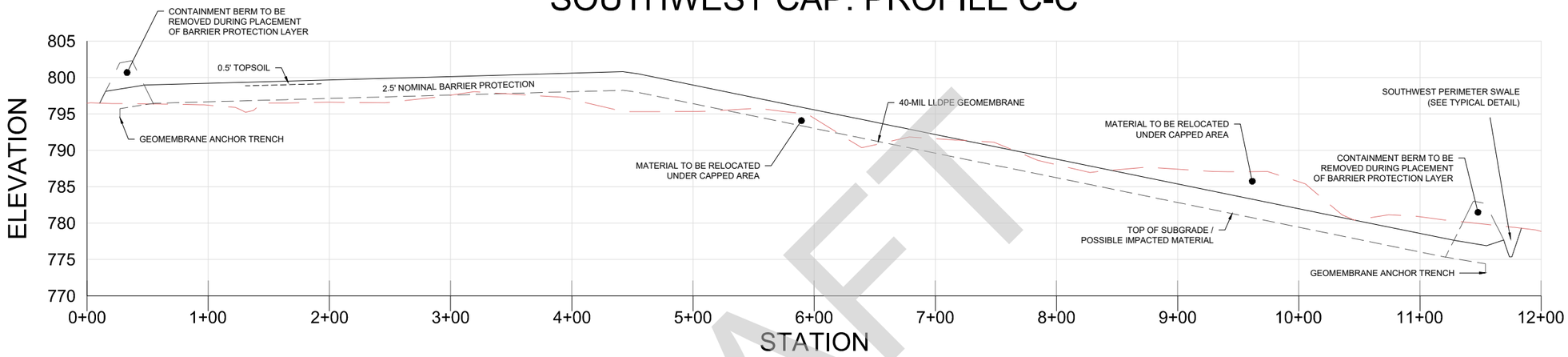
- EXISTING GROUND SURFACE
- TOP OF CONTAINMENT BERM
- TOP OF RE-GRADED IMPACTED MATERIAL
- TOP OF FINISH GRADE
- WASTE
- ESTIMATED WASTE BOTTOM

Rose & Westra, a Division of GZA
601 Fifth Street NW, Suite 102
Grand Rapids, Michigan 49504

CAPPING SYSTEM TYPICAL PROFILE A-A & B-B

PREPARED BY:		PREPARED FOR:	
GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE PE-015
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: MARCH 2022	PROJECT NO. 16.0062961.81	REVISION NO.	

SOUTHWEST CAP: PROFILE C-C



LEGEND

- EXISTING GROUND SURFACE
- TOP OF CONTAINMENT BERM
- TOP OF RE-GRADED IMPACTED MATERIAL
- TOP OF FINISH GRADE

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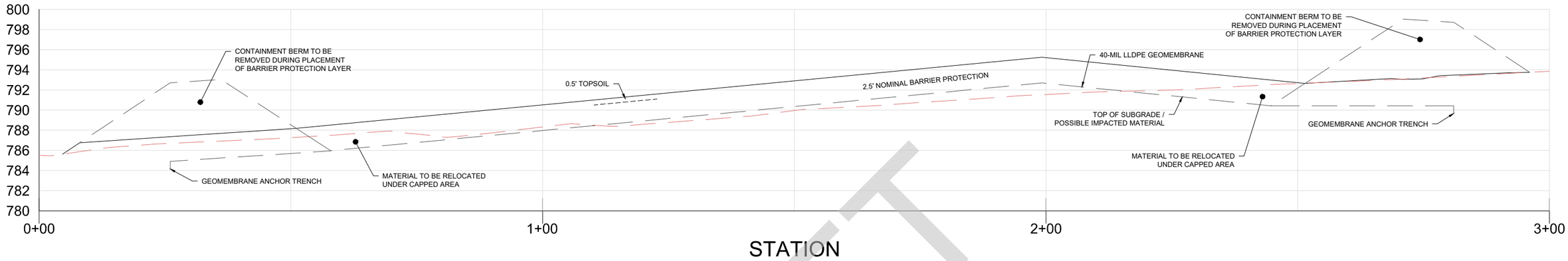
Grand Rapids, Michigan 49504

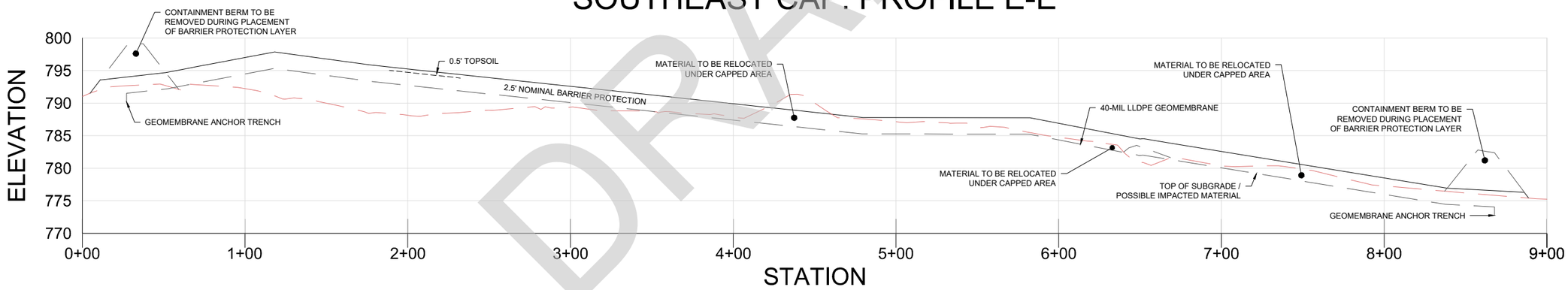
CAPPING SYSTEM TYPICAL PROFILE C-C

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE PE-016
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: MARCH 2022	PROJECT NO. 16.0062961.81	REVISION NO.	

SOUTHEAST CAP: PROFILE D-D



SOUTHEAST CAP: PROFILE E-E



LEGEND

- EXISTING GROUND SURFACE
- TOP OF CONTAINMENT BERM
- TOP OF RE-GRADED IMPACTED MATERIAL
- TOP OF FINISH GRADE

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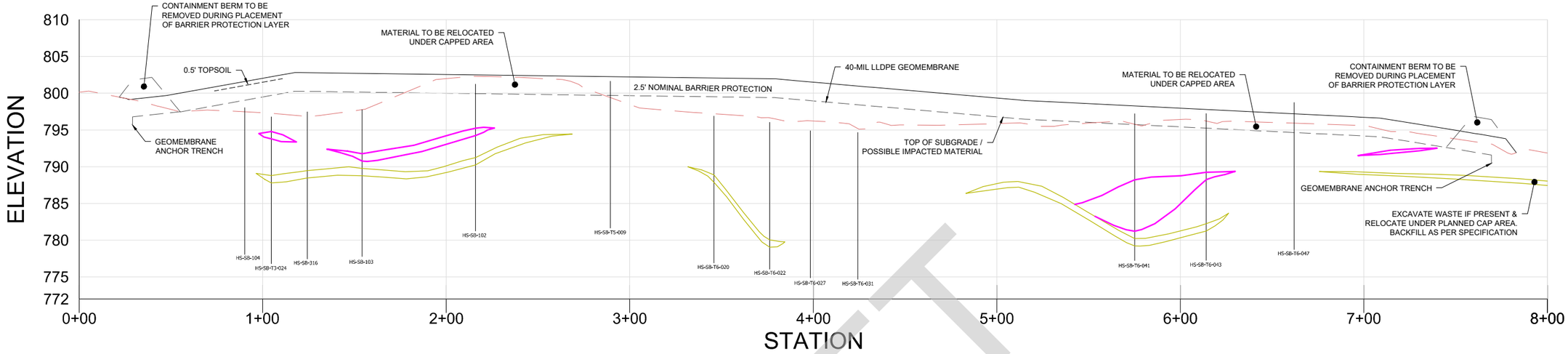
Grand Rapids, Michigan 49504

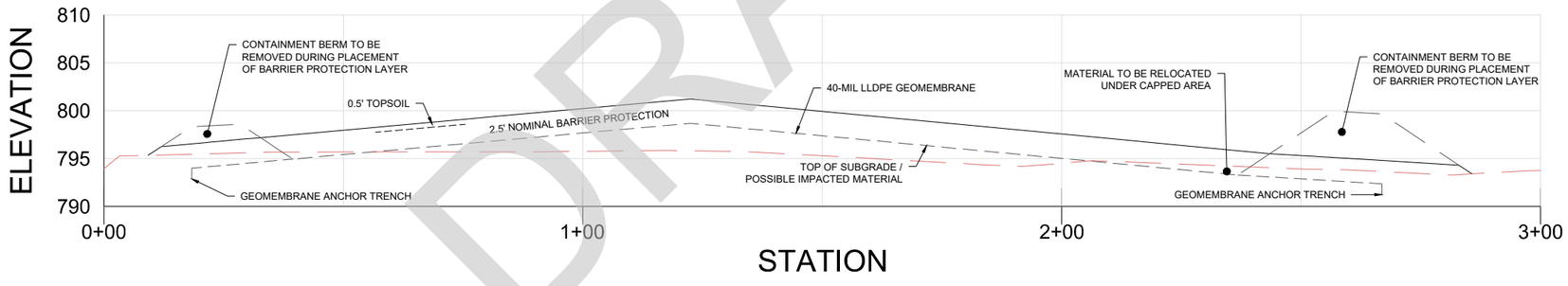
CAPPING SYSTEM TYPICAL PROFILE D-D & E-E

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE PE-017
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: MARCH 2022	PROJECT NO. 16.0062961.81	REVISION NO.	

NORTHWEST CAP: PROFILE F-F



NORTHWEST CAP: PROFILE G-G



LEGEND

- EXISTING GROUND SURFACE
- TOP OF CONTAINMENT BERM
- TOP OF RE-GRADED IMPACTED MATERIAL
- TOP OF FINISH GRADE
- WASTE
- ESTIMATED WASTE BOTTOM

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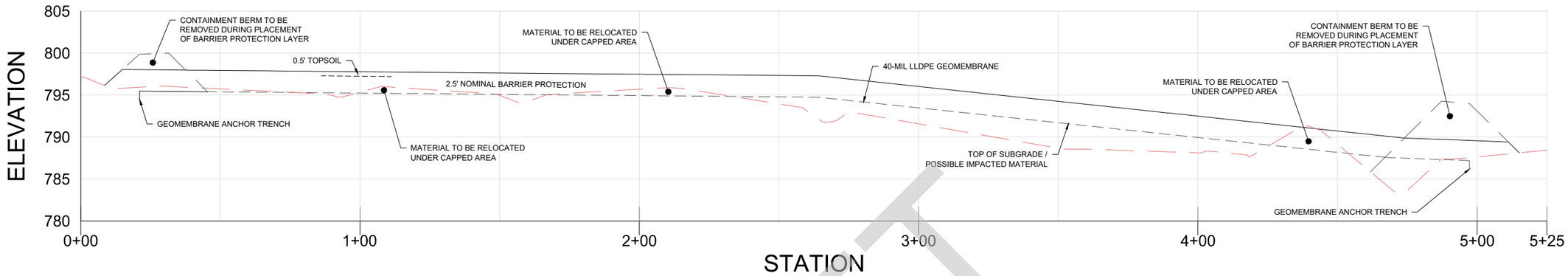
601 Fifth Street NW, Suite 102
Grand Rapids, Michigan 49504

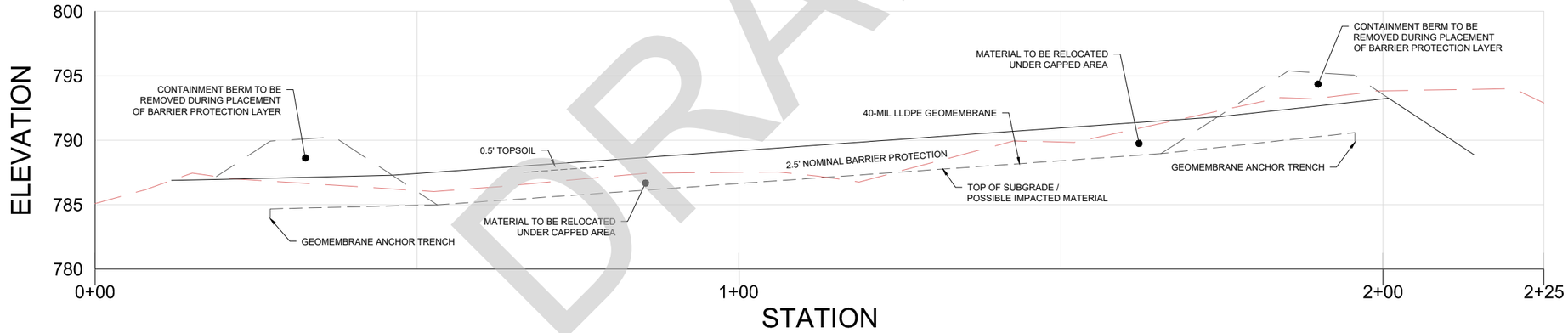
CAPPING SYSTEM TYPICAL PROFILE F-F & G-G

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE PE-018
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: MARCH 2022	PROJECT NO. 16.0062961.81	REVISION NO.	

NORTHEAST CAP: PROFILE H-H



NORTHEAST CAP: PROFILE I-I



LEGEND

- EXISTING GROUND SURFACE
- TOP OF CONTAINMENT BERM
- TOP OF RE-GRADED IMPACTED MATERIAL
- TOP OF FINISH GRADE

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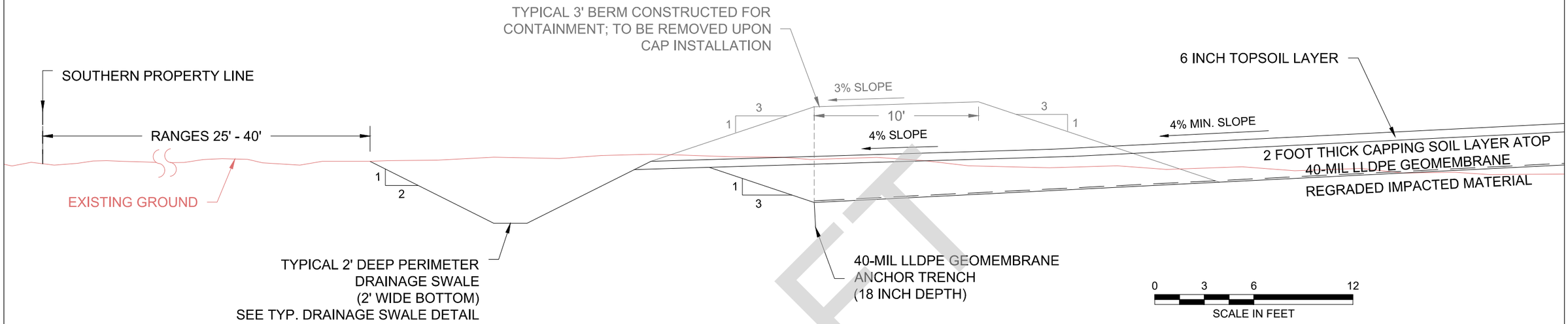
Grand Rapids, Michigan 49504

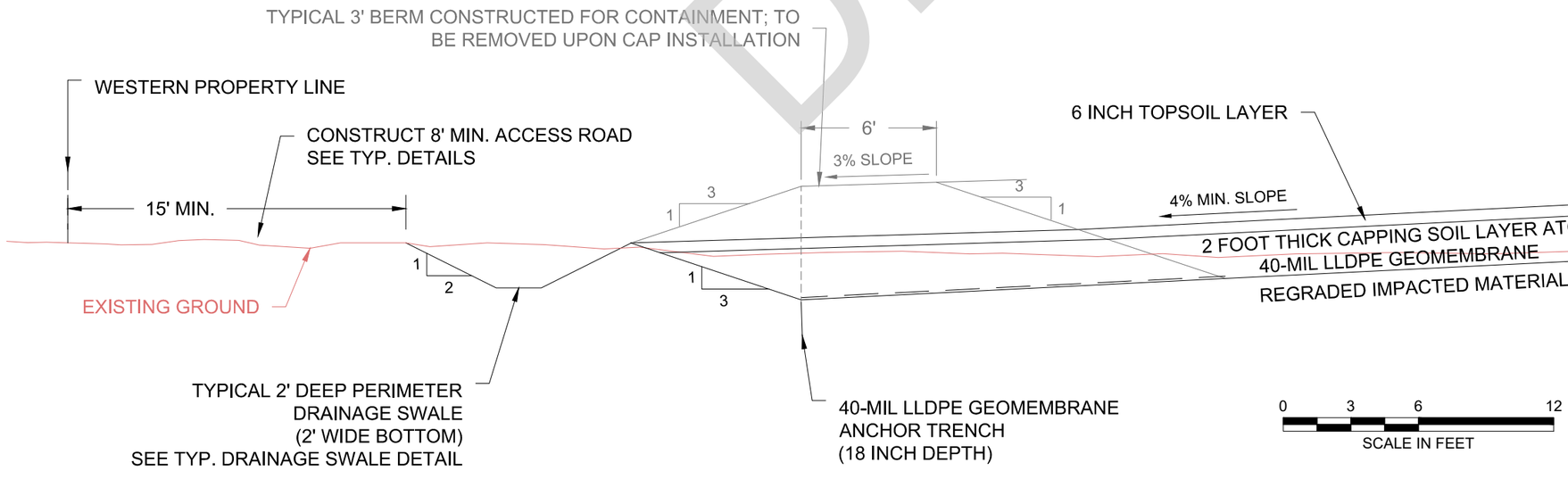
CAPPING SYSTEM TYPICAL PROFILE H-H & I-I

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE PE-019
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: MARCH 2022	PROJECT NO. 16.0062961.81	REVISION NO.	

TYPICAL SECTION OF SOUTHWEST CAP
SOUTH BERM



TYPICAL SECTION OF SOUTHWEST CAP
WEST BERM



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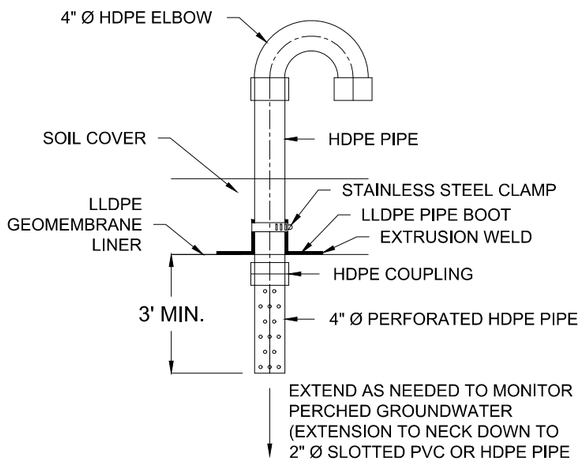
Grand Rapids, Michigan 49504

TYPICAL FINAL CAPPING SYSTEM SECTIONS

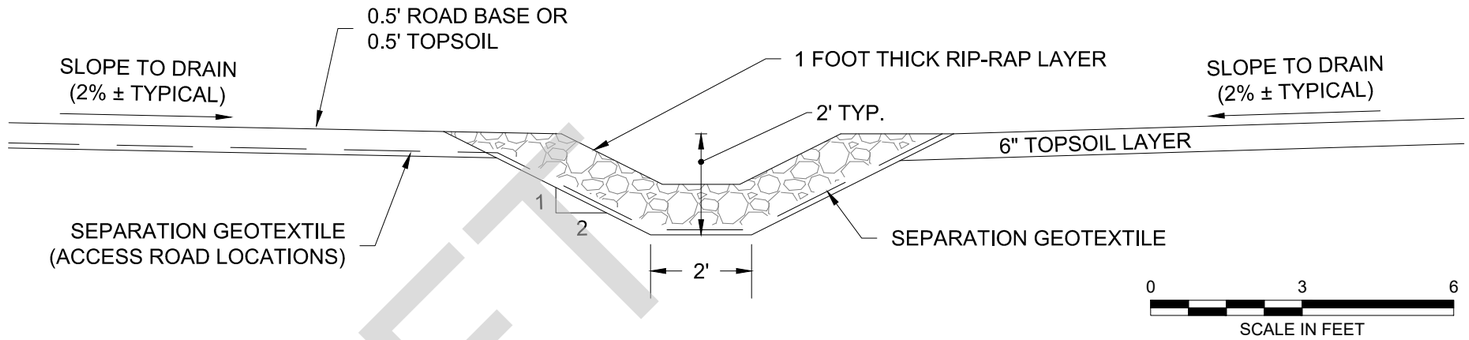
PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE PE-020
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: MARCH 2022	PROJECT NO. 16.0062961.81	REVISION NO.	

LANDFILL COVER GAS VENT

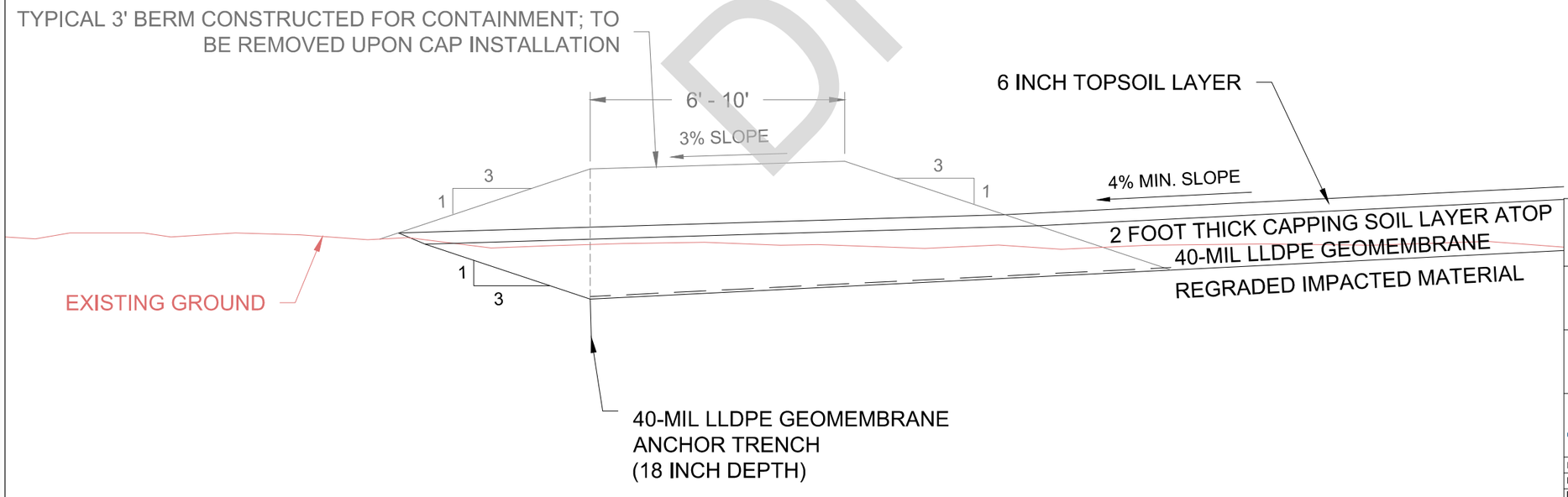
(NOT TO SCALE)



TYPICAL DRAINAGE SWALE



TYPICAL SECTION OF PERIMETER BERM



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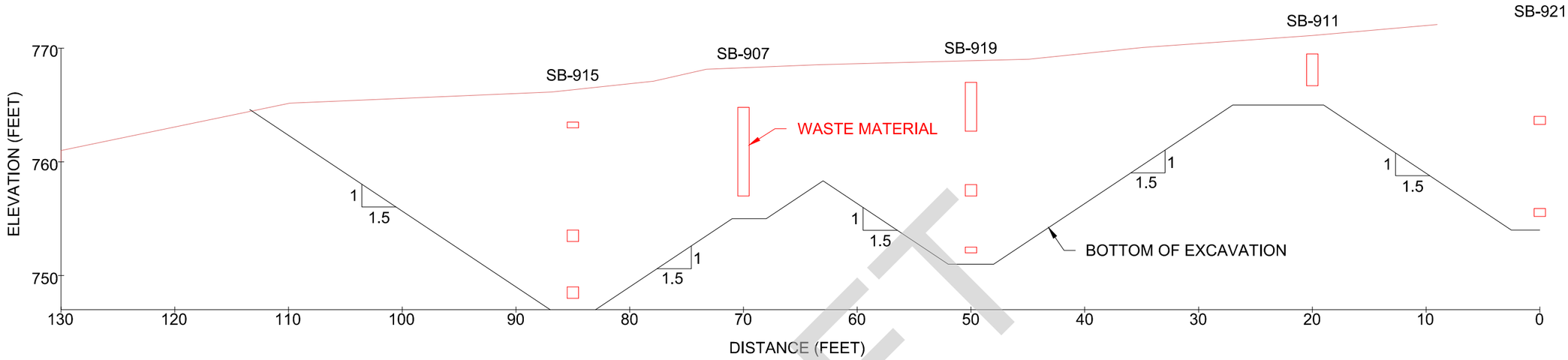
Grand Rapids, Michigan 49504

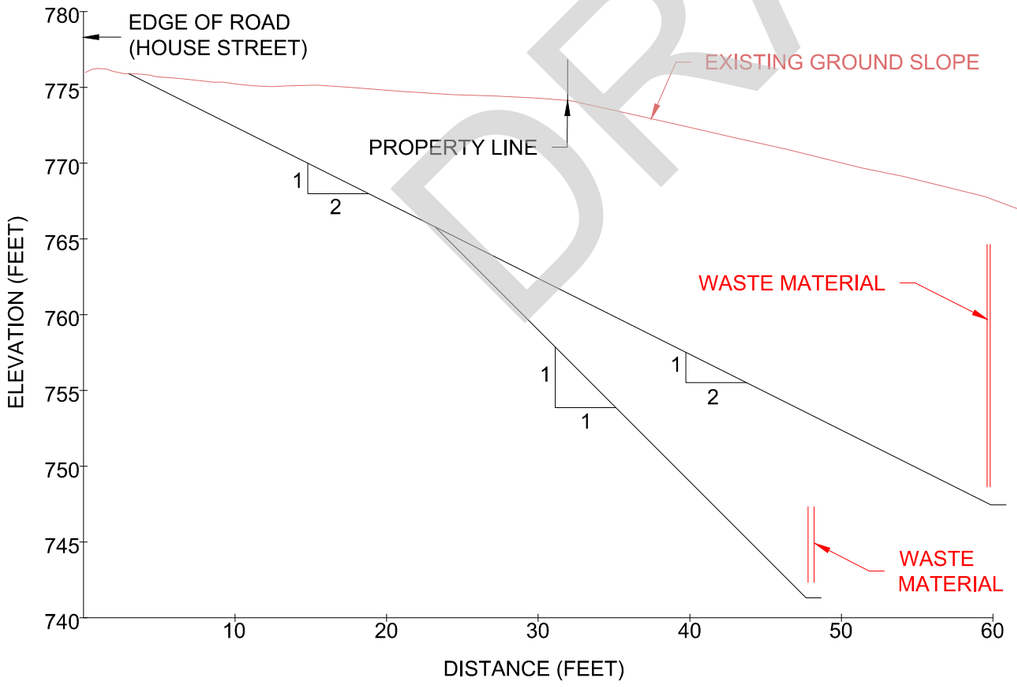
TYPICAL CAP SYSTEM DETAILS

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE PE-021
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: MARCH 2022	PROJECT NO. 16.0062961.81	REVISION NO.	

EXCAVATION OF WASTE WITHIN RETENTION BASIN CONSTRUCTION AREA



EXCAVATION OF WASTE ALONG SOUTH PROPERTY LINE



GENERAL NOTES

1. EXCAVATION SIDE SLOPES SHOWN AT 1(H) : 1(V) TO 2(H) : 1(V) FOR PRESENTATION PURPOSES. ACTUAL EXCAVATIONS TO COMPLY WITH OSHA REQUIREMENTS
2. INTENT OF WASTE EXCAVATION IS TO REMOVE ENCOUNTERED WASTE MATERIAL, WHICH MAY DIFFER FROM THAT SHOWN BOTH HORIZONTALLY AND VERTICALLY.

0 5 10 20
SCALE IN FEET

Rose & Westra, a Division of GZA
601 Fifth Street NW, Suite 102
Grand Rapids, Michigan 49504

TYPICAL WASTE EXCAVATION DETAILS

PREPARED BY:		PREPARED FOR:	
GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE PE-022
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: APRIL 2022	PROJECT NO. 16.0062961.81	REVISION NO.	

ATTACHMENT D

SPECIFICATIONS

SECTION 31 05 19

GEOSYNTHETICS for EARTHWORK

PART 1 – GENERAL

1.01. DESCRIPTION

A. This section specifies the material and construction requirements for:

1. Separation Geotextile
2. Geomembrane

B. Related work specified elsewhere:

1. Excavation and Fill: Section 31 23 00

1.02. DEFINITIONS:

A. Separation Geotextile is nominal 6 oz/sy nonwoven filter fabric overlying the drainage swales to separate rip-rap from the underlying soil. It will also be used beneath temporary road base during construction, and maintenance roads that will remain following installation of the cap.

B. Geomembrane is the 40 mil linear low-density polyethylene (LLDPE) liner, to be installed over the proposed top-of-waste or subgrade within each mound area. Smooth surface LLDPE will be used on the top and side slope of mounds with a slope less than 5%; double-rough LLDPE will be used on areas where the slope exceeds 5%.

1.03. JOB CONDITIONS:

A. Retain the services of a geomembrane manufacturer and installer certified by the manufacturer to supply and install the 40 Mil LLDPE liner.

B. Exercise care in placing the geomembrane to allow removal of free particles greater than 3 inches in diameter from the subgrade surface.

1.04. SUBMITTALS:

A. Prior to shipping the product, submit the following to the Owner's Representative for review and approval:

1. Separation Geotextile

a. Geotextile supplier/manufacturer

b. Manufacturer's product specifications

c. Manufacturer's recommendations for installation and anchoring as appropriate for the intended use and application.

d. Manufacturer's quality control test data, as specified, herein traceable to the lot numbers and roll numbers of geosynthetic material delivered to the project site.

e. Manufacturer's certificate or statement of compliance in accordance with these specifications.

2. Geomembrane

a. Pre-Construction Submittals

i. LLDPE geomembrane supplier/manufacturer

ii. Manufacturer's product specifications

iii. Manufacturer's recommendations for installation

iv. LLDPE geomembrane installer

v. Installer’s qualifications

vi. Installer’s quality control plan

vii. Geomembrane Deployment, Panel Layout, and Quality Control Plan

viii. Manufacturer's written certification that the installer is approved by the manufacturer and the manufacturer will warranty the installers work.

ix. Manufacturer's quality control test data, as specified herein, traceable to the lot numbers and roll numbers of geosynthetic material delivered to the project site.

x. Manufacturer's certificate or statement of compliance in accordance with these specifications.

xi. Manufacturer's Warranty

xii. Independent Laboratory Test Results

b. Post-Construction Submittals

i. All field seaming quality control test data including test seam data, and non-destructive seam testing data; and

ii. Destructive seam sample test data.

iii. Submit the post-construction geomembrane documentation identified above, the independent laboratory test results of the destructive seam samples, and the data accepted by the CQA Engineer prior to placement of any material over the geomembrane.

PART 2 - PRODUCTS

2.01 PROVIDE THE FOLLOWING GEOSYNTHETIC MATERIAL THAT SATISFY THE SPECIFIED MINIMUM AVERAGE ROLL VALUES.

2.02 MATERIALS

A. Separation Geotextile:

1. Separation Geotextile - non-woven, needle punched polypropylene or polyester, continuous filament material meeting or exceeding the following minimum requirements:

Property	Test Method	Value
Unit Weight (oz/yd^2)	ASTM D5261	6 (nominal)
Grab Tensile Strength (lbs)	ASTM D4632	160
Elongation (%)	ASTM D4632	50
Trapezoidal Tear Strength (lbs)	ASTM D4533	60
CBR Puncture Strength (lbs)	ASTM D6241	425
Permittivity (sec^{-1})	ASTM D4491	0.02
Apparent Opening Size (U.S. sieve number equivalent)	ASTM D4751	70-100
Ultraviolet Stability (% Ret. @ 500 hrs.) (see Note 2)	ASTM D4355	50%

Notes:

(1) All values are minimum average roll values (MARV) except AOS which is a maximum average roll value (MaxARV), and UV stability which is a minimum value.
(2) Evaluation to be on 2-inch strip tensile specimens after 500 hours exposure.

2. Furnish certificates of compliance from the manufacturer for the geotextile delivered to the site. Test samples of the geotextile for the parameters specified, provide results to the Owner's Representative.

3. Responsibility of the CQA Engineer:

   a. Review the test data and compare them to specifications. Identify rolls not meeting specifications and notify the Contractor that those rolls are not installed); and

   b. Observe the storage of rolls delivered to the Site and the procedures used to shelter them from sunlight, storm water and construction traffic.

B. Geomembrane

1. Provide a smooth and textured Geomembrane cover material fabricated from linear low-density polyethylene (LLDPE), nominal 40 mil continuous thickness that complies with the minimum standards presented below:

Properties	Test Method	Test Values	Test Frequency (min.)
Thickness mils (min. avg.)	ASTM D5199 (smooth) ASTM D 5994 (textured)	nom. (-5%)	per roll
Lowest individual for 8 out of 10 values		-10%	
lowest individual for any of the 10 values		-15%	
Asperity Height mils (minimum average)	ASTM D 7466	16 mil	every 2nd roll *(1)*
Density (max.)	ASTM D 1505	0.939 g/ml	200,000 lbs.

Properties	Test Method	Test Values	Test Frequency (min.)
	ASTM D 792		
Tensile Properties (minimum average) *(2)*	ASTM D 6693 Type IV		
break strength		60 lb/in.	20,000 lbs.
break elongation		250%	
2% Modulus – lb./in. (max.)	ASTM D 5323	2400	per formulation
Tear Resistance (minimum average)	ASTM D 1004	22 lbs.	45,000 lbs.
Puncture Resistance (minimum average)	ASTM D 4833	44 lbs.	45,000 lbs.
Axi-Symmetric Break Resistance Strain - % (min.)	ASTM D 5617	30	per formulation
Carbon Black Content (%)	ASTM D 4218 *(3)*	2.0-3.0%	45,000 lbs.
Carbon Black Dispersion	ASTM D 5596	*Note (4)*	45,000 lbs.
Oxidative Induction Time (OIT) *(5)*			200,000 lbs.
(a) Standard OIT (min. ave.)	ASTM D3895	100	
or —			
(b) High Pressure OIT (min. ave.)	ASTM D5885	400	
Oven Aging at 85°C *(6)* D 5721			
(a) Standard OIT (min. ave.)			
retained after 90 days	ASTM D 3895	35	Per formulation
– or-			
(b)High Pressure OIT (min. ave.)			
- % retained after 90 days	ASTM D 5885	60	
UV Resistance *(7)*			Per formulation
(a) Standard OIT (min. ave.)	ASTM D 3895	N.R. *(8)*	
-or-			
(b) High Pressure OIT (min. ave.) -	ASTM D 5885	35	
% retained after 1600 hrs *(9)*			

Notes:

(1) Alternate the measurement side for double-sided textured sheet.

(2) Machine direction (MD) and cross-machine direction (XMD) average values should be on the basis of five test specimens each direction. Break elongation is calculated using a gage length of 2 inches at 2 inches/minute.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for ten different views: nine Categories 1 or 2 and one in Category 3.

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

2. Submit the following information from the geomembrane manufacturer:

   a. The following quality control data on the raw material (resin) for geomembrane shall be provided by the resin manufacturer.

Parameter	Test Rate
Polymer Density	1 per Resin Lot

   b. Documentation demonstrating it has produced at least 50 acres (242,000 square yards) of similar liner material;

   c. Quality control data from the resin producer demonstrating the physical properties of the material by lot number; and

   d. Documentation that shows correlation between the resin lot number and the respective liner rolls.

   e. Provide the manufacturer's sampling procedure and analysis to verify that the LLDPE is "PFAS-Free".

3. Submit a geomembrane deployment plan for review and approval by the Owner's Representative before beginning deployment. Include:

   a. The proposed orientation of seams with respect to cap slopes.

   b. Documented evidence that the field crew foreman of the liner installer has a minimum qualification of successful experience of at least 50 acres of previous landfill or comparable geosynthetic systems on a minimum of five different projects.

4. In addition to the manufacturer's pre-construction testing requirements listed above, employ an Independent Testing Laboratory to conduct conformance testing of the manufactured geomembrane, at a minimum frequency of one sample per 100,000 square feet. Obtain samples at the manufacturing plant, following production of the rolls. Only samples on rolls actually delivered to the site are to be accepted as meeting the above frequency requirement. Obtain samples by cutting at least a minimum 2-foot-wide piece along the entire roll width. Material is not to be taken from the inner or outer wraps of a roll. The sample shall be clearly marked with the roll number, product, manufacturer, and machine direction.

5. Test each sample as follows:

Test	Specification
Thickness	ASTM D5994
Asperity Height (Textured)	ASTM D7466
Density	ASTM D1505/D792
Carbon Black Content	ASTM D4218
Carbon Black Dispersion	ASTM D5596
Tensile Strength at Break	ASTM D6693
Elongation at Break	ASTM D6693

6. Provide copies of all results to the QA/QA Engineer to verify the measured value of the samples tested comply with the value specified. If a conformance sample does not meet the required specifications, collect samples from adjoining roll numbers and test them until the extent of material failing to meet specification is determined. Any rolls from which samples failing to meet the project specifications were obtained are to be rejected for use on the project.

PART 3 - EXECUTION

3.01 SEPARATION GEOTEXTILE

A. Installation Procedures:

1. Geotextile shall be installed as shown on the drawings and in accordance with the manufacturer's recommendations.
2. Separation Geotextile may be joined by either sewing, heat bonding or overlapping a minimum 18 inches; the methods and materials for seaming shall be subject to the approval of the Engineer.
3. Traffic or construction equipment will not be permitted directly on the geotextile.
4. At the time of installation, geotextile shall be rejected if it has defects, rips, holes, flaws, deterioration or damage incurred during manufacture, transportation or storage.
5. Geotextile shall be placed over underlying materials only after survey record information has been obtained by the Owner’s surveyor, if applicable.
6. The fabric shall be protected at all times during construction from damage resulting from sunlight, excessive surface water, construction traffic, improper installation procedures, or any other condition which can result in damage to the fabric. Geotextile found to be damaged as a result of improper construction procedures or inadequate protection, shall be replaced by the Contractor at his expense.
7. No grade stakes shall be allowed to penetrate the Geotextile for controlling the lift thickness of the overlying soil.

3.02 GEOMEMBRANE

A. Manufacturer's Conformance Testing

1. Conduct a conformance testing program to document that the specified material requirements are obtained in the manufacturing of the geomembrane. At a minimum include the following:
   a. Test the geomembrane supplied to the project for the parameters and test frequencies listed in Section 2.02(B)(1) in this section.
   b. Submit quality control data from the resin producer demonstrating the physical properties of the material by lot number. Provide

documentation that shows correlation between the resin lot number and the respective liner rolls.

c. Ship the geomembrane in rolls that are properly identified with the following:

i. Manufacturer's Name, Plant and Location

ii. Product Name and Model/Type No.

iii. Lot Number or Designation identifying the date of manufacture and production run

iv. Roll Number

B. Installer Qualifications and Requirements

1. Be approved by the manufacturer as being qualified.

2. Install the geomembrane in accordance with the manufacturer's recommendations, Michigan Environmental, Great Lakes and Energy requirements and these specifications.

3. Verification that the installer's field crew foreman has a documented minimum qualification identified above. Submit resumes for all installer's personnel who will be doing field seaming and field testing that demonstrates they are qualified to do the work specified.

4. Prepare and submit a Quality Control Plan (QC Plan) acceptable to the Owner's Representative and QA Engineer addressing the installation, seaming and testing requirements specified herein. Adhere to the approved QC Plan, and the requirements specified herein.

5. Submit a liner deployment plan to the Owner's Representative for review and approval at least ten (10) days before beginning deployment. Include the procedures for deploying and protecting underlying geosynthetic materials.

C. Sequence of Construction

1. Construct the geomembrane to the limits shown on the Drawings and in accordance with these Specifications.

2. Any deviations from the Drawings or Specifications require the prior approval of the Owner's Representative and must be documented in the Record Drawings .

3. Place and seam the geomembrane to cover the entire area of the underlying waste and soil to the limits identified on the contract Drawings or as directed by the Owner's Representative. Secure exposed (unwelded) ends of the geomembrane to prevent uplift from wind or movement associated with runoff or precipitation. Deploy only that amount of geomembrane that can be welded to an adjacent section before the day's end.

4. Deploy and conduct all testing of the geomembrane in the presence of the Owner's Engineer. Provide documentation of all deployment, seaming,

testing, and observations of the installed geomembrane to the Owner's Engineer for evaluation within 24-hours where it will be evaluated prior to approval.

D. Geomembrane Installation

1. Inspect the geomembrane upon delivery and after deployment for any damage or defects. Remove damaged or defective material from the project site.

2. Refueling of any equipment on the geomembrane is prohibited. Vehicles are not allowed on the geomembrane. Personnel working on the geomembrane are not permitted to smoke or wear damaging shoes or engage in other activities which could damage the geomembrane. At the Owner's discretion, repair or replace any damaged geomembrane by equipment, material handling, trafficking, leakage, or any other means.

3. Install the geomembrane as follows::

   a. Unroll only those sections which are to be seamed together or secured in one day. Panels should be positioned with the overlap recommended by the manufacturer, but not less than 2 inches. The edge of the upslope sheet shall be positioned above the edge of the downslope sheet.

   b. After panels are initially in place, remove as many wrinkles as possible. Unroll panels and allow the liner to "relax" before beginning field seaming. The purpose of this is to make the edges that are to be bonded as smooth and free of wrinkles as possible.

   c. Once panels are in place and smooth, commence field seaming operations.

4. Field seaming is affected by ambient weather conditions which varies depending on the method of field seaming. Establish control parameters prior to the start of field seaming and submit these parameters as well as the method and procedure for seaming to the CQA Engineer for approval.

5. Comply with the following field seaming at a minimum:

   a. Remove all foreign matter (dirt, water, oil etc.) from the edges to be bonded. For extrusion-type welds, thoroughly clean the bonding surface by mechanical abrasion or alternative methods approved by the Owner's Representative to remove surface impurities and prepare the surface for bonding. Use No. 80 grit or finer sandpaper for all abrasive buffing.. Use of solvents to clean the geomembrane if prohibited.

   b. To the extent practical, start field seaming from the top of the slope down. This will keep wrinkles that may occur due to having people working on the side slopes behind the area being seamed. Complete tack welds (if needed using heat only; double-sided tape, glue or other method are not permitted. Completely seam the

geomembrane to the ends of all panels to limit the potential of tear propagation along the seam.

c. Repair locations where the completed liner exhibits any "trampolining" during daylight hours to the complete satisfaction of the QA Engineer and the Owner's Representative.

d. Using rope, sandbags or other device approved by the QA Engineer, anchor all unseamed edges at the end of each day or installation segment. Connect sandbags securing the geomembrane on the side slopes by rope fastened at the top of the slope section by a temporary anchor, as necessary. Staples, U-shaped rods or other penetrating anchors used to secure the geomembrane are not permitted.

e. Repair or replace any damage to the geomembrane due to wind, rain, hail, or other weather to the satisfaction of the Owner's Representative and the QA Engineer.

6. Use fusion welding for all field seaming; limit extrusion welding to patchwork. The Owner's Representative reserves the right to reject any proposed seaming method believed to be unacceptable. Additional concepts and requirements of proper field seaming include:

a. Join adjacent sheets by overlapped at least 2 inches or in accordance with the manufacturer's specifications after the necessary aligning and cutting.

b. Orient seams shall be perpendicular to the slope. Minimize the number of field seams in corners and odd-shaped geometric locations.

c. Should the ambient temperature and wind chill be below 32°F, preheating of the geomembrane unless it is demonstrated that this is not necessary [i.e., acceptable test (start-up) seams which duplicate, as closely as possible, actual field conditions can be achieved]. Preheating may be achieved by natural and/or artificial means (shelters and heating devices). Measure ambient temperature 18 inches above the geomembrane surface. Document the location of all measurement readings and submit as part of the daily field report..

d. Use of a moveable protective layer of plastic placed directly below each overlap of geomembrane that is to be seamed to limit moisture build-up between the sheets to be welded is acceptable.

e. Seam panels to the outside edge.

f. Use of a firm working surface like a flat board, conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support is acceptable.

g. No excessive grinding prior to welding shall be permitted. Replace overground or improperly ground areas at the Contractor's expense.

h. Complete seams at panel corners of 3 or 4 sheets with a patch having a minimum dimension of 24 inches, extrusion welded to the parent sheet.

E. Testing During Construction

1. Observe the surface of the underlying subgrade to check for perforations, protrusions, or other detrimental effects, before deploying the roll of geomembrane. Document in writing each day that the subgrade surface was checked and that its condition is satisfactory for covering with the liner. Provide a copy of this statement in the Daily Field reports. A satisfactory subgrade shall be relatively smooth and even.

2. The CQA Engineer will also observe the subgrade surface and will inform the installer of areas that, in the CQA Engineer's opinion, are unsatisfactory for covering.

3. The installer will check the condition of each roll for defects and imperfections as it is deployed. The Engineer will observe the condition of each sheet as it is being deployed. Observed defects will be marked on the sheet and will be noted in field reports. Each defect will be patched, and the patch seam will be non-destructively tested, as described below. The date of the successful non-destructive test will be marked on the liner and will be noted in field reports.

4. Provide, maintain and use equipment and personnel at the site to perform testing of test seams. Check seaming equipment daily before beginning seaming (in the morning, after extended breaks, after five hours of continuous seaming, after lunch, after equipment changes, after operator changes, and after significant changes in ambient or geomembrane temperatures) by destructive testing a seam specimen with a tensiometer. Use each seamer to make at least one test seam each day. Requirements for test seams follow:

a. The test seam sample will be at least 0.9 m (3 ft) long by 0.3 m (1 ft) wide with the seam centered lengthwise. Six adjoining specimens 25 mm (1 in) wide each will be die cut from the test seam sample. These specimens will be tested in the field with a tensiometer for both shear (3 specimens) and peel (3 specimen). Test seams will be tested by the Geomembrane Contractor under observation of the CQA Engineer. Specimens that fail in the weld are failures; seaming and testing a different specimen is required. Supply all necessary knowledgeable personnel and testing equipment. Strain measurements in the field are not required.

b. A passing machine or hand welded test seam will be achieved when the criteria described below in Section E, (7) are satisfied with the exclusion of any strain requirements. If a test seam fails, the entire operation will be repeated. If the additional test seam

fails, the seaming apparatus or seamer will not be used for seaming until the deficiencies are corrected and two consecutive successful full test seams are achieved. Test seam failure is defined as failure of any one of the specimens tested in shear or peel.

c. The CQA Engineer will observe all test seam procedures and log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description.

d. A satisfactory test seam will fail the parent material in both peel and shear. The Engineer will observe the destructive testing of test specimens and record the results in field reports.

5. Non-destructive tests will be done on all field seams to measure the integrity of the seam. Seams made by extrusion welding will be tested with a vacuum box (ASTM D4437) and seams made with a double hot wedge will be pressure tested as follows (pressure gauges and equipment will have been calibrated within 180 days of the project initiation and a current calibration certificate shall be provided):

a. Single Weld Seams (extrusion weld) - The Contractor is to maintain and use equipment and personnel at the Site to perform continuous vacuum box testing on all single weld production seams. The system must be capable of applying a vacuum of at least 5 psi and held for a time determined sufficient by the CQA Engineer to observe the vacuum test. Spark test all extrusion welds that are not accessible for vacuum testing, such as those used for welding the LLDPE pipe boot to the gas vent riser pipes.

b. Double Weld Seams (hot wedge) - Maintain and use equipment and personnel to perform air pressure testing of all double weld seams. The system must be capable of applying a pressure of at least 30 psi for not less than 5 minutes. Perform all pressure and vacuum testing under the supervision of the CQA Engineer. Conduct pressure loss tests in accordance with the procedures outlined in ASTM D5820-95.

c. Conduct air pressure tests of fusion-welded seams as follows. Pressure losses over a measurement period of 5 minutes must be less than 2 psi. At no time during the test shall the pressure drop below 30 psi to be considered a passing test. Release air pressure from the end of the test seam opposite the pressure source at end of the test. If air is not released through this point, the seam will be checked to identify any clogging, then repaired and retested.

d. If a pressure loss greater than 2 psi occurs during the test and it is determined that the pressure loss is not due to testing apparatus malfunction, pressurize the seam and apply a soap solution to the seam. The Owner's Representative and the geomembrane installer will check for leaks. The geomembrane installer will repair the leak by placing a cap strip and retesting the seam by pressure test.

e. If a leak is determined to be on the underneath side of the seam,

make a progressive search of the seam until that portion of the leaking seam is found. Repair the leaking section of seam with a cap strip. Document the remaining section of seam not capped that passed the air pressure test and repair the sections of the seam damaged by the leak search with cap strips.

f. Record the results of each non-destructive test in daily field reports with the date marked on the liner next to the seam to allow inspection of the liner upon completion.

6. Record the location of each sheet as each is deployed and its respective seam. Collect seam samples for destructive testing at the minimum rate of one sample per every 1,000 feet of seam or at least one sample for each seaming unit on each day seaming takes place at locations selected by the Owner's Representative . Survey the location of each sample and plot the location on the sheet deployment plan.

7. Split each sample into three pieces, each 18 inches long (parallel to the seam) and 12 inches wide. One piece will be field-tested by the Contractor, one piece will be tested by the CQA Engineer (or a subcontracted independent laboratory) and one piece will be retained by the Owner's Representative. If the Contractor's field test meets the strength requirements listed below, then submit the CQA Engineer sample piece to the independent lab for testing. If the Contractor's field test does not meet the strength requirements listed below, then investigate and repair the liner seam as described below without independent lab testing of the sample from the failed field test. Cut test samples into ten l-inch wide strips perpendicular to the seam orientation. Test five (5) strips for peel strength and five (5) for shear strength (ASTM D4437). All five strips must satisfy the strength and peel separation and elongation requirements listed below.

Hot Wedge Seams	
Test	**Required Value**
Seam Shear Strength (lbs/in.)	60 min.
Seam Shear Elongation (1) (%)	50 min.
Seam Peel Strength (lbs/in.)	50 min.
Seam Peel Separation (%)	25 max.
Extrusion Fillet Seams	
Test	**Minimum Value**
Seam Shear Strength (lbs/in.)	60 min.
Seam Shear Elongation (1) (%)	50 min.
Seam Peel Strength (lbs/in.)	44 min.
Seam Peel Separation (%)	25 max.

Notes: (1) Elongation measurements omitted for field testing.

8. Remediation is required for any failing destructive test sample. The installer will be required to: (1) patch the seam over the non-conforming destructive test sample location and extending the patch to the nearest

adjacent conforming destructive test sample location; or (2) collect and destructive test an additional sample from each side (a minimum 10 feet from failed seam) of the failing destructive test sample location to identify the limits of the defective seam. These two retest samples must pass both shear and peel testing.

9. If these two samples do not pass, then obtain additional samples until the questionable seam area is defined. Place a patch over the seam between the two passing destructive test locations. Seams will be non-destructively tested as described above.

10. Traffic or construction equipment not associated with field seaming shall are not permitted directly on the geomembrane. Replace all membrane areas that become torn or damaged by constructing a cap strip. Repairs to seams made by extrusion bead to a seam edge previously fusion welded or extrusion methods are not permitted unless approved by the CQA Engineer. Using non-destructive protocols, test repaired areas. .

11. The CQA Engineer is responsible to make field observations, visual examinations, monitor material measurements and the type of installation equipment used to determine if the methods used are in compliance with the specifications for the project.

12. Perform field tests as soon as possible after materials receipt or after completion of a portion of the constructed work in order to provide prompt field test results. The CQA Engineer will observe all production seam field test procedures. The remainder of the successful test seam sample will be assigned a number and marked accordingly by the CQA Engineer, who will also log the date, seam number, approximate location in the seam, and field test pass-or-fail description, if applicable. The CQA Engineer will be responsible to archive the specimen.

13. Provide an installation certificate that states the geomembrane was supplied and installed in accordance with design specifications and manufacturer's requirements and state that all QC testing was done as required by these specifications.

14. Retain all ownership and responsibility for the geomembrane until final acceptance of the project by Owner.

F. Other Requirements

1. Protect the LLDPE geomembrane from exposure to sunlight during transportation and storage. Store the geomembrane off the ground.

2. All seams are subject to the approval of the CQA Engineer. Seaming the LLDPE geomembrane in temperatures less than 32ºF or higher than 120ºF without prior approval of the CQA Engineer is not permitted. Complete all seams during daylight hours. Do not seam in winds equal to or exceeding 20 miles per hour or during precipitation.

3. Repair or replace and LLDPE geomembrane which becomes torn or damaged. Extend the patch a minimum l.5 feet beyond the perimeter of the tear or damage.

G. Potentially Damaging Activities

1. Personnel working on the geomembrane are not permitted to smoke, wear damaging shoes, or engage in any activity which damages the geomembrane.

2. Upon completion of each section of the geomembrane, the CQA Engineer will observe its condition (both sheets and seams) for defects. Repair any observed defects (nicks, gouges, etc.) to the satisfaction of the Owner's Representative before covering.

H. Protection of Leading Edges on Top Area of Final Cover System

1. Between construction of partial sections of the membrane liner, leading edges of the membrane may be exposed or buried for extended periods of time prior to their joining to adjacent, subsequent membrane sections. The combined action of abrasive soil and equipment impact stresses may "etch" unprotected membrane surfaces sufficiently to affect seam strengths. Therefore, it is necessary to protect leading edges in high activity areas with sacrificial layers of geotextile and LLDPE sheet until they are ready for final seaming.

2. At a minimum, covered by a layer of geotextile overlain by a layer of LLDPE sheet (alternatively, plywood made be used in lieu of geotextile and LLDPE sheet), each leading edge to be seamed that must be buried or which must be exposed for periods of one month or longer..

3. Provide and install non-woven geotextile with a minimum weight of 6 ounces per square yard. The sacrificial LLDPE sheet is to have a minimum thickness equal to that of the membrane liner to be protected and a minimum width of 2 feet. Cover the protective sheets with either soil or weighted with sandbags to prevent displacement by wind. Center the edge of the sheet to be protected beneath the overlying protective layers prior to burial or weighing with sandbags. Burry the leading edges located in areas expected to receive direct traffic from construction equipment under a minimum thickness of one foot of buffer soil.

I. Progress

1. Installation and protection of the geomembrane in areas simultaneous to construction of other underlying/overlying components of the landfill final cover system is permittable.

*****END OF SECTION *****

SECTION 31 22 00

GRADING

PART 1 - GENERAL

1.01. SCOPE:

A. This section specifies the work required by the Contractor to grade the earth materials on the Site.

B. Related work specified elsewhere:

1. Excavation and Fill: Section 31 23 00

1.02. DEFINITIONS:

A. Site grading consists of excavation, backfilling and grading to shape excavated slopes, landfill slopes, embankments and fills, and work areas to remove irregularities and to provide positive drainage during construction and for restoring the site.

1.03. SUBMITTALS:

A. None.

1.04. JOB CONDITIONS:

A. Preserve, protect, and maintain existing structures, channels, roads, drives, drains, sewers, utilities, monitoring wells and all other site features during construction unless otherwise stated and shown.

B. Be thoroughly familiar with the Site, the Site conditions, and all aspects of the Contract Drawings and project specification before commencing any intrusive work.

C. Visually inspect and verify that all soil, erosion, and sedimentation controls are in place and functioning as designed.

PART 2 - PRODUCTS

3.01. MATERIALS:

A. As described in other sections of the specifications and on the Contract Drawings.

PART 3 - EXECUTION

3.01. GENERAL

A. Verify that layout stakes and grades are current, that all runoff controls and temporary storage facilities are in place prior to the start of any earth moving operations.

3.02 EXCAVATION and FILL:

A. Perform earthwork in accordance with Section 31 23 00.

3.03 SITE GRADING DURING CONSTRUCTION:

A. Grade work areas as necessary during construction to divert surface water runoff from excavations and to provide positive drainage of embankments or fills.

3.04 FINISH GRADING:

A. On completion of the work, clean all ditches, channels and drainage pipes and restore them to their pre-construction condition, including removal of temporary haul roads and drainage pipes; restore and finish the site in a neat and presentable condition as approved by both the Owner's Representative and Owner including all haul roads, lay-down areas, parking areas and trailer areas and any other areas disturbed by the construction work.

B. Grade the site to provide positive drainage as shown or as directed and approved by the Owner's Representative.

*****END OF SECTION*****

SECTION 31 23 00

EXCAVATION and FILL

PART 1 - GENERAL

1.01 SCOPE:

A. This section specifies the work required by the Contractor to complete the excavation and backfilling requirements for the various components of this project as shown on the contract drawings and as specified herein.

B. Related Work Specified Elsewhere:

1. Grading: Section 31 22 00.
2. Geosynthetics for Earthwork: Section 31 05 19

1.02 DEFINITIONS:

A. Earth excavation is the removal of in-place, fill soils, waste and natural overburden soils using proper earth moving equipment.

B. Fill placement or backfilling is the placement and compaction of earthen materials to construct the various components of the project to the lines and grades shown.

C. Authorized excavation is excavation of soils, waste and/or soil with waste to the excavation limits shown. It includes excavation of material considered unsuitable by and other excavation as directed by the Owner's Representative.

D. Unauthorized excavation is excavation of materials beyond the limits shown or not authorized by the Owner's Representative to be excavated.

1.03 JOB CONDITIONS:

A. Protect Aboveground and Underground Structures, Utilities and Facilities: Where shown, the locations of above ground and below ground facilities are approximate. The contract drawings do not define all above ground or below ground utilities, structures, wells, and other existing facilities at, or adjacent to the project Site and work area. Identify, properly locate, and protect all utilities, underground structures, above ground structures and appurtenances on, or adjacent to the project Site. Contact the Owner's Representative to obtain further information, requirements, and restrictions, related to work procedures.

B. Health and Safety: At all times safeguard persons and properties in accordance with all provisions of the Health and Safety Plan submitted by the Contractor to the Owner.

C. Dust Control: Control dust in the work area, haul roads, and at the perimeter of the Site by sprinkling with potable water or by other methods approved by the

Owner's Representative and in accordance with the requirements of EGLE. Use of petroleum products to control dust is not permitted.

D. Access Roads, Ramps and Staging Areas:

E. Construct temporary staging areas, access roads and drainage pipes as necessary to provide access to the work areas and cross the existing perimeter drainage channel, as approved by the Owner's Representative.

F. Maintain all temporary staging areas and access roads along with existing Site access roads throughout the duration of the contract as necessary to provide access to the Site for the Contractors operations, the operations of Owner, representatives of Regulatory authorities, the Owner's Representative, and others engaged by Owner at the Site.

G. Remove all temporary roads, ramps, temporary drainage pipes and staging areas, when no longer needed, and restore the Site as presented in the Contract Drawings or as approved by the Owner's Representative.

H. Borrow: Provide all borrow soil, barrier protection material, topsoil and stone products required.

I. Construction Quality Assurance/Quality Control:

J. Implement a construction quality assurance/quality control (QA/QC) program during construction to ensure that the placed soils and materials meet the requirements of these specifications. The CQA Engineer will conduct the quality program.

K. Comply with the requirements of the approved QA/QC Plan and provide all necessary testing and documentation that is specified. Provide documentation to the Owner's Representative that the Contractor's subcontractor at any level complies with the approved QA/QC Plan.

L. Assist the CQA Engineer and others as directed by the Owner's Representative as needed to accommodate sample collection and testing at no additional cost to Owner.

M. SUBMITTALS:

N. Submit dust control procedures, off-Site material sources, earthwork procedures, material handling and stockpiling procedures and locations, material placement procedures and QA/QC control plans for review and approval by the Owner's Representative before initiating any work described by said plan(s).

O. Submit a copy of the Contractor's Health and Safety Plan to the Owner's Representative for project record.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Gas Vent Riser Stone:

1. Provide and place Gas Vent Riser stone that is a washed, crushed stone or crushed gravel free of clays, organics, snow, ice and friable or deleterious particles, and that meets the material requirements of MDOT and the following gradation requirements:

Sieve Size	Percent Finer by Weight
1-1/2 – inch	100
1 - inch	90 - 100
½ - inch	0 - 15

2. In addition, provide on Gas Vent Riser Stone that has a minimum coefficient of permeability of 1 x 10^{-2} cm/sec.

B. Barrier Protection Layer:

1. Provide and place Barrier protection layer material as described below.
2. Us only material that is classified according to the Unified Soil Classification System as SP, SM, ML-CL, CL, or SC, with a maximum plasticity index of 25, having a maximum permeability of 5 x 10^{-6} cm/sec, have a maximum particle size of one (1) inches in its longest dimension.
3. Place only Barrier protection layer material that is free of organic material, construction debris, ice, snow, and deleterious material that is approved by the Owner's Representative.

C. Topsoil:

1. To the extent possible, use topsoil obtained from on-Site. Should an insufficient quantity of topsoil be available on Site, supplement with topsoil from an off-Site source.
2. Provide topsoil that is free of refuse, snow, ice, any material toxic to plant growth, subsoil, woody vegetation and stumps, roots, brush, stones, clay lumps, and objects larger than 2 inches in greatest dimension. Thoroughly break-up and mix sod and herbaceous growth such as grass and weeds with the soil during handling operations.
3. Provide independent documentation and testing that verifies that off-Site Topsoil, if needed, complies with the following minimum requirements:
    a. The pH of the material is between 6.0 and 7.5.
    b. The organic content is not less than 3 percent nor more than 20 percent.
    c. It is well graded with a maximum particle size of 2 inches and with 20 to 90 percent by weight passing a No. 200 sieve.

d. Contains:

i. Arsenic at concentrations no greater than 5,800 micrograms per kilogram (ug/kg)

ii. Perfluorooctane sulfonate (PFOS) at concentrations no greater than 0.22 ug/kg or Perfluorooctanoic acid (PFOA) at concentrations no greater than 350 ug/kg

iii. No pesticides at concentrations greater than the lowest MDEQ Part 201 Residential Soil Clean Up Criteria for each pesticide.

D. Coarse Aggregate:

1. Provide Coarse Aggregate from a MDOT approved source that meets the following criteria:

a. washed, crushed stone or crushed gravel free of clays, organics, snow, ice and friable or deleterious particles, and shall meet the material requirements of MDOT and meet the following gradation requirements:

Sieve Size	Percent Finer by Weight
1-1/2 - inch	100
1 - inch	90 - 100
½ - inch	0 - 15

b. Magnesium sulfate, free-thaw, Los Angeles abrasion test, flat and elongated particles and crushed particles in accordance with the requirements of MDOT.

c. Coefficient of permeability of $1x10^{-2}$ cm/sec or greater when compacted to a dense state.

E. Crushed Stone:

1. Provide Crushed Stone from a MDOT approved source.

2. Crushed Stone must be a dolomitic crushed stone or crushed gravel free of dust, clays, organics, snow, ice and friable or deleterious particles and meet the requirements of MDOT and meet the following gradation requirements.

Sieve Size	Percent Finer by Weight
2 - inch	100
1/4 - inch	30 - 65
No. 40	5 - 40
No. 200	0 - 10

3. Comply with requirements of MDOT for the concentration of magnesium sulfate, and soundness loss.

F. Riprap:

1. Provide Riprap from a MDOT approved source.

2. Fine Riprap must be a crushed stone or crushed gravel free of dust, clays, organics, snow, ice and friable or deleterious particles and meet the requirements of MDOT (Fine Stone Filling) and additionally with the following gradation requirements.

Stone Size	Percent of Total by Weight
Smaller than 8-inches	90 - 100
Larger than 3-inches	50 - 100
Smaller than No. 10 Sieve	0 - 10

2.02 SOURCE OF MATERIALS:

A. Provide sufficient documentation that demonstrates all soils off-Site sources (except for small amounts from perimeter tie-in soil excavations, and any available on-Site topsoil) that are proposed for use at the Site by the Contractor meets all the specified requirements.

B. In addition, test and provide documentation that the off-Site soils meet all requirements of the QA/QC plan.

C. Evaluate each proposed borrow source as specified and according to the requirements of the QA/QC plan prior to submission of the source to the Owner's Representative for review and approval prior to importing any soil to the Site.

D. Pre-qualification of a source by the Engineer does not relieve the Contractor of its responsibility to supply soil which meets the specified requirements. Soil imported to the Site and placed which does not meet the specified requirements will be removed and replaced by the Contractor at no additional cost to Owner.

PART 3 - EXECUTION

3.01 LAYOUT:

A. Accurately locate and maintain location of all proposed construction components, and existing roads, utilities, monitoring wells, drainage structures and existing landfill components, features, and advise the Owner's Representative of any discrepancies prior to commencing work.

3.02 PROTECTION OF SUBGRADES AND FILL GRADES:

A. The subgrade soils are generally waste fill soils of varying composition and strength properties. They are sensitive to disturbance from construction activity when in the presence of excessive moisture. Prevent water from collecting on earthen subgrade surfaces. Properly drain and protect all excavation and fill grades.

B. Grade the waste (and soil with waste) to the final subgrade elevations including areas requiring tie-in construction of the final cover system to the containment berms and any previously constructed final cover system of an adjacent covered area.

C. Design and construct temporary haul roads with proper materials and thicknesses to protect subgrades, fill grades, underground utilities, constructed components and other work as shown and specified.

D. Failure to properly excavate and protect approved subgrades that results in additional excavation and backfill to attain a suitable subgrade in accordance with these specifications shall be at the sole expense of the Contractor.

E. Maintain both work in progress and completed work until the construction is complete and accepted by the Owner's Representative. Repair and/or replace any erosion or degradation of the Contractor's work at no additional cost to Owner.

F. Maintain the landfill final cover system and earthen areas until the construction is complete and covered with a uniform dense stand of vegetation at least 2 inches in height. Repair any and all erosion, desiccation, weathering and/or degradation of the final cover system components and earthen areas to the satisfaction of the Owner's Representative at no additional cost to the Owner.

G. Exercise caution when placing Barrier Protection Material atop the underlying geosynthetics.

3.03 EQUIPMENT:

A. Select, furnish, and properly maintain equipment which will perform the required excavation and compact the fill uniformly to the required density and/or permeability. Submit Contractor's selection of equipment to the Owner's Representative for review prior to construction.

B. Do not proceed with any intrusive Sitework until the soil erosion and sedimentation controls are properly installed and all submittals relating to soil handing in this and other sections have been reviewed and approved by the Owner's Representative.

3.04 EARTH AND WASTE EXCAVATION

A. Make all excavation tie-ins to the cover system to existing grades in the presence of the Owner's Representative. Extend to the lines and grades shown and described on the Contract Drawings and to suitable conditions as determined by the Owners Representative.

B. Fine grade the top of waste/intermediate cover soil surface to eliminate surface irregularities and produce an even surface. Excavate the material down to design grade, within specified tolerances, and place the material in areas below design top-of-waste cover soil grade in areas where an existing cap soil or waste soil is above design grade.

C. Waste that is present and/or encountered outside of the designated design waste mounds shall be relocated within a designated waste mound as directed by the Engineer.

D. All excavation work shall be executed to the lines and grades shown on the drawings, unless directed otherwise by the Engineer. All excavation work shall be performed in such a way to minimize disturbance and maintain stability of subgrade soils and slopes. Special care shall be taken to not disturb the bottom of

excavations. Excavation to the final subgrade levels must be done by methods which minimize traffic on the subgrade.

E. The excavation equipment must be of such size and capacity sufficient to excavate the materials encountered and to the specified depths as shown. Excavation in sands, silts and soft clays represent potentially unstable subgrade conditions and proper protection should be implemented.

F. The Contractor shall be responsible at all times for safe and prudent excavation operations so as to protect the workers, the public, utilities and structures, and adjacent property. The Contractor shall perform all excavation in accordance with OSHA standards. The Contractor shall observe all applicable local, state and federal requirements and acquire all necessary permits.

G. Subgrades and slopes which have been damaged or degraded as a result of Contractor's activities, or failure of the Contractor to properly protect them shall be repaired at the Contractor's expense as directed by the Engineer.

H. Subgrades in which soft or unsuitable materials are encountered, which are not a result of Contractor's operations or failure to protect subgrades, shall be undercut and backfilled with appropriate fill as directed by the Engineer.

I. No materials or fill shall be placed by the Contractor until the subgrades are observed and tested by the Engineer and surveys are completed as required.

3.05 STOCKPILING:

A. Do not placed any material adjacent to the sides of sheeted or open excavations within a distance equal to two times the maximum depth of the excavation. Stockpiling material over existing geosynthetic membranes, landfills, utilities, leachate collection and transfer systems, sewers, force mains, water lines may induce settlement and is not permitted.

3.06 FILLING AND BACKFILLING:

A. Preparation: Do not place fill or backfill until underlying subgrades have been observed, tested, and verified by the Owner’s Representative..

B. Materials: Place the following material at the locations depicted on the Contract drawings, and as specified or at other locations as directed by the Owner’s Representative.

1. Gas Vent Riser Stone

   a. For sub-surface backfill around the gas vent riser pipes.

2. Barrier Protection Layer:

   a. Atop the geomembrane in the capped area.

3. Topsoil:

   a. Over the barrier protection layer.

4. Coarse Aggregate:

   a. Locations as shown.

5. Crushed Stone:

   a. Locations as shown.

6. Riprap:

   a. For lining the drainage channel on the west and south sides of the Southwest Mound, and as shown on the drawings.

C. Placement and Compaction:

1. Gas Vent Riser Stone

   a. Contractor shall place gas vent riser stone around the gas vent riser pipes as shown and specified.

2. Barrier Protection Layer:

   a. Placed in 2 lifts via low ground-pressure bulldozers in the areas designated to have 2-feet thickness. Push the soil uphill from the toe of slope or sideways across the slope, but not in a downslope direction. Compacted to a minimum of 90 percent of the maximum dry density as determined by the modified Proctor test (ASTM D1557), with a maximum moisture content within 4 percent of its optimum moisture content. Compact using a sheepsfoot or smooth drum roller, as appropriate based on the material type. Equipment used to compact this soil must be compatible with the soil type and the loose lift thickness. Place the material in a manner to prevent sliding and damaging the underlying geomembrane.

   b. Compact each lift of barrier protection soil around each gas vent riser, or any other penetration using a jumping jack tamper. Compacted to form a seal around the pipe to the satisfaction of the Owner's Representative.

   c. Track the surface of the barrier protection layer perpendicular to the slope contour, with bulldozer and moistened to promote bonding immediately before spreading the overlying topsoil layer.

3. Topsoil

   a. Prepare all grades within the areas to be covered by topsoil so that the completed work, after topsoil is spread, conforms to the specified lines and grades.

   b. Scarify the surface of the barrier protection layer and moisten it before topsoil is placed to permit bonding of the topsoil with the subsoil.

   c. Only allow trucks used to transport and place topsoil to travel on haul roads atop the geosynthetics having a minimum of 3 feet of overlying soil (inclusive of the barrier protection layer) to protect the geosynthetics underlying the barrier protection layer.

   d. Do not place topsoil that is in an unworkable condition due to excessive moisture, frost or other conditions until it is suitable for spreading. Place and spread Topsoil on the designated area and

graded to 6 inches minimum thickness. Clear and dispose all large stiff clods, rocks, roots or other foreign matter after the topsoil is spread so that the finished surface will be acceptable for subsequent compaction and seeding. Use a bulldozer to track and compact the topsoil. Track the bulldozer perpendicular to the slope contour to limit erosion rills.

4. Coarse Aggregate:

   a. Place Coarse aggregate to the lines and levels shown on the drawings and in a manner that will preclude damage to the final cover system components.

5. Crushed Stone:

   a. Place Crushed Stone in the locations as shown on the drawings.

6. Riprap:

   a. Prior to placement of stone riprap, the underlying materials must be properly placed, compacted, and graded as specified.

   b. Place stone for riprap within the lines, grades and slopes specified and in such a manner as to produce a well graded mass of rock with a minimum percentage of voids.

   c. Place riprap to its full course thickness in one operation and in such a manner as to avoid displacing or damaging the underlying material. On slopes, place starting at the toe of the slope and advance systematically up the slope. Distribute larger stones within the entire mass of stones such that the final position conforms to the grade specified. Verify that the finished layer of stone is free from objectionable pockets of small stones and clusters of larger stones. Placing stone in layers is not permitted.

*****END OF SECTION*****

SECTION 32 91 12

TOP SOIL FOR SEEDING AND PLANTING

PART 1 – GENERAL

1.01 SCOPE

A. The Work of this Section furnishings of all labor, equipment, supplies, and materials to place topsoil on the cap. Work includes the handling, sorting, placement, grading, shaping, conditioning, and fertilizing of topsoil, and plantings. A minimum of six (6) inches of topsoil is required above the backfill and on other disturbed areas of the Site impacted by the construction.

B. Related Work specified elsewhere:

1. Excavation and Fill: Section 31 23 00
2. Grading: Section 31 22 00

1.02 JOB CONDITIONS

A. Protect all existing work; repair and re-grade areas damaged by equipment and materials.

B. Use caution when placing topsoil around gas vents.

1.03 SUBMITTALS

A. At least thirty (30) days in advance of starting any topsoil operations on Site, provide the Owner's Representative with the composition, test data, manufacture's information, and/or source of topsoil material as presented in these specifications for review and approval. Analytical results of topsoil that does not comply with the testing parameters or the characteristics identified below are not acceptable for use at the Site.

PART 2 – PRODUCTS

2.01 TOPSOIL

A. The intent of the work is to utilize, to the extent practical, reclaimed topsoil previously stripped from on-site locations as directed by the Owner's Representative.

B. If sufficient quantity of on-site topsoil is not available, supply acceptable clean, weed-free topsoil from off-site sources. Determine the quantity of off-site topsoil required for each mound and areas that may have been impacted by construction.

C. Provide topsoil free from subsoil, of uniform quality free of hard clods, stiff clay, hardpan, sods, partially disintegrated stone, lime, cement, ashes, debris, trash, slag, concrete, tar residues, tarred paper, boards, chips, sticks, stumps, rocks, weeds, brush, and all other undesirable material and substances toxic to plant growth.

D. Topsoil supplied form an off-site source that is acceptable for use is classified as a sandy loam by the USDA textural classification system determined by sieve and pipette or hydrometer analysis with the following makeup:

1. Contain less than 60 percent sand by weight and less than 35% clay by weight.

2. Fine to medium sand fraction (0.10 to 0.50 mm in diameter) at least 90 percent of the sand fraction. No more than 3 percent of the soil shall be gravel (>1 mm <1-in in diameter).

E. Organic soils, such as peat or muck, are not acceptable as topsoil material. The concentration of soluble salts less than 500 ppm and sodium adsorption ratio is less than 12 are acceptable.

F. New imported topsoil must contain a minimum of 2.5 percent and maximum 12 percent of organic matter as determined by the Loss on Ignition Test, Association of Official Agricultural Chemists, with not more than 50 percent clay and not more than 55 percent sand as determined in accordance with ASTM D 482, "Particle-Size Analysis of Soils" to be considered acceptable. To adjust organic matter content, the soil may be amended, by the addition of composted leaf mold or peat moss. Use of organic amendments is acceptable only if random soil sampling indicates thorough incorporation. Soil shall be capable of supporting and germinating vegetation.

G. The topsoil reaction (pH) shall be between 6.0 and 7.5.

H. Topsoil with arsenic at concentrations greater than 5,800 micrograms per kilogram (ug/kg) is not acceptable.

I. Laboratory analysis of topsoil with per perfluorooctane sulfonate (PFOS) at concentrations greater than 0.22 ug/kg or perfluorooctanoic acid (PFOA) at concentrations greater than 350 ug/kg are not acceptable.

J. Topsoil that does not comply with the lowest MDEQ Part 201 Residential Soil Clean Up Criteria for each pesticide will be rejected for use.

K. Topsoil gradation within the following limits:

Sieve Size	Percent Finer by Weight
1-in	100
1/4-in	97
No. 10	90
No. 100	40 to 60

L. Do not destroy topsoil structure through excessive and unnecessary handling and compaction. Inappropriate handling leading to the compaction or deterioration of soil structure will result in rejection of topsoil for use.

M. Testing Requirement: Submit samples to assure topsoil fulfills specified requirements regarding textural analysis, organic matter content, pH and fertility as follows:

1. Provide one 20lb sample of topsoil to Owner’s Representative from each site that will be used as a topsoil borrow area. Submit samples at least

seven (7) days prior to beginning stripping operations or commencing topsoiling operations on the site.

2. Conduct Standard Soil Test on all soils with Organic Matter that includes reporting of the following parameters: pH, Buffer pH, Extractable Nutrients, Extractable Heavy Metals (e.g., Lead), Cation Exchange Capacity, Percent Base Saturation, Percent Organic Matter, and Total Soil Nitrogen. The laboratory test results shall provide recommendations for nutrient and pH adjustments.

3. Perform a minimum of one test on each distinct on-site topsoil or off-site loam source. Perform a standard soil test for every 500 CY of topsoil or loam used at the site.

4. Soil testing shall be performed at an approved accredited testing laboratory

N. All soils proposed for use on-Site from off-Site sources must be approved by the Owner's Representative for such.

PART 3 - EXECUTION

3.01 TOPSOIL

A. Amend topsoil in accordance with the recommendations of the Testing Laboratory provided in their report and in accordance with these specifications.

B. Clear, grub and bring final sub-grade to the designated elevation prior to spreading topsoil. Spread topsoil so as to form a cover of topsoil in all areas to be seeded, sodded, or otherwise vegetated to a minimum depth of six (6) inches unless otherwise shown on the drawings or directed by the Owner's Representative.

C. Scarified or otherwise roughen disturbed areas outside of the footprint of the caps to a depth of 2 inches, just prior to the placing topsoil.

D. Gather and remove all stiff clods, hard lumps, large stones, trash, stakes, wood, brush, stumps, roots, or other objectionable material from topsoiled area through screening, raking, or similar means after spreading. Use of a lawn roller to provide moderate compaction is acceptable.

E. Dispose of all material removed from topsoil as non-contaminated soil.

F. Promptly fertilize, seed, lightly compact, mulch, or otherwise cover, and stabilize through tracking with suitable equipment.

*****END OF SECTION*****

SECTION 32 92 19

SEEDING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies the minimum requirements for seeding and mulching.

B. Related work specified elsewhere

1. Topsoil for Seeding and Planting; Section 32 91 12.

1.02 SUBMITTALS

A. At least ten (10) days prior to use, provide the Owner's Representative copies of the manufacturer's information for any soil amendments proposed for use at the Site that verify compliance with the requirements contained in this section.

B. Provide copies of all analysis that verifies compliance with the technical the seed mix for the project records.

C. Submit manufacturer's specifications of all mechanical equipment Contractor intends to use for soil preparation or seeding to the Owner's Representative for review and approval prior to its intended use on Site.

PART 2 - PRODUCTS

2.01 MATERIAL

A. Seed mix specified and one that complies with current state and local rules and regulations. Contractor may propose alternative seed mix for review and approval by the Owner's Representative and is demonstrated to comply with applicable state and local rules and regulations.

B. Verify that mulch conforms to current state and local regulation.

C. Fertilizer that contains 9% nitrogen, 18% available phosphoric acid, and 9% soluble potash.

D. Limestone that conforms to state and local regulations.

PART 3 - EXECUTION:

3.01 APPLICATION

A. After the topsoil is placed to the grades and lines shown and specified, fertilize the seed and mulch with limestone placed at the following rates according to the topsoil pH.

Topsoil pH	**Limestone Rate (lbs/1000 S.F.)**
6.5 or greater	0
6.0	40
5.5	80

B. Prior to seeding, fertilized the area using 12 pounds of 9-18-9 fertilizer per 1,000 square feet (or as specified by the manufacturer) worked lightly into the soil.

C. Apply the following seed mix at a rate of six (6) pounds per 1,000 square feet.

Common Name	**Percent by weight**
Fine Fescue (2 varieties min. must include creeping red)	50-70%
Perennial Ryegrass (2 varieties minimum)	15-40%
Annual Ryegrass	5-15%
Clover (White preferred)	5-10%

D. Immediately after seeding, deploy mulch (hay or straw) be evenly applied to seeded areas at the rate of 100 pounds per 1,000 square feet.

3.02 GROUND PREPARATION AND SEDING

A. Maintain areas to be seeded at the design grades. Eliminate irregularities which form low places which will hold water. Distribute fertilizers, seed, and mulch in the amounts specified evenly on the surfaces to be seeded.

B. Use a harrow, disk, track with a dozer, or otherwise completely pulverized to a state of tillage acceptable to the Owner's Representative. Track the topsoil surface with a dozer traveling up-and-down the slope. Remove all stone or other undesirable material over two inches in greatest dimension for reuse.

C. Incorporate limestone and/or fertilizer as specified shall to a depth of no more than two inches below the finished grades unless otherwise specified. Orient mechanical drills or seeders such that the seed depth does not exceeding one-quarter inch. Cover seeds that have been distributed on the surface to a depth not exceeding one-quarter inch by raking, brush or chain harrowing, or other approved method. Do not broadcast seed during windy weather. After sowing, lightly roll the seeded areas with rollers that have been pre-approved by the Owner's Representative.

D. Alternatively, the Contractor can apply the seed using an approved hydro-seed method provided the procedure is provided to the Owner's Representative at least ten (10) days prior to application.

3.03 MULCHING

A. Clear the surface of areas where mulch is to be applied of stones, stumps, wire or other obstacles which might hinder the subsequent seeding operations, and where required by the plans, harrow or disk the ground to produce a state of suitable tillage. Spread the mulch uniformly in a blanket of sufficient thickness to hide the soil from view.

B. Mulch may be spread by hand or by machinery. When mulching and seeding are specified, the mulch may be spread before or not later than three days after seeding unless otherwise approved. Anchorage will be required unless otherwise specified on the plans. Anchorage to hold the mulch in place may be applied by an approved method during the mulching operation or subsequently if the Contractor so desires.

C. Care and protect mulched areas until final acceptance of the project. Care includes protecting against traffic by approved warning signs or barricades, and repair of areas damaged by erosion, wind, fire or other causes. Expeditiously repair any area that has been damaged to re-establish the condition and grade of the soil prior to mulching; re-mulched as specified under this work.

3.04 CARE DURING CONSTRUCTION

A. Care for the seeded and mulched areas until final acceptance of the project. Care consists of providing protection against traffic by approved warning signs or barricades and repairing of any areas damaged following the seeding or mulching operations due to wind, water, fire, or other causes. Repair and re-establish damaged areas to the condition and grade of the area prior to seeding, then re-fertilize, re-seed and re-mulch as specified herein.

B. Keep seeded areas mowed until acceptance of the contract by cutting to a height of three inches when growth reaches six inches or when the growth tends to smother seedlings or as directed.

3.05 POST CONSTRUCTION CARE

A. Provide post construction care for a period equal to six months or the following spring, from the time of seeding, whichever is greater but not exceeding one year.

B. Final acceptance of the seeded areas will be determined solely by the Owner's Representative and the Contractor. Rework, fertilize, reseed, and mulch any bare or spotty vegetated areas as directed by the Owner's Representative.

*****END OF SECTION *****

SECTION 33 05 31

THERMOPLASTIC UTILITY PIPE

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies the material and construction requirements associated with pipe components of this project as shown on the Contract Drawings and as specified herein.

B. Related Work Specified Elsewhere:

1. Excavation and Fill: Section 31 23 00

2. Geosynthetics for Earthwork: Section 31 05 19

1.02 DEFINITIONS:

A. Gas vent riser pipes are 4-inch diameter SDR-17 HDPE pipes placed into the cap to allow gases within the mound to vent at locations shown on the drawings. The underground portions are perforated, and the above-ground sections are solid.

B. Perched water monitoring pipes are 2-inch diameter slotted polyvinyl chloride (PVC) pipes attached to the gas vents by a reducer and extend to depth to monitor apparent perched groundwater.

C. Fittings including pipe couplings, ells, caps, and reducers as depicted or inferred on the drawings.

D. HDPE pipe couplings are to be affixed by electro-fusion welding.

E. PVC couplings to PVC pipe are to be connected as defined by the Owner's Representative.

1.03 SUBMITTALS:

A. Provide the following items to the Owner's Representative for review and approval prior to ordering the material.

1. Pipe supplier, manufacturer and manufacturer's recommendations for installation, including product specifications, and fabrication drawings and requirements.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Supply SDR-17, 4-inch nominal diameter, HDPE pipe made of high density, high molecular weight polyethylene pipe material.

B. Four (4) rows of one-half inch (1/2) diameter holes spaced 90 degrees apart with perforations 6-inches on center and staggered from row-to-row are required for gas vent riser.

C. Supply Schedule 40, 2-inch nominal diameter, PVC pipe.

D. PVC pipe screen shall be Schedule 40, 2-inch nominal diameter, 0.010-inch slots.

PART 3 - EXECUTION

3.01 GAS VENT RISER

A. Install all pipe to the lines and grades shown on the drawings or in locations directed by the Owner's Representative. Handle and assemble all pipe in accordance with the manufacturer's instructions, unless otherwise authorized by the Owner's Representative.

B. Provide and install pipe that is homogeneous throughout and free from cracks, holes, foreign inclusions, or other defects.

*****END OF SECTION*****

ATTACHMENT E

BORING LOGS

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Wolverine World Wide, LLC
Cap Design
Rockford, Michigan

Boring No.: HS-GT-1
Page: 1 of 2
File No.: 16.0062961.81
Check: J. Groenleer

Contractor: Stearns Drilling Company
Foreman: J. Gryska
Logged by: C. Melby
Date Start/Finish: 3-2-22 / 3-2-22
Boring Location: 587,511 N; 12,788,485 E
GS Elev.: 774.0' **Datum:** NAD83/NAVD88

	Auger/ Casing	Sampler
Type:	Hollow Stem Auger	Split Spoon
O.D. / I.D.:	8.0" / 4.25"	2.0" / 1 3/8"
Hammer Wt.:	140lbs	NA
Hammer Fall:	30.0"	NA
TOC Elev.:	NA	NA

GROUNDWATER READINGS

Date	Time	Depth	Casing	Stab

Surveyed By: GZA (Trimble R1) **Survey Date:** 3/2/2022

Depth	Sample Information No.	Pen./ Rec. (in.)	Depth (Ft.)	Blows (/6")	Test Data	Sample Description & Classification	Stratum Desc.	Remarks	Equipment Installed
1	1	24/18	0-2	WOH-2 4-4		Medium stiff, brown, CLAY & SILT, trace fine to medium Sand, moist.	CLAY & SILT		None
2	2	24/21	2-4	2-5 5-6		Loose to medium dense, brown, fine to medium SAND, little Silt, moist.	2' SAND		
4	3	24/19	4-6	2-3 3-2		Loose, light brown to brown, fine to medium SAND, some Silt, moist.			
6	4	24/23	6-8	2-3 3-5		Loose, light brown, fine to medium SAND, little Silt, moist to dry.			
8	5	24/20	8-10	2-2 4-4		Loose, light brown, fine to medium SAND, little Silt, dry.			
15	6	24/22	15-17	3-3 4-6		Loose, light brown, fine to medium SAND, little Silt, dry.			
17	7	24/19	17-19	3-3 5-4		Loose, light brown, fine to medium SAND, little Silt, dry.			
19	8	24/24	19-21	2-7 12-15		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
21	9	24/22	21-23	6-10 13-13		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
23	10	24/20	23-25	4-10 15-22		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
25	11	24/16	25-27	11-19 21-25		Dense, light brown, fine to medium SAND, little Silt, wet.		1	
27	12	24/20	27-29	6-9 15-15		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
29	13	24/22	29-31	4-6 8-11		Medium dense, light brown, fine to medium			

REMARKS

1. Falling head test conducted at approximately 25.0 feet below ground suface. Five gallons of water was added to the augers during the test. Moisture content in the split spoon from approximately 25.0 to 27.0 feet below ground surface was due to water added during the test and is not groundwater.

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

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GeoEnvironmental, Inc.
Engineers and Scientists

Wolverine World Wide, LLC
Cap Design
Rockford, Michigan

Boring No.: HS-GT-1
Page: 2 **of** 2
File No.: 16.0062961.81
Check: J. Groenleer

Depth	Sample Information					Sample Description & Classification	Stratum Desc.	Remarks	Equipment Installed
	No.	Pen./ Rec. (in.)	Depth (Ft.)	Blows (/6")	Test Data				
31						SAND, little Silt, dry.	SAND		
32	14	24/21	31-33	5-7 7-8		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
33									
34	15	24/21	33-35	7-13 19-29		Dense, light brown, fine to medium SAND, little Silt, dry.			
35									
36	16	24/24	35-37	21-21 29-36		Very dense, light brown, fine to medium SAND, little Silt, dry.			
37							37'		
38						Bottom of Borehole at 37.0 Feet		2 3 4	
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60									
61									
62									
63									
64									

REMARKS

2. Groundwater was not encountered during drilling or upon completion.
3. Borehole was backfilled with bentonite chips upon completion.
4. Approximate ground surface elevation is based on digital raster files of bare Earth digital elevation models (DEMs), generated from LiDAR data with 1-meter horizontal accuracy and 18.5-centimeter vertical accuracy. Digital files of DEMs and LiDAR data were provided by Kent County.

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

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Wolverine World Wide, LLC
Cap Design
Rockford, Michigan

Boring No.: HS-GT-2
Page: 1 of 2
File No.: 16.0062961.81
Check: J. Groenleer

Contractor: Stearns Drilling Company
Foreman: J. Gryska
Logged by: C. Melby
Date Start/Finish: 3-2-22 / 3-2-22
Boring Location: 587,601 N; 12,788,642 E
GS Elev.: 784.0' **Datum:** NAD83/NAVD88

	Auger/ Casing	Sampler
Type:	Hollow Stem Auger	Split Spoon
O.D. / I.D.:	8.0" / 4.25"	2.0" / 1 3/8"
Hammer Wt.:	140lbs	NA
Hammer Fall:	30.0"	NA
TOC Elev.:	NA	NA

GROUNDWATER READINGS

Date	Time	Depth	Casing	Stab

Surveyed By: GZA (Trimble R1) **Survey Date:** 3/2/2022

Depth	Sample Information No.	Pen./ Rec. (in.)	Depth (Ft.)	Blows (/6")	Test Data	Sample Description & Classification	Stratum Desc.	Remarks	Equipment Installed
1	1	24/14	0-2	2-2 3-4		Medium stiff, brown, SILT & CLAY, some fine to medium Sand, moist.	SILT & CLAY		None
2	2	24/24	2-4	3-3 3-4		Medium stiff, brown, SILT & CLAY, some fine to medium SAnd, moist.			
4	3	24/12	4-6	3-6 8-9		Stiff, brown, CLAY & SILT, little fine to medium Sand, moist.	4' CLAY & SILT		
6	4	24/12	6-8	4-9 14-18		Very stiff, brown, Silty CLAY, trace fine to medium Sand embedded, dry.	6' Silty CLAY		
8	5	24/24	8-10	5-11 16-18		Very stiff, brown, Silty CLAY, trace fine Sand embedded, dry.			
14	6	24/16	14-16	2-2 4-5		Loose, light brown, fine to medium SAND, little Silt, dry.	14' SAND		
19	7	24/17	19-21	2-6 8-12		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
21	8	24/19	21-23	5-10 20-27		Dense, light brown, fine to medium SAND, little Silt, dry.			
23	9	24/18	23-25	9-18 23-27		Dense, light brown, fine to medium SAND, little Silt, dry.			
25	10	24/24	25-27	4-11 13-18		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
27	11	24/16	27-29	5-7 8-11		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
29	12	24/17	29-31	3-8 15-14		Medium dense, light brown, fine to medium			

REMARKS

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

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Rockford, Michigan

Boring No.: HS-GT-2
Page: 2 **of** 2
File No.: 16.0062961.81
Check: J. Groenleer

Depth	Sample Information					Sample Description & Classification	Stratum Desc.	Remarks	Equipment Installed
	No.	Pen./ Rec. (in.)	Depth (Ft.)	Blows (/6")	Test Data				
						SAND, little Silt, dry.	SAND		
31–32	13	24/18	31-33	3-5 9-11		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
33–34	14	24/13	33-35	6-10 12-13		Medium dense, light brown, fine to medium SAND, little Silt, wet.		1	
35–36	15	24/21	35-37	4-6 8-13		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
37–38	16	24/21	37-39	7-11 16-19		Medium dense, light brown, fine to medium SAND, trace Silt, dry.			
39–40	17	24/19	39-41	8-15 22-27		Dense, light brown, fine to medium SAND, little Silt, dry.			
41–42	18	24/18	41-43	10-19 26-25		Dense, light brown, fine to medium SAND, little Silt, dry.			
43–44	19	24/19	43-45	9-17 29-44		Dense, light brown, fine to medium SAND, little Silt, dry.			
45							45'		
45–64						Bottom of Borehole at 45.0 Feet		2 3 4	

REMARKS

1. Falling head test conducted at approximately 33.0 feet below ground surface. Five gallons of water was added to the augers during the test. Moisture content in the split spoon from approximately 33.0 to 35.0 feet below ground surface was due to water added during the test and was not groundwater.
2. Groundwater was not encountered during drilling or upon completion.
3. Borehole was backfilled with bentonite chips upon completion.
4. Approximate ground surface elevation is based on digital raster files of bare Earth digital elevation models (DEMs), generated from LiDAR data with 1-meter horizontal accuracy and 18.5-centimeter vertical accuracy. Digital files of DEMs and LiDAR data were provided by Kent County.

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

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Cap Design
Rockford, Michigan

Boring No.: HS-GT-3
Page: 1 of 2
File No.: 16.0062961.81
Check: J. Groenleer

Contractor: Stearns Drilling Company
Foreman: J. Gryska
Logged by: C. Melby
Date Start/Finish: 3-1-22 / 3-1-22
Boring Location: 588,140 N; 12,788,498 E
GS Elev.: 785.0' **Datum:** NAD83/NAVD88

	Auger/ Casing	Sampler
Type:	Hollow Stem Auger	Split Spoon
O.D. / I.D.:	8.0" / 4.25"	2.0" / 1 3/8"
Hammer Wt.:	140lbs	NA
Hammer Fall:	30.0"	NA
TOC Elev.:	NA	NA

GROUNDWATER READINGS

Date	Time	Depth	Casing	Stab

Surveyed By: GZA (Trimble R1) **Survey Date:** 3/1/2022

Depth	Sample Information No.	Pen./ Rec. (in.)	Depth (Ft.)	Blows (/6")	Test Data	Sample Description & Classification	Stratum Desc.	Remarks	Equipment Installed
1	1	24/24	0-2	2-2 4-6		Medium stiff, brown, CLAY & SILT, some fine to coarse Sand, moist.	CLAY & SILT		None
2	2	24/13	2-4	5-4 5-5		Stiff, brown, CLAY & SILT, little fine to medium Sand, moist.			
4	3	24/17	4-6	2-2 2-3		Soft, brown, Silty CLAY, little fine to medium Sand, moist.	4' Silty CLAY		
6	4	24/18	6-8	4-50 17-12		Hard, brown, Silty CLAY, little fine to medium Sand, moist. Changing at 6.6 feet to: Gray and brown, GRAVEL and fine to coarse Sand, dry (likely Cobble).	6.6' GRAVEL		
8	5	24/18	8-10	4-10 11-13		Medium dense, brown, fine to medium SAND, little Silt, dry with 2 inch Silty Clay seam at 9.5 feet.	8' SAND		
14	6	9/9	14-14.8	3-60/3"		Brown, Silty CLAY, trace fine to medium Sand, dry with 1.0" Gravel/Cobble (rock) at bottom.	14' Silty CLAY		
19	7	24/17	19-21	5-8 10-14		Medium dense, light brown, fine to medium SAND, little Silt, moist to dry.	19' SAND		
24	8	24/19	24-26	3-7 11-13		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
29	9	24/16	29-31	3-7 10-12		Medium dense, light brown, fine to medium			

REMARKS

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

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Engineers and Scientists

Wolverine World Wide, LLC
Cap Design
Rockford, Michigan

Boring No.: HS-GT-3
Page: 2 **of** 2
File No.: 16.0062961.81
Check: J. Groenleer

Depth	Sample Information					Sample Description & Classification	Stratum Desc.	Remarks	Equipment Installed
	No.	Pen./ Rec. (in.)	Depth (Ft.)	Blows (/6")	Test Data				
31						SAND, little Silt, dry.	SAND		
32									
33									
34	10	24/19	34-36	6-8 10-11		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
35									
36	11	24/17	36-38	10-9 12-16		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
37									
38							38'		
39						Bottom of Borehole at 38.0 Feet		1 2 3	
40									
41									
42									
43									
44									
45									
46									
47									
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54									
55									
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62									
63									
64									

REMARKS

1. Groundwater was not encountered during drilling or upon completion.
2. Borehole was backfilled with bentonite chips upon completion.
3. Approximate ground surface elevation is based on digital raster files of bare Earth digital elevation models (DEMs), generated from LiDAR data with 1-meter horizontal accuracy and 18.5-centimeter vertical accuracy. Digital files of DEMs and LiDAR data were provided by Kent County.

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

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Wolverine World Wide, LLC
Cap Design
Rockford, Michigan

Boring No.: HS-GT-4
Page: 1 **of** 2
File No.: 16.0062961.81
Check: J. Groenleer

Contractor: Stearns Drilling Company
Foreman: J. Gryska
Logged by: C. Melby
Date Start/Finish: 3-1-22 / 3-1-22
Boring Location: 588,494 N; 12,788,488 E
GS Elev.: 797.0' **Datum:** NAD83/NAVD88

	Auger/ Casing	Sampler
Type:	Hollow Stem Auger	Split Spoon
O.D. / I.D.:	8.0" / 4.25"	2.0" / 1 3/8"
Hammer Wt.:	140lbs	NA
Hammer Fall:	30.0"	NA
TOC Elev.:	NA	NA

GROUNDWATER READINGS

Date	Time	Depth	Casing	Stab

Surveyed By: GZA (Trimble R1) **Survey Date:** 3/1/2022

Depth	Sample Information: No.	Pen./ Rec. (in.)	Depth (Ft.)	Blows (/6")	Test Data	Sample Description & Classification	Stratum Desc.	Remarks	Equipment Installed
1	1	24/24	0-2	3-1 4-3		Medium stiff, brown, SILT & CLAY, some fine to medium Sand, moist.	SILT & CLAY		None
2	2	24/16	2-4	4-4 6-7		Stiff, brown, SILT & CLAY, some fine to medium Sand, moist.			
4	3	24/19	4-6	3-3 4-6		Stiff, brown, SILT & CLAY, some fine to medium Sand, moist.			
6	4	24/24	6-8	5-11 16-20		Very stiff, brown, CLAY & SILT, little fine to medium Sand, dry. Changing at 7.5 feet to: Brown and gray, fine to coarse SAND, trace Silt, dry.	6' CLAY & SILT 7.5'		
8	5	24/14	8-10	5-10 8-6		Medium dense, gray and brown, GRAVEL and fine to coarse Sand, little Silt, dry.	8' SAND GRAVEL		
14	6	24/14	14-16	2-3 3-4		Loose, brown and gray, fine to coarse SAND and Gravel, little Silt, dry.	14' SAND		
19	7	24/19	19-21	2-3 3-4		Loose, brown, fine to medium SAND, little Silt, dry to moist.			
24	8	24/17	24-26	7-11 13-12		Medium dense, light brown, fine to coarse SAND, little fine Sand, dry. Changing at 25.5 feet to: Medium dense, light brown, fine to coarse Silty SAND, dry.			
29	9	24/16	29-31	4-5 7-10		Medium dense, light brown, fine to medium			

REMARKS

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

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Wolverine World Wide, LLC
Cap Design
Rockford, Michigan

Boring No.: HS-GT-4
Page: 2 **of** 2
File No.: 16.0062961.81
Check: J. Groenleer

Depth	Sample Information					Sample Description & Classification	Stratum Desc.	Remarks	Equipment Installed
	No.	Pen./ Rec. (in.)	Depth (Ft.)	Blows (/6")	Test Data				
31						SAND, little Silt, dry.	SAND		
32									
33									
34	10	24/18	34-36	5-8 9-11		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
35									
36	11	24/17	36-38	6-3 3-5		Loose, light brown, fine to medium SAND, little Silt, dry. Changing at 36.8 feet to: Brown, SILT, little fine Sand, wet. Changing at 37.1 feet to: Loose, light brown, fine to medium SAND, little Silt, dry.	36.8' 37.1' SILT 38' SAND	1 2 3 4	
37									
38						Bottom of Borehole at 38.0 Feet			
39									
40									
41									
42									
43									
44									
45									
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REMARKS

1. Perched water encountered at approximately 36.8 feet below ground surface.
2. Groundwater was not encountered during drilling or upon completion.
3. Borehole was backfilled with bentonite chips upon completion.
4. Approximate ground surface elevation is based on digital raster files of bare Earth digital elevation models (DEMs), generated from LiDAR data with 1-meter horizontal accuracy and 18.5-centimeter vertical accuracy. Digital files of DEMs and LiDAR data were provided by Kent County.

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

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Engineers and Scientists

Wolverine World Wide, LLC
Cap Design
Rockford, Michigan

Boring No.: HS-GT-5
Page: 1 of 2
File No.: 16.0062961.81
Check: J. Groenleer

Contractor: Stearns Drilling Company
Foreman: J. Gryska
Logged by: C. Melby
Date Start/Finish: 2-28-22 / 2-28-22
Boring Location: 587,376 N; 12,787,878 E
GS Elev.: 780.0' **Datum:** NAD83/NAVD88

	Auger/ Casing	Sampler
Type:	Hollow Stem Auger	Split Spoon
O.D. / I.D.:	8.0" / 4.25"	2.0" / 1 3/8"
Hammer Wt.:	140lbs	NA
Hammer Fall:	30.0"	NA
TOC Elev.:	NA	NA

GROUNDWATER READINGS

Date	Time	Depth	Casing	Stab

Surveyed By: GZA (Trimble R1) **Survey Date:** 2/28/2022

Depth	Sample Information: No.	Pen./ Rec. (in.)	Depth (Ft.)	Blows (/6")	Test Data	Sample Description & Classification	Stratum Desc.	Remarks	Equipment Installed
1	1	24/22	0-2	2-4 5-5		Loose, brown, fine to medium SAND, little Silt, dry.	SAND		None
2	2	24/17	2-4	2-3 3-4		Loose, brown, fine to medium SAND, little Silt, dry.			
4	3	24/22	4-6	2-4 5-6		Loose, brown, fine to medium SAND, little Silt, dry.			
6	4	24/18	6-8	3-3 3-4		Loose, brown, fine to medium SAND, trace Silt, wet. Changing at 6.8 feet to: Brown and gray, Silty CLAY, moist.	6.8' Silty CLAY	1	
8	5	24/17	8-10	2-4 5-6		Stiff, brown and gray, Silty CLAY, moist. Changing at 8.8 feet to: Brown, fine to medium SAND, little Silt, dry.	8.8' SAND		
14	6	24/18	14-16	2-4 8-8		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
19	7	24/19	19-21	2-1 2-4		Very loose, light brown, fine to medium SAND, trace Silt, dry. Changing at 19.8 feet to: Brown, Silty CLAY, moist. Changing at 20.3 feet to: Very loose, light brown, fine to medium SAND, trace Silt, moist to dry.	19.8' 20.3' Silty CLAY SAND 22' Silty CLAY	2	
24	8	24/24	24-26	3-4 6-9		Stiff, gray, Silty CLAY, trace medium Sand embedded, moist to dry.			
28							28' SAND	3	
29	9	24/17	29-31	5-8 13-21		Medium dense, light brown, fine to medium			

REMARKS

1. Perched water encountered at approximtely 6.0 feet below ground surface.
2. Driller noticed change in auger speed (harder to advance) at 22.0 feet below ground surface. Likely a strata change.
3. Driller noticed change in auger speed (easier) at 28.0 feet below ground surface. Likely a strata change.

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

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Rockford, Michigan

Boring No.: HS-GT-5
Page: 2 **of** 2
File No.: 16.0062961.81
Check: J. Groenleer

Depth	Sample Information					Sample Description & Classification	Stratum Desc.	Remarks	Equipment Installed
	No.	Pen./ Rec. (in.)	Depth (Ft.)	Blows (/6")	Test Data				
31						SAND, little Silt, dry.	SAND		
32									
33									
34	10	24/24	34-36	6-11 19-20		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
35									
36									
37									
38									
39	11	24/24	39-41	5-9 11-21		Medium dense, light brown, fine to medium SAND, little Silt, dry.			
40									
41	12	24/24	41-43	17-23 23-23		Dense, light brown, fine to medium SAND, little Silt, dry.			
42									
43						Bottom of Borehole at 43.0 Feet	43'	4 5 6	
44									
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REMARKS

4. Groundwater was not encountered during drilling or upon completion.
5. Borehole was backfilled with bentonite chips upon completion.
6. Approximate ground surface elevation is based on digital raster files of bare Earth digital elevation models (DEMs), generated from LiDAR data with 1-meter horizontal accuracy and 18.5-centimeter vertical accuracy. Digital files of DEMs and LiDAR data were provided by Kent County.

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

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Wolverine World Wide, LLC
Cap Design
Rockford, Michigan

Boring No.: HS-GT-6
Page: 1 of 2
File No.: 16.0062961.81
Check: J. Groenleer

Contractor: Stearns Drilling Company
Foreman: J. Gryska
Logged by: C. Melby
Date Start/Finish: 2-28-22 / 2-28-22
Boring Location: 588,460 N; 12,787,895 E
GS Elev.: 797.0' **Datum:** NAD83/NAVD88

	Auger/ Casing	Sampler
Type:	Hollow Stem Auger	Split Spoon
O.D. / I.D.:	8.0" / 4.25"	2.0" / 1 3/8"
Hammer Wt.:	140lbs	NA
Hammer Fall:	30.0"	NA
TOC Elev.:	NA	NA

GROUNDWATER READINGS

Date	Time	Depth	Casing	Stab

Surveyed By: GZA (Trimble R1) **Survey Date:** 3/1/2022

Depth	Sample Information No.	Pen./ Rec. (in.)	Depth (Ft.)	Blows (/6")	Test Data	Sample Description & Classification	Stratum Desc.	Remarks	Equipment Installed
1	1	24/24	0-2	2-3 4-4		Medium stiff, brown, SILT & CLAY, little fine to medium Sand embedded, dry.	SILT & CLAY		None
2	2	24/20	2-4	3-4 4-6		Medium stiff to stiff, brown, CLAY & SILT, little fine to medium Sand embedded, dry.	2' CLAY & SILT		
4	3	24/24	4-6	2-2 2-3		Soft to medium stiff, brown, CLAY & SILT, trace fine to medium Sand embedded, moist.			
6	4	24/24	6-8	1-3 3-6		Medium stiff, brown, Silty CLAY, trace fine to medium Sand embedded, moist.	6' Silty CLAY		
8	5	24/24	8-10	2-4 8-8		Medium stiff, brown, Silty CLAY, trace fine to medium Sand embedded, moist.			
14	6	24/24	14-16	3-16 24-26		Hard, brown, Silty CLAY, some fine to coarse Sand embedded, moist. Changing at 15.2 feet to: Dense, gray and brown, GRAVEL and fine to coarse Sand, moist.			
19	7	24/24	19-21	3-8 9-8		Medium dense, brown, fine to coarse SAND, trace Silt, wet. Changing at 19.2 feet to: Stiff, brown, Silty CLAY, trace fine to medium Sand embedded, moist. Changing at 20.1 feet to: Medium dense, brown, fine to medium SAND, little Silt, wet. Changing at 20.8 feet to: Stiff, brown, Silty CLAY, moist.	19' 19.2' SAND 20.1' Silty CLAY 20.8' SAND Silty CLAY	1	
24	8	24/24	24-26	3-8 12-14		Very stiff, brown, Silty CLAY, moist. Changing at 25.2 feet to: Medium dense, light brown, fine to medium SAND, little Silt, dry.	25.2' SAND		
29	9	24/16	29-31	8-9 16-21		Medium dense, brown, fine to medium			

REMARKS

1. Perched water encountered at approximately 19.0 feet below ground surface.

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

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Cap Design
Rockford, Michigan

Boring No.: HS-GT-6
Page: 2 **of** 2
File No.: 16.0062961.81
Check: J. Groenleer

Depth	Sample Information					Sample Description & Classification	Stratum Desc.	Remarks	Equipment Installed
	No.	Pen./ Rec. (in.)	Depth (Ft.)	Blows (/6")	Test Data				
31						SAND, little Silt, dry.	SAND		
32									
33									
34	10	24/18	34-36	5-12 18-22		Medium dense to dense, brown, fine to medium SAND, little Silt, dry.			
35									
36	11	24/16	36-38	26-17 14-12		Dense, brown, fine to coarse SAND, little Silt, dry.			
37									
38							38'		
38						Bottom of Borehole at 38.0 Feet		2 3 4	
39									
40									
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42									
43									
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REMARKS

2. Groundwater was not encountered during drilling or upon completion.
3. Borehole was backfilled with bentonite chips upon completion.
4. Approximate ground surface elevation is based on digital raster files of bare Earth digital elevation models (DEMs), generated from LiDAR data with 1-meter horizontal accuracy and 18.5-centimeter vertical accuracy. Digital files of DEMs and LiDAR data were provided by Kent County.

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

APPENDIX D

MONITORING PLAN

Rose & Westra
A Division of GZA

GEOTECHNICAL
ENVIRONMENTAL
ECOLOGICAL
WATER
CONSTRUCTION MANAGEMENT

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HOUSE STREET FINAL REMEDY MONITORING PLAN

1855 HOUSE STREET NE
Plainfield Township, Kent County, Michigan

April 26, 2022
File No. 16.0062961.81

PREPARED FOR:
Wolverine World Wide, Inc.
Rockford, Michigan

Rose & Westra, a Division of GZA GeoEnvironmental, Inc.
601 Fifth Street NW | Suite 102 | Grand Rapids, MI 49504
616-956-6123

30 Offices Nationwide
www.GZA.com

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FIGURES

ACRONYMS

CD	Consent Decree, effective February 19, 2020 (No. 1:18-cv-0039-JTN-ESC)
EGLE	Michigan Department of Environment, Great Lakes and Energy
HSP	House Street Property, also referred to as
PIC	Principal-in-Charge
PM	Project Manager
PFAS Compounds	Poly- and Perfluorinated Alkyl Substances as defined in Appendix G of the CD
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
R&W/GZA	Rose & Westra, a Division of GZA GeoEnvironmental, Inc.
SOPs	Standard Operating Procedures
Wolverine	Wolverine World Wide, Inc.

1.0 INTRODUCTION

This monitoring plan has been prepared for monitoring to follow the House Street Property (HSP) Cap Final Remedy construction. The plan presents the proposed Monitoring Program, which has been developed and will be implemented under the most recent revision of the existing *Quality Assurance Project Plan (QAPP) for the Former Wolverine Tannery, House Street Property, and Wolven/Jewell Area, Per- and Polyfluoroalkyl Substances Investigation Program* (R&W/GZA, 2021 as amended).

2.0 MONITORING PROGRAM ORGANIZATION

The Monitoring Program organization will follow the organizational chart provided in the QAPP. In general, field activities are overseen by a Field Team Lead who is experienced in the proposed monitoring activities. Field personnel work under the direction of the Field Team Lead as appropriate. The field team is overseen by the Project Manager (PM), Principal-in-Charge (PIC), and Quality Assurance Officer (QAO). Refer to the QAPP for additional details on project organization.

The selected analytical laboratory for poly- and perfluorinated alkyl substances (PFAS) samples is specified in the QAPP. The QAO is responsible for verifying the laboratory performs analyses in accordance with the QAPP and documenting any material deviations. Per the QAPP, a percentage of laboratory data are validated by an independent third party.

3.0 PROPOSED MONITORING APPROACH

The following summarizes the components of the post-construction Monitoring for the HSP Final Remedy:

- Piezometer installation in historical perched water areas;
- Piezometer water level measurements to be completed quarterly for two years following construction completion;
- Baseline groundwater sampling from nine existing monitoring well clusters (installed as part of other investigations related to the HSP to be completed within six months of construction completion;
- One follow-up groundwater sampling event from the nine existing monitoring well clusters sampled during the baseline event to be completed one year following the baseline event; and,
- Data evaluation and consultation with the Michigan Department of Environment, Great Lakes, and Energy (EGLE) to develop a long-term monitoring plan.

These components are detailed in the following subsections.

3.1 PIEZOMETER INSTALLATION AND WATER LEVEL MEASUREMENTS

Piezometers are proposed in capped areas where perched water was observed (refer to Figure 11M of the *Implementation of the 2018 Work Plan Summary Report*, dated May 21, 2019 (R&W/GZA 2019). Up to six piezometers will be installed in conjunction with the landfill gas venting system and in accordance with the design

plans (refer to **Figure 1** for approximate locations). The bottom elevation of the piezometers will be situated at the approximate elevation of the base of the temporary monitoring well screens installed in 2018-2019 (See **Table 1**).

Following installation, the location and elevation of the piezometers will be surveyed by a Michigan-licensed surveyor. GZA will complete two years of quarterly water level measurements from the piezometers and transmit the tabulated data to EGLE as part of quarterly reporting under the Consent Decree (CD). Each year one of the quarterly measurements will be completed in conjunction with the groundwater sampling (refer to **Sections 3.2** and **3.3**). The purpose of the piezometer installation and water level measurements is to evaluate the effect the cap has on the perched water thickness within the waste material.

3.2 BASELINE GROUNDWATER SAMPLING

Within six months of Final Remedy construction completion, groundwater samples will be collected from nine monitoring well clusters (refer to **Figure 2**) and analyzed for PFAS Compounds. Samples will be collected using standard low-flow sampling methodology in accordance with Standard Operating Procedures (SOPs) in the EGLE-approved QAPP. GZA will transmit the tabulated data to EGLE as part of existing data transmittal and reporting mechanisms under the CD.

3.3 FOLLOW-UP GROUNDWATER SAMPLING

An additional set of groundwater samples will be collected one year following the baseline groundwater sampling event. The samples will be collected from the baseline groundwater sampling wells and will be analyzed for PFAS Compounds in accordance with the QAPP. GZA will transmit the tabulated data to EGLE as part of existing data transmittal and reporting mechanisms under the CD.

3.4 DATA EVALUATION

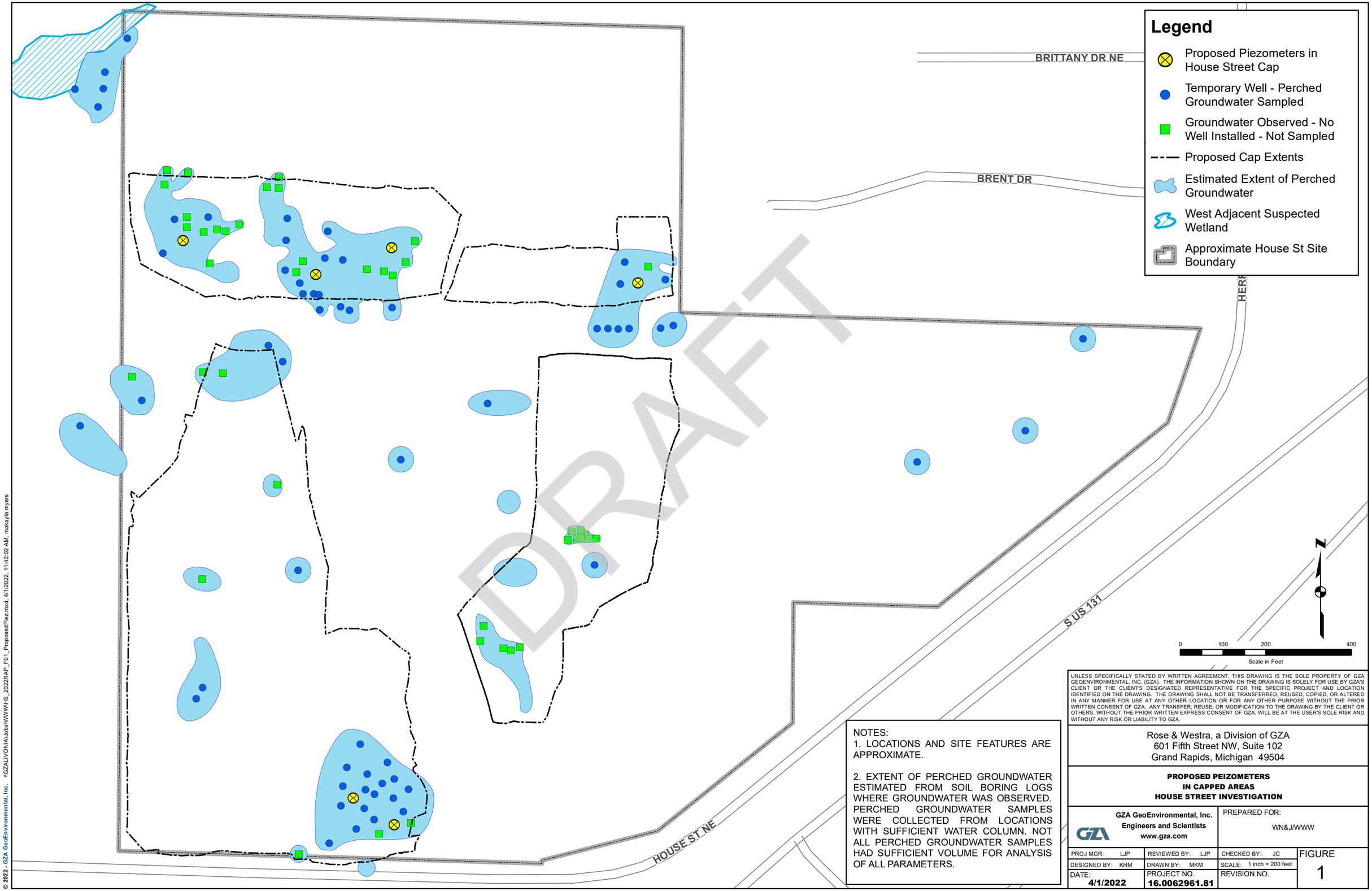
Following completion of the eight quarters of water level measurements and two groundwater sampling events, GZA will compile the post-construction monitoring data into a summary memorandum and recommend a long-term monitoring plan for the Final Remedy.

TABLE

TABLE 1
PROPOSED PIEZOMETERS
HSP FINAL REMEDY

Proposed Piezometer	Piezometer Location	Corresponding Temporary Wells	Temp Well Bottom Elevation	Proposed Piezometer Screen Length	Proposed Piezometer Bottom Elevation
HS-PZ-01	NW Cap Area	HS-SB-T2-030	772	5	772
HS-PZ-02	N Central Cap Area	HS-SB-T6-024	776	5	776
HS-PZ-03	NE Cap Area	HS-SB-T6-038	776	5	776
HS-PZ-04	NE Cap Area	HS-SB-T6-104	769	5	769
HS-PZ-05	SW Cap Area	HS-SB-937	730	5	730
HS-PZ-06	SW Cap Area	HS-SB-949	731	5	731

FIGURES



NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

2. EXTENT OF PERCHED GROUNDWATER ESTIMATED FROM SOIL BORING LOGS WHERE GROUNDWATER WAS OBSERVED. PERCHED GROUNDWATER SAMPLES WERE COLLECTED FROM LOCATIONS WITH SUFFICIENT WATER COLUMN. NOT ALL PERCHED GROUNDWATER SAMPLES HAD SUFFICIENT VOLUME FOR ANALYSIS OF ALL PARAMETERS.

Rose & Westra, a Division of GZA
601 Fifth Street NW, Suite 102
Grand Rapids, Michigan 49504

PROPOSED PEIZOMETERS
IN CAPPED AREAS
HOUSE STREET INVESTIGATION

GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR: WN&J/WWW

PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE 1
DESIGNED BY: KHM	DRAWN BY: MKM	SCALE: 1 inch = 200 feet	
DATE: **4/1/2022**	PROJECT NO. **16.0062961.81**	REVISION NO.	

LEGEND

- PROPOSED CAP MONITORING LOCATION - MONITORING WELL CLUSTER PREVIOUSLY INSTALLED
- PROPOSED CAP MONITORING LOCATION - MONITORING WELL CLUSTER PROPOSED
- HIGHWAY
- PRIMARY COUNTY ROAD
- OTHER ROAD
- RIVER OR STREAM
- SURFACE WATER
- APPROXIMATE HOUSE ST. DISPOSAL SITE BOUNDARY
- NORTH KENT STUDY AREA OUTLINE

APPROXIMATE PFOS + PFOA EXTENT (ppt)

- < 4 ng/L
- 4 - 10 ng/L (CD VALUE)
- 11 - 70 ng/L
- 71 - 1,000 ng/L
- 1,001 - 111,000 ng/L (MAX)

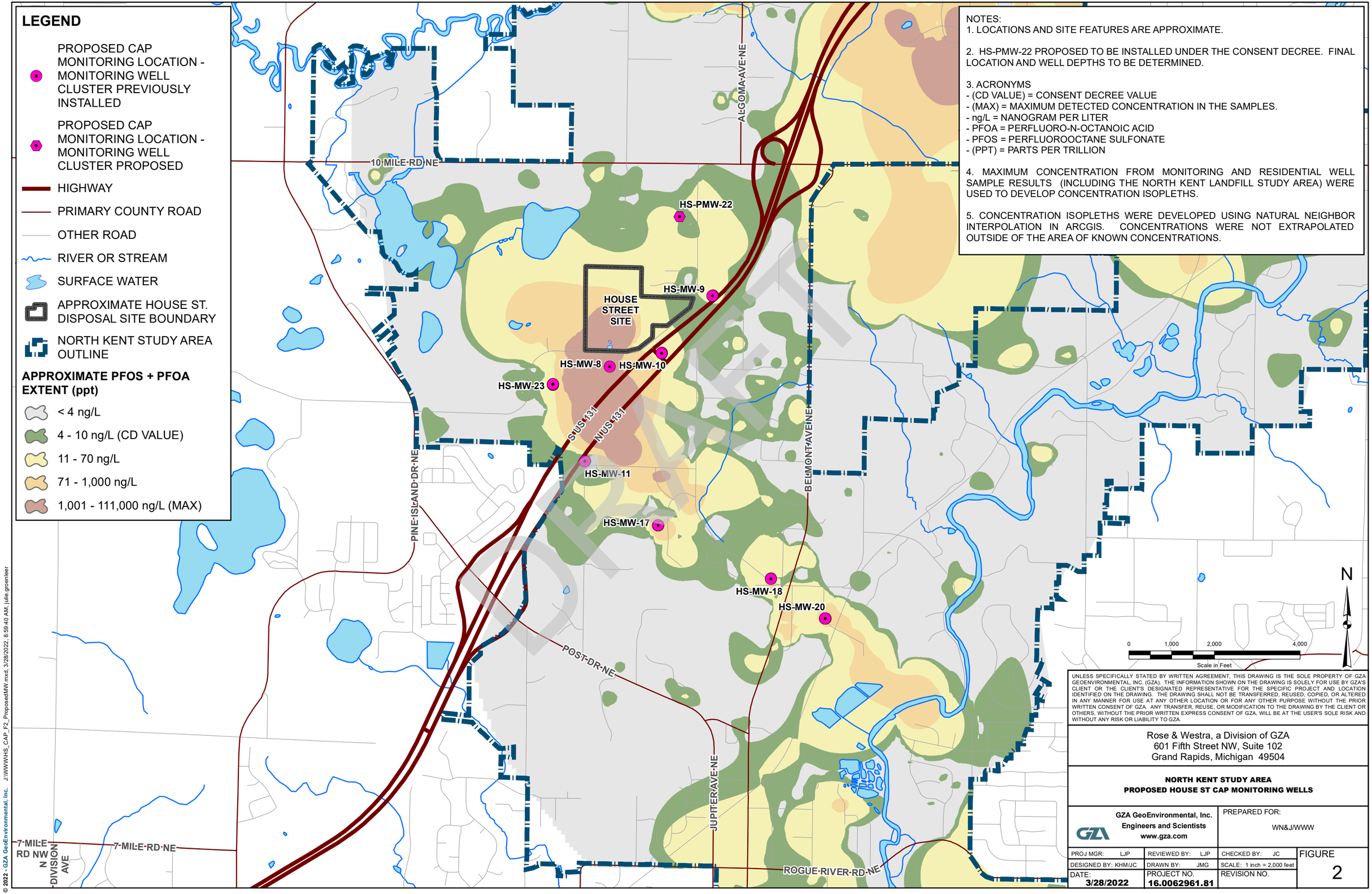
NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

2. HS-PMW-22 PROPOSED TO BE INSTALLED UNDER THE CONSENT DECREE. FINAL LOCATION AND WELL DEPTHS TO BE DETERMINED.

3. ACRONYMS
- (CD VALUE) = CONSENT DECREE VALUE
- (MAX) = MAXIMUM DETECTED CONCENTRATION IN THE SAMPLES.
- ng/L = NANOGRAM PER LITER
- PFOA = PERFLUORO-N-OCTANOIC ACID
- PFOS = PERFLUOROOCTANE SULFONATE
- (PPT) = PARTS PER TRILLION

4. MAXIMUM CONCENTRATION FROM MONITORING AND RESIDENTIAL WELL SAMPLE RESULTS (INCLUDING THE NORTH KENT LANDFILL STUDY AREA) WERE USED TO DEVELOP CONCENTRATION ISOPLETHS.

5. CONCENTRATION ISOPLETHS WERE DEVELOPED USING NATURAL NEIGHBOR INTERPOLATION IN ARCGIS. CONCENTRATIONS WERE NOT EXTRAPOLATED OUTSIDE OF THE AREA OF KNOWN CONCENTRATIONS.



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NORTH KENT STUDY AREA
PROPOSED HOUSE ST CAP MONITORING WELLS

GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR: WN&J/WWW

PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE 2
DESIGNED BY: KHM/JC	DRAWN BY: JMG	SCALE: 1 inch = 2,000 feet	
DATE: 3/28/2022	PROJECT NO. 16.0062961.81	REVISION NO.	

J:\WWW\HS_CAP_F2_ProposedMW.mxd, 3/28/2022, 8:59:40 AM, julie.groenleer