

June 11, 2024

## GEOTECHNICAL MEMORANDUM

RE: Tecumseh Dam Spillway Improvements Lenawee County, Michigan Project No: 129021SG2020

This memorandum summarizes Spicer Group's geotechnical investigation for the proposed spillway improvement project.

## **Project Overview:**

This project will involve removal and reconstruction of the current auxiliary spillway. The existing auxiliary spillway is located at the northeast end of the dam. It is approximately 40 feet wide at the upstream end and 25 feet wide at the downstream end. It is comprised of a concrete slab with 3- to 10-foot-high sidewall. Sidewalls are constructed of concrete and steel sheet piling. The top of the spillway slab is at about elevation 767 or 768. The dam impounds the Red Mill Pond.

The new spillway is conceived to be about 140 feet long by about 40 feet wide with an 18-inch thick concrete slab and concrete sidewalls up to about 11 feet tall.

### **Subsurface Investigation:**

Subsurface conditions at the site were explored on April 4 and 6 and May 1, 2023 by drilling two rigdrilled borings and two hand auger borings near the spillway. Borings B1 through B3 were drilled by McDowell & Associates under subcontract to Spicer Group. B4 was drilled by Spicer Group.

Rig-drilled borings were dilled using hollow stem auger methods, with samples obtained at 2.5- to 5-foot intervals in accordance with the standard penetration test, in which a 2-inch O.D. split barrel sampler is driven three 6-inch increments by a 140-lb hammer falling 30 inches.

Hand auger borings were drilled by 2.75-inch diameter hand auger equipment in locations not accessible to a drill rig. In select locations, relative density and consistency were determined using a Sowers-type dynamic cone penetrometer, in which a 1.5-inch diameter cone is driven three successive 1.75-inch increments using a 15-lb hammer freely falling 20 inches.

During drilling, soils were visually/manually classified in accordance with the Unified Soil Classification System per ASTM D2487 and D248. Boring logs, are attached, along with boring location maps.

Laboratory testing, including moisture content, calibrated penetrometer, and grain-size analyses, were performed on selected soil samples. The results are attached and used to correlate with engineering properties and filtration requirements.

The ground surface elevation at the boring locations was estimated by plotting their locations on the topographic survey. The approximate elevations are shown below:

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Boring	B-1	B-2	B-3	B-4
Elevation	773	776	779	771

## **Conclusions & Recommendations:**

In general, the observed subsurface conditions should not impose any significant impediment to the proposed project. The soils at the site will tend to have moderate strength and moderate compressibility. Permeability, moisture sensitivity, and frost susceptibility will be variable, depending on fines content. Grain-size analysis results indicate that the some of the materials immediately below the bottom of the slab (the sand and gravel layer) are broadly graded, and may tend to be more susceptible to internal erosion.

Soil	Unit Weight			Undrained Shear Strength
	lb/ft <sup>3</sup>	degrees	lb/ft <sup>2</sup>	lb/ft <sup>2</sup>
Existing Fill	120	32	0	0
Sand & Gravel	120	33	0	0
Fine Sand	120	34	0	0
Silty Clay	125	32	400	4000

The soils observed in the borings can be categorized into four general units. The units and their appropriate geotechnical design properties are listed below:

## **Retaining Walls & Foundations**

Spillway walls will support lateral pressures from the soil and groundwater retained behind them. Earth pressure coefficients can be calculated from the parameters provided above. An underdrain system should be considered to prevent excess unbalanced hydrostatic forces.

We expect foundations for cast-in-place concrete spillway walls will bear in the fine sand unit. This material should provide suitable support with a recommended allowable bearing pressure of 2,000 lb/ft<sup>2</sup> (factor of safety of about 3). Under this loading, total settlement can be expected to be less than about 1/4 inch and differential settlements will be about half of the total.

If sheet piling is used to construct spillway walls, or used as temporary cofferdams during construction, the soil properties given in the table above can be used in their design. The cobbley soil units observed in the borings might make driving sheet piles more difficult; however, we do not expect to be an excessive hindrance (there is existing sheet piling at the site and the borings were able to be advanced and sampled through these soils).

## **Spillway Slab**

We expect a new concrete slab will form the spillway bottom. We expect the subgrade to consist predominantly of medium dense fine sand; however, portions of the subgrade might include the existing fill unit or the sand and gravel material. Care should be taken if the subgrade material is existing fill, as undocumented fill can be highly variable and with unknown placement. The fill and sand and gravel soils observed in the borings at that elevation, however, appear to be capable of providing good support. We suggest placing the slab on a base of open-graded coarse crushed aggregate, such as MDOT 29A to provide uniform support and dissipation of excess hydrostatic pressure. A filter-compatible subbase

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should be used under the aggregate, such as MDOT 2NS. A perforated underdrain (without geotextile sock) should be placed within the aggregate course and be extended to a positive outlet.

## Earthwork

The on-site soils should be able to be readily excavated using conventional equipment. The on-site soils are variable and have a significant amount of clay and silt, so may prove challenging to adequately compact. Therefore, imported fill should be considered, especially for areas supporting structures or slabs. Imported fill should generally meet the requirements of MDOT Class III granular material.

Prior to placing new fill or concrete, the subgrade should be inspected for topsoil, highly organic soils, debris/rubbish, or excessively soft or loose soils. Where encountered, the unsuitable material should be excavated and replaced with compacted granular soil (such are MDOT Class II or III, or 2NS).

All fill should be conditioned to near its optimum moisture content, placed in thin lifts (generally less than about 8 inches thick, depending on the compaction equipment) and compacted to at least 95% of its maximum dry density, as determined by ASTM D1557 or the MDOT one-point cone method.

Temporary excavations should be appropriately sloped or shored, as determined by the contractor's competent person. Site soils can generally be classified as Type C soils, with maximum temporary slopes of 1.5H:1V.

To prevent internal erosion/piping of soils adjacent to the new spillway walls and/or slab, filtration characteristics of the fill should be considered. The procedure discussed in the NRCS *National Engineering Handbook* Part 633, Chapter 26 is appropriate. Based on the laboratory grain-size analyses performed, the coarser material observed in sample B1D would be adequately filtered by MDOT 6A aggregate. The other samples that were tested would be filtered by MDOT 2NS or ASTM C33 sand. MDOT 29A generally meets filter criteria for 2NS sand. For less critical applications, filtration can be accomplished with a needle-punched nonwoven geotextile meeting MDOT's specification for Geotextile Blanket, with an AOS less than 0.35 mm.

## SOILS INVESTIGATION TECUMSEH SPILLWAY TECUMSEH, MICHIGAN

SPICER GROUP, INC. 331 BAY STREET PETOSKEY, MICHIGAN 49770

APRIL 10, 2023 BY McDOWELL & ASSOCIATES

## **McDowell & Associates**

Geotechnical, Environmental & Hydrogeological Services • Materials Testing & Inspection 21355 Hatcher Avenue • Ferndale, MI 48220 Phone: (248) 399-2066 • Fax: (248) 399-2157 www.mcdowasc.com

April 10, 2023

Spicer Group, Inc. 331 Bay Street Petoskey, Michigan 49770

Job No. 23-111

Attention: Mr. Nils W. Lindwall

Subject: Soils Investigation Tecumseh Spillway Tecumseh, Michigan

Dear Mr. Lindwall:

We welcome this opportunity to offer our services for your project.

In accordance with your request, we performed three (3) borings at the subject project. The borings were drilled at the locations you required and are shown approximately on the attached Soil Boring Location Plan.

Detailed soil descriptions and stratifications for each completed boring are shown on the attached boring logs.

If you have any questions or if we can be further service, please do not hesitate to call.

Very truly yours,

McDOWELL & ASSOCIATES

An forme Re

Tony (Antoine) Merheb, M.S., P.E. Senior Geotechnical Engineer

TM/

#### LOG OF SOIL BORING NO. 1

Soils Investigation PROJECT

Str.

%

		Phor	ne: (248)	399-2066 • Fax: (248) 399-2157	PROJEC1	-	ils Investig	-		
			NO	23-111	LOCATIC	<u>Te</u>	cumseh D	am Spillwa	ay	
					200/110	Ev	ans and M	laumee St	reets	
		SUR	FACEE	LEV DATE _4/6/2023			cumseh, M			_
Sample & Type	Depth	Legend		SOIL DESCRIPTION	Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	
				Moist dark brown sandy TOPSOIL with trace of						
	1		1'0"	gravel, fill						_
A	2	-		Very compact moist brown clayey SAND with	7					+
SS	-			gravel and trace of brick, fill	12	8.6				+
	3				7					
	4		3'6"	Compact moist dark brown to black SAND & GRAVEL with brick, stones and asphalt, fill						_
			4'6"							_
B SS	5	<i>\////</i>		Very stiff moist brown silty CLAY with sand and trace of pebbles, fill	4	14.4				+
	6	ЩЩ	5'8"		11			*	(3000)	-
		KXXX								
	7	BIII		COBBLES and stones, possible fill						$\rightarrow$
C SS	8	83333	7'7"							+
33	0	100								+
	9	-								1
		6								$\square$
D SS	10	1300		Medium compact wet brown fine to coarse SAND &	3	10.1				_
33	11			GRAVEL with trace of silt	4	10.1				+
		0.5								+
	12	No. Sala								
										_
	13	20.0								+
	14	2.00								+
			11'6"	Very stiff moist blue silty CLAY with sand and						
E	15			pebbles and occasional stones	2					_
SS	16				7	11.7				+
	10	-		Very compact wet brown to gray fine SAND with occasional stone and pebbles and discolored	10					+
	17			streaks						-
			17'6"							
	18									_
	19									+
	1.5									+
F	20				7					
SS	0.1			Extremely compact wet brown fine SAND with trace of silt	14 21	22.6				$\downarrow$
┝──┦	21				21					+
$\vdash$	22									+
$\mid$	23									$\downarrow$
$\vdash$	24		23'8"							+
G	24			Compact wet gray fine SAND with trace of gravel	4					+
SS	25	/////	24'6"	Very stiff moist blue silty CLAY with traces of sand	9					
				and pebbles	12					
	PE OF SAMPLE - DISTURB		REMAR	KS: *Calibrated penetrometer		GF	ROUND WAT	ER OBSERV	ATIONS	
U.L	- UNDIST.	LINER				NCOUNTE NCOUNTE		7 F		NS. NS.
S.S	- SPLIT SP	OON		Standard Departmention Test Driving 9" OD Servel 41 Milli		FTER CON			T. 6 <sup>II</sup>	NS.
	- PENETR			Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30": Count Made at 6" Intervals		OLUMES	пк <b>э</b> .	⊦ Heavy		NS.



LOG OF SOIL BORING NO. <u>1 (continued)</u>

PROJECT Soils Investigation

LOCATION

Tecumseh Dam Spillway

Evans and Maumee Streets

JOB NO.	23-111

		SUR	FACE ELE	DATE <u>4/6/2023</u>	Tecumseh, Michigan					
Sample		1			Penetration	Moisture	Natural	Dry Den	Unc. Comp.	Str.
& Type	Depth 26	Legend		SOIL DESCRIPTION	Blows for 6"	%	Wt. P.C.F.	Wt. P.C.F.	Strength PSF.	%
	20			Very stiff moist blue silty CLAY with traces of						
	27			sand and pebbles						
	28		28'2"							
		<u> </u>		COBBLE						
	29	))))))	28'11"							
H SS	30				<u>34</u> 60					
33	30									
	31									
				Extremely stiff moist blue silty CLAY HARDPAN with sand and pebbles						
	32			with build and peoples						
	33									
$\vdash$	24									
	34				05					
I SS	35		35'0"		<u>25</u> 40					
			33.0							
	36									
	37									
$\vdash$		-		Note: Used track rig.						
	38	-								
$\vdash$	39	.								
	- 55									
	40									
	41	]								
	42	-								
	40	-								
	43	-								
	44	-								
	45	]								
	46	.								
$\vdash$	47	-								
	47									
	48	1								
		]								
	49									
<b> </b>	50	-								
			DEMADIZO							
D. U.L. S.T. S.S. R.C.	E OF SAMPLE - DISTURB - UNDIST. - SHELBY - SPLIT SP - ROCK CO - PENETR	BED LINER TUBE POON DRE	REMARKS:	: Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. I G.W. /	GR ENCOUNTEF ENCOUNTEF AFTER COM AFTER	RED AT RED AT	ER OBSERV 7 FT. 15 FT. 5 FT. 5 FT.	ATIONS 7 INS. 2 INS. 6 INS. INS.	
				140# Hammer Falling 30": Count Made at 6" Intervals		VOLUMES	1110.	Heavy	1110.	



#### LOG OF SOIL BORING NO. 2

PROJECT Soils Investigation

V		Phon	ie: (248)	399-2066 • Fax: (248) 399-2157		PROJEC	•	is investig	-		
				22 111		LOCATI		<u>cumseh D</u>	am Spillw	ay	
		JOB	NU	23-111	-	LUCAN	<u>Eva</u>	ans and M	laumee St	treets	
		SUR	FACE E	LEV DATE _4/4/20	23		Teo	cumseh, N	Michigan		
Sample	Depth	Legend		SOIL DESCRIPTION		Penetration	Moisture	Natural	Dry Den	Unc. Comp.	Str.
& Type	Depui	Legenu				Blows for 6"	%	Wt. P.C.F.	Wt. P.C.F.	Strength PSF.	%
	1			Moist dark brown clayey TOPSOIL, fill							
		/////	1'1"	Stiff moist brown sandy CLAY with pebbles,							
A	2		2'0"	stones and concrete, fill		4					
SS			20			4	10.6				
	3			Medium compact moist brown fine to mediur		3					
				SAND with traces of clay, gravel and concre	ie						
	4			and topsoil seams, fill		-					
B SS	5	/////	4'6"			4	14.1				
00	0			Stiff moist brown gravelly CLAY with trace of		5	17.1				
	6			concrete, fill							
		<u>KKKK</u>	6'2"								
С	7	BIII		COBBLES and stones, possible fill		8					
SS		8888	7'6"			8 9					
	8	00		Compact moist brown SAND & GRAVEL wit	h	9					
	9			stones, possible fill	1						
D	9	0.10				6					
SS	10		9'6"	Stiff moist blue sandy CLAY with sand and pebbles, possible fill		6	16.9				
			10'0"	pebbles, possible illi		3					
	11										
				Compact wet gray clayey gravelly SAND							
	12										
	10										
	13		13'0"								
	14	-									
E	14					2					
SS	15					5	23.1				
						7					
	16										
				Compact wet brown fine SAND with trace of	silt						
	17										
	10										
	18										
	19										
	10					2					
F	20		19'6"			3					
SS			20'6"	Compact wet gray fine SAND		6					
	21		200								
	<u> </u>										
$\vdash$	22	-		Note: Used track rig.							
	23	1									
	20										
	24										
		1									
	25										
	TYPE OF SAMPLE REMARKS: D DISTURBED						GF	ROUND WAT	ER OBSERV	ATIONS	
U.L.	- UNDIST.	LINER					ENCOUNTEI		9 F		
S.S.	- SHELBY	OON					ENCOUNTEI		F 8 F	T. INS. T. 0 INS.	
	<ul> <li>ROCK CO</li> <li>PENETR</li> </ul>			Standard Penetration Test - Driving 2" OD Sampler 1' Wit 140# Hammer Falling 30": Count Made at 6" Intervals	h	G.W. A	AFTER /OLUMES	HRS.	F	T. INS.	
()				THOR TRAINING TAILING OU . COUNT MADE ALO INTERVAIS		G.W. V	OLOIVIES		Heavy	1	

#### LOG OF SOIL BORING NO. 3

Soils Investigation PROJECT

Tecumseh Dam Spillway

611	DE	ACE	ELL	EV/
30	КΓ	ACE		EV.

NO.		23-111		LOCATI		Tecumsen Dam Spilway						
					Eva	ans and N	laumee St	reets				
ACE E	LEV.	DA	TE 4/4/2023	Tecumseh, Michigan								
		SOIL DESCRIPTION		Penetration Blows for 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %			
0'11"		dark brown sandy TOPSOIL of vegetation and occasiona						-				
0'0"	Moist stone	brown clayey fine SAND wit	h gravel and									
2'2"	Moist	brown clayey fine SAND wit	h silt, gravel,									
3'0"	cobbl	es and topsoil streaks, fill										
	Note	<u>es</u> :										
	(1)	Boring advanced by hand d	Irilling methods.									
	(2)	Four attempts to drill deepe										
		too much stones to advance attempt refusal at 2'4". Sec										
		refusal at 2'8". Third attemp Fourth attempt refusal at 2'										
		Fourth altempt relusar at 20	0.									

3         Second start				22	Moist	brown clayey fine SAND with s	ilt, gravel,					ļ	
4         5           6         7           8         9           10         10           11         11           12         13           14         15           16         17           18         19           10         10           11         12           13         14           14         15           16         17           18         19           12         13           14         16           17         18           19         10           11         12           12         13           14         16           17         18           19         10           11         12           12         13           14         16           17         18           19         20           21         22           22         21           22         22           23         24           25         PMORE           Notex Used track rig		3		3'0"	cobbl	es and topsoil streaks, fill							
Note:         Notes:           0 <td0< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td><u> </u></td><td></td></td0<>												<u> </u>	
Image: standard predmath register         Image: standard predmath register<		4											
Image: standard predmath register         Image: standard predmath register<					Nati								
6         0		5			NOte	<u>es</u> :						l	
6         0					(1)	Paring advanced by band drilli	na mothodo						
7         Remote order of advance boring. First attempt refusal at 26'.           9		6			(1)	Bonng advanced by nand drill	ng methods.					Í	
7         refusal at 28". Third attempt refusal at 3'.           9         -           10         -           11         -           12         -           13         -           16         -           17         -           18         -           11         -           122         -           133         -           14         -           13         -           14         -           122         -           13         -           14         -           15         -           16         -           17         -           18         -           19         -           20         -           21         -           22         -           23         -           24         -           25         -           10         -           122         -           23         -           24         -           25         -           24 <td></td> <td></td> <td></td> <td></td> <td>(2)</td> <td>Four attempts to drill deeper th</td> <td>an 3' hut</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>					(2)	Four attempts to drill deeper th	an 3' hut						
B         Image: Constraint of the second attempt refusal at 24°. The full set at 26°.         Image: Constraint of the second attempt refusal at 26°.         Image: Const		7			(2)	too much stopes to advance b	oring First					[	
8         9         9         10 <td></td> <td></td> <td></td> <td></td> <td></td> <td>attempt refusal at 2'4" Second</td> <td>l attemnt</td> <td></td> <td></td> <td></td> <td></td> <td> </td> <td></td>						attempt refusal at 2'4" Second	l attemnt						
Fourth attempt refusal at 2'6'.         Image: Construction of the second s		0				refusal at 2'8". Third attempt re	efusal at 3'.						
9     0     0     0     0     0     0       11     0     0     0     0     0     0       12     0     0     0     0     0     0       13     0     0     0     0     0     0       14     1     0     0     0     0     0       16     16     0     0     0     0     0       19     0     0     0     0     0     0       20     0     0     0     0     0     0       21     0     0     0     0     0     0       22     0     0     0     0     0     0       22     0     0     0     0     0     0       23     23     24     0     0     0     0       24     25     5     Sandard Penetration Test - Diving 2'00 Sampler 1' With     60///200 Sampler 1' With     60///200 Sampler 1' With		0										l	
10         1           11         1           12         1           13         1           14         1           15         1           16         1           17         1           18         1           19         1           20         21           21         1           22         1           23         1           24         25           760 SWIE         RMAK3           GRUARDS INFORMER           8 SURTINEE         Sendard Penetration Test - Driving 2'00 Sampler 1' With         Sendard Penetration Test - Driving 2'00 Sampler 1' With		0				•						l	
11         12           13         14           15         16           16         17           18         19           20         21           22         23           23         23           24         23           25         RMRK:           COUND ULTER DAT INFORMER           S.S SRUKTONE		9										l	
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13       14         14       14         15       16         16       17         18       10         19       10         20       11         21       20         21       20         21       10         22       21         22       22         23       10         24       25													
14       15       16       17       18       19       20       21       21       22       23       24       23       VFE of SMPLE       0       RMARKS:       GROUND WATER OBSERVATIONS       UL       VEX       Standard Penetration Test - Driving 2* 00 Sampler 1* With       GWL SPORTERD AT       CWL SPORTERD AT       CWL SPORTERD AT       Standard Penetration Test - Driving 2* 00 Sampler 1* With       GWL SPORTERD AT       CWL FTER HRS		12											
14       15       16       17       18       19       20       21       21       22       23       24       23       VFE of SMPLE       0       RMARKS:       GROUND WATER OBSERVATIONS       UL       VEX       Standard Penetration Test - Driving 2* 00 Sampler 1* With       GWL SPORTERD AT       CWL SPORTERD AT       CWL SPORTERD AT       Standard Penetration Test - Driving 2* 00 Sampler 1* With       GWL SPORTERD AT       CWL FTER HRS													
14       15       16       17       18       19       20       21       21       22       23       24       23       VFE of SMPLE       0       RMARKS:       GROUND WATER OBSERVATIONS       UL       VEX       Standard Penetration Test - Driving 2* 00 Sampler 1* With       GWL SPORTERD AT       CWL SPORTERD AT       CWL SPORTERD AT       Standard Penetration Test - Driving 2* 00 Sampler 1* With       GWL SPORTERD AT       CWL FTER HRS		13	1									1	
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16       1		17										Ì	
16       1		15											
17       17         18       18         19       19         20       10         21       10         22       10         21       10         22       10         23       10         23       10         23       10         24       10         25       10         10       10         25       10         11       10         11       10         11       10         11       10         11       10         11       10         11       10         11       10         12       10         12       10         12       10         12       10         12       10         12       10         13       10         14       10         15       10         16       10         17       10         18       10         19       10         10       10		15											
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21       21         22       Note: Used track rig.         23       23         24       24         25       REMARKS:         25       GROUND WATER OBSERVATIONS         1. UNDIST. LINER       REMARKS:         0. UNDIST. LINER       G.W. ENCOUNTERED AT       FT. None INS.         S. S. SPLIT SPOON       Standard Penetration Test - Driving 2" OD Sampler 1' With       G.W. AFTER COMPLETION		19										l	
21       21         22       Note: Used track rig.         23       23         24       24         25       REMARKS:         25       GROUND WATER OBSERVATIONS         1. UNDIST. LINER       REMARKS:         0. UNDIST. LINER       G.W. ENCOUNTERED AT       FT. None INS.         S. S. SPLIT SPOON       Standard Penetration Test - Driving 2" OD Sampler 1' With       G.W. AFTER COMPLETION													
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Z5     GROUND WATER OBSERVATIONS       D DISTURBED     GROUND WATER OBSERVATIONS       U.L UNDIST. LINER     G.W. ENCOUNTERED AT       SS SPLIT SPOON     G.W. ENCOUNTERED AT       R.C ROCK CORE     Standard Penetration Test - Driving 2" OD Sampler 1' With		23										l	
Z5     GROUND WATER OBSERVATIONS       D DISTURBED     GROUND WATER OBSERVATIONS       U.L UNDIST. LINER     G.W. ENCOUNTERED AT       SS SPLIT SPOON     G.W. ENCOUNTERED AT       R.C ROCK CORE     Standard Penetration Test - Driving 2" OD Sampler 1' With													
TYPE OF SAMPLE     REMARKS:     GROUND WATER OBSERVATIONS       D DISTURBED     U.L UNDIST. LINER     G.W. ENCOUNTERED AT     FT.     INS.       U.L UNDIST. LINER     G.W. ENCOUNTERED AT     FT.     INS.       S.S SPLIT SPOON     G.W. AFTER COMPLETION     FT.     INS.       R.C ROCK CORE     Standard Penetration Test - Driving 2° OD Sampler 1' With     G.W. AFTER COMPLETION     FT.     INS.		24	-									i	
TYPE OF SAMPLE     REMARKS:     GROUND WATER OBSERVATIONS       D DISTURBED     U.L UNDIST. LINER     G.W. ENCOUNTERED AT     FT.     INS.       U.L UNDIST. LINER     G.W. ENCOUNTERED AT     FT.     INS.       S.S SPLIT SPOON     G.W. AFTER COMPLETION     FT.     INS.       R.C ROCK CORE     Standard Penetration Test - Driving 2° OD Sampler 1' With     G.W. AFTER COMPLETION     FT.     INS.		05										i	
D.     - DISTURBED     G.W. ENCOUNTERED AT     FT.     None     INS.       U.L.     - UNDIST. LINER     G.W. ENCOUNTERED AT     FT.     INS.       S.T.     - SHELBY TUBE     G.W. ENCOUNTERED AT     FT.     INS.       S.S.     - SPLIT SPOON     G.W. AFTER COMPLETION     FT.     INS.       R.C.     - ROCK CORE     Standard Penetration Test - Driving 2° OD Sampler 1' With     G.W. AFTER     HRS.     FT.     INS.		25										i	
D.     - DISTURBED     G.W. ENCOUNTERED AT     FT.     None     INS.       U.L.     - UNDIST. LINER     G.W. ENCOUNTERED AT     FT.     INS.       S.T.     - SHELBY TUBE     G.W. ENCOUNTERED AT     FT.     INS.       S.S.     - SPLIT SPOON     G.W. AFTER COMPLETION     FT.     INS.       R.C.     - ROCK CORE     Standard Penetration Test - Driving 2° OD Sampler 1' With     G.W. AFTER     HRS.     FT.     INS.													
R.C ROCK CORE Standard Penetration Test - Driving 2" OD Sampler 1' With G.W. AFTER HRS. FT. INS.	D. U.L. S.T.	<ul> <li>DISTURBE</li> <li>UNDIST. L</li> <li>SHELBY T</li> </ul>	ed Liner Tube	REMARI	KS:			G.W. E	NCOUNTER	RED AT RED AT	F	T. None INS	
	R.C	- ROCK CO	DRE		Standa 140	ard Penetration Test - Driving 2" OD Sam # Hammer Falling 30": Count Made at 6" I	bler 1' With ntervals	G.W. A G.W. A	AFTER COM	PLETION		T. INS	



Depth

1

2

Legend

Sample & Type

JOB NO.

## SIEVE ANALYSIS SUMMARY

<u>Boring</u>	Sample	% Passing <u>#4 Sieve</u>	% Passing <u>#10 Sieve</u>	% Passing <u>#40 Sieve</u>	% Passing #100 Sieve	% Passing #200 Sieve
1	D	45.0	24.7	8.6	4.7	3.8
	F	100.0	100.0	98.5	9.0	6.3
2	D	75.7	66.4	46.1	33.6	28.9
	E	100.0	100.0	96.2	4.3	3.4



## **LEGEND**

Soil Boring Locations, 1 through 3: Drilled by McDowell & Associates



McDowell & Associates 21355 Hatcher Avenue Ferndale, Michigan 48220 Phone: (248) 399-2066 Fax: (248) 399-2157

Soil Boring Location Plan Job No. 23-111



Project No: 129021SG2020

## LOGS OF HAND AUGER BORINGS

Project Name: Tecumseh Dam Spillway Project Location: Lenawee County, Michigan

4	Location: 6 feet south and 8 feet west of d/s end of concrete traiing wall in area between spillway and river. Lat: Long:			By:	NWL
	Surface: grass/weeds GW: 4.5 feet during drilling		D	ate:	5/1/2023
Depth	Material Description	Sample	DCPT		Other
0	2 inches Topsoil				
	Orange-brown, fine to coarse, CLAYEY SAND (SC) with gravel - moist - loose				
1 —					
2 —			6 6	6	
3 —	Light brown, fine, CLAYEY SAND (SC) - moist - loose				
	Orange-brown, SANDY CLAY (CL) - moist - loose		3 4	7	PP:0.25-0.75tsf
4 —					
	becomes wet				
5					
	Brown, fine, SAND WITH SILT (SP-SM) - saturated - loose		3 3	5	
6 —	becomes gray				
7					
	Boring termnated at 7 feet below ground surface. Two other attempts encountered refusal on coarse gravel at 1 to 2 feet.				
8					





August 5, 2024

## GEOTECHNICAL MEMORANDUM

RE: Tecumseh Dam Spillway Improvements Lenawee County, Michigan Project No: 129021SG2020

This memorandum provides revised recommendations for filter sand and drainstone gradations for the spillway underdrain system.

Filter sand and drainstone gradation requirements were determined using the filter methodology presented in NRCS's National Engineering Handbook, Part 633, Chapter 26: *Gradation Design of Sand and Gravel Filters*. A summary of the calculations is attached. The resulting gradations do not exactly fit common AASHTO or MDOT material specifications, so the materials must be produced by blending multiple materials.

## Drainstone

Sieve	Opening	Percent Passing
2-in	50 mm	100
1 ½-in	37.5 mm	90 - 100
<sup>3</sup> /4-in	19 mm	40 - 85
1/2-in	12.5 mm	10 - 50
3/8-in	9.5 mm	5 - 40
No. 4	4.75 mm	0 - 25
No. 8	2.36 mm	0-10
No. 200	0.075 mm	0-3

This gradation is very similar to MDOT 6A or 46G.

## **Filter Sand**

Sieve	Opening	Percent Passing
1-in	25 mm	100
1/2-in	12.5 mm	75 - 100
3/8-in	9.5 mm	65 - 100
No. 4	4.75 mm	50 - 95
No. 8	2.36 mm	30 - 75
No. 16	1.18 mm	10 - 50
No. 30	0.60 mmm	0-30
No. 50	0.30 mm	0 - 10
No. 100	0.15 mm	0-5
No. 200	0.075 mm	0-3

August 5, 2024 Page 2 of 2

This gradation is similar to the coarse side of MDOT 2NS.

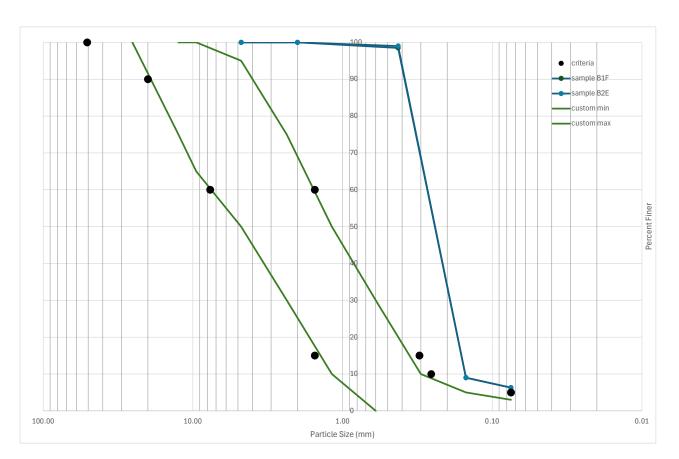
Aggregates used for sand filter and drainstone should be produced from natural aggregate or ledgestone. Aggregates must be clean, hard, durable, uncoated, and free of clay lumps, organic matter, soft or flakey material, and other foreign matter. Crushed Portland cement concrete or asphaltic concrete should not be used.

#### Filter Criteria

(in accordance with NRCS Part 633 Soils Engineering, National Engineering Handbook, Chapter 26 Gradation Design of Sand and Gravel Filters) Tecumseh Dam - Spillway Slab

		Base Soil = B1F		Base Soil = B2E	
	Sieve Size		Corrected %		Corrected %
	(mm)	% Passing	Passing	% Passing	Passing
No. 4	4.75	100	100.0	100	100.0
No. 10	2	100	100.0	100	100.0
No. 40	0.425	98.5	98.5	99	96.2
No. 100	0.15	9	9.0	9	4.3
No. 200	0.075	6.3	6.3	6.3	3.4

CF =	1.00	1.00
Category = Filter Gradation	4	4
d85 =	0.38 mm	0.39 mm
Max D15 =	1.53 mm	1.57 mm
Min D15 =	0.31 mm	0.31 mm
Max D60 =	7.67 mm	7.83 mm
Min D60 =	1.53 mm	1.57 mm
Max D100 =	50.80 mm	50.80 mm
Max P200 =	5 percent	5 percent
Min D10 =	0.26 mm	0.26 mm
Min D5 =	0.075 mm	0.075 mm
Max D90 =	20 mm	20 mm



#### Filter Criteria (in accordance with NRCS Part 633 Soils Engineering, National Engineering Handbook, Chapter 26 Gradation Design of Sand and Gravel Filters)

### Base Soil =Custom Filter (fine side)

	Sieve Size	Corrected %	
	(mm)	% Passing	Passing
1"	25	100	100.0
1/2"	12.5	100	100.0
3/8"	9.5	100	100.0
No. 4	4.75	95	95.0
No. 8	2.36	75	75.0
No. 16	1.18	50	50.0
No. 30	0.6	30	30.0
No. 50	0.3	10	10.0
No. 100	0.15	5	5.0
No. 200	0.075	3	3.0

CF =	1.00	
Category =	4	
Filter Gradation d85 =	3.56	mm
uo5 - Max D15 =	14.22	
Min D15 =	2.84	mm
Max D60 =	71.10	mm
Min D60 =	14.22	mm
Max D100 =	50.80	mm
Max P200 =	5	percent
Min D10 =	2.37	mm
Min D5 =	0.075	mm
Max D90 =	40	mm

