SOILS INVESTIGATION
PAVEMENT RENOVATION
BAY CITY ARMORY
2510 WILDER ROAD
MONITOR TOWNSHIP, MICHIGAN

BECKETT & RAEDER
535 W. WILLIAM STREET
SUITE 101
ANN ARBOR, MICHIGAN 48103

APRIL 11, 2022
BY
McDOWELL & ASSOCIATES

McDowell & Associates

Geotechnical, Environmental & Hydrogeological Services • Materials Testing & Inspection

3730 James Savage Road, Midland, MI 48642
Phone: (989) 496-3610 • Fax: (989) 496-3190
www.mcdowasc.com

April 11, 2022

Beckett & Raeder
535 W. William Street
Suite 101
Ann Arbor, Michigan 48103

Job No. 22-64488

Attention: Mr. Kristofer Enlow

Subject: Soils Investigation
Pavement Renovation
Bay City Armory
2510 Wilder Road
Monitor Township, Michigan

Dear Mr. Enlow:

In accordance with your request, we have made a Soils Investigation at the subject project.

Four (4) Soil Test Borings, designated as 1 through 4, were performed at the locations you required in the existing southern parking lot area. The approximate locations of the borings are shown on the Soil Boring Location Plan which accompanies this report. The borings were advanced to a depth of ten feet six inches (10'6") below the existing pavement surface.

Soil descriptions, groundwater observations, and the results of field and laboratory tests are to be found on the accompanying Logs of Soil Test Borings and summary sheet of Sieve Analysis results.

The borings encountered two-inch (2") and three-inch (3") thick asphalt pavement, nine inches (9") to four feet three inches (4'3") of fill soils consisting of brown sand and gravel, compact to very compact brown and discolored brown fine sand to silty fine sand and stiff dark brown sandy clay, followed by stiff to extremely stiff brown to variegated sandy clay which were found throughout the remainder of the borings.

Pavement and soil descriptions and depths shown on the boring logs are approximate indications of change from one soil type to another and are not intended to represent an area of exact geological change or stratification. Also, the site shows signs of modification which could indicate fill and soil conditions different from those encountered at the boring locations.

Water was encountered in Boring 4 at a depth of two feet six inches (2'6") below the existing pavement surface. Water was measured upon completion of the drilling operation in Boring 4 at a depth of eight feet (8'). No water was encountered in Borings 1, 2 or 3. It should be noted that short-term groundwater observations may not provide a reliable indication of the depth of the water table. In clay soils, this is due to the slow rate of infiltration of water into the borehole as well as the potential for water to become trapped in overlying layers of granular soils during periods of heavy rainfall. Water levels in granular soils fluctuate with seasonal and climatic changes as well as with the amount of rainfall in the area immediately prior to the measurements.

Standard Penetration Tests were made during sampling using an automatic hammer. These tests indicate the site soils have good to very good strengths and densities. Tests taken at a depth of two feet six inches (2'6") gave results ranging from 7 to 14 blows per foot. The five-foot (5') test values varied from 11 to 23 blows per foot. At depths of seven feet six inches (7'6") and below, the results ranged from 15 to 29 blows per foot.

It is understood that the existing southern parking lot area at the site will be renovated. Based on Google Earth images of the site, it appears the parking lot supports many types of military trucks and equipment. No traffic information has been provided to use for this parking lot. We have assumed light traffic volume in parking areas with a daily truck number (DTN) of two 18-kip single-axle truckload applications per day. We have assumed a DTN of ten trucks per day in moderate parking areas and a DTN of 30 trucks per day in heavy truck traffic areas and drives. If traffic is greater than these intensities, then thicker pavement sections may be needed.

The soil conditions encountered in the borings indicate that the existing pavement materials overlie sand and clay-type subgrade soils. Moisture contents in the site soils ranged from 9.5% to 17.6%. We would expect the clay soils at the site to have a California Bearing Ratio (CBR) value of 3% and a modulus of subgrade reaction of one hundred pounds per cubic inch (100 pci). The asphalt pavement was found to be two inches (2") and three inches (3") thick. The aggregate base material found under the asphalt was six inches (6") to ten inches (10") thick. The Soil Survey for Bay County, prepared by the U.S. Department of Agriculture Soil Conservation Service, shows the soils at the site consist of Made land and Londo loam. The survey indicates the loam soils are susceptible to severe frost heave and severe seasonal wetness. It appears the existing pavement materials are probably too thin to support the expected vehicular loadings. The clay soils at the site contain significant silt-size particles which would be susceptible to frost heave problems. If the existing fill soils found at the borings have been in place for at least 20 years, we would anticipate that most of the potential settlement of these soils has already occurred and any long-term future settlement should theoretically be minor.

Based on the project information provided and the results of field and laboratory tests, it appears that the fill and native non-organic soils at the borings are suitable for the support of pavements if some potential settlement can be tolerated. If some potential settlement cannot be tolerated, then all existing fill soils should be removed and properly installed and compacted engineered fill should be placed in the resulting excavations. This may be a relatively expensive and difficult solution considering the limited road rights-of-way, existing underground utilities,

nearby buildings, and other physical constraints limiting the possibility of removing these soils from the pavement area.

If the existing fill soils found at the borings have been in place for at least 20 years, we would anticipate that most of the potential settlement of these soils has already occurred and any long-term future settlement should theoretically be minor. If the possibility for some potential settlement cannot be tolerated, then all existing fill soils should be excavated from the roadways and replaced with properly installed and compacted engineered fill. The excavations should extend about one foot (1') outside the roadway edges for every foot below the planned pavement surface. The removal of the unsuitable soils should be done in the presence of a qualified soils engineer to provide reasonable assurance that no uncontrolled fill or highly organic soils are left behind before the placement of the engineered fill. The resulting subgrade should be proof rolled with a heavy, rubber-tired construction vehicle. Any unstable or yielding soils found during proof rolling should be scarified, dried and recompacted or removed and replaced with similar material or compacted bank run sand preferably consisting of MDOT Type I or II granular soils. If the bottom of the excavation is not sufficiently stable to install the bank run sand, then a layer of coarse stone fill such as MDOT 6AA or one-inch (1") to three-inch (3") crushed stone or crushed concrete could be installed. Geotextile fabric should be placed between the coarse stone engineered fill material and lower native granular soils and upper granular fill soils to minimize the amount of fines infiltrating into the coarse aggregate material. The granular MDOT Type I or II soils should be deposited in horizontal lifts not to exceed nine inches (9") in thickness with each lift being compacted uniformly to a minimum density of 95% of its maximum value as determined by the Modified Proctor Test (AASHTO T-180 or ASTM D-1557). If there is insufficient right-of-way to allow an overdig at the edge of the pavement area, then a one-foot (1') overcut could occur.

If the possibility for some potential settlement can be tolerated, then the existing pavements and base aggregate materials could be removed, exposing the fill and native subgrade soils. In the areas to be paved, any loose soil, soft soil, organic soil, or other obviously objectionable material should be removed and the subgrade thoroughly proof-compacted with heavy, rubber-tired equipment. If during the proof-compaction operation areas are found where the soils yield excessively, the yielding materials should be scarified, dried and recompacted or removed and replaced with similar material or clean crushed concrete or stone up to one inch (1") to three inches (3") in size. Undercutting and placement of clean crushed concrete or crushed stone may be required in areas of unstable subgrade. After proof-compaction, the upper one foot (1') of the grade should be compacted to a minimum density of 95% of its maximum dry density as determined by the Modified Proctor Test (AASHTO T-180 or ASTM D-1557) as outlined above. Care should be taken to ensure compaction of fill soils required in the vicinity of manholes and/or catch basins.

After the subgrade has been properly compacted and fill has been properly placed and compacted, the pavement material consisting of asphalt or concrete could be installed. The following pavement thicknesses are suggested:

A. Car or Light Truck Parking Areas (2 trucks per day)

1.	Deep Strength Asphalt	1½"	MDOT 13A Wear Course Asphalt
		2½"	MDOT 11A Base Course Asphalt
		2½"	MDOT 11A Base Course Asphalt
		12"	Compacted Subgrade
2.	Asphaltic Pavement	1½"	MDOT 13A Wear Course Asphalt
		2"	MDOT 11A Base Course Asphalt
		8"	Compacted MDOT 21AA-Type Crushed Stone
		12"	Compacted Subgrade
3.	Concrete Pavement	6"	MDOT P35 Concrete
		8"	Compacted MDOT Class II Sand Base
		12"	Compacted Subgrade

B. Moderate Truck Traffic Areas (10 trucks per day)

1.	Deep Strength Asphalt	2½"	MDOT 13A Wear Course Asphalt
		3"	MDOT 11A Base Course Asphalt
		3"	MDOT 11A Base Course Asphalt
		12"	Compacted Subgrade
2.	Asphaltic Pavement	1½"	MDOT 13A Wear Course Asphalt
		3"	MDOT 11A Base Course Asphalt
		10"	Compacted MDOT 21AA-Type Crushed Stone
		12"	Compacted Subgrade
3.	Concrete Pavement	6"	MDOT P35 Concrete
		8"	Compacted MDOT Class II Sand Base
		12"	Compacted Subgrade

C. Heavy Truck Traffic Areas (30 trucks per day)

1.	Deep Strength Asphalt	3"	MDOT 13A Wear Course Asphalt
		3½"	MDOT 11A Base Course Asphalt
		3½"	MDOT 11A Base Course Asphalt
		12"	Compacted Subgrade
2.	Asphaltic Pavement	3"	MDOT 13A Wear Course Asphalt
		3"	MDOT 11A Base Course Asphalt
		10"	Compacted MDOT 21AA-Type Crushed Stone
		12"	Compacted Subgrade
3.	Concrete Pavement	6"	MDOT P35 Concrete
		8"	Compacted MDOT Class II Sand Base
		12"	Compacted Subgrade

In trash receptacle areas or high wheel load turning areas, reinforced concrete pads should be utilized. Generally, eight-inch (8") thick reinforced concrete pads are used in areas where solid waste removal trucks unload dumpsters.

The subsoils at the site are expected to be very susceptible to frost heaving. It is recommended that pavements be properly graded to promote effective drainage of water and prevent the ponding of surface water in low areas. A system of "stub drains" or one drain placed around the catch basin and backfilled with pea stone should be installed at any catch basin or manhole structures to drain any collection of surface water runoff, and thus minimize the possibility of frost penetration and heave. The drain tile should be wrapped with a geofabric. Edge drains should be installed in watered landscaped areas or shallow groundwater areas (typically where groundwater is found to be within 18" of the planned pavement surface). These drains could be field determined during construction. Existing catch basins and manhole structures should be checked and repaired as needed.

The stabilization procedures outlined above should result in reasonably stable pavements. It should be recognized, however, that all asphalt pavements need repairs from time to time as a result of progressive yielding under repeated traffic loads for a prolonged period of time. Placing the new pavement materials over existing non-engineered fill soils may result in long-term differential settlement and some potential cracking of the pavement.

As an alternative to removing and replacing the existing pavements, an asphalt overlay could be installed over the existing pavements. However, reflective cracking and deterioration of the overlay would probably occur over a period of time due to the current condition of the existing pavement and underlying fill soil conditions. To minimize this potential cracking and deterioration, it is suggested that the existing pavements be milled or pulverized. If they are milled, then the milling should extend down to at least two inches (2"). Note that the existing asphalt pavement at Boring 1 was found to be only two inches (2") thick. Any badly deteriorated and cracked areas in the existing pavements should be saw cut, removed and patched. Over these patched areas and in less deteriorated areas with cracks, a geotextile fabric such as Petromat® 4597 (or equivalent) should then be installed. Care must be taken to properly tack coat between the existing pavement, fabric, and new overlays. Finally, a two-inch (2") thick overlay could be installed over the fabric. It may be beneficial to install bleeder, stub and possibly edge drains along the subject roadways to help drain the existing aggregate base. Existing drainage structures should be checked and repaired as required. It should be noted that the milling operation could produce significant vibrations to the nearby existing buildings and utilities. The paving contractor would probably have more experience concerning the magnitude of vibrations caused by the milling operation and could better answer this question.

If you wish to pulverize the existing pavements, then they could be incorporated into the aggregate base thicknesses noted above. Recognize that any pulverized asphalt could deteriorate and settle over time, resulting in some distress to new pavements supported over these materials.

The evaluations and recommendations presented in this report have been formulated on the basis of reported or assumed data relating to the location, type, finished grades and traffic conditions

for the proposed project. Any significant change in this data in the final design plans should be brought to our attention for review and evaluation with respect to the prevailing subsoil conditions.

Experience indicates that the actual subsoil conditions at the site could vary from pavement borings made at specific locations. It is, therefore, essential that a qualified geotechnical engineering testing firm be retained to provide soil engineering services during the site preparation, excavation, compaction and paving phases of the proposed project. This is to observe compliance with design concepts, specifications and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to the start of construction.

If we can be of any further service, please feel free to call.

Very truly yours,

McDOWELL & ASSOCIATES

Daniel A. Kaniarz, M.S., P.E.

DAK/nm

McDOWELL & ASSOCIATES
Geotechnical, Environmental, & Hydrogeologic Services
3730 James Savage Road • Midland, MI 48642
Phone: (989) 496-3610 • Fax: (989) 496-3190

LOG OF SOIL BORING NO. 1

PROJECT Soils Investigation
Pavement Renovation

LOCATION Bay City Armory
2510 Wilder Road
Monitor Township, Michigan

JOB NO. 22-64488

SURFACE ELEV. _____ **DATE** 4-5-2022

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.	Str. %
			0'2" ASPHALT						
	1		0'9" Moist brown SAND & GRAVEL, aggregate fill						
A	2			3					
UL			Stiff moist dark brown sandy CLAY with moist fine sand seams, fill	4	15.0	123			
	3			4			*	(3000)	
			3'6"						
	4								
B				3					
UL	5			4	12.6	136		2875	
			Stiff moist variegated sandy CLAY with trace of pebbles	7			*	(4500)	
	6								
C	7			6					
UL			7'0"	9	11.0	135		6475	
	8			12			*	(8000)	
	9		Extremely stiff moist brown sandy CLAY with pebbles						
D				6					
UL	10			10					
				12					
	11		10'6"						
	12								
	13								
	14								
	15		Notes:						
	16		1) Used automatic hammer.						
	17		2) Patched boring upon completion with cold patch asphalt.						
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS: *Calibrated Penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT . FT. INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES NONE

McDOWELL & ASSOCIATES
Geotechnical, Environmental, & Hydrogeologic Services
3730 James Savage Road • Midland, MI 48642
Phone: (989) 496-3610 • Fax: (989) 496-3190

LOG OF SOIL BORING NO. 2

PROJECT Soils Investigation
Pavement Renovation

LOCATION Bay City Armory
2510 Wilder Road
Monitor Township, Michigan

JOB NO. 22-64488

SURFACE ELEV. _____ **DATE** 4-5-2022

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.	Str. %
			0'3" ASPHALT						
	1		0'9" Moist brown SAND & GRAVEL, aggregate fill						
A	2		Very compact moist discolored brown silty fine SAND with trace of gravel, fill	9					
UL				8	9.5	130			
	3			5					
			3'0"						
	4		Stiff moist brown sandy CLAY with trace of pebbles						
B				4					
UL	5		4'6"	7	10.4	139		5480	
				9			*	(6500)	
	6		Very stiff moist brown sandy CLAY with pebbles						
C	7			6					
UL			7'0"	11	10.1	139		6980	
	8			16			*	(8000)	
	9		Extremely stiff moist brown sandy CLAY with pebbles						
D				6					
UL	10			12					
				17					
	11		10'6"						
	12								
	13								
	14								
	15		Notes:						
	16		1) Used automatic hammer.						
	17		2) Patched boring upon completion with cold patch asphalt.						
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS: *Calibrated Penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT . FT. INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES NONE

McDOWELL & ASSOCIATES
Geotechnical, Environmental, & Hydrogeologic Services
3730 James Savage Road • Midland, MI 48642
Phone: (989) 496-3610 • Fax: (989) 496-3190

LOG OF SOIL BORING NO. 3

PROJECT Soils Investigation
Pavement Renovation

LOCATION Bay City Armory
2510 Wilder Road
Monitor Township, Michigan

JOB NO. 22-64488

SURFACE ELEV. _____ **DATE** 4-5-2022

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.	Str. %
			0'3" ASPHALT						
	1		1'0" ← Moist brown SAND & GRAVEL, aggregate fill						
A	2			5					
UL				6	9.3	140		3395	
	3		Very stiff moist brown sandy CLAY with trace of pebbles	8			*	(5000)	
	4								
B				7					
UL	5		4'6"	9	10.3	139		6000	
				11			*	(8000)	
	6								
C	7			6					
UL				8	10.7	138		6540	
	8		Extremely stiff moist brown sandy CLAY with pebbles	12			*	(8000)	
	9								
D				6					
UL	10			12					
				14					
	11		10'6"						
	12								
	13								
	14								
	15		Notes:						
	16		1) Used automatic hammer.						
	17		2) Patched boring upon completion with cold patch asphalt.						
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS: *Calibrated Penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT . FT. INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES NONE

McDOWELL & ASSOCIATES
Geotechnical, Environmental, & Hydrogeologic Services
3730 James Savage Road • Midland, MI 48642
Phone: (989) 496-3610 • Fax: (989) 496-3190

LOG OF SOIL BORING NO. 4

PROJECT Soils Investigation
Pavement Renovation

LOCATION Bay City Armory
2510 Wilder Road
Monitor Township, Michigan

JOB NO. 22-64488

SURFACE ELEV. _____ **DATE** 4-5-2022

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.	Str. %
			0'3" ASPHALT						
	1		1'1" Moist brown SAND & GRAVEL, aggregate fill						
			Compact moist brown fine SAND with trace of silt, fill						
A	2			3					
UL			2'6"	3	17.6	115			
	3			4					
			Compact wet brown fine SAND with trace of silt, fill						
	4								
B			4'6"	7					
UL	5		Extremely stiff moist variegated sandy CLAY with trace of pebbles	10	10.8	140		5800	
				13			*	(6000)	
	6		6'0"						
C	7			3					
UL			Very stiff brown sandy CLAY with pebbles	5	10.5	137			
	8			10			*	(6500)	
			8'6"						
	9								
D			Extremely stiff moist brown sandy CLAY with pebbles	5					
UL	10			10					
			10'6"	14					
	11								
	12								
	13								
	14								
	15								
	16								
	17								
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

Notes:

1) Used automatic hammer.

2) Patched boring upon completion with cold patch asphalt.

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS: *Calibrated Penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

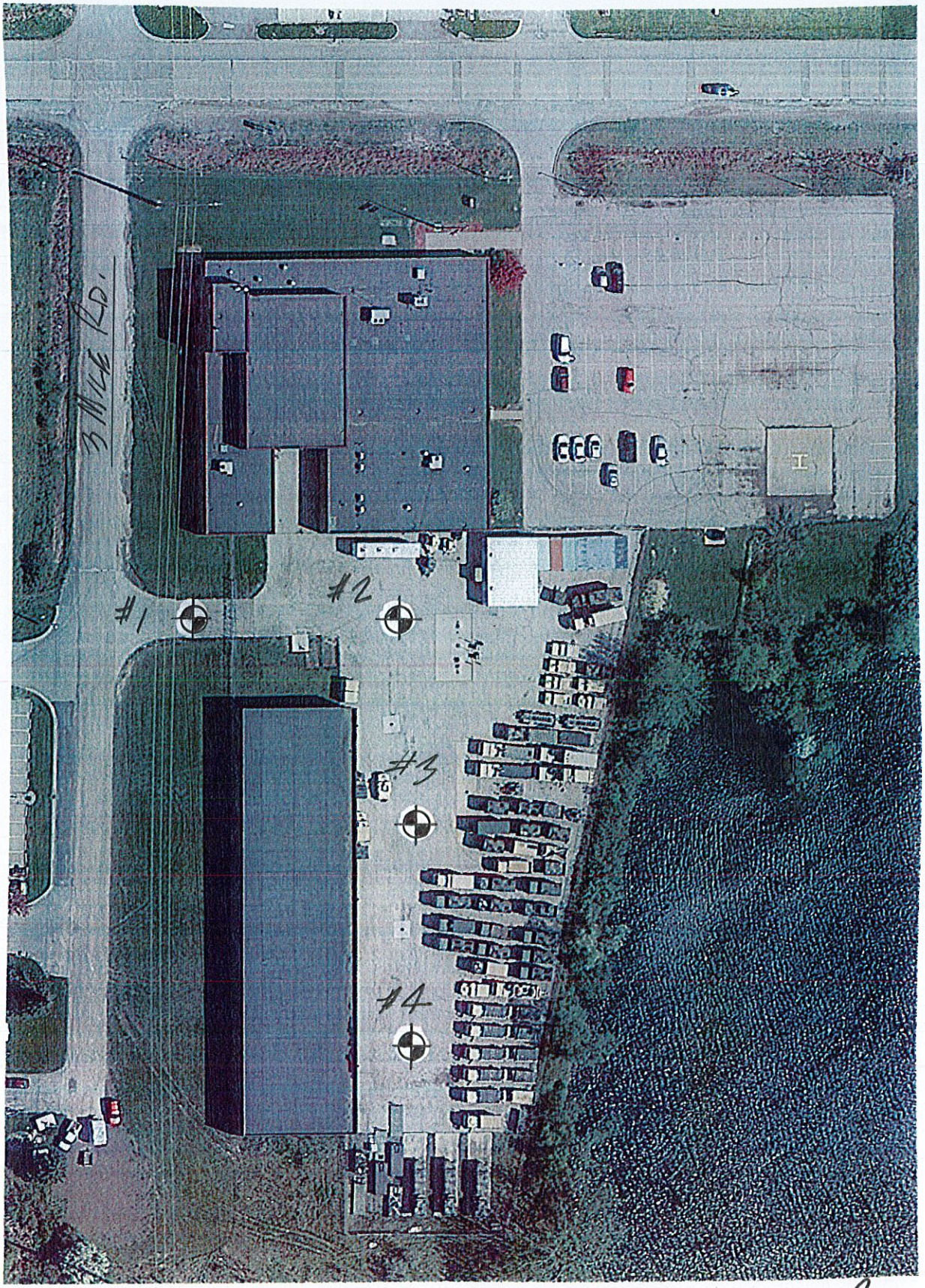
G.W. ENCOUNTERED AT 2 FT. 6 INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION 8 FT. 0 INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES MODERATE

Job No. 22-64488

SIEVE ANALYSIS

Boring	Sample	% Passing #4 Sieve	% Passing #10 Sieve	% Passing #40 Sieve	% Passing #100 Sieve	% Passing #200 Sieve
2	A	97.1	96.4	88.3	35.6	26.3
4	A	100.0	99.8	97.1	35.0	6.5

WILDER ROAD



NO SCALE

SOIL BORING LOCATION PLAN

#22-64488

SOILS INVESTIGATION
PAVEMENT RENOVATION
BAY CITY ARMORY
2510 WILDER ROAD
MONITOR TOWNSHIP, MICHIGAN

BECKETT & RAEDER
535 W. WILLIAM STREET
SUITE 101
ANN ARBOR, MICHIGAN 48103

MARCH 10, 2022
BY
McDOWELL & ASSOCIATES

McDowell & Associates

Geotechnical, Environmental & Hydrogeological Services • Materials Testing & Inspection

3730 James Savage Road, Midland, MI 48642
Phone: (989) 496-3610 • Fax: (989) 496-3190
www.mcdowasc.com

March 10, 2022

Beckett & Raeder
535 W. William Street
Suite 101
Ann Arbor, Michigan 48103

Job No. 22-64485

Attention: Mr. Kristofer Enlow

Subject: Soils Investigation
Pavement Renovation
Bay City Armory
2510 Wilder Road
Monitor Township, Michigan

Dear Mr. Enlow:

In accordance with your request, we have made a Soils Investigation at the subject project.

Four (4) Soil Test Borings, designated as 1 through 4, were performed at the locations you required. The approximate locations of the borings are shown on the Soil Boring Location Plan which accompanies this report. The borings were advanced to a depth of ten feet six inches (10'6") below the existing pavement surface.

Soil descriptions, groundwater observations, and the results of field and laboratory tests are to be found on the accompanying Logs of Soil Test Borings and Loss on Ignition summary sheet.

The borings encountered three-inch (3") thick asphalt and eight-inch (8") thick concrete pavement, four inches (4") to three feet four inches (3'4") of fill soils consisting of brown sand and gravel, medium compact dark brown slightly organic fine sand and very stiff discolored brown sandy clay, followed by stiff to extremely stiff brown sandy clay which were found throughout the remainder of the borings.

Pavement and soil descriptions and depths shown on the boring logs are approximate indications of change from one soil type to another and are not intended to represent an area of exact geological change or stratification. Also, the site shows signs of modification which could indicate fill and soil conditions different from those encountered at the boring locations.

No water was encountered in the borings during the drilling operation. It should be noted that short-term groundwater observations may not provide a reliable indication of the depth of the

water table. In clay soils, this is due to the slow rate of infiltration of water into the boreholes as well as the potential for water to become trapped in overlying layers of granular soils during periods of heavy rainfall. Water levels in granular soils fluctuate with seasonal and climatic changes as well as with the amount of rainfall in the area immediately prior to the measurements. It should be expected that groundwater level fluctuations may occur on a seasonal basis and that seams of water-bearing sands or silts could be found within the various clay strata at the site.

Standard Penetration Tests were made during sampling using an automatic hammer. These tests indicate that the native soils have poor to good strengths and densities. These tests indicate the site soils have poor to very good strengths and densities. Tests taken at a depth of two feet six inches (2'6") gave results ranging from 4 to 11 blows per foot. The five-foot (5') test values varied from 6 to 14 blows per foot. At depths of seven feet six inches (7'6") and below, the results ranged from 20 to 26 blows per foot.

A Loss on Ignition Test was performed on Sample 4A. This test indicates the sand fill found at this boring has an organic content on the order of 3.4%. It should be noted that soils with organics at or greater than 5% are considered unacceptable for pavement support.

It is understood that the existing parking lot at the site which contains a helicopter landing pad will be renovated. It appears this parking lot supports mostly car-type traffic with occasional truck traffic (i.e., sanitary and delivery trucks). Google Earth images of the site show that an existing parking lot south of the Armory Building supports military trucks and equipment, but the subject lot appears to support only cars. It is assumed the helicopter pad will be removed. If it is to be replaced with a new pad, then it will need to be designed utilizing U.S. Air Force design requirements and procedures. A design of the helicopter pad pavement is beyond the scope of this report. No car or truck traffic information has been provided to us for this parking lot. We have assumed that the automobile parking areas will support a daily truck number of two and drive areas will support a daily truck number of ten 18-kip single-axle truckload applications per day. If traffic is greater than these intensities, then thicker pavement sections may be needed.

The soil conditions encountered in the borings indicate that the existing pavement materials overlie sand and clay-type subgrade soils. The sand fill in Boring 4 has an organic content on the order of 3.4%. Moisture contents in the site soils range from 9.0% to 15.5%. We would expect the clay soils at the site to have a California Bearing Ratio (CBR) value of 3% and a modulus of subgrade reaction of one hundred pounds per cubic inch (100 pci). The asphalt pavement was found to be three inches (3") thick. Eight-inch-thick (8") thick concrete was found at Boring 4. The aggregate base material found under the asphalt was four inches (4") to five inches (5") thick. The Soil Survey for Bay County prepared by the U.S. Department of Agriculture Soil Conservation Service shows the soils at the site consist of Made land and Londo loam. The survey indicates the loam soils are susceptible to severe frost heave and severe seasonal wetness. It appears the existing pavement materials are probably too thin to support the expected vehicular loadings. The clay soils at the site contain significant silt-size particles which would be susceptible to frost heave problems. If the existing fill soils found at the borings have

been in place for at least 20 years, we would anticipate that most of the potential settlement of these soils has already occurred and any long-term future settlement should theoretically be minor. As noted earlier, soils with organic content greater than 5% are considered unacceptable for pavement support

Based on the project information provided and the results of field and laboratory tests, it appears that the fill and native non-organic soils at the borings are suitable for the support of pavements if some potential settlement can be tolerated. If some potential settlement cannot be tolerated, then all existing fill soils should be removed and properly installed and compacted engineered fill should be placed in the resulting excavations. This may be a relatively expensive and difficult solution considering the limited road rights-of-way, existing underground utilities, nearby buildings, and other physical constraints limiting the possibility of removing these soils from the pavement area.

If the existing fill soils found at the borings have been in place for at least 20 years, we would anticipate that most of the potential settlement of these soils has already occurred and any long-term future settlement should theoretically be minor. If the possibility for some potential settlement cannot be tolerated, then all existing fill soils should be excavated from the roadways and replaced with properly installed and compacted engineered fill. Any soils with organic contents greater than about 5% should also be removed from planned pavement areas. It appears the sand fill soils at Boring 4 can remain. The excavations should extend about one foot (1') outside the roadway edges for every foot below the planned pavement surface. The removal of the unsuitable soils should be done in the presence of a qualified soils engineer to provide reasonable assurance that no uncontrolled fill or highly organic soils are left behind before the placement of the engineered fill. The resulting subgrade should be proof rolled with a heavy, rubber-tired construction vehicle. Any unstable or yielding soils found during proof rolling should be scarified, dried and recompacted or removed and replaced with similar material or compacted bank run sand preferably consisting of MDOT Type I or II granular soils. If the bottom of the excavation is not sufficiently stable to install the bank run sand, then a layer of coarse stone fill such as MDOT 6AA or one-inch (1") to three-inch (3") crushed stone or crushed concrete could be installed. Geotextile fabric should be placed between the coarse stone engineered fill material and lower native granular soils and upper granular fill soils to minimize the amount of fines infiltrating into the coarse aggregate material. The granular MDOT Type I or II soils should be deposited in horizontal lifts not to exceed nine inches (9") in thickness with each lift being compacted uniformly to a minimum density of 95% of its maximum value as determined by the Modified Proctor Test (AASHTO T-180 or ASTM D-1557). If there is insufficient right-of-way to allow an overdig at the edge of the pavement area, then a one-foot (1') overcut could occur.

If the possibility for some potential settlement can be tolerated, then the existing pavements and base aggregate materials could be removed, exposing the fill and native subgrade soils. In the areas to be paved, any loose soil, soft soil, organic soil, or other obviously objectionable material should be removed and the subgrade thoroughly proof-compacted with heavy, rubber-tired equipment. If during the proof-compaction operation areas are found where the soils yield

excessively, the yielding materials should be scarified dried and recompacted or removed and replaced with similar material or clean crushed concrete or stone up to one inch (1") to three inches (3") in size. Undercutting and placement of clean crushed concrete or crushed stone may be required in areas of unstable subgrade. After proof-compaction, the upper one foot (1') of the grade should be compacted to a minimum density of 95% of its maximum dry density as determined by the Modified Proctor Test (AASHTO T-180 or ASTM D-1557) as outlined above. Care should be taken to ensure compaction of fill soils required in the vicinity of manholes and/or catch basins.

After the subgrade has been properly compacted and fill has been properly placed and compacted, the pavement material consisting of asphalt or concrete could be installed. The following pavement thicknesses are suggested:

A. Automobile Parking Areas (2 Trucks per Day)

1.	Deep Strength Asphalt	6½"	Asphalt
		12"	Compacted Subgrade
2.	Asphaltic Pavement	3"	Asphalt
		8"	Compacted 21AA Crushed Stone
		12"	Compacted Subgrade
3.	Concrete Pavement	6"	Concrete
		8"	Compacted Class II Sand Base
		12"	Compacted Subgrade

B. Drive Areas (10 Trucks per Day)

1.	Deep Strength Asphalt	8"	Asphalt
		12"	Compacted Subgrade
2.	Asphaltic Pavement	4½"	Asphalt
		8"	Compacted 21AA Crushed Stone
		12"	Compacted Subgrade
3.	Concrete Pavement	6"	Concrete
		8"	Compacted Class II Sand Base
		12"	Compacted Subgrade

In trash receptacle areas or high wheel load turning areas, reinforced concrete pads should be utilized. Generally, eight-inch (8") thick reinforced concrete pads are used in areas where solid waste removal trucks unload dumpsters.

The subsoils at the site are expected to be very susceptible to frost heaving. It is recommended that pavements be properly graded to promote effective drainage of water and prevent the ponding of surface water in low areas. A system of "stub drains" or one drain placed around the catch basin and backfilled with pea stone should be installed at any catch basin or manhole structures to drain any collection of surface water runoff, and thus minimize the possibility of frost penetration and heave. The drain tile should be wrapped with a geofabric. Edge drains should be installed in watered landscaped areas or shallow groundwater areas (typically where groundwater is found to be within 18" of the planned pavement surface). These drains could be field determined during construction. Existing catch basins and manhole structures should be checked and repaired as needed.

The stabilization procedures outlined above should result in reasonably stable pavements. It should be recognized, however, that all asphalt pavements need repairs from time to time as a result of progressive yielding under repeated traffic loads for a prolonged period of time. Placing the new pavement materials over existing non-engineered fill soils may result in long-term differential settlement and some potential cracking of the pavement.

As an alternative to removing and replacing the existing pavements, an asphalt overlay could be installed over the existing pavements. However, reflective cracking and deterioration of the overlay would probably occur over a period of time due to the current condition of the existing pavement and underlying fill soil conditions. To minimize this potential cracking and deterioration, it is suggested that the existing pavements be milled or pulverized. If they are milled, then the milling should extend down to at least two inches (2"). Any badly deteriorated and cracked areas in the existing pavements should be saw cut, removed and patched. Over these patched areas and in less deteriorated areas with cracks, a geotextile fabric such as Petromat® 4597 (or equivalent) should then be installed. Care must be taken to properly tack coat between the existing pavement, fabric, and new overlays. Finally, a two-inch (2") thick overlay could be installed over the fabric. It may be beneficial to install bleeder, stub and possibly edge drains along the subject roadways to help drain the existing aggregate base. Existing drainage structures should be checked and repaired as required. It should be noted that the milling operation could produce significant vibrations to the nearby existing buildings and utilities. The paving contractor would probably have more experience concerning the magnitude of vibrations caused by the milling operation and could better answer this question.

If you wish to pulverize the existing pavements, then they could be incorporated into the aggregate base thicknesses noted above. Recognize that any pulverized asphalt could deteriorate and settle over time, resulting in some distress to new pavements supported over these materials.

The evaluations and recommendations presented in this report have been formulated on the basis of reported or assumed data relating to the location, type, finished grades and traffic conditions for the proposed project. Any significant change in this data in the final design plans should be brought to our attention for review and evaluation with respect to the prevailing subsoil conditions.

Experience indicates that the actual subsoil conditions at the site could vary from pavement borings made at specific locations. It is, therefore, essential that a qualified geotechnical engineering testing firm be retained to provide soil engineering services during the site preparation, excavation, compaction and paving phases of the proposed project. This is to observe compliance with design concepts, specifications and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to the start of construction.

If we can be of any further service, please feel free to call.

Very truly yours,

McDOWELL & ASSOCIATES

Daniel A. Kaniarz, M.S., P.E.

DAK/nm

McDOWELL & ASSOCIATES
Geotechnical, Environmental, & Hydrogeologic Services
3730 James Savage Road • Midland, MI 48642
Phone: (989) 496-3610 • Fax: (989) 496-3190

LOG OF SOIL BORING NO. 1

PROJECT Soils Investigation
Pavement Renovation

LOCATION Bay City Armory
2510 Wilder Road
Monitor Township, Michigan

JOB NO. 22-64485

SURFACE ELEV. _____ **DATE** 3-4-2022

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.	Str. %
			0'3" ASPHALT						
	1		0'7" Moist brown SAND & GRAVEL, aggregate fill						
A	2		Very stiff moist discolored brown sandy CLAY, fill	8					
UL				6	14.8	127			
	3		2'6"	4			*	(4000)	
	4								
B			Stiff moist variegated sandy CLAY with trace of pebbles	2					
UL	5			3	13.3	137			
				5			*	(3000)	
	6		6'0"						
C	7			5					
UL				9	11.1	136		4695	
	8			11			*	(8000)	
			Extremely stiff moist brown sandy CLAY with pebbles						
	9								
D				6					
UL	10			9					
				13					
	11		10'6"						
	12								
	13								
	14								
	15								
			Notes:						
	16		1) Used automatic hammer.						
	17		2) Patched boring upon completion with cold patch asphalt.						
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT . FT. INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES NONE

McDOWELL & ASSOCIATES
Geotechnical, Environmental, & Hydrogeologic Services
3730 James Savage Road • Midland, MI 48642
Phone: (989) 496-3610 • Fax: (989) 496-3190

LOG OF SOIL BORING NO. 2

PROJECT Soils Investigation
Pavement Renovation

LOCATION Bay City Armory
2510 Wilder Road
Monitor Township, Michigan

JOB NO. 22-64485

SURFACE ELEV. _____ **DATE** 3-4-2022

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.	Str. %
			0'3" ASPHALT						
	1		0'7" Moist brown SAND & GRAVEL, aggregate fill						
A	2			4					
UL			Stiff moist brown sandy CLAY with trace of	5	15.1	124		3970	
	3		pebbles	6			*	(4000)	
	4								
B			4'0"	4					
UL	5			6	11.7	134		6040	
			Very stiff moist variegated sandy CLAY with	8			*	(6000)	
	6		trace of pebbles						
C	7		6'6"	5					
UL				10	10.2	140		7240	
	8			10			*	(8000)	
	9		Extremely stiff moist brown sandy CLAY with						
D			pebbles	7					
UL	10			11					
				15					
	11		10'6"						
	12								
	13								
	14								
	15		Notes:						
	16		1) Used automatic hammer.						
	17		2) Patched boring upon completion						
			with cold patch asphalt.						
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT . FT. INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES NONE

McDOWELL & ASSOCIATES
Geotechnical, Environmental, & Hydrogeologic Services
3730 James Savage Road • Midland, MI 48642
Phone: (989) 496-3610 • Fax: (989) 496-3190

LOG OF SOIL BORING NO. 3

PROJECT Soils Investigation
Pavement Renovation

LOCATION Bay City Armory
2510 Wilder Road
Monitor Township, Michigan

JOB NO. 22-64485

SURFACE ELEV. _____ **DATE** 3-4-2022

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.	Str. %
			0'3" ASPHALT						
	1		0'8" Moist brown SAND & GRAVEL, aggregate fill						
A	2			2					
UL				3	14.1	127		2445	
	3			4			*	(2500)	
			Stiff moist brown sandy CLAY with trace of pebbles						
	4								
B				2					
UL	5			3	12.5	127			
				3			*	(2500)	
	6		6'0"						
C	7			6					
UL				9	9.0	140		7685	
	8			13			*	(8000)	
			Extremely stiff moist brown sandy CLAY with pebbles						
	9								
D				7					
UL	10			12					
				14					
	11		10'6"						
	12								
	13								
	14								
	15		Notes:						
	16		1) Used automatic hammer.						
	17		2) Patched boring upon completion with cold patch asphalt.						
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT . FT. INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES NONE

McDOWELL & ASSOCIATES
Geotechnical, Environmental, & Hydrogeologic Services
3730 James Savage Road • Midland, MI 48642
Phone: (989) 496-3610 • Fax: (989) 496-3190

LOG OF SOIL BORING NO. 4

PROJECT Soils Investigation
Pavement Renovation

LOCATION Bay City Armory
2510 Wilder Road
Monitor Township, Michigan

JOB NO. 22-64485

SURFACE ELEV. _____ **DATE** 3-4-2022

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.	Str. %
			CONCRETE 0'8"						
	1								
A	2			5					
UL			Medium compact moist dark brown slightly organic fine SAND, fill	2	12.8	122			
	3			2					
	4		4'0"						
B				1					
UL	5		Stiff moist brown sandy CLAY with trace of pebbles and moist silt and fine sand seams	2	15.5	130		1895	
				5			*	(2500)	
	6								
			6'6"						
C	7			7					
UL				10	9.6	138		5830	
	8			12			*	(8000)	
	9		Extremely stiff moist brown sandy CLAY with pebbles and occasional stones						
D				6					
UL	10			9					
				12					
	11		10'6"						
	12								
	13								
	14								
	15		Notes:						
	16		1) Used automatic hammer.						
	17		2) Patched boring upon completion with cold patch asphalt.						
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30": Count Made at 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT . FT. INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES NONE

Job No. 22-64485

LOSS ON IGNITION

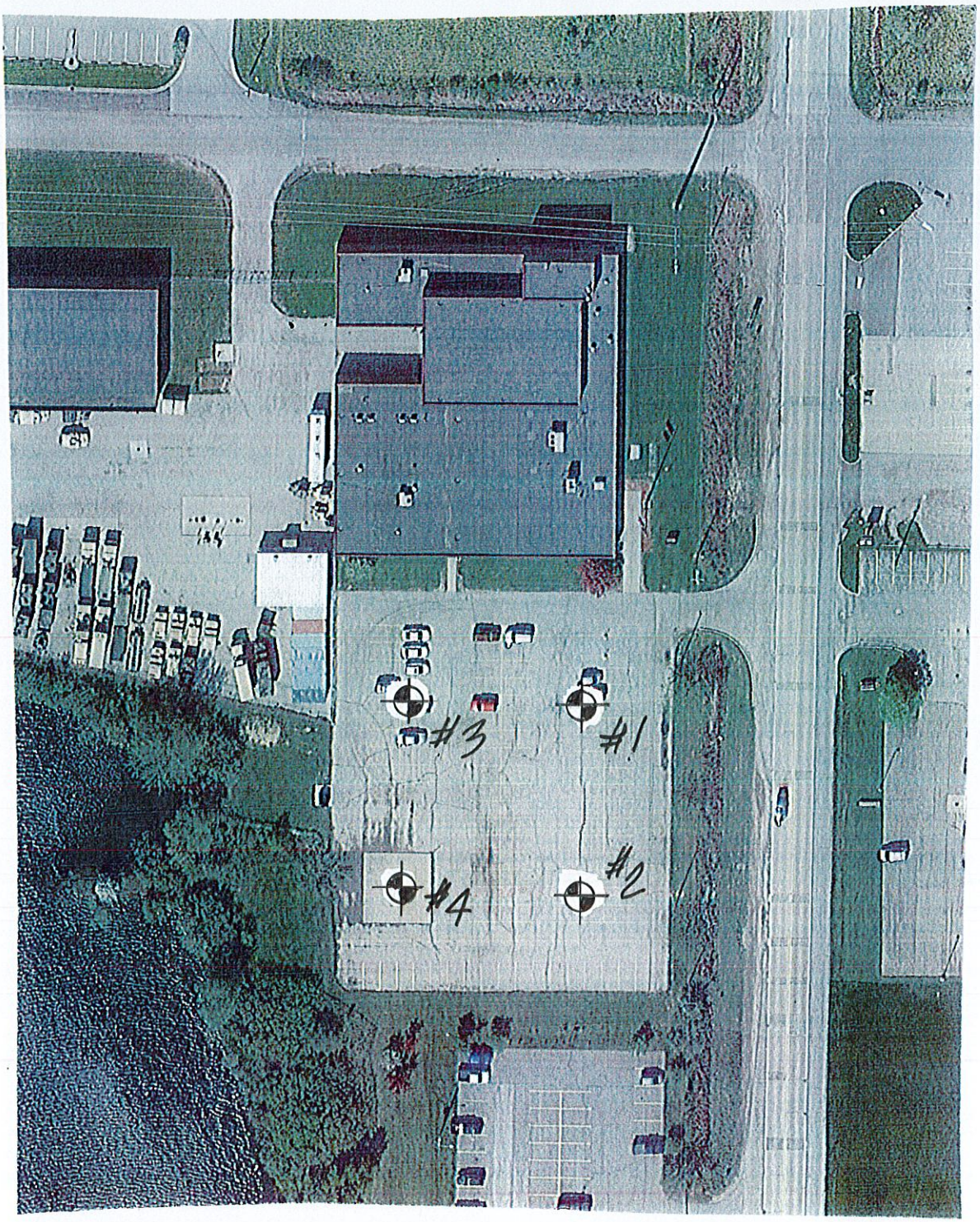
Boring	Sample	Organic Content
4	A	3.4%

NO SCALE

N

WILDER ROAD

3 MILE RD.



SOIL BORING LOCATION PLAN

#22-64485