Report of Geotechnical Investigation

for

FR 3458-1.4 over Carp River

Bridge Replacement

USDA Forest Service – Eastern Region

Hiawatha National Forest – St. Ignace Ranger District

Mackinac County, Michigan

Prepared by:
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June 17, 2020

UPEA Project Number: U28-00286

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I hereby certify that the subsurface exploration report, evaluation and recommendations contained herein were prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Michigan.

Gust Junttila
Jun 17 2020 9:49 AM

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Gust B. Junttila, P.E.

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Registration No.

6/17/2020
Date

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1.0 Project Overview

1.1 Introduction

The following Report of Geotechnical Investigation is for the proposed bridge replacement project on Forest Road 3458, mile point 1.4, over the Carp River, Mackinac County, Michigan (*see* ***Appendix I, Project Location Map***). U.P. Engineers & Architects, Inc. (UPEA) was retained by the USDA Forest Service to perform subsurface exploration and geotechnical engineering services for the design of the proposed bridge. UPEA retained American Engineering Testing, Inc. (AET) to perform the subsurface exploration work.

1.2 Project Description

The existing two-span timber stringer bridge is proposed to be replaced with a single span timber slab bridge with a slightly longer span. The proposed bridge must be capable of supporting its own dead load, asphalt wearing surface, an HL-93 Modified design vehicle and all of Michigan's legal truck loads and overload trucks. Bridge foundation support is expected to be provided by driven timber piles.

1.3 Purpose

The purpose of this report is to present a summary of the soil boring results and provide recommendations regarding foundation design and construction considerations for the proposed bridge.

The soil borings were conducted by American Engineering Testing, Inc. (AET) in order to identify soil types, depths of various soil strata, and dynamic soil penetration resistance (Standard Penetration Test blow counts) of the soil.

This report was prepared under the supervision of a Professional Engineer registered in the State of Michigan. The geotechnical report describes the geologic characterizations of the ground and groundwater conditions encountered at the boring locations and those anticipated during construction. This report provides soil parameters for use by the design structural Engineer of Record for the proposed bridge.

2.0 Exploration and Testing Procedures

2.1 Drilling and Sampling Procedures

In accordance with AASHTO LRFD Specifications for bridge foundation design, one soil boring was drilled for each proposed substructure unit. These two soil boring locations are located behind each existing abutment on alternate sides of the roadway and are designated as SB-01 (south abutment) and SB-02 (north abutment). SB-01 is approximately 5 feet south of the south abutment on the west side of the road, and SB-02 is approximately 5 feet north of the north abutment on the east side of the road (see ***Appendix I, Soil Boring Location Map***).

AET completed the soil borings on May 5, 2020 with a two-man crew using a CME 55 rotary drill rig mounted on a freightliner single-axle truck chassis. Drilling methods utilized 4 ¼ inch I.D. hollow shaft augers (HSA) and 3-7/8 inch mud rotary drilling techniques.

In both locations, representative soil samples were obtained in general accordance with the current ASTM Specification D-1586 “Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.” In this procedure, a two-inch O.D. split barrel sampler is driven into the ground a distance of 18 inches by means of a 140 lb. hammer repeatedly falling 30 inches. The standard penetration resistance value (N) is the number of blows per foot of penetration for the final 12 inches of driving. This value can be used to provide a qualitative indication of the in-place density of cohesionless soils. This characterization is qualitative since many factors can significantly affect the standard penetration resistance value and prevent direct correlation. After driving, the sampler is retrieved and opened, and the sample is analyzed. The soil was visually/manually classified according to type by the Field Geologist/Geologist Technician, under the guidelines of the Unified Soil Classification System (USCS) (see ***Appendix II***) and specification ASTM D-2488 “Identification of Soils (Visual-Manual Procedure)”. Field logs noting the methods of drilling and sampling, along with the Standard Penetration values (N-values, “blows per foot”), preliminary soil classification, and observed groundwater levels were completed during drilling. Finalized boring logs are included as ***Appendix IV*****.**

The two (2) soil borings, SB-01 and SB-02, were drilled to auger refusal depths (at apparent bedrock) of 43.3 and 42.6 feet below ground surface (bgs), respectively. Rock cores were not taken. Samples were collected at 2.5 foot intervals for the first 10 feet bgs, at 5 foot intervals below 10 feet, and at each change in soil consistency thereafter to the boring termination depth.

Groundwater encountered during drilling was located at about 6.8 feet bgs. Soil borings were backfilled with native material and a bentonite hole plug upon completion.

2.2 Laboratory Procedures

All soil samples collected in the field were examined and classified by an AET staff engineer in the laboratory. The penetration test samples were also provided by AET to UPEA in sealed containers. UPEA visually observed the distribution of grain sizes, plasticity, organic content, moisture condition, color and the presence of lenses and seams. Classification according to USCS/ASTM D-2487 was verified. The estimated soil group is included following the soil description on the boring logs. These logs are contained in ***Appendix IV***. Similar soils were grouped into strata, or layers, on the logs. Please note that strata lines represent the approximate boundaries between soil types and there may be gradual variations in both the horizontal and vertical directions.

3.0 Exploration Results

3.1 Existing Site Conditions

The existing structure is a 45 foot two-span timber stringer bridge with timber pile foundations. The bridge approach roadway on each side consists of sand fill with a gravel surface. There is approximately 4.3 feet from the top of the existing bridge deck (approximate soil boring surface elevation) to the top of the river bank at each abutment. There is approximately 5.6 feet from the top of the existing bridge deck to the observed water level elevation.

3.2 Subsurface Soil Conditions

Soil boring SB-01 was advanced from elevation 717.5 feet (NAVD88). Roadway fill consisting of

sand with silt and gravel was encountered from the ground surface to approximately 1 foot bgs, followed by sand to 4.5 feet bgs. Sand with trace wood was encountered from 4.5 to 18 feet bgs. Wet, very dense sand with silt (and silty sand) was encountered from 18 to 34.5 feet bgs. Moist, dense, clayey sand with gravel was encountered from 34.5 feet bgs to approximately 42.2 feet bgs. Auger refusal and the end of exploration was at 43.3 feet bgs, with possible bedrock beginning at 42.2 feet bgs (elevation = 675.3 feet). Groundwater was encountered at about 6.8 feet bgs.

Soil boring SB-02 was advanced from elevation 717.5 feet (NAVD88). Roadway fill consisting of sand with silt and gravel was encountered from the ground surface to approximately 1 foot bgs, followed by sand and a little gravel to 2 feet bgs. Slightly organic sand with silt and gravel and a little roots and wood was encountered to 9.5 feet bgs. Sand with a little wood was encountered from 9.5 to 18 feet bgs. Wet, medium dense sand with silt (and silty sand) was encountered from 18 to 34.5 feet bgs. Moist to wet, medium dense, clayey sand with gravel was encountered from 34.5 feet bgs to approximately 41.6 feet bgs (with a possible boulder at 36 feet bgs). Auger refusal and the end of exploration was at 42.6 feet bgs, with possible bedrock beginning at 41.6 feet bgs (elevation = 675.9 feet). Groundwater was encountered at about 6.8 feet bgs.

Since both soil borings terminated at nearly the same elevations, it is our assumption that bedrock was encountered, as opposed to a boulder.

3.3 Groundwater Conditions

Groundwater encountered during drilling was located at about 6.81 feet bgs. Groundwater should be expected at the level of the Carp River. Seasonal fluctuations in groundwater should be anticipated.

4.0 Analysis and Recommendations

The following sections provide recommendations as well as general construction considerations for site preparation, foundation design and construction based on the site information collected during the subsurface exploration at the site.

4.1 Site Preparation

As part of the removal of the existing bridge, the existing timber piles at each abutment may be left in place (cut off at grade) if the outside edge of the existing piles is not within one (1) pile diameter of the outside edge of the proposed piles. If the outside edge of the proposed piles is closer than one (1) pile diameter to the outside edge of the existing piles, it is recommended that the existing piles are completely removed from the ground. It is recommended that the piles at the pier in the middle of the river are completely removed from the ground for hydraulic and aquatic organism considerations.

Behind each abutment, it is recommended to excavate to an elevation that is about one (1) to two (2) feet below the top of the proposed riprap bank elevation on the front side of the abutment. This elevation is estimated to be at 713 feet (+/-) (approximately 4.5 feet bgs). It is not anticipated that groundwater will be encountered at this elevation, but that is dependent on the level of the river and seasonal fluctuations. If groundwater is encountered, it is recommended to dewater the excavation with a sump pump until groundwater is about 3 feet

below the bottom of the excavation prior to placement of backfill material. The limits of lateral excavation should be equal to the depth, at a minimum.

With the assumption of an adequately dewatered excavation, it is recommended to backfill the abutments with “Structural Backfill” sand in accordance with Sections 208 and 704 of FHWA FP-14 Specifications. The sand backfill shall be placed in lifts not exceeding 6 inches in loose thickness and compacted to a minimum of ninety-five percent (95%) of the maximum dry density; in-place density and moisture content shall be determined according to AASHTO T 310 or other approved test procedures. This backfill should be placed up to the bottom of the proposed aggregate base material and extended out to the limits of the excavation. The on-site soil shall not be re-used for abutment backfill. A minimum 4-inch diameter perforated flexible drain pipe should be located behind and parallel to each abutment, with its invert elevation above the water table. The drain pipe should be wrapped in filter fabric and sloped to daylight and discharge beyond the ends of the proposed wingwalls.

4.2 Driven Timber Pile Foundations

Based on the subsurface soil conditions, driven treated timber piles are a suitable foundation for the proposed bridge. Pile resistance will be a combination of side friction and end bearing. Pile lengths are estimated to be 30 to 40 feet.

Pile center to center spacing is recommended to be not less than three (3) pile widths/diameters. Riprap should be sized and banks installed in front of each abutment as a scour countermeasure.

4.3 Road Restoration

Surfacing shall consist of 6 inches of ¾ inch minus compacted aggregate, and where required, 3 inches of asphalt pavement over the prepared base course, or as required by the owner. Asphalt and aggregate shall meet MDOT and/or FHWA specifications. The existing road subbase material within the frost zone, south of the bridge, primarily consists of sand, which is suitable as is. North of the bridge there is slightly organic sand with silt and gravel within the frost zone. See section 4.1 for backfill recommendations within the proposed excavations. In addition, consideration should be given to excavate “slightly organic” material (to 4 feet bgs) for the entire project limits to the north and install sand subbase material.

4.4 Lateral Loads

It is recommended to use the following variables for the structural design of the abutments and wingwalls resisting lateral loads from soil backfill and/or live load surcharge: moist unit weight of soil of 120 pcf and a conservative effective angle of repose of 30°. “At rest” (Ko) coefficient = 0.5; “active” (Ka) coefficient = 0.33 and the “passive” (Kp) coefficient = 2.5 to 3.0.

In accordance with AASHTO LRFD Bridge Design Specifications, a live load surcharge shall be applied where vehicular load is expected to act on the surface of the backfill within a distance equal to one-half the wall height behind the back face of the wall. Uniform horizontal earth pressure due to live load surcharge shall be calculated and utilized in design per AASHTO LRFD 3.11.6.4.

4.5 Construction Considerations

All excavations shall be performed in accordance with pertinent state, local and federal (OSHA) regulations. Excavation safety is the responsibility of the Contractor. Material stockpiles or heavy equipment should not be placed near the edge of excavated slopes. Stockpiled materials and equipment may be placed no closer than a distance equal to 1.5 times the depth of excavation from the top edge of excavated slope.

For structural design of any required temporary cofferdams we recommend the following variables: The average moist unit weight of the typical soil is 120 pcf and a conservative effective angle of repose of 30° provided the soils are not, and do not become, saturated. At an effective angle of repose of 30°, the “at rest” (Ko) coefficient is approximately 0.5; “active” (Ka) coefficient is 0.33 and the “passive” (Kp) coefficient is approximately 3.0.

Dewatering systems, if required based on site conditions, are typically installed in the field by contractor’s typical methods. The Contractor may need to adjust the method until finding the adequate pumping system.

5.0 General Qualifications

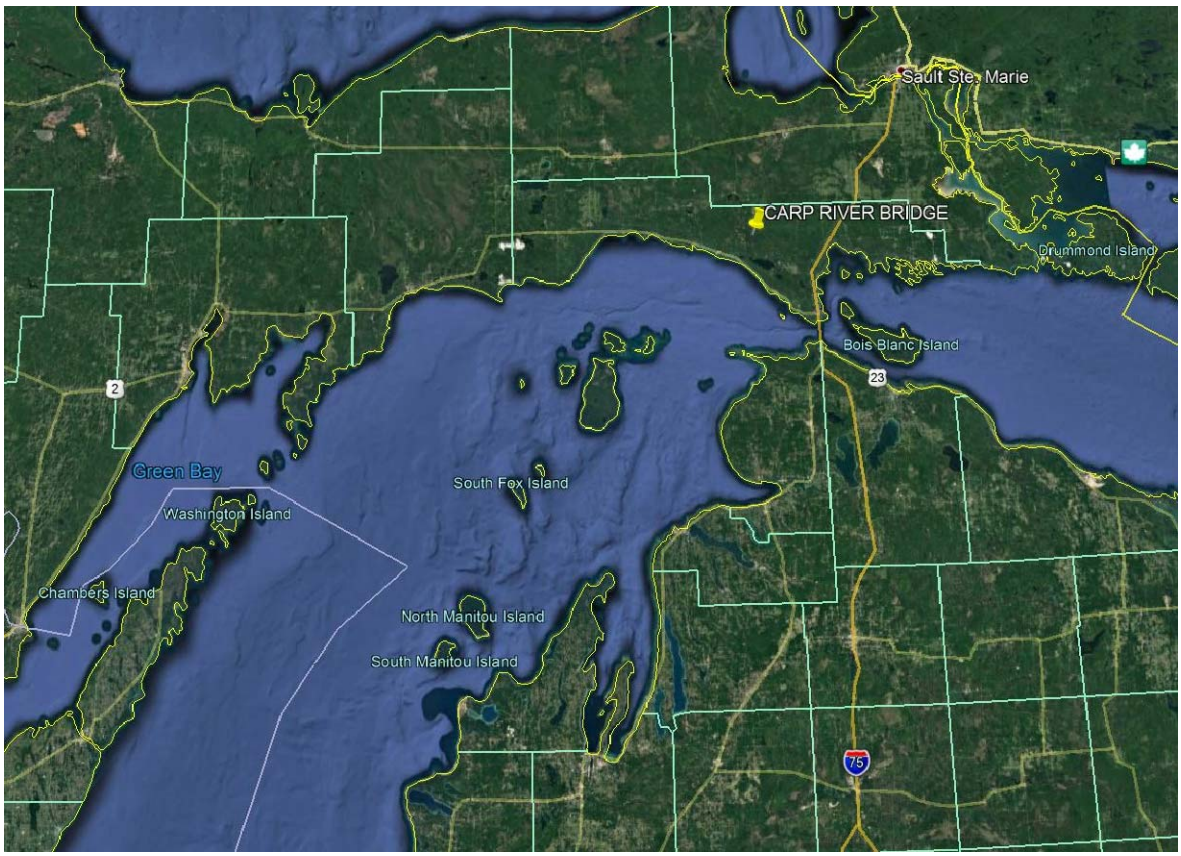
This report has been prepared in general accordance with normally accepted geotechnical engineering practices to aid in the evaluation of this site and to assist our Client in the design of this project. We have prepared this report for the purpose intended by UPEA our Client, and reliance on its contents by anyone other than UPEA and our Client is at the sole risk of the user. No other warranty, expressed or implied, is made. The scope is limited to the specific project and location described herein, and our description of the project represents our understanding of the significant aspects relevant to the geotechnical characteristics. In the event that any changes in the design or location of the facilities as outlined in this report are planned, UPEA should be informed so that the changes can be reviewed and the conclusions of this report modified as necessary, in writing, by the geotechnical engineer.

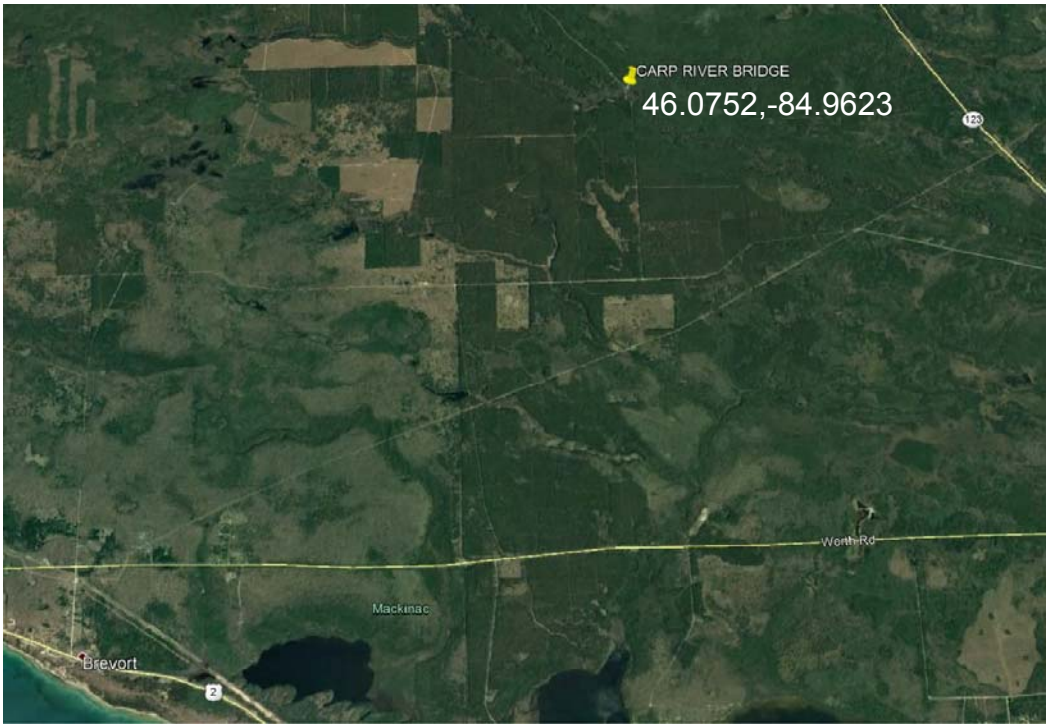
The analysis and recommendations submitted in this report are based on the data obtained from the soil borings performed at the locations indicated on the location diagram and from the information discussed in this report. This report does not reflect any variations which may occur between the borings. In the performance of subsurface explorations, specific information is obtained from specific locations at specific times. However, it is well-established that variations in soil and rock conditions exist on most sites between boring locations and that seasonal fluctuations in groundwater levels will likely occur. The nature and extent of variations may not become evident until a later date. If variations become evident, it will be necessary for a re-evaluation of the recommendations contained in this report after performing on-site observations during the construction period and noting the characteristics of the variations.

The scope of services for this project does not include either specifically, or by implication, any environmental or biological assessment of the site, or identification of or prevention of pollutants, hazardous materials, or conditions at, or affecting, the site. Other studies beyond the scope of this project would be required to evaluate the potential of such contamination or pollution.

Appendix I – Location Maps

- **Project Location Map**
- **Soil Boring Location Map**





PROJECT LOCATION MAP

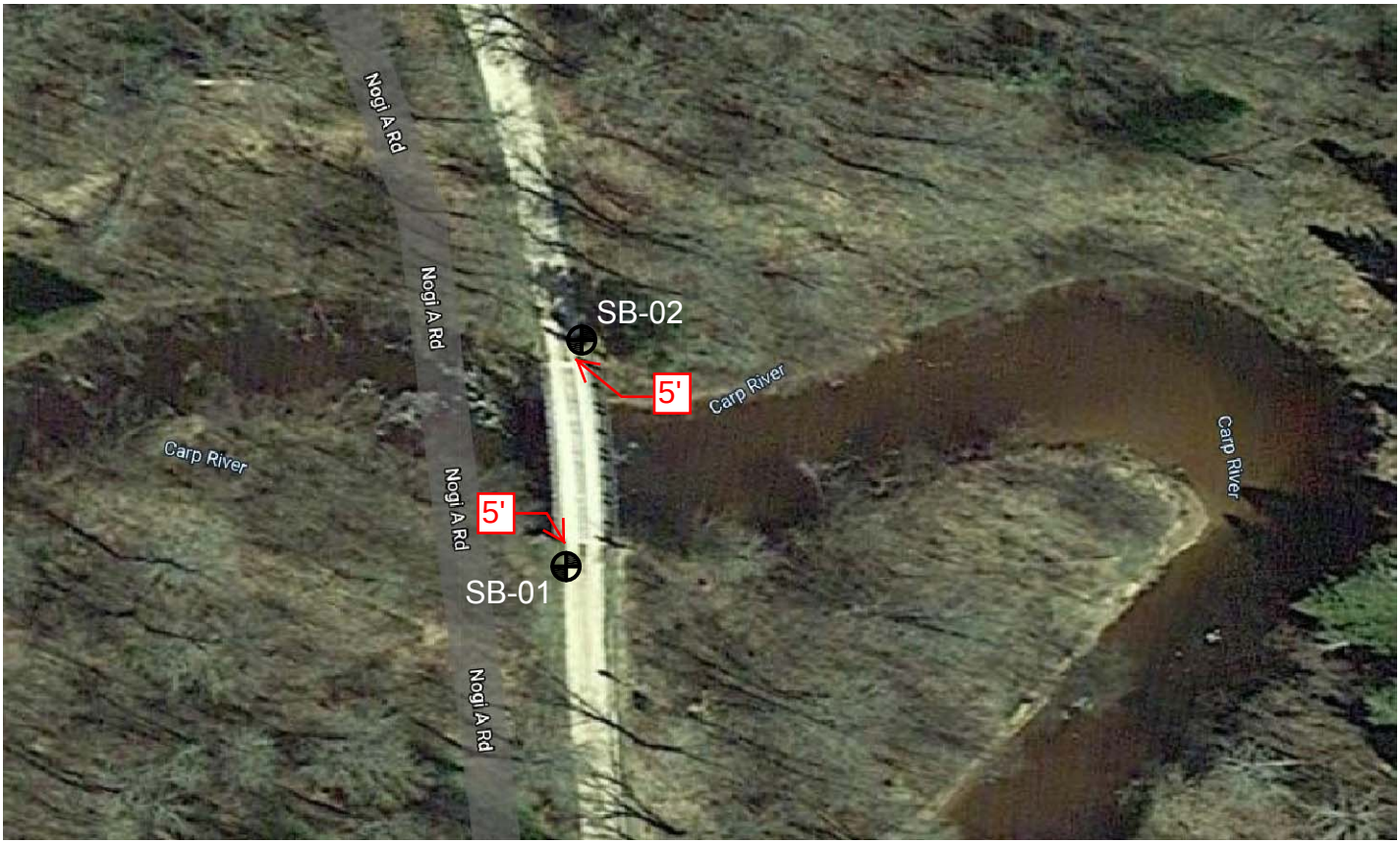
UPEA ENGINEERS & ARCHITECTS

U.P. ENGINEERS & ARCHITECTS, INC.

Houghton Iron Mountain Ishpeming Sault Ste. Marie Marinette

FR 3458-1.4 OVER CARP RIVER
USDA FOREST SERVICE
HIAWATHA NAT'L FOREST - MACKINAC COUNTY, MI

DRAWN: GBJ	DATE: 6/15/2020	JOB No: U28-00286	DRAWING:



SOIL BORING LOCATION MAP

UPEA ENGINEERS & ARCHITECTS
U.P. ENGINEERS & ARCHITECTS, INC.
Houghton Iron Mountain Ishpeming Sault Ste. Marie Marinette

FR 3458-1.4 OVER CARP RIVER
USDA FOREST SERVICE
HIAWATHA NAT'L FOREST - MACKINAC COUNTY, MI

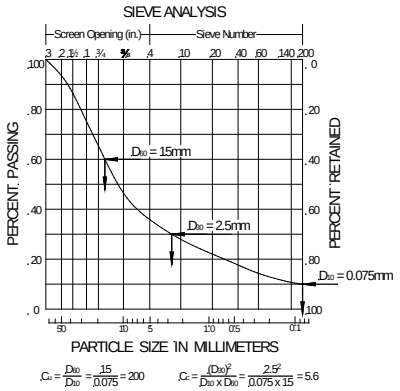
DRAWN: GBJ	DATE: 6/15/2020	JOB No: U28-00286	DRAWING:

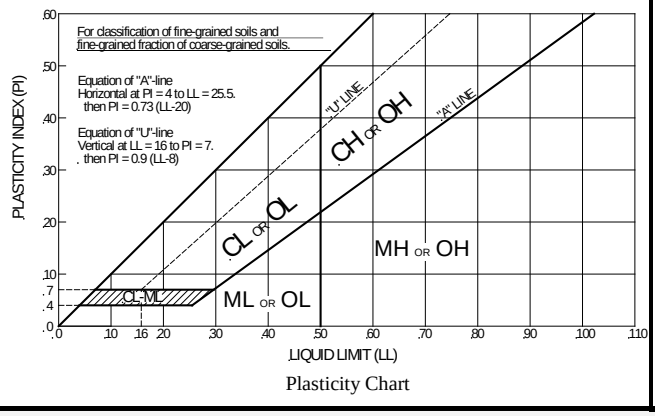
Appendix II – Classification of Soils for Engineering Purposes (Unified Soil Classification System)

UNIFIED SOIL CLASSIFICATION SYSTEM
ASTM Designations: D 2487, D2488

AMERICAN ENGINEERING TESTING, INC.

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification: Group Symbol	Soil Classification: Group Name[B]
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	Cu≥4 and 1≤Cc≤3[E]	GW	Well graded gravel[F]
			Cu<4 and/or 1>Cc>3[E]	GP	Poorly graded gravel[F]
		Gravels with Fines more than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	Cu≥6 and 1≤Cc≤3[E]	SW	Well-graded sand[I]
			Cu<6 and/or 1>Cc>3[E]	SP	Poorly-graded sand[I]
		Sands with Fines more than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve (see Plasticity Chart below)	Silts and Clays Liquid limit less than 50	inorganic	PI>7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI<4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	Liquid limit–oven dried <0.75 Liquid limit – not dried	OL	Organic clay[K,L,M,N] Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		organic	Liquid limit–oven dried <0.75 Liquid limit – not dried	OH	Organic clay[K,L,M,P] Organic silt[K,L,M,Q]
Highly organic soil			Primarily organic matter, dark in color, and organic in odor	PT	Peat[R]





Plasticity Chart

Notes

[A]Based on the material passing the 3-in (75-mm) sieve.
[B]If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C]Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
[D]Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E]$Cu = D_{60} / D_{10}$, $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F]If soil contains ≥15% sand, add "with sand" to group name.
[G]If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H]If fines are organic, add "with organic fines" to group name.
[I]If soil contains ≥15% gravel, add "with gravel" to group name.
[J]If Atterberg limits plot is hatched area, soil is a CL-ML silty clay.
[K]If soil contains 15 to 29% plus No. 200 add "with sand" or "with gravel", whichever is predominant.
[L]If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.
[M]If soil contains ≥30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N]PI≥4 and plots on or above "A" line.
[O]PI<4 or plots below "A" line.
[P]PI plots on or above "A" line.
[Q]PI plots below "A" line.
[R]Fiber Content description shown below.

ADDITIONAL TERMINOLOGY NOTES USED BY AET FOR SOIL IDENTIFICATION AND DESCRIPTION

Grain Size

Term	Particle Size
Boulders	Over 12"
Cobbles	3" to 12"
Gravel	#4 sieve to 3"
Sand	#200 to #4 sieve
Fines (silt & clay)	Pass #200 sieve

Gravel Percentages

Term	Percent
A Little Gravel	3% - 14%
With Gravel	15% - 29%
Gravelly	30% - 50%

Consistency of Plastic Soils

Term	N-Value, BPF
Very Soft	less than 2
Soft	2 - 4
Firm	5 - 8
Stiff	9 - 15
Very Stiff	16 - 30
Hard	Greater than 30

Relative Density of Non-Plastic Soils

Term	N-Value, BPF
Very Loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	Greater than 50

Moisture/Frost Condition

(MC Column)

D (Dry): Absence of moisture, dusty, dry to touch.
M (Moist): Damp, although free water not visible. Soil may still have a high water content (over "optimum").
W (Wet/ Waterbearing): Free water visible, intended to describe non-plastic soils. Waterbearing usually relates to sands and sand with silt.
F (Frozen): Soil frozen

Layering Notes

Laminations: Layers less than ½" thick of differing material or color.
Lenses: Pockets or layers greater than ½" thick of differing material or color.

Peat Description

Term	Fiber Content (Visual Estimate)
Fibric Peat:	Greater than 67%
Hemic Peat:	33 – 67%
Sapric Peat:	Less than 33%

Organic Description (if no lab tests)

Soils are described as *organic*, if soil is not peat and is judged to have sufficient organic fines content to influence the Liquid Limit properties. *Slightly organic* used for borderline cases.

Root Inclusions

With roots: Judged to have sufficient quantity of roots to influence the soil properties.
Trace roots: Small roots present, but not judged to be in sufficient quantity to significantly affect soil properties.

Appendix III – Soil Exploration – General Notes and Legend

BORING LOG NOTES

DRILLING AND SAMPLING SYMBOLS

Symbol	Definition
B,H,N:	Size of flush-joint casing
CA:	Crew Assistant (initials)
CAS:	Pipe casing, number indicates nominal diameter in inches
CC:	Crew Chief (initials)
COT:	Clean-out tube
DC:	Drive casing; number indicates diameter in inches
DM:	Drilling mud or bentonite slurry
DR:	Driller (initials)
DS:	Disturbed sample from auger flights
FA:	Flight auger; number indicates outside diameter in inches
HA:	Hand auger; number indicates outside diameter
HSA:	Hollow stem auger; number indicates inside diameter in inches
LG:	Field logger (initials)
MC:	Column used to describe moisture condition of samples and for the ground water level symbols
N (BPF):	Standard penetration resistance (N-value) in blows per foot (see notes)
NQ:	NQ wireline core barrel
PQ:	PQ wireline core barrel
RD:	Rotary drilling with fluid and roller or drag bit
REC:	In split-spoon (see notes) and thin-walled tube sampling, the recovered length (in inches) of sample. In rock coring, the length of core recovered (expressed as percent of the total core run). Zero indicates no sample recovered.
REV:	Revert drilling fluid
SS:	Standard split-spoon sampler (steel; 1-3/8" is inside diameter; 2" outside diameter); unless indicated otherwise
SU	Spin-up sample from hollow stem auger
TW:	Thin-walled tube; number indicates inside diameter in inches
WASH:	Sample of material obtained by screening returning rotary drilling fluid or by which has collected inside the borehole after "falling" through drilling fluid
WH:	Sampler advanced by static weight of drill rod and 140-pound hammer
WR:	Sampler advanced by static weight of drill rod
94mm:	94 millimeter wireline core barrel
▼:	Water level directly measured in boring
∇:	Estimated water level based solely on sample appearance

TEST SYMBOLS

Symbol	Definition
CONS:	One-dimensional consolidation test
DEN:	Dry density, pcf
DST:	Direct shear test
E:	Pressuremeter Modulus, tsf
HYD:	Hydrometer analysis
LL:	Liquid Limit, %
LP:	Pressuremeter Limit Pressure, tsf
OC:	Organic Content, %
PERM:	Coefficient of permeability (K) test; F - Field; L - Laboratory
PL:	Plastic Limit, %
q_p:	Pocket Penetrometer strength, tsf (approximate)
q_c:	Static cone bearing pressure, tsf
q_u:	Unconfined compressive strength, psf
R:	Electrical Resistivity, ohm-cms
RQD:	Rock Quality Designation of Rock Core, in percent (aggregate length of core pieces 4" or more in length as a percent of total core run)
SA:	Sieve analysis
TRX:	Triaxial compression test
VSR:	Vane shear strength, remoulded (field), psf
VSU:	Vane shear strength, undisturbed (field), psf
WC:	Water content, as percent of dry weight
%-200:	Percent of material finer than #200 sieve

STANDARD PENETRATION TEST NOTES

The standard penetration test consists of driving the sampler with a 140 pound hammer and counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), permitted in ASTM:D1586, the blows for each complete 6" increment and for each partial increment is on the boring log. For partial increments, the number of blows is shown to the nearest 0.1' below the slash.

The length of sample recovered, as shown on the "REC" column, may be greater than the distance indicated in the N column. The disparity is because the N-value is recorded below the initial 6" set (unless partial penetration defined in ASTM:D1586 is encountered) whereas the length of sample recovered is for the entire sampler drive (which may even extend more than 18").

Appendix IV – Soil Boring Logs

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **07-20533** LOG OF BORING NO. **SB-01 (Carp) (p. 1 of 1)**

PROJECT: **Soil Borings for Bridge Replacement; Hiawatha & Ottawa National Forests, MI**

SURFACE ELEVATION: **717.5** LATITUDE: **46.075097** LONGITUDE: **-84.962316**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	qp	LL	PL	%-#200
1–2	FILL, sand with silt and gravel, brown and reddish brown	FILL	4	M	SS	12					
3–4	FILL, sand, reddish brown		5	M	SS	10					
5–6	FILL, sand, trace wood, dark brown		2	▼	SS	16					
7–8	FILL, sand, trace wood, brown and gray		7	W	SS	19					
9–11			8	W	SS	24					
12–16			10	W	SS	12					
17–20	SAND WITH SILT, light brown, wet, very dense (SP-SM)	COARSE ALLUVIUM	60	W	SS	20					
21–25			75	W	SS	16					
26–30	SILTY SAND, light brown, wet, very dense (SM)		45/0.5 51/0.5 50/0.4	W	SS	13					
31–35	CLAYEY SAND, a little gravel, grayish brown, moist, medium dense (SC)	MIXED ALLUVIUM	16	M	SS	22					
36–40	CLAYEY SAND, with gravel, light brown, moist, dense (SC)		37	M	SS	14					
41–43	POSSIBLE BEDROCK, dark gray and white	POSSIBLE BEDROCK	50/0.1		SS	0					
	AUGER REFUSAL AT 43.3 FEET										
	Boring backfilled with bentonite grout										

DEPTH:	DRILLING METHOD
0-14½'	**4.25" HSA**
14½-43.2'	**RD w/DM**
BORING COMPLETED:	**5/5/20**
DR: **JA**	LG: **KM** Rig: **51**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
5/5/20	**14:25**	**11.5**	**9.5**	**8.9**	**None**	**6.9**
5/5/20	**14:35**	**11.5**	**9.5**	**8.4**	**None**	**6.6**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-LAT-LONG 07-20533_UPEA MICHIGAN BRIDGES.GPJ AET+CPT+WELL.GDT 6/15/20

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **07-20533** LOG OF BORING NO. **SB-02 (Carp) (p. 1 of 1)**

PROJECT: **Soil Borings for Bridge Replacement; Hiawatha & Ottawa National Forests, MI**

SURFACE ELEVATION: **717.5** LATITUDE: **46.075250** LONGITUDE: **-84.962299**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	qp	LL	PL	%-#200
1-2	FILL, sand with silt and gravel, brown and reddish brown	FILL	6	M	SS	12					
3-4	FILL, sand, a little gravel, reddish brown		8	M	SS	8					
5-6	FILL, slightly organic sand with silt and gravel, a little roots and wood, brown and reddish brown and gray		3	▼	SS	14					
7-8			2	W	SS	12					
9-10	FILL, slightly organic silty sand, with wood, brown and dark brown		6	W	SS	14					
11-17	FILL, sand, a little wood, brown and grayish brown		8	W	SS	18					
18-22	SAND WITH SILT, light brown, wet, medium dense (SP-SM)	COARSE ALLUVIUM	20	W	SS	20					
23-34	SILTY SAND, light brown, wet, medium dense to loose (SM)		19	W	SS	18					
			8	W	SS	20					
35-39	CLAYEY SAND, a little gravel, grayish brown, moist to wet, medium dense (SC) *Possible Boulder at 36 feet	MIXED ALLUVIUM	11	W	SS	18					
40-41	CLAYEY SAND, with gravel, light brown, moise, medium dense (SC)		50	W	SS	24					
42	POSSIBLE BEDROCK, dark gray and white	POSSIBLE BEDROCK	50/0.1		SS	0					
	AUGER REFUSAL AT 42.6 FEET *Boring backfilled with bentonite grout*										

DEPTH:	DRILLING METHOD
0-14½'	**4.25" HSA**
14½-42.5'	**RD w/DM**
BORING COMPLETED:	**5/5/20**
DR: **JA**	LG: **KM** Rig: **51**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
5/5/20	**08:30**	**11.5**	**9.5**	**9.5**	**None**	**7.2**
5/5/20	**08:40**	**11.5**	**9.5**	**8.3**	**None**	**6.5**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-LAT-LONG 07-20533_UPEA MICHIGAN BRIDGES.GPJ AET+CPT+WELL.GDT 6/15/20