SUBMITTED TO:
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100 Cognac Court
Lake Saint Louis, MO 63367

BY:
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GEOTECHNICAL FEASIBILITY STUDY

Lake Saint Louis Seawalls

LAKE SAINT LOUIS, MISSOURI

SHANNON & WILSON

January 31, 2022

Shannon & Wilson No: 107905-001

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Submitted To: Lake Saint Louis Community Association
100 Cognac Court
Lake Saint Louis, MO 63367
Attn: Heather Becker

Subject: GEOTECHNICAL FEASIBILITY STUDY, LAKE SAINT LOUIS SEAWALLS, LAKE SAINT LOUIS, MISSOURI

Our report summarizing the results of the geotechnical feasibility study for the Lake Saint Louis Community Association's proposed seawalls at the Windjammer Marina and Jefferson Point in Lake Saint Louis, Missouri is enclosed. The services we have provided are generally as outlined in our proposal dated October 5, 2021 and authorized by you on November 24, 2021.

We appreciate the opportunity to work with you again and look forward to continuing our involvement on this project. Please contact us if you have questions concerning this report.

Sincerely,

SHANNON & WILSON, INC.
Professional Engineering Corporation
Missouri Certificate of Authority #000413

Vonmarie
Martinez-Chaluisant
NUMBER
PE-2016003092

01/31/2022

Vonmarie Martinez, P.E.
Senior Geotechnical Engineer

VMC:PMK:TJA/tad

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1 INTRODUCTION

This report summarizes the results of a geotechnical feasibility study for the Lake Saint Louis Community Association's (LSLCA) proposed seawalls at the Windjammer Marina and Jefferson Point located in Lake Saint Louis, Missouri. The purpose of this study was to perform a geotechnical exploration to evaluate possible seawall options. The scope of services included subsurface explorations using rotary borings, field and laboratory testing of recovered soil and rock samples, and evaluation of the subsurface conditions as they relate to the proposed construction. The services were provided in general accordance with our proposal dated October 5, 2022 and authorized by Ms. Heather Becker of Lake Saint Louis Community Association on November 24, 2021.

2 PROJECT AND SITE DESCRIPTION

We understand this project will be similar in scope to the Main Marina Seawall project, which we previously completed for the LSLCA. We understand LSLCA desires to build seawalls at the Windjammer Marina and Jefferson Point. The project location is shown on Figure 1 and each site is described in detail below.

2.1 Windjammer Marina

The Windjammer Marina is located at the end of Wharf Street off Veterans Memorial Parkway in Lake Saint Louis, Missouri. The seawall will be approximately 300 feet in length along the western boardwalk and about 350 feet in length along the shoreline of the pavilion/boat ramp area, totaling about 650 feet in length.

The northern portion of the Windjammer site contains an approximately 9.5-foot-wide boardwalk supported on concrete piers within the lake and by a concrete retaining wall along the shoreline. Above the concrete retaining wall, a 2-tier concrete block retaining wall extends approximately 280 feet north to south above and parallel to the boardwalk. This retaining wall transitions to a single tier retaining wall for the southernmost approximately 70-feet. Each tier of the wall is up to about 5 feet in height, with the first tier located immediately behind the boardwalk. Where 2-tiers are present the horizontal distance between the two tiers is about 5 feet. The total height of the concrete block retaining wall where two tiers are present is up to about 6 feet. A grass covered slope, up to about 6 feet in height, extends above the wall with paved parking area at the top of the slope. We anticipate geotextile reinforcement grid is located behind the retaining wall below the ground surface. We do not have details about the design or construction of the existing concrete piers, concrete retaining wall, or concrete block retaining wall. Overall, the parking lot is between 5 and 12 feet above the boardwalk.

The southern portion of the Windjammer Marina consists of gently sloping ground, with several docks, pavilions, a bar, and a boat ramp. A 2-foot to 3-foot-tall railroad tie retaining wall, riprap and gravel are present along the shoreline.

The proposed seawall would be approximately 6 feet from the existing concrete retaining wall that supports the boardwalk on the northern shoreline of the marina and then would extend along the southern shoreline. Some grading in the vicinity of the pavilion will be required to provide a level surface extending directly behind the seawall to the finished floor elevation of the pavilion. From the pavilion towards the boat ramp, the seawall elevation will taper down from the finished floor elevation of the pavilion to the shoreline. The elevations of the seawall will be better defined as the design progresses.

2.2 Jefferson Point

Jefferson Point is located east of Civic Center Drive near the I-64 bridge crossing Lake Saint Louis. The site lies approximately 2 to 3 feet above normal pool lake level. The site is relatively flat with grass, pavement, and gravel covered areas along with several structures and docks. The seawall will be approximately 280 feet in length along the eastern shoreline of Jefferson Point. The area adjacent to the proposed seawall has been used for storage of the Lake's barge, debris dredged and/or pulled from the lake, and provides for equipment access to the lake. There is a concrete block retaining wall along the southern portion of the shoreline, where the lake's barge is stored.

3 FIELD EXPLORATIONS AND LABORATORY TESTING

3.1 Field Explorations

The site exploration consisted of a visual reconnaissance of the site and surrounding area, and the drilling of seven (7) borings. Five (5) borings were drilled at the Windjammer Marina at the approximate location shown on Figure 2. Two (2) borings were drilled at Jefferson Point at the approximate location shown on Figure 3. Borings were located as close as possible to the approximate location of the proposed seawall.

3.1.1 Site Reconnaissance

Shannon & Wilson field representatives established the exploration locations at the site using a hand-held GPS and surveyed the boring elevations using a laser level and referenced to the manhole identified on Figure 2. From the *Lake Saint Louis Overall Sewer Layout* drawing dated 11/07/18 by Pickett, Ray & Silver Inc., the reference manhole is at elevation 506.19 feet. On January 18, 2022, we surveyed the reference manhole, lake water level, and boring locations.

3.1.2 Soil Drilling and Sampling

The borings were drilled between December 15 and December 17, 2021, using a CME 1050 rotary drill rig equipped with hollow stem augers and NQ-sized rock core equipment. The borings were completed by Roberts Environmental Drilling, Inc. under subcontract to Shannon & Wilson, Inc.

An experienced geologist from Shannon & Wilson was present throughout the site exploration to observe the drilling, select sample location and frequency, inspect recovered samples, preserve portions of collected samples for laboratory testing, and prepare descriptive field logs of observed conditions. Appendix A includes the Soil Description and Log Key used during the field exploration. Pocket penetrometer measurements were performed on recovered cohesive soil samples.

Individual logs of each boring summarizing intervals and types, material descriptions, groundwater observations, and other pertinent field and laboratory observations and data are included in Appendix A. Stratification boundaries and characteristics of the soil materials shown on the boring logs and discussed in this report are based on observations made during the subsurface exploration, the results of sample examination, laboratory test results, and interpretations of the local and regional geology. The location of stratification boundaries between different material types is approximate because changes in these boundaries may occur gradually or between sampled intervals.

Borings where drilled and sampled in accordance with standard drilling practice and ASTM procedures where applicable. Samples were recovered at depths selected by the Shannon & Wilson field representative. Split-spoon samples and Standard Penetration Tests (SPTs) were obtained at about 2.5-foot intervals in the upper 10 feet with 2.5- to 5-foot intervals below this depth. Recovered split-spoon samples were sealed in glass jars by a Shannon & Wilson field representative and transported to our laboratory for further inspection and testing. Shelby tube samples were collected at selected intervals. The explorations were backfilled with soil cuttings and bentonite chips upon completion. Borings SW-02 and SW-05 were patched with asphalt cold-patch.

3.2 Rock Coring

Rock coring was performed in Borings SW-06 and SW-07. The bedrock was cored using NQ-sized, split-inner barrel, wire-line coring tools capable of retrieving 5- or 10-foot-long core lengths. The NQ-sized core barrel retrieves a 2.5-inch diameter core and cuts a 3.8-inch diameter hole.

Each coring run was measured to determine recovery (the percentage ratio between the length of the core recovered and the length of the core drilled in a given run) and Rock Quality Designation (RQD) (the percentage ratio between the sum of the lengths of pieces of core greater than 4 inches and the length of the core drilled in a given run). A summary of RQD versus rock quality, which is generally accepted in the profession, is provided in Exhibit 3-1. Rock core photos are included in Appendix B.

Exhibit 3-1: RQD versus Rock Quality

RQD (percent)	Rock Quality
90 – 100	Excellent
75 – 90	Good
50 – 75	Fair
25 – 50	Poor
0 – 25	Very Poor

3.3 Laboratory Testing

Recovered cohesive soil samples were tested to determine their natural moisture content. Liquid and plastic limit determinations and grain size analysis were performed on selected samples to aid in classification. Unconsolidated-undrained strength and unconfined compression strength tests were performed on selected samples to determine the strength properties of the materials. A uniaxial compressive strength test was performed on a rock core sample. Laboratory testing was performed using current ASTM procedures. The results of laboratory testing are summarized graphically on the boring logs and included in Appendix C.

4 SUBSURFACE CONDITIONS

4.1 Windjammer Marina

Four borings (SW-02 through SW-05) were extended from the ground surface to the planned termination depth of 30 feet below the ground surface (bgs). One boring (SW-01) was terminated at SPT refusal at 29.8 feet bgs. Borings SW-02 and SW-05 were drilled through the pavement and encountered 5 inches of asphalt overlying 5 inches of crushed limestone base rock.

Boring SW-01 encountered stiff to medium stiff, lean clay from the ground surface to 5.5 feet and from 12.5 to 22 feet. A medium stiff, fat clay was encountered from 5.5 to 8 feet. The fat clay was underlain by medium stiff to stiff, gravelly lean clay to 12.5 feet, and hard, gravelly lean clay from 22 feet to 29.8 feet. Boring SW-01 was terminated on split spoon refusal.

Boring SW-02 encountered soft fill consisting of gravelly lean clay and crushed rock to a depth of 5.5 feet. Medium stiff to very stiff, fat clay layers were encountered from 5.5 to 9 feet and from 25.5 to 29.5 feet at Boring SW-02. A medium stiff, lean clay was encountered from 9 to 25.5 feet. The boring was terminated at 30 feet on medium dense, clayey gravel with sand.

Boring SW-03 encountered 3 feet of medium stiff, lean clay with varying contents of sand and gravel. Soft to very stiff, gravelly lean clay was encountered from 3 to 8 feet and from 18 to 22 feet. Very loose to loose, gravel with varying contents of sand and clay was encountered between 8 and 18 feet. A medium stiff, sandy lean clay was encountered between 22 and 27 feet. Medium stiff, fat clay, was encountered below 27 feet to the termination of the boring at 30 feet bgs.

Boring SW-04 was drilled in the beach surface and encountered hard, sandy silt with gravel in the upper 3 feet underlain by 15 feet loose to medium dense, sand with varying amounts of gravel and clay. Below 18 feet, the soil profile at Boring SW-04 consisted of medium stiff, lean and fat clay layers to the termination depth of 30 feet bgs.

Boring SW-05 encountered medium dense to very dense, sand with varying amounts of gravel and clay that extended to 16 feet. Below 16 feet, the soil profile at Boring SW-05 consisted of soft to stiff, lean clay to the termination of the boring at 30 feet bgs.

4.2 Jefferson Point

Two borings (SW-06 and SW-07) were drilled at the Jefferson Point site. Borings SW-06 and SW-07 encountered a medium dense to loose, sand layer that extended to 3 feet bgs. At Boring SW-06 the sand layer was underlain by stiff, lean clay that extended to the top of rock at 17.5 feet bgs. Boring SW-07 encountered a medium stiff to stiff, sandy silt from 3 to 8 feet bgs underlain by medium stiff to stiff, lean clay that extended to the top of rock at 18.6 feet bgs.

Five and ten feet of rock was cored at Borings SW-06 and SW-07, respectively. The bedrock consisted of medium strong to strong limestone. The rock is classified as very poor to good based on the RQD.

4.3 Groundwater Conditions

Groundwater was encountered at the time of drilling at all borings between elevation 483 and 501 feet. A Lake Saint Louis Dam Inspection Report performed by the Department of Natural Resources dated November 4, 2008 indicates a primary spillway crest elevation of 499.90 feet, a normal pool elevation of 499.66 feet, and a minimum crest of dam elevation of 512.37 feet. We anticipate that groundwater levels at the boring locations will fluctuate with variations in the lake water elevation, precipitation, site grading, and drainage conditions.

The presence of groundwater should not be construed to represent an exact or permanent condition. There is uncertainty with the interpretation of short-term groundwater level readings in boreholes, particularly when the soil is of relatively low permeability such as the clay that is underlying this site.

5 SEAWALL FEASIBILITY

Based on the explorations performed in this phase of the project, we anticipate that a sheet pile wall is feasible at the boring locations at the Windjammer Marina and Jefferson Point sites.

5.1 Design and Construction Considerations

5.1.1 Windjammer Marina

Boring SW-01 was drilled at the parking level, which is approximately 11 feet above the mudline, and about 45 feet horizontal distance to the proposed wall location. Boring SW-02 was drilled about 11 feet above the mudline and about 20 feet horizontal distance to the shoreline. There is a concern that the bedrock elevation at the wall location may be higher than the depths encountered at Borings SW-01 and SW-02. If bedrock is encountered at a higher elevation at the wall location, a sheet pile wall might require anchorage to limit deflection while supporting the imposed loads or a different wall type might be required. We recommend two additional borings be advanced using limited access drilling equipment that can be placed on and anchored to the existing boardwalk.

Existing concrete piers that support the boardwalk in the northern portion of the proposed seawall need to be removed prior to the installation of the sheet piling.

The provided *Lake Saint Louis Overall Sewer Layout* drawing dated 11/07/18 by Pickett, Ray & Silver Inc. indicates there is an 8-inch clay sewer near Boring SW-03. The sewer will need to be located during the design process to include it in the construction documents. Additional utilities will also need to be identified during the design process.

5.1.2 Jefferson Point

Preliminary borings at the Jefferson Point site indicate bedrock at depths ranging from 17.5 to 18.6 feet bgs. Assuming that the retained height of wall is 6 feet, our preliminary calculations indicate that there will be just enough overburden to have the needed sheet pile embedment to cantilever the sheet pile wall. We recommend an additional exploration between Borings SW-06 and SW-07 to confirm the depth to bedrock between the two completed borings.

The provided *Lake Saint Louis Overall Sewer Layout* drawing dated 11/07/18 by Pickett, Ray & Silver Inc. does not show any manholes at the site; however, our site reconnaissance indicated the presence of sewer lines at the site. Further investigation is needed to identify utilities that may be impacted by the proposed construction.

5.2 Estimated Cost

We estimate the construction of a sheet pile wall at Windjammer Marina will range between $800,000 and $1,100,000. This estimated cost does not include improvements to the pavilion at Windjammer Marina, such as backfilling the area between the pavilion and the sheet pile wall, extending the concrete slab, or a safety fence. This estimate assumes that construction of a portion of the sheet pile wall at Windjammer Marina will be performed overwater. We estimate the cost of construction for a sheet pile wall at Jefferson Point will range between $350,000 and $450,000.

The estimated construction cost presented above does not include additional geotechnical explorations, design, preparation of specifications and construction documents, bidding assistance, and construction observation. We expect that our fee for these services will range between $60,000 and $80,000 for both sites combined.

6 LIMITATIONS

The analyses, conclusions, and recommendations contained in this report are based on the site conditions as they existed at the time of our field exploration and further assume that the borings are representative of the subsurface conditions throughout the site, i.e. the subsurface conditions everywhere are not significantly different from those disclosed by the borings. If, during construction, subsurface conditions different from those encountered in the exploratory borings are observed or appear to be present beneath excavations, we should be advised so that we can review those conditions and reconsider our recommendations where necessary.

Unanticipated soil, rock, and groundwater conditions are frequently encountered and cannot be fully determined by merely taking samples from borings. Such unexpected conditions commonly require that additional expenditures be made to obtain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

We recommend that we be retained to perform additional explorations, design, preparation of plans and specifications, and provide construction observation.

The scope of our services for this report did not include any environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air on, below, or around this site. Any statements contained in this report, or on the boring logs, regarding odors noted or unusual or suspicious items or conditions observed, are strictly for the information of our client.

7 REFERENCES

American Society for Testing and Materials (ASTM). Annual Book of ASTM Standards, ASTM, Philadelphia, PA; Current Edition.

Terzaghi, K., R.B. Peck, and G. Mesri. Soil Mechanics in Engineering Practice. Third Edition, John Wiley & Sons, Inc., New York, NY; 1996.

FIGURES

Figures

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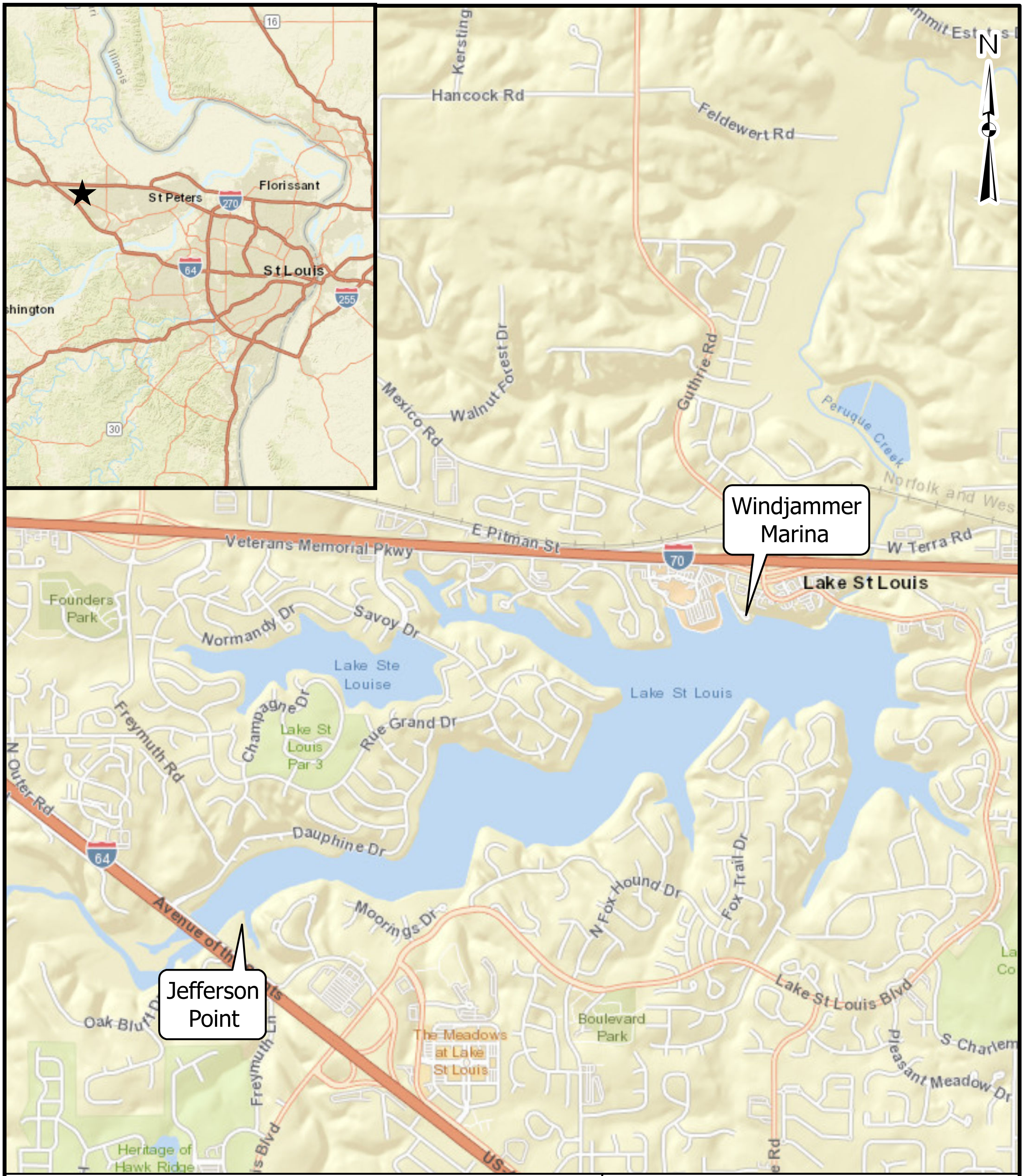

Missouri Dept. of Conservation, Esri, HERE, Garmin, INCREMENT P, NGA, USGS, Esri, HERE, Garmin, NGA, USGS, NPS

0 3,000 6,000

Feet

Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

PROJECT LOCATION

January 2022 107905-001

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Figure 1

Esri Community Maps Contributors, Missouri Dept. of Conservation, Missouri DNR, © OpenStreetMap, Microsoft, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, East-West Gateway COG, STL Imagery Consortium, Maxar, Microsoft

LEGEND

⊕ Soil Boring

Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

BORING LOCATIONS
WINDJAMMER MARINA

January 2022
107905-001

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Figure 2

Esri Community Maps Contributors, Missouri Dept. of Conservation, Missouri DNR, © OpenStreetMap, Microsoft, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, East-West Gateway COG, STL Imagery Consortium, Maxar, Microsoft

LEGEND

⊕ Soil Boring

Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

BORING LOCATIONS
JEFFERSON POINT

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Figure 3

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Appendix A

Boring Logs

CONTENTS

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Shannon & Wilson uses a soil identification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on this and the following page. Soil descriptions are based on visual-manual procedures (ASTM D2488) and laboratory testing procedures (ASTM D2487), if performed.

Structure[1]

Interbedded	Alternating layers of varying material or color with layers at least ¼-inch thick; singular: bed.
Laminated	Alternating layers of varying material or color with layers less than ¼-inch thick; singular: lamination.
Fissured	Breaks along definite planes or fractures with little resistance.
Slickensided	Fracture planes appear polished or glossy; sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps that resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay.
Homogeneous	Same color and appearance throughout.

Angularity and Shape[1]

Angular	Sharp edges and unpolished planar surfaces.
Subangular	Similar to angular but with rounded edges.
Subrounded	Nearly planar sides with well-rounded edges.
Rounded	Smoothly curved sides with no edges.
Flat	Width/thickness ratio > 3.
Elongated	Length/width ratio > 3.

Standard Penetration Test (SPT)[3]

Hammer	140 pounds with a 30-inch free fall. Rope on 6- to 10-inch-diameter cathead 2-¼ rope turns > 100 rpm. If automatic hammers are used, blow counts shown on boring logs should be adjusted to account for efficiency of hammer.
Sampler	10 to 30 inches long Shoe I.D. = 1.375 inches Barrel I.D. = 1.5 inches Barrel O.D. = 2 inches
N-Value	Sum blow counts for second and third 6-inch increments. Refusal: 50 blows for 6 inches or less; 10 blows for 0 inches.

Moisture Content

Dry	Absence of moisture, dusty, dry to the touch.
Moist	Damp but no visible water.
Wet	Visible free water, from below water table.

Gradation

Poorly Graded	Narrow range of grain sizes present or, within the range of grain sizes present, one or more sizes are missing (Gap Graded). Meets criteria in ASTM D2487, if tested.
Well-Graded	Full range and even distribution of grain sizes present. Meets criteria in ASTM D2487, if tested.

Cementation[1]

Weak	Crumbles/breaks with handling or slight finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

Plasticity[2]

Nonplastic	Cannot roll a ⅛-inch thread at any water content.	PI < 4
Low	A thread can barely be rolled and a lump cannot be formed when drier than the plastic limit.	4 < PI < 10
Medium	A thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. A lump crumbles when drier than the plastic limit.	10 < PI < 20
Hard	It takes considerable time rolling and kneading to reach the plastic limit. A thread can be rerolled several times after reaching the plastic limit. A lump can be formed without crumbling when drier than the plastic limit.	PI > 21

Additional Terms

Mottled	Irregular patches of different colors.
Bioturbated	Soil disturbance or mixing by plants or animals.
Diamict	Nonsorted sediment; sand and gravel in silt and/or clay matrix.
Cuttings	Material brought to surface by drilling.
Slough	Material that caved from sides of borehole.
Sheared	Disturbed texture; mix of strengths.

Notes:

[1] Reprinted, with permission, from ASTM D2488 – 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

[2] Adapted, with permission, from ASTM D2488 – 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

[3] Penetration resistances (N-values) shown on boring logs are as recorded in the field and have not been corrected for hammer efficiency, overburden, or other factors.

Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

SOIL DESCRIPTION AND LOG KEY

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Unified Soil Classification System (USCS)
Modified from USACE Tech Memo 3-357, ASTM D2487, and ASTM D2488

Major Divisions			Symbol	Typical Identifications
Coarse-Grained Soils *(more than 50% retained on No. 200 sieve)*	Gravels *(more than 50% of coarse fraction retained on No. 4 sieve)*	Gravel *(less than 5% fines)*	GW ▨	Well-Graded Gravel; Well-Graded Gravel with Sand
			GP ▨	Poorly Graded Gravel; Poorly Graded Gravel with Sand
		Silty or Clayey Gravel *(more than 12% fines)*	GM ▨	Silty Gravel; Silty Gravel with Sand
			GC ▨	Clayey Gravel; Clayey Gravel with Sand
	Sands *(50% or more of coarse fraction passes the No. 4 sieve)*	Sand *(less than 5% fines)*	SW ▨	Well-Graded Sand; Well-Graded Sand with Gravel
			SP ▨	Poorly Graded Sand; Poorly Graded Sand with Gravel
		Silty or Clayey Sand *(more than 12% fines)*	SM ▨	Silty Sand; Silty Sand with Gravel
			SC ▨	Clayey Sand; Clayey Sand with Gravel
Fine-Grained Soils *(50% or more passes the No. 200 sieve)*	Silt and Clays *(liquid limit less than 50)*	Inorganic	ML ▨	Silt; Silt with Sand or Gravel; Sandy or Gravelly Silt
			CL ▨	Lean Clay; Lean Clay with Sand or Gravel; Sandy or Gravelly Lean Clay
		Organic	OL ▨	Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
	Silts and Clays *(liquid limit 50 or more)*	Inorganic	MH ▨	Elastic Silt; Elastic Silt with Sand or Gravel; Sandy or Gravelly Elastic Silt
			CH ▨	Fat Clay; Fat Clay with Sand or Gravel; Sandy or Gravelly Fat Clay
		Organic	OH ▨	Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
Highly Organic Soils Primarily organic matter, dark in color, and organic odor			PT ▨	Peat or other highly organic soils (see ASTM D4427)

Notes:
Dual symbols *(symbols separated by a hyphen, i.e., SP-SM, Sand with Silt)* are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart. Graphics shown on the logs for these soil types are a combination of the two graphic *symbols (e.g., SP and SM)*. Borderline symbols *(symbols separated by a slash, i.e., CL/ML, Lean Clay to Silt; SP-SM/SM, Sand with Silt to Silty Sand)* indicate that the soil properties are close to the defining boundary between two groups. No. 4 size = 4.75 mm = 0.187 in; No. 200 size = 0.075 mm = 0.003 in.

Acronyms and Abbreviations

ATD: At Time of Drilling	MgO: Magnesium Oxide	psi: Pounds per Square Inch
Diam.: Diameter	mm: Millimeter	PVC: Polyvinyl Chloride
Elev.: Elevation	MnO: Manganese Oxide	rpm: Rotations per Minute
ft: feet	NA: Not Applicable or Not Available	SPT: Standard Penetration Test
FeO: Iron Oxide	NP: Nonplastic	USCS: Unified Soil Classification System
gal: Gallons	O.D.: Outside Diameter	q_u: Unconfined Compressive Strength
Horiz.: Horizontal	OW: Observation Well	VWP: Vibrating Wire Piezometer
HSA: Hollow-Stem Auger	pcf: Pounds per Cubic Foot	Vert.: Vertical
I.D.: Inside Diameter	PID: Photo-Ionization Detector	WOH: Weight of Hammer
in: inches	PMT: Pressuremeter Test	WOR: Weight of Rods
lbs: Pounds	ppm: Parts per Million	Wt.: Weight

Well and Backfill Symbols

▨	Bentonite Cement Grout
▨	Bentonite Grout
▨	Bentonite Chips
▨	Silica Sand
▤	Perforated or Screened Casing
▨	Surface Cement Seal
■	Asphalt or Cap
▨	Slough
‖	Inclinometer or Non-perforated Casing
▨	Instrumentation Riser or Electrical Lead
▨	Vibrating Wire Piezometer with Designation

Relative Density
Cohesionless Soils

N, SPT, Blows/ft	Relative Density
< 4	Very loose
4 – 10	Loose
10 – 30	Medium dense
30 – 50	Dense
> 50	Very dense

Relative Consistency
Cohesive Soils

N, SPT, Blows/ft	Relative Consistency
< 2	Very soft
2 – 4	Soft
4 – 8	Medium stiff
8 – 15	Stiff
15 – 30	Very stiff
> 30	Hard

Percentages

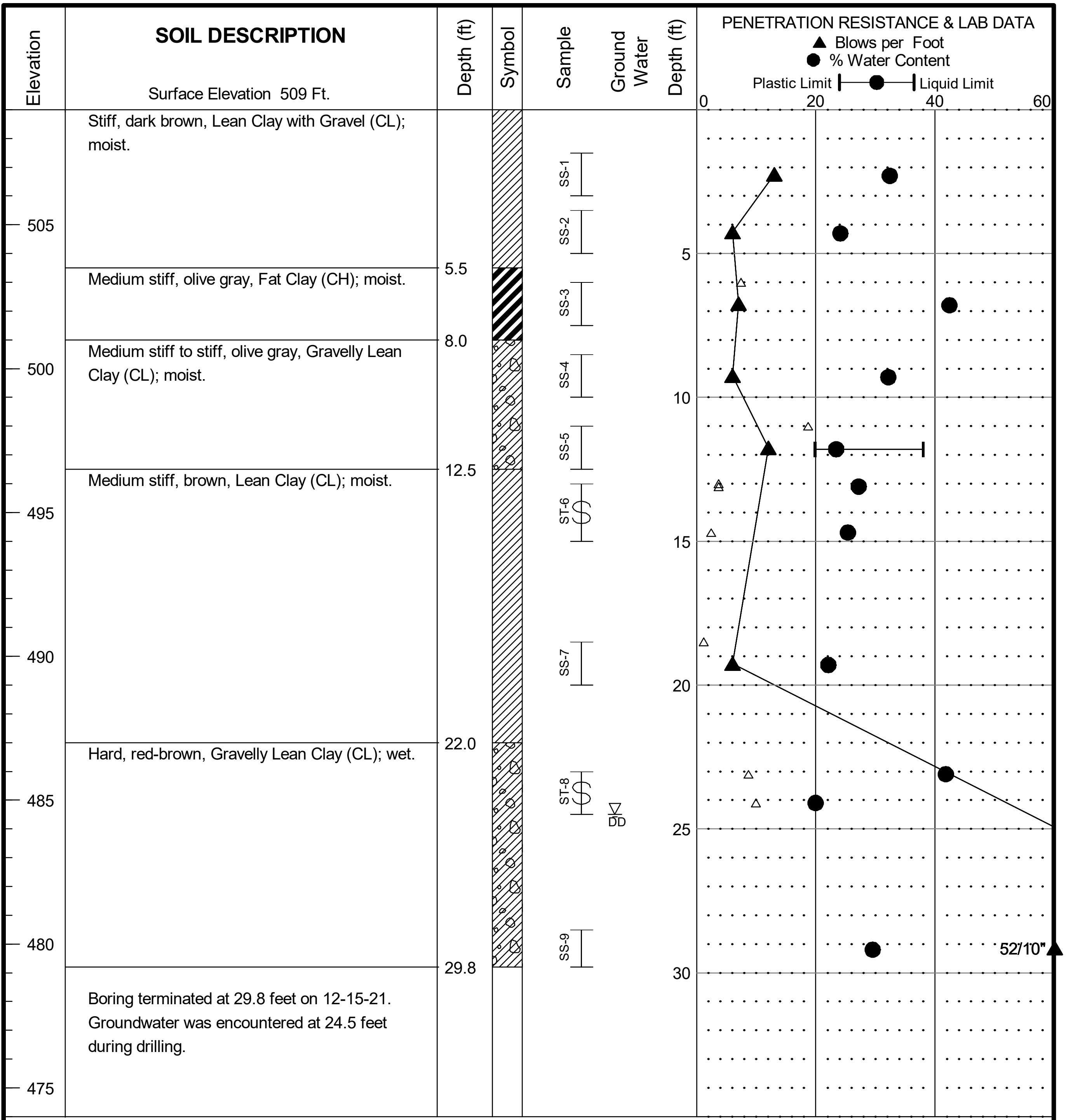
Trace: < 5%	Few: 5 to 10%	Little: 15 to 25%
Some: 30 to 45%	Mostly: 50 to 100%	

Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

SOIL DESCRIPTION AND LOG KEY

January 2022
107905-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants



Elevation	SOIL DESCRIPTION Surface Elevation 509 Ft.	Depth (ft)
	Stiff, dark brown, Lean Clay with Gravel (CL); moist.	5.5
	Medium stiff, olive gray, Fat Clay (CH); moist.	8.0
	Medium stiff to stiff, olive gray, Gravelly Lean Clay (CL); moist.	12.5
	Medium stiff, brown, Lean Clay (CL); moist.	22.0
	Hard, red-brown, Gravelly Lean Clay (CL); wet.	29.8
	Boring terminated at 29.8 feet on 12-15-21. Groundwater was encountered at 24.5 feet during drilling.	

Log: MAR Rev: DPM Typ: CMB Driller: Roberts Environmental Drilling Drilling Method: HSA Date Completed: 12/15/2021

MASTER SU 107905-001 BORING LOGS.GPJ

△ Pocket Penetrometer Shear Strength
☐ Vane Shear Strength
◆ Torvane Shear Strength
◇ Unconfined Compression Shear Strength
○ Unconsolidated Undrained Shear Strength

LEGEND

* Sample Not Recovered
⌶ 2-inch O.D. Split Spoon Sample
$ 3-inch O.D. Shelby Tube Sample
REC% / RQD% ◧ Rock Core

∇ Ground Water Level -
DD - During Drilling
X.X - Time In Hours

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
3. Groundwater level, if indicated above, is for the date specified, and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USCS designation is based on visual-manual classification and selected laboratory index testing.

Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

LOG OF BORING SW-01

January 2022

107905-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

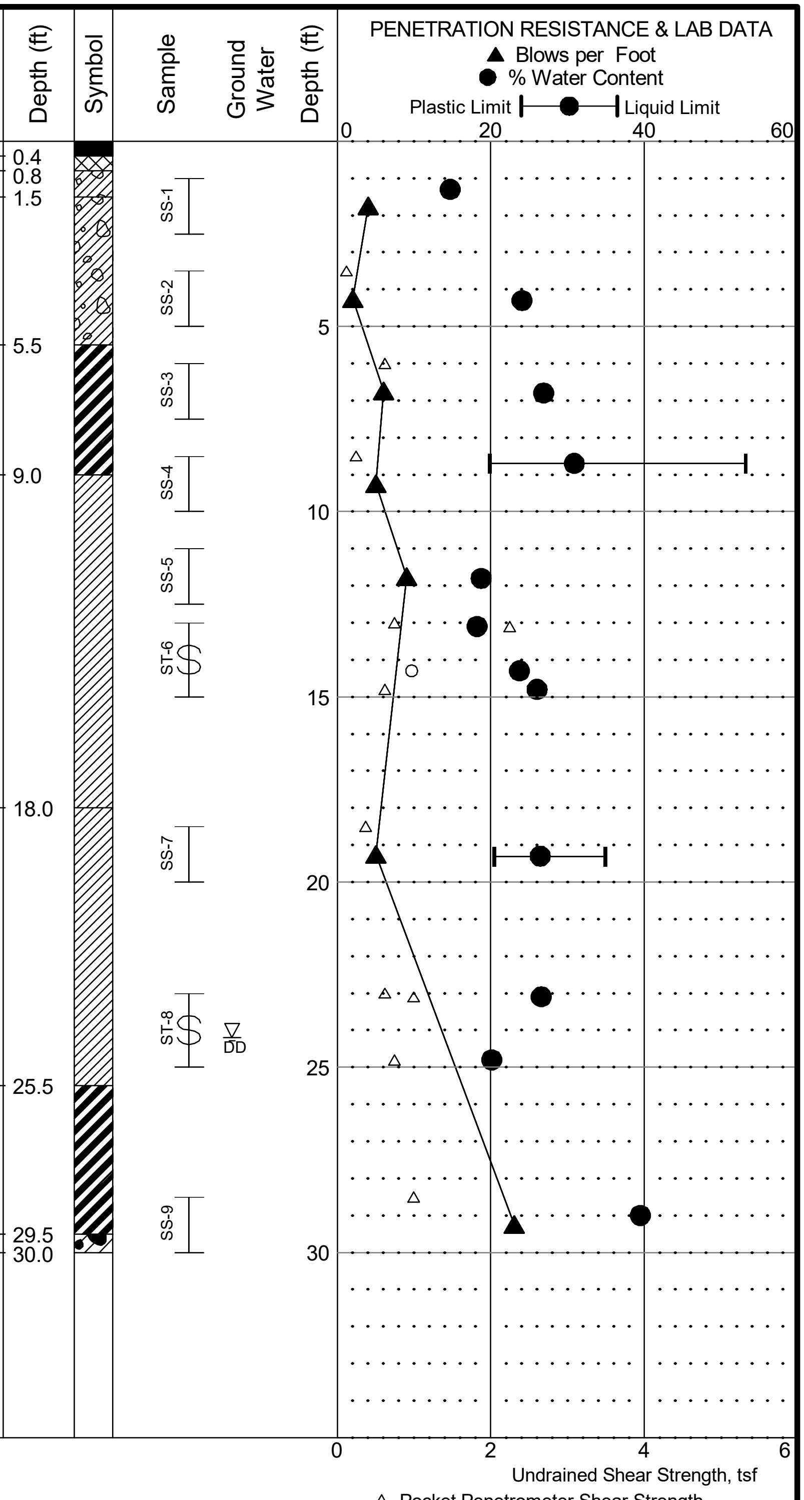
Date Completed: 12/15/2021
Drilling Method: HSA
Driller: Roberts Environmental Drilling, Inc.
Typ: CMB
Rev: DPM
Log: MAR

SOIL DESCRIPTION

Surface Elevation 507 Ft.

Soil Description	Depth (ft)
5-inches Asphalt. (Pavement)	0.4
Poorly Graded Gravel (GP); base gravel. (Fill)	0.8
Soft to medium stiff, olive gray, Gravelly Lean Clay with Sand (CL); moist.	1.5
Soft, red-brown, Gravelly Lean Clay (CL); moist.	5.5
Medium stiff, olive gray, Fat Clay (CH); moist.	9.0
Medium stiff, olive gray, Lean Clay (CL); moist. 14.3 Feet - Dry Density = 100.6 pcf	18.0
Medium stiff, red-brown, Lean Clay (CL); moist.	25.5
Very stiff, red-brown, Sandy Fat Clay with Gravel (CH); moist to wet.	29.5
Medium dense, red-brown, Clayey Gravel with Sand (GC); wet.	30.0

Boring terminated at 30.0 feet on 12-15-21. Groundwater was encountered at 24.2 feet during drilling.



△ Pocket Penetrometer Shear Strength
□ Vane Shear Strength
◆ Torvane Shear Strength
◇ Unconfined Compression Shear Strength
○ Unconsolidated Undrained Shear Strength

LEGEND

*	Sample Not Recovered	⊽	Ground Water Level - DD - During Drilling X.X - Time In Hours
⌶	2-inch O.D. Split Spoon Sample		
$	3-inch O.D. Shelby Tube Sample		
REC% RQD% ◧	Rock Core		

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
3. Groundwater level, if indicated above, is for the date specified, and may vary.
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Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

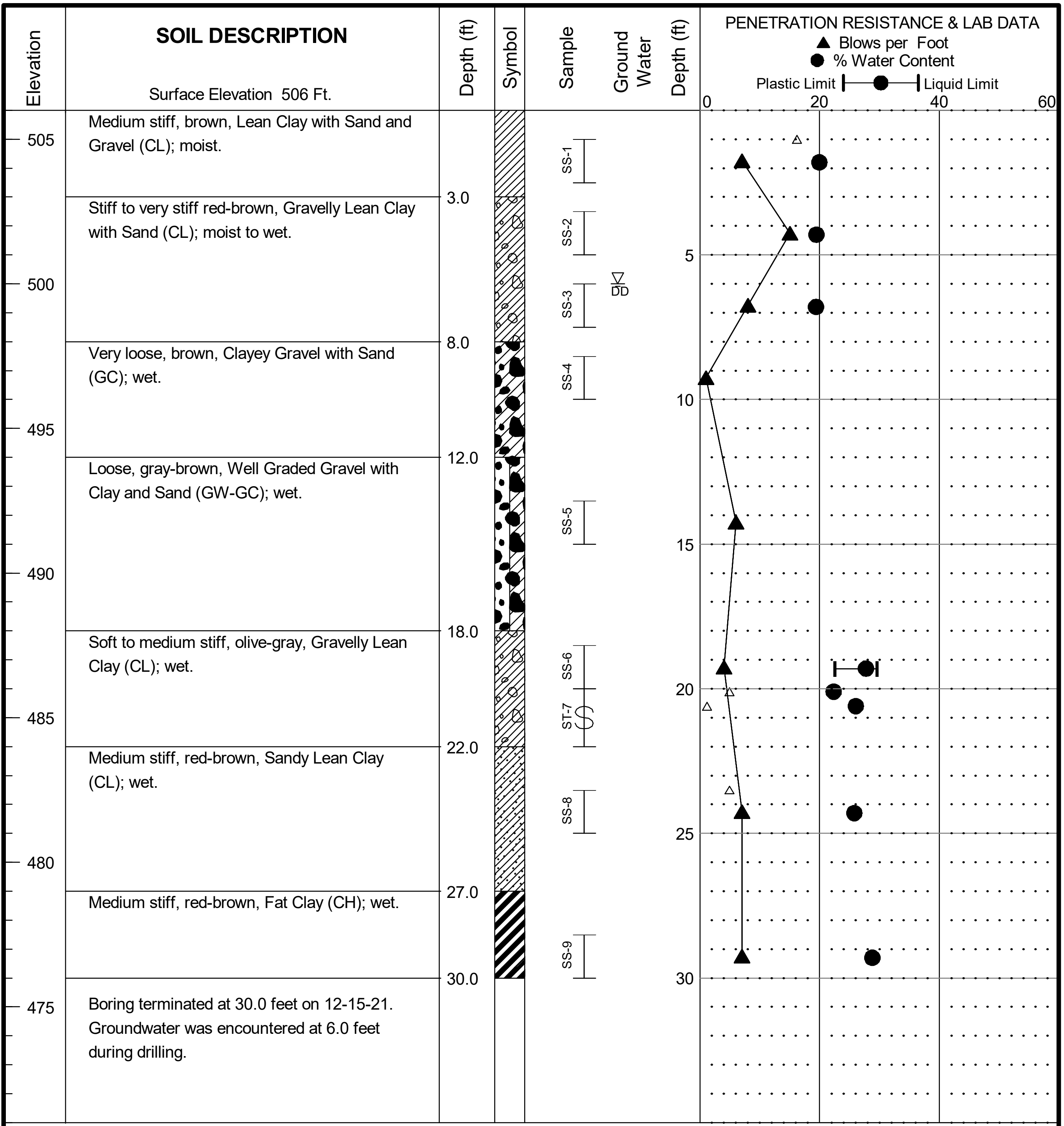
LOG OF BORING SW-02

January 2022
107905-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Page 1 of 1

MASTER SU 107905-001 BORING LOGS.GPJ



SOIL DESCRIPTION	Depth (ft)
Surface Elevation 506 Ft.	
Medium stiff, brown, Lean Clay with Sand and Gravel (CL); moist.	3.0
Stiff to very stiff red-brown, Gravelly Lean Clay with Sand (CL); moist to wet.	8.0
Very loose, brown, Clayey Gravel with Sand (GC); wet.	12.0
Loose, gray-brown, Well Graded Gravel with Clay and Sand (GW-GC); wet.	18.0
Soft to medium stiff, olive-gray, Gravelly Lean Clay (CL); wet.	22.0
Medium stiff, red-brown, Sandy Lean Clay (CL); wet.	27.0
Medium stiff, red-brown, Fat Clay (CH); wet.	30.0
Boring terminated at 30.0 feet on 12-15-21. Groundwater was encountered at 6.0 feet during drilling.	

Log: MAR Rev: DPM Typ: CMB Driller: Roberts Environmental Drilling Drilling Method: HSA Date Completed: 12/15/2021

LEGEND

- * Sample Not Recovered
- ⌶ 2-inch O.D. Split Spoon Sample
- 3-inch O.D. Shelby Tube Sample
- REC% RQD% ◧ Rock Core

∇ Ground Water Level -
DD - During Drilling
X.X - Time In Hours

△ Pocket Penetrometer Shear Strength
□ Vane Shear Strength
◆ Torvane Shear Strength
◇ Unconfined Compression Shear Strength
○ Unconsolidated Undrained Shear Strength

NOTES

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4. Refer to KEY for explanation of "Symbols" and definitions.
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MASTER SU 107905-001 BORING LOGS.GPJ

Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

LOG OF BORING SW-03

January 2022 107905-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

SOIL DESCRIPTION

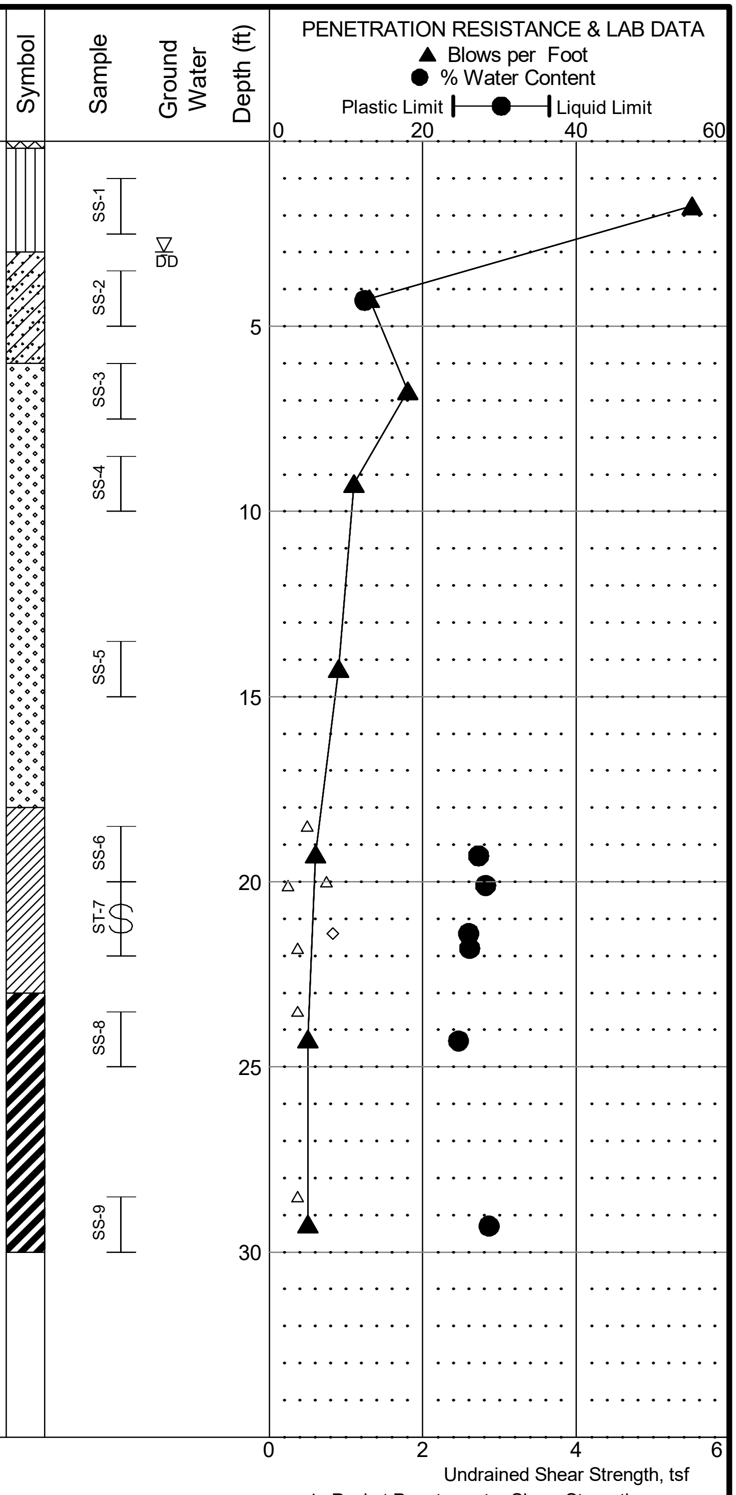
Surface Elevation 502 Ft.

Elevation	Soil Description	Depth (ft)
	Poorly Graded Gravel (GP); beach surface. (Fill)	0.2
500	Hard, yellow-brown to red-yellow, Sandy Silt with Gravel (ML); moist.	3.0
	Medium dense, yellow to red-yellow, Clayey Sand with Gravel (SC); wet.	6.0
495	Loose to medium dense, brown to red-yellow, Well Graded Sand with Gravel (SW); wet.	18.0
480	Medium stiff, brown to dark brown, Lean Clay (CL); wet. 21.4 Feet - Dry Density = 97.6 pcf	23.0
475	Medium stiff, red-brown, Fat Clay (CH); wet.	30.0
470	Boring terminated at 30.0 feet on 12-15-21. Groundwater was encountered at 3.0 feet during drilling.	

Date Completed: 12/15/2021

Driller: Roberts Environmental Drilling, Inc. Drilling Method: HSA

Log: MAR Rev: DPM Typ: CMB



△ Pocket Penetrometer Shear Strength
☐ Vane Shear Strength
◆ Torvane Shear Strength
◇ Unconfined Compression Shear Strength
○ Unconsolidated Undrained Shear Strength

LEGEND

* Sample Not Recovered
⌶ 2-inch O.D. Split Spoon Sample
$ 3-inch O.D. Shelby Tube Sample
REC% / RQD% ◧ Rock Core

▽ Ground Water Level -
DD - During Drilling
X.X - Time In Hours

NOTES

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Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

LOG OF BORING SW-04

January 2022
107905-001

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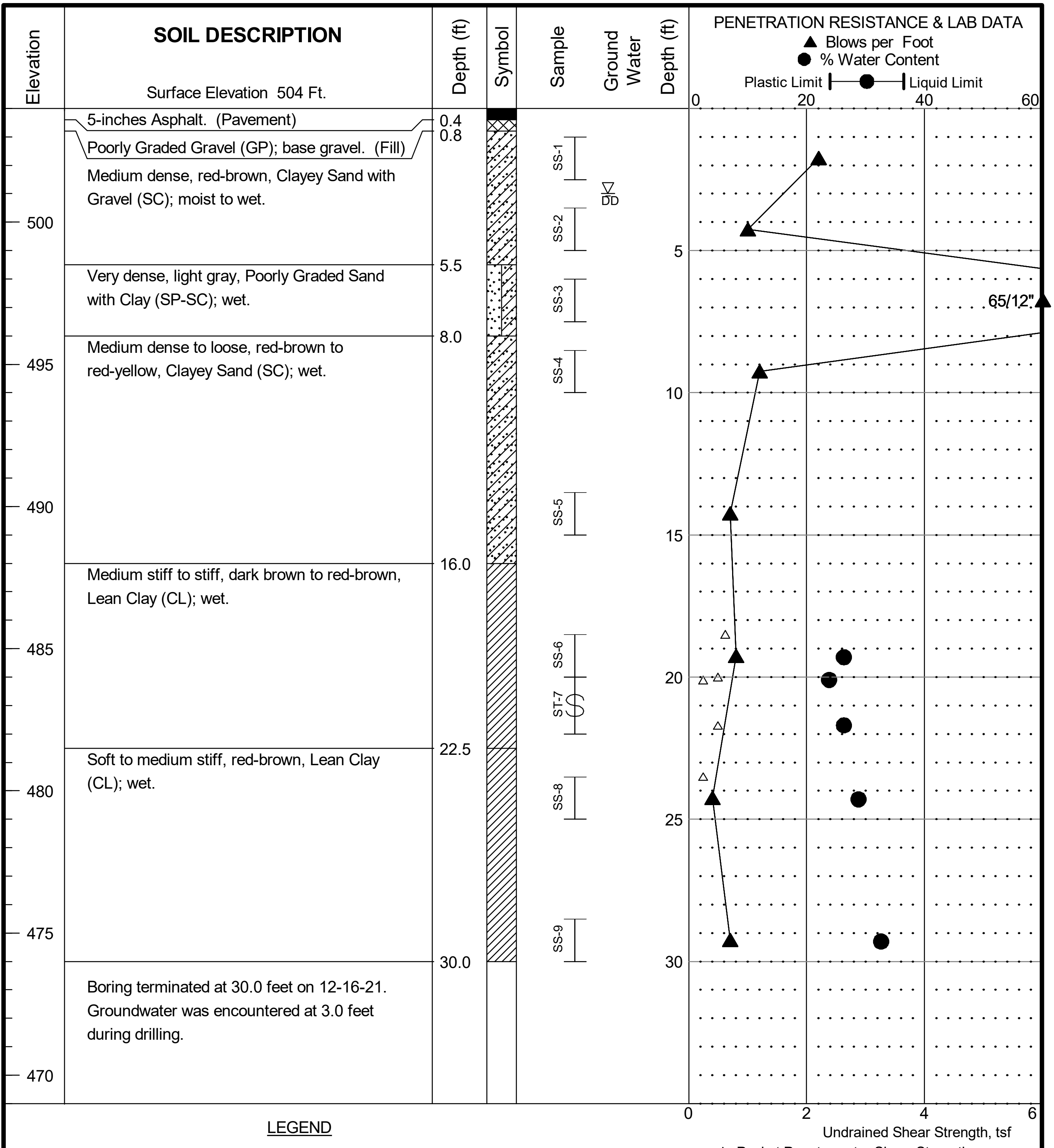
Page 1 of 1

MASTER SU 107905-001 BORING LOGS.GPJ



SOIL DESCRIPTION

Surface Elevation 504 Ft.

Soil Description	Depth (ft)
5-inches Asphalt. (Pavement)	0.4
Poorly Graded Gravel (GP); base gravel. (Fill)	0.8
Medium dense, red-brown, Clayey Sand with Gravel (SC); moist to wet.	5.5
Very dense, light gray, Poorly Graded Sand with Clay (SP-SC); wet.	8.0
Medium dense to loose, red-brown to red-yellow, Clayey Sand (SC); wet.	16.0
Medium stiff to stiff, dark brown to red-brown, Lean Clay (CL); wet.	22.5
Soft to medium stiff, red-brown, Lean Clay (CL); wet.	30.0

Boring terminated at 30.0 feet on 12-16-21. Groundwater was encountered at 3.0 feet during drilling.

Log: MAR Rev: DPM Typ: CMB Driller: Roberts Environmental Drilling Drilling Method: HSA Date Completed: 12/16/2021

△ Pocket Penetrometer Shear Strength
☐ Vane Shear Strength
◆ Torvane Shear Strength
◇ Unconfined Compression Shear Strength
○ Unconsolidated Undrained Shear Strength

LEGEND

- * Sample Not Recovered
- ⌶ 2-inch O.D. Split Spoon Sample
- $ 3-inch O.D. Shelby Tube Sample
- REC% / RQD% ◧ Rock Core

∇ Ground Water Level -
DD - During Drilling
X.X - Time In Hours

NOTES

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Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

LOG OF BORING SW-05

January 2022
107905-001

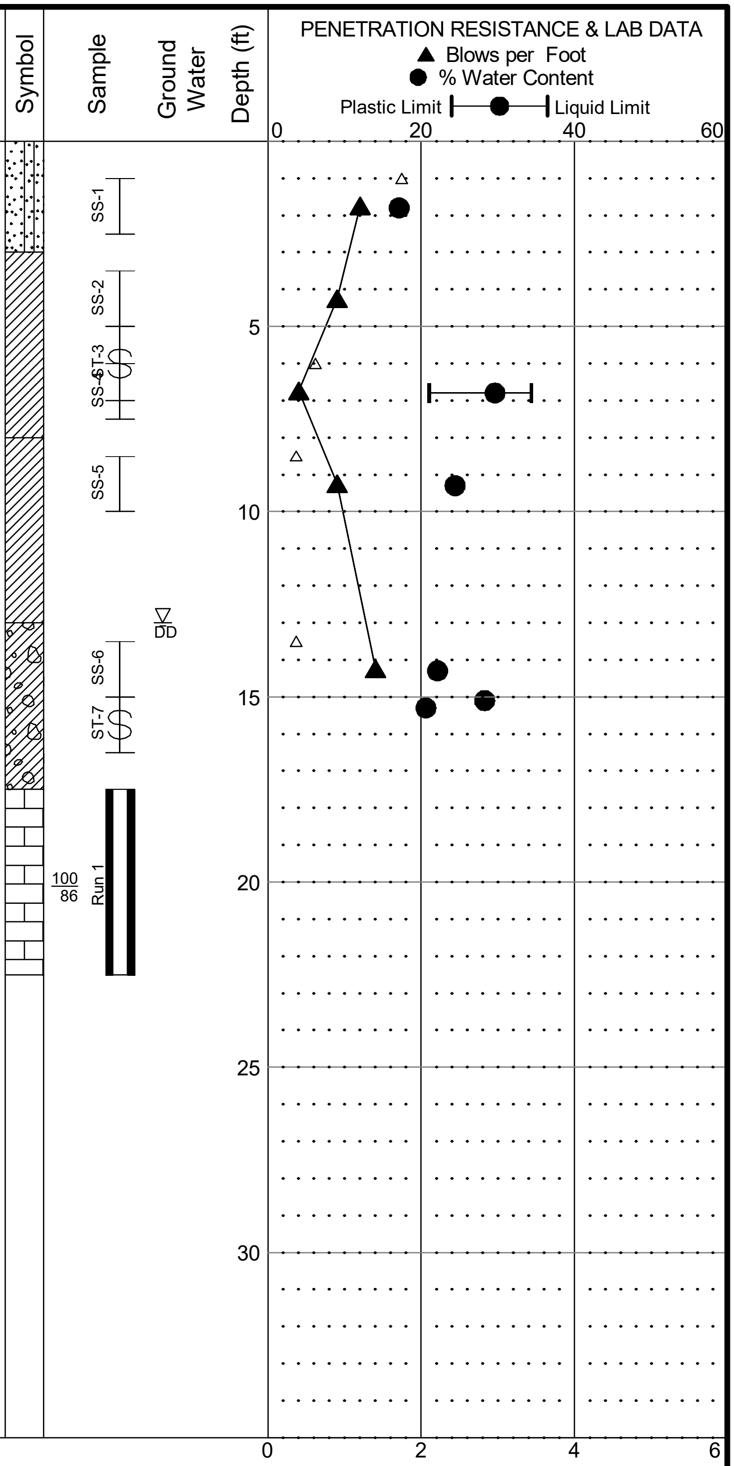
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Log: MAR Rev: DPM Typ: CMB Driller: Roberts Environmental Drilling Drilling Method: H/C Date Completed: 12/16/2021

SOIL DESCRIPTION

Surface Elevation 502 Ft.

Elevation	Soil Description	Depth (ft)
500	Medium dense, gray to dark gray, Poorly Graded Sand with Silt (SP-SM); moist.	3.0
495	Stiff, dark gray, Lean Clay (CL); moist. -Pushed Shelby tube 5.0 - 7.0 feet, no recovery. Drove split spoon 6.0 - 7.5 feet to obtain sample.	8.0
490	Stiff, dark brown, Lean Clay with Sand (CL); moist.	13.0
485	Stiff, brown to red-brown, Gravelly Lean Clay (CL); wet. -Auger refusal at 17.5 feet, began rock coring.	17.5
480	LIMESTONE: medium strong to strong rock, light gray to tan; fine to coarse crystalline; massive bedding; slightly weathered to fresh.	22.5
475 470	Boring terminated at 22.5 feet on 12-16-21. Groundwater was encountered at 13.0 feet during drilling prior to rock core drilling.	



LEGEND

- * Sample Not Recovered
- ⌶ 2-inch O.D. Split Spoon Sample
- $ 3-inch O.D. Shelby Tube Sample
- REC%/RQD% ◨ Rock Core
- ▽ Ground Water Level - DD - During Drilling X.X - Time In Hours

- △ Pocket Penetrometer Shear Strength
- □ Vane Shear Strength
- ◆ Torvane Shear Strength
- ◇ Unconfined Compression Shear Strength
- ○ Unconsolidated Undrained Shear Strength

NOTES

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Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

LOG OF BORING SW-06

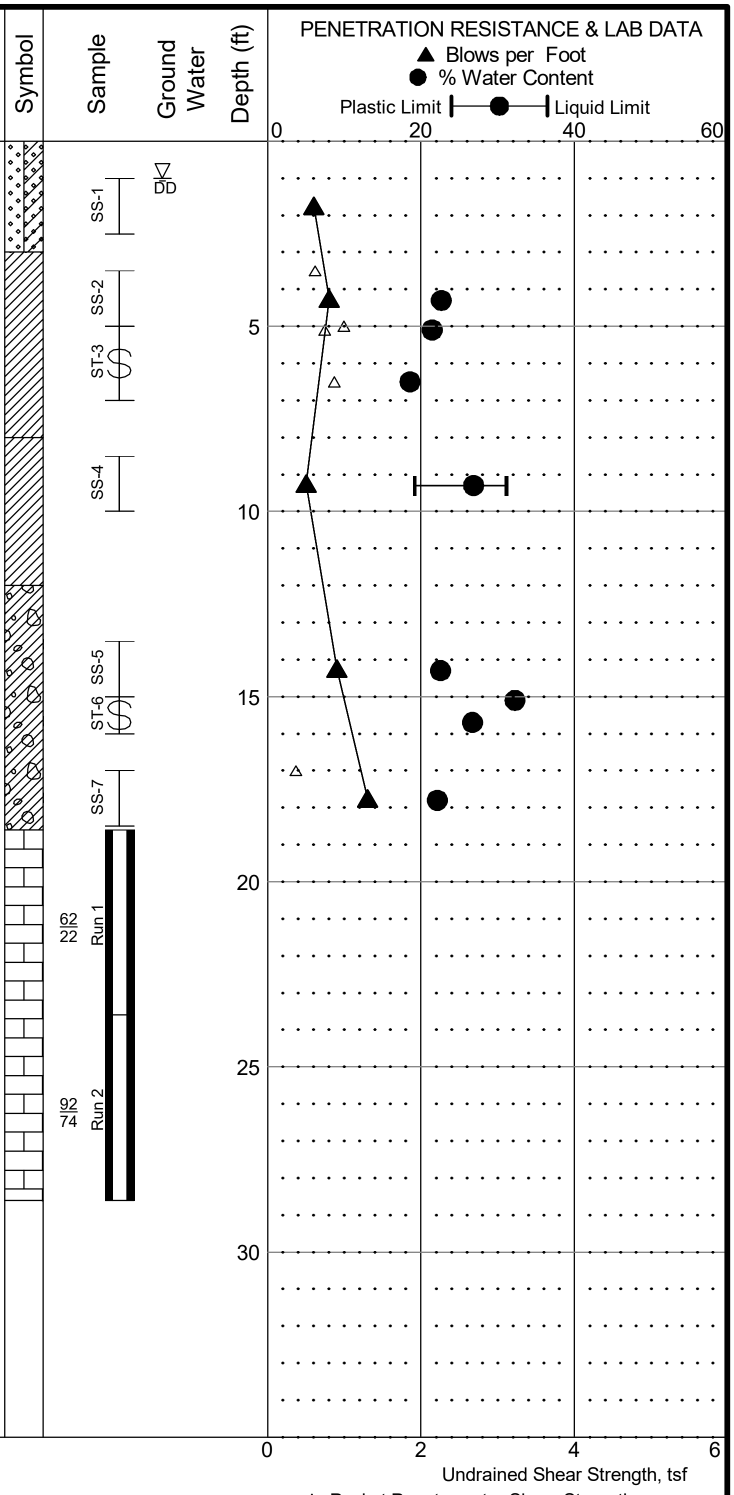
January 2022
107905-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Page 1 of 1

MASTER SU 107905-001 BORING LOGS.GPJ

Elevation	SOIL DESCRIPTION Surface Elevation 502 Ft.	Depth (ft)
500	Loose, gray to dark gray, Well Graded Sand with Clay (SW-SC); moist to wet.	
	Medium stiff to stiff, olive gray to dark gray, Lean Clay (CL); wet; trace organics.	3.0
495	Medium stiff, gray to dark gray, Lean Clay (CL); wet.	8.0
490	Stiff, gray to dark gray, Gravelly Lean Clay (CL); wet. -Auger refusal at 18.6 feet, began rock coring.	12.0
485	LIMESTONE: medium strong to strong rock, light brown gray to light gray; fine to medium crystalline; slightly weathered to fresh; occasional chert nodules; frequent styolites; horizontal clay filled seams. -Highly fractured and core loss 18.6 to 20.1 feet. -Core loss 20.3 to 20.7 feet. -Core loss 21.3 to 21.8 feet. **-Unconfined Strength at 22.9 feet = 6854 psi.** -Highly fractured 24.3 to 24.7 feet. -Core loss 26.5 to 26.9 feet.	18.6
480 475	Boring terminated at 28.6 feet on 12-17-21. Groundwater was encountered at 1.0 feet during drilling prior to rock core drilling.	28.6
470		



Log: MAR Rev: DPM Typ: CMB Driller: Roberts Environmental Drilling Drilling Method: H/C Date Completed: 12/17/2021

LEGEND

*	Sample Not Recovered
⌶	2-inch O.D. Split Spoon Sample
$	3-inch O.D. Shelby Tube Sample
REC% RQD% ◧	Rock Core
▽	Ground Water Level - DD - During Drilling X.X - Time In Hours

NOTES

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Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

LOG OF BORING SW-07

January 2022
107905-001

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Page 1 of 1

MASTER SU 107905-001 BORING LOGS.GPJ

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APPENDIX B: ROCK CORE PHOTOGRAPHS

Appendix B

Rock Core Photographs

CONTENTS

APPENDIX B: ROCK CORE PHOTOGRAPHS

Rock Core Photograph Boring SW-06 Run 1 from 17.5 to 22.5 feet

Rock Core Photograph Boring SW-07 Run 1 from 18.6 to 28.6 feet

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APPENDIX C: LABORATORY TEST RESULTS

Appendix C

Laboratory Test Results

CONTENTS

APPENDIX C: LABORATORY TEST RESULTS

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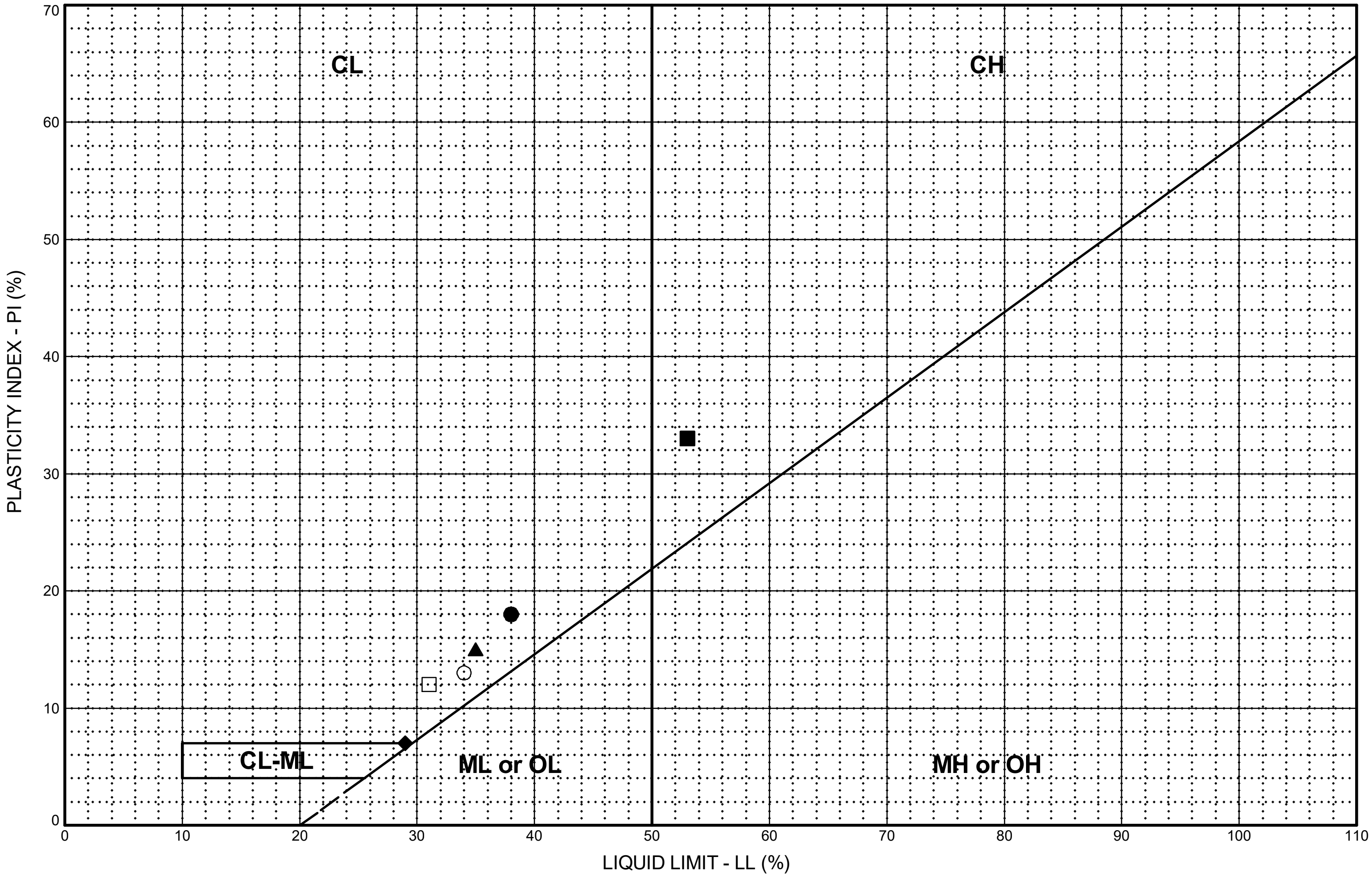

LEGEND

CL: Low plasticity inorganic clays; sandy and silty clays

CH: High plasticity inorganic clays

ML or OL: Inorganic and organic silts and clayey silts of low plasticity

MH or OH: Inorganic and organic silts and clayey silts of high plasticity

CL-ML: Silty clays and clayey silts

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION	LL %	PL %	PI %	NAT. W.C. %	PASS. #200, %
● SW-01, SS-5	11.8	CL	Olive gray, Gravelly Lean Clay.	38	20	18	23.4	
■ SW-02, SS-4	8.7	CH	Olive gray, Fat Clay.	53	20	33	30.8	
▲ SW-02, SS-7	19.3	CL	Red-brown, Lean Clay.	35	20	15	26.4	99.3
◆ SW-03, SS-6	19.3	CL	Olive-gray, Gravelly Lean Clay.	29	22	7	27.7	66.0
○ SW-06, SS-4	6.8	CL	Dark gray, Lean Clay.	34	21	13	29.6	
□ SW-07, SS-4	9.3	CL	Gray to dark gray, Lean Clay.	31	19	12	26.8	90.2

Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

PLASTICITY CHART

January 2022 107905-001

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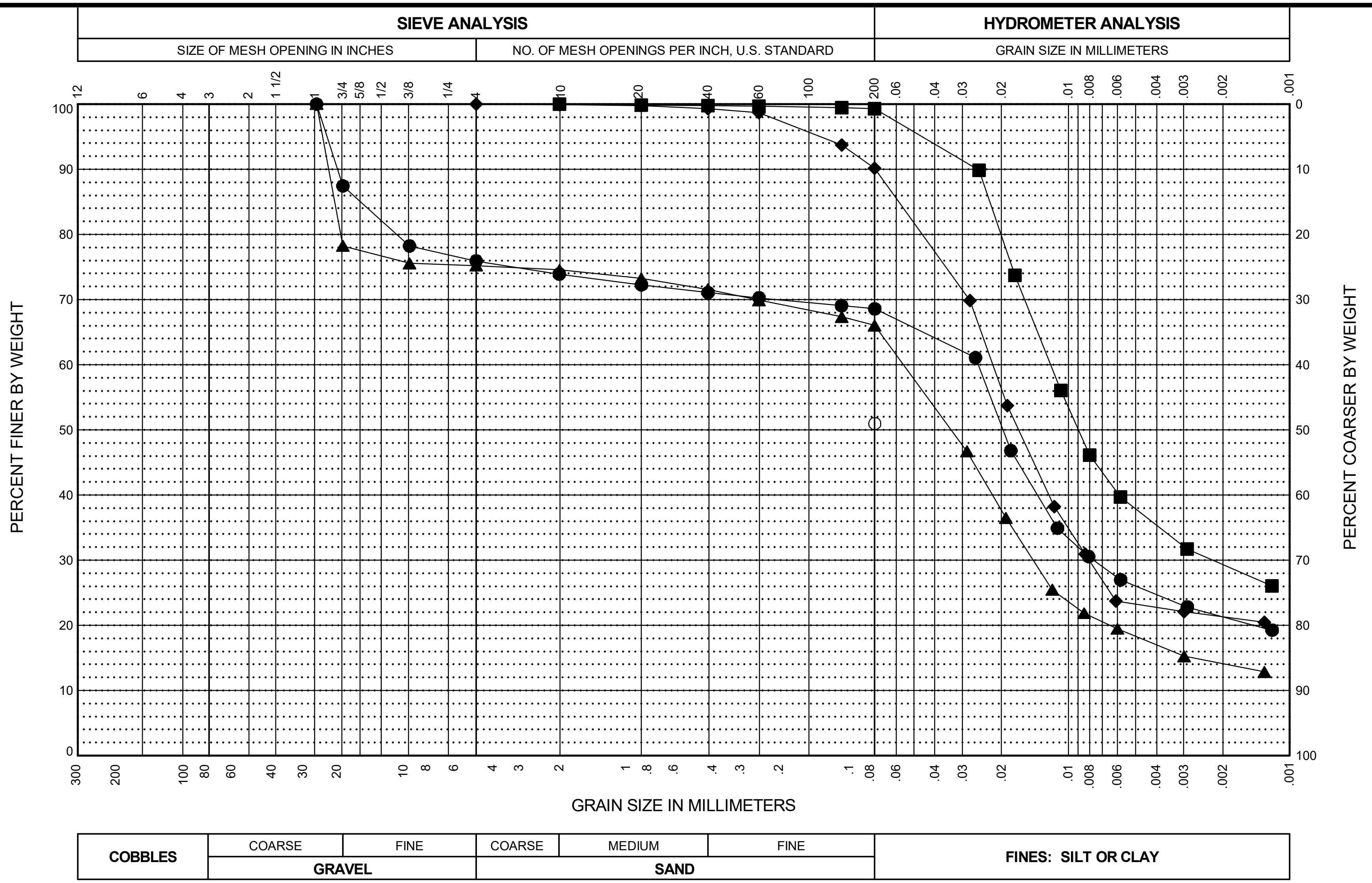
FIG. C-1

ATTERBERG - NORMAL 107905-001 BORING LOGS.GPJ SHAN_WIL.GDT 1/27/22



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	FINES %	NAT. W.C. %	LL %	PL %	PI %
● SW-01, SS-4 & SS-5	10.5	CL	Olive gray, Gravelly Lean Clay.	68.6				
■ SW-02, SS-7	19.3	CL	Red-brown, Lean Clay.	99.3	26.4	35	20	15
▲ SW-03, SS-6	19.3	CL	Olive-gray, Gravelly Lean Clay.	66.0	27.7	29	22	7
◆ SW-07, SS-4	9.3	CL	Gray to dark gray, Lean Clay.	90.2	26.8	31	19	12
○ SW-07, SS-5	14.3	CL	Gray to dark gray, Gravelly Lean Clay.	51.0	22.5			

Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

GRAIN SIZE DISTRIBUTION

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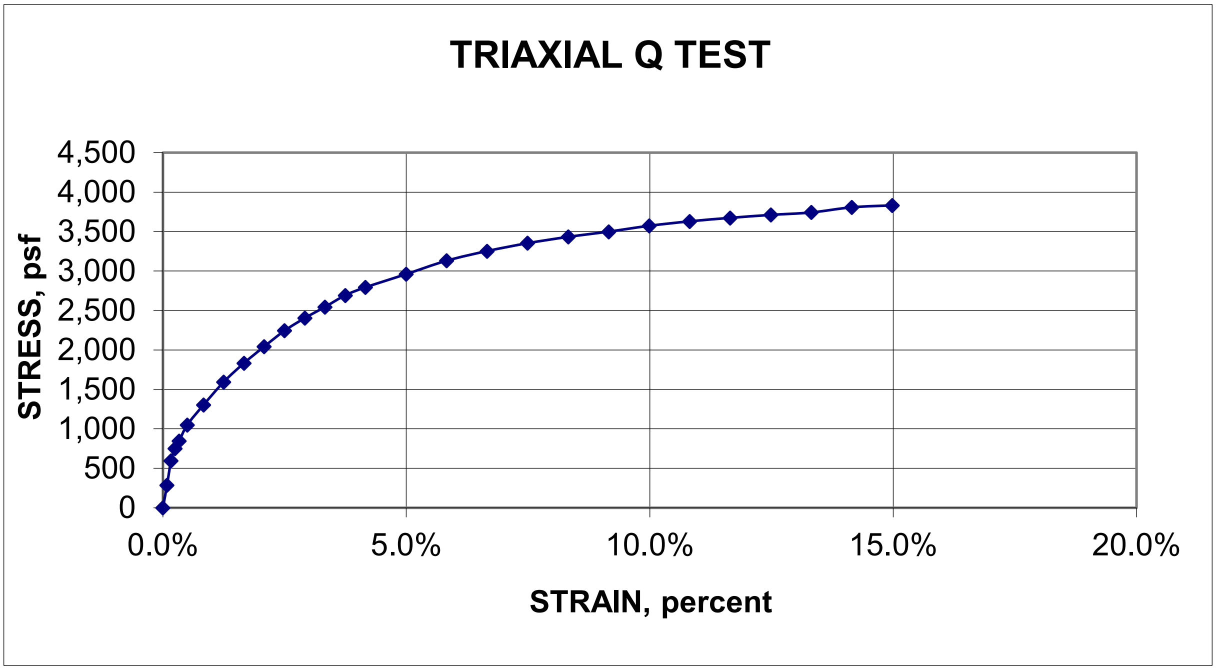
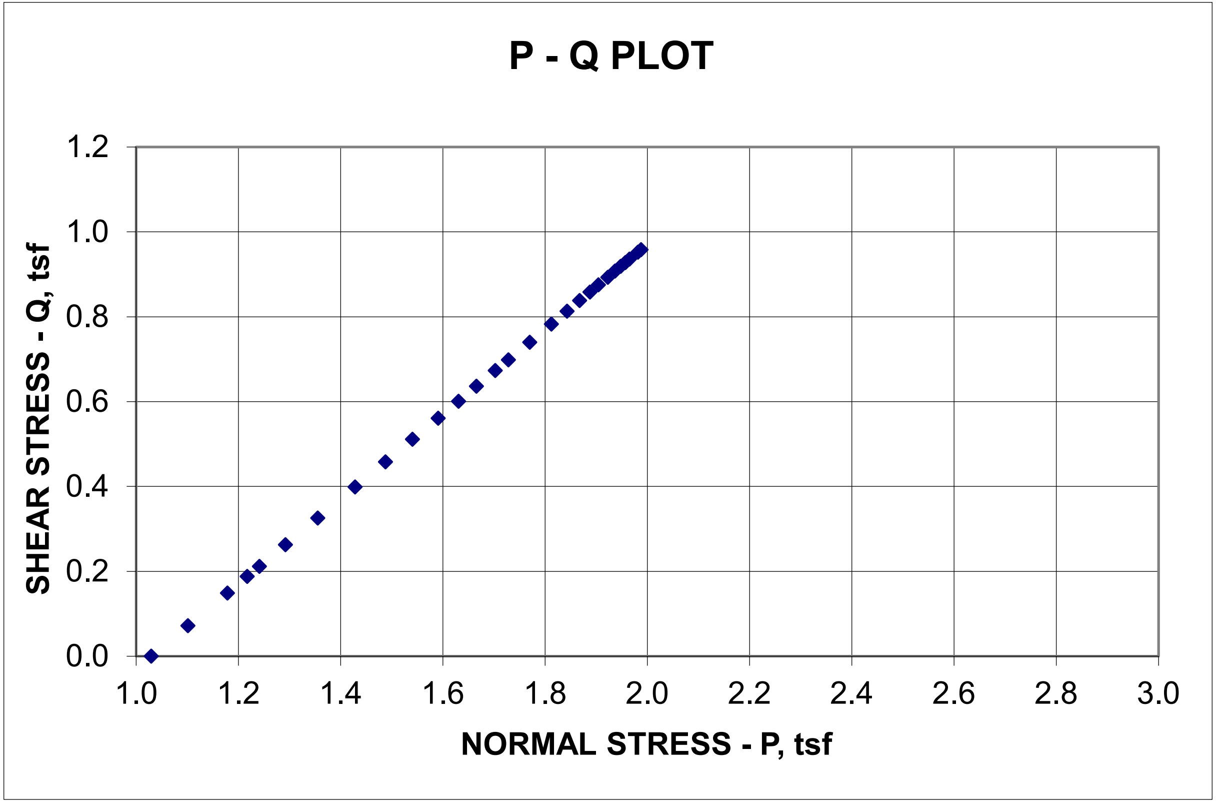
FIG. C-2

GSA - NORMAL 107905-001 BORING LOGS.GPJ SHAN_WIL.GDT 1/27/22

UNCONSOLIDATED, UNDRAINED STRENGTH IN TRIAXIAL COMPRESSION
PLOT OF TEST DATA





Photograph
of
Failure

Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

UNCONSOLIDATED, UNDRAINED STRENGTH

IN TRIAXIAL COMPRESSION

BORING - SW-02 : SAMPLE - ST-6

January 2022 107905-001

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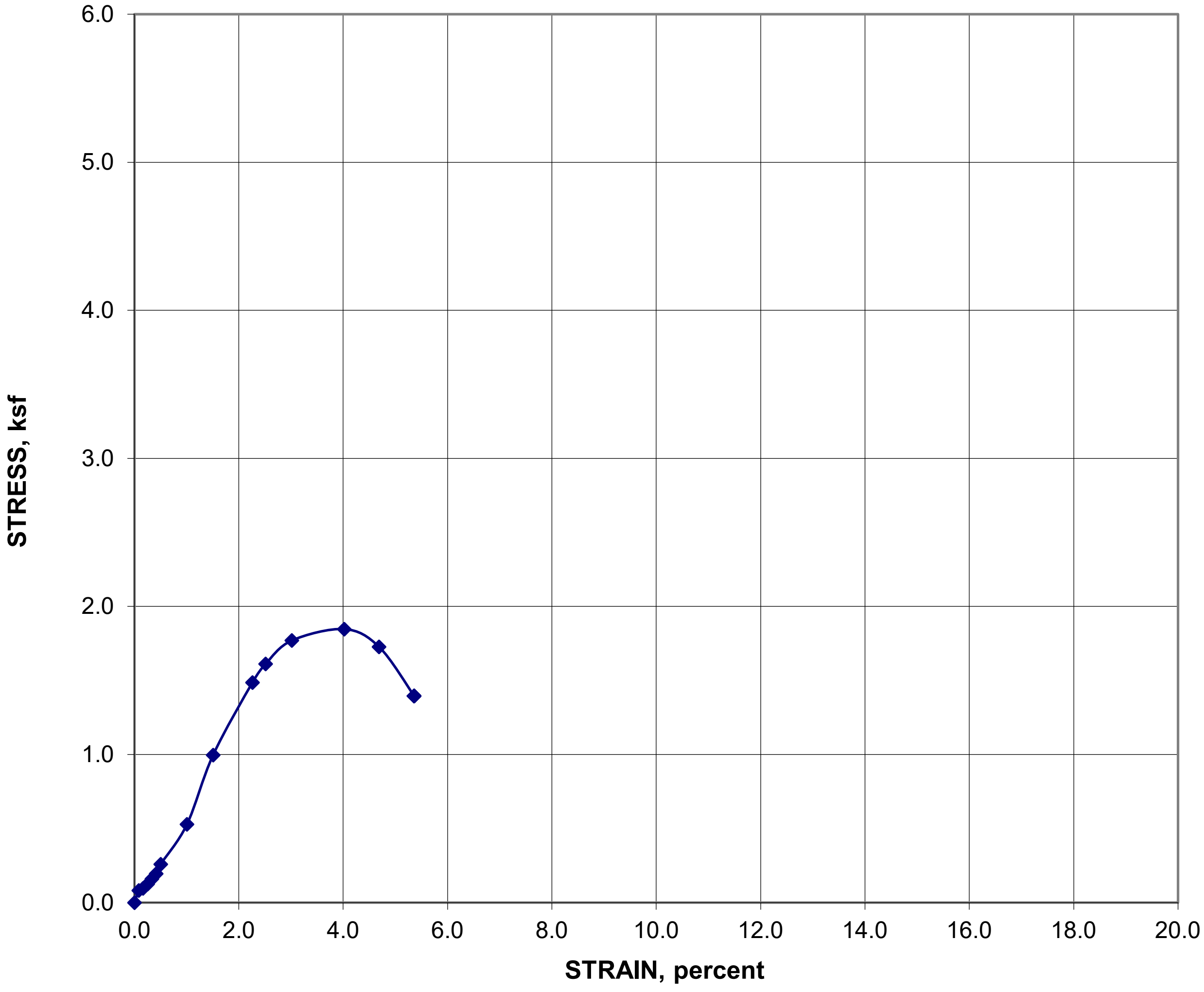
Consultants

FIG. C-3

UNCONFINED COMPRESSION STRENGTH



SHEAR STRENGTH ksf	*H-D RATIO*	AVG STRAIN RATE in per min	*STRENGTH* ksf	*STRAIN*	*MOISTURE*	*DRY DENSITY* pcf
0.924	2.08	0.016	1.847	4.0%	25.9%	97.6

Sample Identification: Boring SW-04, Sample ST-7, at 21.4 feet

DESCRIPTION
Brown to dark brown, Lean Clay (CL).

Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

UNCONFINED COMPRESSION TEST
SW-04
ST-7

January 2022 107905-001

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FIG. C-4

TSi
geotechnical, inc.

Uniaxial Compressive Strength Test of Rock Core

(ASTM D7012-14, method C)

Project: Lake St. Louis Marinas
Boring Number: SW-07
Date: 1/11/2022
Project Number: 107905-001
Sample Number:
Depth: 22.7-23.1

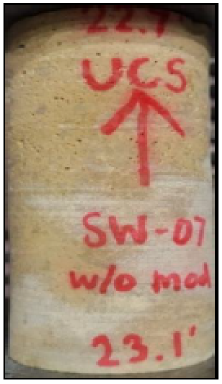
Visual Description: DOLOMITE and LIMESTONE, interspersed, fresh to slightly weathered

Specimen Weight	472.75	g
Diameter	1.820	inches
Length	4.280	inches
Volume	**0.0064**	ft^3

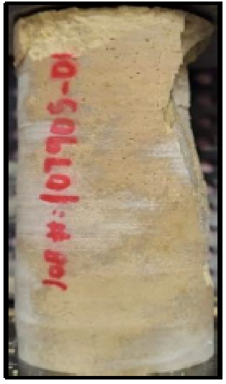
Wet unit weight	**161.7**	pcf
Length:Diameter Ratio	**2.35**	

Specimen Area (metric)	**1678.416**	mm^2
Specimen Area	**2.601**	in^2
Total Load on Specimen	**17830**	lbs
Unconfined Strength (qu)	**6854**	**psi**
Unconfined Strength (qu)	**493**	**tsf**
Unconfined Strength (qu)	**47**	**MPa**

Before



After



Tested by: SLY
Date: 1/11/2022
Calculated by: SLY
Date: 1/11/2022
Checked by: AD
Date: 1/12/2022

Lake Saint Louis Seawalls
Lake Saint Louis, Missouri

Uniaxial Compressive Strength

January 2022
107905-001

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FIG. C-5

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IMPORTANT INFORMATION

Important Information

About Your Geotechnical Engineering Report

IMPORTANT INFORMATION

IMPORTANT INFORMATION

Important Information

About Your Geotechnical/Environmental Report

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors that were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports, and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland