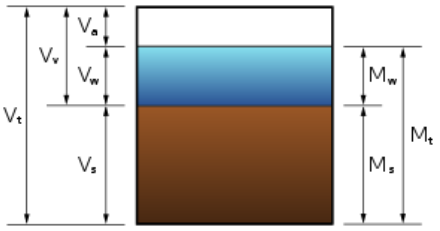

Lorenzen Soil Mechanics, Inc.

Riverfront Trails

Geotechnical Engineering Report

Missoula, Montana

Prepared for:
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March 8, 2021
Amended July 12, 2022

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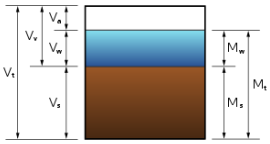


1 INTRODUCTION

This report has been amended to reflect that there are no basement level recommendations and to update groundwater depth elevations.

Through Tollefson Construction, Woith Engineering requested Lorenzen Soil Mechanics, Inc. (LSM) to complete a geotechnical/materials investigation for the proposed Riverfront Trails development located within the Linda Vista neighborhood. Lorenzen Soil Mechanics, Inc. (LSM) has completed a geotechnical evaluation for the proposed streets that will serve the development.

The primary purpose of the evaluation was to assess the street, bicycle trail, and underground utility subgrade materials, measure the infiltration rates at depth for potential dry well sumps, and to provide typical sections for the proposed streets and trails. LSM has also provided general recommendations for the residential building foundations based on the soils encountered during the street subsurface investigation. The soils may differ at each of the lot locations and the general recommendations provided may not be applicable.

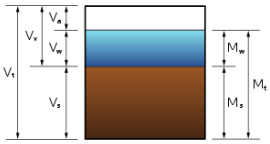
2 SITE EVALUATION

The site has been used primarily for agricultural grazing and haying purposes. It is currently undeveloped. The development will be on the north and south sides of Old Bitterroot Road. A Google Earth image from 2007 indicates the site had produced alfalfa hay. A drainage ditch travels along the southern portion of the property's west border, crosses beneath Old Bitterroot Road, and then angles to the northwest toward the Bitterroot River away from the northern portion of the property's west border.

Geologically, this area is mapped on the MBMG Open File Report 373 - Missoula West 30' x 60' Quadrangle Geologic Map as Quaternary period Alluvium of Modern Channels and Flood Plains (Qal). These deposits are characterized as well-rounded gravel and sand with lesser amounts of clay.

Two nearby water wells associated with the recently constructed Jeanette Rankine Elementary School and data-based at the Montana Bureau of Mines and Geology, indicate groundwater table depths of 19 and 35 feet. The two water wells were drilled to depths of 120 and 178 feet, respectively. The water well lithologies were somewhat varied. The shallower well was logged as 15 feet of silty sand and gravel overlying an 8-foot thick moist clay layer, then moving into saturated sand with clay seams. Bedrock was encountered in the shallower well at a depth of 114 feet. The deeper of the two wells was logged as 35 feet of sand and gravel overlying saturated sand with clay seams. Bedrock was logged in the deeper well at a depth of 105 feet.

The proposed Riverfront Trails Development streets will be carrying primarily residential traffic but must be able to carry heavier truck traffic for garbage collection, emergency fire trucks, freight deliveries, and at their onset, construction traffic that will include concrete trucks, and



building materials delivery trucks. It is LSM's opinion that it is the construction traffic that will be delivering the highest concentrated traffic loadings to the streets. If possible, LSM recommends keeping the asphalt from being placed as long as possible, then re-dressing the base course and placing the asphalt plant mix.

LSM conducted a subsurface investigation on September 9th and 10th, 2020. Boland Drilling of Great Falls drilled a total of ten boreholes with their truck-mounted Mobile B59 drill rig. Figure 2 depicts the borehole locations. Horizontal coordinates were obtained using a Garmin eTrex Vista® HCx GPS unit. The boreholes were advanced and sampled to depths ranging from 9.5 to 20 feet. The four shallower 9.5-foot deep boreholes received a 4-inch diameter PVC pipe for infiltration testing. The five 16.5-foot deep boreholes received a 1-inch diameter slotted PVC pipe that was used as a piezometer to measure the depth to the static groundwater water table. BH-01 was drilled to 20 feet and experienced 18 inches of sand heave when lowering the Standard Penetration Test (SPT) steel split spoon sampler to the 20-foot depth. Sand heave usually occurs in granular soils under a hydrostatic head pressure that carries sand up inside the hollow stem augers and limits the SPT sampling. The SPT sampler was driven through the sand at the 18.5-foot depth. 'Washed' sand was what was returned in the sampler. The SPT blow counts were taken but should not be relied upon to bear any relation to the relative density of the soil below 20 feet.

In general, silty sand and sandy silt overlie high quality sand and gravel aggregates. The underlying aggregates will allow for rapid stormwater infiltration collected in dry well sumps that extend into the gravel layer. The finer-grained soils overlying the gravels are considered somewhat problematic for the construction of roadways but can be addressed with separation/stabilization geotextile and a subbase layer as part of the typical section or by removing the upper 1 foot of topsoil, likely exposing the aggregate subgrade.

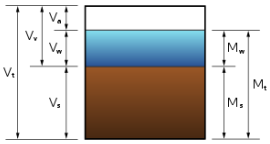
The groundwater table was encountered in each of the boreholes that were drilled to 15 feet and deeper. BH-06 was logged as encountering the groundwater table at 12 feet during the drilling operations. It was read as 'dry' nine days later at 15.2 feet. It was recorded at 14.25 feet several months later in January 2021.

Logs of the boreholes and of the two water wells, soil testing and water infiltration testing results, and seismic spectral accelerations are provided in Appendix A. Photographs of the drilling operations and the soil samples are included in Appendix B.

3 STREET RECOMMENDATIONS

3.1 Subgrade Soils

Sandy loam topsoil was logged as 1 foot across the site. The topsoil overlies primarily cohesionless soils that varied from poorly graded gravel with silt and sand (GP) [A-1-a], poorly graded sand (SP) [A-3], silty sand (SM) [A-4], and in one borehole (BH-10), silt (ML) [A-4].



The Missoula County Public Works Department classifies A-1-a soils as a 'good' subgrade and A-4 soils as an 'average' subgrade. LSM cautions that an A-4 soil subgrade is susceptible to frost heave during the winter months and frost boils during the thawing periods.

3.2 Street Typical Sections

LSM recommends removing the upper 1 foot of topsoil and constructing the street typical section on the granular subgrades. The A-1-a to A-4 range of AASHTO subgrade classification soils can be expected to have California Bearing Ratio (CBR) values of 45 for the poorly graded gravel and 10 for the silty sand/sandy silt soils.

Using the CBR value of 10 as a conservative design, LSM recommends a street typical section of:

Asphalt Concrete:	4 inches Plant Mix.
Crushed Granular Base:	6 inches Crushed 1 1/2-inch minus.
Crushed Subbase:	8 inches Crushed 3-inch minus.
Scarified Subgrade:	6 inches.

LSM recommends preparing the subgrade and constructing the typical section aggregates by:

1. Removing the upper 1 foot of topsoil across the street alignment. Extend the street excavation horizontally to include 1 foot beyond the back of the street curbing.
2. Scarifying to a depth of at least 6 inches and wetting the surface to, or up to 2 percent over, its optimum moisture content.
3. Compacting the wetted subgrade to a modified relative compaction (ASTM D1557) of at least 95 percent.
4. Providing a crushed 3-inch minus crushed subbase course meeting the gradation presented in Table 1. Recycled asphalt and/or concrete are acceptable, provided they meet the gradation bands in Table 1.

TABLE 1: 3" Minus Crushed Subbase Course

Sieve Size	Percent Passing
3"	90 -100
2 1/2"	85 - 95
1 1/2"	75 - 95
3/4"	65 - 85
No. 4	25 - 60
No. 200	3 - 10

5. Placing the crushed 3-inch minus subbase in 8-inch (maximum) loose lift thicknesses and compacting each lift to a modified relative compaction of at least 95 percent.
6. Providing a crushed 1 1/2-inch minus base course meeting the gradation presented in Table 2. Recycled asphalt and/or concrete are acceptable, provided they meet the gradation bands in Table 2.

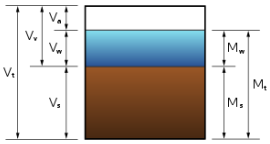


TABLE 2: 1 1/2" Minus Crushed Base Course

Sieve Size	Percent Passing
1 1/2"	100
3/4"	90 - 100
3/8"	70 - 90
No. 4	40 - 70
No. 10	25 - 55
No. 200	2 - 8

7. Placing the crushed 1 1/2-inch minus base and compacting it to a modified relative compaction of at least 95 percent and within 2 percent of its optimum moisture content.

LSM suggests using a vibratory pad roller compactor having an operating weight of at least 25,000 pounds and a centrifugal force of at least 45,000 pounds to compact the subgrade and the aggregate courses.

Plant Mix Surfacing

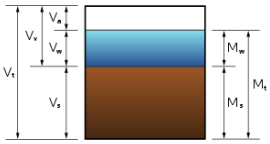
For the asphalt concrete, LSM recommends using PG 64-22 for the binder and for the plant mix surfacing aggregate meeting the Montana Public Work's gradation presented in Table 3. The gradation bands represent the job mix target limits, which determine the suitability of aggregate. Provide the final job mix target gradation within the specified bands and uniformly graded from coarse to fine, not to vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice-versa. For example, using the 3/8" and No. 4 sieves, a gradation of 73 percent and 48 percent passing their respective sieves is acceptable, 73 percent and 62 percent passing their respective sieves is not.

TABLE 3: Plant Mix Surfacing Gradation

Sieve Size	% Passing Job Mix Target Bands	Job Mix Tolerances
3/4"	100	-
1/2"	83 - 93	+/- 7
3/8"	73 - 97	+/- 7
No. 4	47 - 63	+/- 6
No. 10	32 - 43	+/- 6
No. 40	15 - 25	+/- 5
No. 200	5 - 7	+/- 2

The job mix formula establishes target values. During mix production, the gradations are to fall within the job mix limits presented in Table 3, i.e. if a QA job mix target of 6 has been selected for the No. 200 sieve and since the tolerance is +/-2, the job mix gradation for production would be 4 - 8.

Compact the asphalt concrete plant mix surfacing in one lift to an average relative compaction (ASTM D2041) of at least 93 percent, and no individual sample being less than 92 percent.



3.3 Off-Street Bike Trails Typical Section

Off Street bike trails are proposed for this development. Though the loadings are much lighter than the streets, the subgrade and base course preparation must receive the same level of attention as given for the streets. For drainage purposes, LSM suggests the grading for the bicycle trail be kept above the existing grade. LSM recommends shoulders are included with the trail surface width to provide lateral stability for the plant mix surfacing. LSM recommends keeping the vegetation mat in place. The root mat acts similar to a stabilization geotextile but will still need a separation geotextile to limit the migration of base aggregate into the subgrade and vice-versa.

LSM recommends a typical section for the Off-street Bike Trails of:

Asphalt Concrete:	1 1/2 inches Plant Mix.
Crushed Granular Base:	8 inches Crushed 1 1/2-inch minus.
Woven Geotextile:	Propex® 200ST.

LSM recommends preparing the subgrade and constructing the bicycle typical section aggregates by:

1. Compacting the existing ground surface to a standard relative compaction (ASTM D698) of at least 95 percent.
2. Providing a woven geotextile meeting the engineering characteristics of Propex® 200ST.
3. Placing the woven geotextile across the compacted surface, overlapping the joints by at least 1 foot.
4. Providing 8 inches of 1 1/2-inch crushed base course meeting the gradation presented in Table 2.
5. Placing the base course over the woven geotextile and compacting it to a modified relative compaction of at least 95 percent and at a moisture content within 2 percent of its optimum moisture content.
6. Placing the 1 1/2-inch thick plant mix asphalt across the base course and compact to an average relative compaction (ASTM D2041) of at least 93 percent, and no individual sample being less than 92 percent.

3.4 Street Subsurface Drainage

With the exception of BH-01, the boreholes received either a slotted 1 1/2-inch diameter PVC as a piezometer or a 4-inch diameter PVC pipe slotted across the bottom 2 feet that was used for infiltration testing. Holman Consulting Engineers conducted the infiltration testing on January 28 and 29, 2021. The infiltration testing rates are presented in Table 4.

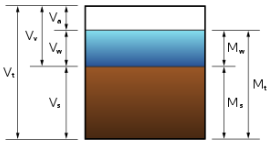


TABLE 4: Infiltration Rates

Borehole	Infiltration Rates (inches/hour)
BH-03	345
BH-05	238
BH-07	94
BH-10	144

The groundwater table was encountered in each of the piezometers. LSM recorded piezometer readings on September 19, 2020. Holman Consulting Engineers read the piezometers the same dates they conducted the infiltration testing in January, 2021. The shallowest readings are presented in Table 5.

TABLE 5: Groundwater Table at its Shallowest Depth

Borehole	Groundwater Table Depth	
BH-01	16'-0" (09/09/20)	Not Measured – Borehole Filled
BH-02	12'-1" (09/09/20)	6' – 10" (06/2021)
BH-04	13'-2" (09/19/20)	8' - 2" (06/2021)
BH-06	12'-0" (09/10/20)	10' - 8" (06/2021)
BH-08	14'-6" (09/19/20	12' – 2"" (06/2021)
BH-09	13'-0" (09/10/20)	10' – 10" (06/2021)

3.5 Compaction and Fresh Concrete Testing Frequency

LSM suggests a testing frequency presented in Table 5 for subgrade and backfill compaction and for fresh concrete for the streets' curbs and gutters and their sidewalks.

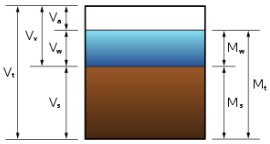
TABLE 6: Compaction and Fresh Concrete Testing Frequency

Compaction Testing	
Street Subgrade and Aggregates	1 Test per 5,000 Square Feet per Lift
Concrete Testing	
Curb/Sidewalk Concrete	1 Test per 50 Cubic Yards per Day

4 GENERAL RESIDENTIAL RECOMMENDATIONS

Based on the soils encountered during the street drilling operations, LSM is making general recommendations for the residential foundations, foundation walls, and slabs-on-grade. If fine-grained soils are encountered that differ from what LSM encountered during the street excavations, contact LSM to evaluate the subgrade soils and to provide additional design recommendations.

Basement levels are not recommend at this site due to the possibility of cyclical groundwater fluctuations that may lead to basement flooding. The shallowest groundwater depth was measured at 12 feet but this was in the month of September, 2020. The piezometers are still intact and LSM understands the groundwater table has indeed risen.



4.1 Foundations

Footing over-excavations to the gravels or sands are recommended for crawl spaces and for slabs on grades. Interior footings can be placed directly below the slabs-on-grade but are also to be supported on the underlying gravels or sands. Compact the footing subgrades to a standard relative compaction (ASTM D698) of at least 98 percent and at a moisture content within 2 percent of the subgrade's optimum moisture content.

Provided the foundation subgrades have been prepared and compacted as noted, an allowable soil bearing pressure up to 3,000 pounds per square foot (psf) is recommended for the foundation subgrades on the native gravel and sand soils.

LSM believes the gravel subgrade at depth is porous and will adequately pass infiltrated surface water that arrives at the foundation elevation. With the presence of gravel soils at the foundation depth, LSM does not believe perimeter foundation drains are necessary. The BH-10 location did have sandy silt down to the 7-foot depth and will not rapidly transmit infiltrated water. If these soils are encountered at the foundation elevation, LSM recommends extending the excavation further until gravels are encountered or installing a perimeter drain system that carries the infiltrated water to a dry well.

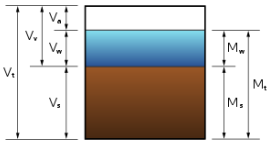
4.2 Foundation Walls

LSM recommends foundation walls associated with the exterior footings be cast-in-place reinforced concrete, damp proofed, and to include water stops at the foundation wall/footing keyway.

The sandy silt and granular soils can be re-used as backfill against the foundation walls provided the cobble-sized (>3") particles are either removed entirely or be at least 1 foot away from the walls. Compacting these materials as backfill will offer an internal angle of friction (ϕ) of 34°, and a moist unit weight (γ_m) of at least 135 pcf. For the on-site soils being used as backfill, LSM recommends using an at-rest equivalent fluid unit weight (γ_f) of 59.5 pounds per cubic foot (pcf) for foundation wall design where the tops of the walls are not allowed to rotate. LSM recommends using an active equivalent fluid unit weight (γ_f) of 38.2 pounds per cubic foot (pcf) for retaining wall design where the tops of the walls are allowed to rotate. With a level backfill, the following equations can be used to obtain a resultant lateral force (pounds per lineal foot) acting at the lower one-third of the wall heights (H in feet):

Active Pressure, P_a:	$19.1 \times H^2$
Passive Pressure, P_p:	$238.8 \times H^2$
At-rest Pressure, P_0:	$29.8 \times H^2$
Seismic Pressure, P_E:	$10.1 \times H^2$
Seismic Active Pressure, $P_{(E+a)}$:	$29.2 \times H^2$

LSM recommends walls associated with the foundation footings or columns be cast-in-place reinforced concrete. At least 2 inches of rigid EPS insulation is suggested for use along the exterior sides of the perimeter walls. In addition to providing insulation benefits, the rigid



insulation board will offer some cushion and protection to the wall waterproofing during the backfilling operations.

4.3 Slabs-on-Grade

For crawl spaces on the silty soils that may have a slab-on-grade and for the garage slabs, LSM recommends including a 9-inch thick gravel layer meeting the gradation in Table 2 and a 3-inch thick leveling course of 3/4-inch sandy gravel beneath the slab. LSM suggests the placement of the aggregates even if there is no slab in the crawl spaces.

Varying amounts of curling within the slabs are likely to occur due to differences in the moisture content or to temperature variations between the top and the bottom of the slab. To help mitigate potential slab curling, LSM recommends the following options:

1. Putting a chloride-free retardant additive into the fresh concrete mix;
2. Maintaining a minimum of 1.5 inches clearance on all rebar; and,
3. Placing a 15-mil thick polyolefin vapor barrier across the prepared subgrade surface prior to placing the fresh concrete. In addition to being a vapor barrier, the Stego® vapor barrier has a radon diffusion coefficient of 8.8 x 10^{-12} square meters per second.

The purpose of the retardant in the first option is to slow the set at the surface of the slab. No chlorides are allowed in any of the admixtures for the slabs-on-grade. The concrete at the slab surface will generally harden quicker than the concrete at the bottom of the slab. This is particularly true of concrete placed during hot weather conditions. The use of a retardant can also reduce cold joints, allow smaller crews to finish flat work, and permit later joint sawing.

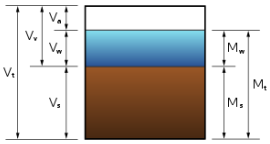
LSM recommends including isolation and control (contraction) joints within the slab-on-grade. Joint geometries should include:

1. Placing isolation joints at all interior column locations.
2. Spacing saw-cut or forming control joints from 24 to 36 times the thickness of the slab in each direction and extending the control joints to one-quarter the thickness of the slab.
3. Terminating reinforcing bars within 2 inches of both sides of control joints to limit the transfer of shrinkage and contraction restraints.
4. If sawing, cut the joints with a conventional saw within 4 to 12 hours after the concrete is finished, or with a dry-cut early entry saw within 1 to 4 hours after the concrete is finished. If fiber reinforcing is used, increase the saw cut to one-third the thickness of the slab.

If added correctly, fiber reinforcement can limit the growth of shrinkage cracking. LSM yields to the structural engineer for the joint designs.

4.4 Underground Utilities

For utility trench excavations, the trench materials are expected to meet OSHA's requirements for a Type C soil. The steepest unsupported slope within a Type C soil trench is 1 1/2H:1V.



Use bedding soils that are minus 3/4-inch granular materials and are non-corrosive. A non-corrosive soil has a resistivity value greater than 3,000 ohm-centimeters. LSM recommends extending the bedding soil from the bottom of the utility trench to 6 inches above the top of the utility conduits. The native materials can be re-used as trench backfill over the bedding.

Soil compaction in utility trenches deeper than 5 feet should be performed using a remote trench compactor and observed by an inspector. When the backfill has been brought back to within 5 feet of the surface, perform compaction testing. Compact the trench soils to a standard relative compaction of at least 95 percent.

4.5 Groundwater Table and Surface Water

The groundwater table was encountered during the drilling operations which extended to 20 feet at its deepest depth. Piezometers were inserted in five of the boreholes and the shallowest reading was 12 feet. One of the piezometers, BH-06, noted a groundwater table at 12 feet when it was drilled on September 10. A second reading was taken on September 19, at which time it was dry to its bottom at 15.2 feet. A third reading was taken on January 29, 2021, at the time of the groundwater infiltration testing for nearby sites and the groundwater table was measured at 14.25 feet.

Infiltration rates were presented in Table 4 and they ranged from 94 to 345 inches per hour at the 8-foot depths in BH-07 and BH-03, respectively. LSM understands the City of Missoula recommends a safety factor of 3.0, making the design rates 31 to 115 inches per hour.

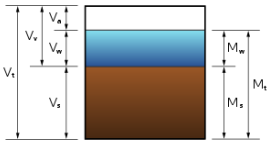
LSM notes that the groundwater is likely under a hydrostatic head pressure (BH-01) which may lead to the groundwater table rising after the overburden soils are removed for deep basements. LSM does not recommend basement level elevations at this development.

LSM recommends berming all open excavations during construction to prevent surface water from entering.

4.6 Seismic Considerations

The Missoula area is within the Northern Intermountain Seismic Belt seismotectonic province. The ASCE/SEI 7-16 Hazards Report was used to develop the spectral response values for a seismic site class ‘C’, “Very Dense Soils and Soft Rock”. LSM recommends the maximum credible spectral response accelerations at short 0.2-second periods, S_{MS}, and at 1-second periods, S_{M1}, to determine the seismic design base shear. A risk category of II was used. The spectral response acceleration parameters are presented in Table 7.

The seismic backfill pressures against the buried portion of the foundation walls can be determined by adding a seismic event component, P_E, based on Seed and Whitman (1970) to the coefficient of active pressure P_a. The P_E was calculated to be 10.1 x H^2, making the active pressure against the wall during an earthquake equal to 29.2x H^2 and was presented in Section



4.2. A factor of safety of 1.1 can be used for earthquake design lateral earth pressures and the allowable bearing capacity can be increased by one-third for seismic design.

TABLE 7: Seismic Coefficients

ASCE/SEI 7/16, Earthquake Loads	
Site Class Definition	C
Mapped Spectral Response Acceleration Parameter, S_S for 0.2 second	0.392g
Mapped Spectral Response Acceleration Parameter, S_1 for 1.0 second	0.132g
Adjusted Maximum Considered Earthquake Spectral Response Acceleration Parameter, S_{MS}	0.510g
Adjusted Maximum Considered Earthquake Spectral Response Acceleration Parameter, S_{M1}	0.199g
Design Spectral Response Acceleration Parameter, S_{DS}	0.340g
Design Spectral Response Acceleration Parameter, S_{D1}	0.132g

Due to the groundwater table being less than 15 feet and the nature of the granular soils encountered in the test pits, liquefaction during a seismic event is considered a moderate concern at this site during a significant seismic event of a moment magnitude greater than 6.0.

4.7 Shrink/Swell Characteristics

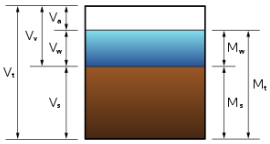
The volume change potential of the on-site granular soils encountered during the street drilling is expected to be low. The presence of the silty subgrades at the upper portion of the soil profile will present issues regarding frost heaving during the colder winter months and frost boils during the thaw periods beneath sidewalks and patios. To mitigate the effects of frost heave, LSM recommends including at least 9 inches of a base course meeting the gradation in Table 2 beneath exterior flatwork.

The building designs should include eaves and roof gutters with downspouts that will carry roof runoff water at least 7 feet horizontally away from the buildings. Provide positive drainage around the entire building on a 2 percent grade extending at least 10 feet horizontally away from the building.

5 BASIS OF RECOMMENDATIONS

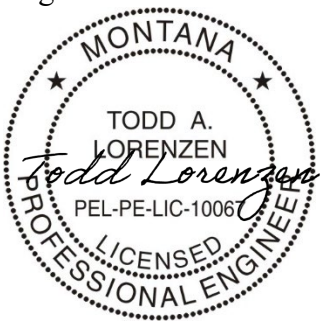
The analyses and recommendations submitted in this report are based upon the subsurface investigation. Often, variations occur within the subgrade, the nature and extent of which do not become evident until additional exploration or construction is conducted.

This report is for the exclusive use of Tollefson Construction, Woith Engineering, and their design team. In the absence of LSM's written approval, LSM makes no representation and assumes no responsibility to other parties regarding this report. The data, analyses, and recommendations may not be appropriate for other structures or purposes. Again, general recommendations made for the residential sites were based on the soils encountered during the street test pitting operations. If the structure foundation soils differ, contact LSM for additional foundation recommendation guidance. Parties contemplating structures or purposes other than what this report was written are directed to contact LSM.



Professional Certification

I hereby certify that this report was prepared by me and that I am a duly Licensed Professional Engineer under the laws of the State of Montana.



March 8, 2021

Amended July 12, 2022

Todd Lorenzen, P.E.
Geotechnical Engineer

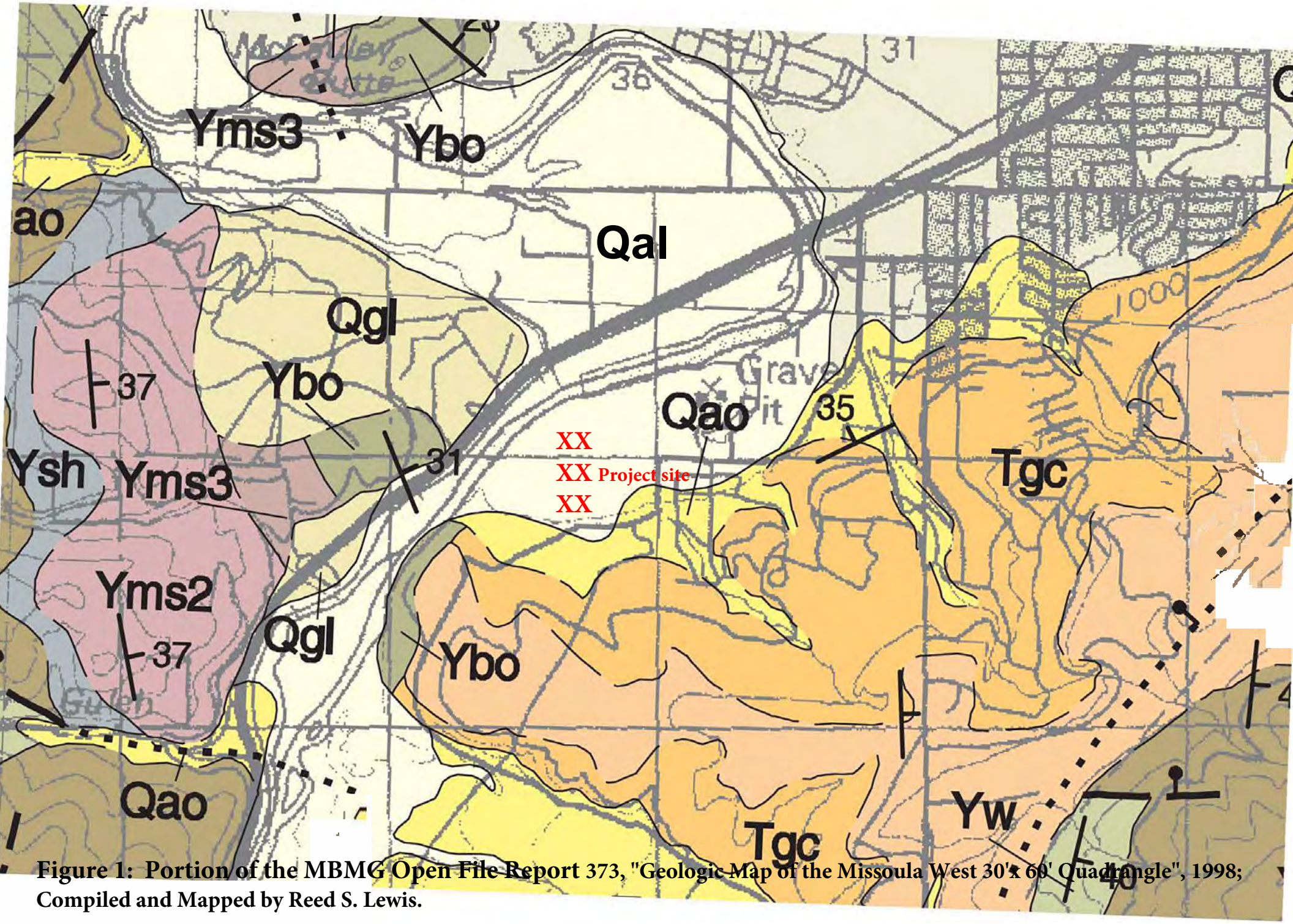
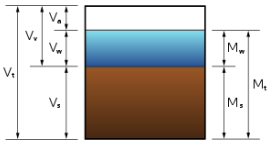


Figure 1: Portion of the MBMG Open File Report 373, "Geologic Map of the Missoula West 30'x 60' Quadrangle", 1998; Compiled and Mapped by Reed S. Lewis.

M

Figure 2: Borehole Locations



APPENDIX A. LOGS OF BOREHOLES AND TESTING INFORMATION

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1-3/8" I.D., 2" O.D., unless otherwise noted	CA:	Casing Advancer
ST:	Thin-Walled Tube - 2" O.D., unless otherwise noted	DA:	Drill Auger
CB:	California Sampler - 2" I.D., 2.5" O.D., unless otherwise noted	HA:	Hand Auger
DB:	Diamond Bit Coring - 4", NX, unless otherwise noted	RB:	Rock Bit
BS:	Bulk Sample or Auger Sample	GS:	Grab Sample

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the "Standard Penetration" or "N-value". The field blow counts are reported for each 6-inch interval, or portion thereof if greater than 50 blows are required to advance the full 6-inch interval. For over-sized split spoon samplers, non-standard hammers, or non-standard drop heights, the field penetration values are reported on the bore log. The values must be corrected to obtain the N-value.

WL:	Water Level	WS:	While Sampling	NE:	Not Encountered
WCl:	Wet Cave-In	WD:	While Drilling		
DCI:	Dry Cave-In	BCR:	Before Casing Removal		
AB:	After Boring	ACR:	After Casing Removal		

Groundwater table levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater table levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater table levels may not be possible with only short-term observations.

DESCRIPTIVE SOIL CLASSIFICATION: Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: gravel or sand. Cobbles and boulders are not part of the USCS system but are included, when present, as percentages. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; depending on their plasticity, they are described as clay or silt. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils are defined on the basis of their consistency.

CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-value (SS) Blows/Ft.	Consistency
< 500	0 - 1	Very Soft
500 - 1,000	2 - 4	Soft
1,001 - 2,000	5 - 8	Medium Stiff
2,001 - 4,000	9 - 15	Stiff
4,001 - 8,000	16 - 30	Very Stiff
8,000 +	30 +	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration or N-value (SS) Blows/Ft.	California Barrel (CB) Blows/Ft.	Relative Density
0 - 4	0 - 6	Very Loose
5 - 10	7 - 18	Loose
11 - 30	19 - 58	Medium Dense
31 - 50	59 - 98	Dense
50 +	99 +	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of Other Constituents	Percent of Dry Weight
Trace	< 15
With	15 - 30
Modifier	> 30

USCS* GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75 mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 Sieve (0.075mm)

*For AASHTO grain size the #4 sieve is replaced with the #10 sieve

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of Other Constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifiers	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-Plastic	0
Slightly	1 - 5
Low	6 - 10
Medium	11 - 20
Highly	21 - 40
Very Highly	> 40

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	Group Name [B]
Coarse Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines	Cu ≥ 4 and 1≤ Cc ≤ 3	GW	Well-graded Gravel [F]
			Cu < and/or 1 > Cc > 3	GP	Poorly graded gravel [F]
		Gravels with Fines More than 12% fines	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	Cu ≥ 6 and 1 ≤ Cc ≤ 3	SW	Well-graded Sand [I]
			Cu < 6 and/or 1 > Cc > 3	SP	Poorly graded Sand [I]
		Sands with Fines More than 12% fines	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	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line	CL	Lean Clay [K,L,M]
			PI < 4 or plots below "A" line	ML	Silt [K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic Clay [K,L,M,N]
					Organic Silt [K,L,M,Q]
	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 / Liquid limit - not dried < 0.75	OH	Organic Clay [K,L,M,P]
					Organic Silt [K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contains cobbles and/or boulders, add "with cobbles or boulders, or both" as necessary 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] $Cu = D_{60} / D_{10} \quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[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 in shaded 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.

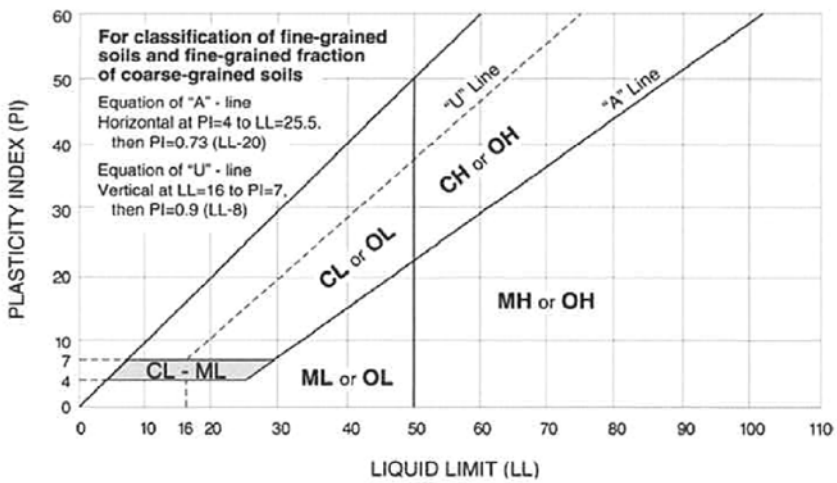
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[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.

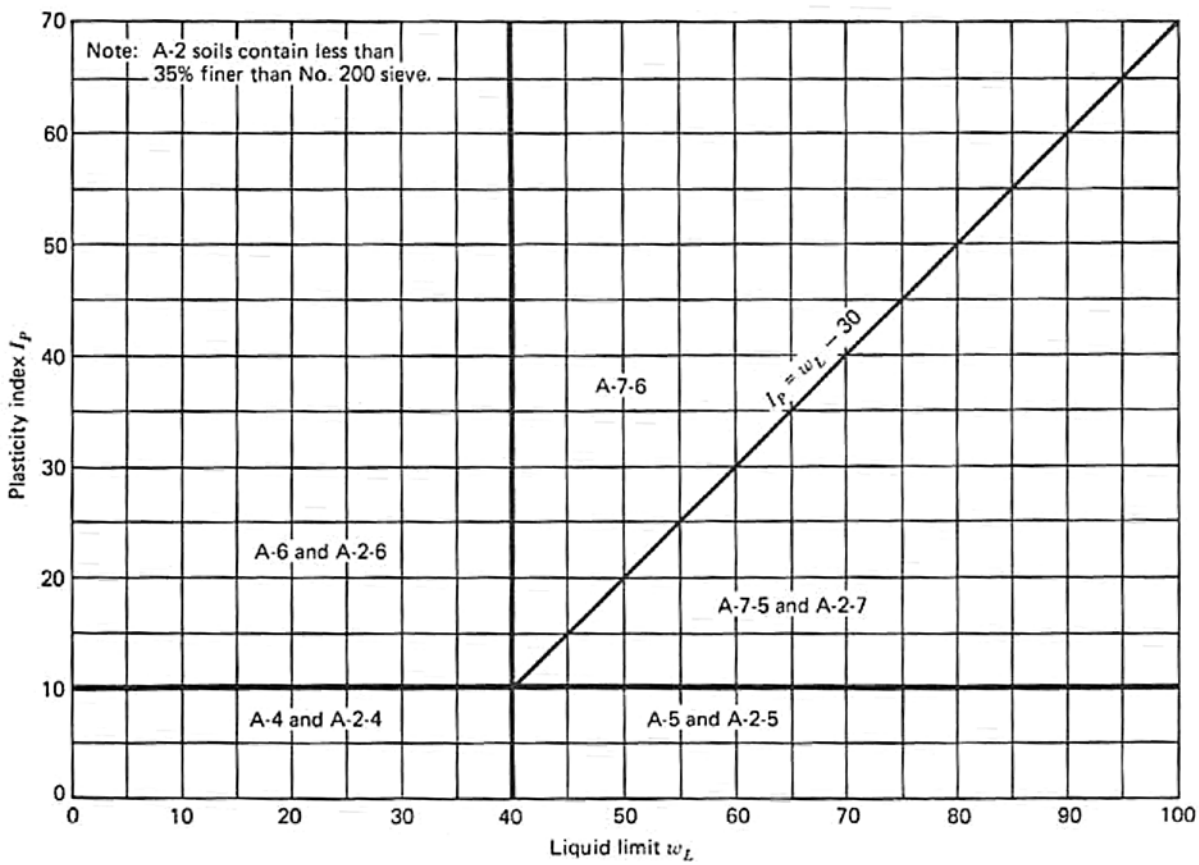
[Q] PI plots below "A" line.



AASHTO SOIL CLASSIFICATION SYSTEM

General classification	**Granular materials** (35 percent or less of total sample passing No. 200)							**Silt-clay material** (More than 35 percent of total sample passing No. 200)			
Group classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7 [1]
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve analysis percent passing No. 10 No. 20 No. 200	 50 max 30 max 15 max	 50 max 25 max	 51 max 10 max	 35 max	 35 max	 35 max	 35 max	 36 min	 36 min	 36 min	 36 min
Characteristics of fraction passing No. 40 Liquid limit, w_L Plastic Index, I_P	 6 max		 NP	 40 max 10 max	 41 min 10 max	 40 max 11 min	 41 min 11 min	 40 max 10 max	 41 min 10 max	 40 max 11 min	 41 min 11 min
Significant constituent materials	gravel and sand		fine sand	silty and clayey gravel and sand				silty soils		clayey soils	

[1] Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30.



Lorenzen Soil Mechanics, Inc.
2720 Palmer Street, Unit C
Missoula, MT 59808
Telephone: 406-830-0633

BORING NUMBER BH-01

CLIENT Tolleffson Construction
PROJECT NAME Riverfront Trails
PROJECT NUMBER BT2020
PROJECT LOCATION Missoula
DATE STARTED 9/9/20 **COMPLETED** 9/9/20
GROUND ELEVATION ____ **HOLE SIZE** 6 inches
DRILLING CONTRACTOR Boland Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mobile B59
▽ **AT TIME OF DRILLING** 16.00 ft
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
▼ **AT END OF DRILLING** 16.00 ft
NOTES N46° 49' 12.1"; W114° 04' 15.7"
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		(SM) TOPSOIL, Sandy Loam with Vegetation Organics; dry; gray (10YR 5/1); no reaction to 10% HCl solution - it beaded on the sample. [A-4].										
		(GP-GM) Poorly Graded GRAVEL with Silt and Sand, traces of Mica; rounded to subangular; dry; very pale brown (10YR 7/3) matrix; medium dense; no reaction to 10% HCl solution. Fines are slightly plastic. [A-1-a]. Drill rate from 0 to 2.5 feet = 180 ft/hr.	SPT	67	3-5-6 (11)			1				
5		Drill rate from 2.5 to 5 feet = 180 ft/hr.										
		(GP) Poorly Graded GRAVEL with Sand, traces of Mica; rounded to subangular; dry; light gray (10YR 7/1, 7/2) matrix; dense; no reaction to 10% HCl solution. [A-1-a].	SPT	72	4-13-19 (32)			1				
		Drill rate from 5 to 7.5 feet = 165 ft/hr.										
		Drill rate from 7.5 to 10 feet = 130 ft/hr.	SPT	67	8-21-19 (40)			2				
10												
			SPT	78	13-23-23 (46)			2				
		Drill rate from 10 to 15 feet = 75 ft/hr.										
15												
		(ML) SILT, traces of Mica; moist to wet; brown (10YR 4/3) to gray (10YR 6/1); loose; no reaction to 10% HCl solution; non-plastic, low dry strength, powdery; rapid dilatency - 'Bull's Liver'. [A-4(0)].	SPT	78	2-4-5 (9)			30	NP	NP	NP	97
		(SP) Poorly Graded SAND; wet.										
		Drill rate from 15 to 20 feet = 385 ft/hr.										
		There was 18 inches of 'sand heave' inside the casing prior to attempting the SPT at the 20-foot depth. The collected sample is considered 'washed material'.	SPT	100	2-9-18 (27)			24				
20												

Bottom of borehole at 20.0 feet.

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BORING NUMBER BH-02

CLIENT Tolleffson Construction
PROJECT NAME Riverfront Trails
PROJECT NUMBER BT2020
PROJECT LOCATION Missoula
DATE STARTED 9/9/20 **COMPLETED** 9/9/20
GROUND ELEVATION _____ **HOLE SIZE** 6 inches
DRILLING CONTRACTOR Boland Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mobile B59
▽ **AT TIME OF DRILLING** 12.10 ft
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
▼ **AT END OF DRILLING** 12.10 ft
NOTES N46° 49' 12.1"; W114° 04' 15.7"
▼ **142hrs AFTER DRILLING** 15.00 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		(SM) TOPSOIL, Sandy Loam with Vegetation Organics; dry; gray (10YR 5/1); no reaction to 10% HCl solution - it beaded on the sample. [A-4].										
		Drill rate from 0 to 2.5 feet = 180 ft/hr.										
		(SM) Silty SAND, traces of Mica; dry ; light gray (10YR 7/2); loose; no reaction to 10% HCl solution. Fines are slightly plastic. [A-4].	SPT	72	4-3-2 (5)			2				
		Drill rate from 2.5 to 5 feet = 215 ft/hr.										
5		(GP) Poorly Graded GRAVEL with Sand, traces of Mica; rounded to subangular; dry to moist; light gray (10YR 7/2) to light brownish gray (10YR 6/2) matrices; dense; no reaction to 10% HCl solution. [A-1-a].	SPT	78	4-15-16 (31)			2				
		Drill rate from 5 to 10 feet = 140 ft/hr.										
10			SPT	78	12-15-16 (31)			4				
		Groundwater table measured at 12.2 feet 9/19/20.										
		(GP) Poorly Graded GRAVEL with Sand, traces of Mica; rounded to subangular; wet; grayish brown (10YR 5/2) matrix; loose; no reaction to 10% HCl solution. [A-1-a].										
		Drill rate from 10 to 15 feet = 85 ft/hr.										
15			SPT	50	2-4-5 (9)			17				
		Bottom of borehole at 16.5 feet.										

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BORING NUMBER BH-03

CLIENT Tolleffson Construction
PROJECT NAME Riverfront Trails
PROJECT NUMBER BT2020
PROJECT LOCATION Missoula
DATE STARTED 9/10/20 **COMPLETED** 9/10/20
GROUND ELEVATION _____ **HOLE SIZE** 6 inches
DRILLING CONTRACTOR Boland Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mobile B59
AT TIME OF DRILLING --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF DRILLING --- GW table was not encountered.
NOTES N46° 49' 12.1"; W114° 04' 15.7"
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		(SM) TOPSOIL, Sandy Loam with Vegetation Organics; dry; gray (10YR 5/1); no reaction to 10% HCl solution - it beaded on the sample. [A-4].										
		Drill rate from 0 to 2.5 feet = 210 ft/hr.										
		(SP) Poorly Graded SAND, traces of Mica; dry; fine- to medium grained; light gray (10YR 7/2); loose; no reaction to 10% HCl solution. [A-3].	SPT	61	5-5-3 (8)			2				
		Drill rate from 2.5 to 5 feet = 145 ft/hr.										
5		(GP) Poorly Graded GRAVEL with Sand, traces of Mica; rounded to subangular; dry; light gray (10YR 7/2) to light brownish gray (10YR 6/2) matrices; dense; no reaction to 10% HCl solution. [A-1-a].	SPT	72	5-16-20 (36)			1				
		Drill rate from 5 to 8 feet = 80 ft/hr.										
			SPT	78	11-19-18 (37)			3				
		Infiltration rate = 0.48 ft/min = 346 in/hr Bottom of borehole at 9.5 feet.										

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BORING NUMBER BH-04

CLIENT Tolleffson Construction
PROJECT NAME Riverfront Trails
PROJECT NUMBER BT2020
PROJECT LOCATION Missoula
DATE STARTED 9/10/20 **COMPLETED** 9/10/20
GROUND ELEVATION _____ **HOLE SIZE** 6 inches
DRILLING CONTRACTOR Boland Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mobile B59
AT TIME OF DRILLING --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF DRILLING --- GW table was not encountered.
NOTES N46° 49' 12.1"; W114° 04' 15.7"
142hrs AFTER DRILLING 13.80 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		(SM) TOPSOIL, Sandy Loam with Vegetation Organics; dry; gray (10YR 5/1); no reaction to 10% HCl solution - it beaded on the sample. [A-4].										
		Drill rate from 0 to 2.5 feet = 225 ft/hr.										
		(SM) Silty SAND, traces of Mica; dry; grayish brown (10YR 5/2); loose; no reaction to 10% HCl solution, the acid beaded on the sample. [A-4].	SPT	33	2-2-4 (6)			2				
		Drill rate from 2.5 to 5 feet = 165 ft/hr.										
5		(GP) Poorly Graded GRAVEL with Sand, traces of Mica; rounded to subangular; dry; light gray (10YR 7/2) matrix; medium dense; no reaction to 10% HCl solution. [A-1-a].	SPT	67	6-12-14 (26)			2				
		Drill rate from 5 to 10 feet = 35 ft/hr.										
10			SPT	67	11-12-11 (23)			2				
		(GP) Poorly Graded GRAVEL with Sand, traces of Mica; rounded to subangular; moist; light gray (10YR 7/2) matrix; medium dense to loose (inferred); no reaction to 10% HCl solution. [A-1-a]. Drill rate from 10 to 15 feet = 140 ft/hr.										
		Groundwater table measured at 13.2 feet 9/19/20.										
15		(ML) SILT with Sand, traces of Mica; wet; gray (10YR 5/1) and very dark grayish brown (10YR 3/2); loose; no reaction to 10% HCl solution; non-plastic; low dry strength, powdery; rapid dilatency -'Bull's Liver'. [A-4].	SPT	72	2-5-4 (9)			28	NP	NP	NP	73

Bottom of borehole at 16.5 feet.

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BORING NUMBER BH-05

CLIENT Tolleffson Construction
PROJECT NAME Riverfront Trails
PROJECT NUMBER BT2020
PROJECT LOCATION Missoula
DATE STARTED 9/10/20 **COMPLETED** 9/10/20
GROUND ELEVATION _____ **HOLE SIZE** 6 inches
DRILLING CONTRACTOR Boland Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mobile B59
AT TIME OF DRILLING --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF DRILLING --- GW table was not encountered.
NOTES N46° 49' 12.1"; W114° 04' 15.7"
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		(SM) TOPSOIL, Sandy Loam with Vegetation Organics; dry; gray (10YR 5/1); no reaction to 10% HCl solution - it beaded on the sample. [A-4].										
		Drill rate from 0 to 2.5 feet = 95 ft/hr.										
		(GP) Poorly Graded GRAVEL with Sand, traces of Mica; rounded to subangular; dry; light brownish gray (10YR 6/2) matrix; medium dense; no reaction to 10% HCl solution. [A-1-a].	SPT	61	7-10-9 (19)			0				
		Drill rate from 2.5 to 5 feet = 165 ft/hr.										
5		(GP) Poorly Graded GRAVEL with Sand, traces of Mica; rounded to subangular; dry; yellowish brown (10YR 5/4) to pale brown (10YR 6/3) matrices; dense to medium dense; no reaction to 10% HCl solution. [A-1-a].	SPT	67	6-19-17 (36)			1				
		Drill rate from 5 to 8 feet = 65 ft/hr.										
			SPT	61	7-10-17 (27)			3				
		Infiltration rate = 0.33 ft/min = 238 in/hr Bottom of borehole at 9.5 feet.										

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BORING NUMBER BH-06

CLIENT Tolleffson Construction
PROJECT NAME Riverfront Trails
PROJECT NUMBER BT2020
PROJECT LOCATION Missoula
DATE STARTED 9/10/20 **COMPLETED** 9/10/20
GROUND ELEVATION _____ **HOLE SIZE** 6 inches
DRILLING CONTRACTOR Boland Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mobile B59
▽ **AT TIME OF DRILLING** 12.00 ft
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
▼ **AT END OF DRILLING** 12.00 ft
NOTES N46° 49' 12.1"; W114° 04' 15.7"
▼ **142hrs AFTER DRILLING** 14.25 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		(SM) TOPSOIL, Sandy Loam with Vegetation Organics; dry; gray (10YR 5/1); no reaction to 10% HCl solution - it beaded on the sample. [A-4].										
		Drill rate from 0 to 2.5 feet =255 ft/hr.										
		(SP) Poorly Graded SAND, traces of Mica; dry; fine- to medium grained; light brownish gray (10YR 6/2); loose; no reaction to 10% HCl solution. [A-3].	SPT	61	1-1-2 (3)			1				
		Drill rate from 2.5 to 5 feet = 195 ft/hr.										
5		(GP) Poorly Graded GRAVEL with Sand, traces of Mica; rounded to subangular; dry to damp; yellowish brown (10YR 6/2) to light gray (10YR 7/1) matrices; medium dense to dense; no reaction to 10% HCl solution. [A-1-a].	SPT	61	5-12-12 (24)			2				
		Drill rate from 5 to 10 feet = 100 ft/hr.										
10			SPT	72	10-21-18 (39)			2				
		Drill rate from 10 to 15 feet = 125 ft/hr.										
		(SP) Poorly Graded SAND with Gravel, traces of Mica; wet; brown (10YR 5/3) matrix; loose; no reaction to 10% HCl solution. Gravels are rounded to subangular. [A-1-a].										
15		Groundwater table measured as dry 9/19/20.	SPT	67	2-2-2 (4)			28				
		Bottom of borehole at 16.5 feet.										

Lorenzen Soil Mechanics, Inc.
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Missoula, MT 59808
Telephone: 406-830-0633

BORING NUMBER BH-07

CLIENT Tolleffson Construction
PROJECT NAME Riverfront Trails
PROJECT NUMBER BT2020
PROJECT LOCATION Missoula
DATE STARTED 9/10/20 **COMPLETED** 9/10/20
GROUND ELEVATION _____ **HOLE SIZE** 6 inches
DRILLING CONTRACTOR Boland Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mobile B59
AT TIME OF DRILLING --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF DRILLING --- GW table was not encountered.
NOTES N46° 49' 12.1"; W114° 04' 15.7"
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		(SM) TOPSOIL, Sandy Loam with Vegetation Organics; dry; gray (10YR 5/1); no reaction to 10% HCl solution - it beaded on the sample. [A-4].										
		Drill rate from 0 to 2.5 feet = 250 ft/hr.										
		(GP) Poorly Graded GRAVEL with Sand, traces of Mica; rounded to subangular; dry; light yellowish brown (10YR 6/4) to light gray (10YR 7/1) matrices; medium dense; no reaction to 10% HCl solution. [A-1-a].	SPT	67	5-6-8 (14)			1				
		Drill rate from 2.5 to 5 feet = 95 ft/hr.										
5			SPT	72	5-9-16 (25)			2				
		Drill rate from 5 to 8 feet = 290 ft/hr.										
		(GP) Poorly Graded GRAVEL with Sand, traces of Mica; rounded to subangular; damp; pale brown (10YR 6/3) matrix; no reaction to 10% HCl solution. [A-1-a].	SPT	72	5-7-10 (17)			2				

Infiltration rate = 0.13 ft/min = 94 in/hr
Bottom of borehole at 9.5 feet.

Lorenzen Soil Mechanics, Inc.
2720 Palmer Street, Unit C
Missoula, MT 59808
Telephone: 406-830-0633

BORING NUMBER BH-08

CLIENT Tolleffson Construction
PROJECT NAME Riverfront Trails
PROJECT NUMBER BT2020
PROJECT LOCATION Missoula
DATE STARTED 9/10/20 **COMPLETED** 9/10/20
GROUND ELEVATION _____ **HOLE SIZE** 6 inches
DRILLING CONTRACTOR Boland Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mobile B59
▽ **AT TIME OF DRILLING** 15.50 ft
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
▼ **AT END OF DRILLING** 15.50 ft
NOTES N46° 49' 12.1"; W114° 04' 15.7"
▼ **142hrs AFTER DRILLING** 15.00 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		(SM) TOPSOIL, Sandy Loam with Vegetation Organics; dry; gray (10YR 5/1); no reaction to 10% HCl solution - it beaded on the sample. [A-4].	GB					2				
		Drill rate from 0 to 2.5 feet = 230 ft/hr.										
		(SP) Poorly Graded SAND, traces of Mica; dry; fine- to medium grained; light brownish gray (10YR 6/2) and brown (10YR 5/3); loose; no reaction to 10% HCl solution. [A-3].	SPT	50	3-4-3 (7)			1				
		Drill rate from 2.5 to 5 feet = 225 ft/hr.										
5		(GP) Poorly Graded GRAVEL with Sand, traces of Mica; rounded to subangular; dry; light brownish gray (10YR 6/2) to yellowish brown (10YR 5/4) matrices; medium dense; no reaction to 10% HCl solution. [A-1-a].	SPT	33	3-5-8 (13)			1				
		Drill rate from 5 to 10 feet = 295 ft/hr.										
10			SPT	61	3-7-8 (15)			3				
		Drill rate from 5 to 10 feet = 240 ft/hr.										
		(CL) Lean CLAY with Sand; wet; brown (7.5YR 4/3); soft (inferred); no reaction to 10% HCl solution; medium plastic; medium dry strength, brittle; no dilatency. [A-6(8)].										
15		▼ Groundwater table measured at 14.6 feet 9/19/20.	SPT	78	1-1-4 (5)			33	35	20	15	85
		(SM) Silty SAND with Gravel, traces of Mica; wet; gray (10YR 6/1); loose (inferred); no reaction with 10% HCl solution. Fines have low plasticity. Gravels are subrounded. [A-2-4].						14				
		Bottom of borehole at 16.5 feet.										

Lorenzen Soil Mechanics, Inc.
2720 Palmer Street, Unit C
Missoula, MT 59808
Telephone: 406-830-0633

BORING NUMBER BH-09

CLIENT Tolleffson Construction
PROJECT NAME Riverfront Trails
PROJECT NUMBER BT2020
PROJECT LOCATION Missoula
DATE STARTED 9/10/20 **COMPLETED** 9/10/20
GROUND ELEVATION _____ **HOLE SIZE** 6 inches
DRILLING CONTRACTOR Boland Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mobile B59
AT TIME OF DRILLING 13.00 ft
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF DRILLING 13.00 ft
NOTES N46° 49' 12.1"; W114° 04' 15.7"
142hrs AFTER DRILLING 15.00 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		(SM) TOPSOIL, Sandy Loam with Vegetation Organics; dry; gray (10YR 5/1); no reaction to 10% HCl solution - it beaded on the sample. [A-4].										
		Drill rate from 0 to 2.5 feet = 335 ft/hr.										
		(SP) Poorly Graded SAND, traces of Mica; dry; fine- to medium grained; light yellowish brown (10YR 6/4); loose; weak reaction to 10% HCl solution. [A-3].	SPT	56	2-3-2 (5)			1				
5		(GP) Poorly Graded GRAVEL with Sand, traces of Mica; rounded to subangular; dry; light gray (10YR 7/1) to pale brown (10YR 6/3) matrices; medium dense; no reaction to 10% HCl solution. [A-1-a].										
		Drill rate from 2.5 to 5 feet = 255 ft/hr.	SPT	56	4-6-9 (15)			1				
		Drill rate from 5 to 8 feet = 250 ft/hr.										
		This borehole was intended to be an infiltration test hole. This changed when the hole collapse upon retrieving the augers and prior to installing the 4-inch diameter hole. The borehole was then extended to 15 feet and a piezometer was installed.	SPT	44	3-8-10 (18)			2				
10		Drill rate from 10 to 15 feet = 355 ft/hr.										
		(GP) Poorly Graded GRAVEL with Sand, traces of Mica; rounded to subangular; wet; yellowish brown (10YR 5/4) matrix; loose; no reaction to 10% HCl solution. [A-1-a].										
15		Groundwater table measured at 15.2 feet 9/19/20.	SPT	44	4-5-5 (10)			12				
		Bottom of borehole at 16.5 feet.										

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2720 Palmer Street, Unit C
Missoula, MT 59808
Telephone: 406-830-0633

BORING NUMBER BH-10

CLIENT Tolleffson Construction
PROJECT NAME Riverfront Trails
PROJECT NUMBER BT2020
PROJECT LOCATION Missoula
DATE STARTED 9/10/20 **COMPLETED** 9/10/20
GROUND ELEVATION _____ **HOLE SIZE** 6 inches
DRILLING CONTRACTOR Boland Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mobile B59
AT TIME OF DRILLING --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF DRILLING --- GW table was not encountered.
NOTES N46° 49' 12.1"; W114° 04' 15.7"
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		(ML) TOPSOIL, Silty Loam with Vegetation Organics; damp; dark grayish brown (10YR 4/2); no reaction to 10% HCl solution - it beaded on the sample. [A-4].	GB					5				
		(ML) SILT; damp; gray (10YR 6/1) and brown (10YR 4/3); loose; strong reaction to 10% HCl solution; slightly plastic; low dry strength, powdery. [A-4].	SPT	61	4-2-3 (5)			7				
5		(ML) Sandy SILT; damp; yellowish brown (10YR 5/6); loose; medium reaction to 10% HCl solution; non-plastic; medium dry strength, brittle. [A-4(0)].	SPT	67	2-3-4 (7)			12	NP	NP	NP	56
		(GP) Poorly Graded GRAVEL with Sand, traces of Mica; rounded to subangular; wet; brown (10YR 5/3) matrix; dense; strong reaction to 10% HCl solution. [A-1-a]. Low percent recovery was due to gravel clast stuck in the split spoon shoe.	SPT	39	11-18-16 (34)			1				

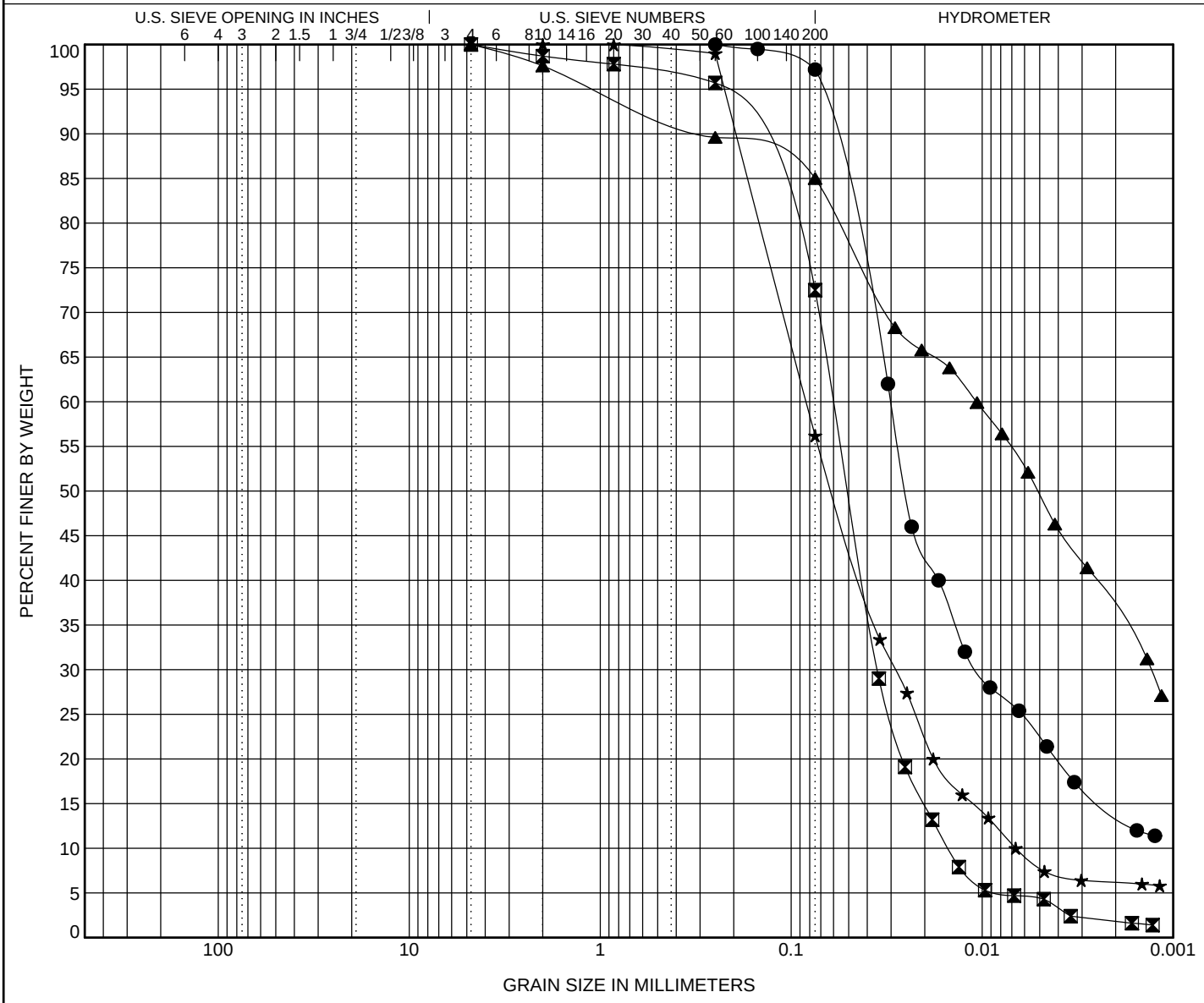
Infiltration rate = 0.20 ft/min = 144 in/hr
Bottom of borehole at 9.5 feet.

GRAIN SIZE DISTRIBUTION

Lorenzen Soil Mechanics, Inc.
2720 Palmer Street, Unit C
Missoula, MT 59808
Telephone: 406-830-0633

CLIENT Tolleffson Construction **PROJECT NAME** Riverfront Trails

PROJECT NUMBER BT2020 **PROJECT LOCATION** Missoula



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**BH-01**	**15.0**	**SILT(ML)**	**NP**	**NP**	**NP**		
⊠	**BH-04**	**15.0**	**SILT with SAND(ML)**	**NP**	**NP**	**NP**	**1.39**	**4.00**
▲	**BH-08**	**15.0**	**LEAN CLAY with SAND(CL)**	**35**	**20**	**15**		
★	**BH-10**	**5.0**	**SANDY SILT(ML)**	**NP**	**NP**	**NP**	**1.46**	**12.48**

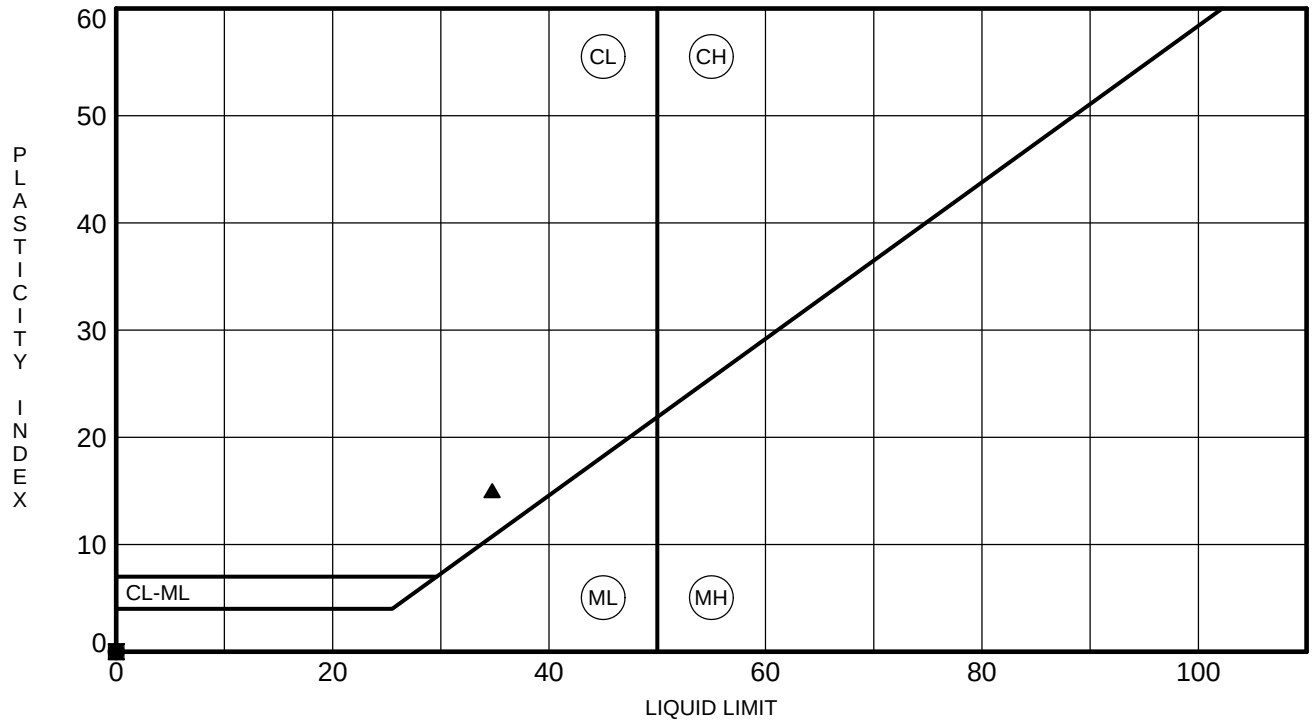
	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH-01**	**15.0**	**0.25**	**0.03**	**0.011**		**0.0**	**2.8**	**74.8**	**22.4**
⊠	**BH-04**	**15.0**	**4.75**	**0.06**	**0.035**	**0.015**	**0.0**	**27.5**	**68.1**	**4.4**
▲	**BH-08**	**15.0**	**4.75**	**0.011**	**0.001**		**0.0**	**15.0**	**35.4**	**49.6**
★	**BH-10**	**5.0**	**2**	**0.083**	**0.029**	**0.007**	**0.0**	**43.8**	**48.4**	**7.8**

ATTERBERG LIMITS' RESULTS

Lorenzen Soil Mechanics, Inc.
2720 Palmer Street, Unit C
Missoula, MT 59808
Telephone: 406-830-0633

CLIENT Tolleffson Construction **PROJECT NAME** Riverfront Trails

PROJECT NUMBER BT2020 **PROJECT LOCATION** Missoula



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**BH-01**	**15.0**	**NP**	**NP**	**NP**	**97**	**SILT(ML)**
⊠	**BH-04**	**15.0**	**NP**	**NP**	**NP**	**73**	**SILT with SAND(ML)**
▲	**BH-08**	**15.0**	**35**	**20**	**15**	**85**	**LEAN CLAY with SAND(CL)**
★	**BH-10**	**5.0**	**NP**	**NP**	**NP**	**56**	**SANDY SILT(ML)**

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View scanned well log (2/13/2019 1:46:14 PM)

Site Name: MISSOULA COUNTY PUBLIC SCHOOLS - JEANETTE RANKIN SCHOOL
GWIC Id: 300055
DNRC Water Right: 30121478

Section 1: Well Owner(s)

1) MISSOULA COUNTY PUBLIC SCHOOLS - JEANETTE RANKIN SCHOOL (MAIL)
915 SOUTH AVE
MISSOULA MT 59801 [09/25/2018]
2) MISSOULA COUNTY PUBLIC SCHOOLS - JEANETTE RANKIN SCHOOL (WELL)
5150 BIGFORK RD
MISSOULA MT 59803 [09/25/2018]

Section 2: Location

Township	Range	Section	Quarter Sections
12N	20W	11	NE¼

County	Geocode
MISSOULA	04209211101150000

Latitude	Longitude	Geomethod	Datum
46.81735	-114.07065	NAV-GPS	NAD27

Ground Surface Altitude	Ground Surface Method	Datum	Date
3138			9/25/2018

Addition	Block	Lot
		1

Section 3: Proposed Use of Water

IRRIGATION (1)

Section 4: Type of Work

Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Tuesday, September 25, 2018

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	120	6

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-2	118	6			WELDED	STEEL

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
100	110	6	240	1 1/4 X 1/4	HOLTE PERFORATOR SLOTS

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	45	BENTONITE	Y

Section 7: Well Test Data

Total Depth: 120
Static Water Level: 19
Water Temperature:

Air Test *

100 gpm with drill stem set at 110 feet for 2 hours.
Time of recovery 0.02 hours.
Recovery water level 19 feet.
Pumping water level _ feet.

** During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

Section 8: Remarks

Section 9: Well Log

Geologic Source

Unassigned

From	To	Description
0	4	SOIL, AND SILTY SAND
4	15	SILTY SAND AND GRAVEL
15	23	RED AND BROWN MOIST CLAY
23	70	SAND WITH WATER, TAN CLAY, SEAMS, VERY LITTLE SEAMS OF PEA GRAVEL
70	92	SAND AND GRAVEL WITH WATER, VERY SANDY LAYERS
92	94	BROWN CLAY
94	114	GRAVEL WITH WATER
114	120	RED ROCK

Driller Certification

All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.

Name: JON NORCROSS
Company: CAMP WELL DRILLING AND PUMP SERVICE
License No: WWC-7
Date Completed: 9/25/2018

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View scanned well log (1/7/2019 10:27:39 AM)

NOTICE >> This well has been marked as ABANDONED in the GWIC database. **<< NOTICE**

Site Name: MISSOULA COUNTY PUBLIC SCHOOLS - JEANETTE RANKIN SCHOOL
GWIC Id: 299902

Section 1: Well Owner(s)

1) MISSOULA COUNTY PUBLIC SCHOOLS - JEANETTE RANKIN SCHOOL (MAIL)
915 SOUTH AVENUE
MISSOULA MT 59801 [09/05/2018]
2) MISSOULA COUNTY PUBLIC SCHOOLS - JEANETTE RANKIN SCHOOL (WELL)
5150 BIGFORK ROAD
MISSOULA MT 59803 [09/05/2018]

Section 2: Location

Township	Range	Section	Quarter Sections
12N	20W	11	NE¼

County	Geocode
MISSOULA	04209211101150000

Latitude	Longitude	Geomethod	Datum
46.817016666667	-114.069316666667	NAV-GPS	NAD27

Ground Surface Altitude	Ground Surface Method	Datum	Date

Addition	Block	Lot

Section 3: Proposed Use of Water

IRRIGATION (1)

Section 4: Type of Work

Drilling Method: ROTARY
Status: ABANDONED

Section 5: Well Completion Date

Date well completed: Wednesday, September 5, 2018

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	180	6

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-2	178	6			WELDED	STEEL

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
99	101	6	104	1-1/4 X 1/4	HOLTE PERFORATOR SLOTS

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	45	BENTONITE SURFACE SEAL	Y

Section 7: Well Test Data

Total Depth: 178
Static Water Level: 35
Water Temperature:

Air Test *

_ gpm with drill stem set at 105 feet for 2 hours.
Time of recovery 0.02 hours.
Recovery water level 19 feet.
Pumping water level _ feet.

** During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

Section 8: Remarks

NO USABLE WATER ENCOUNTERED - (9/5/18); WELL WAS ABANDONED BY JON NORCROSS WWC/7 OF CAMP WELL DRILLING AND PUMP. WELL WAS FILLED WITH BENTONITE. - (10/10/18)

Section 9: Well Log

Geologic Source

Unassigned

From	To	Description
0	3	FILL
3	35	SAND AND GRAVEL
35	67	SAND WITH WATER, CLAY SEAMS
67	99	BROWN CLAY, CLAY AND GRAVEL, FINE SAND LAYERS WITH WATER
99	101	FINE SAND AND SOME GRAVEL WITH WATER
101	105	BROWN CLAY
105	180	HARD RED AND GRAY CLAY, FRACTURES RED AND GRAY ROCK LAYERS

Driller Certification

All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.

Name: JON NORCROSS
Company: CAMP WELL DRILLING & PUMP SUPPLY
License No: WWC-7
Date Completed: 9/5/2018

DAILY FIELD REPORT

HOLMAN
CONSULTING ENGINEERS
• CONSTRUCTION MATERIAL TESTING
• LABORATORY SERVICES • SPECIAL INSPECTIONS
2614 MURPHY ST., MISSOULA, MT 59808 • 406.543.3100

Service Date 1/28 - 1/29/2021
Report Date 2/1/2021

Observed By J. McCune - HCE

Client Lorenzen Soil Mechanics
Todd Lorenzen
Missoula, Montana Office

Project Riverside Trails
Missoula, Montana
Project No.: HCE: 21-8008 Client: NA

Work Performed by Contractor

Soil borings for soil classification, piezometer installation, and infiltration testing.

Comments

All piezometer readings were collected using a graduated water level. Infiltration testing was performed using a Hudson float valve attached to a graduated hose and a submersible pump in a 150 gallon reservoir. The float valve was placed one foot from the bottom of the 4" pipe. One foot of water was maintained for one hour. The float valve was raised to six feet from the bottom of the pipe and filled until the valve shut off. The valve was immediately lowered two feet (four feet from the bottom of the pipe) and a timer was started. The timer was stopped when the valve activated. This is the time for two feet of water drop in the pipe. Process was repeated until the difference between the last four readings did not vary by more than 10%.

Arrived at 11:30 AM on 1/28/2021. Piezometer in BH-6 is broken at the surface. Ice and snow have plugged pipe. Will return and attempt re-test. Collected readings for piezometers BH-8 and BH-9. Conducted infiltration testing on BH-7.

Returned 1/29/2021 at 8:00 AM. Cleaned BH-6 piezometer with wire. Collected piezometer readings for BH-2, BH-4, and BH-6. Conducted infiltration testing on BH-3, BH-5, and BH-10.

See included reports for piezometer readings and infiltration rates.

PIEZOMETER TEST REPORT

HOLMAN
CONSULTING ENGINEERS
• CONSTRUCTION MATERIAL TESTING
• LABORATORY SERVICES • SPECIAL INSPECTIONS
2614 MURPHY ST., MISSOULA, MT 59808 • 406.543.3100

Service Date 1/28 - 1/29/2021
Report Date 2/1/2021

Observed By J. McCune - HCE

Client Lorenzen Soil Mechanics
Todd Lorenzen
Missoula, Montana Office

Project Riverside Trails
Missoula, Montana
Project No.: HCE: 21-8008 Client: NA

Summary

General Location: Piezometer readings (BH-2, BH-4, BH-6, BH-8, BH-9)

Piezometer Reading				
BH	**Date**	**Time**	**Reading**	**Water Level**
2	1/29	1:15 PM	17'-2"	15'-0"
4	1/29	3:45 PM	15'-10"	13'-10"
6	1/29	11:30 AM	14'-3"	14'-3"
8	1/28	3:15 PM	17'-0"	15'-0"
9	1/28	3:30 PM	17'-2"	15'-0"

IINFILTRATION TEST REPORT

MT DEQ-4, Appendix 6-F

HOLMAN CONSULTING ENGINEERS
• CONSTRUCTION MATERIAL TESTING
• LABORATORY SERVICES • SPECIAL INSPECTIONS
2614 MURPHY ST., MISSOULA, MT 59808 • 406.543.3100

Service Date 1/29/2021
Report Date 2/1/2021

Observed By J. McCune - HCE

Client Lorenzen Soil Mechanics
Todd Lorenzen
Missoula, Montana Office

Project Riverside Trails
Missoula, Montana
Project No.: HCE: 21-8008 Client: NA

Summary

General Location: BH-3

Testing Time Intervals - BH-3					
Water Fill	Began		End		Depth to Bottom of Pipe
	Date	Time	Date	Time	
1 Hour Soak	1/29	1:05 PM	1/29	2:05 PM	1'
Fill	1/29	2:05 PM	1/29	2:10 PM	6'
2 Foot Drop	1/29	2:10 PM	1/29	3:00 PM	4'

Infiltration Testing - BH-3				
Test #	Drop Time (min)	Drop Time (dec)	Water Drop	Infiltration Rate (ft/min)
1	1:37	1.62	2'	1.23
2	2:18	2.30	2'	0.87
3	2:37	2.62	2'	0.76
4	3:07	3.12	2'	0.64
5	2:51	2.85	2'	0.70
6	2:52	2.87	2'	0.70
7	3:35	3.58	2'	0.56
8	4:06	4.01	2'	**0.50***
9	4:15	4.25	2'	**0.47***
10	4:23	4.38	2'	**0.47***
11	4:19	4.23	2'	**0.46***

* <10% Difference

Infiltration Rate in Feet per Minute: 0.48 ft/min

IINFILTRATION TEST REPORT

MT DEQ-4, Appendix 6-F

HOLMAN CONSULTING ENGINEERS
• CONSTRUCTION MATERIAL TESTING
• LABORATORY SERVICES • SPECIAL INSPECTIONS
2614 MURPHY ST., MISSOULA, MT 59808 • 406.543.3100

Service Date 1/29/2021
Report Date 2/1/2021

Observed By J. McCune - HCE

Client Lorenzen Soil Mechanics
Todd Lorenzen
Missoula, Montana Office

Project Riverside Trails
Missoula, Montana
Project No.: HCE: 21-8008 Client: NA

Summary

General Location: BH-5

Testing Time Intervals - BH-5					
Water Fill	**Began**		**End**		**Depth to Bottom of Pipe**
	Date	**Time**	**Date**	**Time**	
1 Hour Soak	1/29	3:10 PM	1/29	4:10 PM	1'
Fill	1/29	4:10 PM	1/29	4:12 PM	6'
2 Foot Drop	1/29	4:12 PM	1/29	5:15 PM	4'

Infiltration Testing - BH-5				
Test #	**Drop Time (min)**	**Drop Time (dec)**	**Water Drop**	**Infiltration Rate (ft/min)**
1	4:11	4.18	2'	0.48
2	3:21	3.35	2'	0.60
3	3:40	3.67	2'	0.54
4	3:51	3.85	2'	0.52
5	4:05	4.08	2'	0.50
6	4:15	4.25	2'	0.48
7	5:17	5.28	2'	0.38
8	6:08	6.13	2'	**0.33***
9	6:07	6.12	2'	**0.33***
10	6:10	6.17	2'	**0.32***
11	6:00	6.00	2'	**0.33***

* <10% Difference

Infiltration Rate in Feet per Minute: 0.33 ft/min

IINFILTRATION TEST REPORT

MT DEQ-4, Appendix 6-F

HOLMAN CONSULTING ENGINEERS
• CONSTRUCTION MATERIAL TESTING
• LABORATORY SERVICES • SPECIAL INSPECTIONS
2614 MURPHY ST., MISSOULA, MT 59808 • 406.543.3100

Service Date 1/28/2021
Report Date 2/1/2021

Observed By J. McCune - HCE

Client Lorenzen Soil Mechanics
Todd Lorenzen
Missoula, Montana Office

Project Riverside Trails
Missoula, Montana
Project No.: HCE: 21-8008 Client: NA

Summary

General Location: BH-7

Testing Time Intervals - BH-7					
Water Fill	**Began**		**End**		**Depth to Bottom of Pipe**
	Date	**Time**	**Date**	**Time**	
1 Hour Soak	1/28	11:45 AM	1/28	12:45 PM	1'
Fill	1/28	12:45 PM	1/28	12:46 PM	6'
2 Foot Drop	1/28	12:46 PM	1/28	3:00 PM	4'

Infiltration Testing - BH-7				
Test #	**Drop Time (min)**	**Drop Time (dec)**	**Water Drop**	**Infiltration Rate (ft/min)**
1	4:56	4.92	2'	0.41
2	5:02	5.03	2'	0.40
3	5:56	5.92	2'	0.34
4	5:39	5.65	2'	0.35
5	10:43	10.72	2'	0.19
6	11:37	11.61	2'	0.17
7	13:24	13.40	2'	0.15
8	15:50	15.83	2'	**0.13***
9	15:51	15.85	2'	**0.13***
10	16:08	16.13	2'	**0.12***
11	16:04	16.07	2'	**0.12***

* <10% Difference

Infiltration Rate in Feet per Minute: 0.13 ft/min

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Service Date 1/29/2021
Report Date 2/1/2021

Observed By J. McCune - HCE

Client Lorenzen Soil Mechanics
Todd Lorenzen
Missoula, Montana Office

Project Riverside Trails
Missoula, Montana
Project No.: HCE: 21-8008 Client: NA

Summary

General Location: BH-10

Testing Time Intervals - BH-10					
Water Fill	**Began**		**End**		**Depth to Bottom of Pipe**
	Date	**Time**	**Date**	**Time**	
1 Hour Soak	1/29	8:35 AM	1/29	9:35 AM	1'
Fill	1/29	9:35 AM	1/29	9:42 AM	6'
2 Foot Drop	1/29	9:42 AM	1/29	11:25 AM	4'

Infiltration Testing - BH-10				
Test #	**Drop Time (min)**	**Drop Time (dec)**	**Water Drop**	**Infiltration Rate (ft/min)**
1	4:07	4.12	2'	0.49
2	5:45	5.75	2'	0.35
3	6:48	6.80	2'	0.29
4	7:17	7.28	2'	0.27
5	8:26	8.43	2'	0.24
6	9:01	9.02	2'	0.22
7	9:31	9.52	2'	**0.21***
8	9:54	9.90	2'	**0.20***
9	10:04	10.07	2'	**0.20***
10	10:24	10.40	2'	**0.19***

* <10% Difference

Infiltration Rate in Feet per Minute: 0.20 ft/min

ASCE 7 Hazards Report

Address:
No Address at This Location

Standard:	ASCE/SEI 7-16	**Elevation:**	3140.21 ft (NAVD 88)
Risk Category:	II	**Latitude:**	46.81931
Soil Class:	C - Very Dense Soil and Soft Rock	**Longitude:**	-114.071277

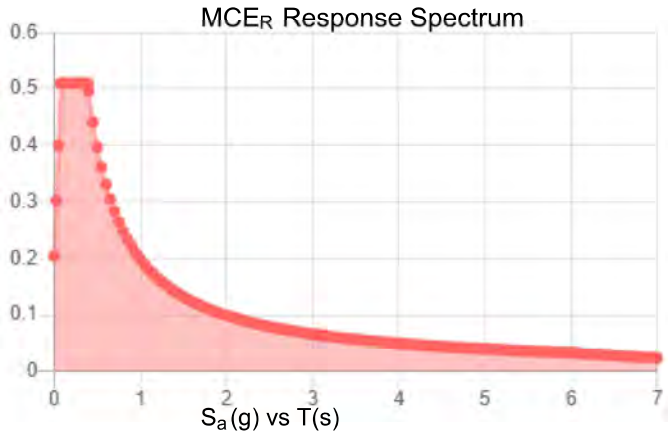
Seismic

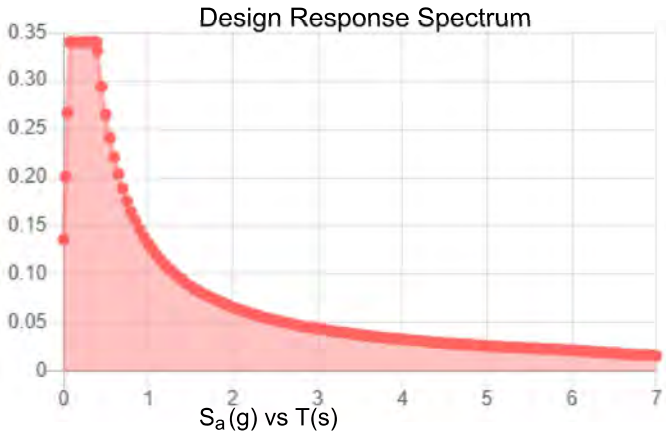
Site Soil Class: C - Very Dense Soil and Soft Rock

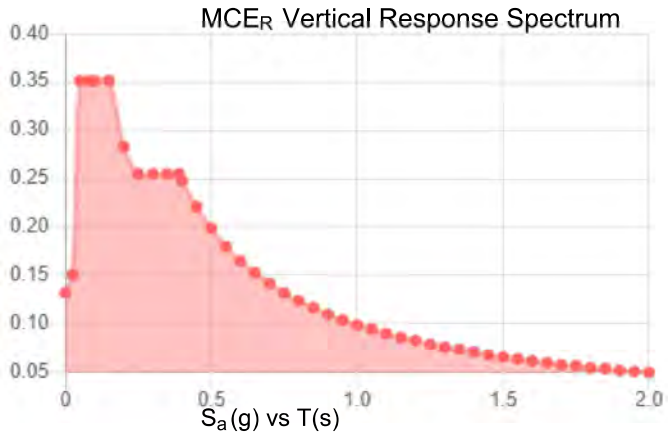
Results:

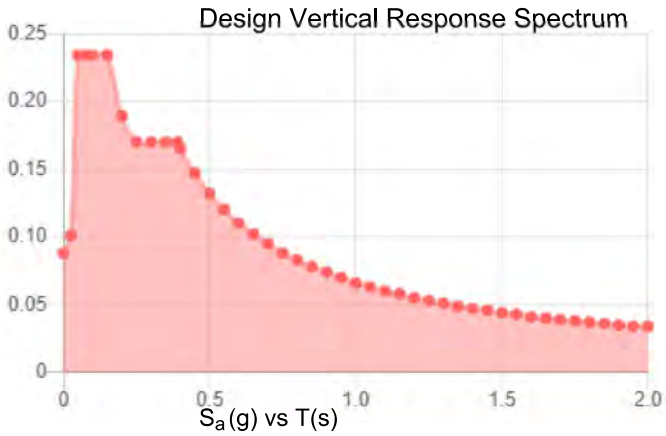
S_S :	0.392	S_{D1} :	0.132
S_1 :	0.132	T_L :	6
F_a :	1.3	PGA :	0.173
F_v :	1.5	PGA_M :	0.212
S_{MS} :	0.51	F_{PGA} :	1.227
S_{M1} :	0.199	I_e :	1
S_{DS} :	0.34	C_v :	0.861

Seismic Design Category C









Data Accessed: Sun Feb 21 2021

Date Source: USGS Seismic Design Maps based on ASCE/SEI 7-16 and ASCE/SEI 7-16 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-16 Ch. 21 are available from USGS.

The ASCE 7 Hazard Tool is provided for your convenience, for informational purposes only, and is provided “as is” and without warranties of any kind. The location data included herein has been obtained from information developed, produced, and maintained by third party providers; or has been extrapolated from maps incorporated in the ASCE 7 standard. While ASCE has made every effort to use data obtained from reliable sources or methodologies, ASCE does not make any representations or warranties as to the accuracy, completeness, reliability, currency, or quality of any data provided herein. Any third-party links provided by this Tool should not be construed as an endorsement, affiliation, relationship, or sponsorship of such third-party content by or from ASCE.

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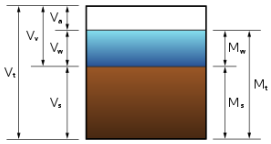


APPENDIX B. PHOTOGRAPHS

Description: BH-01 Location. View is to the southwest.

Description: BH-01 Location. View is to the west.

Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-01 Split Spoon (SS) sample from the 2.5- to 4-foot depth.

Description: BH-01 SS sample from the 5- to 6.5-foot depth.

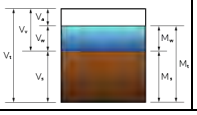
Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-01 auger cuttings from above 8 feet.

Description: BH-01 SS sample from the 8- to 9.5-foot depth.

Lorenzen Soil Mechanics, Inc.

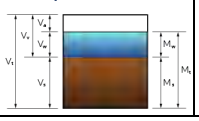


Project: Riverfront Trails

Description: BH-01 Auger cuttings from above 10 feet.

Description: BH-01 SS sample from the 10- to 11.5-foot depth.

Lorenzen Soil Mechanics, Inc.

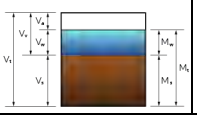


Project: Riverfront Trails

Description: BH-01 SS sample from the 15- to 16.5-foot depth.

Description: BH-01 SS sample from the 20- foot depth – wash sample from sand heave.

Lorenzen Soil Mechanics, Inc.

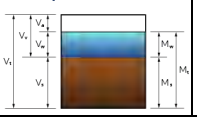


Project: Riverfront Trails

Description: BH-02 Location. View is to the north from BH-01 stake location.

Description: BH-02 Location. View is to the southwest.

Lorenzen Soil Mechanics, Inc.

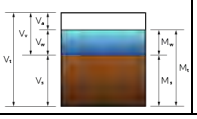


Project: Riverfront Trails

Description: BH-02 SS sample from the 2.5- to 4-foot depth.

Description: BH-02 SS sample from the 5- to 6.5-foot depth.

Lorenzen Soil Mechanics, Inc.

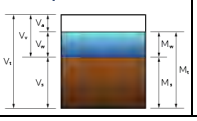


Project: Riverfront Trails

Description: BH-02 SS sample from the 10- to 11.5-foot depth.

Description: BH-02 SS sample from the 15- to 16.5-foot depth.

Lorenzen Soil Mechanics, Inc.



Project: Riverfront Trails

Description: BH-03 Location. View is to the east from the BH-02 Piezometer.

Description: BH-03 Location. View is to the southwest.

Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-03 Location. View is to the west.

Description: BH-03 SS sample from the 2.5- to 4-foot depth.

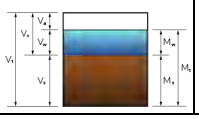
Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-03 SS sample from the 5- to 6.5-foot depth.

Description: BH-03 SS sample from the 8- to 9.5-foot depth.

Lorenzen Soil Mechanics, Inc.



Project: Riverfront Trails

Description: BH-03 Location of infiltrometer test pipe. View is to the east towards BH-04 location.

Description: BH-04 Location. View is to the southeast.

Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-04 SS sample from the 2.5- to 4-foot depth.

Description: BH-04 SS sample from the 5- to 6.5-foot depth.

Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-04 SS sample from the 10- to 11.5-foot depth. (depth is not noted on the label)

Description: BH-04 Auger cuttings from above 15 feet.

Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-04 SS sample from the 15- to 16.5-foot depth. Pocket penetrometer value was 0.25 tsf.

Description: BH-04 Piezometer location. View is to the south toward BH-05.

Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-05 SS sample from the 2.5- to 4-foot depth.

Description: BH-05 SS sample from the 5- to 6.5-foot depth.

Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-05 SS sample from the 8- to 9.5-foot depth.

Description: TP-05 Infiltrometer pipe location. View is to the west.

Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: TP-05 Infiltrometer pipe location. View is to the east.

Description: TP-05 Infiltrometer pipe location. View is to the south.

Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-06 Location. View is to the southwest.

Description: BH-06 Location. View is o the northeast.

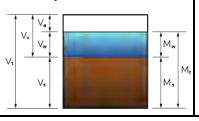
Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-06 SS sample from the 2.5- to 4-foot depth.

Description: BH-06 SS sample from the 5- to 6.5-foot depth.

Lorenzen Soil Mechanics, Inc.

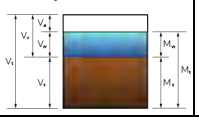


Project: Riverfront Trails

Description: BH-06 SS sample from the 10- to 11.5-foot depth.

Description: BH-06 SS sample from the 15- to 16.5-foot depth.

Lorenzen Soil Mechanics, Inc.



Project: Riverfront Trails

Description: BH-06 Piezometer installation.

Description: BH-07 Location. View is to the southwest.

Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-07 Location. View is to the northeast.

Description: BH-07 SS sample from the 2.5- to 4-foot depth.

Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-07 SS sample from the 5- to 6.5-foot depth.

Description: BH-07 SS sample from the 8- to 9.5-foot depth.

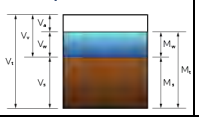
Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-08 Location. View is to the south.

Description: BH-08 Location. View is to the northeast.

Lorenzen Soil Mechanics, Inc.



Project: Riverfront Trails

Description: BH-08 SS sample from the 2.5- to 4-foot depth.

Description: BH-08 SS sample from the 5- to 6.5-foot depth.

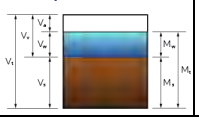
Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-08 SS sample from the 10- to 11.5-foot depth.

Description: BH-08 SS sample from the 15- to 16.5-foot depth.

Lorenzen Soil Mechanics, Inc.



Project: Riverfront Trails

Description: BH-08 Piezometer location. View is to the north.

Description: BH-09 Location. View is to the south.

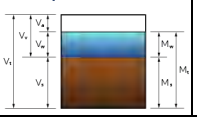
Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-09 Location. View is to the west.

Description: BH-09 Location. View is to the northeast.

Lorenzen Soil Mechanics, Inc.



Project: Riverfront Trails

Description: BH-09 SS sample from the 2.5- to 4-foot depth.

Description: BH-09 SS sample from the 5- to 6.5-foot depth.

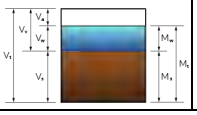
Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-09 SS sample from the 8- to 9.5-foot depth.

Description: BH-09 SS sample from the 15- to 16.5-foot depth.

Lorenzen Soil Mechanics, Inc.

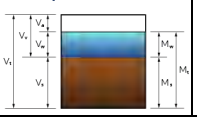


Project: Riverfront Trails

Description: BH-10 Location. View is to the west.

Description: BH-10 Location. View is to the south.

Lorenzen Soil Mechanics, Inc.



Project: Riverfront Trails

Description: TP-10 Location. View is to the southeast.

Description: BH-10 SS sample from the 2.5- to 4-foot depth.

Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-10 SS sample from the 5- to 6.5-foot depth.

Description: BH-10 SS sample from the 8- to 9.5-foot depth.

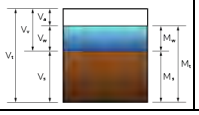
Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-01 Moisture content samples prior to being placed into the drying oven.

Description: BH-01 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.

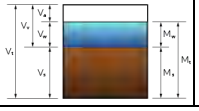


Project: Riverfront Trails

Description: BH-02 Moisture content samples prior to being placed into the drying oven.

Description: BH-02 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.

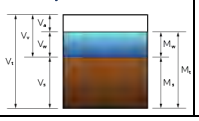


Project: Riverfront Trails

Description: BH-03 Moisture content samples prior to being placed into the drying oven.

Description: BH-03 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.

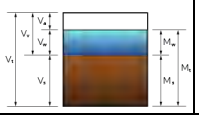


Project: Riverfront Trails

Description: BH-04 Moisture content samples prior to being placed into the drying oven.

Description: BH-04 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.

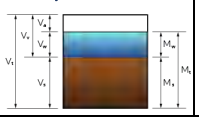


Project: Riverfront Trails

Description: BH-05 Moisture content samples prior to being placed into the drying oven.

Description: BH-05 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.

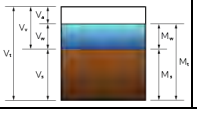


Project: Riverfront Trails

Description: BH-06 Moisture content samples prior to being placed into the drying oven.

Description: BH-06 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.

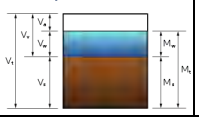


Project: Riverfront Trails

Description: BH-07 Moisture content samples prior to being placed into the drying oven.

Description: BH-07 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.



Project: Riverfront Trails

Description: BH-08 Moisture content samples prior to being placed into the drying oven.

Description: BH-08 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails

Description: BH-09 Moisture content samples prior to being placed into the drying oven.

Description: BH-09 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.

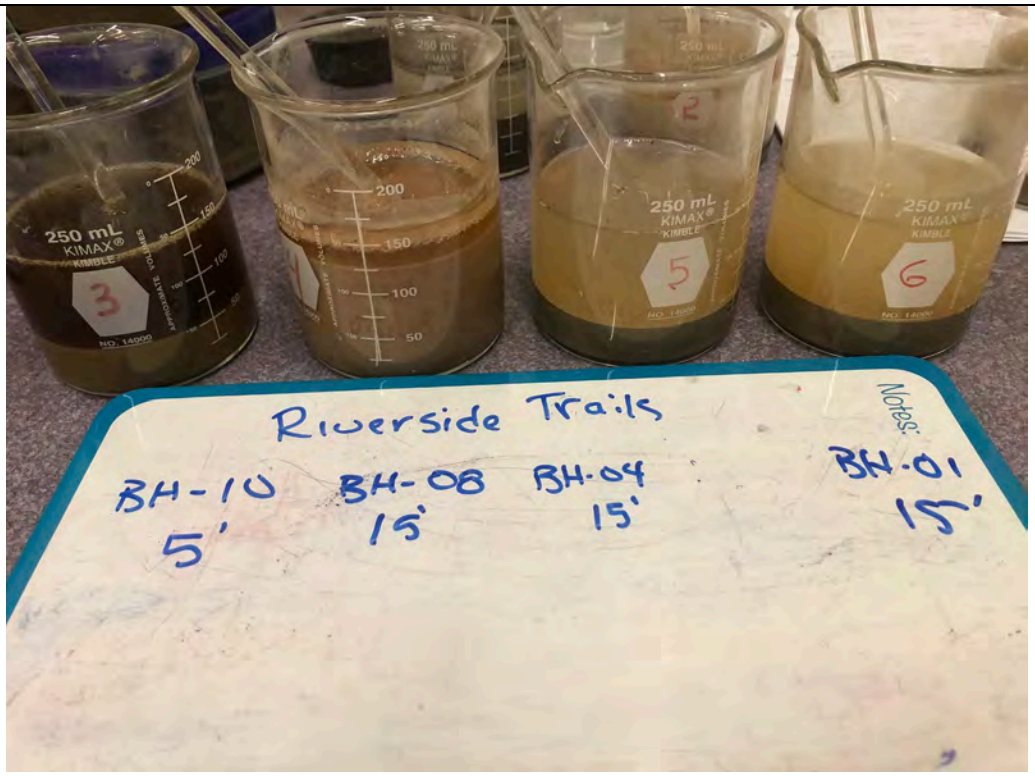
Project: Riverfront Trails

Description: BH-10 Moisture content samples prior to being placed into the drying oven.

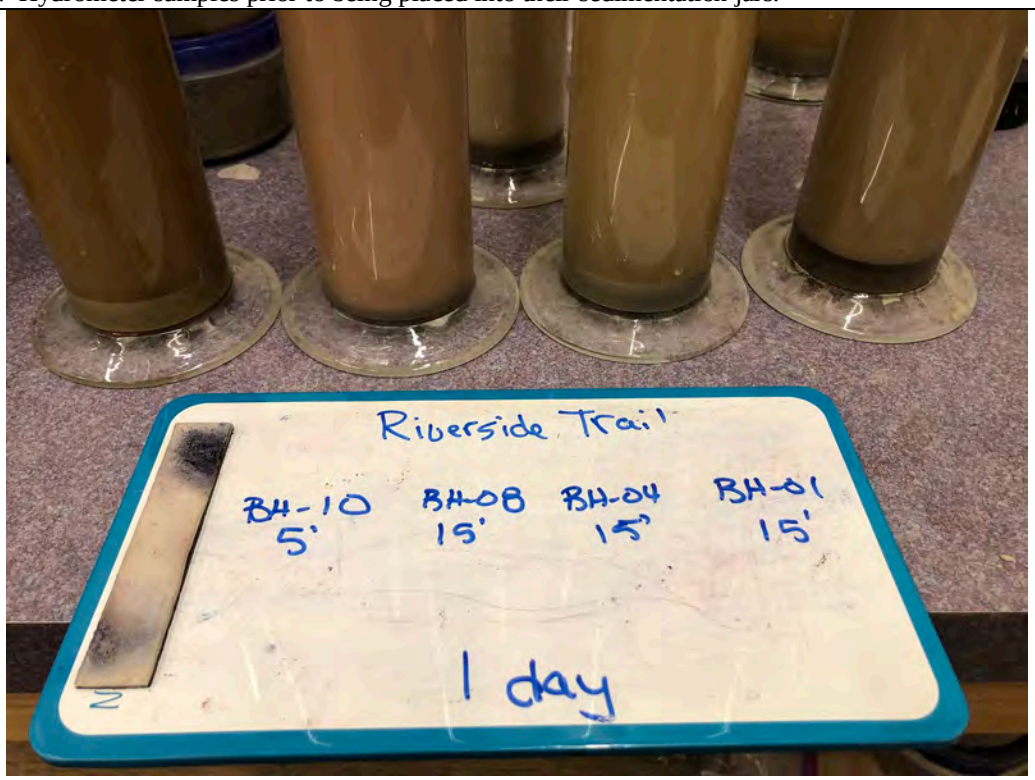
Description: BH-10 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails



Description: Hydrometer samples prior to being placed into their sedimentation jars.



Description: Hydrometer samples after 1 day in their sedimentation jars.

Lorenzen Soil Mechanics, Inc.

Project: Riverfront Trails