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November 7, 2017

Brelje and Race
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Geotechnical Information Report
Phase 1 Pipeline Segment
Los Alamos Trunk Replacement
Santa Rosa, California

Project Number: 1148.42.04.1

INTRODUCTION

The letter presents a summary of geotechnical subsurface information for the Phase 1 segment of the Los Alamos Trunk Replacement project in Santa Rosa, California (See Site Location Map, Plate 1). Phase 1 will generally follow the alignment of the existing trunk sewer starting at Streamside Drive and finishing at Elaine Drive (See Exploration Plan, Plate 2).

STUDY

Site Exploration

We reviewed our previous geotechnical studies in the vicinity and selected geologic references pertinent to the site. On June 14, July 5, and August 1, 2017, we performed a geotechnical reconnaissance of the alignment and explored the subsurface conditions by drilling five borings at four locations to depths ranging from about 7½ to 36 feet. The borings were drilled with a truck-mounted drill rig equipped with 8-inch diameter, hollow stem augers at the approximate locations shown on the Exploration Plan, Plate 2. The boring locations were determined approximately by pacing their distance from features shown on the Exploration Plan and should be considered accurate only to the degree implied by the method used. Our field engineer located and logged the borings and obtained samples of the materials encountered for visual examination, classification and laboratory testing.

Relatively undisturbed samples were obtained from the borings at selected intervals by driving a 2.43-inch inside diameter, split spoon sampler, containing 6-inch long brass liners, using a 140-pound hammer dropping approximately 30 inches. The sampler was driven 12 to 18 inches. The blows required to drive each 6-inch increment were recorded and the blows required to drive the last 12 inches, or portion thereof, were converted to equivalent Standard Penetration Test (SPT) blow counts for correlation with empirical data. Disturbed samples were also obtained at selected depths by driving a 1.375-inch inside diameter (2-inch outside diameter) SPT sampler, without liners or rings, using a 140-pound hammer dropping approximately 30 inches. The sampler was driven 12 to 18 inches, the blows to drive each 6-inch increment were recorded, and the blows required to drive the final 12 inches, or portion thereof, are provided on the boring logs.

The logs of the borings showing the materials encountered, groundwater conditions, converted blow counts and sample depths are presented on Plates 3 through 7. The soil is described in accordance with the Unified Soil Classification System, outlined on Plate 8. Bedrock is described in accordance with Engineering Geology Rock Terms, shown on Plate 9.

The boring logs show our interpretation of the subsurface soil, bedrock and groundwater conditions on the date and at the locations indicated. Subsurface conditions may vary at other locations and times. Our interpretation is based on visual inspection of soil and bedrock samples, laboratory test results and interpretation of drilling and sampling resistance. The location of the soil and bedrock boundaries should be considered approximate. The transition between soil and bedrock types may be gradual.

Laboratory Testing

The samples obtained from the borings and creek bottoms were transported to our office and re-examined to verify soil classifications, evaluate characteristics, and assign tests pertinent to our analysis. Selected samples were laboratory tested to determine their water content, dry density, shear strength and classification. The results of the tests are presented on the boring logs and on Plates 10 through 13.

GEOLOGY AND SUBSURFACE CONDITIONS

Published geology maps (McGlaughlin et al., 2008) indicate the proposed Phase 1 alignment is underlain by Holocene and Pleistocene age alluvial deposits, undivided (Qt), Young Holocene alluvial fan and fluvial terrace deposits (Qhf_1), and old Holocene alluvial fan and fluvial terrace deposits (Qtf_2). These units along with a description are presented on Plate 2.

Borings B-2, B-8 and B-3 were drilled within the alluvial deposits, undivided unit (Qt). These borings generally encountered medium stiff to very stiff clay with varying amounts of sand and gravel interbedded with occasional layers of medium dense sand and gravel with varying amounts of clay to the maximum depth explored. Boring B-8, which encountered refusal at 6½ feet is the exception as it encountered medium dense to very dense silty sand with gravel for its full depth.

Boring B-2 and B-13 were drilled in the old Holocene alluvial fan and fluvial terrace deposits. These borings encountered layers of medium stiff to hard clay and silt with varying amounts of sand and loose to medium dense sand and gravel with varying amounts of clay to a depth of about 19 feet. These soils were underlain by conglomerate and siltstone bedrock. The conglomerate is firm, friable and highly weathered. The siltstone is firm, friable and moderately weathered.

TRENCH CONDITIONS

High Groundwater

Groundwater was only encountered in Boring B-13 at a depth 25½ feet. However, these borings were drilled in the summertime of 2017, so it is possible that groundwater will rise to higher elevations during the year and/or after extended periods of heavy rain. Depending on the depth of the trench, it should be anticipated that groundwater could be encountered within the planned trench excavations.

Excavation Stability

Excavations can appear to be stable when first exposed but will lose strength over time and will fail unpredictably if left unsupported. This can happen whether the soil is silt, clay, sand or gravel. The geologic units and borings along the Phase 1 pipeline segment yielded various combinations of these soils including loose to medium dense sand and gravel. If sand becomes saturated, it has been our experience that when the confinement for sand is removed, the saturated sand can flow into the trench. Trenches will need to be shored during construction in accordance with OSHA regulations.

Excavation Bottoms

Depending on the trench excavation and groundwater level, saturated sand could be encountered in the bottom of trench excavations. Saturated sand that is encountered in bottom of trench excavations can become very unstable and exhibit “pumping” behavior when it is unloaded by the removal of the confining pressure of the spoils above and adjacent to it. It may be necessary to overexcavate a portion of these soils and replace them with additional bedding material to achieve the desired support of the pipeline. This condition is especially critical for gravity lines that are sensitive to settlement.

Cobbles, Boulders and Bedrock

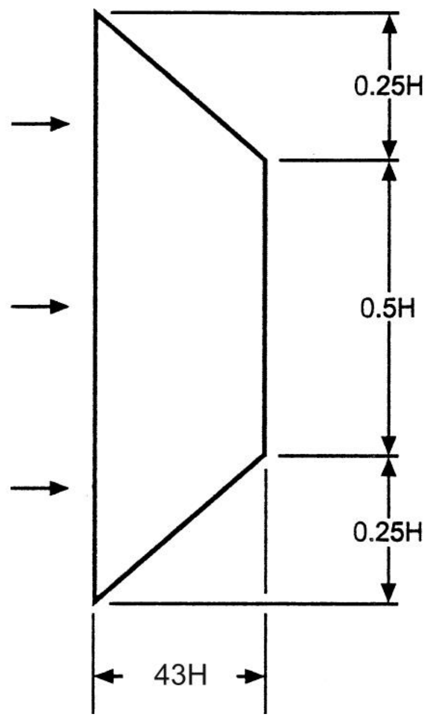
We anticipate that cobbles, boulders and bedrock may be encountered in deeper trench excavations. Our borings encountered these materials in the old Holocene alluvial fan and fluvial terrace deposits. Due to the nature of these materials, excavations can be expected to yield oversize materials and have irregular excavation walls. If large material is not broken up within the excavation limits, nearby utilities may be disrupted by movement of these materials. Trench limits will probably be difficult to control.

We anticipate there is potential for failure within the walls of trench excavations through these materials. Failures would likely consist of blocks of rock or cobbles/boulders falling into the trench. Depending on how the trench is shored, it could be possible for blocks of rock and/or cobbles/boulders between shores to fall into the trench. Bedrock will need to be evaluated during excavation to determine if adverse fracture and bedding orientations exist that could potentially lead to rockfall failures along the trench walls. The contractor should follow the guidelines set by OSHA and should have a Competent Person, as defined by OSHA, on site to review the excavation conditions.

RECOMMENDATIONS

Temporary Excavations

Temporary excavations for pipeline trenches and/or sending and receiving pits should be shored in accordance with OSHA requirements and per the recommendations set forth herein. Shoring should be capable of supporting an active pressure of 43H in pounds per square foot (where H is the height of the trench wall in feet) in a trapezoidal distribution as shown below:



The shoring and safety of excavations is solely the responsibility of the contractor. Attention is drawn to the State of California Safety Orders dealing with "Excavations and Trenches."

As stated previously, dewatering may be required in order to construct portions of the proposed sewer. In particular, dewatering may be required during or shortly after the rainy season. The project plans and specifications should require that the general contractor be responsible for the design, operation and maintenance of the temporary dewatering system.

Where unstable excavation bottoms are observed, additional excavation should be performed to provide space for at least 12 inches of ¾ inch drain rock, ballast rock, or other materials capable of bridging the weaker materials to provide adequate bedding support. A geotextile filter fabric, such as Mirafi 160N or equivalent, should be wrapped around this material. The depth of excavation and the need for fabric should be evaluated and determined during construction.

Excavation Backfill

Unless otherwise specified by the City of Santa Rosa or the project plans and specifications, the trenches should be backfilled using virgin or recycled Class 2 Aggregate Base within pavement areas. The aggregate base should comply with the minimum requirements in Caltrans Standard Specifications, Section 26 for Class 2 Aggregate Base. Outside of pavement areas, the trench can be backfill with native soils excavated from the trench. Backfill should be moisture-conditioned as necessary, and placed in horizontal layers not exceeding 8 inches in thickness, before compaction. Each layer should be compacted to at least 90 percent relative compaction as determined by ASTM Test Method D-1557. Jetting or ponding of trench backfill to aid in achieving the recommended degree of compaction should not be attempted.

As an alternative, Controlled Low Strength Material (CLSM) can be used for backfill. The excavated materials, minus debris, can be used in a CLSM mixture. The project plans and specifications should require that the general contractor be responsible for providing a mix design that uses the soil excavated from the trench and meets the requirements, including minimum and maximum strengths, of the City of Santa Rosa. The CLSM mixture should be able to be excavated with conventional equipment for ease of future repairs and/or modifications to the pipeline.

LIMITATIONS

This report has been prepared by RGH for the exclusive use of Brelje and Race as an aid in the construction of the proposed Phase 1 pipeline segment described in this report. The borings represent the subsurface conditions at the locations and on the date indicated. It is not warranted that they are representative of such conditions elsewhere or at other times.

The scope of our services did not include an environmental assessment or a study of the presence or absence of toxic mold and/or hazardous, toxic or corrosive materials in the soil, surface water, groundwater or air (on, below or around this site), nor did it include an evaluation or study for the presence or absence of wetlands. These studies should be conducted under separate cover, scope and fee and should be provided by a qualified expert in those fields.

We trust this provides the information you require at this time. Please call if you have questions.

Very truly yours,
RGH Consultants

Jared J. Pratt
Associate Engineering Geologist

Eric G. Chase
Senior Associate Engineer

EGC:JJP:ec:ejw
Electronically submitted

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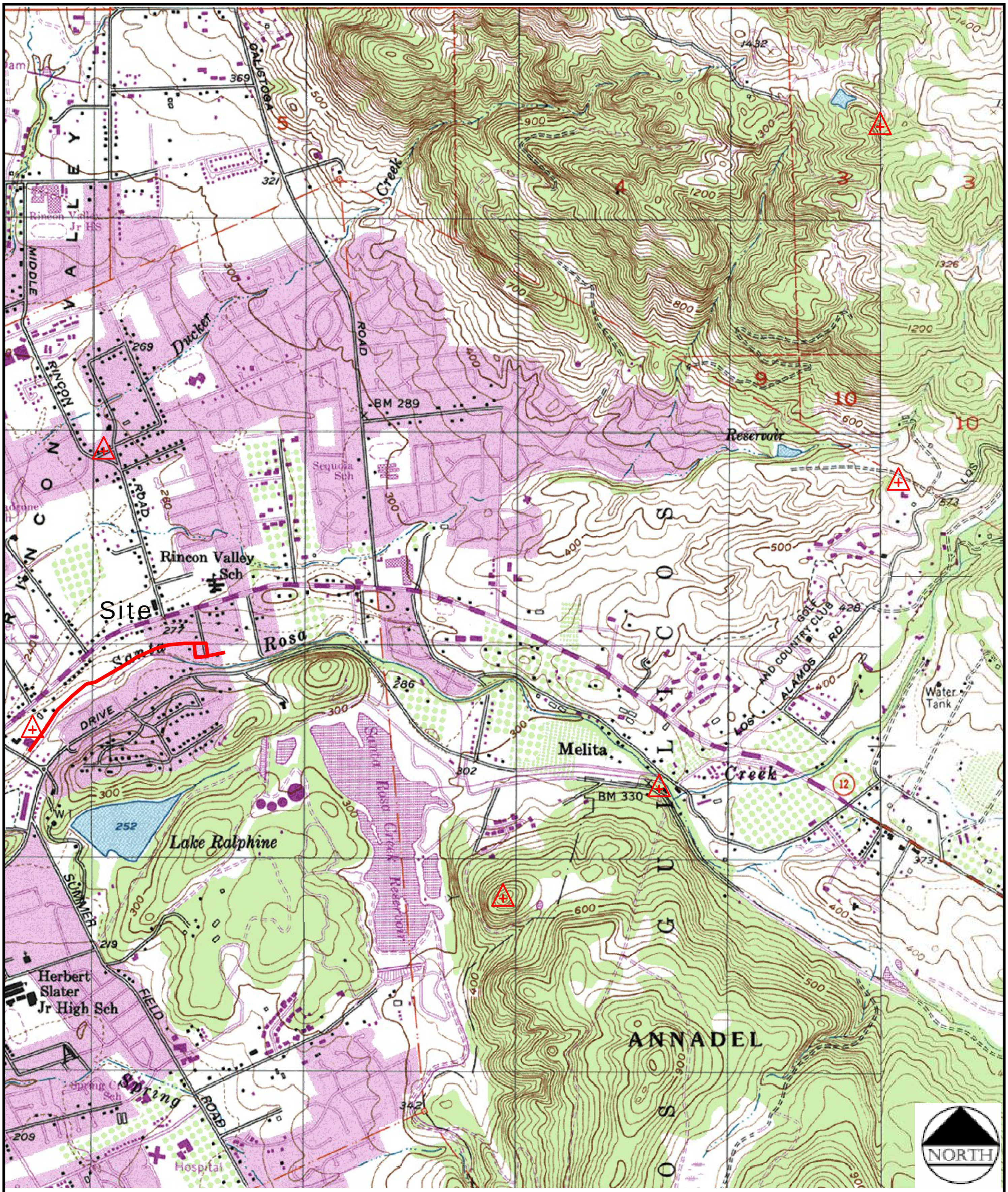
Attachments: References
Plate 1 – Site Location Map
Plate 2 – Exploration Plan
Plate 3 - Log of Boring B-1
Plate 4 - Log of Boring B-2
Plate 5 - Log of Boring B-3
Plate 6 - Log of Boring B-8
Plate 7 - Log of Boring B-13
Plate 8 - Soil Classification Chart and Key to Test Data
Plate 9 – Engineering Geology Rock Terms
Plates 10 through 13 – Strength Test Data

REFERENCES

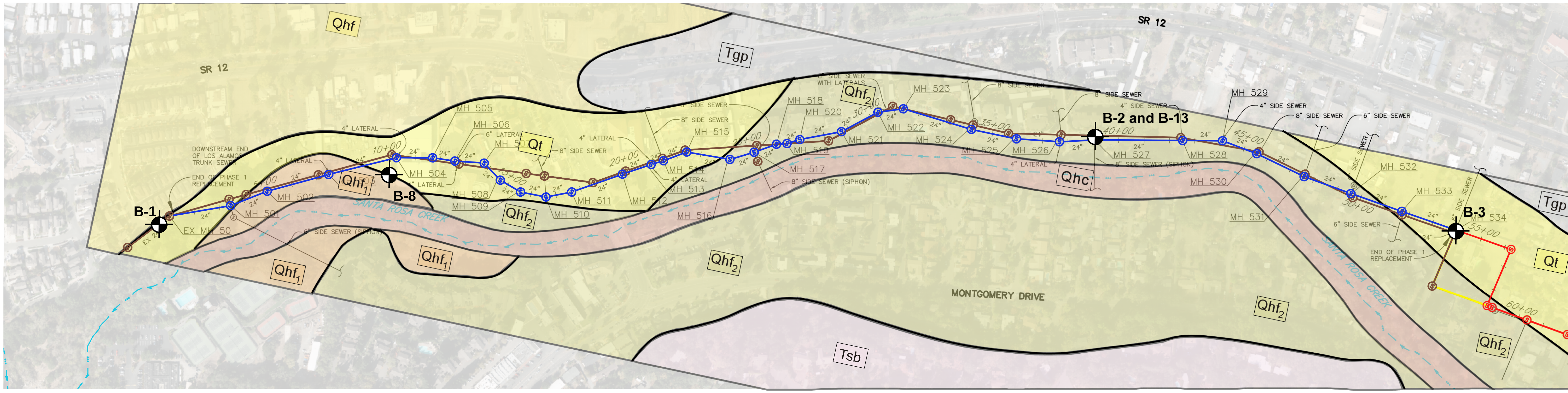
McLaughlin, R.J., Langenheim, V.E., Sarna-Wojcicki, A.M., Flek, R.J., McPhee, D.K., Roberts, C.W., McCabe, C.A., and Wan, E., 2008, Geologic and Geophysical Framework of the Santa Rosa 7.5’ Quadrangle, Sonoma County, California, U.S. Geological Survey, Open-File Report 2008-1009, 51 p., 3 plates, Scale 1:24,000.



Reference: Maptech Topoquad, Santa Rosa, California Quadrangle

Scale: 1" = 2000'

RGH CONSULTANTS	SITE LOCATION MAP Los Alamos Trunk Replacement Phase 1 Pipeline Segment Santa Rosa, California	PLATE 1
Job No: 1148.42.04.1 / Date: NOV 2017		



DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

Qhc **Channels (Holocene)**–Incise older deposits

Qhf **Alluvial fan and fluvial terrace deposits, undivided (Holocene)** sand and silt, derived primarily from Pleistocene and older non-marine gravel, late Tertiary volcanic rocks, and Mesozoic bedrock units of the Franciscan Complex, Coast Range ophiolite and Great Valley sequence. Unit may be further subdivided into the following units.

Qhf_1 **Young Holocene alluvial fan and fluvial terrace deposits**–Inset into old Holocene alluvial fans and fluvial terraces and pre-Holocene deposits

Qhf_2 **Old Holocene alluvial fan and fluvial terrace deposits (Holocene?)**–Inset into older Holocene and pre-Holocene deposits

Qt **Alluvial deposits, undivided (Holocene and Pleistocene)**–Includes undivided Holocene and Pleistocene terrace deposits

TERTIARY ROCKS

Tgp **Fluvial and lacustrine deposits of Humbug Creek (Pliocene)**–Gravel, sandstone, siltstone, mudstone, nonmarine diatomite, and locally mapped intercalated siliceous tuff (Tst). In Santa Rosa and western Kenwood quadrangles, unit consists largely of boulder, cobble and pebble gravel, and sand and silt derived from underlying Mesozoic rocks and from Tertiary volcanic rocks and exhibits primarily west-northwest directed paleoflow. On the basis of stratigraphy and the ages of underlying and interbedded volcanic units, we interpret the age of the fluvial and lacustrine deposits of Humbug Creek to be 3.3-4.4 Ma. Unit may be unconformably overlain by Pleistocene and Pliocene fluvial and lacustrine deposits (QTg) in Rincon Valley

Tsb **Andesite, basaltic andesite and basalt**–Subaerial andesitic to basaltic flows, flow breccia and tuff-breccia, local waterlain andesitic tuff and minor dacitic ash-flow tuff, aerially between the Healdsburg and southern Rodgers Creek segments of the Rodgers Creek Fault Zone and the Mark West Fault Zone. Unit may compose a relatively thin cover to pre-Miocene basement (cross sections A-C). Andesitic rocks are intercalated with and underlain by the Petaluma Formation and the numerous named and unnamed rhyodacitic to andesitic tuffs (Tst), and local rhyodacitic flows and intrusive rocks (Tsr) of the Sonoma

Dated andesitic rocks in the Santa Rosa 7.5’ quadrangle (table 2.2, and figure 2.2) span a significantly narrower age range than the tephra units (Tst). Andesite along Fountain Grove Parkway northeast of the Healdsburg Fault Zone is dated at 5.0 ± 0.4 Ma. Basaltic andesite from the Cloverleaf Ranch area yielded a plateau age of 4.53 ± 0.04 Ma. Andesitic flows in an area of abandoned cobblestone quarries east of Lake Ralphine are dated at 4.4 ± 0.03 Ma. East of the Bennett Valley Fault in Annadel State Park, a lithologically and texturally similar

Near the northeast corner of Santa Rosa 7.5’ quadrangle, porphyritic basaltic andesite that overlies the 4.83 Ma Lawlor Tuff, is dated at 4.63 ± 0.02 Ma. Collectively, andesitic rocks northeast of the Rodgers Creek-Healdsburg Fault Zone and southwest of the Maacama Fault appear to range in age from ~5.4 to 4.4 Ma

N

400 0 400 feet

EXPLANATION

B-3 Boring Location and Number

(McGlaughlin et al., 2008)

RGH CONSULTANTS	EXPLORATION PLAN Los Alamos Trunk Replacement Phase 1 Pipeline Segment Santa Rosa, California	PLATE 2
Job No: 1148.42.04.1 Date: NOV 2017		

Date(s) Drilled: **6/14/17**	Logged By: **BPC**	Checked By: **EGC**
Drilling Method: **Hollow Stem Auger**	Drill Bit Size/Type: **8" Hollow Stem**	Total Depth of Borehole: **36 feet**
Drill Rig Type: **Mobile B53**	Drilling Contractor: **Pearson Drilling**	Approximate Surface Elevation: **Existing Ground Surface**
Groundwater Level and Date Measured: **No Groundwater Encountered**	Sampling Method(s): **Modified California, SPT**	Hammer Data: **140#, 30" drop, auto trip hammer**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				BROWN SANDY CLAY (CL), stiff, dry to moist, fine sand, trace fine gravel								
			15										
	5												
			13			105.4	21.5						Su = 3428.5 psf
					GRAY, BROWN, AND MOTTLED RED SANDY CLAY W/ GRAVEL (CL), stiff, moist, fine to coarse sand, fine subrounded gravel								
	10												
			11			110.4	14.2						Su = 1947.5 psf
					MOTTLED GRAY-BROWN AND RED CLAYEY SAND (SC), medium dense, moist, fine to coarse sand								
	15												
			13					46.8					
	20												
			9		MOTTLED GRAY AND RED BROWN CLAY W/ SAND (CL), stiff, moist, fine sand								
					GRAY AND RED BROWN GRAVEL W/ CLAY & SAND (GP-GC), medium dense, moist								
	25												
			18		MOTTLED GRAY AND RED-BROWN SANDY CLAY (CL), very stiff, moist								

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Job No: 1148.42.04.1 | Date: NOV 2017

LOG OF BORING B-1
Los Alamos Trunk Replacement
Phase 1 Pipeline Segment
Santa Rosa, California

PLATE
3

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	30		21		MOTTLED GRAY AND RED-BROWN SANDY CLAY (CL), very stiff, moist								
	35		15 15		GRAY AND MOTTLED RED-BROWN SANDY CLAY (CL), stiff, moist, fine to medium sand, trace find subrounded gravel								
					Bottom of boring at 36 feet. No free water encountered.								
	40												
	45												
	50												
	55												
	60												

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Job No: 1148.42.04.1 | Date: NOV 2017

LOG OF BORING B-1 CONT.
Los Alamos Trunk Replacement
Phase 1 Pipeline Segment
Santa Rosa, California

PLATE
3 Cont.

Date(s) Drilled **6/14/17**	Logged By **BPC**	Checked By **EGC**
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type **8" Hollow Stem**	Total Depth of Borehole **7 1/2 feet**
Drill Rig Type **Mobile B53**	Drilling Contractor **Pearson Drilling**	Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **No Groundwater Encountered**	Sampling Method(s) **Modified California, SPT**	Hammer Data **140#, 30" drop, auto trip hammer**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				7" asphalt								
					BROWN SANDY CLAY (CL), medium stiff, moist, fine to coarse sand								
			8		BROWN CLAYEY SAND (SC), loose, dry to moist, fine sand, occasional coarse sand, porous, rootlets			39.1					
	5		28		GRAY AND BROWN GRAVEL W/ SAND (GP), medium dense, dry, fine to coarse sand, subrounded gravel to 3" diameter								
					Auger refusal at 7 1/2 feet No free water encountered.								
	10												
	15												
	20												
	25												

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Job No: 1148.42.04.1 | Date: NOV 2017

LOG OF BORING B-2
Los Alamos Trunk Replacement
Phase 1 Pipeline Segment
Santa Rosa, California

Date(s) Drilled	6/14/17	Logged By	BPC	Checked By	EGC
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type	8" Hollow Stem	Total Depth of Borehole	21 feet
Drill Rig Type	Mobile B53	Drilling Contractor	Pearson Drilling	Approximate Surface Elevation	Existing Ground Surface
Groundwater Level and Date Measured	No Groundwater Encountered	Sampling Method(s)	Modified California, SPT	Hammer Data	140#, 30" drop, auto trip hammer

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				RED-BROWN CLAYEY SAND (SC), loose, dry to moist, fine to coarse sand								
					BROWN SANDY CLAY (CL), medium stiff to stiff, moist, fine to coarse sand								
			8										
	5												
			8			110.7	18.5						Su = 1624 psf
					MOTTLED GRAY AND RED BROWN CLAY W/ SAND (CL), stiff to very stiff, moist, fine sand								
	10												
			11			94.4	28.1						Su = 2132.5 psf
					BROWN SANDY CLAY W/ GRAVEL (CL), stiff, wet, fine to coarse sand								
	15												
			21										
					GRAY BROWN CLAY W/ SAND (CL), very stiff, moist, fine to coarse sand								
	20				MOTTLED GRAY, YELLOW, AND RED-BROWN SAND W/ GRAVEL AND CLAY (SC), dense, moist, fine to coarse sand								
			34										
					Bottom of boring at 21 feet. No free water encountered.								
	25												

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Job No: 1148.42.04.1 | Date: NOV 2017

LOG OF BORING B-3
Los Alamos Trunk Replacement
Phase 1 Pipeline Segment
Santa Rosa, California

PLATE
5

Date(s) Drilled **7/5/17**	Logged By **SC**	Checked By **EGC**
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type **8" Hollow Stem**	Total Depth of Borehole **6 1/2 feet**
Drill Rig Type **Mobile B-53**	Drilling Contractor **Pearson Drilling**	Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **No Groundwater Encountered**	Sampling Method(s) **SPT**	Hammer Data **140#, 30" drop, auto trip hammer**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				LIGHT BROWN SILTY SAND W/ GRAVEL (SM) medium dense to very dense, dry, fine to medium sand, fine to coarse gravel, cobbles, roots								
		SPT	13/8"										
	5	SPT	33										
					Auger refusal at 6 1/2 feet. No free water encountered								
	10												
	15												
	20												
	25												

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Job No: 1148.42.04.1 | Date: NOV 2017

LOG OF BORING B-8
Los Alamos Trunk Replacement
Phase 1 Pipeline Segment
Santa Rosa, California

PLATE
6

Date(s) Drilled **8/1/17**	Logged By **SC**	Checked By **EGC**
Drilling Method **Rotary Wash**	Drill Bit Size/Type **3 1/2"**	Total Depth of Borehole **26 1/2 feet**
Drill Rig Type **Track Mounted**	Drilling Contractor **Taber**	Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **25 1/2 feet**	Sampling Method(s) **Modified California, SPT**	Hammer Data **140#, 30" drop**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				7" asphalt								
					BROWN SANDY CLAY (CL), medium stiff, moist, fine to coarse sand								
					BROWN CLAYEY SAND (SC), loose, dry to moist, fine sand, occasional coarse sand, porous, rootlets								
	5				GRAY AND BROWN GRAVEL W/ SAND (GP), medium dense, dry, fine to coarse sand, subrounded gravel to 3" diameter								
					BROWN SILT W/ SAND AND GRAVEL (ML), very hard, dry, fine to coarse sand								
	10		32/4.5"										
					LIGHT ORANGE BROWN CLAY W/ SAND AND GRAVEL (CL), hard, moist, fine to coarse sand, coarse gravel								
	15		34										
	20		37		MOTTLED RED BROWN AND GRAY CONGLOMERATE, firm,friable, highly weathered								
					YELLOW BROWN SILTSTONE, firm, friable, moderately weathered								
	25		12		▽								
					Bottom of boring at 26 1/2 feet. Groundwater encountered at 25 1/2 feet.								

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Job No: 1148.42.04.1 | Date: NOV 2017

LOG OF BORING B-13
Los Alamos Trunk Replacement
Phase 1 Pipeline Segment
Santa Rosa, California

PLATE
7

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
1	2	3	4	5	6	7	8	9	10	11	12	13	14

COLUMN DESCRIPTIONS

1 Elevation (feet): Elevation (MSL, feet).
2 Depth (feet): Depth in feet below the ground surface.
3 Sample Type: Type of soil sample collected at the depth interval shown.
4 Sampling Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating interval using the hammer identified on the boring log.
5 Graphic Log: Graphic depiction of the subsurface material encountered.
6 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
7 Dry Density (pcf): Dry density, in pcf.
8 Water Content (%): Water content, percent.
9 % <#200 Sieve: % <#200 Sieve
10 PI, %: Plasticity Index, expressed as a water content.
11 LL, %: Liquid Limit, expressed as a water content.
12 Expansion Index (EI): Expansion Index (EI)
13 UC, ksf: Unconfined compressive strength, in kips per square foot.
14 REMARKS AND OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field personnel.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Asphaltic Concrete (AC)
Lean CLAY, CLAY w/SAND, SANDY CLAY (CL)
Silty SAND (SM)
Siltstone
Poorly graded GRAVEL (GP)
Clayey SAND (SC)
Conglomerate
SILT, SILT w/SAND, SANDY SILT (ML)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Bulk Sample
2.5-inch-ID Modified California w/ brass liners
2-inch-OD unlined split spoon (SPT)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
? Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

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Job No: 1148.42.04.1 | Date: NOV 2017

SOIL CLASSIFICATION AND KEY TO TEST DATA

Los Alamos Trunk Replacement
Phase 1 Pipeline Segment
Santa Rosa, California

PLATE
8

LAYERING

MASSIVE	Greater than 6 feet
THICKLY BEDDED	2 to 6 feet
MEDIUM BEDDED	8 to 24 inches
THINLY BEDDED	2½ to 8 inches
VERY THINLY BEDDED	¾ to 2½ inches
CLOSELY LAMINATED	¼ to ¾ inches
VERY CLOSELY LAMINATED	Less than ¼ inch

JOINT, FRACTURE, OR SHEAR SPACING

VERY WIDELY SPACED	Greater than 6 feet
WIDELY SPACED	2 to 6 feet
MODERATELY SPACED	8 to 24 inches
CLOSELY SPACED	2½ to 8 inches
VERY CLOSELY SPACED	¾ to 2½ inches
EXTREMELY CLOSELY SPACED	Less than ¼ inch

HARDNESS

Soft - pliable; can be dug by hand

Firm - can be gouged deeply or carved with a pocket knife

Moderately Hard - can be readily scratched by a knife blade; scratch leaves heavy trace of dust and is readily visible after the powder has been blown away

Hard - can be scratched with difficulty; scratch produces little powder and is often faintly visible

Very Hard - cannot be scratched with pocket knife, leaves a metallic streak

STRENGTH

Plastic - capable of being molded by hand

Friable - crumbles by rubbing with fingers

Weak - an unfractured specimen of such material will crumble under light hammer blows

Moderately Strong - specimen will withstand a few heavy hammer blows before breaking

Strong - specimen will withstand a few heavy ringing hammer blows and usually yields large fragments

Very Strong - rock will resist heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments

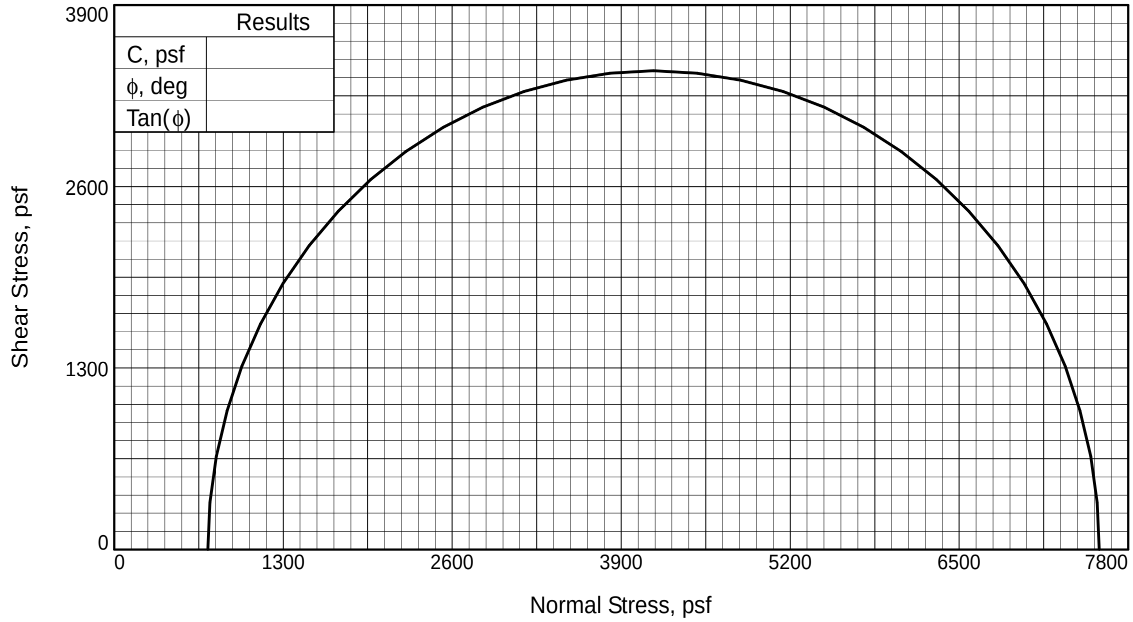
DEGREE OF WEATHERING

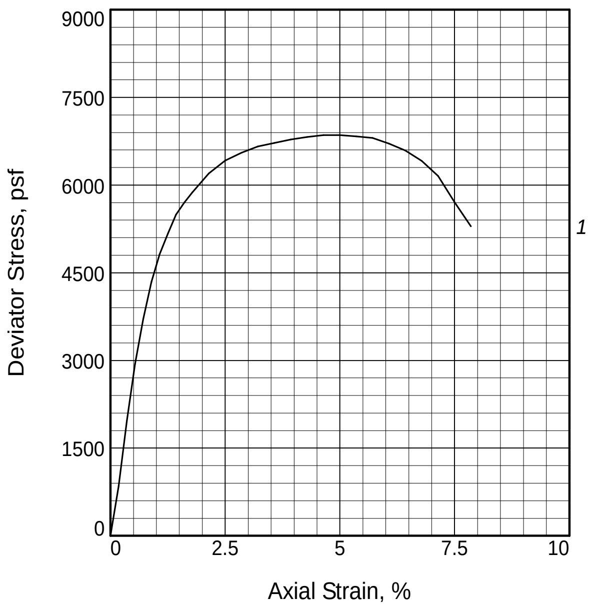
Highly Weathered - abundant fractures coated with oxides, carbonates, sulphates, mud, etc., thorough discoloration, rock disintegration, mineral decomposition

Moderately Weathered - some fracture coating, moderate or localized discoloration, little to no effect on cementation, slight mineral decomposition

Slightly Weathered - a few stained fractures, slight discoloration, little or no effect on cementation, no mineral composition

Fresh - unaffected by weathering agents; no appreciable change with depth





Sample No.		1
Initial	Water Content, %	21.5
	Dry Density, pcf	105.4
	Saturation, %	96.8
	Void Ratio	0.5990
	Diameter, in.	2.39
	Height, in.	5.60
At Test	Water Content, %	21.5
	Dry Density, pcf	105.4
	Saturation, %	96.8
	Void Ratio	0.5990
	Diameter, in.	2.39
	Height, in.	5.60
Strain rate, in./min.		0.060
Back Pressure, psf		0
Cell Pressure, psf		720
Fail. Stress, psf		6857
Strain, %		5.0
Ult. Stress, psf		6857
Strain, %		5.0
σ_1 Failure, psf		7577
σ_3 Failure, psf		720

Type of Test:
Unconsolidated Undrained

Sample Type: Tube

Description: Brown Clay (CH)

Assumed Specific Gravity= 2.70

Tested By: KJC

Checked By: SEF

Client: RGH Consultants

Project: Los Alamos Trunk Replacement

Source of Sample: B-1 **Depth:** 6.0'

Proj. No.: 1148.42.04.1 **Date Sampled:** Not Stated

RGH
CONSULTANTS

Job No: 1148.42.04.1 Date: NOV 2017

STRENGTH TEST DATA
Los Alamos Trunk Replacement
Phase 1 Pipeline Segment
Santa Rosa, California

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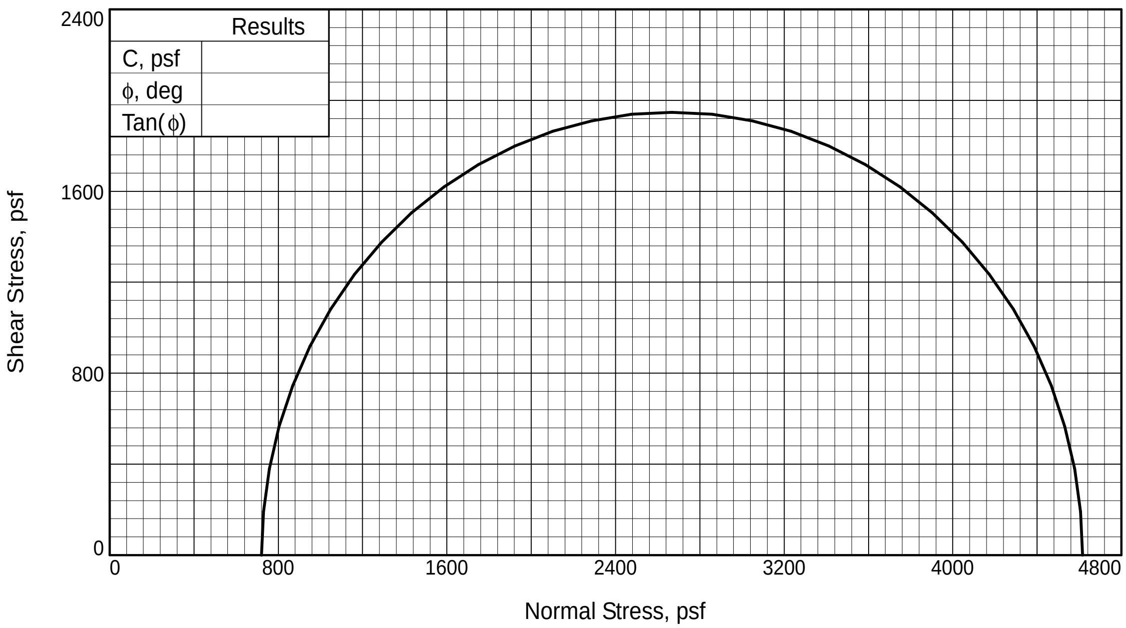

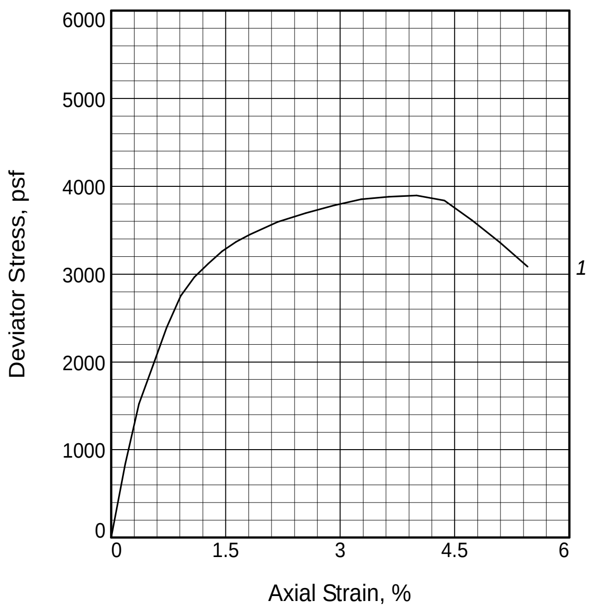

Sample No.		1
Initial	Water Content, %	14.2
	Dry Density, pcf	110.4
	Saturation, %	72.7
	Void Ratio	0.5268
	Diameter, in.	2.39
	Height, in.	5.50
At Test	Water Content, %	14.2
	Dry Density, pcf	110.4
	Saturation, %	72.7
	Void Ratio	0.5268
	Diameter, in.	2.39
	Height, in.	5.50
Strain rate, in./min.		0.060
Back Pressure, psf		0
Cell Pressure, psf		720
Fail. Stress, psf		3895
Strain, %		4.0
Ult. Stress, psf		3895
Strain, %		4.0
σ_1 Failure, psf		4615
σ_3 Failure, psf		720

Type of Test:
Unconsolidated Undrained

Sample Type: Tube

Description: Dark Brown Gravelly Clay W/ Sand (CL)

Assumed Specific Gravity= 2.70

Tested By: KJC

Checked By: SEF

Client: RGH Consultants

Project: Los Alamos Trunk Replacement

Source of Sample: B-1 **Depth:** 11.0'

Proj. No.: 1148.42.04.1 **Date Sampled:** Not Stated

RGH
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Job No: 1148.42.04.1 | Date: NOV 2017

STRENGTH TEST DATA
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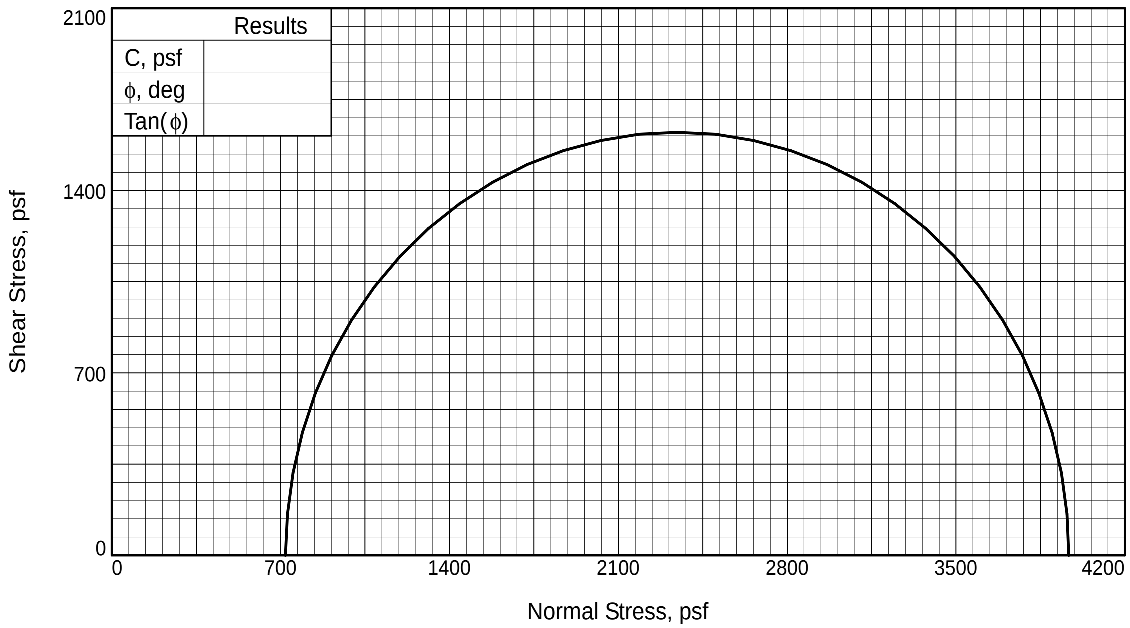

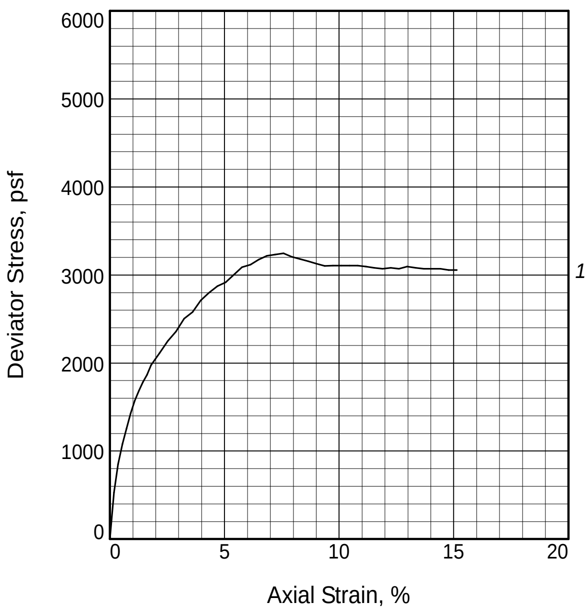

Sample No.		1
Initial	Water Content, %	18.5
	Dry Density, pcf	110.7
	Saturation, %	95.8
	Void Ratio	0.5222
	Diameter, in.	2.39
	Height, in.	5.55
At Test	Water Content, %	18.5
	Dry Density, pcf	110.7
	Saturation, %	95.8
	Void Ratio	0.5222
	Diameter, in.	2.39
	Height, in.	5.55
Strain rate, in./min.		0.060
Back Pressure, psf		0
Cell Pressure, psf		720
Fail. Stress, psf		3248
Strain, %		7.6
Ult. Stress, psf		3248
Strain, %		7.6
σ_1 Failure, psf		3968
σ_3 Failure, psf		720

Type of Test:
Unconsolidated Undrained

Sample Type: Tube

Description: Brown Sandy Clay (CL)

Assumed Specific Gravity= 2.70

Tested By: KJC

Checked By: SEF

Client: RGH Consultants

Project: Los Alamos Trunk Replacement

Source of Sample: B-3 **Depth:** 6.0'

Proj. No.: 1148.42.04.1 **Date Sampled:** Not Stated

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Job No: 1148.42.04.1 | Date: NOV 2017

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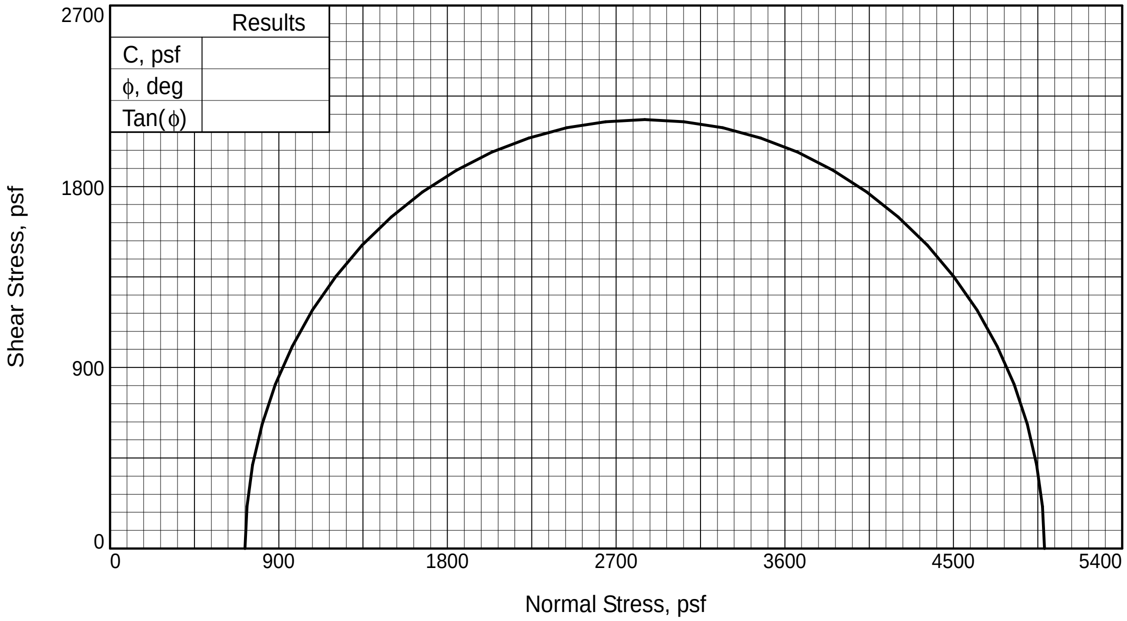

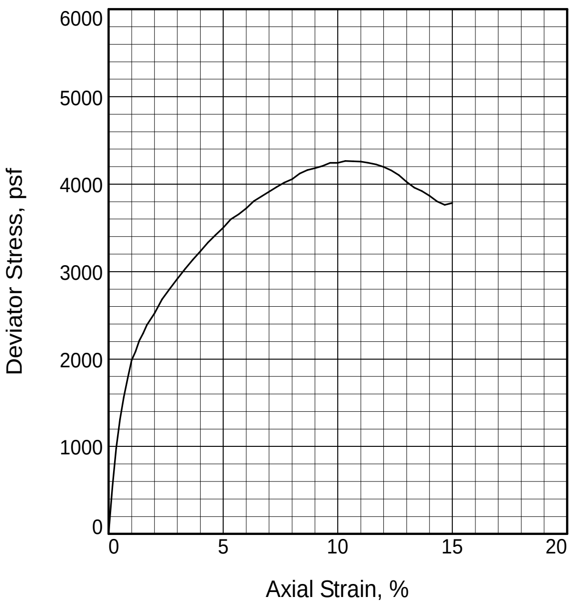

Sample No.		1
Initial	Water Content, %	28.1
	Dry Density, pcf	94.4
	Saturation, %	96.7
	Void Ratio	0.7857
	Diameter, in.	2.41
	Height, in.	6.00
At Test	Water Content, %	28.1
	Dry Density, pcf	94.4
	Saturation, %	96.7
	Void Ratio	0.7857
	Diameter, in.	2.41
	Height, in.	6.00
Strain rate, in./min.		0.060
Back Pressure, psf		0
Cell Pressure, psf		720
Fail. Stress, psf		4265
Strain, %		10.3
Ult. Stress, psf		4265
Strain, %		10.3
σ_1 Failure, psf		4985
σ_3 Failure, psf		720

Type of Test:
Unconsolidated Undrained

Sample Type: Tube

Description: Brown Clay (CL)

Assumed Specific Gravity= 2.70

Tested By: KJC

Checked By: SEF

Client: RGH Consultants

Project: Los Alamos Trunk Replacement

Source of Sample: B-3 **Depth:** 11.0'

Proj. No.: 1148.42.04.1 **Date Sampled:** Not Stated

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Job No: 1148.42.04.1 | Date: NOV 2017

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