July 31, 2018
Project No.: 20191164.001A

Ms. Hannah Salafia
Sonoma County Water Agency
404 Aviation Boulevard
Santa Rosa, CA 95403

SUBJECT: Limited Liquefaction Assessment
Sonoma County Water Agency
Ely Booster Station
100 Ely Road North
Petaluma, California

Dear Ms. Salafia:

This report presents the results of our limited liquefaction assessment for the Ely Booster Station located at 100 Ely Road in Petaluma, California. The conclusions and recommendations presented in this letter are based on the subsurface conditions encountered and data collected at the location of our current boring and are subject to the provisions outlined in the Limitations section of this letter. Additionally, the conclusions and recommendations presented herein should not be extrapolated to other areas, applied to other improvements, or used for other projects without Kleinfelder's review and comment.

PROJECT SUMMARY

The current project consists of a limited geotechnical investigation to assess the potential liquefaction risk at this site after it was identified as a location with a high liquefaction potential by the Sonoma County Water Agency Draft Local Hazard Mitigation Plan (April 24, 2018). The general site location is shown on Figure 1, Site Location. A more detailed depiction of the existing site layout, along with the approximate location of the exploratory boring performed for this study, is shown on Figure 2, Site Plan.

SCOPE OF SERVICES

As authorized by the Sonoma County Water Agency Agreement Memorandum, signed July 16, 2018, our scope of services included the following items:

- Review of previous geotechnical work in the site area
- Pre-field activities including well permit acquisition and USA clearance
- Field exploration including drilling one exploratory boring
- Installation of monitoring well upon boring completion
- Engineering analysis and evaluation of field data

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- Preparation of this geotechnical letter including:
  - A description of the site surface and subsurface conditions encountered during the field investigation, including a boring log
  - Summary of our field exploration and liquefaction potential assessment
  - Seismic design parameters in accordance with the 2016 California Building Code
  - Discussion of conceptual liquefaction mitigation options, if applicable.

FIELD EXPLORATION

Drilled Boring

Prior to drilling, Kleinfelder's engineer met with a representative of the Sonoma County Water Agency onsite to discuss information regarding locations of site underground utilities, and to mark the proposed boring location. Underground Service Alert of Northern California (USA-North) was contacted to inform local utilities of the planned drilling operation.

Kleinfelder's subsurface exploration was performed on July 20, 2018, and consisted of drilling a single boring (Boring K-1) at the approximate location shown on Figure 2. The boring location was not surveyed, but was established based on measuring from existing landmarks. Therefore, the location of the boring shown on Figure 2 should be considered approximate.

Boring K-1 was advanced to a depth of approximately 50½ feet below the existing ground surface. The boring was drilled using a CME-55 drill rig equipped with 6-inch-diameter casing using the mud rotary method. A Kleinfelder geologist logged the borings, visually classified the soil encountered according to the Unified Soil Classification System (see Figure A-1 in Appendix A), and obtained samples of the subsurface materials. Soil classifications made in the field from samples and auger cuttings were performed in general accordance with relevant portions of ASTM D2488. Sample classifications, blow counts recorded during sampling, and other relevant information were recorded on the boring logs. The Unified Soil Classification System and a key to the symbols used on the boring logs are both described on Figure A-1 in Appendix A. A Soil Description Key is presented on Figure A-2. The boring log is presented on Figure A-3.

Upon completion of drilling and sampling, a monitoring well was installed in the boring to a depth of 50 feet. The monitoring well was screened from 10 to 50 feet in depth. Annular backfill consisted of sand from 50.5 to 10 feet, bentonite from 10-8 feet, and grout from 8 feet to the existing ground surface. The installation was completed with a well box at the surface.

Sampling Procedures

Soil samples were collected from the borings at depth intervals of approximately 2½ to 10 feet. Samples were collected from the borings at selected depths by driving either a 2.5-inch inside diameter (I.D.) California sampler, or a 1.4-inch I.D. Standard Penetration Test (SPT) sampler driven 18 inches (unless otherwise noted) into undisturbed soil. The samplers were driven using a 140-pound automatic hammer free-falling a distance of 30 inches. Blow counts were recorded at 6-inch intervals for each sample attempt and are reported on the logs.

The SPT sampler did not contain liners. The 2.5-inch I.D. California sampler contained stainless steel liners. The Standard Penetration Test (SPT) sampler was in accordance with American Society of Testing Materials (ASTM) D1586. The California sampler was in general conformance with ASTM D3550. Driven soil samples obtained using these samplers may have experienced some disturbance due to hammer impact, retrieval, and handling.

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Soil samples obtained from the borings were packaged and sealed in the field to reduce moisture loss and disturbance. Following drilling, the samples were returned to our laboratory for further examination.

SUBSURFACE CONDITIONS

The subsurface conditions encountered in Boring K-1 at the site generally consisted of a thin layer of undocumented artificial fill underlain by an approximately 7-foot-thick layer of top soil and alluvial soil which is underlain by Petaluma Formation/older alluvium deposits. For engineering purposes, the Petaluma Formation/older alluvium deposits encountered can be classified as very dense poorly graded gravel and sand with a varying amount of fines, or as a very dense clayey sand.

Groundwater was encountered at approximately 15 feet below the existing ground surface at the time of drilling on July 20, 2018. Kleinfelder returned to the site July 25, 2018 and measured the groundwater depth at 8.5 feet.

CALIFORNIA BUILDING CODE (2016) SEISMIC DESIGN PARAMETERS

Seismic design information based upon the 2016 CBC, which utilizes the ASCE 7-10, is presented in Table 1. The Maximum Considered Earthquake (MCE) mapped spectral accelerations for 0.2 second and 1 second periods (S_S and S_1), mapped peak ground acceleration (PGA), and mapped long-period transition period (T_L) were estimated based on Section 1613 of the CBC and Chapter 22 of the ASCE 7-10 using the United States Geological Survey (USGS) U.S. seismic design maps. The mapped acceleration values, associated soil amplification factors (F_a and F_v), and corresponding site modified (S_{MS} and S_{M1}) and design spectral accelerations (S_{DS} and S_{D1}), based on CBC, are presented in Table 1. Considering the soil conditions encountered at the site, we recommend a Site Class C for this site for any future improvements. The Seismic Design Category is estimated to be D.

To provide the ground motion parameters associated with the 2016 CBC, an online tool (https://earthquake.usgs.gov/designmaps/us/application.php?) was used, which was developed by the USGS based on the Seismic Design Maps in the 2015 IBC. Estimated values of PGA are based on mapped values of Maximum Considered Earthquake Geometric Mean (MCE_G) Peak Ground Accelerations (Figure 22-7, ASCE 7-10). The resulting 2016 CBC seismic design factors (for a risk factor of I, II, or III) are presented below in Table 1.

TABLE 1
GROUND MOTION PARAMETERS BASED ON 2016 CBC

Parameter	Value	Reference
S_S	1.576g	2016 CBC Section 1613.3.1
S_1	0.618g	2016 CBC Section 1613.3.1
Site Class	C	2016 CBC Section 1613.3.2
Seismic Design Category	D	2016 CBC Tables 1613.3.5 (1) and (2)
F_a	1.0	2016 CBC Table 1613.3.3(1)
F_v	1.3	2016 CBC Table 1613.3.3(2)

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Parameter	Value	Reference
S_{MS}	1.576g	2016 CBC Section 1613.3.3
S_{M1}	0.803g	2016 CBC Section 1613.3.3
S_{DS}	1.051g	2016 CBC Section 1613.4.4
S_{D1}	0.535g	2016 CBC Section 1613.4.4
PGA	0.611g	ASCE 7-10 Figure 22-7
F_{PGA}	1.000	ASCE 7-10 Table 11.8-1
PGA_M	0.611g	ASCE 7-10 Section 11.8.3
C_{RS}	0.982	ASCE 7-10 Figure 22-17
C_{R1}	0.972	ASCE 7-10 Figure 22-18
T_L	12 seconds	ASCE 7-10 Figure 22-12

LIQUEFACTION-SUSCEPTIBILTY ASSESSMENT AND CONCLUSIONS

Earthquake-induced soil liquefaction can be described as a significant loss of soil strength and stiffness caused by an increase in pore water pressure resulting from cyclic loading during shaking. Liquefaction is most prevalent in loose to medium dense sandy and gravely soils below the groundwater table, but can also occur in non-plastic to low-plasticity finer grained soils. The potential consequences of liquefaction to engineered structures include loss of bearing capacity, buoyancy forces on underground structures, ground oscillations or “cyclic mobility,” increased lateral earth pressures on retaining walls, settlement, and lateral spreading or “flow failures” in slopes.

Following a review of the boring log and soil samples collected for this study, it was apparent that the soils sampled are not susceptible to liquefaction. Therefore, it was not necessary to perform laboratory testing for the purposes of this assessment. Based on the materials encountered in the boring, including very dense granular soils and clayey soils, the site is not considered susceptible to soil liquefaction.

LIMITATIONS

The recommendations contained in this letter are subject to the limitations presented herein. In addition, a brochure prepared by GBA (Geoprofessional Business Association) has been included in Appendix B. We recommend that all individuals reading this letter also read this brochure.

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder’s profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions and recommendations are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. Kleinfelder makes no other representation, guarantee or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

The scope of services for this subsurface exploration and letter did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or groundwater at this site.

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CLOSING

We appreciate the opportunity to provide this letter for your use. If you have questions or require additional information, please contact us at 707.571.1883.

Sincerely,

KLEINFELDER, INC.

Martin J. Pucci, PE
Senior Engineer

William V. McCormick, PG, CEG
Sr. Principal Engineering Geologist

Attachments:

FIGURES

Figure 1	Site Location
Figure 2	Site Plan

APPENDICES

Appendix A	Boring Log
Appendix B	GBA Important Information About Your Geotechnical Engineering Report

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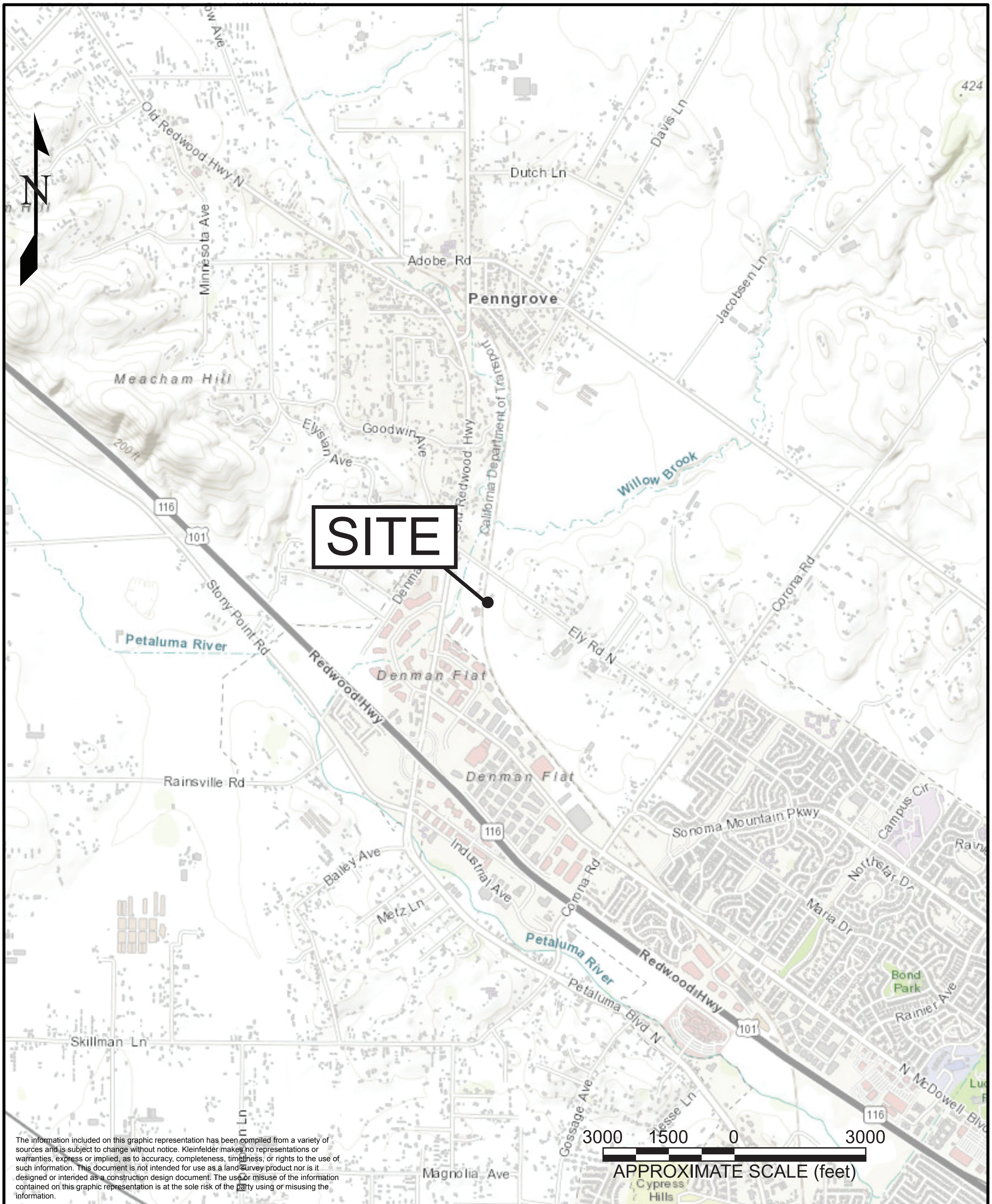
Figures



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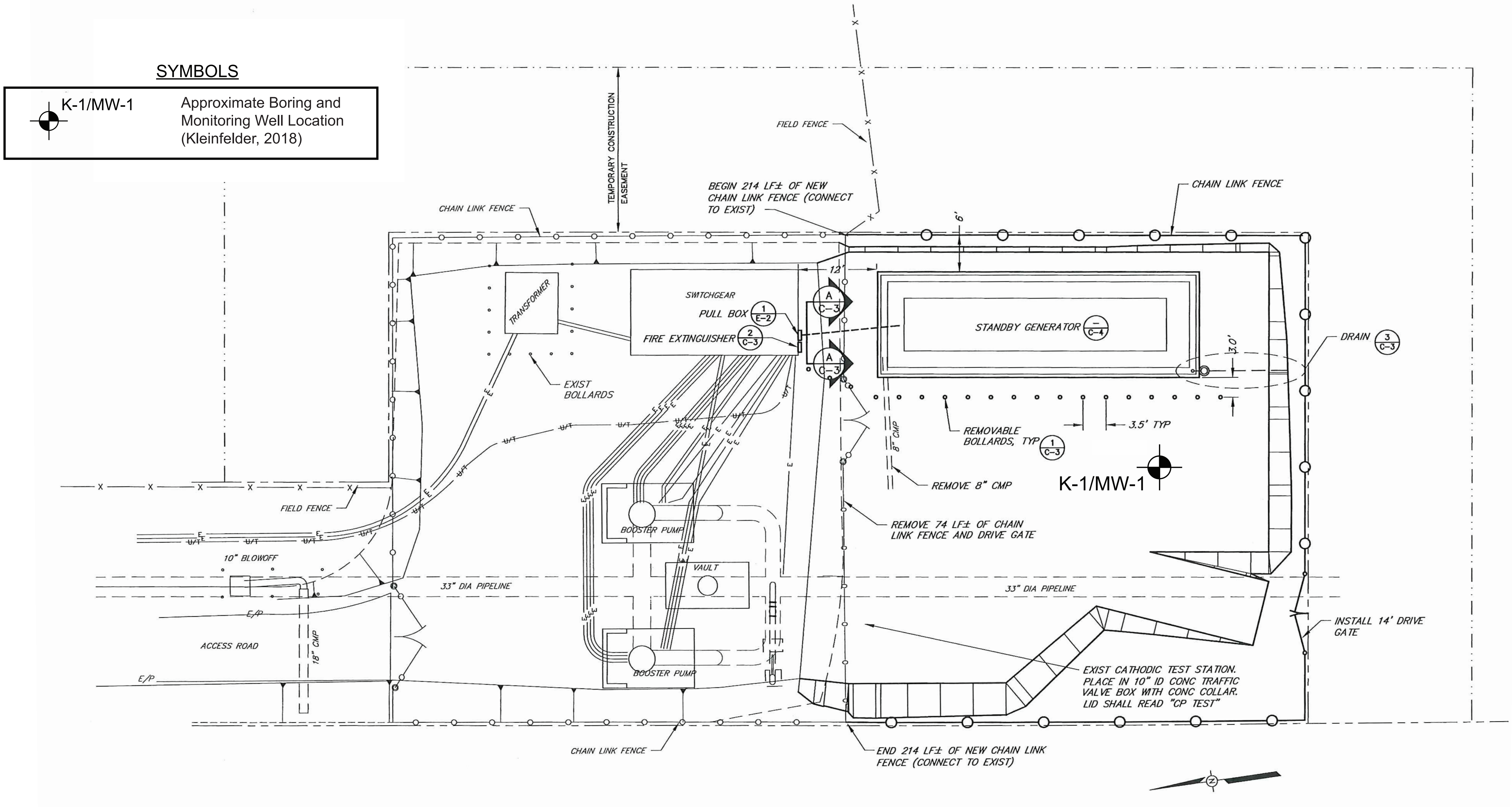
PROJECT NO.	20183845
DRAWN	JULY 2018
DRAWN BY	SDC
CHECKED BY	MJP
FILE NAME	Figure 1 Site Location.ai

SITE LOCATION

SCWA BOOSTER STATION
100 ELY ROAD N
SONOMA COUNTY, CALIFORNIA

FIGURE
1

Santa Rosa



PLAN

Reference: Ely Booster Pump Station: Standby Generator Grading and Paving Plan, Sonoma County Water Agency, September 2004

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APPROXIMATE SCALE (feet)

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DRAWN	JULY 2018
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CHECKED BY	MJP
FILE NAME	Figure 2 Site Plan.ai

SITE PLAN

SCWA BOOSTER STATION
100 ELY ROAD N
SONOMA COUNTY, CALIFORNIA

FIGURE

2

Santa Rosa

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Appendix A

PLOTTED: 07/27/2018 10:33 AM BY: SDCain
OFFICE FILTER: SANTA ROSA
PROJECT NUMBER: 20191164.001A
gINT FILE: Klf_gint_master_2017
gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2017.GLB [LEGEND 1 (GRAPHICS KEY) USCS_NOR_CAL]

SAMPLER AND DRILLING METHOD GRAPHICS

- BULK / GRAB / BAG SAMPLE
- MODIFIED CALIFORNIA SAMPLER (2 or 2-1/2 in. (50.8 or 63.5 mm.) outer diameter)
- CALIFORNIA SAMPLER (3 in. (76.2 mm.) outer diameter)
- STANDARD PENETRATION SPLIT SPOON SAMPLER (2 in. (50.8 mm.) outer diameter and 1-3/8 in. (34.9 mm.) inner diameter)
- HQ CORE SAMPLE (2.500 in. (63.5 mm.) core diameter)
- SHELBY TUBE SAMPLER
- PUSH TYPE SAMPLER
- SONIC CONTINUOUS SAMPLER
- HAND AUGER
- AUGER CUTTINGS

GROUND WATER GRAPHICS

- WATER LEVEL (level where first observed)
- WATER LEVEL (level after exploration completion)
- WATER LEVEL (additional levels after exploration)
- OBSERVED SEEPAGE

NOTES

- The report and graphics key are an integral part of these logs. All data and interpretations in this log are subject to the explanations and limitations stated in the report.
- Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual or differ from those shown.
- No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.
- Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.
- In general, Unified Soil Classification System designations presented on the logs were based on visual classification in the field and were modified where appropriate based on gradation and index property testing.
- Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing the No. 200 sieve require dual USCS symbols, ie., GW-GM, GP-GM, GW-GC, GP-GC, GC-GM, SW-SM, SP-SM, SW-SC, SP-SC, SC-SM.
- If sampler is not able to be driven at least 6 inches then 50/X indicates number of blows required to drive the identified sampler X inches with a 140 pound hammer falling 30 inches.

ABBREVIATIONS
WOH - Weight of Hammer
WOR - Weight of Rod

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	**GRAVELS** (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVEL WITH <5% FINES	$Cu \geq 4$ and $1 \leq Cc \leq 3$	**GW**	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			$Cu < 4$ and/ or $1 > Cc > 3$	**GP**	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH 5% TO 12% FINES	$Cu \geq 4$ and $1 \leq Cc \leq 3$	**GW-GM**	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
				GW-GC	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
			$Cu < 4$ and/ or $1 > Cc > 3$	**GP-GM**	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
				GP-GC	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
		GRAVELS WITH > 12% FINES		**GM**	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
				GC-GM	CLAYEY GRAVELS, GRAVEL-SAND-CLAY-SILT MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH <5% FINES	$Cu \geq 6$ and $1 \leq Cc \leq 3$	**SW**	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			$Cu < 6$ and/ or $1 > Cc > 3$	**SP**	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH 5% TO 12% FINES	$Cu \geq 6$ and $1 \leq Cc \leq 3$	**SW-SM**	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
				SW-SC	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
			$Cu < 6$ and/ or $1 > Cc > 3$	**SP-SM**	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
				SP-SC	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
		SANDS WITH > 12% FINES		**SM**	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES
				SC-SM	CLAYEY SANDS, SAND-SILT-CLAY MIXTURES

FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid Limit less than 50)	**ML**	INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, SILTS WITH SLIGHT PLASTICITY
		CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		CL-ML	INORGANIC CLAYS-SILTS OF LOW PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid Limit greater than 50)	**MH**	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
		CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
		OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY

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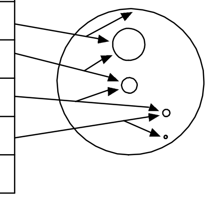
PROJECT NO.: 20191164	GRAPHICS KEY	FIGURE
DRAWN BY:		
CHECKED BY:	SCWA Ely Road 100 N. Ely Road Petaluma, California	A-1
DATE:		
REVISED: -		

GRAIN SIZE

DESCRIPTION		SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders		>12 in. (304.8 mm.)	>12 in. (304.8 mm.)	Larger than basketball-sized
Cobbles		3 - 12 in. (76.2 - 304.8 mm.)	3 - 12 in. (76.2 - 304.8 mm.)	Fist-sized to basketball-sized
Gravel	coarse	3/4 -3 in. (19 - 76.2 mm.)	3/4 -3 in. (19 - 76.2 mm.)	Thumb-sized to fist-sized
	fine	#4 - 3/4 in. (#4 - 19 mm.)	0.19 - 0.75 in. (4.8 - 19 mm.)	Pea-sized to thumb-sized
Sand	coarse	#10 - #4	0.079 - 0.19 in. (2 - 4.9 mm.)	Rock salt-sized to pea-sized
	medium	#40 - #10	0.017 - 0.079 in. (0.43 - 2 mm.)	Sugar-sized to rock salt-sized
	fine	#200 - #40	0.0029 - 0.017 in. (0.07 - 0.43 mm.)	Flour-sized to sugar-sized
Fines		Passing #200	<0.0029 in. (<0.07 mm.)	Flour-sized and smaller



SECONDARY CONSTITUENT

Term of Use	AMOUNT: Secondary Constituent is Fine Grained	AMOUNT: Secondary Constituent is Coarse Grained
Trace	<5%	<15%
With	≥5 to <15%	≥15 to <30%
Modifier	≥15%	≥30%

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

CEMENTATION

DESCRIPTION	FIELD TEST
Weakly	Crumbles or breaks with handling or slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumble or break with finger pressure

CONSISTENCY - FINE-GRAINED SOIL

CONSISTENCY	SPT - N_{60} (# blows / ft)	Pocket Pen (tsf)	UNCONFINED COMPRESSIVE STRENGTH (Q_u)(psf)	VISUAL / MANUAL CRITERIA
Very Soft	<2	PP < 0.25	<500	Thumb will penetrate more than 1 inch (25 mm). Extrudes between fingers when squeezed.
Soft	2 - 4	0.25≤ PP <0.5	500 - 1000	Thumb will penetrate soil about 1 inch (25 mm). Remolded by light finger pressure.
Medium Stiff	4 - 8	0.5≤ PP <1	1000 - 2000	Thumb will penetrate soil about 1/4 inch (6 mm). Remolded by strong finger pressure.
Stiff	8 - 15	1≤ PP <2	2000 - 4000	Can be imprinted with considerable pressure from thumb.
Very Stiff	15 - 30	2≤ PP <4	4000 - 8000	Thumb will not indent soil but readily indented with thumbnail.
Hard	>30	4≤ PP	>8000	Thumbnail will not indent soil.

FROM TERZAGHI AND PECK, 1948; LAMBE AND WHITMAN, 1969; FHWA, 2002; AND ASTM D2488

REACTION WITH HYDROCHLORIC ACID

DESCRIPTION	FIELD TEST
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPT-N_{60} (# blows/ft)	MODIFIED CA SAMPLER (# blows/ft)	CALIFORNIA SAMPLER (# blows/ft)	RELATIVE DENSITY (%)
Very Loose	<4	<4	<5	0 - 15
Loose	4 - 10	5 - 12	5 - 15	15 - 35
Medium Dense	10 - 30	12 - 35	15 - 40	35 - 65
Dense	30 - 50	35 - 60	40 - 70	65 - 85
Very Dense	>50	>60	>70	85 - 100

FROM TERZAGHI AND PECK, 1948

PLASTICITY

DESCRIPTION	LL	FIELD TEST
Non-plastic	NP	A 1/8-in. (3 mm.) thread cannot be rolled at any water content.
Low (L)	< 30	The thread can barely be rolled and the lump or thread cannot be formed when drier than the plastic limit.
Medium (M)	30 - 50	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump or thread crumbles when drier than the plastic limit.
High (H)	> 50	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump or thread can be formed without crumbling when drier than the plastic limit.

STRUCTURE

DESCRIPTION	CRITERIA
Stratified	Alternating layers of varying material or color with layers at least 1/4-in. thick, note thickness.
Laminated	Alternating layers of varying material or color with the layer less than 1/4-in. thick, note thickness.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness.

ANGULARITY

DESCRIPTION	CRITERIA
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Particles are similar to angular description but have rounded edges.
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges.
Rounded	Particles have smoothly curved sides and no edges.

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PROJECT NO.: 20191164	SOIL DESCRIPTION KEY	FIGURE
DRAWN BY:		
CHECKED BY:	SCWA Ely Road 100 N. Ely Road Petaluma, California	A-2
DATE:		
REVISED: -		

PLOTTED: 07/27/2018 10:34 AM BY: SDCain
OFFICE FILTER: SANTA ROSA
PROJECT NUMBER: 20191164.001A
gINT FILE: Klf_gint_master_2017
gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2017.GLB [LEGEND 2 (SOIL DESC KEY)]

PLOTTED: 07/30/2018 10:35 AM BY: SDCain
OFFICE FILTER: SANTA ROSA
gINT FILE: Klf_gint_master_2017 PROJECT NUMBER: 20191164.001A
gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2017.GLB [_KLF_BORING/TEST PIT SOIL LOG]

BORING LOG K-1

Date Begin - End:	7/20/2018	**Drilling Company:**	Pitcher Drilling		
Logged By:	C. Ewing	**Drill Crew:**	James, Willy		
Hor.-Vert. Datum:	WGS84	**Drilling Equipment:**	CME-55	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Mud Rotary		
Weather:	Hot	**Bore Diameter:**	6 in. O.D.		

FIELD EXPLORATION / LABORATORY RESULTS

Latitude: 38.28064° N
Longitude: -122.66516° E
Approximate Ground Surface Elevation (ft.): 49
Surface Condition: Asphalt

Approximate Elevation (feet)	Depth (feet)	Lithologic Description	Blow Counts(BC)= Uncorr. Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
	0	Asphalt Concrete: 2.5"										
		Aggregate Base: 3"										
		Poorly Graded GRAVEL with Sand (GP): light gray to light brownish gray, dry, loose, fine to coarse sand, angular to subangular gravel to 0.75" (Fill)	BC=3 3 3 PP=2	78%								
45		**Sandy Lean CLAY (CL)**: dark brown, moist, stiff, fine to coarse sand, occasional subrounded gravel to 0.5", rootlets (Top soil)										
	5	**Fat CLAY (CH)**: light brownish gray, moist, stiff, increasing sand with depth (Alluvium)	BC=2 7 8 PP=1.5	67%								
40												
	10	**Poorly Graded GRAVEL with Sand (GP)**: yellowish brown to brown, becomes dark gray at 11', dry to moist, very dense, fine to coarse sand, subangular gravel to 0.5", decreasing sand content with depth (Weathered Petaluma Formation/Older Alluvium)	BC=21 50/5"	100%								
35		**Poorly Graded SAND with Clay and Gravel (SP-SC)**: mottled yellowish brown to brown and bluish gray, moist to wet, very dense, fine to coarse sand, subangular to subrounded gravel to 0.5" (Weathered Petaluma Formation/Older Alluvium)										
	15		BC=18 26 28	56%								Start mud rotary at 15'
30		**Clayey SAND (SC)**: gray to bluish gray, moist, very dense, fine to coarse sand, occasional fine gravel to 0.25" (Weathered Petaluma Formation/Older Alluvium)										
	20		BC=19 30 50/6"	67%								
25		**Poorly Graded SAND with Silt (SP-SM)**: gray to dark gray, moist, very dense, fine sand that coarsens with depth, gravel in shoe (Weathered Petaluma Formation/Older Alluvium)										
	25		BC=19 50/5"	100%								
20		**Clayey SAND with Gravel (SC)**: bluish gray, moist, very dense, fine to coarse sand, subangular gravel to 0.5" (Weathered Petaluma Formation/Older Alluvium)										
	30		BC=50/5"	80%								
15												

PLOTTED: 07/30/2018 10:35 AM BY: SDCain
gINT FILE: Klf_gint_master_2017 PROJECT NUMBER: 20191164.001A OFFICE FILTER: SANTA ROSA
gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2017.GLB [_KLF_BORING/TEST PIT SOIL LOG]

BORING LOG K-1

Date Begin - End:	7/20/2018	**Drilling Company:**	Pitcher Drilling
Logged By:	C. Ewing	**Drill Crew:**	James, Willy
Hor.-Vert. Datum:	WGS84	**Drilling Equipment:**	CME-55
Plunge:	-90 degrees	**Drilling Method:**	Mud Rotary
Weather:	Hot	**Bore Diameter:**	6 in. O.D.

Hammer Type - Drop: 140 lb. Auto - 30 in.

FIELD EXPLORATION

Latitude: 38.28064° N
Longitude: -122.66516° E
Approximate Ground Surface Elevation (ft.): 49
Surface Condition: Asphalt

Approximate Elevation (feet)	Depth (feet)	Graphical Log	Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
			Poorly Graded GRAVEL with Sand (GP): bluish gray to dark gray, moist, very dense, fine to coarse sand, subangular to subrounded gravel to 0.25", some clay matrix infill (Weathered Petaluma Formation/Older Alluvium)		BC=50/5"	80%								
10	40		as above, increase in clay content		BC=50/5"	100%								
5	45													
0	50		**Poorly Graded GRAVEL (GP)**: dark gray to bluish gray, moist, very dense, fine to coarse sand, subangular to subrounded gravel to 0.5" (Weathered Petaluma Formation/Older Alluvium)		BC=50/6"	83%								
-5	55													
-10	60													
-15	65													
-20														

The piezometer was terminated at approximately 50.5 ft. below ground surface. Monitoring Well installed to a depth of 50 ft.

GROUNDWATER LEVEL INFORMATION:
- Groundwater was observed at approximately 15 ft. below ground surface during drilling.
- Groundwater was measured at approximately 8.5 ft. below ground surface the Wednesday following drilling completion (7/25/2018)

GENERAL NOTES:
Screen: 50-10'
Sand: 50.5-10'
Bentonite: 10-8'
Grout: 8-0'
Well box at surface
The exploration location and elevation are approximate and were estimated by Kleinfelder using Google Earth.

KLEINFELDER
Bright People. Right Solutions.

PROJECT NO.:	20191164
DRAWN BY:	CSE
CHECKED BY:	MJP
DATE:	
REVISED:	-

BORING LOG K-1

SCWA Ely Booster Station
100 N. Ely Road
Petaluma, California

FIGURE
A-3

Bright People. Right Solutions.

Appendix B

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Th se who rely on a geotechnical-engineering report prepared for a different client can be seriously misled*. No one except authorized client representatives should rely on this geotechnical-engineering report without fi st conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific fa tors when designing the study behind this report and developing the confi mation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configur tion, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office uilding, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configur tion, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like fl ods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modifi d codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe signifi antly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project fin sh, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confi mation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can fi alize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confi ms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifi ations,
- review pertinent elements of other design professionals' plans and specifi ations, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific roject requirements, including options selected from the report, *only* from the design drawings and specifi ations. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the fi ancial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ signifi antly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental fi dings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficie cies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infi tration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

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