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To: Brown
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Proj/Sonoma Valley CSD Main Sewer Trunk Replacement and Recycled Water Pipeline (Watmaugh Road East to Treatment Plant) 70-12-7 #37

Report
Soil Investigation
Sonoma Valley Treatment Plant
Bore Pits
Sonoma County, California

Prepared for
Sonoma County Water Agency
P.O. Box 11628
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By

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September 28, 2007

INTRODUCTION

This report presents the results of our soil investigation for the proposed "bore pits" at the Sonoma Valley Wastewater Treatment Plant in Sonoma, California. The treatment plant is located adjacent to the west side of 8th Street East approximately 1/2-mile north of Fremont Drive (Highway 12/121). The proposed bore pits will be located near the southwest corner of the facility adjacent to the northeast and southwest sides of Schell Creek. The bore pits will be excavated approximately 17 to 20 feet below the existing ground surface to facilitate horizontal boring beneath Schell Creek and installation of approximately 80 lineal feet of new main sewer trunk line. Preliminary plans indicate that the new sewer trunk line will consist of a 42-inch diameter PVC pipe within a 60-inch-diameter steel encasement. Manholes are also shown at each end of the new trunk line.

The object of our investigation, as outlined in our proposal dated July 9, 2007, was to review selected geologic references in our files, explore subsurface conditions, measure depth to groundwater, if encountered, and determine physical properties of the soils encountered. We then performed engineering analyses to develop conclusions and recommendations concerning:

1. Proximity of the site to active faults.
2. Site preparation and grading, as needed, including inclination of bore pit cut slopes to comply with OSHA requirements.
3. Soil engineering drainage.
4. Supplemental soil engineering services.

WORK PERFORMED

We reviewed selected, published geologic information in our files including:

1. The "Geology for Planning in Sonoma County" maps, Special Report 120, California Division of Mines and Geology, 1980.

2. Association of Bay Area Governments website (www.abag.ca.gov), 2004, Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map.

3. Association of Bay Area Governments website (www.abag.ca.gov), 2004, Liquefaction Susceptibility Map.

4. "Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada," Uniform Building Code (UBC), 1997.

On August 2, 2007, we were at the site to observe conditions exposed and explore subsurface conditions to the extent of two test borings at the approximate locations indicated on Plate 1. The borings were drilled to depths ranging from about 21 to 30 feet with truck-mounted, auger equipment. Our representative located the borings, observed the drilling, logged the conditions encountered and obtained samples for visual classification and laboratory testing. Relatively undisturbed samples were obtained with a 2.5-inch (inside-diameter) split-spoon sampler driven with a 140-pound drop hammer. The stroke during driving was about 30 inches. The blows required to drive the sampler were recorded and converted to equivalent Standard Penetration blow counts for correlation with empirical data. Logs of the borings showing soil classifications, sample depths and converted blow counts are presented on Plates 2 and 3. The soils are classified in accordance with the Unified Soil Classification System explained on Plate 4.

Selected samples were tested in our laboratory to determine moisture content, dry density, classification (percent free swell and percent passing No. 200 sieve) and strength characteristics. The test results are shown on the logs with the strength data shown in the manner described by the Key to Test Data, Plate 4.

The boring locations shown on Plate 1 were determined by visually estimating from existing surface features. The locations should be considered no more accurate than implied by the methods used to establish the data. At the completion of the exploration, the boring holes were backfilled with bentonite chips.

SURFACE AND SUBSURFACE CONDITIONS

The ground surface southwest of Schell Creek is relatively flat and generally slopes very gently downward to the southeast. A vineyard access road covered with a light to moderate growth of grass and weeds exists between the top of the creek bank along the southwest side and an adjacent vineyard. The area northeast of the creek, in the vicinity of the Test Boring 1, is generally surfaced with gravel and used as a parking area for maintenance equipment used at the treatment plant. An existing sanitary sewer manhole (No. 220-6 shown on the preliminary plan profile) located about 20 feet southwest of Test Boring 1, is positioned in the central portion of an approximate 3 to 4 foot tall berm. The berm extends to the southeast and northwest adjacent to the perimeter of the treatment plant. In general, vegetation along both sides of the creek bank is relatively dense and generally consists of blackberry bushes, shrubs and occasional trees.

The borings and laboratory tests indicate that the site is underlain by discontinuous layers of sandy clay and silt and clayey sand and gravel to the maximum depth explored. Fill materials consisting of gravel surfacing and hard to very stiff gravelly clay were encountered in Boring 1 that extended to a depth of about 3 feet. The upper natural soils below the fill and in Test Boring 2 consist of stiff to hard sandy clays that exhibit low to possibly moderate expansion potential. That is, the materials would tend to undergo low to possibly moderate strength and volume changes with seasonal variations in moisture content. A layer of moderate to possibly highly expansive sandy clay was encountered below the upper topsoils at depths that varied from approximately 2 to 4½ feet and was observed to be about 2 to 3 feet thick. The underlying soils generally consist of medium dense to dense clayey sands and gravels, and stiff to hard sandy clays and silts with varying amounts sand and gravel to the maximum depth explored.

Groundwater was initially observed in both test borings during the exploration at depths that varied from about 17 to 19 feet. Boring 1 was left open for about ½ hour, and the depth to groundwater was remeasured and found to have risen to a depth of about 14 feet below the adjacent grade. Our experience indicates that subsurface water conditions vary seasonally, and groundwater levels can rise and fall several feet annually. In addition, we understand that water levels in Schell Creek may be tidal influenced. Precise depth to groundwater, extent of seasonal water fluctuations or tidal influences, and/or determination of a perched groundwater condition is beyond the scope of this investigation.

The Flood Insurance Rate Map reviewed indicates that the site is not subject to inundation by a 100- or 500-year flood event.

The Liquefaction Susceptibility Map reviewed indicates that the risk of liquefaction at the site could be considered low.

SEISMIC DESIGN PARAMETERS

The geologic maps reviewed did not indicate the presence of active faults at the site, and, therefore, we judge that there is little risk of fault-related ground rupture during earthquakes. The closest faults generally considered active are summarized below, with their distance from the subject site and current 1997 UBC source type designation. The project is located in Seismic Hazard Zone 4, and, we judge that S_D is the appropriate soil profile type for the site, as described in the 1997 UBC, Figure 16-2 and Table 16-J, respectively.

Fault Name	Source Type	Distance from Site	General Direction (Site to Source)
Rodgers Creek	A	5.0 kilometers (3.1 miles)	Southwest
West Napa	B	12.3 kilometers (7.6 miles)	Northeast

In a seismically active region such as Northern California, there is always some possibility for future faulting at any site. However, historical occurrences of surface faulting have generally closely followed the trace of the more recently active faults. Strong ground shaking will occur during earthquakes. The intensity at the site will depend on the distance to

the earthquake epicenter, depth and magnitude of the shock, and the response characteristics of the materials beneath the site. Because of the proximity of active faults in the region and the potential for strong ground shaking, it will be necessary to design and construct the project in strict accordance with current standards for earthquake-resistant construction.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our field exploration, laboratory tests and engineering analysis, we conclude that, from a soil engineering standpoint, the site can be used for the proposed construction. The most significant soil engineering factors that must be considered in design and construction are the variability of soils and soil strengths and potential for ground water to rise to within close proximity of the ground surface, particularly during periods of prolonged wet weather and possibly within periods of high tide.

Our laboratory test data and engineering analyses (summarized on Plate 5) indicates that soil strengths vary from about 1,200 pounds per square foot (psf) up to about 7,000 psf, with an average strength of about 2,500 psf. Such soils are classified as Type B (cohesive soil with an unconfined compressive strength greater than 1,000 psf but less than 1,500 psf) soils in Section 1541.1, Appendix A, of Title 8, California Code of Regulations. However, in a saturated condition or below the groundwater table (submerged) the soils would be considered Type C soils. Short term excavations less than 20 feet deep are indicated in Section 1541.1, Appendix B, of Title 8 to be inclined no steeper than one horizontal to one vertical (1:1) for Type B soils, and 1½:1 for Type C soils.

We believe that the underlying soils could become saturated, particularly during periods of prolonged wet weather in the winter and early spring months. Such conditions coupled with the rise of the creek level, could result in ground water levels in close proximity to the ground surface. Saturation increases pore water pressure and adds weight (driving force) to the soil mass. When the resisting forces are exceeded by the driving forces, failure occurs. Therefore if excavations are performed in the winter or early spring months when saturated soil conditions exist, indicated strengths above the groundwater table would be significantly reduced. Accordingly, during the winter and early spring months, all soils within the proposed excavation zone(s) should be considered Type C soils. In addition, it may be necessary to temporarily brace excavations with shield systems, sheet piling or other approved means during the winter or early spring months, and, possibly during periods of high tide. Because of the variability of soils and soil strengths between categories B and C, we judge that a horizontal setback distance from existing buildings of at least 10 feet be established.

It is likely that groundwater will be encountered in the proposed bore pit excavations. Therefore, gravel working pads with sump pumps or other dewatering measures could also be needed.

Site Grading

Areas to be graded, if any, should be cleared of existing obstructions, debris and brush. Dense growths of grass and vegetation should be removed. The areas to be graded or excavated then should be stripped of the upper few inches of soil containing root growth and

organic matter. We anticipate that the depth of stripping, where needed, would average about 3 inches. The strippings should be removed from the site or stockpiled for reuse as topsoil, or mixed with at least five parts of soil and used as fill at least 10 feet away from structures, driveways, and paved areas.

Within areas to receive fill or backfill, the surfaces exposed by stripping and/or soil removal should be scarified at least 6 inches deep, moisture conditioned to at least 2 percent above optimum (at least 3 percentage points above optimum for highly expansive clayey soils) and compacted to at least 87 percent relative compaction[1]. Approved excavated and/or imported fill or backfill material then should be spread in 8-inch-thick loose lifts, similarly moisture conditioned, and compacted to at least 90 percent.

Imported fill, if needed, should be of low expansion potential and have a Plasticity Index of 15 or less, and be free of organic matter and rocks or hard fragments larger than 4 inches in diameter. Material proposed for use as imported fill should be tested and approved by the soil engineer prior to delivery to the site.

Embankment fill material, if needed, within Schell Creek should be free of organic matter and rocks or hard fragments larger than 6 inches in diameter, and should conform in general to the following requirements:

1 Relative compaction refers to the in-place dry density of fill expressed as a percentage of maximum dry density of the same material determined in accordance with the ASTM D 1557-00 laboratory compaction test procedure. Optimum moisture content refers to the moisture content at maximum dry density.

Sieve Size	Percent Passing
6-inch	100
4-inch	90 - 100
No. 200	30 - 100

Embankment fills should be placed in thin lifts, moisture conditioned to slightly wet of optimum and compacted to at least 90 percent relative compaction.

Finished cut and fill slopes should be trimmed to expose dense material and should be no steeper than two horizontal to one vertical (2:1). Slopes higher than 3 feet should be planted with fast-growing, deep-rooted ground cover to help reduce erosion.

Geotechnical Drainage

Runoff should be directed to non-erosive drainage devices or ditches that channel water away from slopes, creek banks and driveway or equipment parking areas.

Supplemental Geotechnical Services

We should review final plans for conformance with the intent of our recommendations. During excavation and backfilling operations, we should provide intermittent observation and testing to determine that the conditions encountered are as anticipated and to modify our recommendations, if warranted. Field and laboratory tests should be performed to ascertain that the specified moisture content and degree of compaction are being attained in backfills.

LIMITATIONS

We have performed the investigation and prepared this report in accordance with generally accepted standards of the soil engineering profession. No warranty, either express or implied, is given.

It should be understood that our services were limited to the scope of work outlined above and specifically excluded other services including, but not limited to, an evaluation or analysis of soil chemistry, corrosivity, mold and soil/groundwater contamination.

Subsurface conditions are complex and may differ from those indicated by surface features or encountered at test boring locations. Therefore, variations in subsurface conditions not indicated on the logs could be encountered. If the project is revised, or if conditions different from those described in this report are encountered during construction, we should be notified immediately so that we can take timely action to modify our recommendations, if warranted.

Supplemental services as recommended herein are performed on an as-requested basis. These services are in addition to this soil investigation, and are charged for on an hourly basis in accordance with our Standard Schedule of Charges. We can accept no responsibility for items we are not notified to check, nor for use or interpretation by others of the information contained herein.

Site conditions and standards of practice change. Therefore, we should be notified to update this report if construction is not performed within 24 months.

LIST OF PLATES

Plate 1	Test Boring Location Plan and Site Vicinity Map
Plates 2 and 3	Logs of Test Borings 1 and 2
Plate 4	Soil Classification Chart and Key to Test Data
Plate 5	Summary of Average Laboratory Test Data for Proposed Excavation Slopes

DISTRIBUTION

Copies submitted: 5

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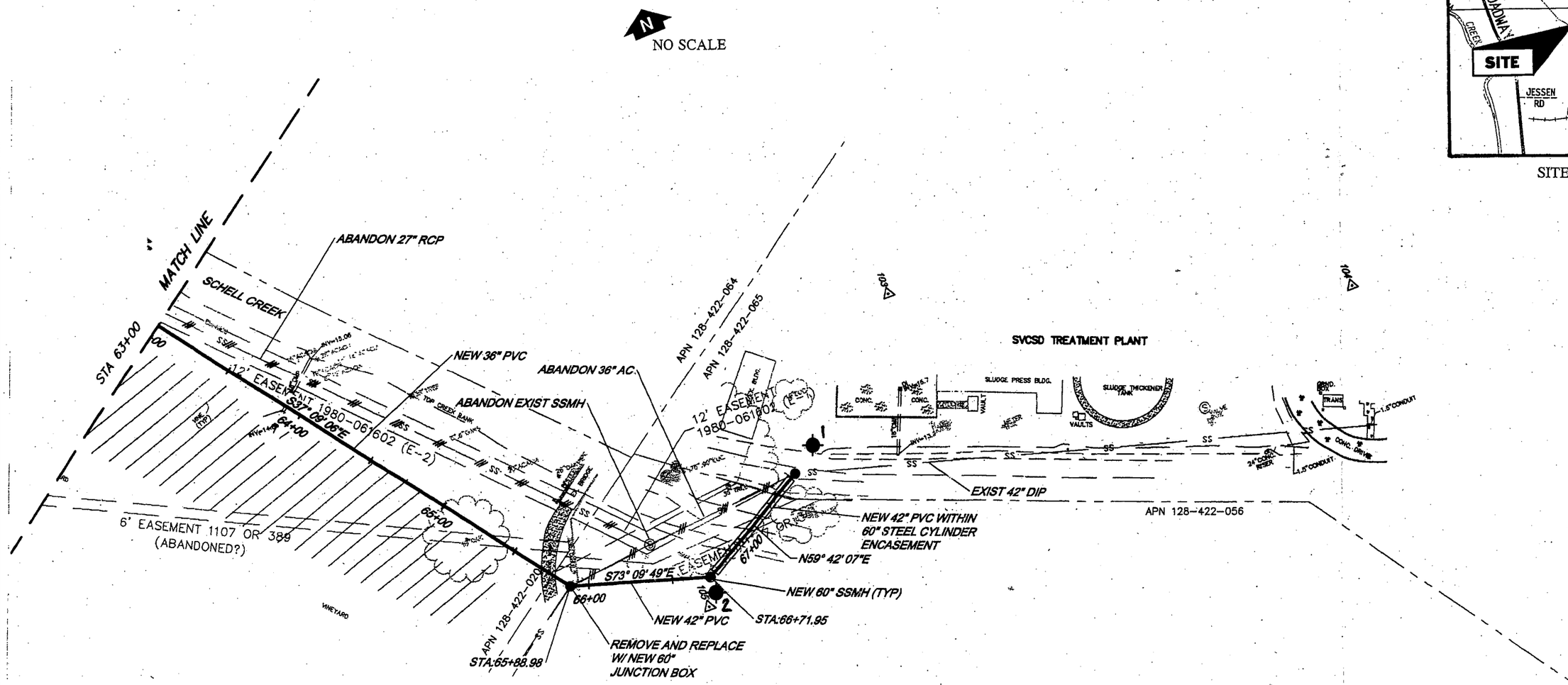
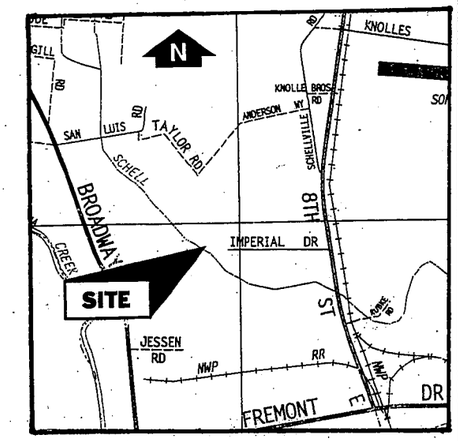
Attention: Eric Brown

DF/JAG:sc/NN/HD/bound/df/Job No. 205.8.1



Approximate Location of Test Boring



SITE VICINITY MAP

GIBLIN ASSOCIATES CONSULTING GEOTECHNICAL ENGINEERS	Job No: 205.8.1 Date: 09-26-07 Appr:	TEST BORING LOCATION PLAN AND SITE VICINITY MAP SONOMA VALLEY TREATMENT PLANT SONOMA COUNTY, CALIFORNIA	PLATE 1

▽ groundwater first encountered at time of drilling

▼ groundwater at time of backfilling

LOG OF BORING 1

Equipment: 6" FLIGHT AUGER

Elevation: 18.0 Date: 8-2-07

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)	Depth (ft)	Sample	Description
				0		GRAY BROWN CLAYEY GRAVEL (GC-GP), dense, dry, with abundant 3-inch-diameter gravel (FILL)
	31	14.7	105			BROWN SANDY CLAY (CL), hard, moist, with occasional gravel (FILL)
				2		
Percent Free Swell = 70 UC(P) = 4500+	25	16.1	106			DARK BROWN SANDY CLAY (CL), very stiff, wet
				4		becomes very stiff DARK BROWN SANDY CLAY (CL/CH), hard, wet
UC(P) = 4500+	37	21.9	101			
				6		
				8		MOTTLED BROWN AND ORANGE OXIDIZED CLAYEY GRAVEL (GC), dense, wet to saturated
Percent Passing No. 200 Sieve = 20.5 TxUU = 2550 (1500)	41	13.5	118			
				10		
				12		MOTTLED ORANGE BROWN VERY CLAYEY SAND (SC), medium dense, saturated
Percent Passing No. 200 Sieve = 37.5 DSCD = 1810 (2000) DSCD = 2360 (3000)	18	27.4	97			
				14		
				16		

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LOG OF BORING 1

SONOMA VALLEY TREATMENT PLANT
SONOMA COUNTY, CALIFORNIA

PLATE **2a**

*Converted to Standard Penetration Blow Counts

▽ groundwater first encountered at time of drilling

▼ groundwater at time of backfilling

LOG OF BORING 1

Equipment: 6" FLIGHT AUGER

Elevation: 18.0 Date: 8-2-07

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)	Depth (ft)	Sample	Description
				16		MOTTLED ORANGE BROWN AND BLACK COARSE SANDY GRAVEL (GC/GP), dense, saturated
Percent Passing No. 200 Sieve = 9.2	42	20.7	107	18		
				20		LIGHT BROWN VERY SANDY SILT (ML), very stiff, saturated
TxUU = 1230 (3250)	26	31.1	90	22		
				24		
Percent Passing No. 200 Sieve = 76.8 UC(P) = 1200	11	35.9	85			becomes stiff, increase in fines
				26		
				28		
	18	30.3	90	30		ORANGE CLAYEY COARSE SAND (SC), medium dense, saturated

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LOG OF BORING 1

SONOMA VALLEY TREATMENT PLANT
SONOMA COUNTY, CALIFORNIA

PLATE **2b**

*Converted to Standard Penetration Blow Counts

▽ groundwater first encountered at time of drilling

▼ groundwater at time of backfilling

LOG OF BORING 2

Equipment: 6" FLIGHT AUGER

Elevation: 16.5 Date: 8-2-07

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)	Depth (ft)	Sample	
				0		BROWN SANDY CLAY (CL), stiff, dry
Percent Free Swell = 70	26	18.9	90	2		DARK GRAY BROWN SANDY CLAY (CL/CH), very stiff, moist, with occasional fine roots
UC(P) = 4500+	28	18.0	90	4		MOTTLED DARK GRAY BROWN SANDY CLAY (CL), very stiff, moist
TxUU = 7210 (1000)	50+	22.1	102	6		becomes hard
				8		
				10		BROWN SANDY CLAY (CL/CH), hard, wet to saturated, with occasional fine gravel
UC(P) = 4100	30	27.5	95	12		
				14		
TxUU = 4390 (2250) Percent Passing No. 200 Sieve = 63.7	50+	26.2	95	16		

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LOG OF BORING 2

SONOMA VALLEY TREATMENT PLANT
SONOMA COUNTY, CALIFORNIA

PLATE **3a**

*Converted to Standard Penetration Blow Counts

▽ groundwater first encountered at time of drilling

▼ groundwater at time of backfilling

LOG OF BORING 2

Equipment 6" FLIGHT AUGER

Elevation 16.5 Date 8-2-07

Laboratory Test Results or Remarks	Blows/foot *	Moisture Content (%)	Dry Density(pcf)	Depth (ft)	Sample	
				16		becomes very sandy
				18		LIGHT BROWN COARSE SANDY GRAVEL (GP), dense, saturated, gravel to 2-inch diameter
	43			20		

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LOG OF BORING 2

SONOMA VALLEY TREATMENT PLANT
SONOMA COUNTY, CALIFORNIA

PLATE **3b**

*Converted to Standard Penetration Blow Counts

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS — MORE THAN HALF IS LARGER THAN No. 200 SIEVE	GRAVEL — MORE THAN HALF OF COARSE FRACTION IS LARGER THAN No. 4 SIEVE SIZE	CLEAN GRAVEL WITH LESS THAN 5% FINES	GW	WELL GRADED GRAVEL, GRAVEL-SAND MIXTURE
			GP	POORLY GRADED GRAVEL, GRAVEL-SAND MIXTURE
		GRAVEL WITH OVER 12% FINES	GM	SILTY GRAVEL, GRAVEL-SAND-SILT MIXTURE
			GC	CLAYEY GRAVEL, GRAVEL-SAND-CLAY MIXTURE
	SAND — MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN No. 4 SIEVE SIZE	CLEAN SAND WITH LESS THAN 5% FINES	SW	WELL GRADED SAND, GRAVELLY SAND
			SP	POORLY GRADED SAND, GRAVELLY SAND
		SAND WITH OVER 12% FINES	SM	SILTY SAND, GRAVEL-SAND-SILT MIXTURE
			SC	CLAYEY SAND, GRAVEL-SAND-CLAY MIXTURE
FINE GRAINED SOILS — MORE THAN HALF IS SMALLER THAN No. 200 SIEVE	SILT AND CLAY — LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILT, ROCK FLOUR, SANDY OR CLAYEY SILT WITH LOW PLASTICITY
			CL	INORGANIC CLAY OF LOW TO MEDIUM PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAY (LEAN)
			OL	ORGANIC CLAY AND ORGANIC SILTY CLAY OF LOW PLASTICITY
	SILT AND CLAY — LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILT, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOIL, ELASTIC SILT
			CH	INORGANIC CLAY OF HIGH PLASTICITY, GRAVELLY, SANDY OR SILTY CLAY (FAT)
			OH	ORGANIC CLAY OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILT
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

KEY TO TEST DATA

				Shear Strength, psf	Confining Pressure, psf
EI	— Expansion Index	TxUU	— Unconsolidated Undrained Triaxial	320	(2600)
Consol	— Consolidation	TxCU	— Consolidated Undrained Triaxial	320	(2600)
LL	— Liquid Limit (in %)	DSCD	— Consolidated Drained Direct Shear	2750	(2000)
PL	— Plastic Limit (in %)	FVS	— Field Vane Shear	470	
PI	— Plasticity Index	LVS	— Laboratory Vane Shear	700	
SA	— Sieve Analysis	UC	— Unconfined Compression	2000 *	
G_s	— Specific Gravity	UC(P)	— Laboratory Penetrometer	700 *	
■	"Undisturbed" Sample				
□	Bulk Sample				

Notes: (1) All strength tests on 2.8" or 2.4" diameter samples unless otherwise indicated * Compressive Strength

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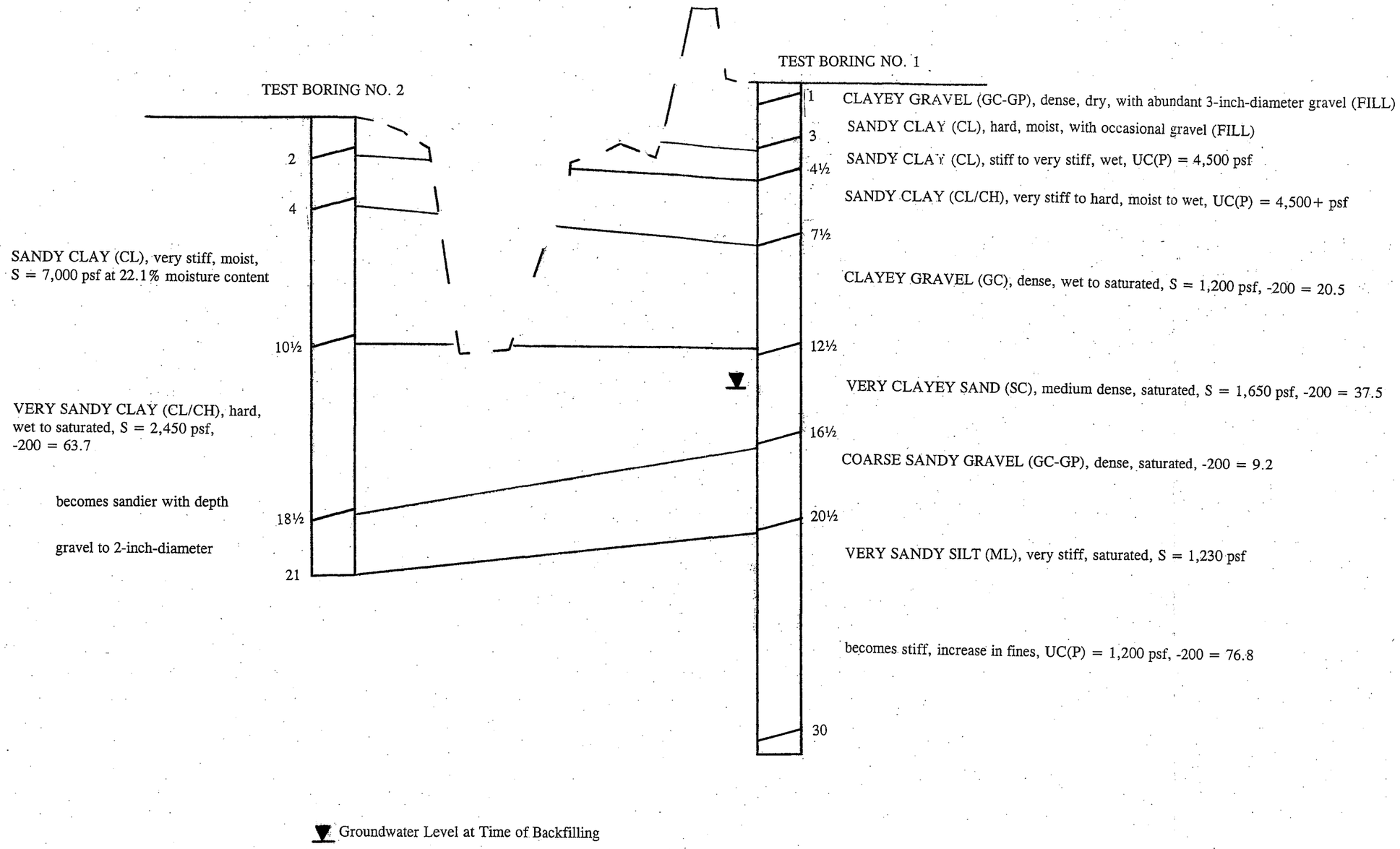
SOIL CLASSIFICATION CHART AND KEY TO TEST DATA

SONOMA VALLEY TREATMENT PLANT
SONOMA COUNTY, CALIFORNIA

PLATE 4



Groundwater Level at Time of Backfilling

Scale: 1 inch = 30 feet horizontal
1 inch = 5 feet vertical

S: Shear Strength
UC(P): Laboratory Penetrometer
-200: Percent Passing No. 200 Sieve

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SUMMARY OF AVERAGE LABORATORY TEST DATA FOR PROPOSED EXCAVATION SLOPES

SONOMA VALLEY TREATMENT PLANT
SONOMA COUNTY, CALIFORNIA

PLATE 5