

# Appendix F

## Geotechnical Report

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May 30, 2012

AA Production Services  
Attention: John Adams  
433 Second Street  
Woodland, CA 95695

**EXPLORATORY DRILLING  
BOULDIN-TYLER CROSSING**  
Highway 12 and Mokelumne River  
San Joaquin-Sacramento Counties, California  
Job No. 998-020

In accordance with your request, we have completed the drilling of two soil exploration borings at the site of the proposed gas pipeline crossing of the Mokelumne River from Tyler to Bouldin Islands. The purpose of this letter is to provide a general description of the materials encountered in the borings. We understand the pipeline will be placed through a casing installed by directional drilling from the landward side of the levee.

Boring 1 was drilled on the southeast side of the Mokelumne River about 170 feet southeast of the levee centerline. Boring 2 was drilled on the northwest side of the river about 350 feet northwest of the levee centerline. Boring 1 was drilled to a depth of about 115 feet, and Boring 2 was drilled to a depth of 113.5 feet, using a CME 45 truck mounted drill rig. Borings 1 and 2 were advanced to depths of 33 and 42 feet, respectively, using six-inch diameter hollow stem augers. The borings were finished using rotary wash methods, bentonite drilling fluid, and a three-inch diameter drag bit. Relatively undisturbed soil samples were obtained from the borings for classification and further review. Logs of the borings are shown on Plates 1 and 2, Log of Boring. The nomenclature used to describe the soils on the logs is defined on Plate 3, Unified Soil Classification System. The results of moisture content, dry density, and unconfined compressive strength tests are included on the logs at the depths of each sample tested. The results of sieve analysis on two selected sand samples are shown on Plate 4, Grain Size Distribution.

Boring 1 encountered medium stiff, dark gray-brown organic clayey silts on the surface and extending to a depth of about two feet. From this level to a depth of about 11 feet, Boring 1 encountered very soft, black silty clayey peat. Boring 2 encountered light brown fine sandy silt fills on the surface and extending to a depth of near three feet. Beneath the peat at Boring 1, and the surface fills at Boring 2, both borings encountered soft to very soft, gray to dark gray fine sandy to clayey organic silts. The soft silts were found to extend to a depth of about 27 feet at Boring 1, and 43 feet at Boring 2. Underlying the silts and extending to depths of about 73 feet in Boring 1, and 77 feet in Boring 2, the borings encountered primarily loose to medium dense gray sandy soils. These sandy soils include silty to clean fine to coarse sands and, occasionally, fine sandy silts. Beneath the sandy zone and extending to the near 115-foot maximum depths drilled, the borings encountered primarily gray-green and gray-blue silty clays and clayey to fine sandy silts, with relatively minor layers of clean to clayey fine to coarse sands.

Due to the drilling methods used, accurate measurement of groundwater levels in the bore holes were not obtained. Based on the appearance of the soil samples, groundwater levels at the borings were estimated to be at depths on the order of four to five feet below the ground surface.



Bouldin-Tyler Crossing  
May 30, 2012  
Job No. 998-020  
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The soil profile appears typical for materials usually encountered in the Sacramento/San Joaquin River delta system. The soft to very soft soils within the upper 26 to 31 feet will consolidate and settle over time. Particularly weak organic silts and peats at depths of less than 26 feet may be subject to shifting and displacement under the weight of levee fills. The pipeline should be kept well below these organic soils in the portions of the alignment beneath the levees. Peat is of very low strength and can have voids and channels of extremely high permeability. It may be difficult to maintain circulation of drilling fluids unless casing is used through the near-surface peaty materials.

Beneath the near surface organic layers, the soils are only of moderate strength but are relatively stable and consolidated under existing loads. We expect that the soils below the near-surface organic layers will provide suitable support for the pipeline, and will not present any unusual problems to directional drilling operations.

The peats and sands above depths of about 73 feet are of relatively high permeability and likely are hydraulically directly linked to flows in the river channel. The silts and clays observed at greater depths are moderately high strength soils of relatively low permeability. This silty/clayey zone appears to be consistent along the pipe crossing route and likely forms an aquitard that restricts vertical hydraulic flow.

Please contact me if you have any questions regarding this letter or require further information. Thank you for this opportunity to be of service.

The following Plates are attached and complete this report:

Plates 1A and 1B - Log of Boring, Boring 1  
Plates 2A and 2B - Log of Boring, Boring 2  
Plate 3 - Unified Soil Classification System  
Plate 4 - Grain Size Distribution

Sincerely,

RANEY GEOTECHNICAL INC.



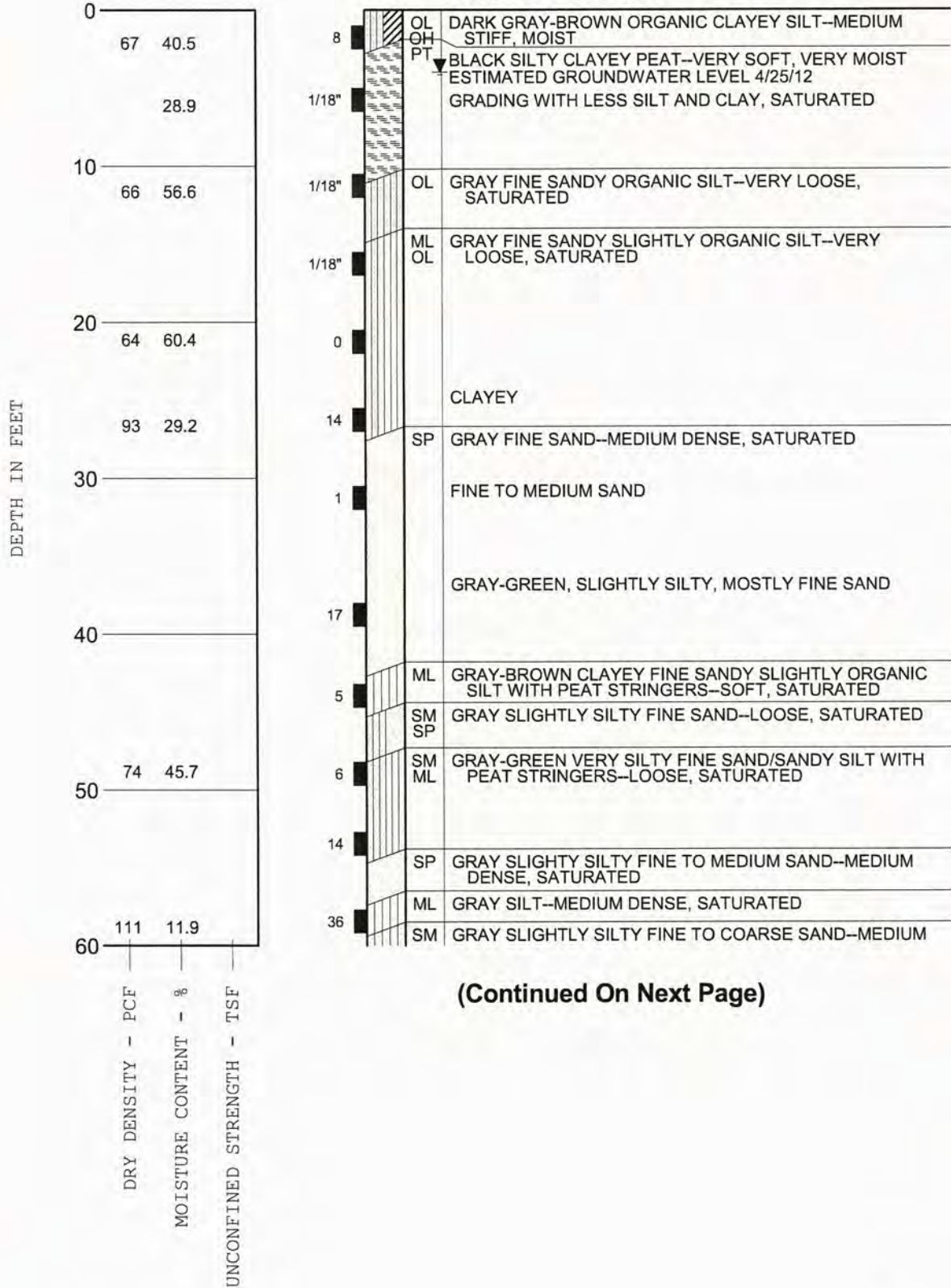
William C. Boli  
Geotechnical Engineer No. 2004

xc: (4) addressee

PROJECT NUMBER: 998-020  
 DRAWN BY: WCB  
 DATE: 5/24/12  
 PLATE NUMBER: 1A

# BORING 1

DRILLED: 4/27/12



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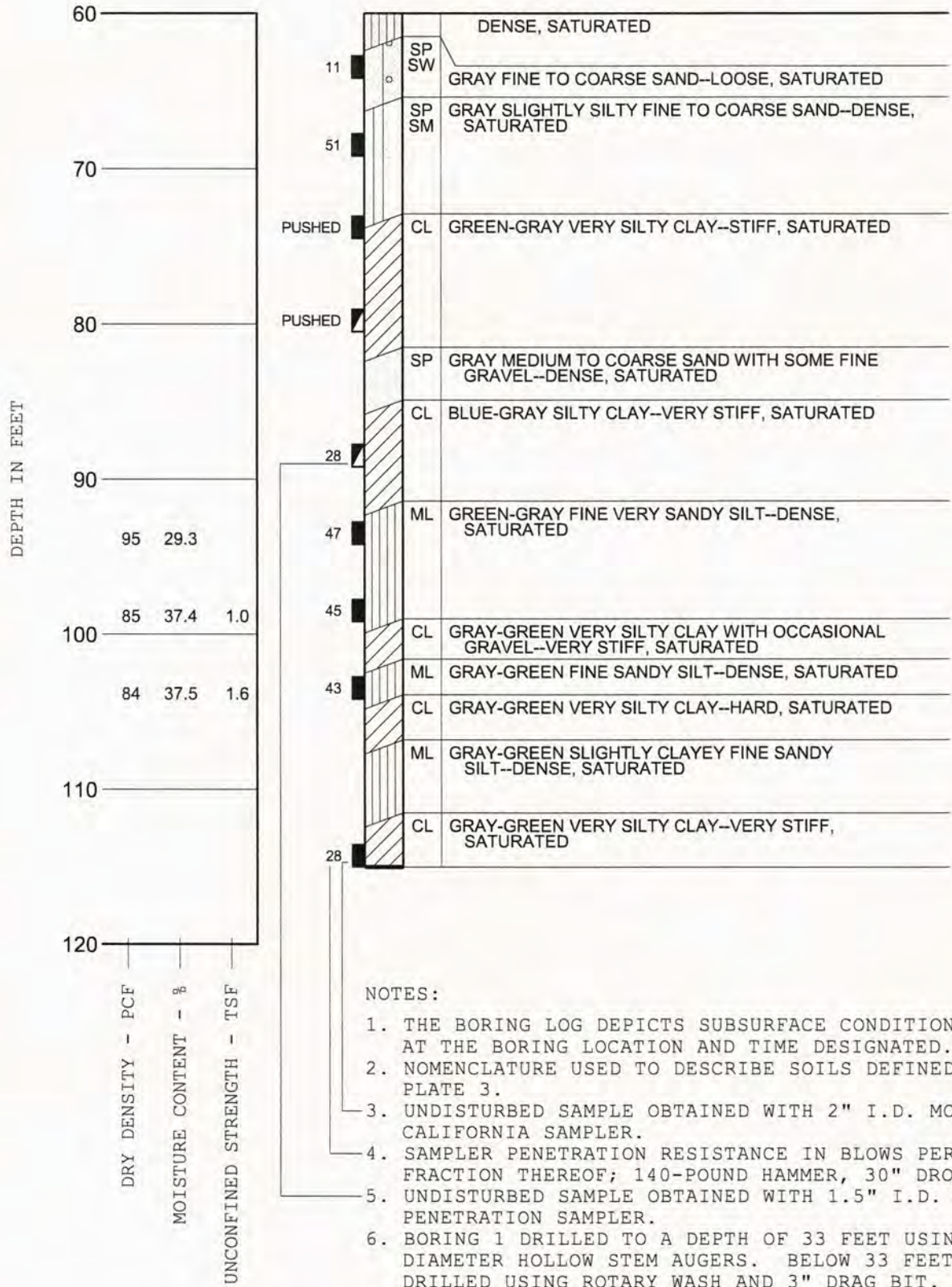
## LOG OF BORING





PROJECT NUMBER: 998-020  
 DRAWN BY: WCB  
 DATE: 5/24/12  
 PLATE NUMBER: 1B

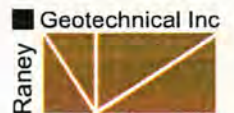
## BORING 1 (Continued)



**NOTES:**

1. THE BORING LOG DEPICTS SUBSURFACE CONDITIONS ONLY AT THE BORING LOCATION AND TIME DESIGNATED.
2. NOMENCLATURE USED TO DESCRIBE SOILS DEFINED ON PLATE 3.
3. UNDISTURBED SAMPLE OBTAINED WITH 2" I.D. MODIFIED CALIFORNIA SAMPLER.
4. SAMPLER PENETRATION RESISTANCE IN BLOWS PER FOOT OR FRACTION THEREOF; 140-POUND HAMMER, 30" DROP.
5. UNDISTURBED SAMPLE OBTAINED WITH 1.5" I.D. STANDARD PENETRATION SAMPLER.
6. BORING 1 DRILLED TO A DEPTH OF 33 FEET USING 6" DIAMETER HOLLOW STEM AUGERS. BELOW 33 FEET BORING DRILLED USING ROTARY WASH AND 3" DRAG BIT.
7. BORING 1 GPS LOCATION: N 38.12877°, W 121.57417°; ESTIMATED 15' ACCURACY.

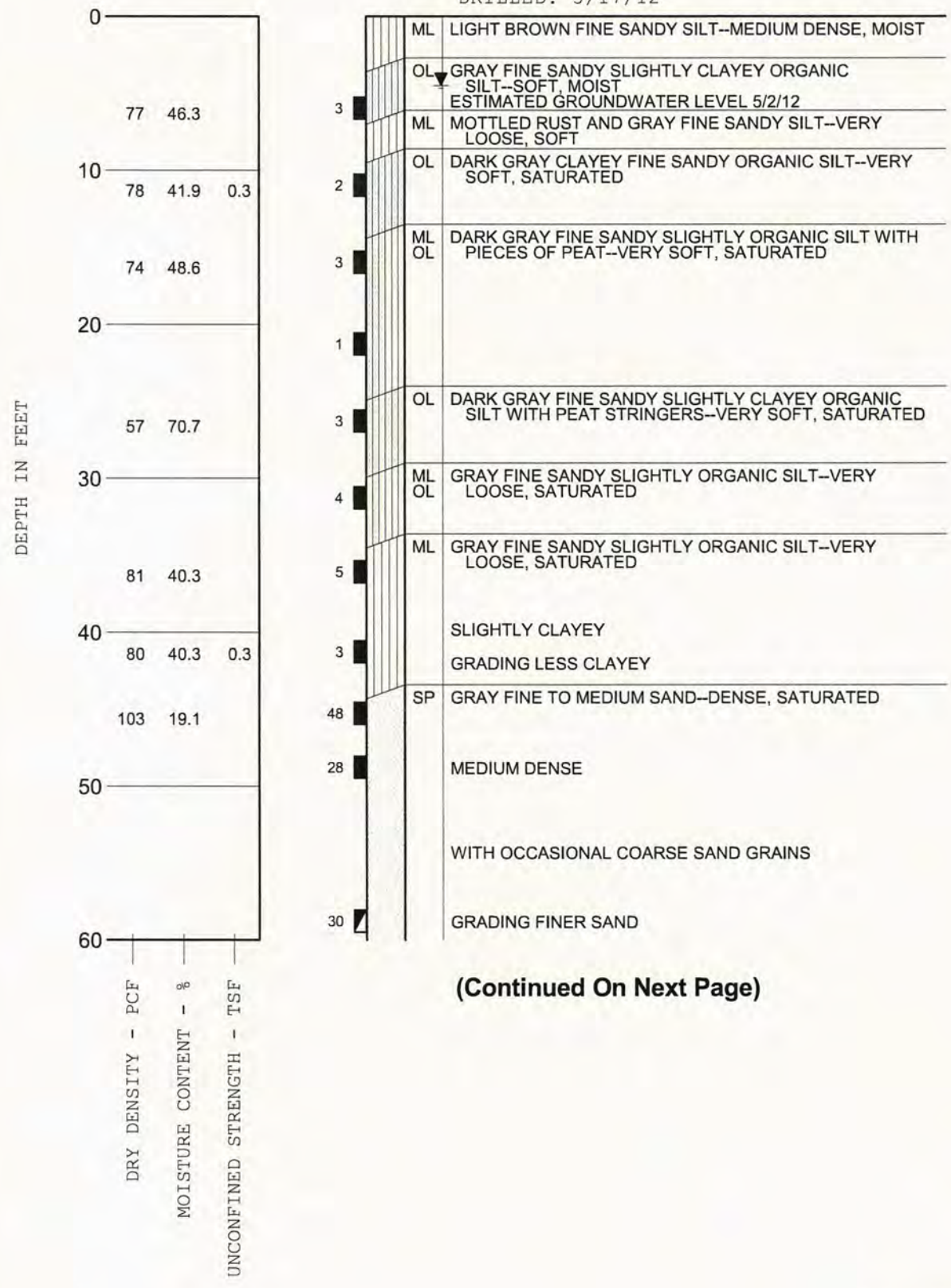
### LOG OF BORING



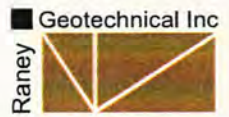
PROJECT NUMBER: 998-020  
 DRAWN BY: WCB  
 DATE: 5/24/12  
 PLATE NUMBER: 2A

# BORING 2

DRILLED: 5/17/12



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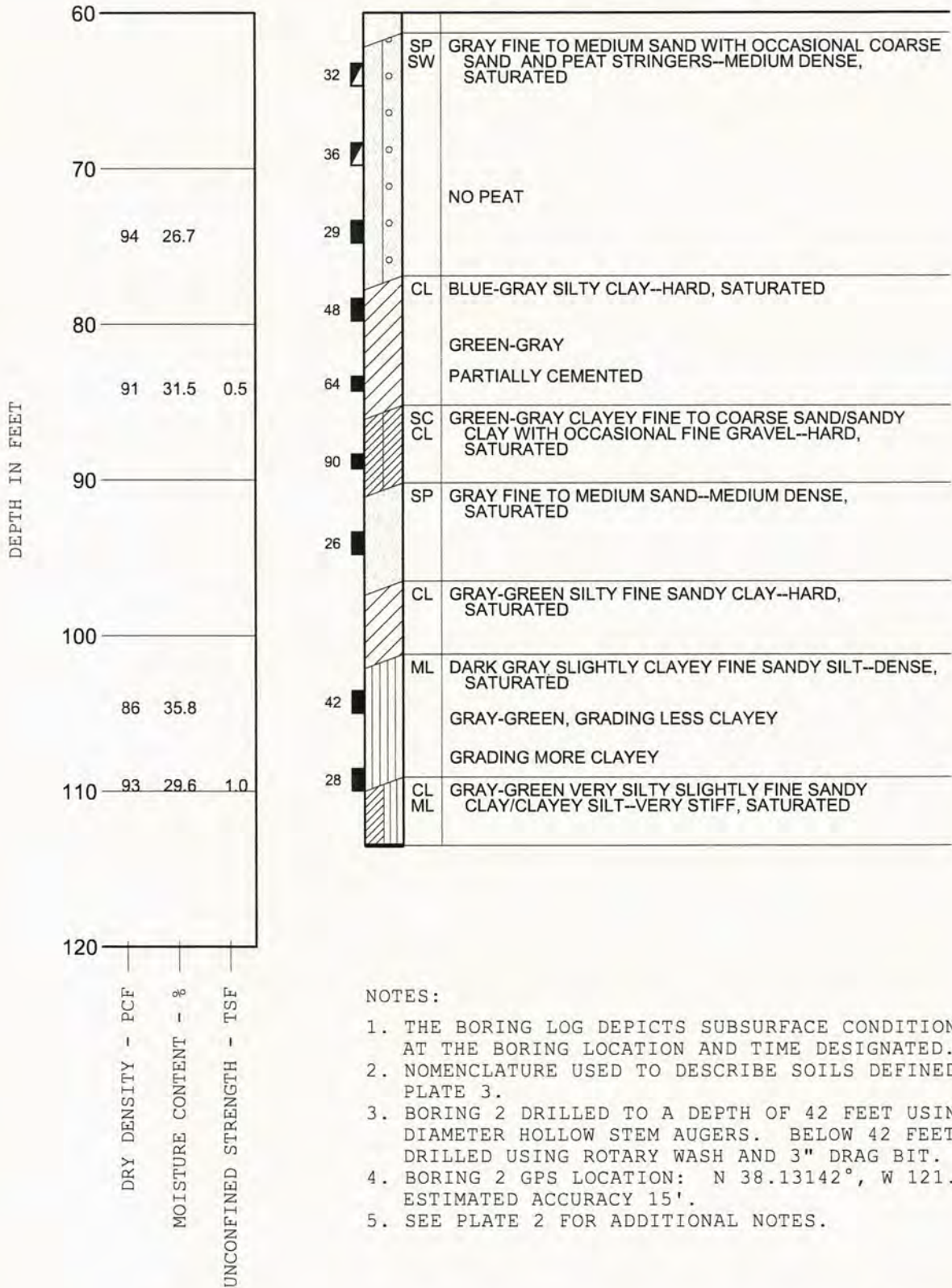


## LOG OF BORING



PROJECT NUMBER: 998-020  
 DRAWN BY: WCB  
 DATE: 5/24/12  
 PLATE NUMBER: 2B

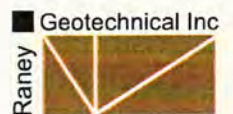
## BORING 2 (Continued)



**NOTES:**

1. THE BORING LOG DEPICTS SUBSURFACE CONDITIONS ONLY AT THE BORING LOCATION AND TIME DESIGNATED.
2. NOMENCLATURE USED TO DESCRIBE SOILS DEFINED ON PLATE 3.
3. BORING 2 DRILLED TO A DEPTH OF 42 FEET USING 6" DIAMETER HOLLOW STEM AUGERS. BELOW 42 FEET BORING DRILLED USING ROTARY WASH AND 3" DRAG BIT.
4. BORING 2 GPS LOCATION: N 38.13142°, W 121.57793°; ESTIMATED ACCURACY 15'.
5. SEE PLATE 2 FOR ADDITIONAL NOTES.

**LOG OF BORING**





GRAPH	SYMBOL	DESCRIPTION	MAJOR DIVISIONS	
	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES	CLEAN GRAVELS WITH LESS THAN 5% FINES	GRAVEL AND GRAVELLY SOILS
	GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES		
	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	GRAVELS WITH MORE THAN 12% FINES	MORE THAN 50% OF COARSE FRACTION <u>RETAINED</u> ON NO. 4 SIEVE
	GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		
	SW	WELL GRADED SANDS, GRAVELLY SANDS	CLEAN SANDS WITH LESS THAN 5% FINES	SANDS AND SANDY SOILS
	SP	POORLY GRADED SANDS, GRAVELLY SANDS		
	SM	SILTY SANDS, SAND-SILT MIXTURES	SANDS WITH MORE THAN 12% FINES	MORE THAN 50% OF COARSE FRACTION <u>PASSING</u> NO. 4 SIEVE
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES		
	ML	INORGANIC SILTS, ROCK FLOUR, OR CLAYEY SILTS WITH SLIGHT PLASTICITY	LIQUID LIMIT <u>LESS</u> THAN 50	SILTS AND CLAYS
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS		
	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY		
	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTS, ELASTIC SILTS	LIQUID LIMIT <u>GREATER</u> THAN 50	SILTS AND CLAYS
	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
OH	ORGANIC CLAYS AND ORGANIC SILTS OF MEDIUM TO HIGH PLASTICITY			
	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT	HIGHLY ORGANIC SOILS	

COARSE GRAINED SOILS  
 MORE THAN 50% LARGER THAN NO. 200 SIEVE

FINE GRAINED SOILS  
 MORE THAN 50% SMALLER THAN NO. 200 SIEVE

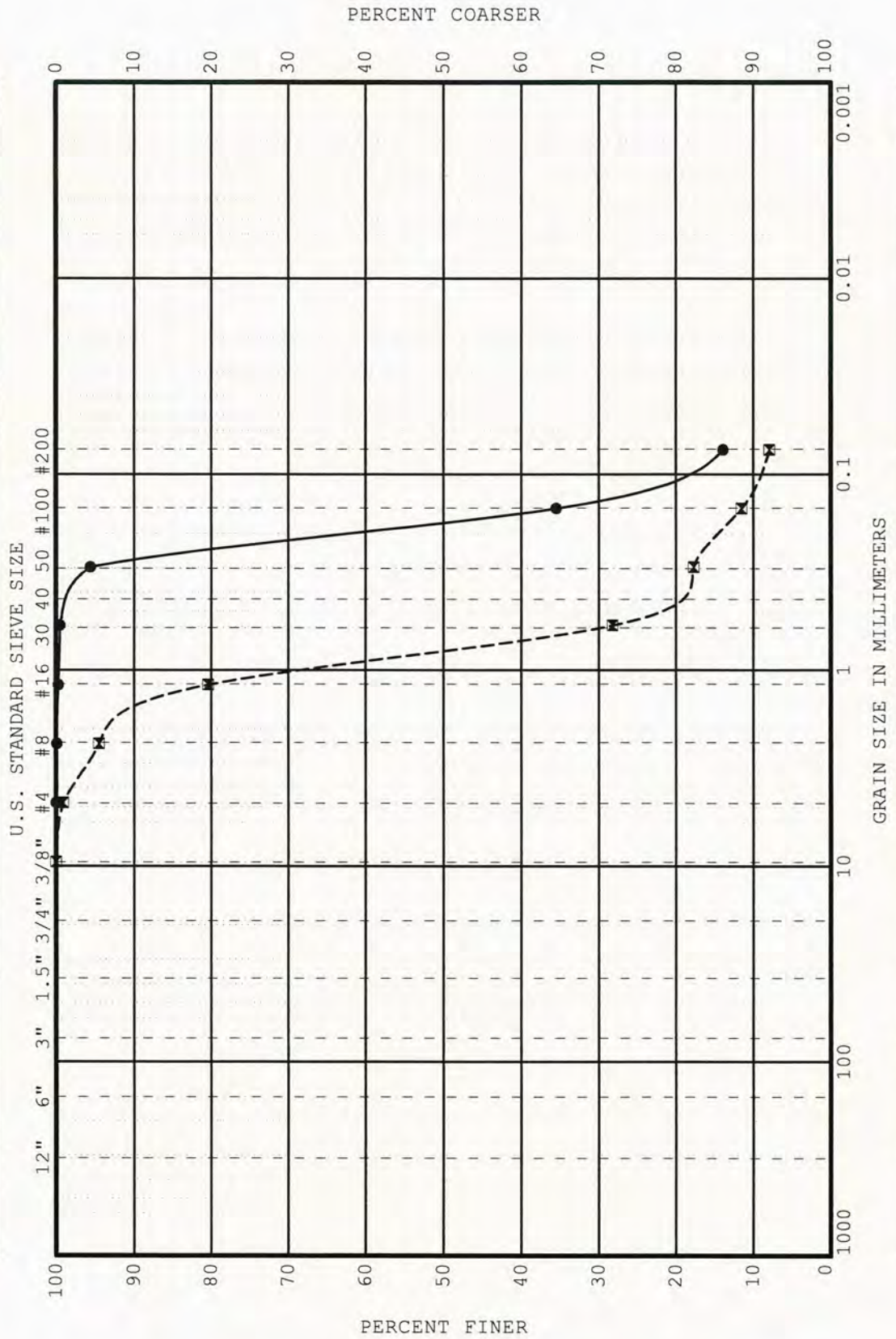
UNIFIED SOIL CLASSIFICATION SYSTEM





PROJECT NUMBER: 998-020  
 PLATE NUMBER: 4

SYMBOL	LOCATION	DEPTH	UNIFIED CLASSIFICATION	DESCRIPTION
●	BORING 1	59.0'	SM	GRAY SLIGHTLY SILTY FINE TO COARSE SAND
⊠	BORING 1	69.0'	SP-SM	GRAY SLIGHTLY SILTY FINE TO COARSE SAND



GRAIN SIZE DISTRIBUTION

