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Woodward-Clyde Consultants

December 16, 1980

Project: 14676A

University of California
Department of Facilities Management
2000 Carleton Street
Berkeley, California 94720

Attention: Ms. Norma Willer
Senior Architect

Gentlemen:

SUPPLEMENTAL GEOTECHNICAL EXPLORATION
NORTHERN REGIONAL LIBRARY
COMPACT SHELVING FACILITY
University of California
Richmond Field Station

In accordance with your request, we have performed a supplemental geotechnical exploration for the subject project. This report supplements the findings and recommendations presented in our report dated April 23, 1980, specifically in regards to magnitudes of settlement estimated for the proposed structure under the design loads.

After we issued the April 23 report, the firm of Rutherford & Chekene, the Structural Engineers for this project, expressed some concern that the settlements which we had estimated for the shelving area in the library facility were too high to be tolerated by the structure without changing the structural design, and thus adding costs to the facilities.

Detailed discussion on the settlement estimates made was presented in our letter of July 15, 1980. As was described in this letter, a significant portion of the range of settlement magnitude estimated was due to potential settlement of the soils below a depth of 60 feet, from which no direct data were available (61 feet was the maximum depth penetrated by the original borings). In addition, the proposed library facility was relocated slightly to the east of its original position at the site. From these factors, it was apparent that there was not enough data basis to more closely refine the estimated settlement range. Therefore, to provide the additional subsurface information needed to refine our settlement estimates, supplemental borings were drilled within the

relocated building area. Soil conditions below the bottom elevations of the previously drilled borings were of particular interest for these analyses. This letter describes the subsurface conditions encountered in the supplemental borings and presents our revised settlement estimates based on this information and the information obtained during our previous explorations.

PROJECT DESCRIPTION

It is our understanding that the description of the proposed regional compact shelving facility given in our April 23, 1980 report is generally still valid. The facility will consist of a heavily loaded shelving area and an adjoining single-story wing that has more conventional floor loads. However, the building has been re-oriented on the site and moved slightly east to the location shown on the attached Site and Boring Location Plan, Figure 1s. In addition, the actual average floor load in the shelving area is expected to be approximately 80 percent of the original design load of 1150 psf used in our previous study.

FIELD EXPLORATION

For this supplemental exploration, four borings were drilled in the proposed shelving area to depths ranging from 81 feet to 101-1/2 feet below the existing ground surface. The approximate locations of these new borings, designated A through D, and the borings drilled during our previous explorations are shown on Figure 1s. Samples of soil encountered in the supplemental borings were recovered and taken to our laboratory for visual examination and testing.

Logs of the supplemental exploratory borings were prepared based on soil classifications made in the field and on laboratory test results. These Logs of Borings are presented as Figures 2s through 5s of this report. Results of the laboratory tests performed for this study are shown at the corresponding sample locations on the Logs of Borings and on Figures 6s and 7s. A more detailed discussion of the supplemental field exploration and laboratory testing programs is presented in the appendix to this report.

SITE AND SOIL CONDITIONS

The present building site is similar to the previous site except that the weeds and grass have been cleared in the building area. The site appears to be essentially level, although ground surface elevations are not available at this time.

Soil conditions encountered in the supplementary borings are generally similar to the conditions encountered in the previously drilled borings, except for the condition of the surface soil. The explorations made in 1979 and early 1980 were each drilled towards the end of the rainy season in the month of March, and the top few feet of silty clay soil was found to be soft and wet. The supplemental borings were drilled at the end of the dry season so that the surface soils were generally dry to damp and, as a result, stiffer.

The underlying soils encountered in the supplemental borings consist of stiff to very stiff silty and sandy clays with some sand and gravel layers. These soils extended down to bedrock, which was encountered at depths ranging from 74 feet to 84 feet in the supplemental borings. The bedrock was generally dark gray-brown weathered shale, although brown sandstone was encountered in Boring D.

In Boring A, the depth to groundwater was measured to be 11 feet below the ground surface two days after this boring was completed. More detailed descriptions of the subsurface conditions are given on the attached Logs of Borings, Figures 2s through 5s.

DISCUSSION AND CONCLUSIONS

The soils underlying the relocated building site are generally similar to the soils encountered in our earlier explorations, although the sandy soils are somewhat more prevalent at the new site. With the exception of the upper few feet of surface soil, the site soils have good strengths and densities. Therefore, it is our opinion that the recommendations for building foundations and floor slabs presented in the April 23 report are still valid. However, with the information gained from the supplemental borings, it has been possible to refine our settlement estimates.

The supplemental test borings indicate that the silty and sandy clays encountered below a depth of 60 feet appear to have densities and compressibilities comparable to the overlying clay soils. A more compressible, low density clay deposit, such as the deposit encountered below a depth of 60 feet at the nearby Seismic Structural Research Laboratory, was not encountered in the borings made for this study. Also, bedrock was encountered in all four test borings at depths of 74 to 84 feet. The 14 to 24 feet of soil between a depth of 60 feet and the top of rock is expected to experience only a nominal amount of consolidation due to the

shelving area loads and should only make a minor contribution to the overall building settlement. In addition, a few sand and gravel layers, which are assumed to be incompressible in our settlement calculations, were encountered above a depth of 60 feet in all of the borings drilled within the presently proposed building area. Some of these layers appear to pinch out to the west and were not encountered in Borings 1 or 4, drilled at the previous building sites. The presence of this sand and gravel is helpful in reducing the amount of settlement resulting from consolidation in the upper 60 feet of soils.

Based on the prior and supplemental data, settlement analyses were made to estimate the total and differential settlements across the relocated building area. Assuming that the average floor load imposed in the shelving area is the original design load of 1150 psf, it is estimated that the maximum ultimate settlement in this area will not exceed 1-1/2 to 2 inches. The maximum settlement is anticipated to occur beneath the central portion of the shelving area. Differential settlements between the shelving area columns should not exceed 1/2 inch. Differential settlements across the first bay of the one-story wing adjacent to the shelving area should be less than 1/2 inch, while the remainder of the one-story wing should experience even smaller differential settlements.

It is our understanding that the actual loading in the shelving area will be approximately 80 percent of the original design load. For a reduction in the design load on the order of 20 percent, the settlements presented herein might be correspondingly reduced, according to theoretical equations. Therefore, an estimated maximum differential settlement of 0.5 inch between the shelving columns would theoretically be reduced to 0.4 inch if the current design floor loads are 80 percent of the original design floor loads.

It is our understanding that some consideration is being given to moving the planned building further west from its present location. It is pointed out that some of the relatively incompressible sand and gravel layers appear to pinch out in this direction, and it would, therefore, be prudent to not move the building in that direction in order to avoid the possible increase in the settlement experienced by the structure.

BASIS FOR CONCLUSIONS

The conclusions presented in this report should be used in conjunction with the recommendations made in our April 23 report

and are based on the assumption that soil and bedrock conditions do not deviate appreciably from those disclosed in the supplemental and original borings. If any unanticipated variations or undesirable conditions are encountered during construction, or if the proposed structure is modified or relocated from the position shown on Figure 1s, the Geotechnical Engineer should be notified so that the recommendations and conclusions presented in our April 23 report and herein can be revised where necessary.

If you have any questions regarding the conclusions presented herein, or if we can be of further service to you on this project, please call us.

Sincerely yours,

Carol Ries

Carol Ries
Assistant Project Engineer

George E. Hervert

George E. Hervert
Vice President

sb

Attachments - Appendix
Figures 1s through 7s

cc: Mr. John Haag
Esherick Homsey Dodge & Davis, Architects

Mr. William Holmes
Rutherford & Chekene, Structural Engineers

APPENDIX

FIELD EXPLORATION AND LABORATORY TESTS

FIELD EXPLORATION

Four exploratory borings designated, A through D, were drilled from November 10 through November 13, 1980, at the locations shown on the Site and Boring Location Plan, Figure 1s. The borings were drilled by Pitcher Drilling Company using a rotary drill rig. Mr. Merrill S. Conant of our firm observed the drilling and sampling operations.

Samples of the soil and rock encountered in the borings were obtained using a modified California Drive Sampler (2-inch I.D. and 2-1/2-inch O.D.) with thin brass liners, a Split Spoon Sampler (1-3/8-inch I.D. and 2-inch O.D.), or a double-barrel Pitcher Coring Sampler (3$\pm$-inch I.D.) The Split Spoon and California drive samplers were driven 18 inches into the soil at the bottom of the hole with a 140-pound hammer falling 30 inches. With the Pitcher coring sampler, a core bit drilled ahead of a stationary inner tube which received the sample.

When a sample was obtained, the sampler was withdrawn from the test hole. For the modified California and Pitcher samplers, the tubes containing the soil samples were removed and sealed to preserve the natural moisture content of the soil. For the Split Spoon sampler, the soil samples were removed from the barrel and placed in glass jars. The samples were then taken to the laboratory for examination and testing.

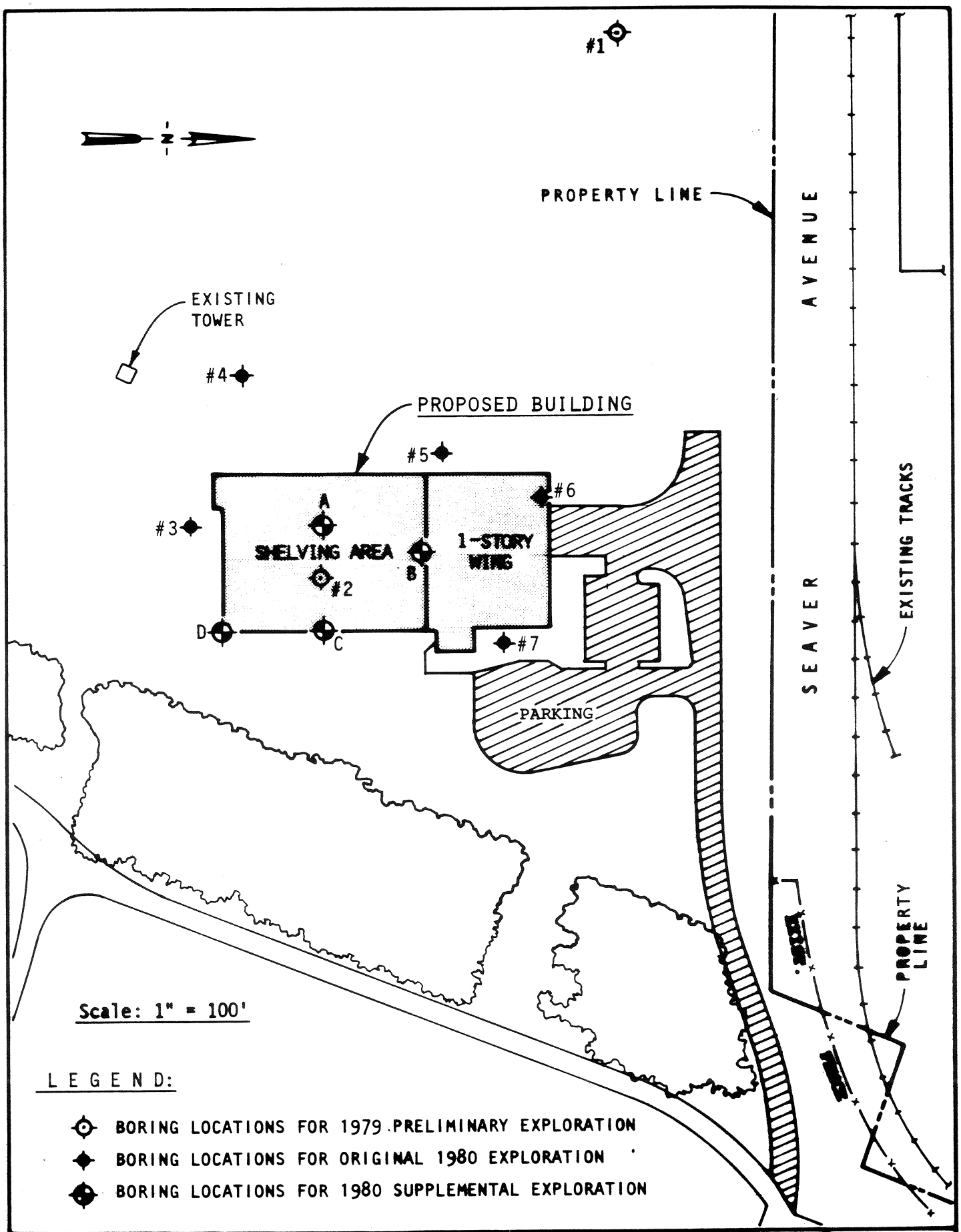
Visual soil classifications were made in the field and verified by inspection of the samples in the laboratory. Boring logs were prepared from the field data and are presented on Figures 2s through 5s.

Borings were located in the field with the aid of Site Study SK-12, prepared by Esherick Homsey Dodge and Davis on September 10, 1980.

LABORATORY TESTING

The water content, dry density, and unconfined compressive strength were determined for selected samples to evaluate the strength and denseness of the soil and rock underlying the building site. The results of these tests, along with the resistance to penetration of the sampler, are shown at the corresponding sample locations on the Logs of Borings, Figures 2s through 5s.

In addition, two consolidation tests were performed on samples of silty and sandy clay encountered in the borings. The results of these tests were used in our evaluation of the compressibility of the clays for estimating potential settlements and are shown in graphical form on Figures 6s and 7s.



Project No. 14676A Woodward-Clyde Consultants	SITE AND BORING LOCATION PLAN NORTHERN REGIONAL LIBRARY COMPACT SHELVING FACILITY Univ. of Calif. - Richmond Field Station	Figure 1s

Project: NORTHERN REGIONAL LIBRARY COMPACT SHELVING FACILITY U.C.-Richmond Field Station	**Log of Boring No. A**

Date Drilled: November 10, 1980 **Remarks:** See SAMPLER KEY on Figure 2s(c)

Type of Boring: 4-7/8" Rotary

Hammer Weight: 140 lbs.

Surface Elevation:

Depth, Ft.	Samples	Blows/Ft.	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content, %	Dry Density, pcf	Unconfined Compressive Strength, psf
5			S I L T Y C L A Y (CL-CH) Stiff to very stiff, dry, gray Becoming damp			
10	1	23	SILTY SAND & GRAVEL (SM-GP) Medium dense, brown, to 2± in. max. size Grading with more gravel Water Level 48 Hours After Drilling	No Recovery		
15			S I L T Y C L A Y (CL) Stiff, light brown, with fine sand			
20	2	-	CONSOL. TEST, See Figure 6s	22	106	3090
25						
30	3	-		-	-	-
			S I L T Y C L A Y (CL-ML) Medium stiff to stiff, light brown, with fine sand			
35			S A N D & G R A V E L (SP-GP) Dense, brown, silty			
			S I L T Y C L A Y (CL)			

Proj. No. 14676A | **Woodward-Clyde Consultants** | Figure 2s(a)

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U.C.-Richmond Field Station

Log of Boring No. A (Continued)

Depth, Ft.	Samples	Blows/Ft.	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, pcf	Unconfined Compressive Strength, psf
40	4	-	S I L T Y C L A Y (CL).....Cont'd Very stiff, olive-gray, with fine sand and sand lenses	No Recovery		
45	5	-		17	115	-
50	6	-		21	105	630
			S I L T Y C L A Y (CL) Very stiff, blocky, olive-gray, with brown staining and calcareous inclusions			
55						
60	7	-				
			C L A Y E Y S A N D (SC) Dense, olive-gray-brown, slightly clayey, with trace of gravel and interlayered with clean sand	18	106	-
65	8	32	S I L T Y C L A Y (CL-CH) Very stiff, moist, olive-gray with brown silt	23	101	6690
70			Becoming sandy			
	9	-	C L A Y E Y S A N D (SC-CL) Dense, brown, with gravel and thin lenses of clay and clean sand	-	-	-
75	10	34		21	108	1610
80			Grading to Silty Clay (CL) interlayered with Sandy Clay			
	11	1		25	98	2080

Proj. No. 14676A

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Figure 2s(b)

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Log of Boring No. A (Continued)

Depth, Ft.	Samples	Blows/Ft.	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, pcf	Unconfined Compressive Strength, psf
85	12	-	Gravel lense S H A L E Very highly weathered to very stiff Silty Clay (CH), brown	9	126	660
90	13	-	S H A L E Soft to moderately hard, fissile, moderately weathered, dark gray-brown	-	-	-
95	14	-		-	-	-
100	15	-		-	-	-
105			BOTTOM OF BORING @ 101½'			
110			SAMPLER KEY FOR ALL BORINGS: 3" I.D. DOUBLE-BARREL PITCHER CORING SAMPLER			
115			2" I.D. MODIFIED CALIFORNIA SAMPLER			
120			2" O.D. STANDARD SPLIT-SPOON SAMPLER			
125						

Project: NORTHERN REGIONAL LIBRARY COMPACT SHELVING FACILITY U.C.-Richmond Field Station	**Log of Boring No. B**
Date Drilled: November 13, 1980	**Remarks:** See SAMPLER KEY on Figure 2s(c)
Type of Boring: 4-7/8" Rotary	
Hammer Weight: 140 lbs.	

Depth, Ft.	Samples	Blows/Ft.	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content, %	Dry Density, pcf	Unconfined Compressive Strength, psf
			Surface Elevation:			
			S I L T Y C L A Y (CL-CH) Medium stiff, dry to damp, gray			
			Becoming moist			
5						
			CLAYEY SAND & GRAVEL (SC-GC) Medium dense to dense, brown, slightly clayey			
10	1	-		-	-	-
			SANDY CLAY (CL): Medium stiff, moist, brown			
15			CLAYEY SAND & GRAVEL (GP-GC): Dense, dark brown			
			S A N D Y C L A Y (CL) Stiff to very stiff, brown, silty			
20	2	-		-	-	-
			Grading with Gravel and more Sand (SC)			
25			Grading with less Sand and without Gravel (CL-ML)			
30	3	-		No Recovery		
			Gravel lense			
	3A	-	Gravel lense	-	-	-
35			S I L T Y C L A Y (CL-ML) Stiff, brown, with sandy lenses			
			S I L T Y C L A Y (CL): Very stiff, olive-gray, sandy, with calcareous inclusions			

Proj. No. 14676A	**Woodward-Clyde Consultants**	Figure 3s(a)

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COMPACT SHELVING FACILITY
U.C.-Richmond Field Station

Log of Boring No. B (Continued)

Depth, Ft.	Samples	Blows/Ft.	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, pcf	Unconfined Compressive Strength, psf
40	4	-	S I L T Y C L A Y (CL) Cont'd.....	18	112	4160
			Becoming less sandy and more plastic (CL-CH)			
45						
50	5	-	CONSOL. TEST, See Figure 7s	22	107	5410
55						
60	6	-	CLAYEY SAND WITH GRAVEL (SC-SP) Dense, olive-gray-brown	17	113	-
65						
			S I L T Y C L A Y (CL-ML) Stiff to very stiff, moist, olive-gray-brown			
70	7	-	CLAYEY SAND WITH GRAVEL (SC-GP) Dense, moist, brown	13	118	-
75			S A N D Y C L A Y (CL-SC) Stiff to very stiff, moist, olive-gray			
80	8	-	S H A L E Soft, moderately weathered, dark gray-brown	-	-	-
			BOTTOM OF BORING @ 81'			

Proj. No. 14676A | Woodward-Clyde Consultants | Figure 3s(b)

Project:	NORTHERN REGIONAL LIBRARY COMPACT SHELVING FACILITY U.C.-Richmond Field Station	**Log of Boring No. C**

Date Drilled: November 12, 1980
Type of Boring: 4-7/8" Rotary
Hammer Weight: 140 lbs.
Remarks: See SAMPLER KEY on Figure 2s(c)

Depth, Ft.	Samples	Blows/Ft.	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content, %	Dry Density, pcf	Unconfined Compressive Strength, psf
			Surface Elevation:			
			S I L T Y C L A Y (CL-CH) Stiff, dry to damp, brown-gray			
			Becoming moist			
5			S I L T Y S A N D (SM-ML) Medium dense, brown, with gravel			
10			Grading with more Gravel (GM)			
15			S A N D Y C L A Y (CL) Stiff, moist, brown			
			SILTY SAND & GRAVEL (SM-GP) Medium dense, dark brown			
20			S I L T Y C L A Y (CL) Stiff to very stiff, moist to wet, brown, with trace of gravel			
25			S I L T Y C L A Y (CH-CL) Very stiff, moist to wet, brown-gray			
			S I L T Y C L A Y (CL-ML) Stiff to very stiff, moist to wet, brown			
30						
35			S A N D Y G R A V E L (GP) Dense, dark brown			
			S I L T Y C L A Y (CL-ML) Stiff to very stiff, moist, gray-brown			

Project: NORTHERN REGIONAL LIBRARY
COMPACT SHELVING FACILITY
U.C.-Richmond Field Station

Log of Boring No. C (Continued)

Depth, Ft.	Samples	Blows/Ft.	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, pcf	Unconfined Compressive Strength, psf
40			S I L T Y C L A Y (CL-CH) Cont'd..... Very stiff to hard, moist, olive-gray, with calcareous inclusions			
45	1	-		22	107	9000
50	2	81	C L A Y E Y S A N D (SC-SM) Very dense, olive-brown	-	-	-
55	3	-	S I L T Y C L A Y (CL) Very stiff, moist, olive-gray, with gravel and sandy clay lenses	21	105	1880
60	4	-	Grading with more Sand and less Gravel (CL-ML)			
			C L A Y E Y S A N D (SC-SM) Dense, brown			
65	5	-	S A N D Y C L A Y (CL-SC) Stiff, olive-brown, with cemented silty sand lenses			
			S I L T Y C L A Y (CL-CH) Very stiff, olive-gray	22	105	6110
70	6	-	S A N D (SW-SM) Very dense, brown, silty	-	-	-
75	7	-	S H A L E Soft, highly weathered, dark gray to brown, with zones weathered to brown clay	10	129	1040
80	8	-	BOTTOM OF BORING @ 82½'	-	-	-

Proj. No. 14676A | Woodward-Clyde Consultants | Figure 4s(b)

Project:	NORTHERN REGIONAL LIBRARY COMPACT SHELVING FACILITY U.C.-Richmond Field Station	**Log of Boring No. D**

Date Drilled: November 11, 1980 **Remarks:** See SAMPLER KEY on Figure 2s(c)

Type of Boring: 4-7/8" Rotary

Hammer Weight: 140 lbs.

Depth, Ft.	Samples	Blows/Ft.	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content, %	Dry Density, pcf	Unconfined Compressive Strength, psf
			Surface Elevation:			
			SILTY CLAY (CL-CH) Stiff to very stiff, dry to damp, gray			
5			Becoming damp			
			S A N D (SP-SM) Medium dense, dark brown, silty, with gravel			
10	1	21		-	-	-
			S A N D Y C L A Y (CL-SC) Very stiff, moist, light brown, with thin sand lenses			
15						
20	2	-		13	122	1500
25						
			S I L T Y C L A Y (CL-ML) Stiff to very stiff, light brown, with calcareous inclusions			
30	3	-		27	96	3590
			SAND & GRAVEL (SP-GP) Dense, brown, silty			
35			S I L T Y C L A Y (CL) Very stiff, moist, olive-gray, with thin sand lenses			

Proj. No. 14676A | **Woodward-Clyde Consultants** | Figure 5s(a)

Project: NORTHERN REGIONAL LIBRARY
COMPACT SHELVING FACILITY
U.C.-Richmond Field Station

Log of Boring No. D (Continued)

Depth, Ft.	Samples	Blows/Ft.	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, pcf	Unconfined Compressive Strength, psf
40	4	-	S I L T Y C L A Y (CL) Cont'd.....	17	112	3900
45						
50	5	-	SAND & GRAVEL (SP-GP) Dense, brown, silty	-	-	-
55						
60	6	-	S A N D Y C L A Y (CL-SC) Very stiff, brown, interlayered with Silty Clay (CL-ML) and Silty Sand (SM), with gravel and calcareous inclusions	20	108	1570
65			Becoming olive-gray-brown			
70	7	-		13	117	1950
80	8	85/6"	C L A Y E Y S A N D S T O N E Soft, highly weathered, brown	-	-	-
	9	* -	* Sample 9 is cuttings from drilling between a depth of 80' and 83'			
			Becoming hard and slightly weathered			
85	10	-		-	-	-
			BOTTOM OF BORING @ 85½'			

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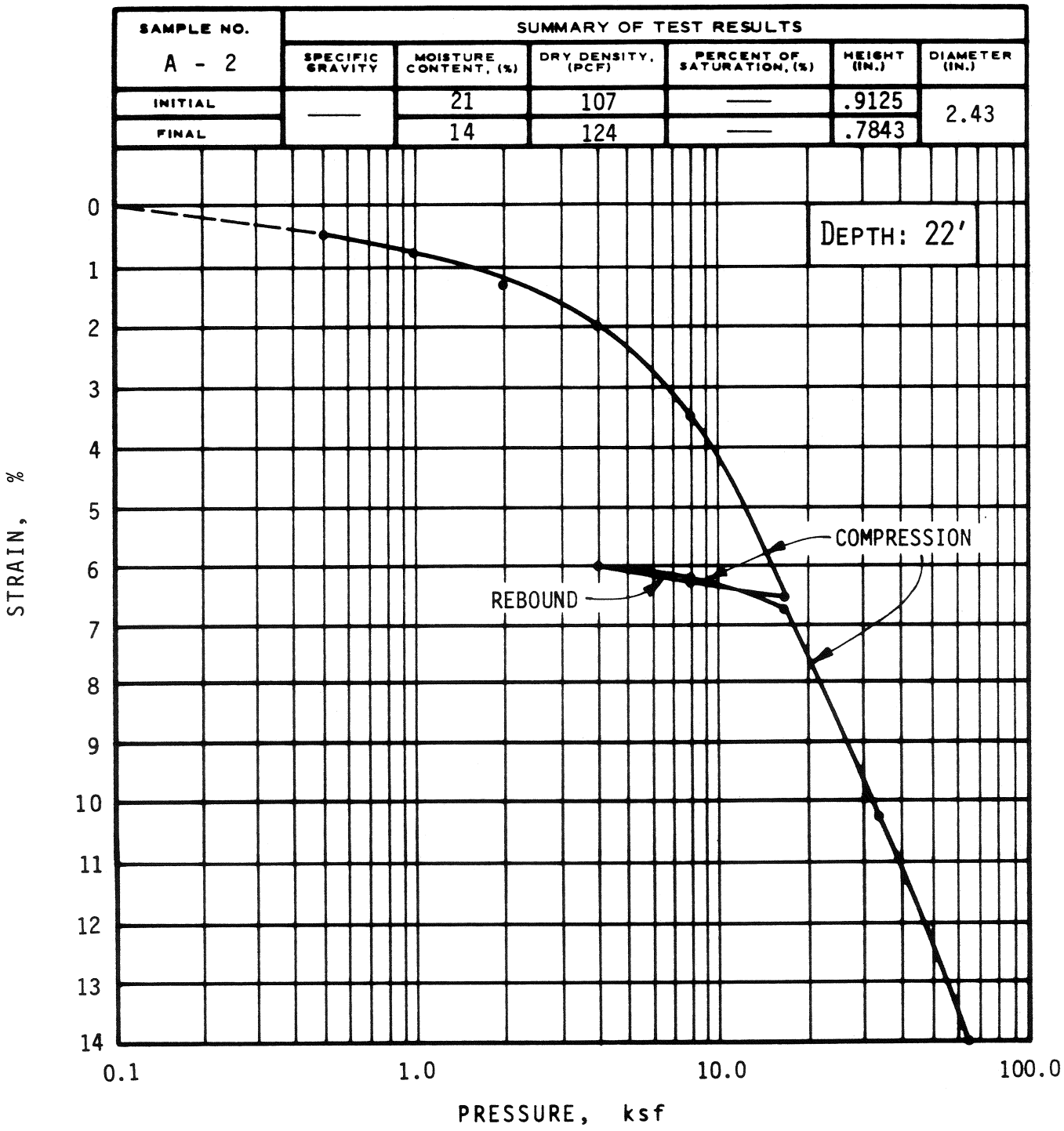
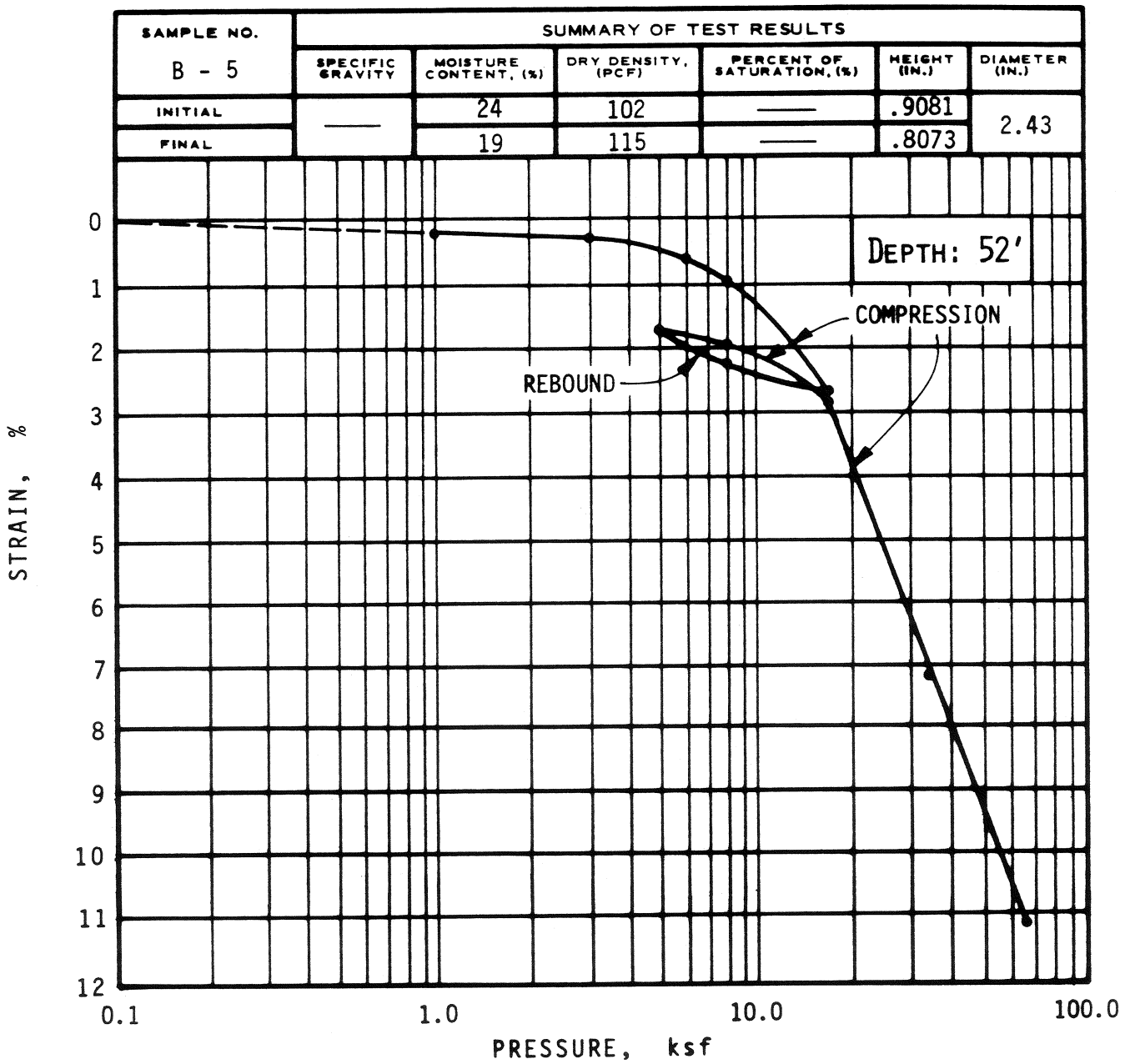


Project No. 14676A Woodward-Clyde Consultants	CONSOLIDATION TEST RESULTS U.C.-NORTHERN REGIONAL LIBRARY	Figure 6s



Project No. 14676A Woodward-Clyde Consultants	CONSOLIDATION TEST RESULTS U.C.-NORTHERN REGIONAL LIBRARY	Figure 7s