Geotechnical Report

For

Star Bend Setback Levee

Levee District No. 1
Sutter County, California

Prepared by:

BLACKBURN CONSULTING, INC.

October 20, 2006

For:

Wood Rodgers, Inc.
&
Levee District No.1
Sutter County

West Sacramento Office:
2437 Front Street ▪ Sacramento, CA 95691
(916) 375-8706 ▪ Fax (916) 375-8709

blackburn consulting

Main Office: (530) 887-1494
11521 Blocker Drive, Suite 110 ▪ Auburn, CA 95603
Modesto Office: (209) 522-6273

Geotechnical ▪ Construction Services ▪ Forensics

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Mr. Jeff Twitchell
Wood Rodgers, Inc.
3301 C Street, Building 100-B
Sacramento, California 95816
Ph. (916) 341-7760
Fax (916) 341-7767

Subject: **Geotechnical Report**
Star Bend Setback Levee
Levee District No. 1
Sutter County, California

Dear Mr. Twitchell,

Blackburn Consulting, Inc. (BCI) is pleased to submit this Geotechnical Report for the Star Bend Setback Levee project along the west bank of the Feather River in Sutter County, California. BCI prepared this report in accordance with our February 1, 2006 Professional Services Contract.

Thank you for selecting BCI to be on your design team. Please call if you have questions or require additional information.

Sincerely;

BLACKBURN CONSULTING, INC.

REGISTERED PROFESSIONAL ENGINEER ROBERT B. LOKTEFF No. 2589 Exp. 12/31/07 GEOTECHNICAL STATE OF CALIFORNIA

Robert B. Lokteff, P.E., G.E.
Principal Geotechnical Engineer

Reviewed by:

PROFESSIONAL GEOLOGIST WILLIAM E. NICHOLS NO. 2229 CERTIFIED ENGINEERING GEOLOGIST EXP 1-31-08 STATE OF CALIFORNIA

W. Eric Nichols, C.E.G.
Senior Project Manager

Copies: 3 Addressee

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1 INTRODUCTION

1.1 Purpose

BCI prepared this Geotechnical Report for design and construction of the Star Bend Setback Levee along the west side of the Feather River in Sutter County, California. This report contains a description of the subsurface conditions, geotechnical analysis, and design/construction recommendations for the new setback levee.

This report is intended for Wood Rodgers, Inc. (WRI) and Levee District No. 1 (LD1) of Sutter County to use during design and construction. This report shall not be used or relied upon by others, or for different locations or improvements without the written consent of BCI.

1.2 Scope of Services

To prepare this report, BCI:

1. Consulted with WRI's Jeff Twitchell and Jonathan Kors to determine the project scope and design alternatives.

2. Consulted with LD1's Bill Hampton to obtain information regarding historical performance of the existing levee at Star Bend.

3. Consulted with Henri Mulder with the U.S. Army Corps of Engineers (USACE), Sacramento District regarding design and construction requirements.

4. Reviewed the following documents:

- USACE engineering manuals (EMs) and Sections 120 and 123 of the California Code of Regulations (CCR 120 and 123) pertaining to levee design/construction.

- Site Plan and Topo Map of the Star Bend area provided by WRI.

- Log of Explorations for Borings 2F97-1, 2F-97-4, 2F-97-11, 2F-97-17, 2F-97-18 and 2F-97-19 prepared by the USACE for the PL84-99 Phase III, Relief Wells – LD1, Feather River at Star Bend project in 1997. These borings were located just north of the Star Bend Levee Setback project area.

- Sheets C-15 and C16 "Site 10, Plan and Profile, Sta. 4+00 to Sta. 13+00" and Sheet C-32 "Miscellaneous Details" prepared by the USACE for the Sacramento River Flood Control Phase II Levee Reconstruction and dated March 13, 1998. These plans show drainage improvements at the landside toe and crest raising at Star Bend within the current project area.

5. Performed a subsurface investigation at the site consisting of six exploratory borings along the proposed setback levee alignment and existing levee, three cone penetrometer tests (CPTs) along the proposed levee alignment, and twelve test pits in a potential borrow site on the riverside of the existing levee near the south end of the project area.

6. Performed laboratory tests on soil samples obtained from the exploratory borings and test pits.

7. Performed seepage, settlement and slope stability analysis.

1.3 Project Description

LD1 of Sutter County plans to construct about 3,400 lineal feet of setback levee on the west side of the Feather River at Star Bend about 8 miles south of Yuba City, California. The new levee will be located at least 1,500 feet east of the main river channel. A Vicinity Map is presented as Figure 1. An aerial photograph of the project area is presented as Figure 2.

WRI told us the following:

- The setback levee is intended to serve as a flood damage reduction measure, eliminating one of the weakest sections of the Feather River right bank levee currently maintained by LD1 of Sutter County between Yuba City and the river's confluence with the Sutter Bypass.

- The setback levee will improve the hydraulic characteristics of the Feather River by reducing flow velocities and the hydraulic gradient near Star Bend by as much as 0.7 to 0.8 feet during high water conditions.

- The setback levee will also function as an ecosystem restoration measure by restoring over 30 acres of river riparian corridor habitat, and creating a contiguous corridor habitat to the adjoining O'Conner Lakes and Abbott lake wildlife and recreation areas.

The setback levee will be designed and constructed in accordance with requirements set forth in applicable USACE engineering manuals and CCR Standards. The levee will be about 24 feet tall with a minimum crest width of 20 feet.

In accordance with current USACE requirements, both the waterside and landside slopes will be 3:1 (horizontal to vertical). The levee will be constructed to provide a minimum 3 feet of freeboard relative to the 1957 design flood levels.

Fill material for the setback levee is planned to primarily consist of soil from the existing levee supplemented as necessary with soil from a nearby borrow site (located between the existing levee and river, near the south end of the project limits) and potentially a borrow site(s) that is yet to be determined, or by amendment with a clay admixture. Material from the nearby borrow area was used to construct the new levee at Shanghai Bend located about 5 miles north of Star Bend.

We understand that the first phase of construction will most likely consist of clearing, original ground preparation, excavation of the inspection trench, construction of a slurry cutoff wall and possible construction of relatively small portions of the new levee where it ties into the existing levee. LD1 of Sutter County plans to construct the remainder of the levee (Phase 2) the following year. However, it is possible that the entire project (Phase 1 and 2) could be constructed during one full construction season.

1.4 Site Description

Land use in the project area is primarily agricultural. The new levee alignment extends through working orchards. Groundcover in-between trees consists of sparse to dense, knee-high seasonal grasses. Irrigation lines and standpipes are located throughout the proposed project area. Photographs of existing conditions are presented on Figure 3.

A ditch extends near-parallel to the existing levee on the landside. The ditch is located about 80 to 200 feet from the landside toe, is up to 6 feet deep and 50 feet wide and overgrown with brush and trees. We understand that the ditch was constructed over 20 years ago to intercept underseepage from the existing levee.

With the exception of the ditch described above, the ground surface is relatively level with an elevation of 43 ft. MSL (above mean sea level) $\pm$ 1 ft.

Irrigation distribution facilities are located landside of the existing levee near the bend of the levee, and a pressure relief well pump station is located on the landside of the existing levee at the north end of the project area.

A limited number of agricultural houses are located within 1,000 feet of the proposed landside toe of the setback levee alignment. The closest is about 400 feet from the toe.

The existing levee is about 24 feet tall with 2:1 (horizontal to vertical) side slopes. During our field investigation we did not observe any obvious signs of slope instability or detrimental erosion on the existing levee.

Figures 2, 3 and 4 show the features described above.

2 GEOLOGY

2.1 Regional Geology

The site is located within the Great Valley geomorphic province of California. The Great Valley (an elongated and essentially flat lying area) extends 400 miles north and south, separating the Coast Ranges on the west from the Sierra Nevada on the east. It is a northwest trending structural trough that was formed by the westward tilting of the Sierra Nevada block against the eastern flank of the Coast Ranges. Beginning about 200 million years ago, sediments derived from the mountains to the east and west have continually filled the Great Valley. The depth of the sediments is estimated to be up to 10,000 feet.

2.2 Local Geology

At the project site, the California Geological Survey[1] maps the surface materials west of the existing levee as Pleistocene age Modesto Formation consisting of undifferentiated terrace deposits of poorly consolidated gravel, sand, silt and clay. The thickness of this unit can vary 10-200 ft across the valley floor. East of the existing levee, surface materials are mapped as Holocene age natural levee and channel alluvium consisting of unconsolidated gravel, sand, silt and clay associated with floodplains and active stream channels. These deposits can vary significantly in grain size and texture depending upon location and depositional environment.

3 SEISMICITY

The project is located in an area of low seismic activity. No active faults are mapped within the immediate site vicinity and the site is not located within an Alquist Priolo "Earthquake Fault Zone" for fault rupture hazard. The nearest active (defined as producing surface rupture within Holocene time) fault is the Prairie Creek-Spenceville-Deadman Fault, located approximately 16 miles east of the site. Caltrans[2] (California Seismic Hazard Map, 1996) indicates a maximum credible earthquake magnitude (Mw) of 6.5 for this fault.

Low-level ground shaking from seismic activity in the region should be anticipated. Using probabilistic procedures provided by CGS[3], the peak horizontal ground acceleration (PGA) with a 10% probability of being exceeded in 50 years is approximately 0.18g for this site.

[1] Geologic Map of the Chico Quadrangle, Map No. 7A, 1992.
[2] California Seismic Hazard Map, 1996.
[3] Seismic Shaking Hazards in California (http://www.consrv.ca.gov/cgs/rghm/pshamap/pshamain.html).

4 SUBSURFACE EXPLORATION AND LABORATORY TESTING

BCI performed a subsurface exploration program to determine the soil and ground water conditions underlying the site and to obtain samples for laboratory testing. The exploration program consisted of the following:

- Two exploratory borings to 63 feet and three cone penetrometer tests (CPTs) to depths of 75 feet along the new setback levee alignment. Spacing of the borings and CPT probes along the alignment was about 600 to 800 feet. One of the CPT probes was located relatively close (within 150 feet) of an exploratory boring in order to confirm/correlate soil types.

- Four exploratory borings to depths of 26½ to 76½ feet on the existing levee crest.

- Twelve test pits to depths of 8 to 18 feet within a potential borrow site located between the existing levee and river at the south end of the project limits.

BCI performed moisture content, dry density, grain size analysis, Atterberg limits, maximum density and optimum moisture content, unconfined compression, triaxial compression, and pH, minimum resistivity, sulfate content on representative soil samples obtained from the borings. Laboratory test results are presented in Appendix B.

Approximate locations of the exploratory borings, CPTs and test pits are shown on Figure 4. Descriptions of drilling, sampling, CPT and excavating methods; along with boring, CPT and test pit logs are presented in Appendix A. Logs showing detailed soil descriptions, approximate soil type boundaries and laboratory test results are also included in Appendix A.

4.1 Exploratory Borings, CPT Probes and Test Pits

Table I contains the generalized subsurface conditions along the new levee alignment based on our exploratory borings, CPT probes and laboratory tests.

Table I
Generalized Subsurface Soil Conditions Along Setback Levee Alignment

Depth	Soil Type
Upper 5'	Silt and Silty Clay (soft to firm, moist)
5' to 10'	Silt, Silty Clay and Lean Clay (firm to hard, moist to wet)
10' to 20'	Variable layers of Fine to Medium Silty Sand and Sandy Silt (loose to medium dense, wet) and Silt, Silty Clay and Lean Clay (very stiff to hard, moist to wet)
20' to 35'	Sta. 4+00: Silty Clay and Lean Clay (hard, moist)
	Sta. 4+00 to Sta. 34+00: Fine to Coarse Sand and Silty Sand (loose to medium dense, wet)
35'-60'	Sta. 4+00 to 20+00: Fat Clay and Elastic Silt (hard, moist), with minor zones of Silty Sand (dense, wet)
	Sta. 20+00 to Sta. 34+00: Fine to Coarse Sand and Silty Sand (medium dense, wet), with gravel below 40'
60' to 70'	Lean Clay and Fat Clay (hard, moist), with minor zones of Sand / Silty Sand (dense, wet)
70' to 75'	Fine to Coarse Sand, Silty Sand and Gravelly Sand (dense, wet)

Based on our exploratory borings, the existing levee was constructed of local soil, and primarily consists of firm to hard silt, sandy silt, silty clay, lean clay and medium dense to dense silty fine sand.

Table II contains the generalized subsurface conditions we encountered in the test pits excavated in the potential borrow area located near the south end of the project area between the existing levee and river.

Table II
Generalized Subsurface Soil Conditions in Nearby Borrow Area

Depth	Soil Type
Upper 6'	Sand / Silty Sand (loose, moist, fine to medium grained sand)
6' to 8'	Sandy Silt (soft to firm, moist, non-plastic to low plasticity fines, fine sand), with zones of decaying organics
8' to 12'	Silt / Elastic Silt (firm, moist, medium plasticity fines)
12' to 18'	Silt / Silt with Sand (soft to stiff, moist to wet, low plasticity fines, fine sand)

4.2 Sutter County Soil Survey

The United States Department of Agriculture (USDA)[4] maps the following near-surface soils in the project vicinity (see Figure 5).

Table III
USDA Soil Mapped in the Project Area

Soil Name	Map Symbol
Conejo loam	124
Holillipah loamy sand	134
Shanghai fine sandy loam	161
Shanghai silt loam	166

The Soil Survey indicates a range of engineering properties for each of these soils, which are presented in the following table.

Table IV
USDA SOIL ENGINEERING PROPERTIES

Soil Name	Depth (inches)	Soil Texture	Unified Soil Classification	Percent Passing Sieve 4	10	40	200	Liquid Limit	Plasticity Index
Conejo, loam	0-30	Loam	CL-ML, ML	95-100	90-100	70-85	50-65	25-35	5-10
	30-60	Loam	CL, CL-ML	95-100	90-100	70-85	50-65	25-40	5-15
Holillipah, loamy sand	0-8	Loamy Sand	SM	90-100	85-100	60-75	20-30	0-24	NP-6
	8-60	Stratified sand to loamy fine sand	SM	90-100	75-100	35-75	10-30	0-23	NP-6
Shanghai, fine sandy loam	0-15	Fine sandy loam	ML, SM	100	100	80-95	40-55	20-30	NP-5
	15-60	Stratified fine sandy loam to silty clay loam	ML	100	100	90-100	85-95	35-45	10-15
Shanghai, silt loam	0-8	Silt loam	ML	100	100	90-100	75-90	30-40	5-10
	8-60	Stratified fine sandy loam to silty clay loam	ML	100	100	90-100	85-95	35-40	10-15

Source: USDA Natural Resources Conservation Service

[4] Web Soil Survey (http://websoilsurvey.nrcs.usda.gov/app/).

The Sutter County Soil Survey indicates that:

- The Conejo loam (124) and Shanghai fine sandy loam (161) have "moderately high" saturated hydraulic conductivity (9 micrometers per second).
- The Shanghai silt loam (166) has a "moderately high" saturated hydraulic conductivity.
- The Holillipah loamy sand (134) has a "high" saturated hydraulic conductivity (92 micrometers per second).

4.3 Ground Water

We observed ground water in all six of our exploratory borings drilled in April and May 2006 along the new and existing levee alignments at depths of 8 to 11 feet below the existing ground surface (35 to 32 feet above MSL).

Data collected by the California Department of Water resources over the last 60 years for Well No. 13N03E02H001M located near the north end of the project area, indicates that the ground water level at the well location typically fluctuates between 16 and 10 feet below the surface (27 to 33 feet above MSL). The data indicates that levels reach as high as 6 to 4 feet below the surface (37 to 39 feet above MSL) every three to ten years.

Data for Well No. 13N03E02H001M is presented in Figure 6.

5 PROPOSED SETBACK LEVEE MATERIAL

There are two current applicable requirements for new levee material:

- CCR 120 states that "Impervious Material" must be used to construct new levees. Impervious Material is defined in Section 120 as a soil with $\geq$ 20% passing a No. 200 sieve (fines fraction), a liquid limit $<$ 50, and plasticity index $\geq$ 8.
- Section 6.5.5 of USACE, (SOP) EDG-03, Sacramento District states that levees should be constructed of material with $\geq$ 20% passing a No. 200 sieve (fines fraction), a liquid limit $\leq$ 45, and plasticity index $\geq$ 8 and $<$ 40.

5.1 Existing Levee Material

BCI's laboratory tests on samples from exploratory borings B1, B2, B3, and B4 indicate that the existing levee material meets the fines fraction and liquid limit requirements for the above criteria. However, test results on soil from three of the four borings indicate that

there are some zones of soil with a plasticity index ranging from 5 to non-plastic. BCI's tests on composite samples from the upper 20 feet of existing levee fill resulted in plasticity indexes ranging from 6 to 13.

Based on the above, selective grading and blending of the existing levee material and potential amendment with borrow soil having a higher plasticity index (or amendment with a clay admixture) will be necessary to produce fill meeting the plasticity index requirements of CCR 120 and SOP EDG-03 for levee fill.

BCI's subsurface investigation of the existing levee material was limited to four borings. If the existing levee material is to be used for new levee fill, we recommend additional sampling and testing to better determine the extent of selective grading and blending, and if import or admixture is necessary. For planning purposes, we recommend that an import volume equal to at least 10% of the total new levee volume be assumed.

Based on our laboratory tests, we estimate a cut-to-fill volume decrease of less than 5% for the existing levee material. This estimate is based on limited information. Actual volume change may vary depending on factors such as differing soil conditions, stripping losses, over-compaction and under-compaction.

5.2 Nearby Borrow Area

The upper approximately 8 feet of soil from the nearby borrow area shown on Figure 4 consists of sand, silty sand and sandy silt with non-plastic to low plasticity fines. We encountered zones of organics at depths of about 6 to 8 feet. Based on the above, the material in the upper 8 feet does not meet the criteria of CCR 120 and SOP EDG-03 for levee fill.

From about 8 to 12 feet (and in some cases down to 15 feet), the soil is predominantly silt and elastic silt that meets the fines fraction and plasticity index requirements of CCR 120 and SOP EDG-03. However, the liquid limit of 6 of 10 samples tested in this zone ranged from 46 to 57, which is greater than the 45 required by SOP EDG-03. Therefore, the silt and elastic silt will need to be mixed with some of the overlying sand, silty sand and sandy silt (or less plastic existing levee material) in order to produce material meeting the liquid limit requirements. We estimate that at least 10%, and as much as 30% of the overlying sand, silty sand, sandy silt or less plastic existing levee material will be required to produce material meeting the CCR 120 and SOP EDG-03 criteria. The actual amount will need to be determined during grading.

Our laboratory tests indicate that the silt and elastic silt from 8 to 15 feet has a moisture content significantly higher (about 10% to 20% higher) than the optimum moisture content based on ASTM D 698. Therefore significant aeration and/or mixing with drier material

will be necessary to produce material with a moisture content within an acceptable range for proper compaction.

We estimate a cut-to-fill volume decrease ranging from 10% to 20% for import from the borrow area due to the relatively loose condition of the sand, silty sand and sandy silt overburden, and high moisture content of the underlying silt and elastic silt.

6 SEEPAGE ANALYSIS AND RECOMMENDATIONS

6.1 Historical Seepage Issues and Mitigation

Based on our discussions with LD1's Bill Hampton, significant underseepage has occurred historically within the Star Bend area. Past mitigation consisted of the following:

- A seepage collection ditch was constructed over 20 years ago. Collected water was pumped back over the levee into the river.
- A landside toe drain was constructed by LD1 in 1986 along the North-South reach of the levee due to seepage extending out past the collection ditch. The drain reduced, but did not eliminate the seepage. The USACE upgraded the North-South toe drain in 1998.
- The USACE constructed pressure relief wells north of the Star Bend project area. We understand the wells are spaced about 50 feet apart. Water is collected in a concrete-lined v-ditch and pumped back over the levee into the river. We understand that some seepage has continued to occur in the area of the relief wells.

6.2 USACE Studies / Requirements

Studies performed by the USACE indicate that there is a high potential for heavy underseepage (capable of causing sand boils) if the calculated landside exit gradient exceeds 0.5. Therefore, the USACE, Sacramento District defines the threshold design exit gradient downstream of the landside slope as 0.5 (Standard Operating Procedure EDG-03 dated July 7, 2004).

6.2.1 Computer Analysis of New Levee Without Underseepage Mitigation

BCI performed seepage analysis for the new levee using Version 4.23, SEEP/W finite element software. We used the soil profiles and hydraulic conductivity values shown below in Tables V and VI. The profiles are based on the generalized subsurface soil conditions shown in Table I in Section 4 of this report. A basis for the hydraulic conductivity values is provided in Appendix C.

Table V
Seepage Analysis Generalized Profile and Parameters
Sta. 0+00 to 20+00

Soil Profile	Soil Type	Vertical Hydraulic Conductivity ft/hr (cm/sec)	Horizontal Hydraulic Conductivity ft/hr (cm/sec)
New Levee Fill	Stiff to Hard Silt/Silty Clay	3.0e-4 (2.5e-6)	1.2e-3 (1.0e-5)
0 to 10 feet*	Soft to Firm Low Plasticity Silt	1.2e-1 (1.0e-3)	4.7e-1 (4.0e-3)
10 to 35 feet**	Loose to Medium Dense Sand	0.59 (5.0e-3)	2.4 (2.0e-2)
35 to 70 feet***	Hard Fat Clay/Elastic Silt	1.2e-4 (1.0-6)	4.7e-4 (4.0e-6)
70 to 75 feet****	Dense Sand	0.59 (5.0e-3)	2.4 (2.0e-2)

Table VI
Seepage Analysis Generalized Profile and Parameters
Sta. 20+00 to 36+00

Soil Profile	Soil Type	Vertical Hydraulic Conductivity ft/hr (cm/sec)	Horizontal Hydraulic Conductivity ft/hr (cm/sec)
New Levee Fill	Stiff to Hard Silt/Silty Clay	3.0e-4 (2.5e-6)	1.2e-3 (1.0e-5)
0 to 10 feet*	Soft to Firm Low Plasticity Silt	1.2e-1 (1.0e-3)	4.7e-1 (4.0e-3)
10 to 60 feet**	Loose to Medium Dense Sand	0.59 (5.0e-3)	2.4 (2.0e-2)
60 to 70 feet***	Hard Fat Clay/Elastic Silt	1.2e-4 (1.0-6)	4.7e-4 (4.0e-6)
70 to 75 feet****	Dense Sand	0.59 (5.0e-3)	2.4 (2.0e-2)

*Lower 5 feet of this layer contains discontinuous lenses of firm to hard silt, silty clay and lean clay.
**Upper 20 feet of this layer contains discontinuous lenses of Silt, Silty Clay and Lean Clay.
*** Contains minor, lenses of Sand and Silty Sand.
**** Contains lenses of Silty Sand and Gravelly Sand.

The generalized soil profiles shown above are relatively conservative, however realistic under some portions of the new levee. Based on our subsurface exploration through the existing levee and the Sutter County Soil Survey, the generalized profiles in Tables V and VI not only underlie the existing levee, but the area upstream of the existing levee, and likely for some distance downstream.

We used a flood-stage water depth of 21 feet based on the design flood elevation of approximately 64 feet MSL and existing ground elevation of approximately 43 MSL. As required by USACOE, we used steady-state seepage conditions in our analysis.

6.2.2 Computer Analysis Results

Using the data outlined above, our computer analysis indicates an exit gradient of 0.61 to 0.64 located 15 to 20 feet from the landside toe during flood stage. Figures 1 and 2 in Appendix C show the gradient contours. Based on our computer analysis results, USACE design criteria, and past history of seepage issues in the area, we recommend underseepage mitigation for the new levee.

6.3 Underseepage Mitigation

Typical underseepage mitigation for levees consists of vertical cutoff walls, seepage berms and pressure relief wells. Section 5-2 of USACE EM 110-2-1913 states that a cutoff is the most positive means of eliminating seepage problems, and CCR 120 requires that a cutoff be constructed where a pervious substratum underlies the proposed area for a new levee.

Based on the above, we recommend a cutoff wall to mitigate underseepage on this project. We present our cutoff wall recommendations and analysis in the following section. We also present alternatives for pressure relief wells and seepage berms. However, these alternatives will not provide as high a level of seepage mitigation as a cutoff wall, and would likely cost more to construct and maintain.

6.4 Underseepage Cutoff Recommendations and Analysis

Our subsurface exploration indicates that a relatively pervious, 25 to 60-foot-thick layer of Sand / Silty Sand underlies the project area starting at a depth of about 10 feet below the surface (see Tables V and VI). Based on CCR 120 criteria, a cutoff through the sand and extending into the underlying less-pervious soil is required.

Based on our experience and current levee practice in the area, a minimum 4-foot-wide soil-bentonite slurry wall is likely the best cutoff alternative due to the relatively deep extent of the pervious stratum. Based on our generalized soil profiles, we estimate the following minimum cutoff depths:

Station	Minimum Estimated Wall Depth
Sta. 0+00 to 20+00	40 feet
Sta. 20+00 to 36+00	62 feet

We used SEEP/W to model the levee with a cutoff wall extending to the depths recommended above. The analysis indicates that the cutoff reduces the gradient at the landside toe to less than 0.10. Our results are shown on Figures 3 and 4 in Appendix C. A preliminary cross-section of the new levee with a cutoff is shown on Figure 7.

A protective fill cap should be constructed on top of the cutoff wall as shown on Figure 7.

6.5 Pressure Relief Well Alternative

We used the method presented in USACE, EM 1110-2-1914 to estimate the spacing and discharge for pressure relief wells extending to the bottom of the pervious layer. Our analysis indicates the depth, spacing and discharge in Table VII to reduce the uplift gradient to ≤ 0.5 midway between the wells during the design flood elevation of 64 feet above MSL.

Table VII
Pressure Relief Well Recommendations

Station	Well Depth (ft.)	Well Diameter (Inches)	Maximum Well Spacing (ft.)	Single Well Discharge (cfm)
0+00 to 20+00	35	8	70	7.1
20+00 to 34+00	60	8	70	14.2

Our analysis data and spreadsheets are presented in Appendix C. A preliminary cross-section of the new levee with relief wells is shown on Figure 7. Based on current levee design practice, we used 5 feet for the distance from the landside toe-of-slope to the relief wells, and a v-ditch depth of 2 feet. We conservatively used 1 foot for the distance from the river-side toe-of-slope slope to the seepage inlet location due to the relatively high permeability of the semi-impervious top blanket of silt.

A concrete lined v-ditch or enclosed-pipe collection system and pumping facility should be designed to receive and dispose of the collected water. Grain size distribution information from our laboratory testing should be used to design the well filter pack and screen size.

Relief wells are prone to clogging and require maintenance to remain operational, and underseepage may migrate through undetected pervious soil strata and bypass the wells. Therefore relief wells do not provide as high of a mitigation level as the cutoff described in the previous section.

6.6 Seepage Berm Alternative

A landside seepage berm would mitigate heavy seepage and potential sand boils near the landside toe of the new levee. However, seepage could still occur near the toe of the berm during flood stage events, and therefore may not be appropriate given the relatively close proximity to existing residences. A seepage berm would also require a significant increase in the amount of borrow needed for the project.

USACE, SOP EDG-03 requires a minimum seepage berm width of four times the maximum levee height, and a maximum exit gradient at the toe of the berm of 0.8.

We performed computer analysis for a 100' long landside seepage berm using SEEP/W computer software. As shown in Figure 5 and 6 in Appendix C, the exit gradient at the toe of the berm ranges from 0.48 to 0.58, which is less than the 0.8 required by the USACE.

7 SLOPE STABILITY ANALYSIS

We evaluated slope stability of the proposed setback levee for the following three design conditions:

- Case 1 – End of Construction
- Case 2 – Sudden Drawdown
- Case 3 – Steady State Seepage

For all design conditions, we used the WINSTABL v.3.0 program to analyze slope stability of the proposed setback levee. For our analysis, we used the Simplified Janbu Method of Slices to analyze randomly shaped failure surfaces.

Based on results of our slope stability analyses, we present the following table showing the calculated factor of safety with respect to the required factor of safety for each design case.

Design Case	Design Conditon	Calculated Factor of Safety	Required Factor of Safety*
1	End of Construction	1.31 - 1.37	1.3
2	Sudden Drawdown	1.30 - 1.36	1.0 - 1.2
3	Steady State Seepage	1.40 - 1.42	1.4

* As outlined in "Design and Construction of Levees", USACE EM 1110-2-1913, April 2000.

Our calculations indicate that slope stability of the proposed setback levee meets the required factor of safety for each design case as outlined in USACE Engineering Manual EM 1110-2-1913. Based on our analysis and the long-term performance of the existing levee with 2:1 side slopes, we expect that the proposed setback levee with 3:1 side slopes will be appropriately stable.

We include a summary of our slope stability analysis and graphical output from the stability trials for each design case in Appendix D.

8 SETTLEMENT ANALYSIS

We calculated levee embankment loads using an embankment height of 25 ft. to evaluate immediate and long-term consolidation settlement. We evaluated settlement based on levee embankment cross-section geometry consisting of a 20 ft. wide embankment crest with 3:1 (horizontal:vertical) side slopes. We used a unit weight of 130 pounds per cubic foot for the new levee fill. We modeled a 100 ft long section of levee to evaluate immediate settlement. For consolidation settlement, we conservatively used an equivalent width of 100 ft in our analysis.

We include our settlement calculations in Appendix E.

8.1 Immediate Settlement

A minor amount of "immediate" ground settlement will occur during levee fill placement. We calculated immediate settlement in the range of ¼ to 2 inches beneath the highest portion of the levee embankment. This relatively small amount of settlement should not cause noticeable distress to the existing levee during construction.

We determined immediate ground settlement based on "elastic" theory using laboratory test results and correlation with in-situ test data. For our analysis, we estimated the stress-strain modulus (E_s) for granular and cohesive soils based on published correlations with SPT data and used the weighted average E_s within the depth evaluated. We neglected settlement below the depth at which a "hard" stratum was encountered (i.e., where E_s in the hard layer is about $10E_s$ of the adjacent upper layer).

8.2 Primary Consolidation Settlement

Based on our analysis, we estimate primary consolidation settlement at this site to be on the order of ½ to 3 inches beneath the highest portion of the levee embankment. To provide the design freeboard, the new levee should be overbuilt by at least 3 inches to account for long-term settlement.

Pre-consolidation pressures and over consolidation ratios are variable, both vertically within individual test borings and horizontally. Therefore, we estimated the pre-consolidation pressure and over consolidation ratio of various soil layers by applying the S_u/P (undrained shear strength over effective overburden stress) relationship to field (SPT) and laboratory test data. For our analysis we assumed an average normally consolidated $(s_u/\sigma'_{vo})_{NC}$ ratio of 0.33 (Schmertmann, 1978).

We determined primary consolidation settlement based on results of laboratory tests and correlation with in-situ test data. We estimated the modified compression index ($C_{c\varepsilon}$) value of individual soil layers based on correlation to the natural moisture content of the soil [$C_{c\varepsilon} = 0.006(w-12)$]. In the over consolidated range, we adopted a modified recompression index ($C_{r\varepsilon}$) value equal to 20% of $C_{c\varepsilon}$ for our analysis.

We used the modified compression index ($C_{c\varepsilon}$) to calculate settlement of normally consolidated soil layers (i.e., OCR = 1) and the modified recompression index ($C_{r\varepsilon}$) for over consolidated soils. For sandy layers and layers with an OCR greater than 5, we neglected consolidation settlement.

8.3 Liquefaction and Seismic Settlement

Liquefaction is a secondary effect associated with seismic loading. It can occur when relatively loose, granular (typically less than 35% fines), saturated soils (generally within about 50 feet of ground surface) are subjected to ground shaking.

Based on soil types we encountered in the borings completed for this study, very loose to medium dense granular soils in the range of soil texture and consistency potentially susceptible to liquefaction below the encountered groundwater levels are present at this site.

We evaluated the potential for liquefaction at this site using soil classification test data and "Standard Penetration Test Analysis" (Simplified Procedure) consistent with National Center for Earthquake Engineering Research (NCEER) 1996 Workshop liquefaction evaluation criteria. We evaluated the CPT data using an in-house spreadsheet program consistent with NCEER liquefaction evaluation criteria. We used a horizontal acceleration at ground surface of 0.18g for our analysis. We show liquefaction analysis results in Appendix E.

We identify a potentially liquefiable layer in Boring 5 within the upper 20 ft of ground surface between elev. 19± and elev. 31±. For this 12 ft thick layer, we calculated factors of safety against liquefaction between 0.6 and 1.0. We estimated liquefaction settlement of the granular layers using simplified procedures outlined in "Geotechnical Earthquake Engineering" (Steven L. Kramer, 1996) to be in the range of 4 to 6 inches.

We consider the potential for seismically induced ground distress (e.g. liquefaction, densification, settlement, lateral spreading, etc.) to be slight at this predominantly flat, low-seismicity site. Therefore, no special mitigation measures are recommended.

9 CONSTRUCTION RECOMMENDATIONS

Where referenced in this report, use ASTM D 698 test methods to determine relative compaction and optimum moisture.

9.1 Site Clearing, Original Ground Preparation and Inspection Trench

1) Remove all structures, pipes, drains, wells, standpipes etc. from the area proposed for the new levee alignment. Abandon wells in accordance with the appropriate regulatory requirements.

2) Strip off the upper 1' of soil from the new levee area and remove all plants, shrubs, brush, and trees. Removal should include the root system, which will be extensive due to the orchards present within the alignment. Widen and remove loose soil from all depressions made by vegetation removal as necessary to allow for subsequent backfilling and compaction equipment.

3) Remove all brush, trees and loose soil from the existing seepage ditch where the proposed levee will cross over the ditch, and a minimum 100 feet past the toe of the setback levee.

4) Excavate a minimum 12-foot wide inspection trench centered on the hinge point of the river-side slope (see Figure 7). The trench should extend to a minimum depth of 6 feet below original grade. Remove all roots, pipes, drains, etc. exposed by the inspection trench.

5) Scarify all areas within the levee footprint area (including the drainage ditch, areas widenend for vegetation removal and inspection trench) to a depth of 8". Moisture condition the scarified soil to within 1% below to 2% over the optimum moisture content and compact to a minimum 97% relative compaction.

6) Backfill all depressions including the seepage ditch and inspection trench with native silt, sandy silt, silty clay, clay or import soil meeting the following criteria:

- 100 % passing the 3" sieve
- 90% to 100% passing the No. 4 sieve
- At least 70% passing the No. 200 sieve
- Liquid limit less than or equal to 50
- Shall not contain organics, debris or other deleterious material

Place fill in maximum 6" thick lifts, moisture condition to within 1% below to 2% over optimum and compact to a minimum 97% relative compaction.

9.2 Levee Fill

Levee fill shall consist of the existing levee material, blended and amended as necessary with import soil and/or clay amendment to meet the following criteria:

- 100 % passing the 3" sieve
- 90% to 100% passing the No. 4 sieve
- At least 20% passing the No. 200 sieve
- Liquid Limit < 50
- Plasticity Index $\geq 8 \leq 40$
- Shall not contain organics, debris or other deleterious material

Place fill in maximum 6" thick lifts, moisture condition to within 1% below to 2% over optimum and compact to a minimum 97% relative compaction.

Bench fill into the existing levee a minimum of one foot for every foot of fill placed, or as necessary to remove loose material and provide proper compaction along the zone of transition.

See Section 5 for conclusions and recommendations regarding the use of existing levee material and soil form the nearby borrow source and cut-to-fill volume change estimates.

9.3 Seepage Berm Fill

If a landside seepage berm is constructed, fill material should consist of fine sand, silty sand or sandy silt that meets the following criteria:

- 100 % passing the 3" sieve
- 90% to 100% passing the No. 4 sieve
- No more than 70% passing the No. 200 Sieve
- Liquid limit less than or equal to 50
- Plasticity Index less than or equal to 5
- Shall not contain organics, debris or other deleterious

Place seepage berm fill in maximum 6" thick lifts, moisture condition to within 1% below to 3% over optimum and compact to a minimum 90% relative compaction.

9.4 Pipes Through Levee

Pipelines placed through the new levee should be constructed in accordance with Title 23 of the California Code of Regulation. Backfill may consist of on-site, native soil or import meeting the criteria in Section 9.2. Backfill shall be placed and compacted in accordance with Section 9.2

9.4.1 Soil Corrosivity

BCI performed corrosion tests on two composite soil samples obtained from the existing levee fill, which should be similar to the soil used to construct the new levee and backfill pipeline trenches. We present the results in Table VIII.

Table VIII
Corrosion Test Results

Sample	PH	Minimum Resistivity (ohm-cm)	Chloride (ppm)	Sulfate (ppm)
Bulk 3 / Boring B3 0 to 20 feet	7.07	3,480	8.2	12.2
Bulk 4 / Boring B4 0 to 20 feet	7.09	2,570	14.3	15.0

Based on the above, the existing levee material does not pose a significant corrosion potential to buried concrete or metal pipes. A Corrosion Engineer should be consulted to determine if corrosion protection is necessary.

10 RISK MANAGEMENT

Our experience and that of our profession clearly indicates that the risks of costly design, construction, and maintenance problems can be significantly lowered by retaining the geotechnical engineer of record to provide additional services during design and construction. For this project, BCI should be retained to:

- Review and provide comments on the civil plans and specifications prior to construction.
- Monitor construction to check and document our report assumptions. At a minimum, BCI should monitor grading, trench backfill, and aggregate base compaction.

- Update this report if design changes occur, 2 years or more lapses between this report and construction, and/or site conditions have changed.

If we are not retained to perform the above applicable services, we are not responsible for any other party's interpretation of our report, and subsequent addendums, letters, and discussions.

11 LIMITATIONS

BCI performed services in accordance with generally accepted geotechnical engineering principles and practices currently used in this area. Where referenced, we used ASTM or Caltrans standards as a general (not strict) *guideline* only. We do not warranty our services.

BCI based this report on the current site conditions. We assumed the soil and ground water conditions encountered in our borings, CPT probes and test pits are representative of the subsurface conditions across the site. Actual conditions between explorations could be different.

Our scope did not include evaluation of on-site hazardous material or biological pollutants. Please contact BCI if you would like an evaluation of one or more of these potentially damaging issues.

Logs of our exploratory borings and test pits are presented in the Appendix A. The lines designating the interface between soil types are approximate. The transition between soil types may be abrupt or gradual. Our recommendations are based on the final logs, which represent our interpretation of the field logs and general knowledge of the site and geological conditions.

Modern design and construction are complex, with many regulatory sources/restrictions, involved parties, construction alternatives, etc. It is common to experience changes and delays. The owner should set aside a reasonable contingency fund based on complexities and cost estimates to cover changes and delays.

Appendix A

Exploratory Borings and Test Pits

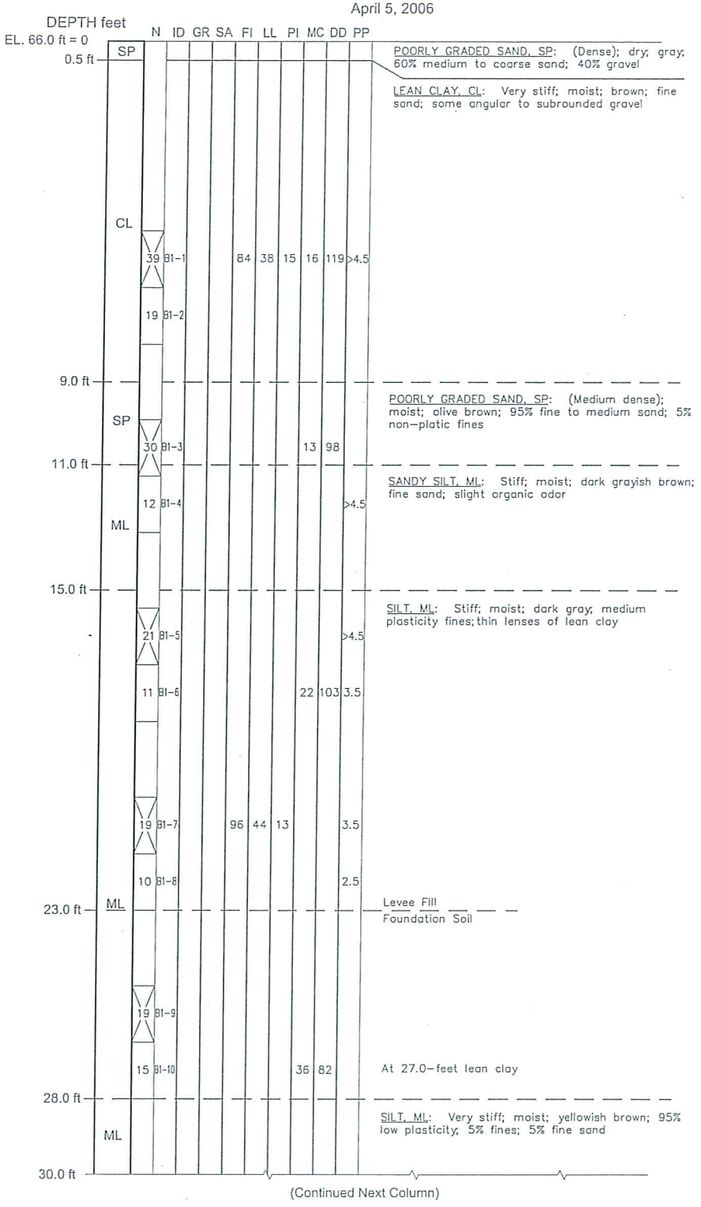
BCI retained Taber Consultants to drill and sample Borings 1 through 4 and Gularte & Associates to drill and sample Borings 5 and 6. Drilling was performed using truck-mounted drill rigs. Borings were advanced using 4" diameter solid flight augers until ground water was encountered. The remainder of each boring was advanced using the mud-rotary method. Soil samples were obtained by driving 2" diameter Standard Penetration and 3" O.D. Modified California Samplers equipped with brass liners into the ground with the force of a 140-pound hammer falling approximately 30 inches. We sealed the samples and delivered them to our laboratory for testing. We also obtained soil samples for laboratory testing and reference. BCI's Geologist James Robbins logged the borings and directed the sampling.

Test pits were excavated with a John Deere backhoe using a 2'-wide bucket. Bulk samples were obtained from the borings, sealed in plastic bags and delivered to BCI's laboratory for evaluation and testing. The test pits were backfilled with the excavation spoils, which were tamped into placed with the backhoe bucket. BCI's Geologist James Robbins logged the test pits.

Notes to Boring and Test Pit Logs

The lines designating the interface between soil types are approximate. The transition between soil types may be abrupt or gradual. Our recommendations are based on the final logs, which represent our interpretation of the field logs and general knowledge of the site and geological conditions. The blow counts shown on the logs are not corrected for sampler size or overburden.

BORING NO. 1-06
April 5, 2006



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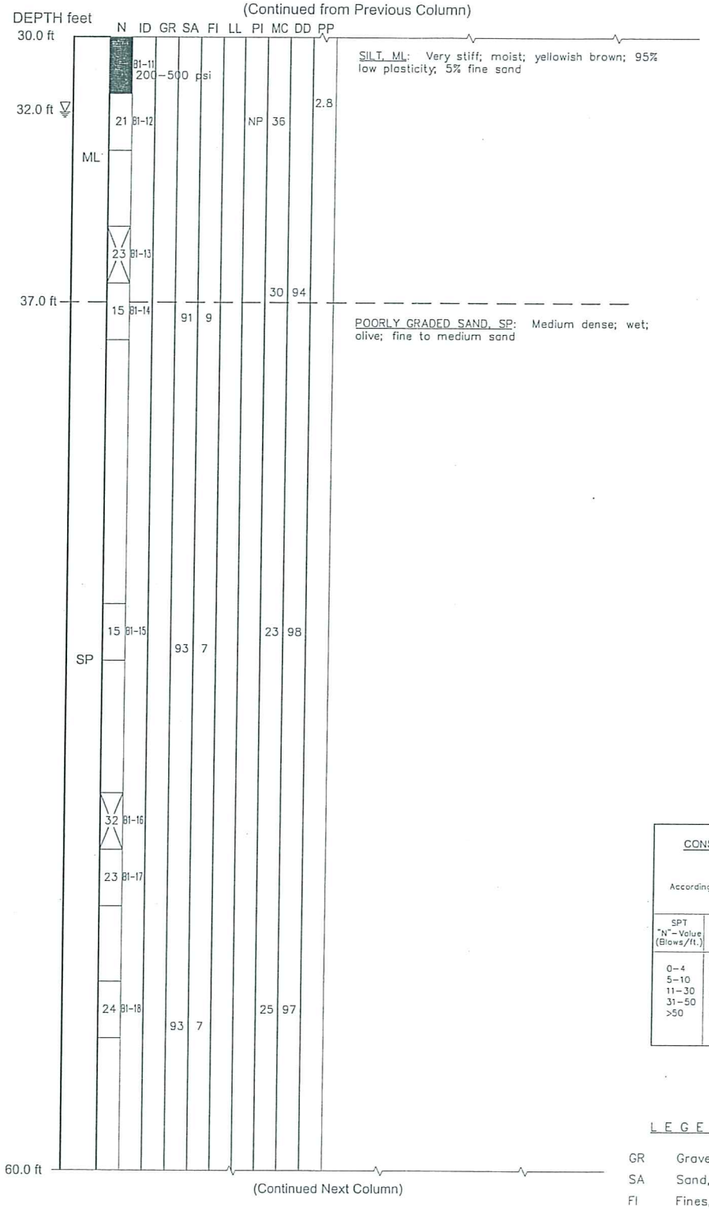

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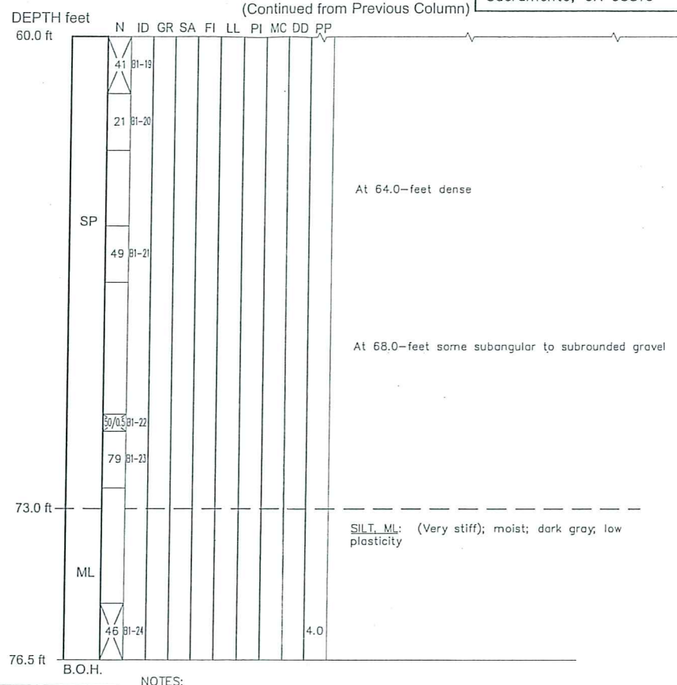

CONSISTENCY CLASSIFICATION FOR SOILS		According to the Standard Penetration Test	
SPT "N"-Value (Blows/ft.)	Granular	SPT "N"-Value (Blows/ft.)	Cohesive
0-4	Very Loose	<2	Very Soft
5-10	Loose	2-4	Soft
11-30	Medium Dense	5-8	Firm
31-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very Stiff
		>31	Hard

NOTES:
1. Field classification of soils was in accordance with ASTM D 2488-00 "Description and Identification of Soils (Visual-Manual Procedure)".
2. Standard Penetration tests were performed in accordance with ASTM D 1586-99 using a hammer operated with an automated drop system. Drill rods were 1 5/8-inch diameter "A"-rods; sampler was driven with brass liners.
3. "2.5 inch sampler": ID=2.5 inch, OD=2.9 inch. Driven in same manner as SPT ("1.4 inch") sampler.
4. The length of each sampled interval is shown graphically on the boring log. Whole number blow counts ("N") represent the "standard penetration resistance" interval in accordance with ASTM D1586-99. Where less than 1 foot of penetration is achieved, the blow count shown is for that fraction of the "standard penetration resistance' interval actually penetrated.
5. Groundwater surface (GWS) elevations in the borings indicated on the Log of Test Boring Sheets reflect the fluid level in the borings on the specified date.
6. Groundwater surface elevations are subject to seasonal fluctuations and may occur at higher or lower elevations depending on the conditions at any particular time.
7. Boring elevations were estimated based on topography provided by Wood Rodgers, Inc.
8. Boring was drilled using 4-inch solid stem auger to 23 feet depth then 4-inch rotary wash to full depth of boring.
9. Boring was grout backfilled at completion with a mixture of Portland Cement and water.
10. Boring was drilled by Breece Franks of Taber Consultants using a CME 75 drill rig. Boring was logged by James Robbins of Blackburn Consulting. Boring was drilled on April 5, 2006.
11. Consistency of soils is shown in ( ) where estimated.

LEGEND:

GR	Gravel, percent by weight passing the 3" sieve and retained on the No. 4 sieve.
SA	Sand, percent by weight passing the No. 4 sieve and retained on the No. 200 sieve.
FI	Fines, percent by weight passing the No. 200 sieve.
LL	Liquid Limit.
PI	Plasticity Index (Liquid Limit minus Plastic Limit).
MC	Laboratory determined moisture content in percent of dry weight.
SM	Combined field visual identification and/or laboratory classification.
N	Number of blows to drive sampler last 12-inches of 18-inch interval.
NP	Nonplastic.
ID	Sample identification.

California Modified Sampler and blow count.

Standard Penetrometer Sampler and blow count.

200-500 psi — 3-inch Shelby Tube and psi to push into soil.

Water Level.

B.O.H. Bottom of Hole.

VERTICAL SCALE: 1" = 2'

REGISTERED CIVIL ENGINEER

REGISTERED PROFESSIONAL ENGINEER ROBERT B. LOKTEFF No. 59558 EXP. 12-31-07 CIVIL STATE OF CALIFORNIA

PLANS APPROVAL DATE

Blackburn Consulting, Inc.
2437 Front Street
West Sacramento, CA 95691

File No. 788.1

Wood Rodgers, Inc.
3301 C Street, Building 100-B
Sacramento, CA 95816

DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	J. B. Robbins FIELD INVESTIGATOR		PREPARED FOR Levee District No. 1 of Sutter County	BRIDGE NO.
SIGN OFF DATE	CHECKED BY	R. B. Lokteff	DATE April 2006		PROJECT ENGINEER	POST MILE

STAR BEND LEVEE SETBACK

LOG OF TEST BORINGS No. 1

10/20/06 788.1 Star Bend Levee Setback Logs.dwg

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) | SHEET | OF

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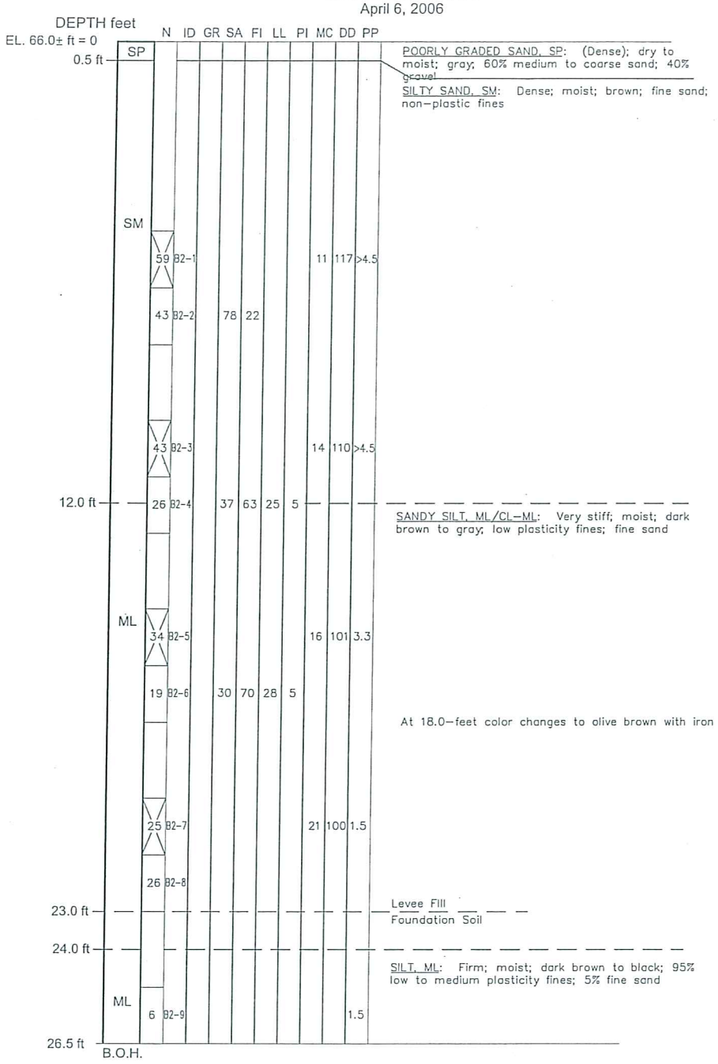
April 6, 2006



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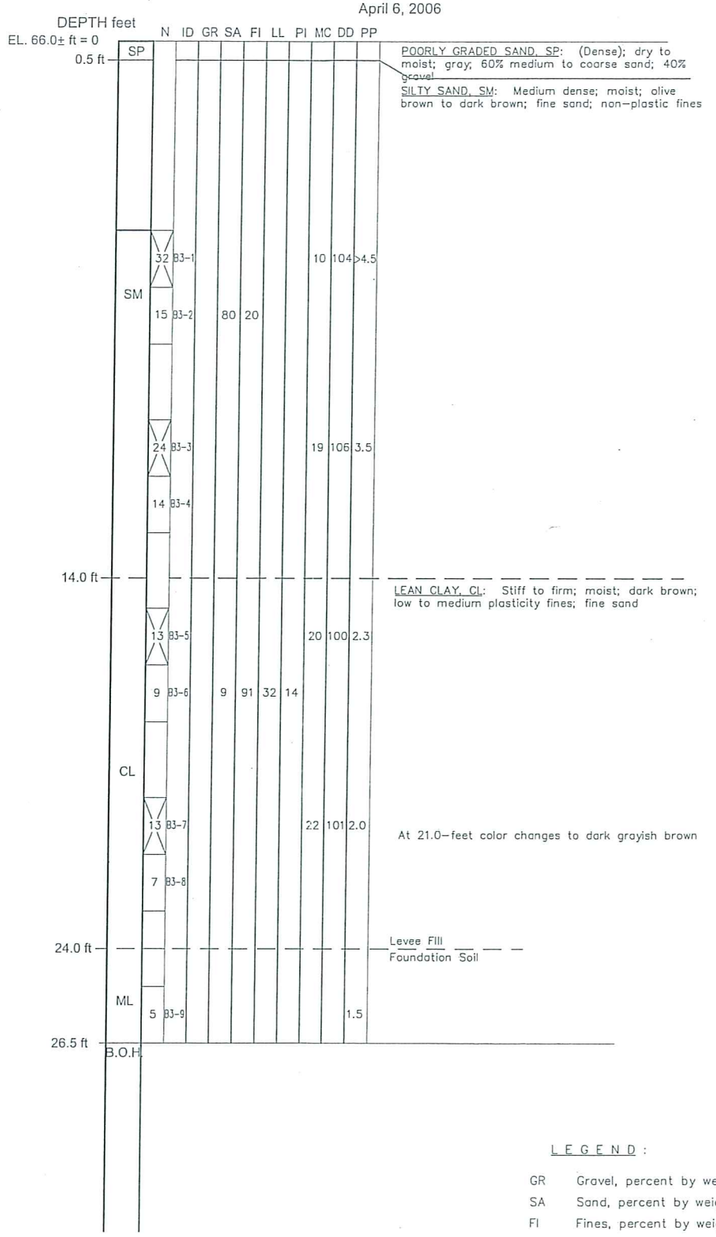
April 6, 2006



REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER ROBERT B. LOKTEFF No. 59558 EXP. 12-31-07 CIVIL STATE OF CALIFORNIA

Blackburn Consulting, Inc.
2437 Front Street
West Sacramento, CA 95691

File No. 788.1

Wood Rodgers, Inc.
3301 C Street, Building 100-B
Sacramento, CA 95816

CONSISTENCY CLASSIFICATION FOR SOILS

According to the Standard Penetration Test

SPT "N"-Value (Blows/ft.)	Granular	SPT "N"-Value (Blows/ft.)	Cohesive
0-4	Very Loose	<2	Very Soft
5-10	Loose	2-4	Soft
11-30	Medium Dense	5-8	Firm
31-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very Stiff
		>31	Hard

NOTES:
1. Field classification of soils was in accordance with ASTM D 2488-00 "Description and Identification of Soils (Visual-Manual Procedure)".
2. Standard Penetration tests were performed in accordance with ASTM D 1586-99 using a hammer operated with an automated drop system. Drill rods were 1 5/8-inch diameter "A"-rods; sampler was driven with brass liners.
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11. Consistency of soils is shown in ( ) where estimated.

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FI	Fines, percent by weight passing the No. 200 sieve.
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California Modified Sampler and blow count.

19 Standard Penetrometer Sampler and blow count.

200-500 psi 3-inch Shelby Tube and psi to push into soil.

Water Level.

B.O.H. Bottom of Hole.

VERTICAL SCALE: 1" = 2'

DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	J. B. Robbins FIELD INVESTIGATOR		PREPARED FOR Levee District No. 1 of Sutter County	BRIDGE NO.
SIGN OFF DATE	CHECKED BY	R. B. Lokteff	DATE April 2006		PROJECT ENGINEER	POST MILE

STAR BEND LEVEE SETBACK

LOG OF TEST BORINGS No. 2

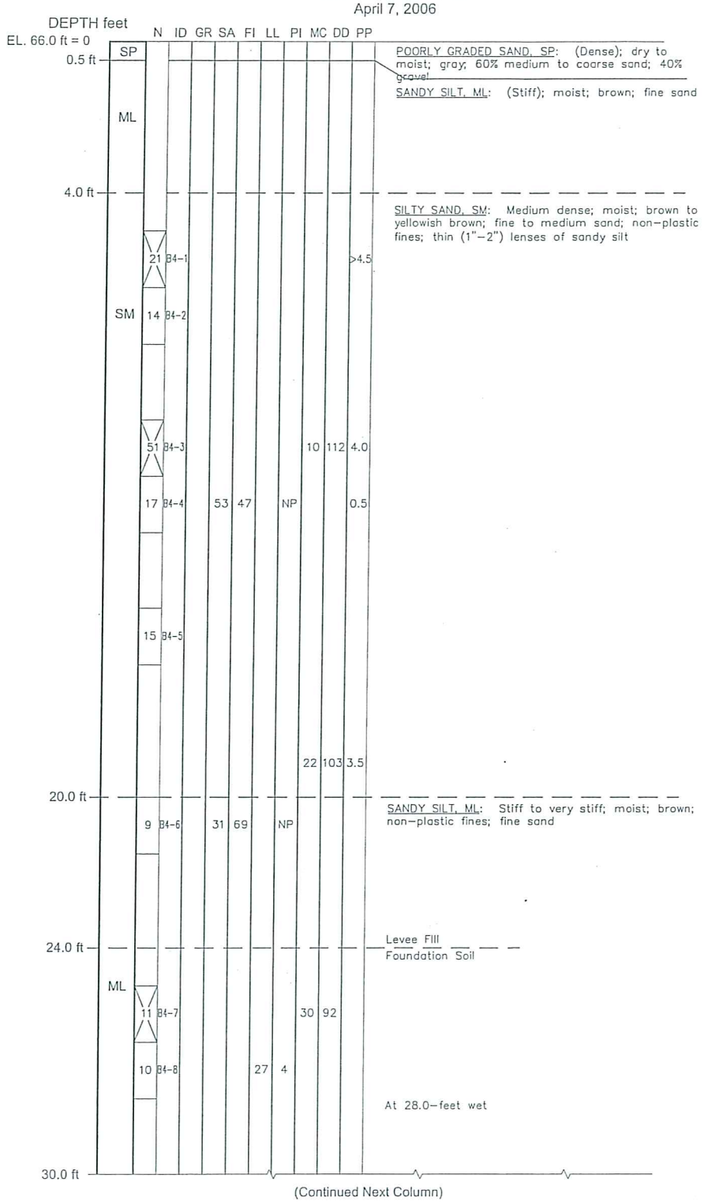
10/20/06 788.1 Star Bend Levee Setback Logs.dwg

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) | SHEET | OF

BORING NO. 4-06
April 7, 2006



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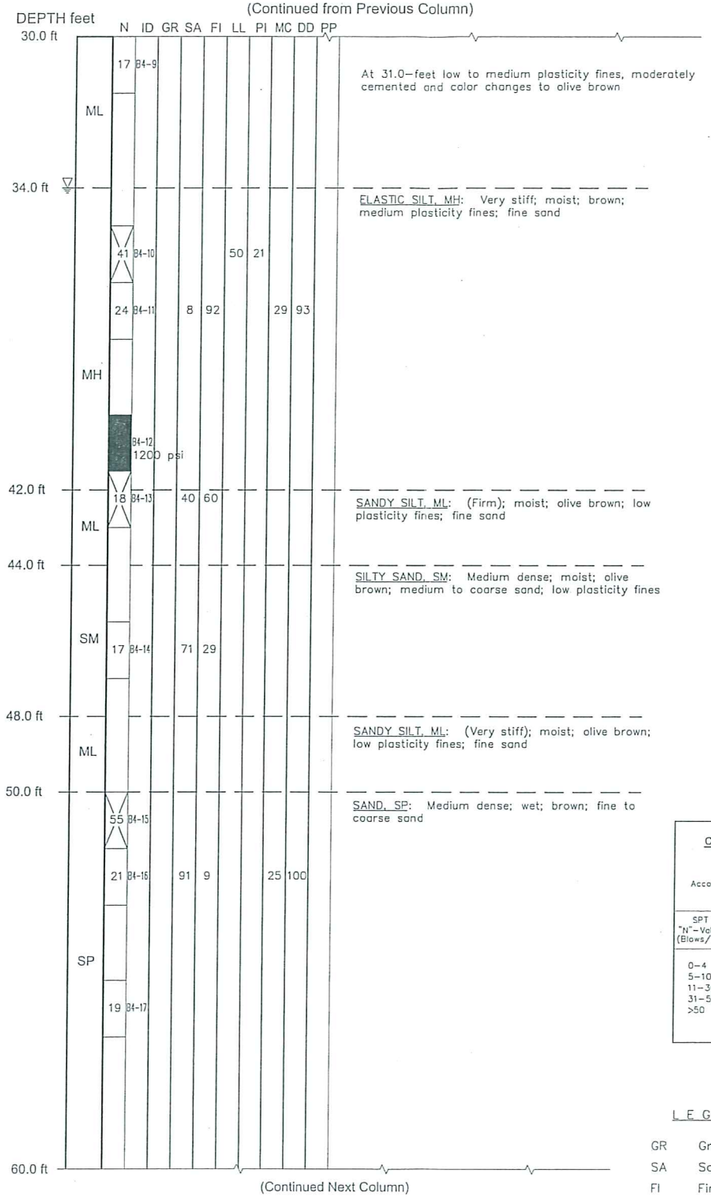

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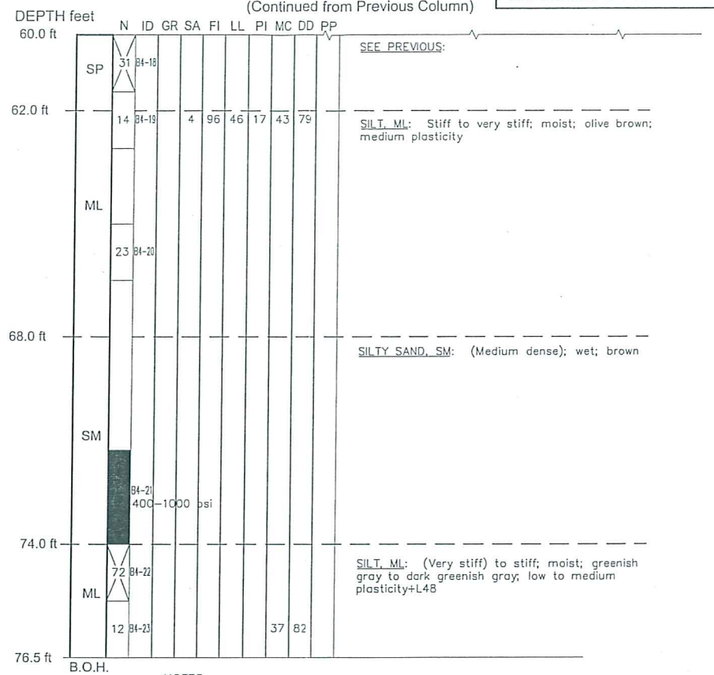

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NOTES:
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Standard Penetrometer Sampler and blow count.

200-500 psi — 3-inch Shelby Tube and psi to push into soil.

Water Level.

B.O.H. Bottom of Hole.

VERTICAL SCALE: 1" = 2'

REGISTERED CIVIL ENGINEER

REGISTERED PROFESSIONAL ENGINEER ROBERT B. LOKTEFF No. 59558 EXP. 12-31-07 CIVIL STATE OF CALIFORNIA

PLANS APPROVAL DATE

Blackburn Consulting, Inc.
2437 Front Street
West Sacramento, CA 95691

File No. 788.1

Wood Rodgers, Inc.
3301 C Street, Building 100-B
Sacramento, CA 95816

DESIGN OVERSIGHT

SIGN OFF DATE

DRAWN BY M. D. Robertson

CHECKED BY R. B. Lokteff

J. B. Robbins
FIELD INVESTIGATOR

DATE April 2006

PREPARED FOR
Levee District No. 1
of Sutter County

PROJECT ENGINEER

BRIDGE NO.

POST MILE

STAR BEND LEVEE SETBACK
LOG OF TEST BORINGS No. 3

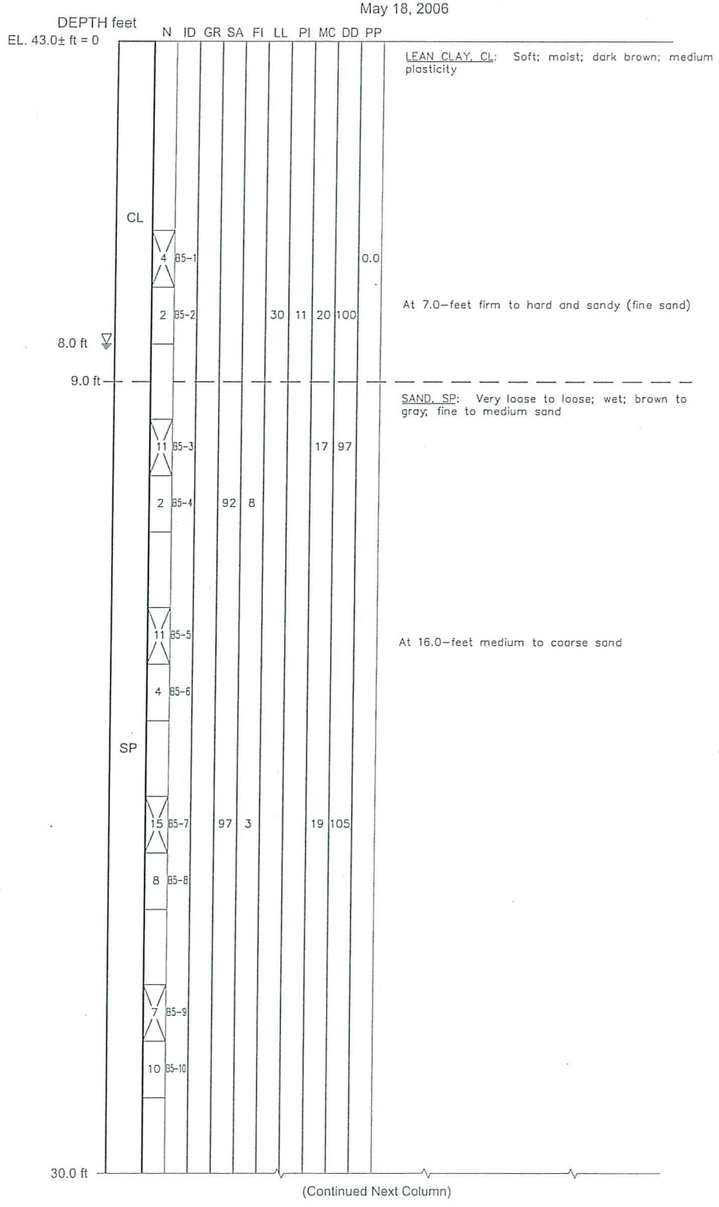
10/20/06 788.1 Star Bend Levee Setback Logs.dwg

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) | SHEET | OF

BORING NO. 5-06
May 18, 2006



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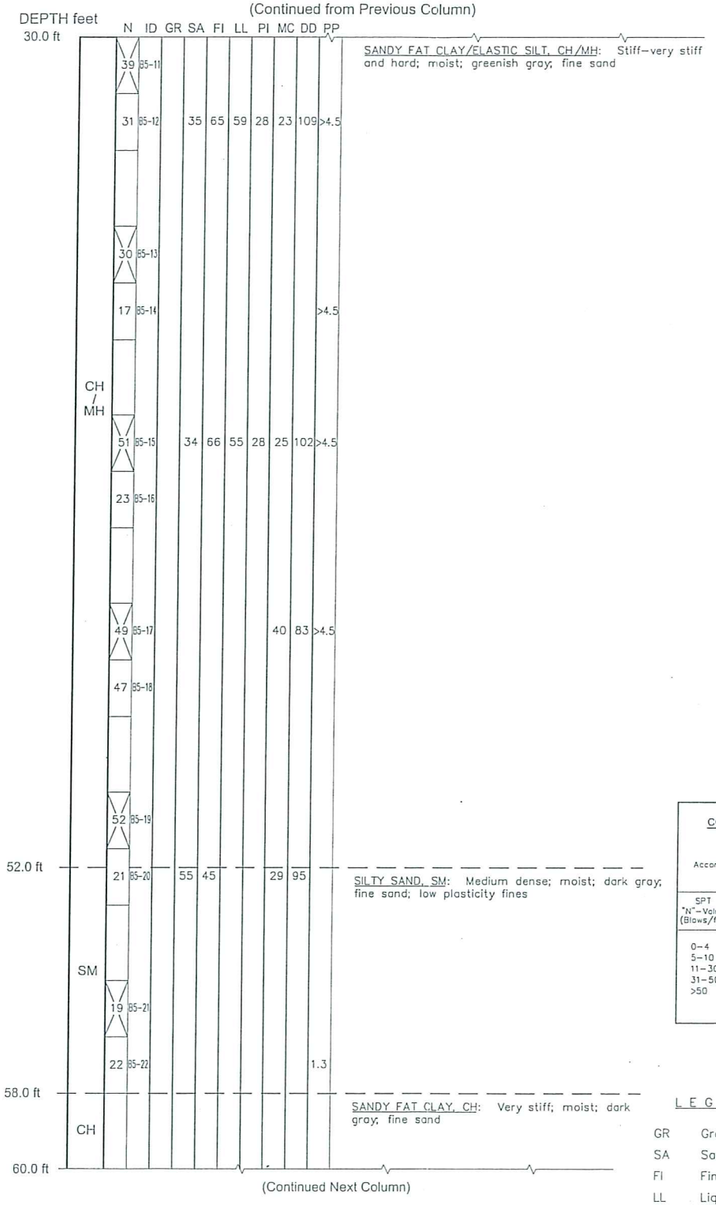

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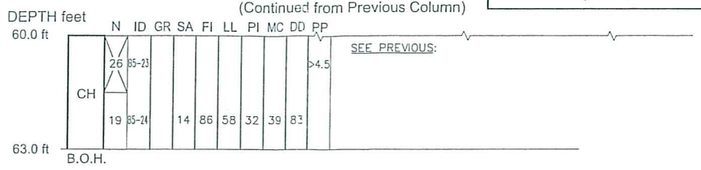

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER ROBERT B. LOKTEFF No. 59558 EXP. 12-31-07 CIVIL STATE OF CALIFORNIA

Blackburn Consulting, Inc.
2437 Front Street
West Sacramento, CA 95691

File No. 788.1

Wood Rodgers, Inc.
3301 C Street, Building 100-B
Sacramento, CA 95816

CONSISTENCY CLASSIFICATION FOR SOILS

According to the Standard Penetration Test

SPT "N"-Value (Blows/ft.)	Granular	SPT "N"-Value (Blows/ft.)	Cohesive
0-4	Very Loose	<2	Very Soft
5-10	Loose	2-4	Soft
11-30	Medium Dense	5-8	Firm
31-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very Stiff
		>31	Hard

NOTES:
1. Field classification of soils was in accordance with ASTM D 2488-00 "Description and Identification of Soils (Visual-Manual Procedure)".
2. Standard Penetration tests were performed in accordance with ASTM D 1586-99 using a hammer operated with an automated drop system. Drill rods were 1 5/8-inch diameter "A"-rods; sampler was driven with brass liners.
3. "2.5 inch sampler": ID=2.5 inch, OD=2.9 inch. Driven in same manner as SPT ("1.4 inch") sampler.
4. The length of each sampled interval is shown graphically on the boring log. Whole number blow counts ("N") represent the "standard penetration resistance" interval in accordance with ASTM D1586-99. Where less than 1 foot of penetration is achieved, the blow count shown is for that fraction of the "standard penetration resistance" interval actually penetrated.
5. Groundwater surface (GWS) elevations in the borings indicated on the Log of Test Boring Sheets reflect the fluid level in the borings on the specified date.
6. Groundwater surface elevations are subject to seasonal fluctuations and may occur at higher or lower elevations depending on the conditions at any particular time.
7. Boring elevations were estimated based on topography provided by Wood Rodgers, Inc.
8. Boring was drilled using 8-inch hollow stem auger to 8 feet depth then 4-inch rotary wash to full depth of boring.
9. Boring was grout backfilled at completion with a mixture of Portland Cement and water.
10. Boring was drilled by Breece Franks of Taber Consultants using a CME 75 drill rig. Boring was logged by James Robbins of Blackburn Consulting. Boring was drilled on May 18, 2006.
11. Consistency of soils is shown in ( ) where estimated.

L E G E N D :

GR	Gravel, percent by weight passing the 3" sieve and retained on the No. 4 sieve.
SA	Sand, percent by weight passing the No. 4 sieve and retained on the No. 200 sieve.
FI	Fines, percent by weight passing the No. 200 sieve.
LL	Liquid Limit.
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SM	Combined field visual identification and/or laboratory classification.
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NP	Nonplastic.
ID	Sample identification.

California Modified Sampler and blow count.

Standard Penetrometer Sampler and blow count.

200-500 psi — 3-inch Shelby Tube and psi to push into soil.

Water Level.

B.O.H. Bottom of Hole.

V E R T I C A L S C A L E : 1" = 2'

DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	J. B. Robbins FIELD INVESTIGATOR	PREPARED FOR Levee District No. 1 of Sutter County	PROJECT ENGINEER	BRIDGE NO.	STAR BEND LEVEE SETBACK
SIGN OFF DATE	CHECKED BY	R. B. Lokteff	DATE April 2006			POST MILE	LOG OF TEST BORINGS No. 4

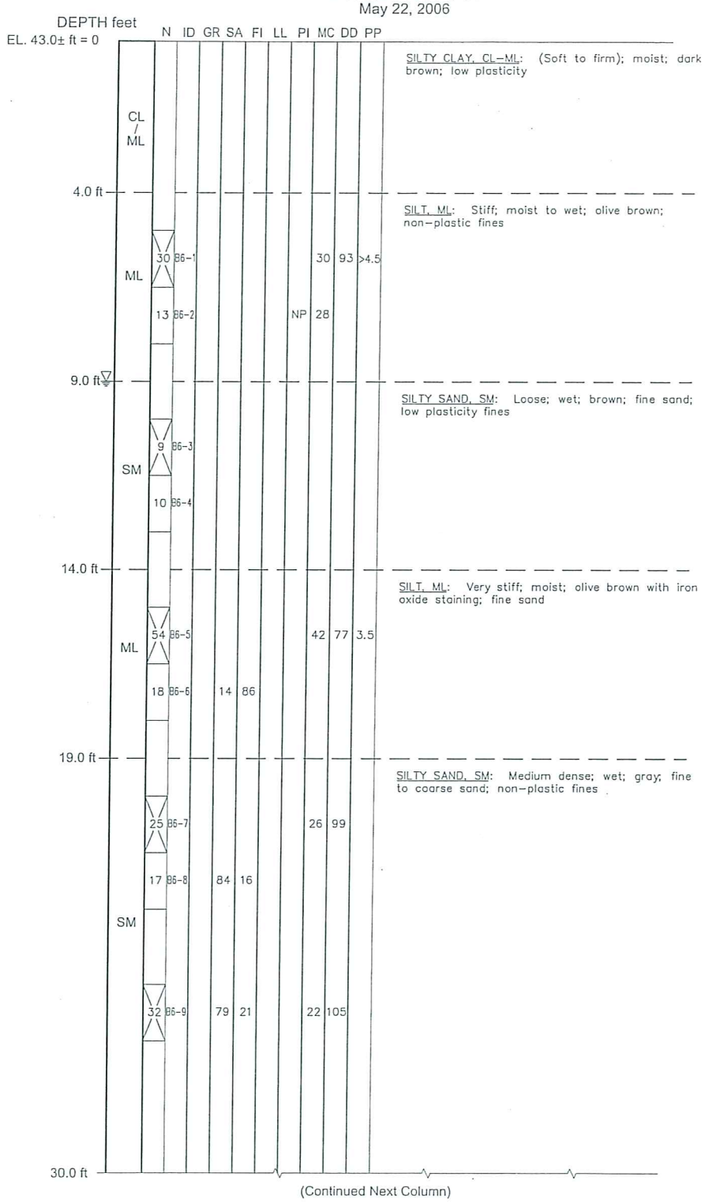
10/20/06 788.1 Star Bend Levee Setback Logs.dwg

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

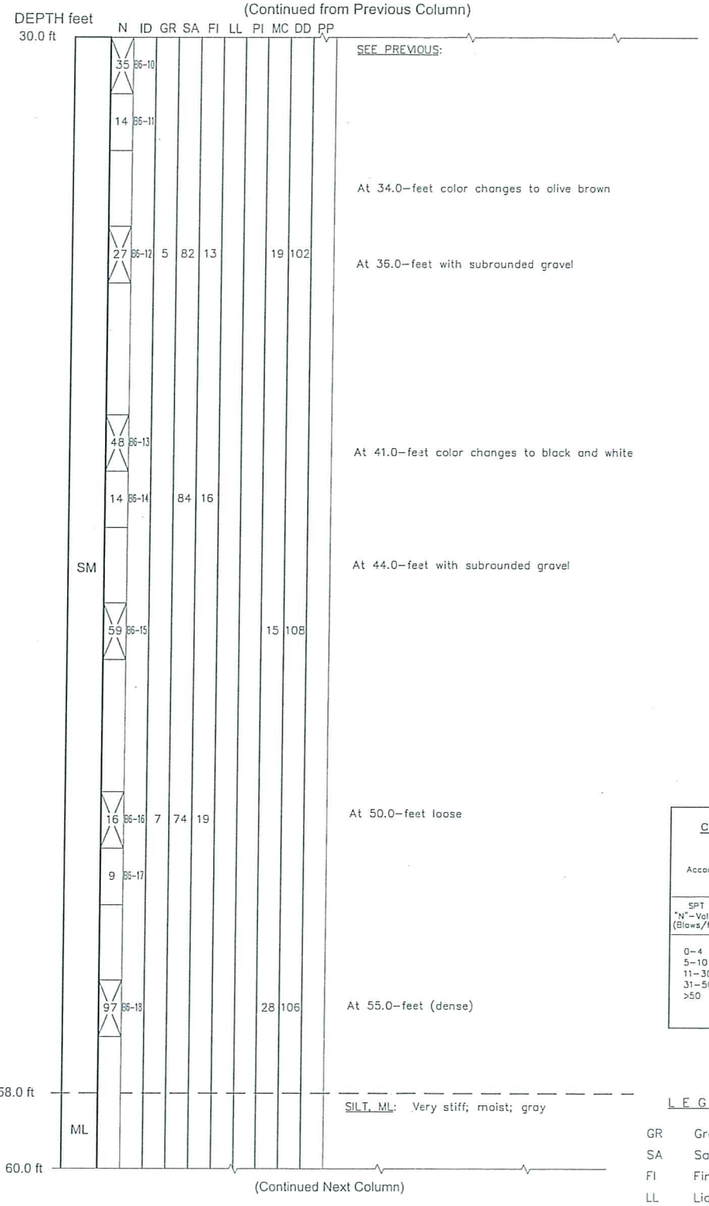
DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) | SHEET | OF

BORING NO. 6-06
May 22, 2006



BORING NO. 6-06
(Continued from Previous Column)



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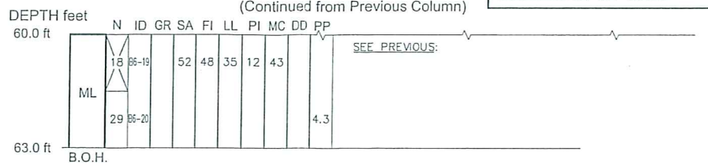
(Continued from Previous Column)



REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER ROBERT B. LOKTEFF No. 59558 EXP. 12-31-07 CIVIL STATE OF CALIFORNIA

Blackburn Consulting, Inc.
2437 Front Street
West Sacramento, CA 95691

File No. 788.1

Wood Rodgers, Inc.
3301 C Street, Building 100–B
Sacramento, CA 95816

CONSISTENCY CLASSIFICATION FOR SOILS

According to the Standard Penetration Test

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31–50	Dense	9–15	Stiff
>50	Very Dense	16–30	Very Stiff
		>31	Hard

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NP	Nonplastic.
ID	Sample identification.

California Modified Sampler and blow count.

18 Standard Penetrometer Sampler and blow count.

200–500 psi 3–inch Shelby Tube and psi to push into soil.

Water Level.

B.O.H. Bottom of Hole.

V E R T I C A L S C A L E : 1" = 2'

DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	J. B. Robbins FIELD INVESTIGATOR	PREPARED FOR Levee District No. 1 of Sutter County	PROJECT ENGINEER	BRIDGE NO.
SIGN OFF DATE	CHECKED BY	R. B. Lokteff	DATE April 2006			POST MILE

STAR BEND LEVEE SETBACK

LOG OF TEST BORINGS No. 5

10/20/06 788.1 Star Bend Levee Setback Logs.dwg

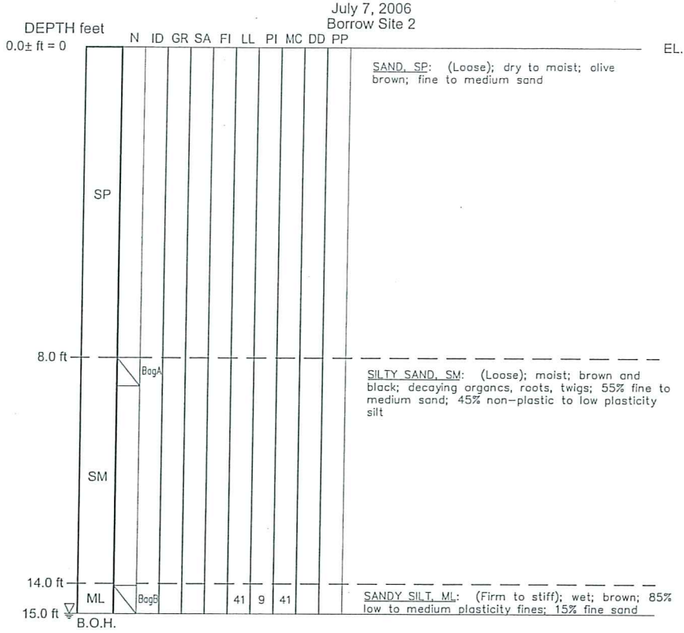
ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) | SHEET | OF

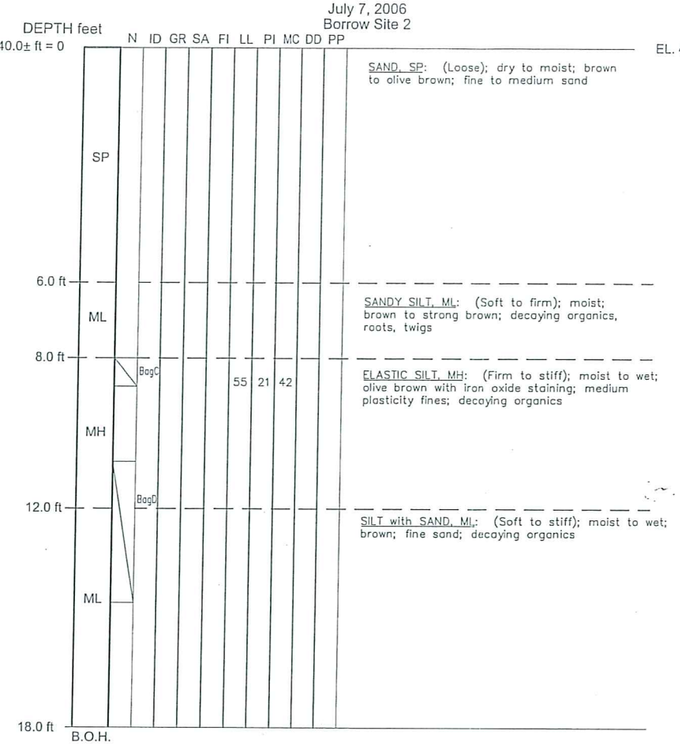
TEST PIT NO. 1-06

July 7, 2006
Borrow Site 2



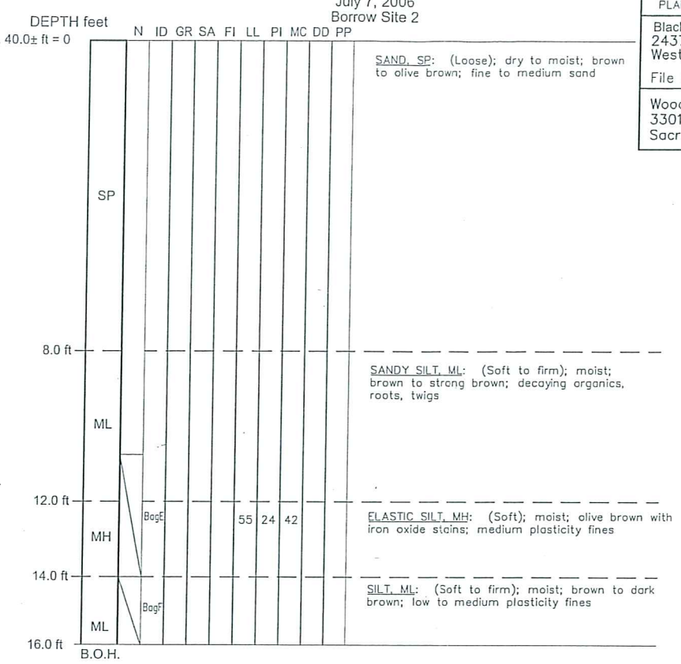
TEST PIT NO. 2-06

July 7, 2006
Borrow Site 2



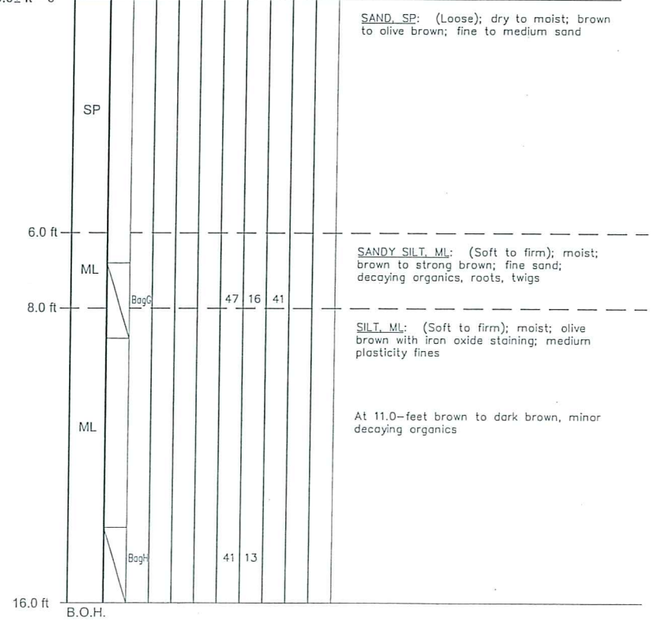
TEST PIT NO. 3-06

July 7, 2006
Borrow Site 2



TEST PIT NO. 4-06

July 7, 2006
Borrow Site 2



VERTICAL SCALE: 1" = 2'

NOTES:
1. Field classification of soils was in accordance with ASTM D 2488-00 "Description and Identification of Soils (Visual-Manual Procedure)".
2. The length of each sampled interval is shown graphically on the boring log.
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8. Test pit were excavated using a John Deere backhoe with a 24-inch wide bucket to full depth.
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10. Test pits were logged by James Robbins of Blackburn Consulting. Test pits were excavated on July 7, 2006.
11. Consistency of soils is shown in ( ) where estimated.

LEGEND:

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MC	Laboratory determined moisture content in percent of dry weight.
SM	Combined field visual identification and/or laboratory classification.
N	Number of blows to drive sampler last 12-inches of 18--inch interval.
NP	Nonplastic.
ID	Sample identification.

California Modified Sampler.
Bulk Sample.
Water Level.
B.O.H. Bottom of Hole.

REGISTERED CIVIL ENGINEER

REGISTERED PROFESSIONAL ENGINEER ROBERT B. LOKTEFF No. 59558 EXP. 12-31-07 CIVIL STATE OF CALIFORNIA

PLANS APPROVAL DATE

Blackburn Consulting, Inc.
2437 Front Street
West Sacramento, CA 95691

File No. 788.1

Wood Rodgers, Inc.
3301 C Street, Building 100-B
Sacramento, CA 95816

DESIGN OVERSIGHT
SIGN OFF DATE
DRAWN BY: M. D. Robertson
CHECKED BY: R. B. Lokteff
J. B. Robbins
FIELD INVESTIGATOR
DATE April 2006

PREPARED FOR
Levee District No. 1
of Sutter County

PROJECT ENGINEER

BRIDGE NO.
POST MILE

STAR BEND LEVEE SETBACK

LOG OF TEST PITS No. 1

10/20/06 788.1 Star Bend Levee Setback Logs.dwg

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY)

SHEET OF

TEST PIT NO. 5-06

July 7, 2006
Borrow Site 2

DEPTH feet		N	ID	GR	SA	FI	LL	PI	MC	DD	PP	
0.0± ft = 0	SP											SAND, SP: (Loose); dry; olive brown to brown; fine to medium sand
2.0 ft	SM											SILTY SAND, SM: (Loose); dry; brown to olive brown; fine sand; low plasticity fines
3.0 ft	SP											SAND, SP: Loose; dry to moist; olive brown to brown; fine to medium sand
5.0 ft	SM											SILTY SAND, SM: (Loose); moist; brown; fine sand; low plasticity fines
8.0 ft	SP											SAND, SP: (Loose); moist to wet; brown; fine to medium sand
11.0 ft	ML	Bag					46	14	42			SANDY SILT, ML: (Soft to firm); moist to wet; dark brown; medium plasticity fines; fine sand; minor decaying organics
15.0 ft	B.O.H.											

TEST PIT NO. 6-06

July 7, 2006
Borrow Site 2

DEPTH feet		N	ID	GR	SA	FI	LL	PI	MC	DD	PP	
EL. 40.0± ft = 0	SP											SAND, SP: (Loose); dry to moist; olive brown; fine to medium sand
6.0 ft	ML											SANDY SILT, ML: (Firm to stiff); moist; dark reddish brown; low plasticity fines; minor organics, twigs, roots
9.0 ft	MH	Bag					53	20	37			ELASTIC SILT, MH: (Firm to stiff); moist; olive brown with iron oxide stains; medium plasticity fines
12.0 ft	ML											SILT, ML: (Firm); moist; dark brown to dark gray; low plasticity fines
15.0 ft	B.O.H.											

TEST PIT NO. 7-06

July 7, 2006
Borrow Site 1

DEPTH feet		N	ID	GR	SA	FI	LL	PI	MC	DD	PP	
EL. 40.0± ft = 0	SM											SILTY SAND, SM: (Loose); dry to moist; olive brown to brown; fine sand; low plasticity fines; weakly cemented
4.0 ft	ML											SANDY SILT, ML: (Firm); moist; brown; low plasticity fines; fine sand
8.0 ft	MH	Bag	K				57	23				ELASTIC SILT, MH: (Firm to stiff); moist; olive brown with iron oxide stains; medium plasticity fines
11.0 ft	ML	Bag	L				38	11	28			SILT, ML: (Firm to stiff); moist; dark brown to dark reddish brown; low plasticity fines
18.0 ft	B.O.H.											

TEST PIT NO. 8-06

July 7, 2006
Borrow Site 1

DEPTH feet		N	ID	GR	SA	FI	LL	PI	MC	DD	PP	
0.0± ft = 0	SP											SAND, SP: (Loose); dry; olive brown; fine to medium sand
2.0 ft	ML											SANDY SILT, ML: (Firm); moist; olive brown; low plasticity fines; fine sand; weakly cemented
4.0 ft	MH											ELASTIC SILT, MH: (Stiff); moist; olive brown with iron oxide staining; medium plasticity fines
8.0 ft	ML											SILT with SAND, ML: (Firm to stiff); moist to wet; brown; low plasticity fines; dark gray fine sand
10.0 ft	MH											ELASTIC SILT, MH: (Stiff); moist; olive brown with iron oxide staining; medium plasticity fines
12.0 ft	ML											SILT with SAND, ML: (Firm to stiff); moist to wet; brown; low plasticity fines; dark gray fine sand
16.0 ft	B.O.H.											

VERTICAL SCALE: 1" = 2'

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER ROBERT B. LOKTEFF No. 59558 EXP. 12-31-07 CIVIL STATE OF CALIFORNIA

Blackburn Consulting, Inc.
2437 Front Street
West Sacramento, CA 95691

File No. 788.1

Wood Rodgers, Inc.
3301 C Street, Building 100-B
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NOTES:
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ID	Sample identification.

California Modified Sampler.
Bulk Sample.
Water Level.
B.O.H. Bottom of Hole.

DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	J. B. Robbins FIELD INVESTIGATOR	PREPARED FOR Levee District No. 1 of Sutter County	BRIDGE NO.
SIGN OFF DATE	CHECKED BY	R. B. Lokteff	DATE April 2006	PROJECT ENGINEER	POST MILE

STAR BEND LEVEE SETBACK

LOG OF TEST PITS No. 2

10/20/06 788.1 Star Bend Levee Setback Logs.dwg

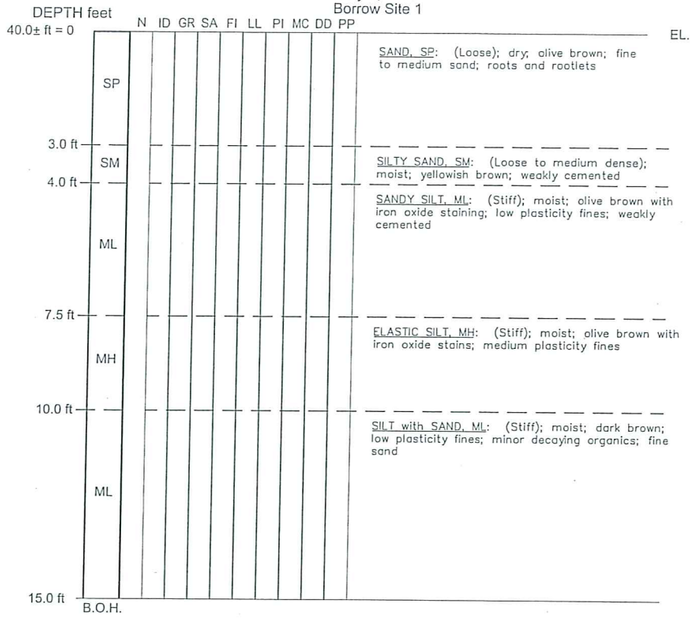
ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) | SHEET | OF

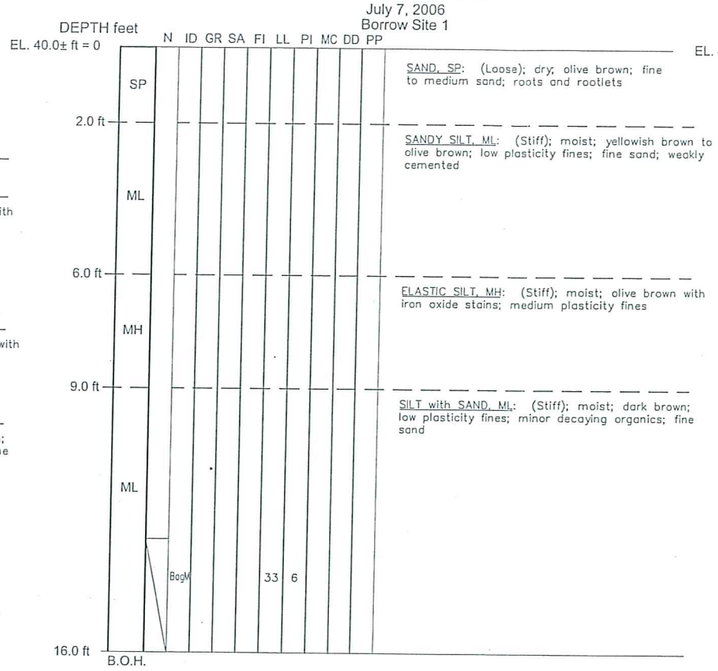
TEST PIT NO. 9-06

July 7, 2006
Borrow Site 1



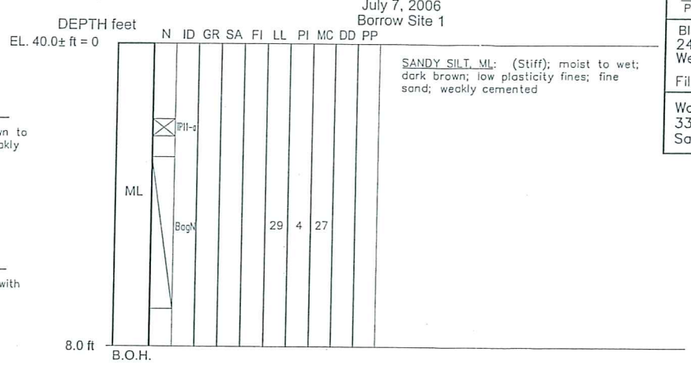
TEST PIT NO. 10-06

July 7, 2006
Borrow Site 1



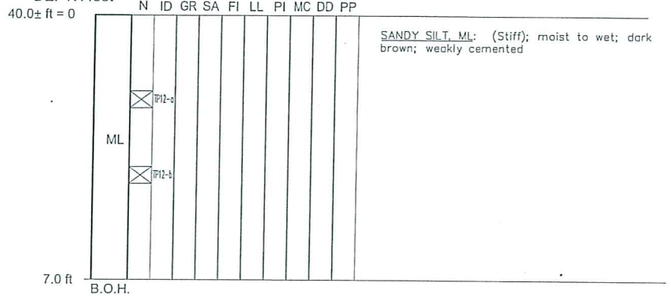
TEST PIT NO. 11-06

July 7, 2006
Borrow Site 1



TEST PIT NO. 12-06

July 7, 2006
Borrow Site 1



REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
ROBERT B. LOKTEFF
No. 59558
EXP. 12-31-07
CIVIL
STATE OF CALIFORNIA

Blackburn Consulting, Inc.
2437 Front Street
West Sacramento, CA 95691

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ID	Sample identification.

California Modified Sampler.

Bulk Sample.

Water Level.

B.O.H. Bottom of Hole.

DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	J. B. Robbins FIELD INVESTIGATOR	PREPARED FOR Levee District No. 1 of Sutter County	PROJECT ENGINEER	BRIDGE NO.
SIGN OFF DATE	CHECKED BY	R. B. Lokteff	DATE April 2006			POST MILE

STAR BEND LEVEE SETBACK

LOG OF TEST PITS No. 3

10/20/06 788.1 Star Bend Levee Setback Logs.dwg

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) | SHEET | OF

Cone Penetration Testing Procedure (CPT)

Gregg In Situ, Inc. carries out all Cone Penetration Tests (CPT) using an integrated electronic cone system, *Figure CPT*. The soundings were conducted using a 20 ton capacity cone with a tip area of 15 cm^2 and a friction sleeve area of 225 cm^2. The cone is designed with an equal end area friction sleeve and a tip end area ratio of 0.85.

The cone takes measurements of cone bearing (q_c), sleeve friction (f_s) and penetration pore water pressure (u_2) at 5-cm intervals during penetration to provide a nearly continuous hydrogeologic log. CPT data reduction and interpretation is performed in real time facilitating on-site decision making. The above mentioned parameters are stored on disk for further analysis and reference. All CPT soundings are performed in accordance with revised (2002) ASTM standards (D 5778-95).

The cone also contains a porous filter element located directly behind the cone tip (u_2), *Figure CPT*. It consists of porous plastic and is 5.0mm thick. The filter element is used to obtain penetration pore pressure as the cone is advanced as well as Pore Pressure Dissipation Tests (PPDT's) during appropriate pauses in penetration. It should be noted that prior to penetration, the element is fully saturated with silicon oil under vacuum pressure to ensure accurate and fast dissipation.

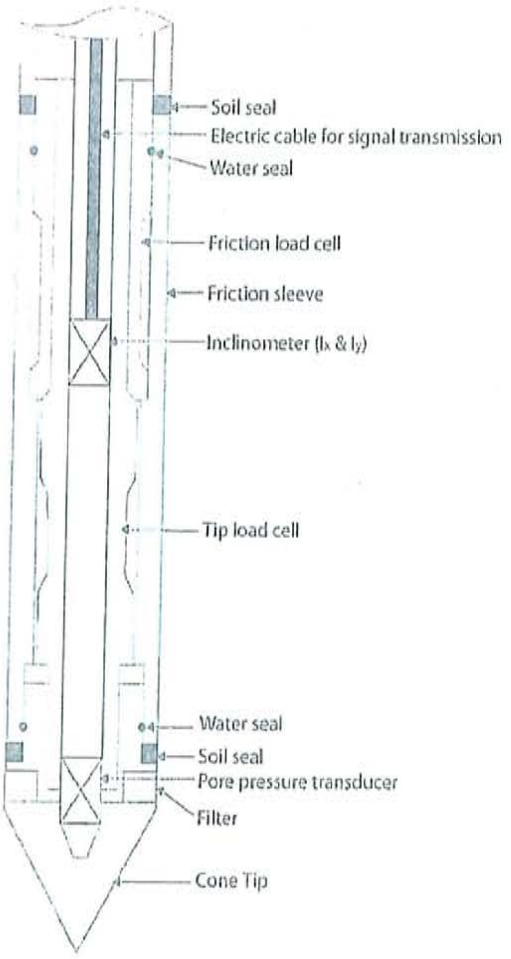


Figure CPT

When the soundings are complete, the test holes are grouted using a Gregg In Situ support rig. The grouting procedures generally consist of pushing a hollow CPT rod with a "knock out" plug to the termination depth of the test hole. Grout is then pumped under pressure as the tremie pipe is pulled from the hole. Disruption or further contamination to the site is therefore minimized.

Cone Penetration Test Data & Interpretation

Soil behavior type and stratigraphic interpretation is based on relationships between cone bearing (q_c), sleeve friction (f_s), and pore water pressure (u_2). The friction ratio (R_f) is a calculated parameter defined by $100 f_s/q_c$ and is used to infer soil behavior type. Generally:

Cohesive soils (clays)

- High friction ratio (R_f) due to small cone bearing (q_c)
- Generate large excess pore water pressures (u_2)

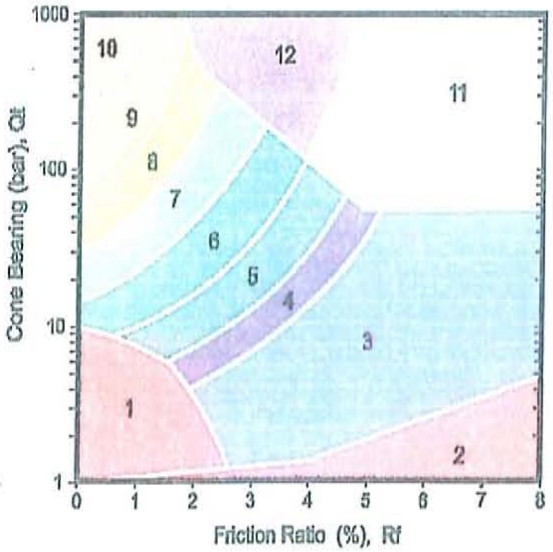
Cohesionless soils (sands)

- Low friction ratio (R_f) due to large cone bearing (q_c)
- Generate very little excess pore water pressures (u_2)

A complete set of baseline readings are taken prior to and at the completion of each sounding to determine temperature shifts and any zero load offsets. Corrections for temperature shifts and zero load offsets can be extremely important, especially when the recorded loads are relatively small. In sandy soils, however, these corrections are generally negligible.

The cone penetration test data collected from your site is presented in graphical form in Appendix CPT. The data includes CPT logs of measured soil parameters, computer calculations of interpreted soil behavior types (SBT), and additional geotechnical parameters. A summary of locations and depths is available in Table 1. Note that all penetration depths referenced in the data are with respect to the existing ground surface.

Soil interpretation for this project was conducted using recent correlations developed by Robertson, 1990, *Figure SBT*. Note that it is not always possible to clearly identify a soil type based solely on q_c, f_s, and u_2. In these situations, experience, judgment, and an assessment of the pore pressure dissipation data should be used to infer the soil behavior type.



ZONE	Qt/N	SBT
1	2	Sensitive, fine grained
2	1	Organic materials
3	1	Clay
4	1.5	Silty clay to clay
5	2	Clayey silt to silty clay
6	2.5	Sandy silt to clayey silt
7	3	Silty sand to sandy silt
8	4	Sand to silty sand
9	5	Sand
10	6	Gravely sand to sand
11	1	Very stiff fine grained*
12	2	Sand to clayey sand*

*over consolidated or cemented

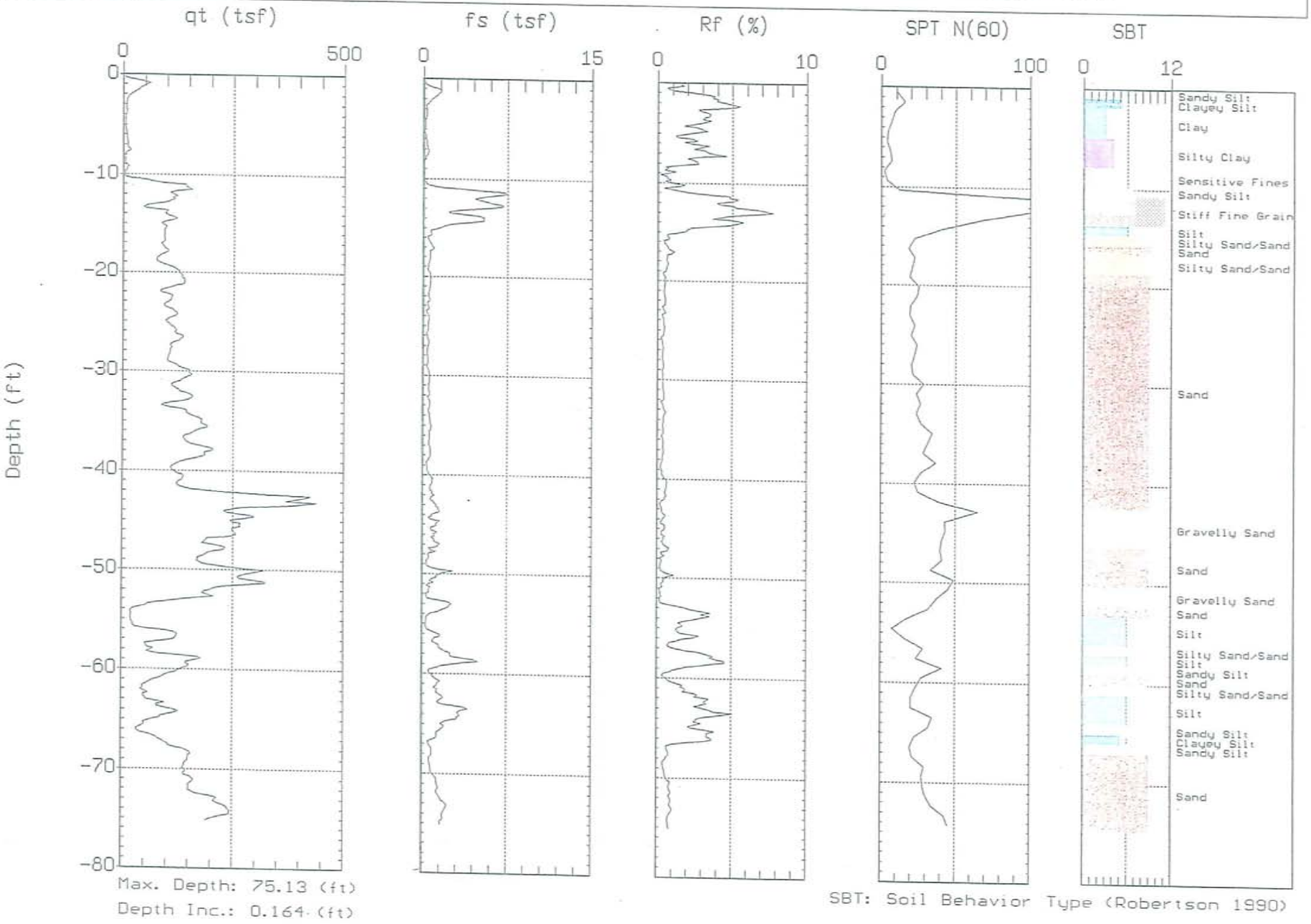
Figure SBT

GREGG

BLACKBURN CONSULTING

Site: STARBENT SET BACK
Location: CPT-01

Engineer: J.ROBBINS
Date: 05:05:06 09:12



Max. Depth: 75.13 (ft)
Depth Inc.: 0.164 (ft)

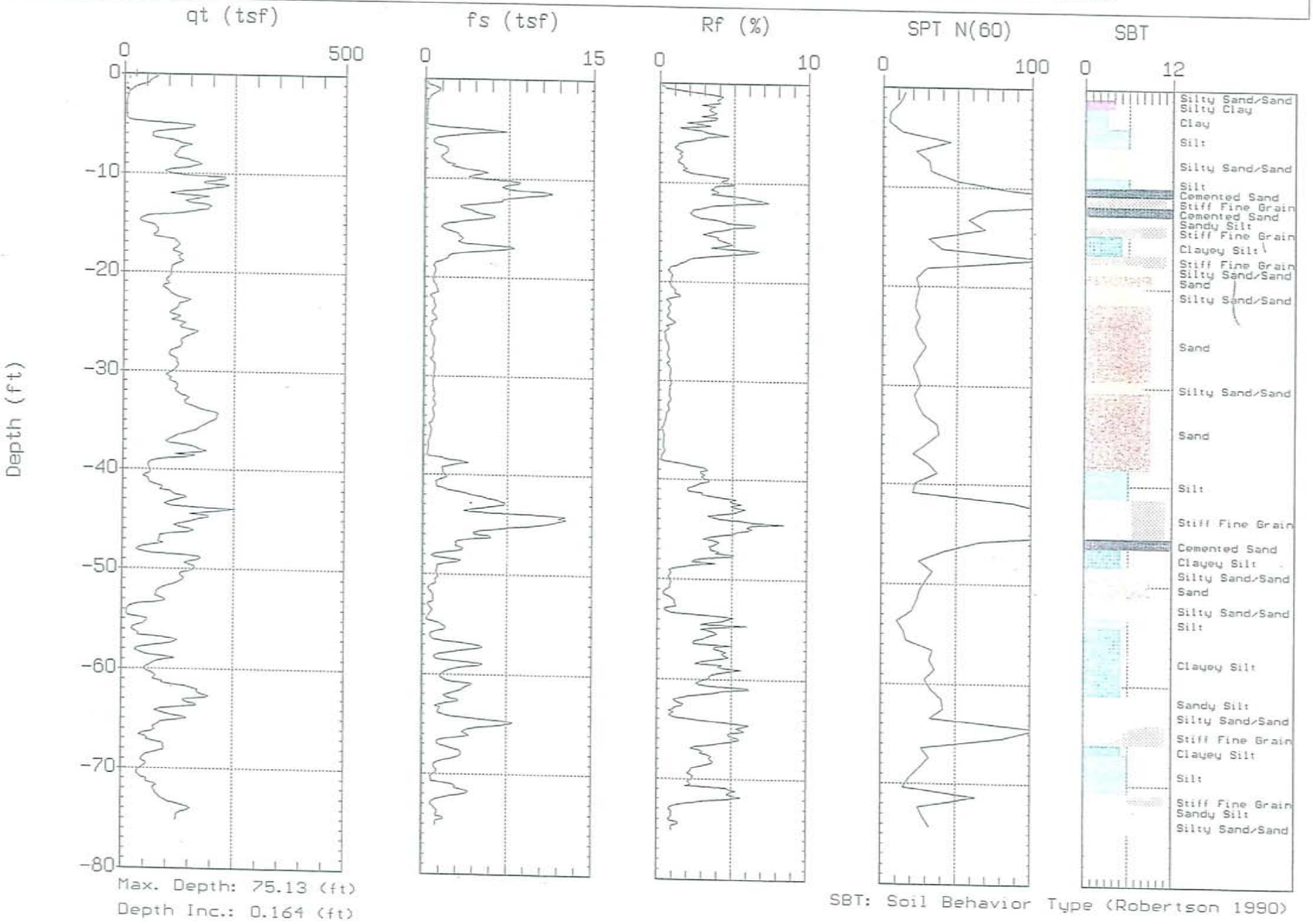
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BLACKBURN CONSULTING

Site: STARBENT SET BACK
Location: CPT-02

Engineer: J.ROBBINS
Date: 05:05:06 10:33



Max. Depth: 75.13 (ft)
Depth Inc.: 0.164 (ft)

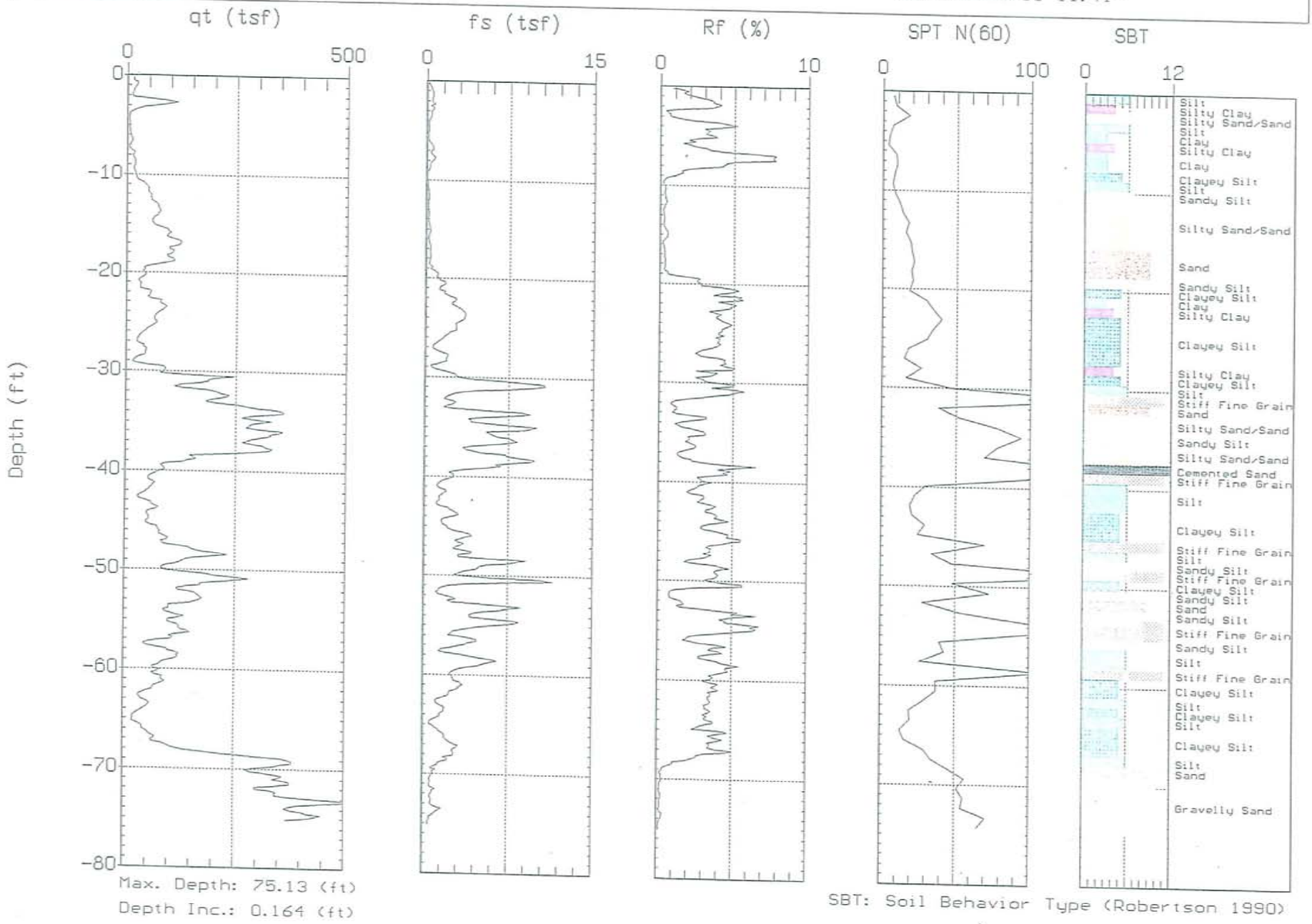
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BLACKBURN CONSULTING

Site: STARBENT SET BACK
Location: CPT-03

Engineer: J.ROBBINS
Date: 05:05:06 11:41



Max. Depth: 75.13 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

Star Bend Setback Levee

Laboratory Test Summary
Samples From Exploratory Borings

Boring #	Sample #	Depth (Feet)	USCS	Dry Density (lb/ft³)	Natural Moisture (%)	% Sand	% Fines	Liquid Limit	Plasticity Index	Unconfined Compressive Strength (tsf)
B1	1-1	5.5-6.0	CL-Fill	119	16	16	84	38	15	
B1	1-3	10.0-10.5	SP-Fill		13					
B1	1-6	16.5-17	ML-Fill	103	22					
B1	1-7	20.5-21.0	ML-Fill			4	96	44	13	
B1	1-10	25.5-26.0	ML	82	36					
B1	1-12	32-32.5	ML		36				NP	
B1	1-13	35.5-36.0	ML	94	30					1.63
B1	1-14	36.5-37.0	SP			91	9			
B1	1-15	45-45.5	SP	98	23	93	7			
B1	1-18	55.0-55.5	SP	97	25	93	7			
B2	2-1	5.5-6.0	SM-Fill	117	11					
B2	2-2	6.0-6.5	SM-Fill			78	22			
B2	2-4	12.0-12.5	CL-ML-Fill			37	63	25	5	
B2	2-5	16.0-16.5	ML-Fill	101	16					
B2	2-6	16.5-17.0	ML-Fill			30	70	28	5	
B2	2-7	21.0-21.5	ML-Fill	100	21					
B3	3-1	6.0-6.5	SM-Fill	104	10					
B3	3-2	6.5-7.0	SM-Fill			80	20			
B3	3-3	11.0-11.5	SM-Fill	106	19					
B3	3-5	16.0-16.5	CL-Fill	100	20					
B3	3-6	16.5-17.0	CL-Fill			9	91	32	14	
B3	3-7	21.0-21.5	CL-Fill	101	22					
B4	4-3	11.0-11.5	SM-Fill	112	10					
B4	4-4	11.5-12.0	SM-Fill			53	47		NP	
B4	4-5	19-19.5	SM-Fill	103	22					
B4	4-6	21.0-21.5	ML-Fill			31	69		NP	
B4	4-7	26.0-26.5	ML	92	30					0.34
B4	4-8	26.5-27.0	ML					27	4	
B4	4-10	36.5-37.0	MH	93	29			50	21	3.23
B4	4-11	37.0-37.5	MH	93	29	8	92			
B4	4-13	42.0-42.5	ML			40	60			
B4	4-14	46.0-46.5	SM			71	29			
B4	4-15	50.5-51	SM	104	22					0.21
B4	4-16	51.5-52.0	SP	100	25	91	9			
B4	4-19	61.0-61.5	ML	79	43	4	96	46	17	
B4	4-23	75.0-75.5	ML	82	37					

Star Bend Setback Levee

Laboratory Test Summary...Continued
Samples From Exploratory Borings

Boring #	Sample #	Depth (Feet)	USCS	Dry Density (lb/ft^3)	Natural Moisture (%)	% Sand	% Fines	Liquid Limit	Plasticity Index	Unconfined Compressive Strength (tsf)
B5	5-2	6.5-7.0	CL	100	20			30	11	
B5	5-3	11.0-11.5	SP	97	17					
B5	5-4	11.5-12.0	SP			92	8			
B5	5-7	21.0-21.5	SP			97	3			
B5	5-11	30.5-31.0	MH	101	24					2.92
B5	5-12	31.5-32.0	MH	109	23	35	65	59	28	
B5	5-15	41.0-41.5	CH	102	25	34	66	55	28	
B5	5-17	46.0-46.5	MH	83	40					0.99
B5	5-20	53.0-53.5	SM	95	29	55	45			
B5	5-24	61.0-61.5	CH	83	39	14	86	58	32	
B6	6-1	6.0-6.5	ML	93	30					
B6	6-2	6.5-7.0	ML		28				NP	
B6	6-5	16.0-16.5	ML	77	42					
B6	6-6	16.5-17.0	ML			14	86			
B6	6-7	21.0-21.5	SM	99	26					
B6	6-8	21.5-22.0	SM			84	16			
B6	6-9	26.0-26.5	SM	105	22	79	21			
B6	6-12	36.0-36.5	SM	102	19	87 (5% grvl)	13			
B6	6-14	41.5-42.0	SM			84	16			
B6	6-15	46.5-47.0	SM	108	15					
B6	6-16	51.0-51.5	SM			81 (7% grvl)	19			
B6	6-18	56.0-56.5	SM	106	28					
B6	6-19	61.0-61.5	ML		43	48	52	35	12	

Star Bend Setback Levee

Laboratory Test Summary
Composite Bulk Samples From Existing Levee Fill

Boring #	Sample #	Depth (Feet)	USCS	Max Dry Density (lb/ft³)	Optimum Moisture (%)	Liquid Limit	Plasticity Index	Percent Gravel	Percent Sand	Percent Fines	Triaxial Test Results*			
											Total Phi (degrees)	Total C (psf)	Effective Phi (degrees)	Effective C (psf)
B1	Bulk 1	1-20	CL	105.1	19.1	36	13	2	23	75	15.4	100	33.3	100
B2	Bulk 2	1-20	CL	118.0	14.0	25	7	1	39	60	8.5	400	31.1	100
B3	Bulk 3	1-20	CL-ML			23	6	0	39	61				
B4	Bulk4	1-200	CL-ML			26	7	1	43	56				

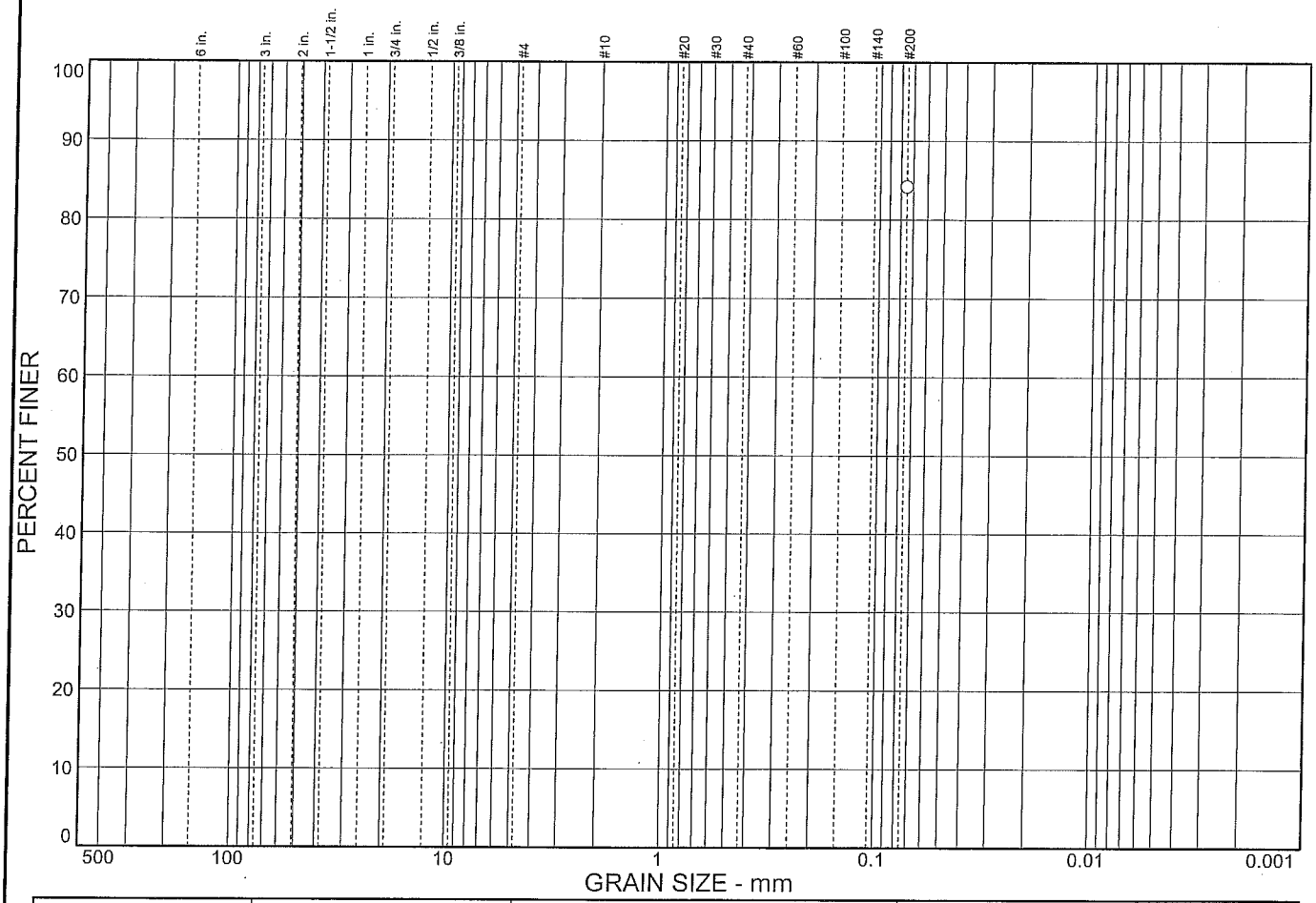
* Specimens compacted to 90% relative compaction based on ASTM D 698

Laboratory Test Summary
Bulk Samples From Test Pits

Test Pit #	Sample #	Depth (Feet)	USCS	Max Dry Density (lb/ft³)	Optimum Moisture (%)	Liquid Limit	Plasticity Index	Natural Moisture (%)	Triaxial Test Results*			
									Total Phi (degrees)	Total C (psf)	Effective Phi (degrees)	Effective C (psf)
TP1	B	14-15	ML			41	9	41				
TP2	C	8-9	MH			55	21	42				
TP3	E	10-14	MH			55	24	42				
TP4	G	7-9	ML			47	16	41				
TP5	I	13-15	ML			46	14	42				
TP6	J	9-12	MH			53	20	37				
TP7	K	8-10	MH	83.3	21.4	57	23		15.7	100	28.5	0
TP7	L	13-15	ML			38	11	28				
TP10	M	13-16	ML			33	6					
TP11	N	4-9	ML			29	4	27				
TP10 &11	L&M	13-16	ML	98.8	20.1	33-38	6-11		16.0	200	28.5	100

*Specimens compacted to 90% relative compaction based on ASRM D698

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
			84.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	84.2		

* (no specification provided)

Material Description

Very dark brown silty clay

Atterberg Limits

PL= 23 LL= 38 PI= 15

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

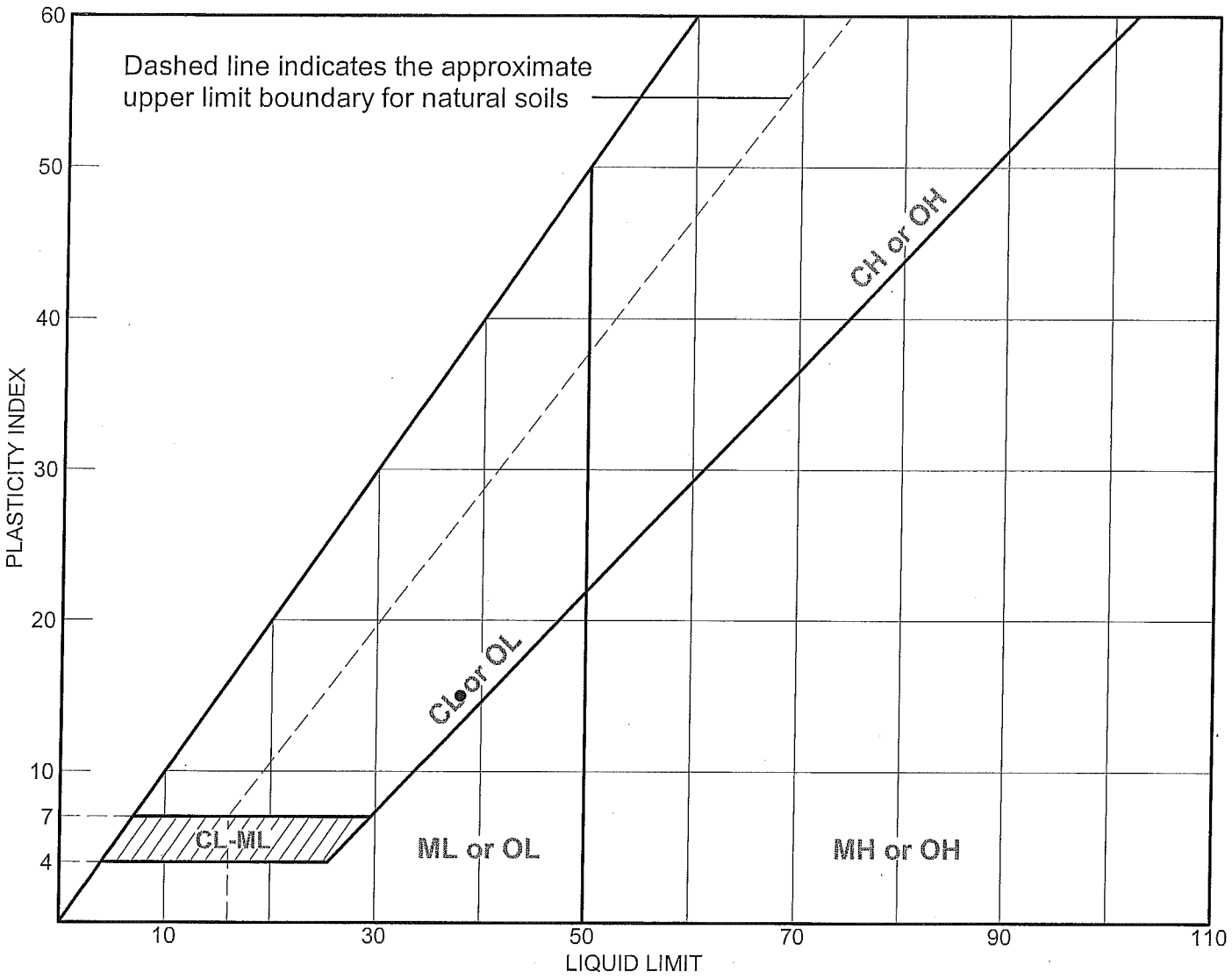
Remarks

Sample No.: B1-1b **Source of Sample:** **Date:** 8-17-06
Location: **Elev./Depth:** 5.5-6.0'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1 **Figure**

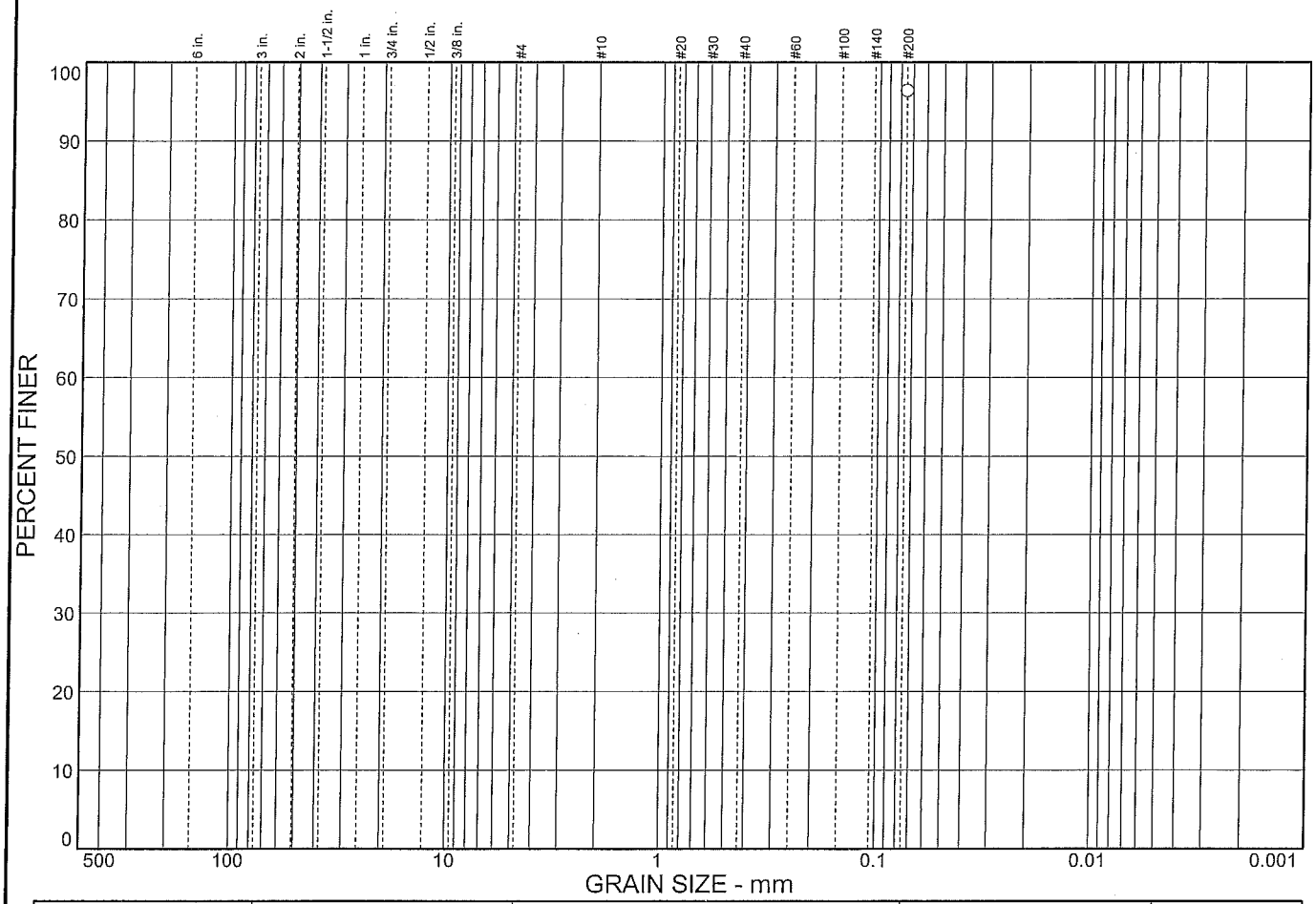
LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		B1-1b	5.5-6.0'		23	38	15	CL

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
			96.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	96.4		

* (no specification provided)

Material Description

Black silt

Atterberg Limits

PL= 31 LL= 44 PI= 13

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO=

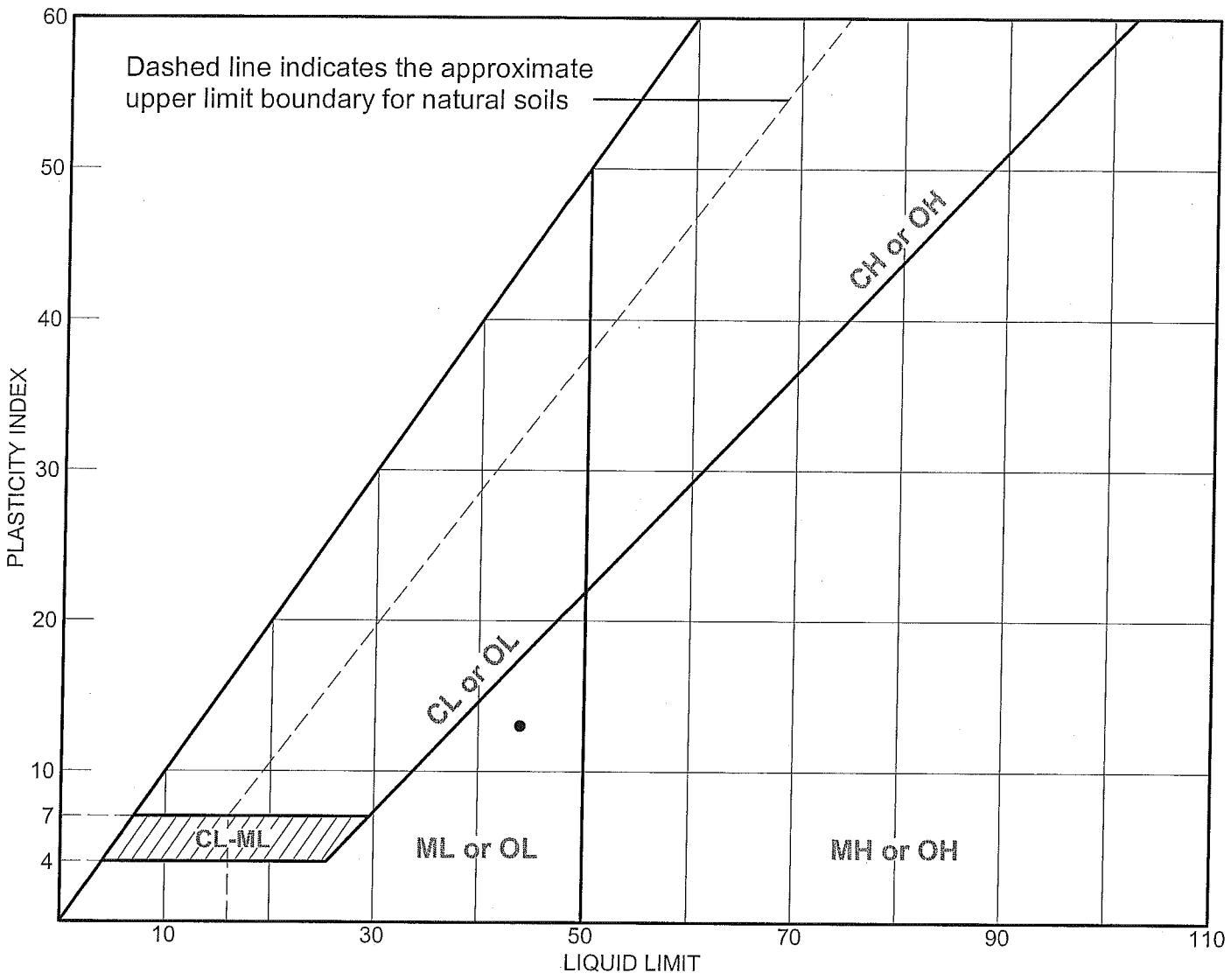
Remarks

Sample No.: B1-7b **Source of Sample:** **Date:** 8-17-06
Location: **Elev./Depth:** 20.5-21.0'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1 **Figure**

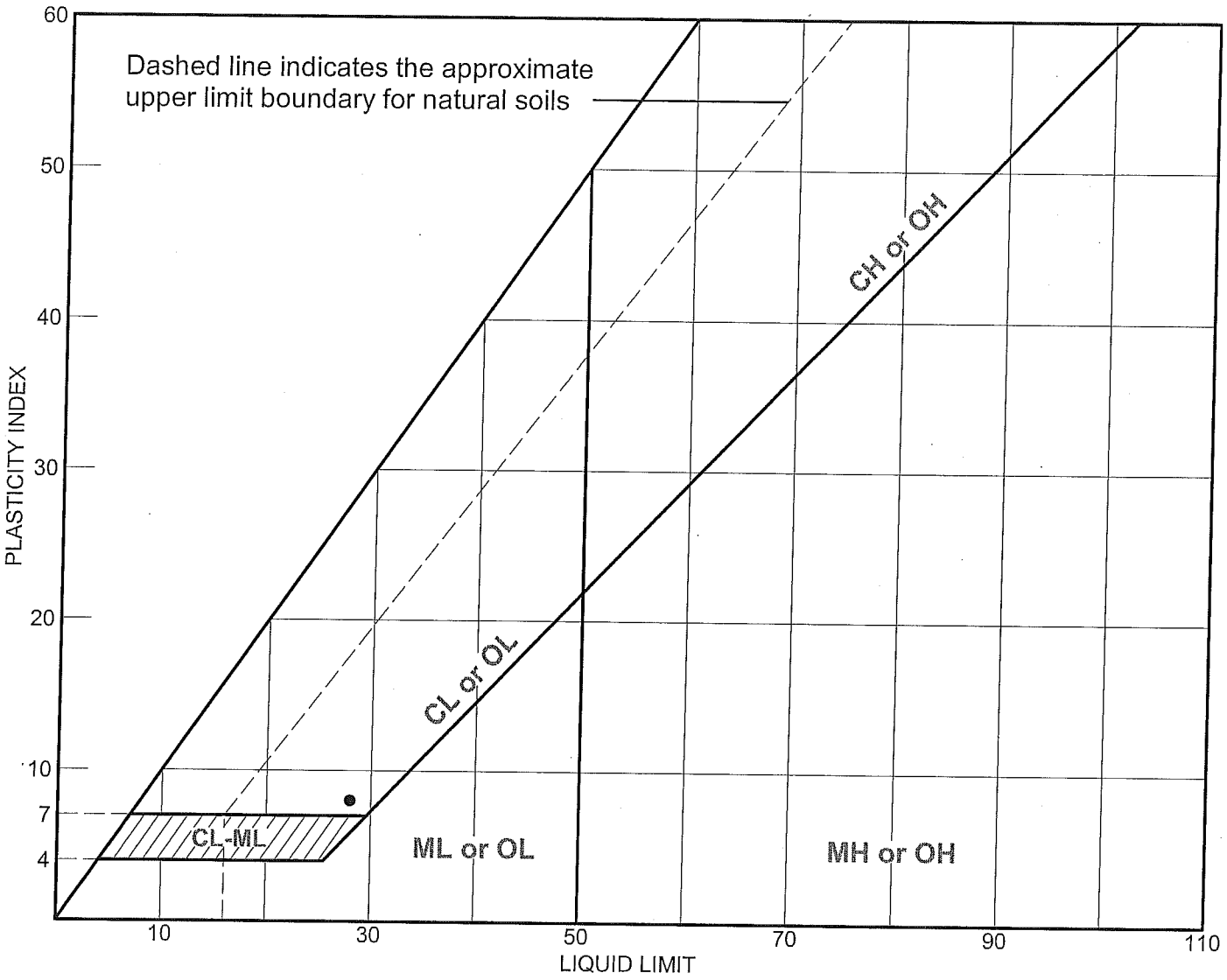
LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		B1-7b	20.5-21.0'		31	44	13	ML

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 Figure

LIQUID AND PLASTIC LIMITS TEST REPORT

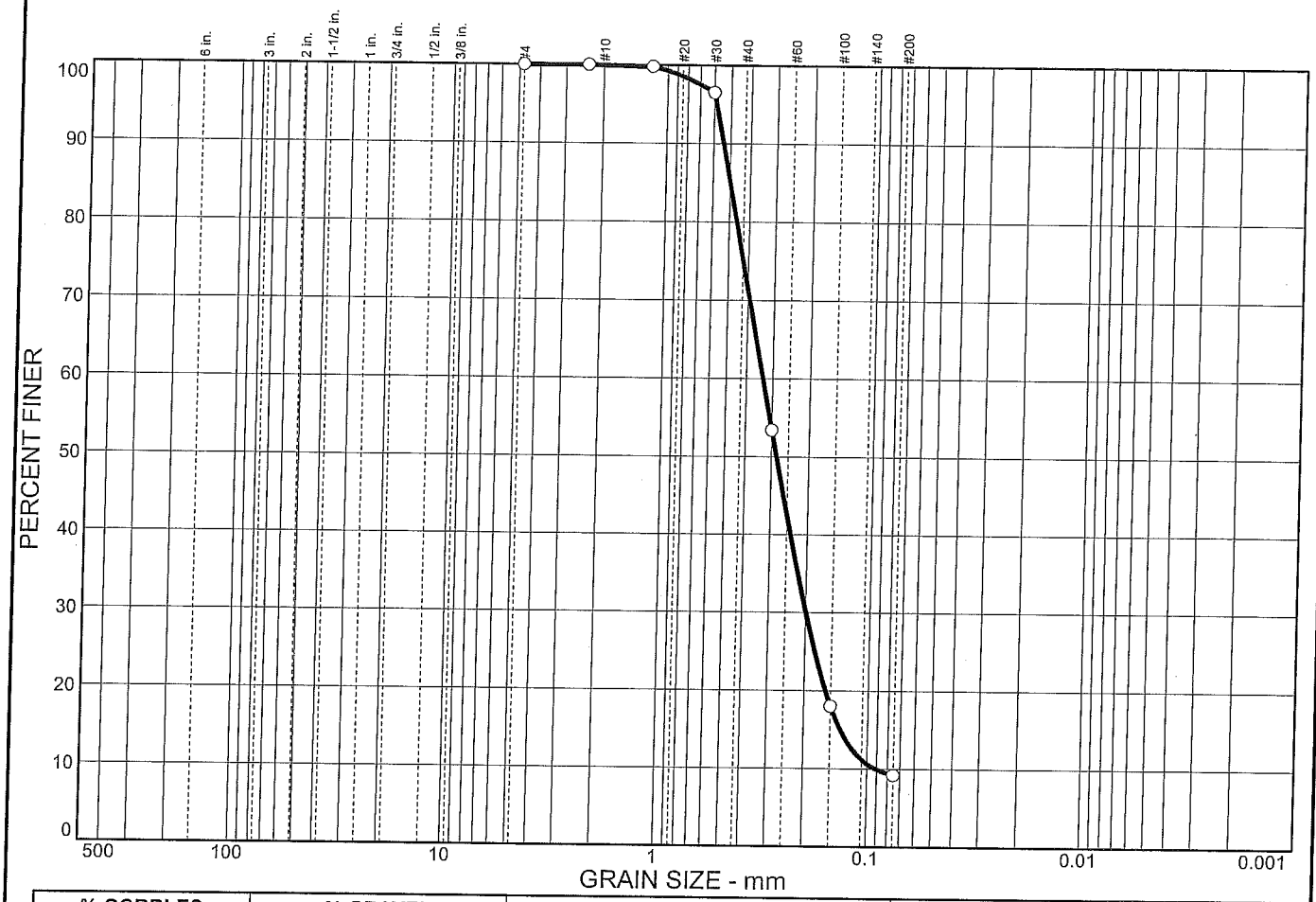


SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		B1-10	27.0-27.5'		20	28	8	CL

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	90.8	9.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	100.0		
#16	99.8		
#30	96.5		
#50	53.4		
#100	18.0		
#200	9.2		

* (no specification provided)

Material Description

Dark yellowish brown poorly graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.498 D_{60}= 0.334 D_{50}= 0.284
D_{30}= 0.200 D_{15}= 0.134 D_{10}= 0.0915
C_u= 3.65 C_c= 1.31

Classification

USCS= SP-SM AASHTO=

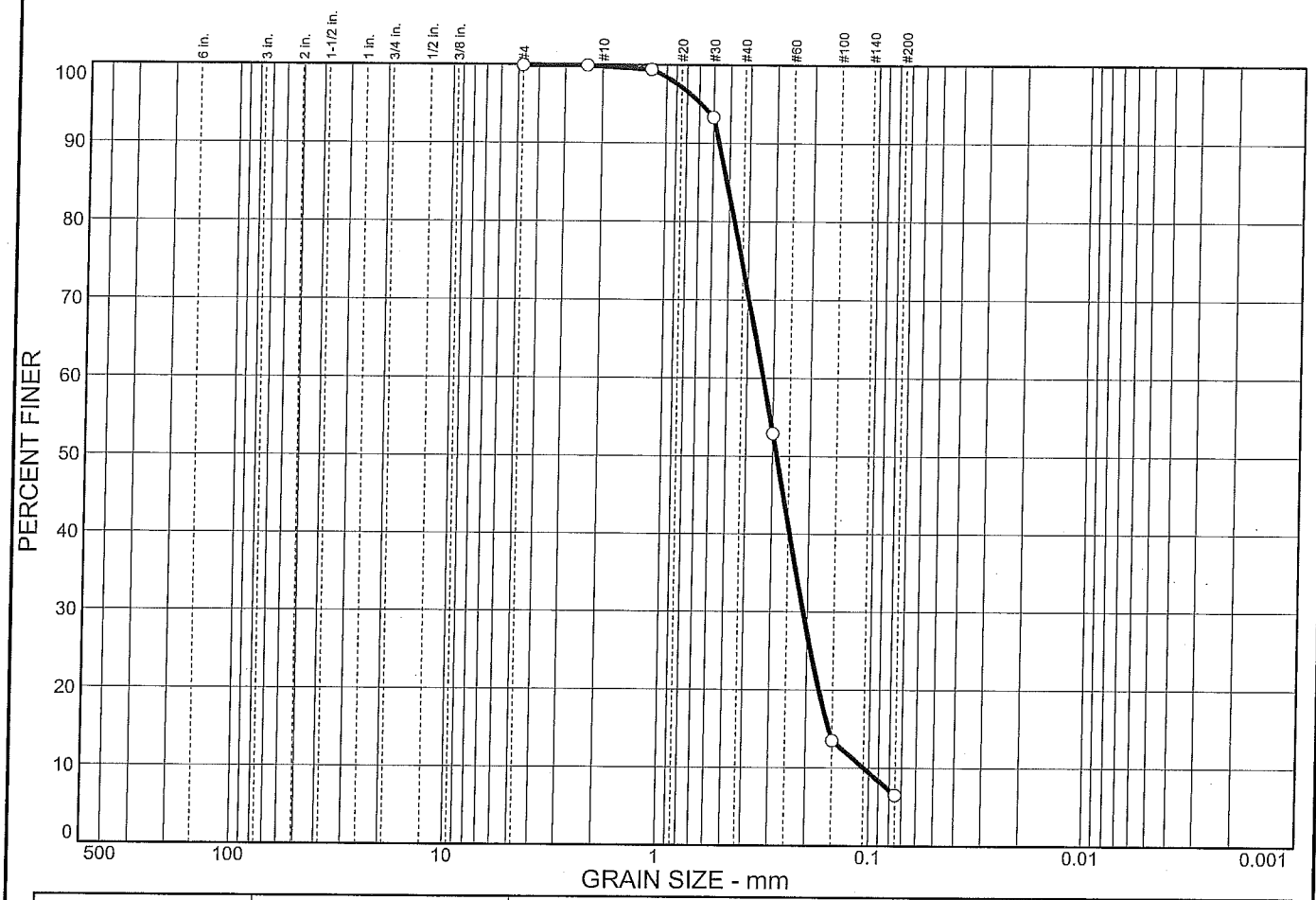
Remarks

Sample No.: B1-14 **Source of Sample:** **Date:** 8-22-06
Location: **Elev./Depth:** 37.0-38.0'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
		93.4	6.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	99.9		
#8	99.9		
#16	99.4		
#30	93.3		
#50	52.9		
#100	13.5		
#200	6.5		

* (no specification provided)

Material Description

Dark olive gray poorly graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.515 D_{60}= 0.336 D_{50}= 0.287
D_{30}= 0.210 D_{15}= 0.156 D_{10}= 0.106
C_u= 3.16 C_c= 1.24

Classification

USCS= SP-SM AASHTO=

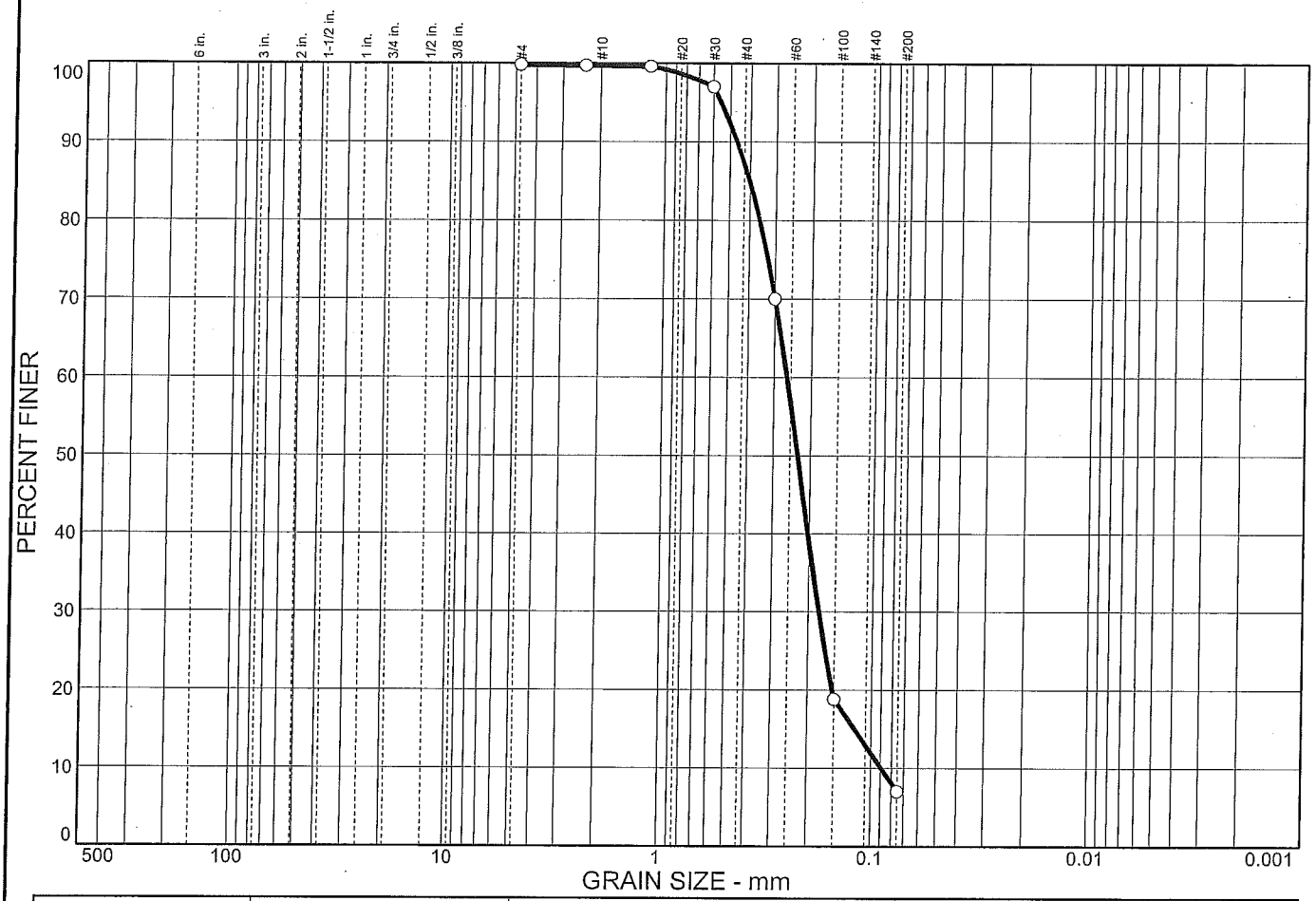
Remarks

Sample No.: B1-17 Source of Sample: Date: 8-22-06
Location: Elev./Depth: 47.5-48.0'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1 Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
		92.8	7.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	99.8		
#8	99.7		
#16	99.6		
#30	97.0		
#50	70.0		
#100	18.8		
#200	7.0		

* (no specification provided)

Material Description

Dark olive gray poorly graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.402 D_{60}= 0.261 D_{50}= 0.230
D_{30}= 0.179 D_{15}= 0.120 D_{10}= 0.0895
C_u= 2.92 C_c= 1.37

Classification

USCS= SP-SM AASHTO=

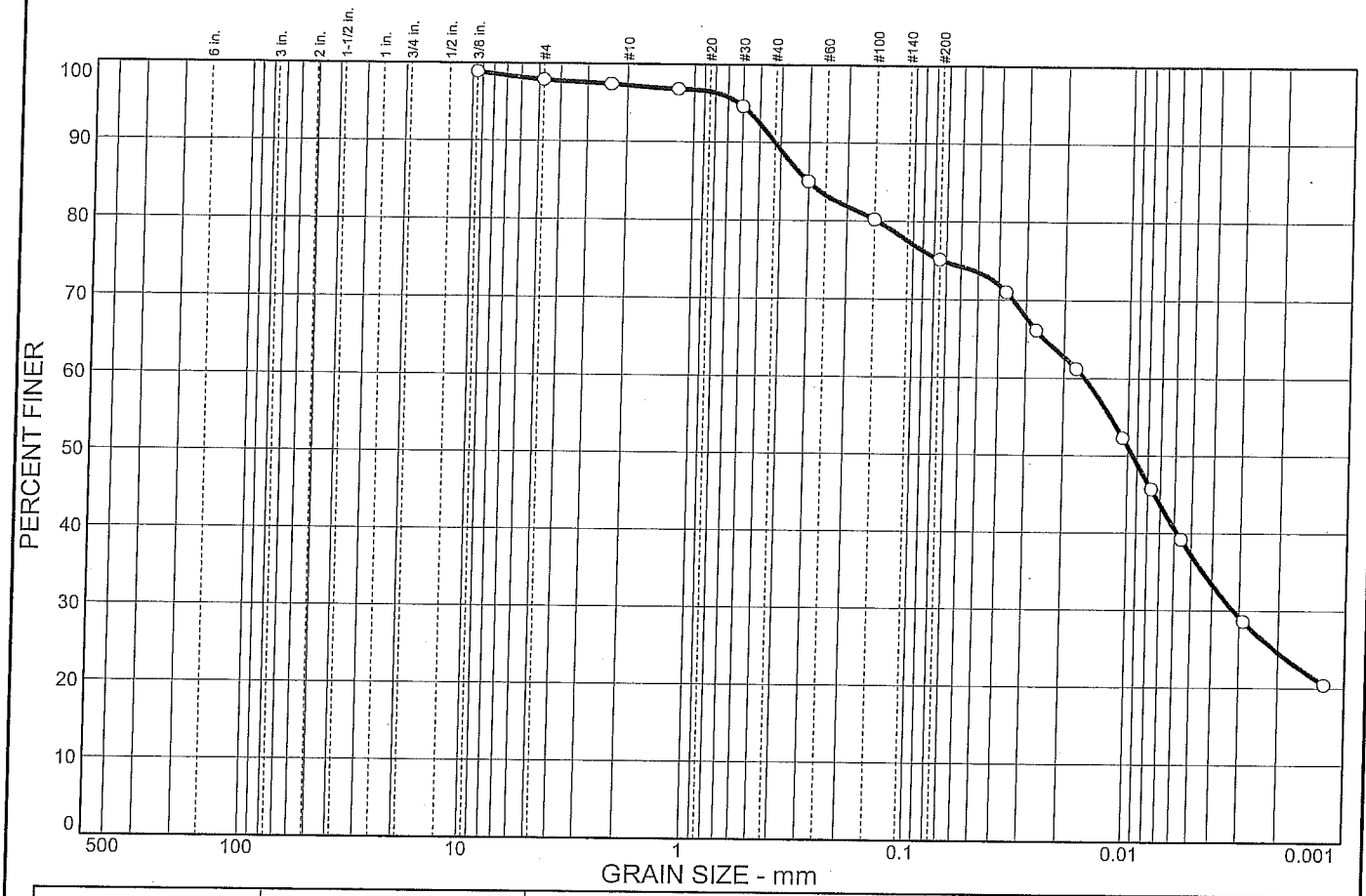
Remarks

Sample No.: B1-20 **Source of Sample:** **Date:** 8-22-06
Location: **Elev./Depth:** 57.5-58.0'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
			0.7	7.3	14.8	37.9	37.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	98.9		
#4	97.9		
#8	97.4		
#16	96.8		
#30	94.6		
#50	85.0		
#100	80.2		
#200	75.1		

* (no specification provided)

Material Description

Olive brown lean clay with sand

Atterberg Limits

PL= 23 LL= 36 PI= 13

Coefficients

D_{85}= 0.300 D_{60}= 0.0160 D_{50}= 0.0095
D_{30}= 0.0032 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

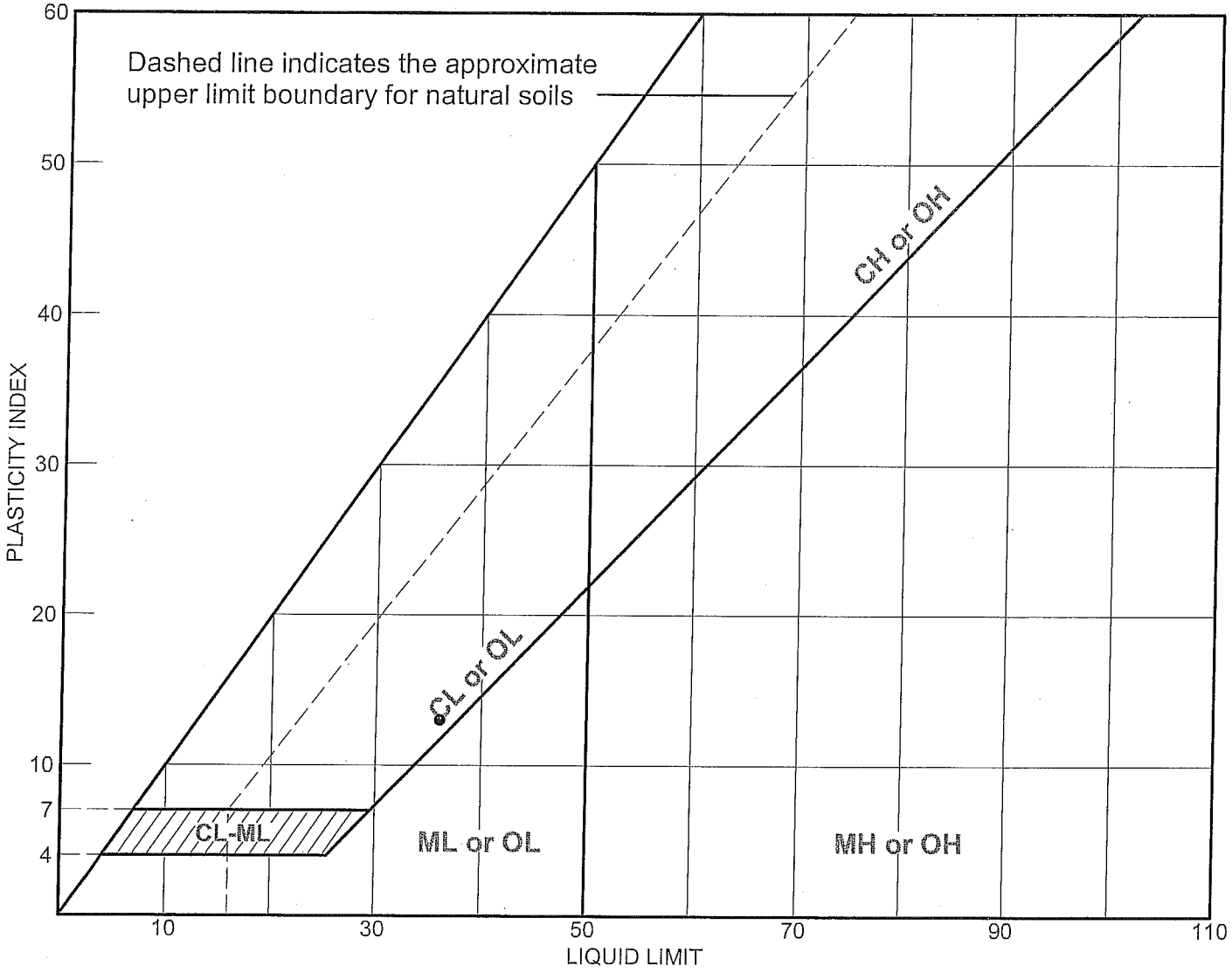
Remarks

Sample No.: Bulk 1 Source of Sample: Date: 6-29-06
Location: Elev./Depth: 1.0-20.0 ft

Blackburn Consulting
W. Sacramento, CA

Client: Wood Rodgers
Project: Star Bend Setback Levee
Project No: 788.1 Figure

LIQUID AND PLASTIC LIMITS TEST REPORT

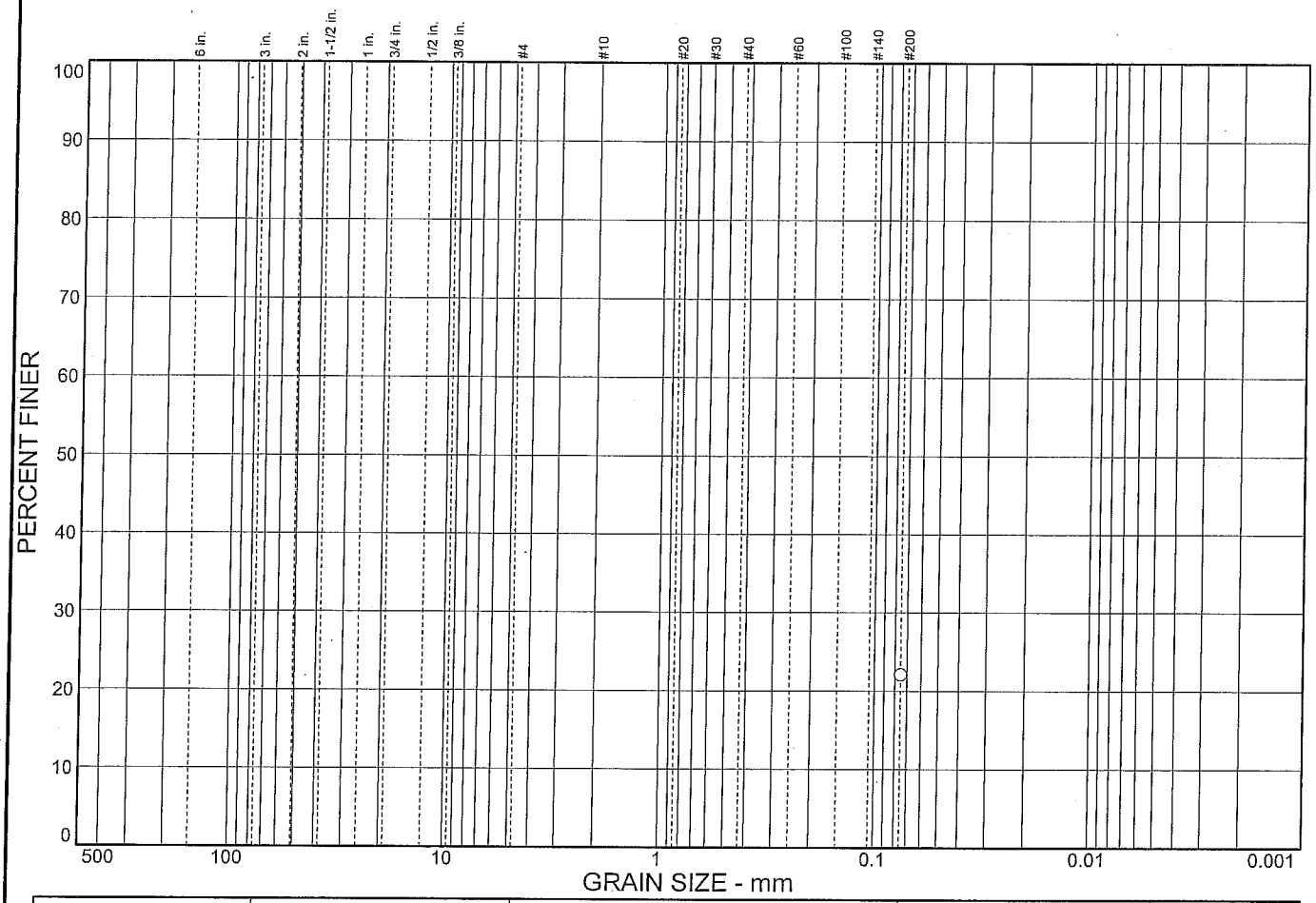


SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		Bulk 1	1.0-20.0 ft		23	36	13	CL

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** Wood Rodgers **Project:** Star Bend Setback Levee **Project No.:** 788.1 Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
			22.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	22.1		

* (no specification provided)

Material Description

Brown silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

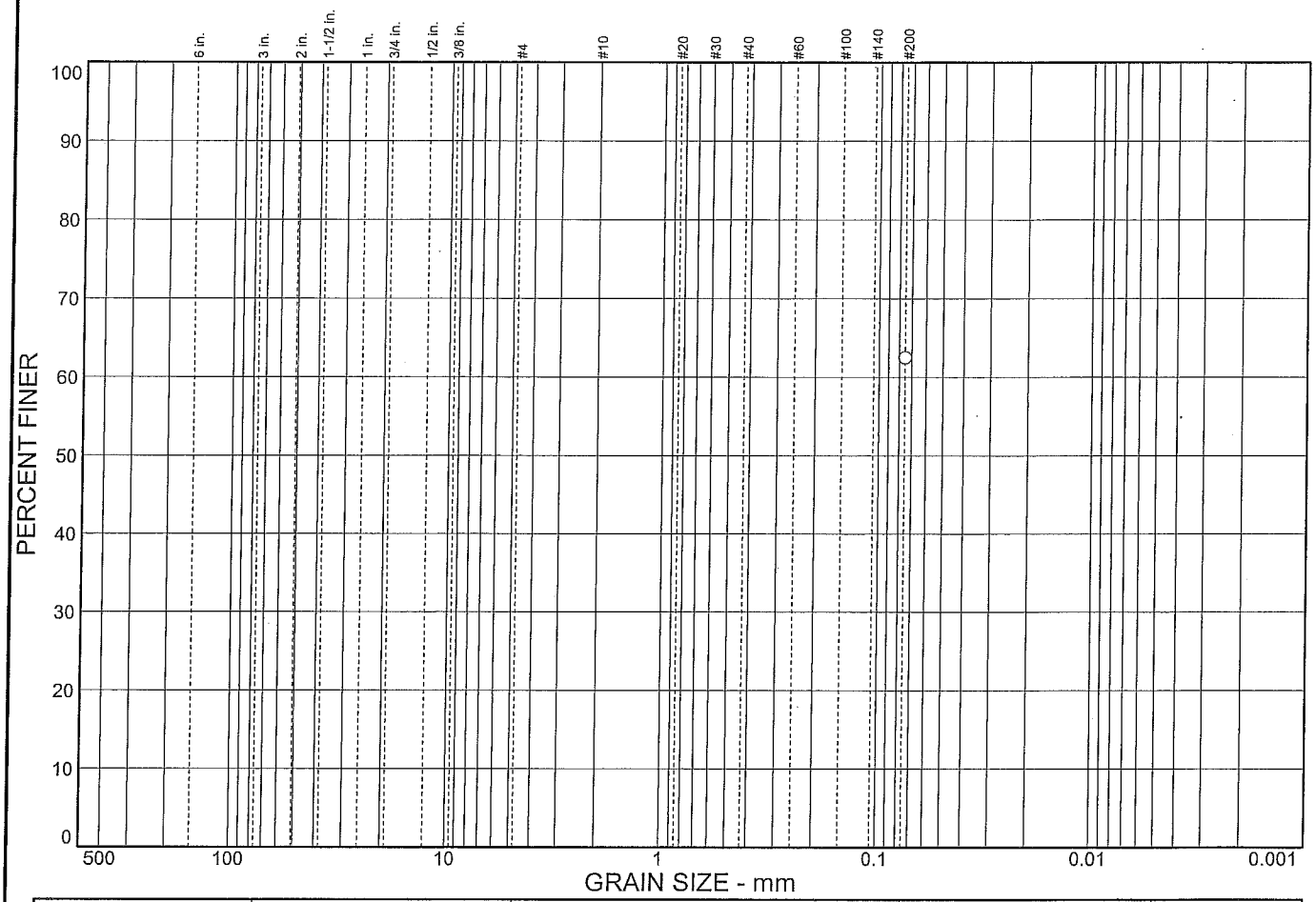
Remarks

Sample No.: B2-2 **Source of Sample:** **Date:** 8-23-06
Location: **Elev./Depth:** 7.0-8.0'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
			62.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	62.5		

* (no specification provided)

Material Description

Dark brown sandy clayey silt

Atterberg Limits

PL= 20 LL= 25 PI= 5

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL-ML AASHTO=

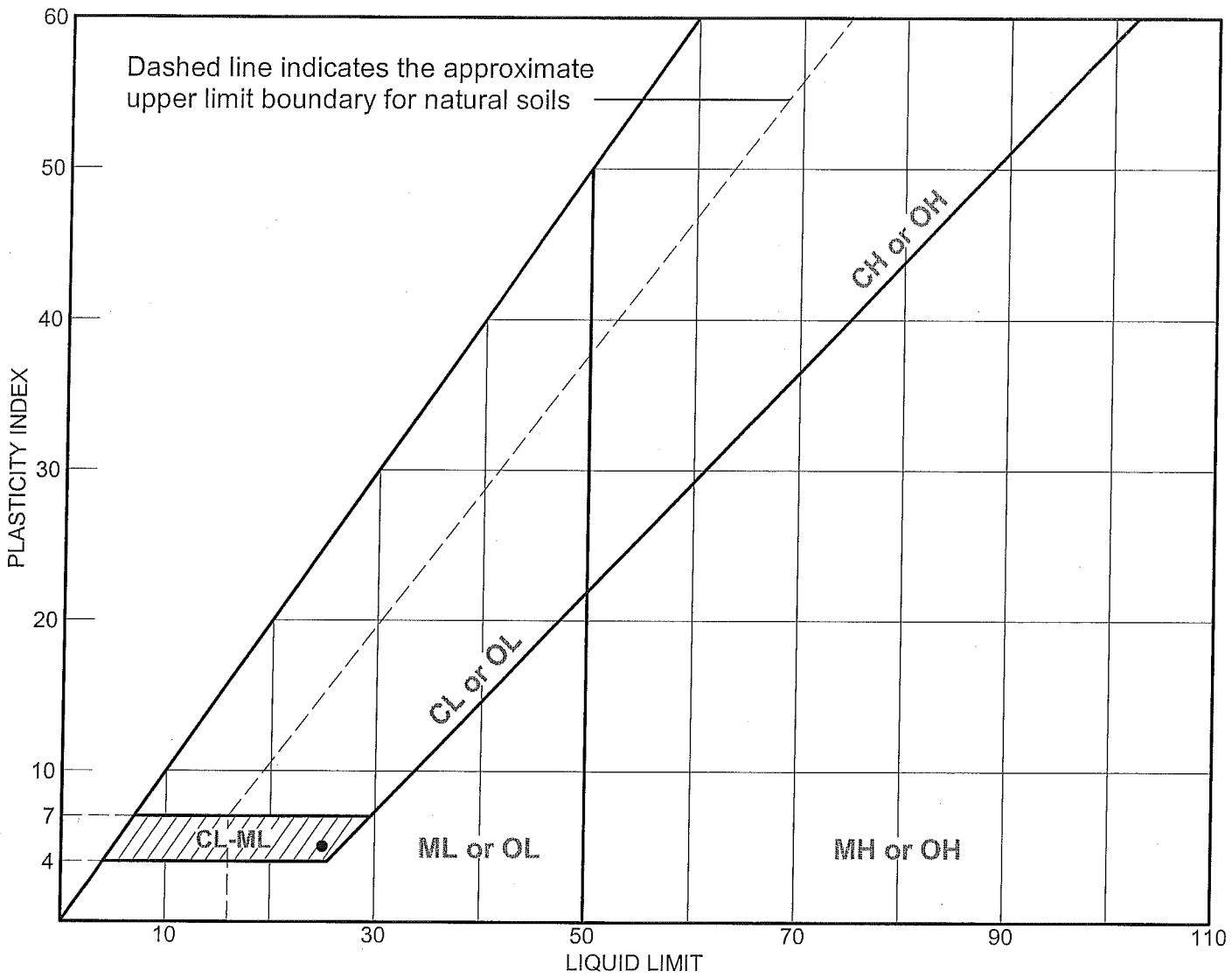
Remarks

Sample No.: B2-4 Source of Sample: Date: 8-23-06
Location: Elev./Depth: 12.0-13.0'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1 Figure

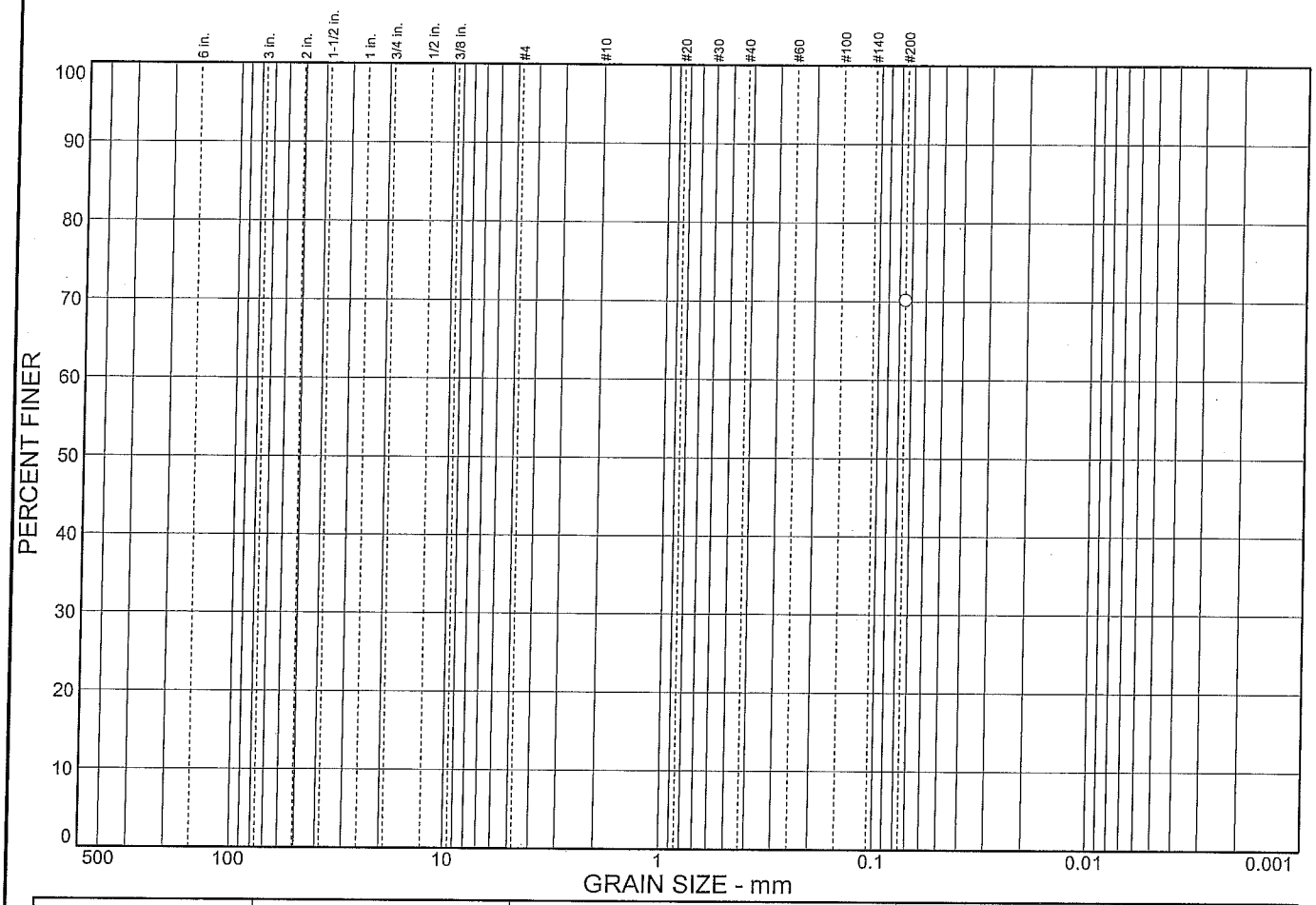
LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		B2-4	12.0-13.0'		20	25	5	CL-ML

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
			70.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	70.2		

* (no specification provided)

Material Description

Dark brown sandy silt

Atterberg Limits

PL= 23 LL= 28 PI= 5

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO=

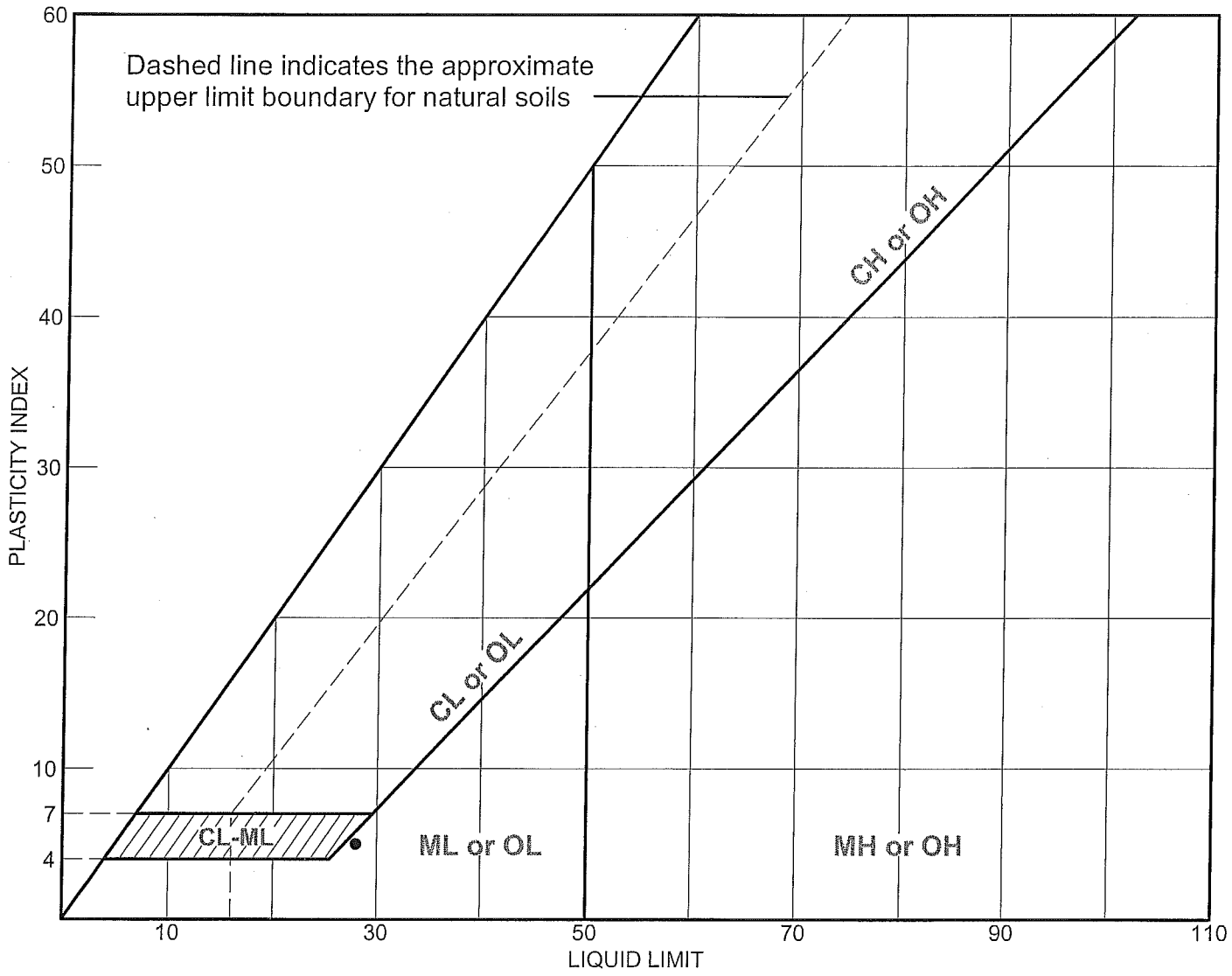
Remarks

Sample No.: B2-6 **Source of Sample:** **Date:** 8-23-06
Location: **Elev./Depth:** 17.0-18.0'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1 **Figure**

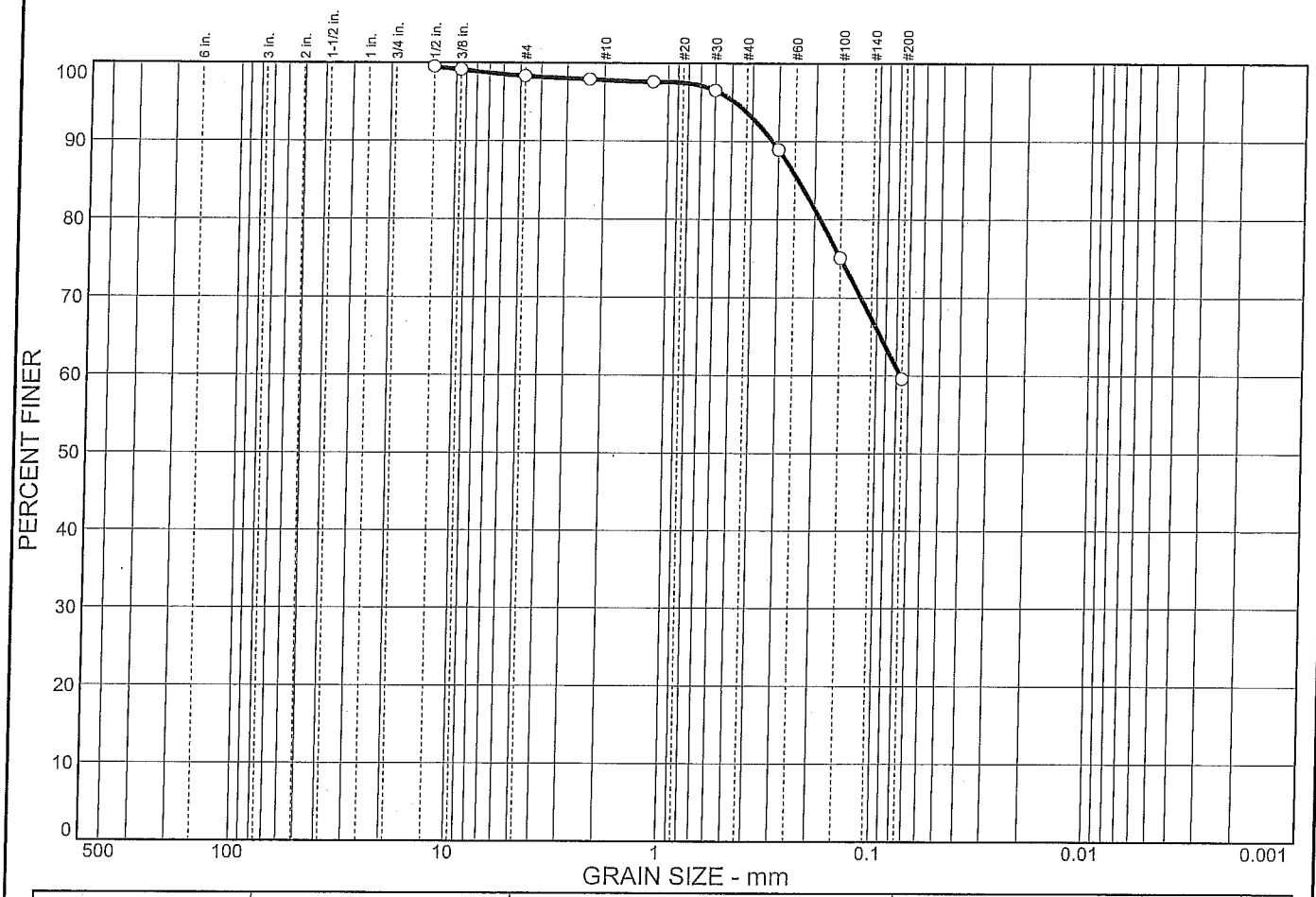
LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		B2-6	17.0-18.0'		23	28	5	ML

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
		38.7	59.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2 in.	99.5		
3/8 in.	99.1		
#4	98.3		
#8	97.9		
#16	97.6		
#30	96.5		
#50	88.9		
#100	75.1		
#200	59.6		

* (no specification provided)

Material Description

Olive brown sandy lean clay

Atterberg Limits

PL= 18 LL= 25 PI= 7

Coefficients

D_{85}= 0.241 D_{60}= 0.0763 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

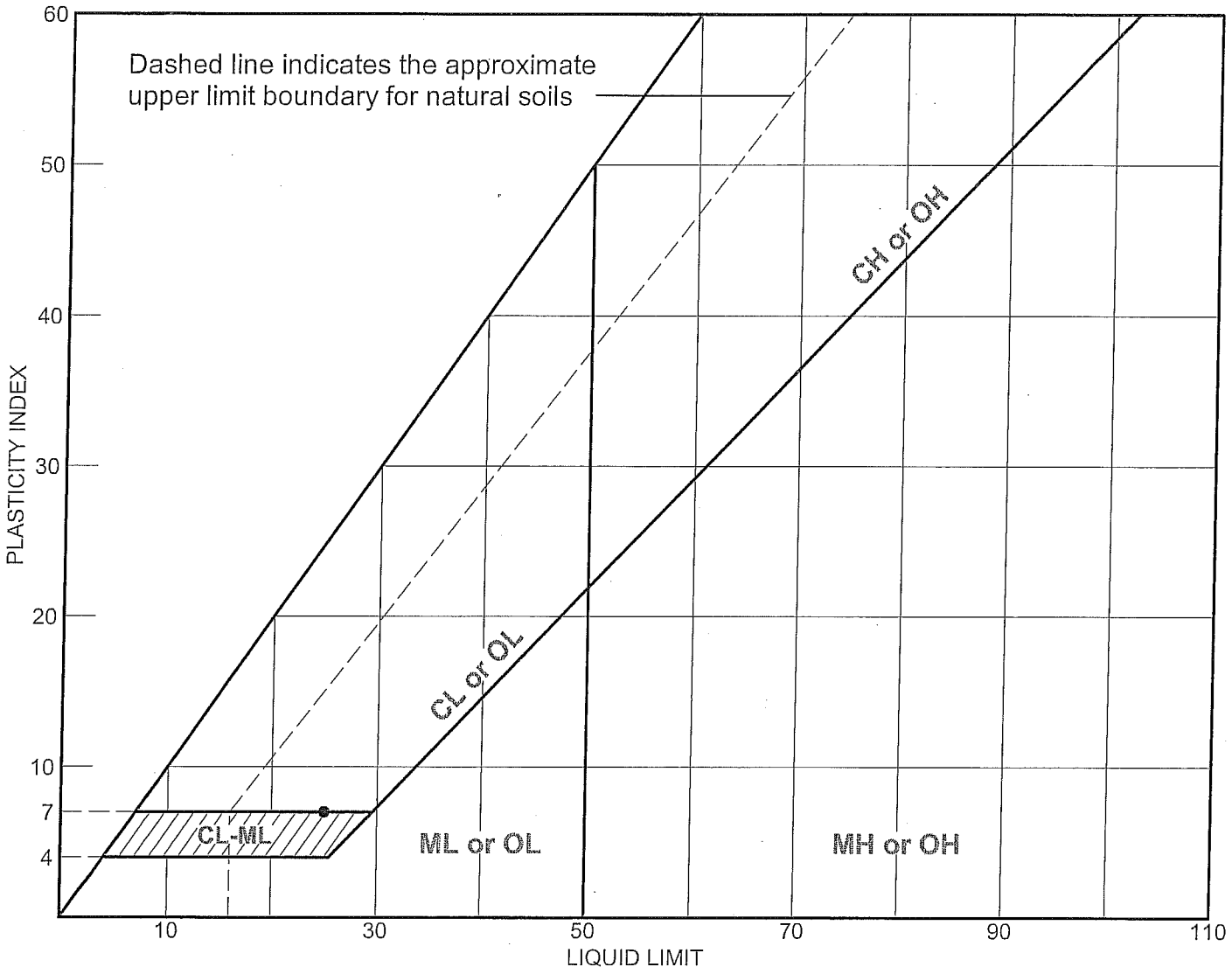
Sample No.: Bulk 2 **Source of Sample:** **Date:** 6-30-06
Location: **Elev./Depth:** 1.0-20.0 ft

Blackburn Consulting
W. Sacramento, CA

Client: Wood Rodgers
Project: Star Bend Setback Levee

Project No: 788.1 **Figure**

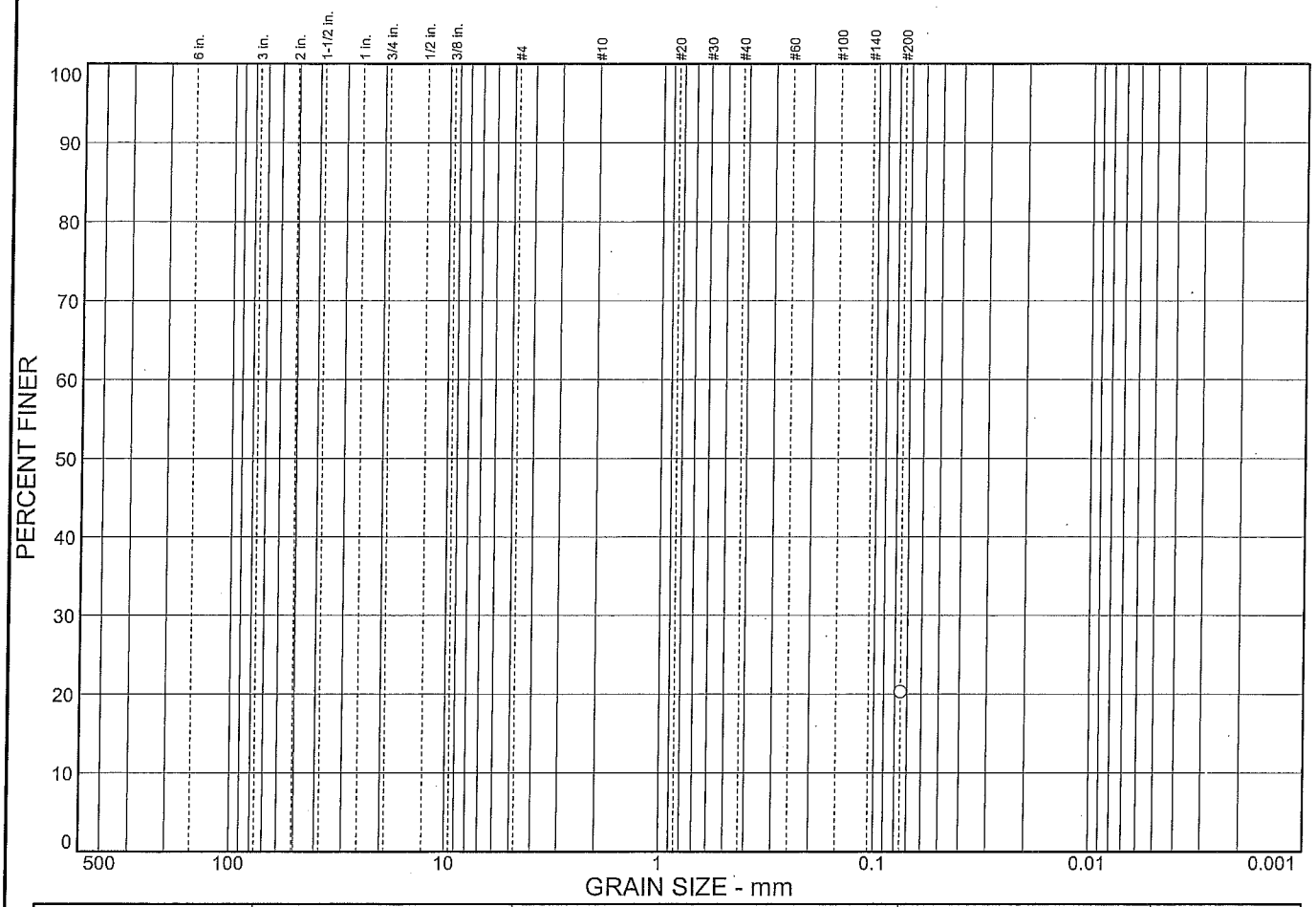
LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		Bulk 2	1.0-20.0 ft		18	25	7	CL

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** Wood Rodgers **Project:** Star Bend Setback Levee **Project No.:** 788.1 Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
			20.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	20.3		

* (no specification provided)

Material Description

Olive brown silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

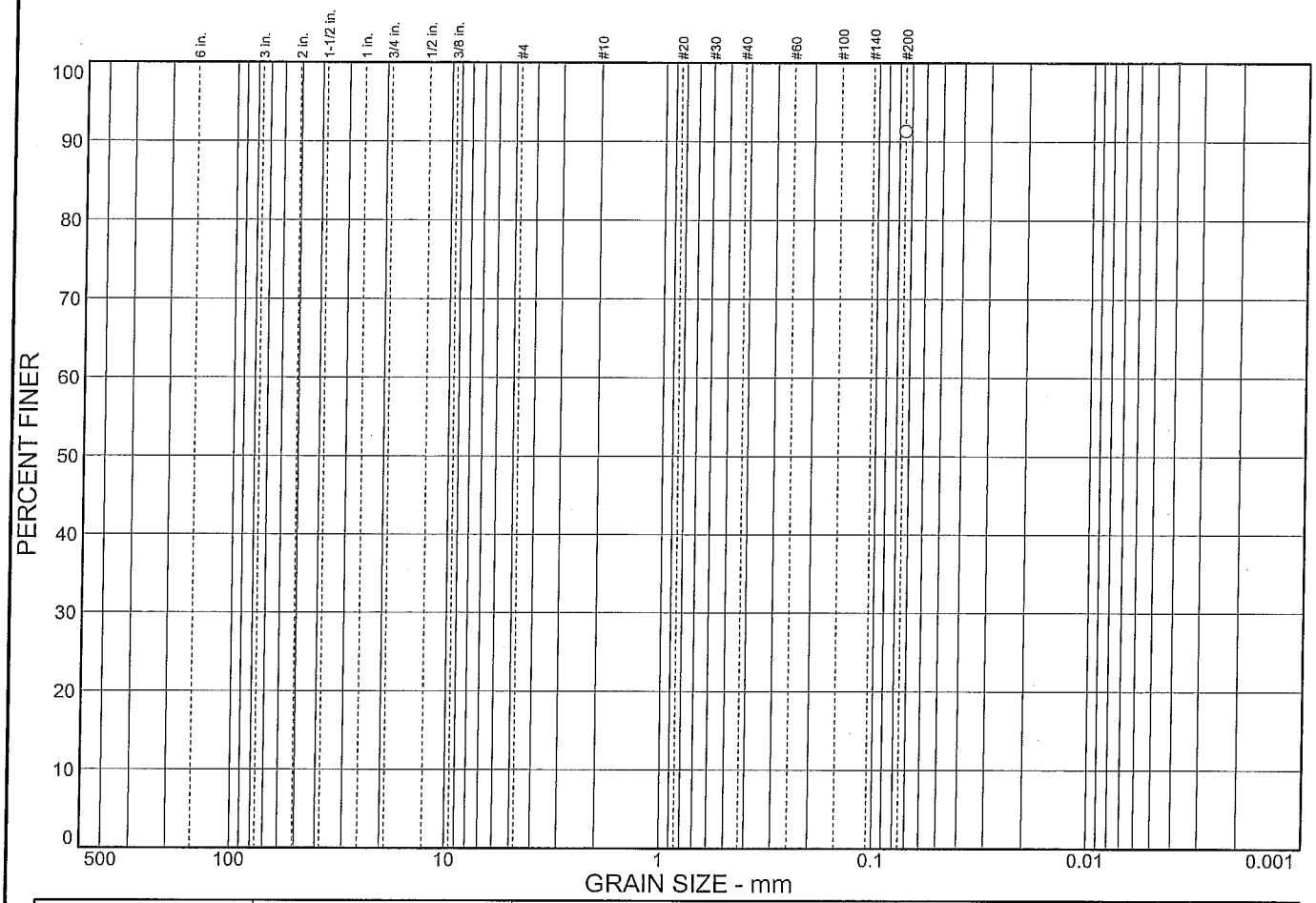
Remarks

Sample No.: B3-2 Source of Sample: Date: 8-23-06
Location: Elev./Depth: 7.0-8.0'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1 Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
			91.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	91.3		

* (no specification provided)

Material Description

Dark brown lean clay with silt

Atterberg Limits

PL= 18 LL= 32 PI= 14

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

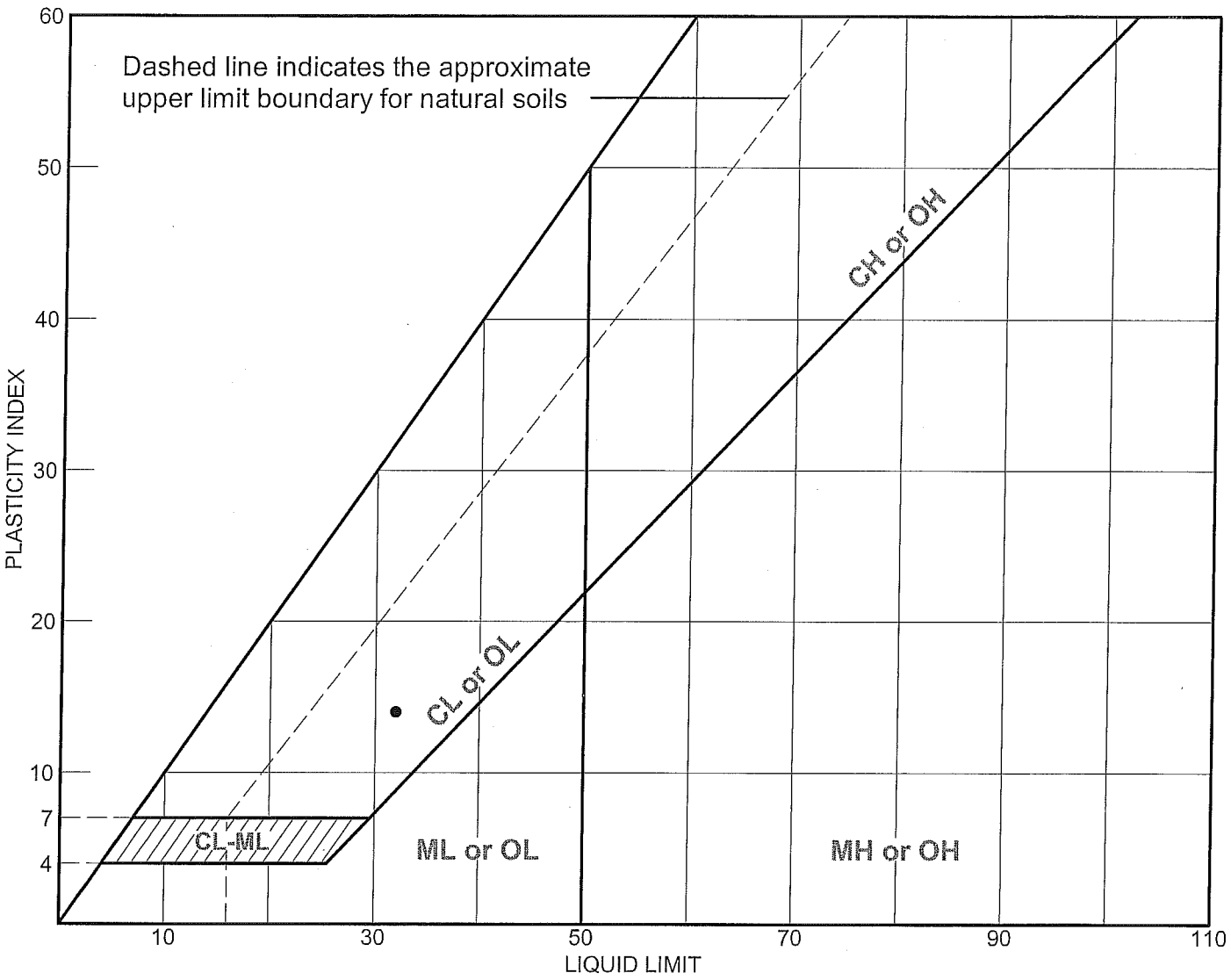
Remarks

Sample No.: B3-6 **Source of Sample:** **Date:** 8-17-06
Location: **Elev./Depth:** 17.0-17.5'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT

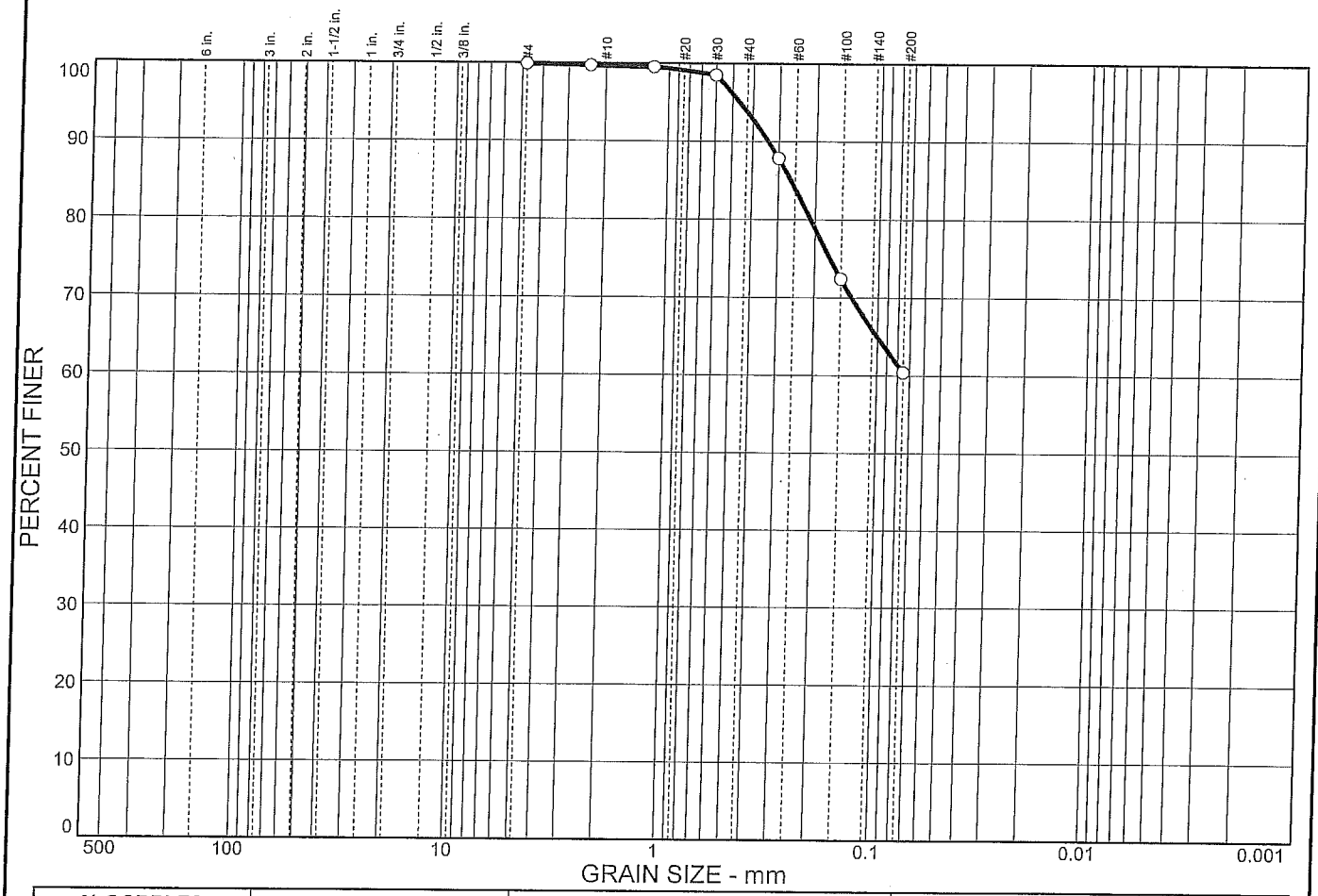


SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		B3-6	17.0-17.5'		18	32	14	CL

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
		39.5	60.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	99.9		
#8	99.7		
#16	99.5		
#30	98.5		
#50	87.8		
#100	72.4		
#200	60.4		

* (no specification provided)

Material Description

Olive brown sandy silty clay

Atterberg Limits

PL= 17 LL= 23 PI= 6

Coefficients

D_{85}= 0.262 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL-ML AASHTO=

Remarks

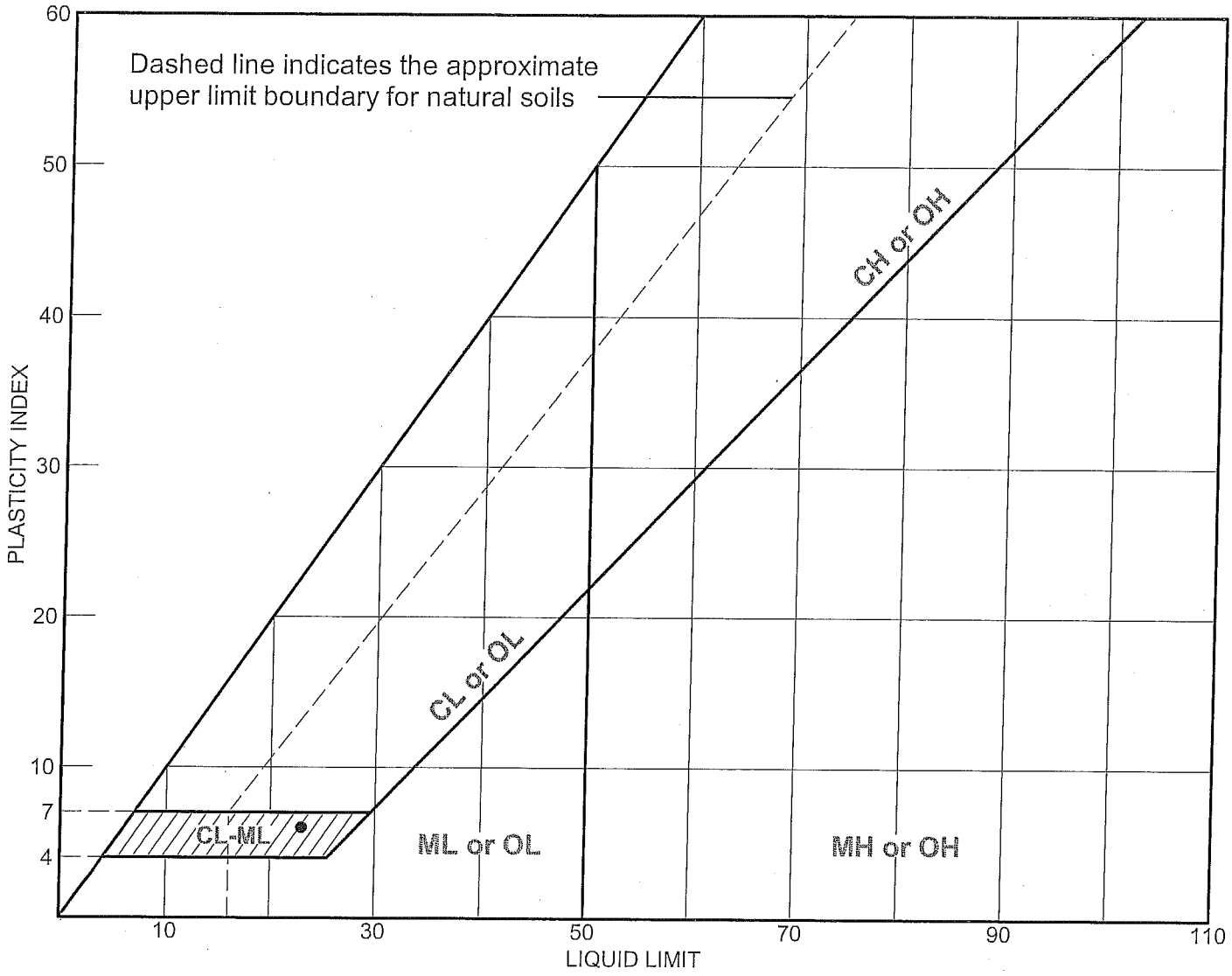
Sample No.: Bulk 3 **Source of Sample:** **Date:** 6-30-06
Location: **Elev./Depth:** 1.0-20.0 ft

Blackburn Consulting
W. Sacramento, CA

Client: Wood Rodgers
Project: Star Bend Setback Levee

Project No: 788.1 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		Bulk 3	1.0-20.0 ft		17	23	6	CL-ML

LIQUID AND PLASTIC LIMITS TEST REPORT

Blackburn Consulting

W. Sacramento, CA

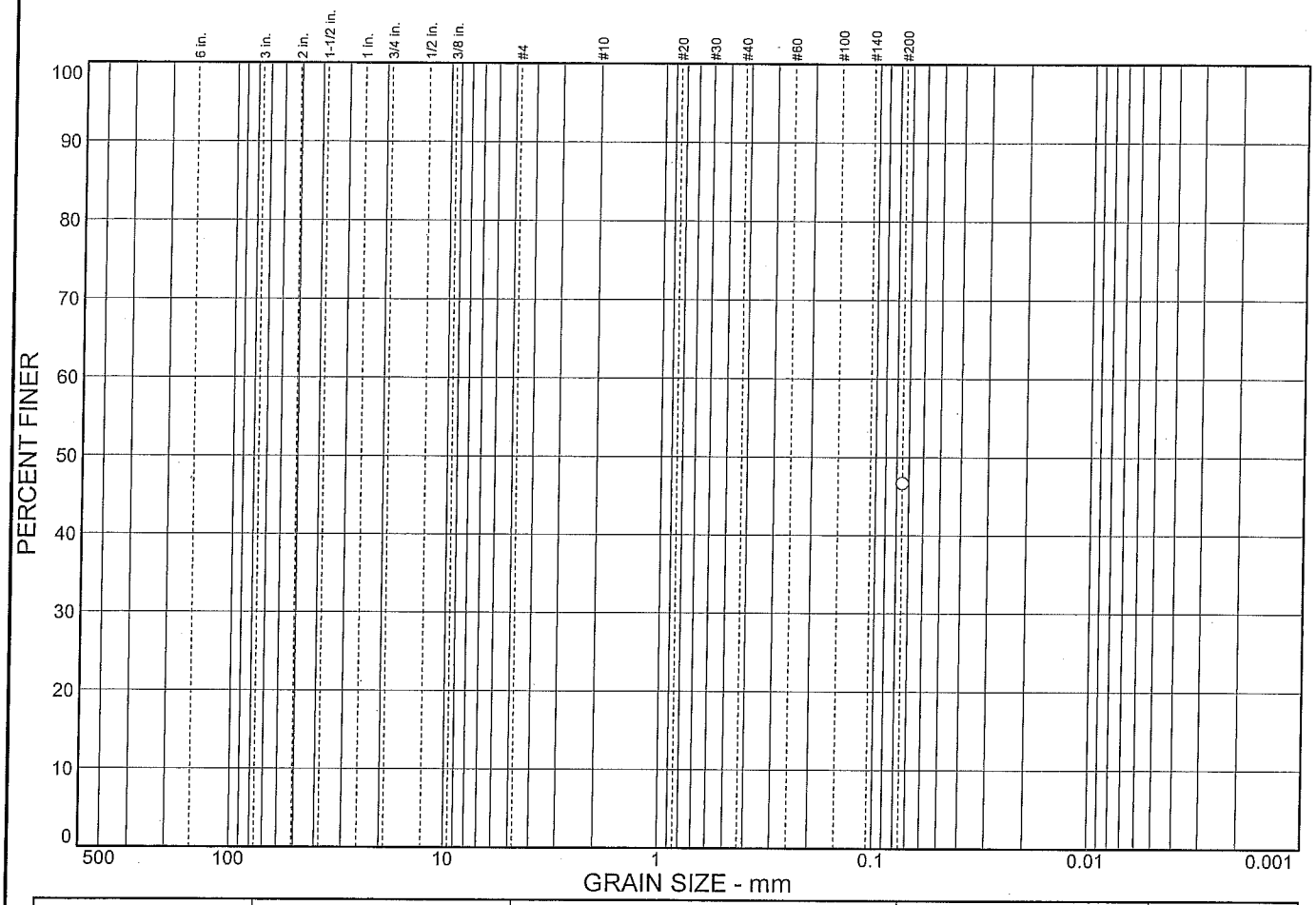
Client: Wood Rodgers

Project: Star Bend Setback Levee

Project No.: 788.1

Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
			46.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	46.7		

* (no specification provided)

Material Description

Dark yellowish brown silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

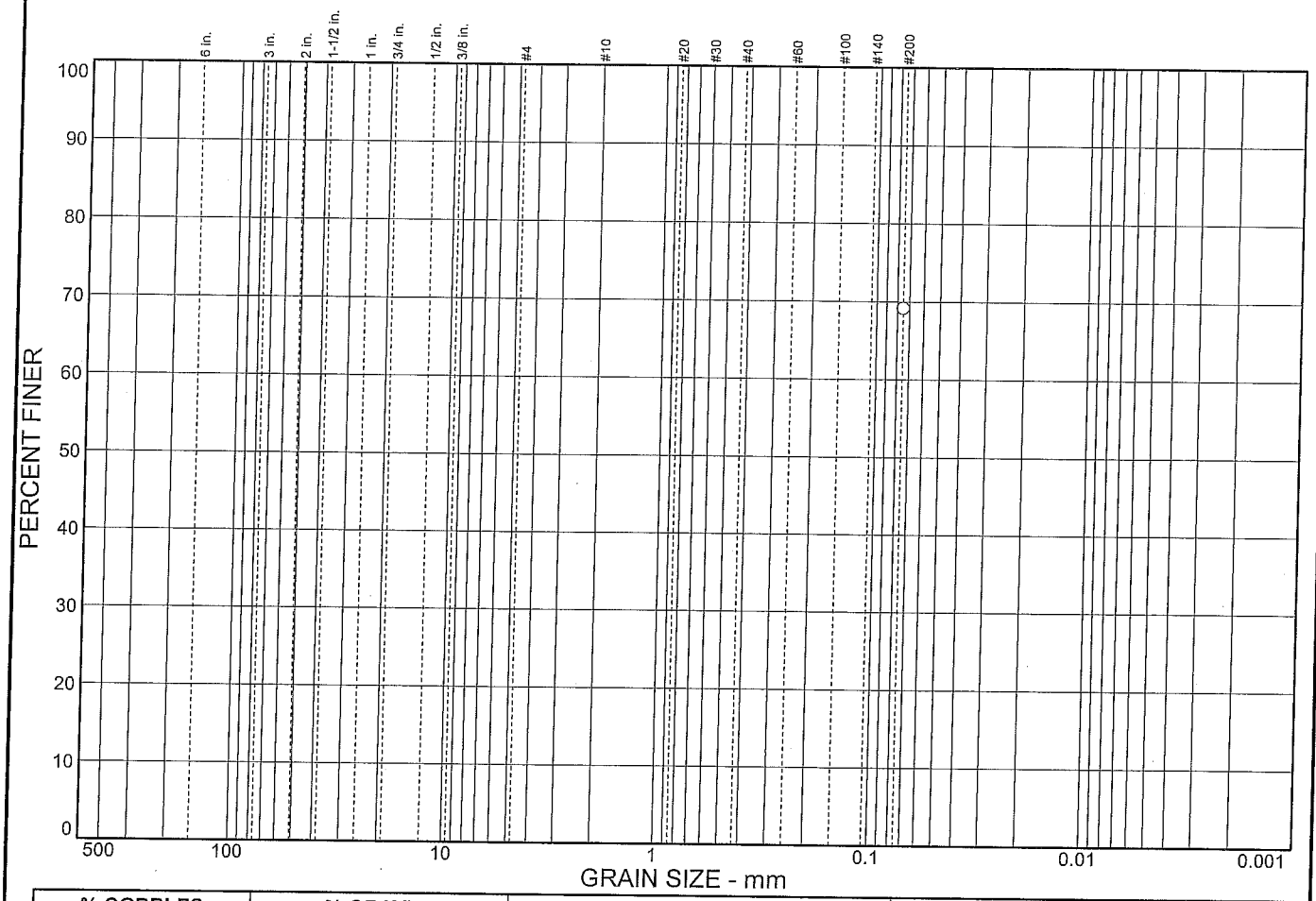
Remarks

Sample No.: B4-4 **Source of Sample:** **Date:** 8-23-06
Location: **Elev./Depth:** 12.0-13.0'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
			69.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	69.2		

* (no specification provided)

Material Description

Dark yellowish brown sandy silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO=

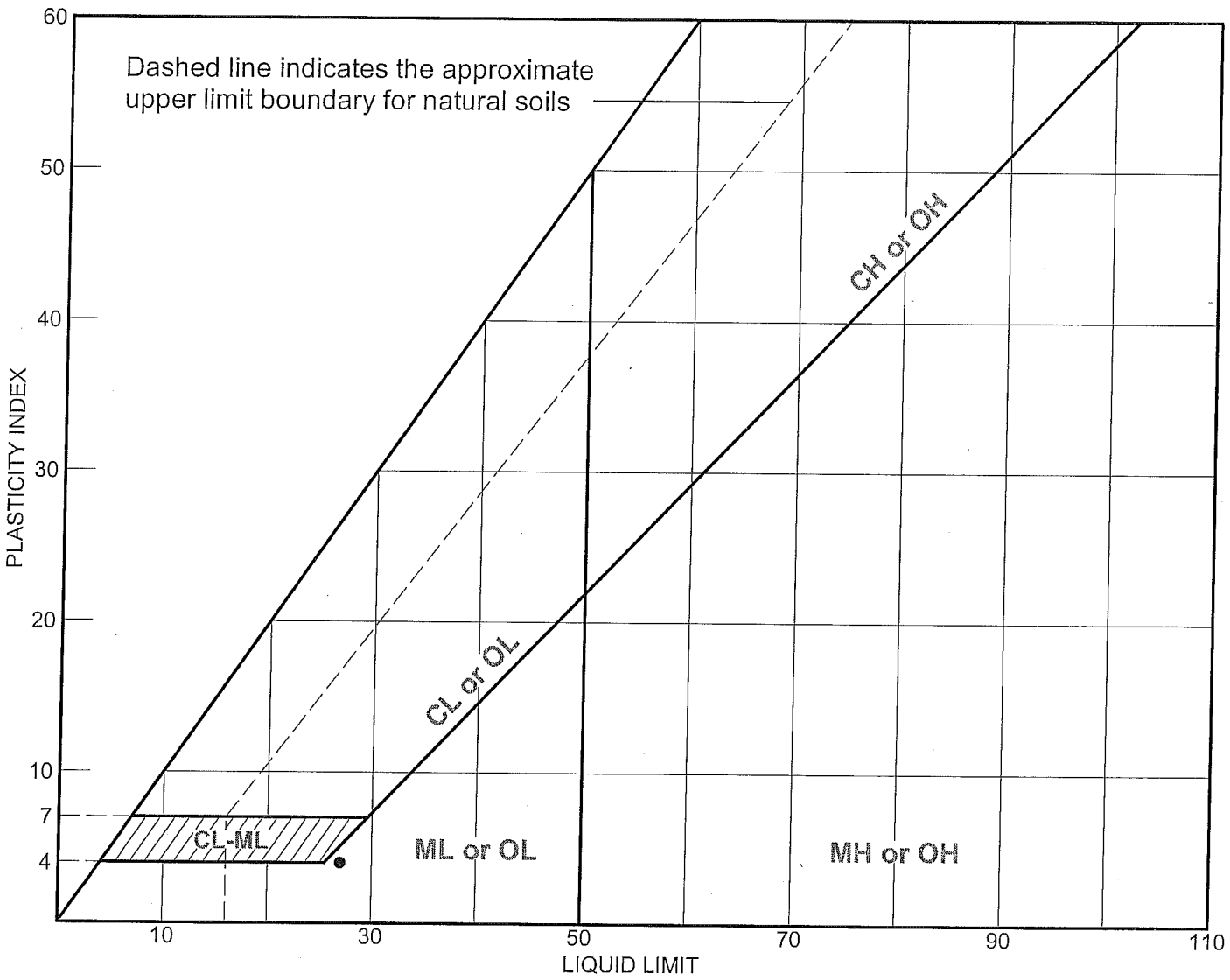
Remarks

Sample No.: B4-6 **Source of Sample:** **Date:** 8-23-06
Location: **Elev./Depth:** 20.5-21.5'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT

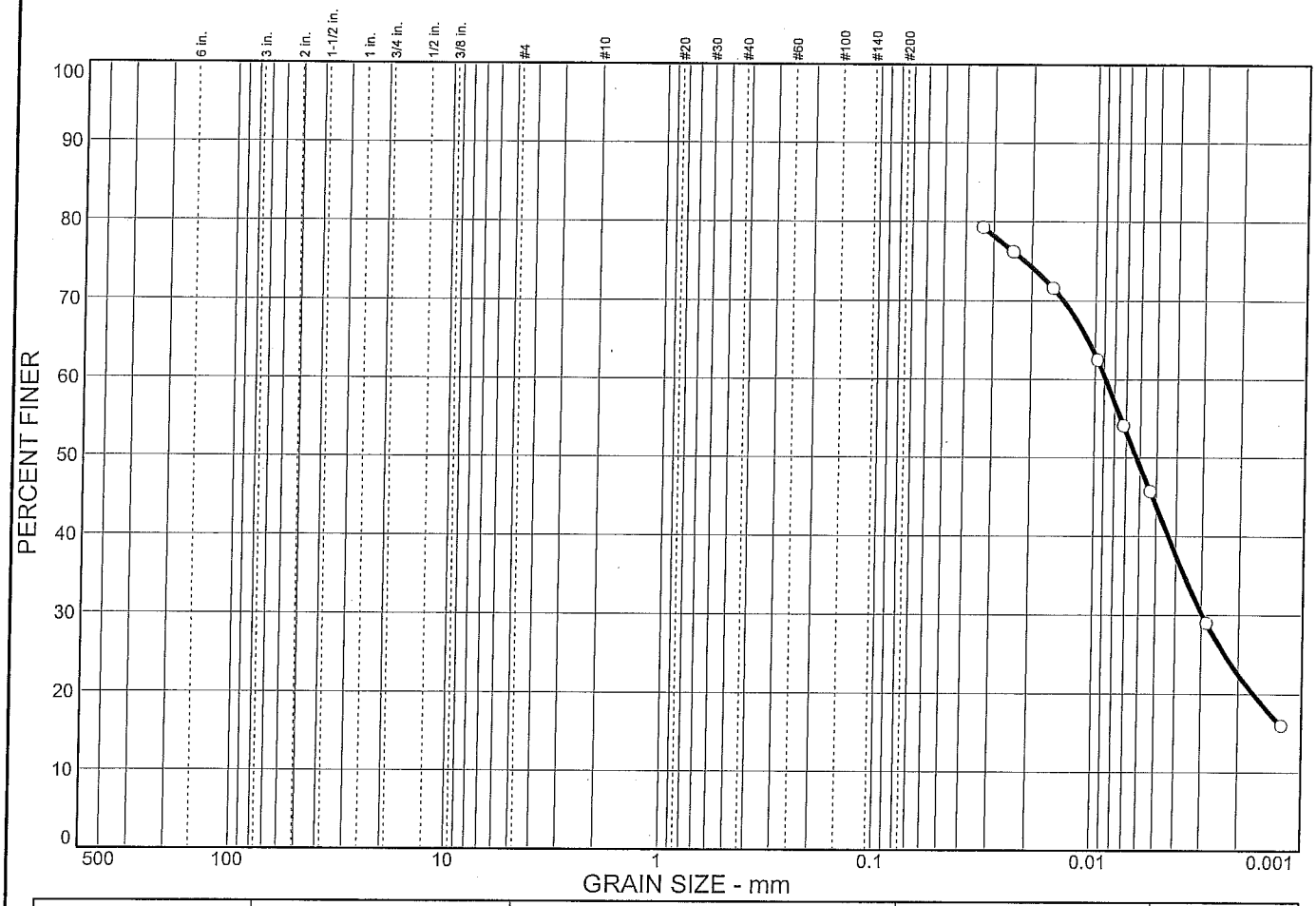


SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		B4-8	26.0-27.5'		23	27	4	ML

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)

* (no specification provided)

Material Description

Light yellowish brown elastic Silt (MH)

Atterberg Limits

PL= 29 LL= 50 PI= 21

Coefficients

D_{85}= D_{60}= 0.0089 D_{50}= 0.0063
D_{30}= 0.0030 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

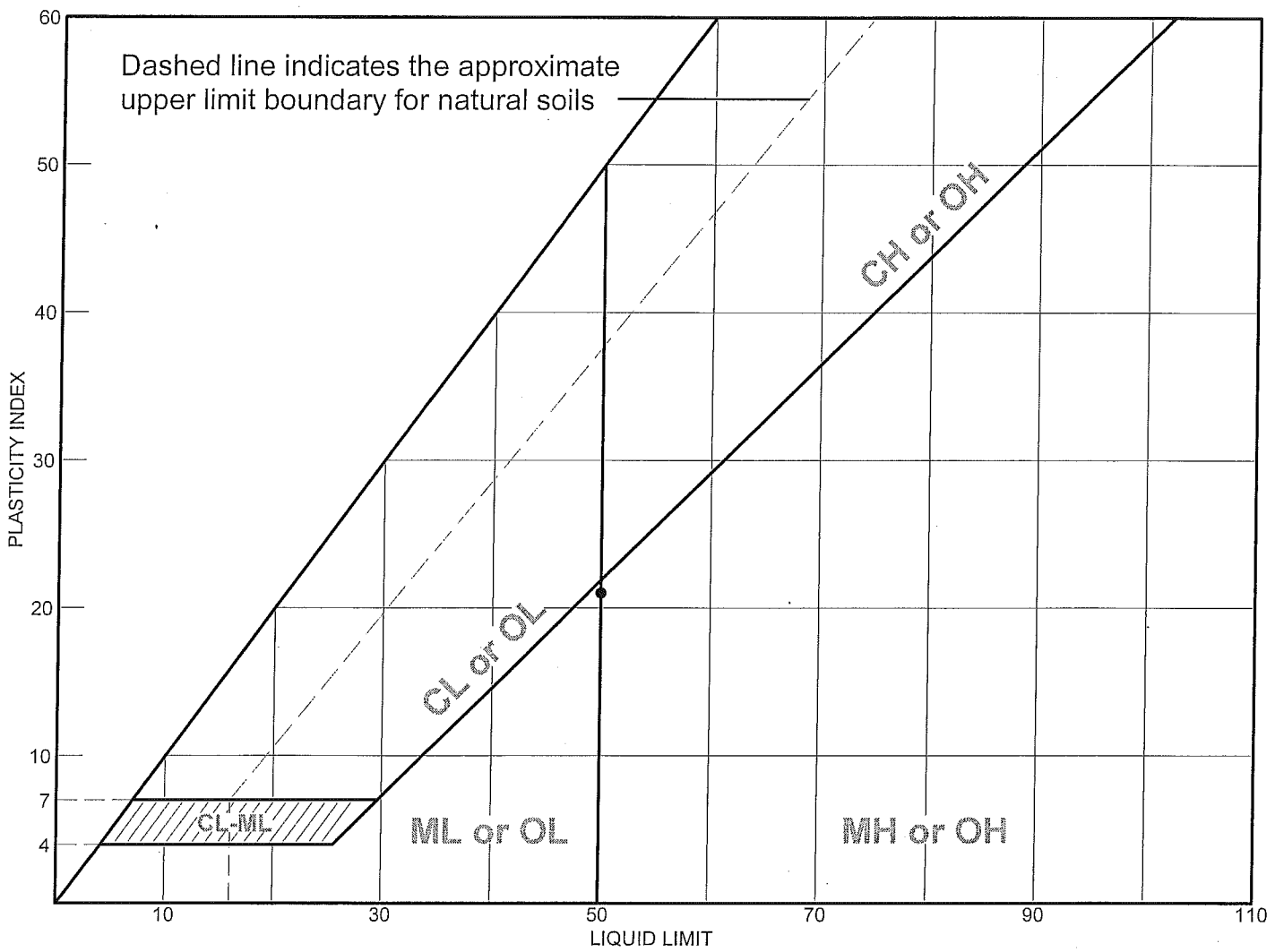
Remarks

Sample No.: B4-10B **Source of Sample:** B4 **Date:** 7-7-06
Location: **Elev./Depth:** 35.5-36.0

Blackburn Consulting
Auburn, California

Client: Wood Rodgers
Project: Star Bend Setback Levee
Project No: 788.1

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Light yellowish brown elastic Silt (MH)	50	29	21			MH

Project No. 788.1 **Client:** Wood Rodgers

Project: Star Bend Setback Levee

● **Source:** B4 **Sample No.:** B4-10B **Elev./Depth:** 35.5-36.0

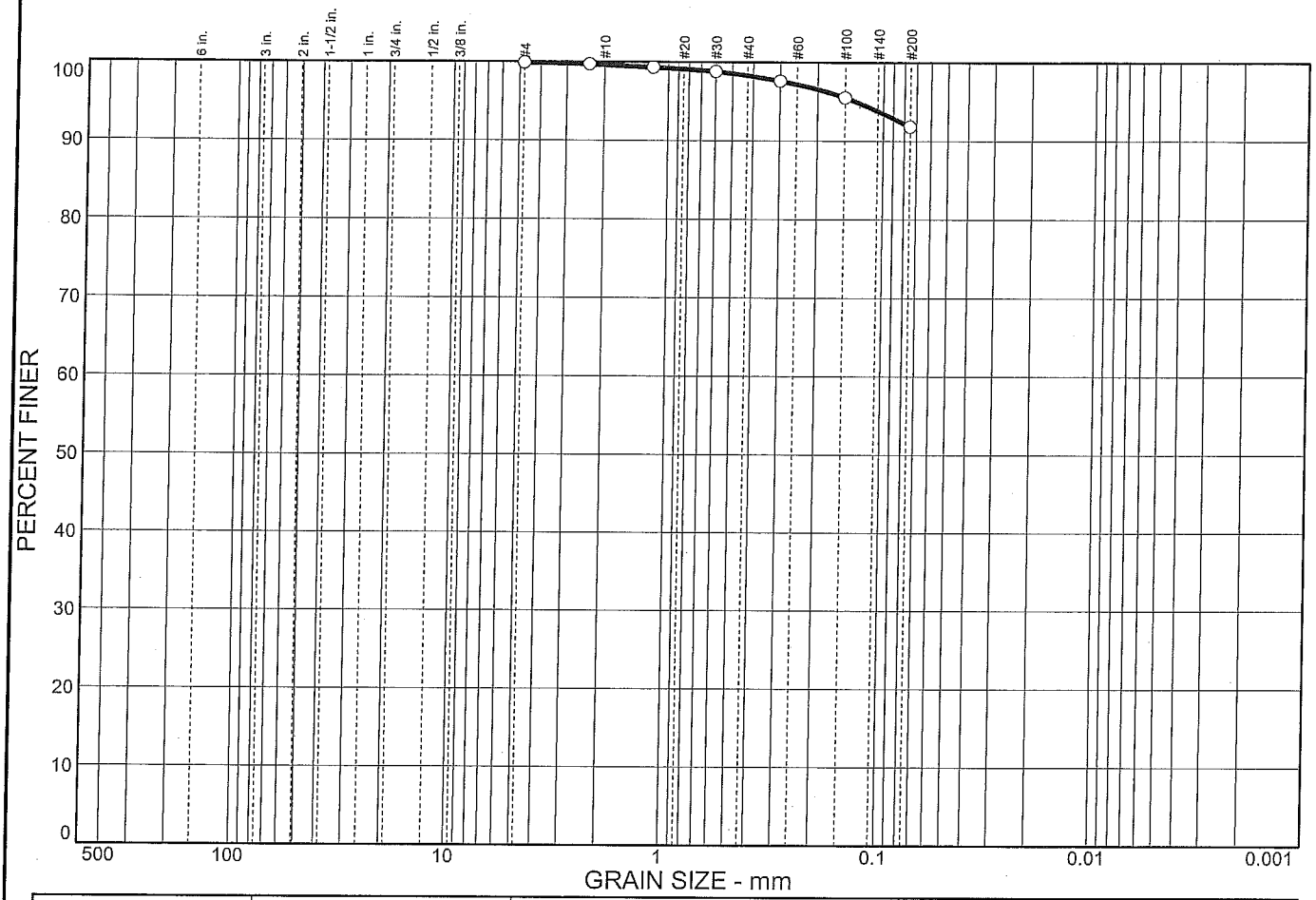
Remarks:

● 7-7-06

Blackburn Consulting

Auburn, California

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
		8.1	91.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	99.9		
#8	99.7		
#16	99.3		
#30	98.8		
#50	97.6		
#100	95.5		
#200	91.8		

* (no specification provided)

Material Description

Light olive brown silty clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL-ML AASHTO=

Remarks

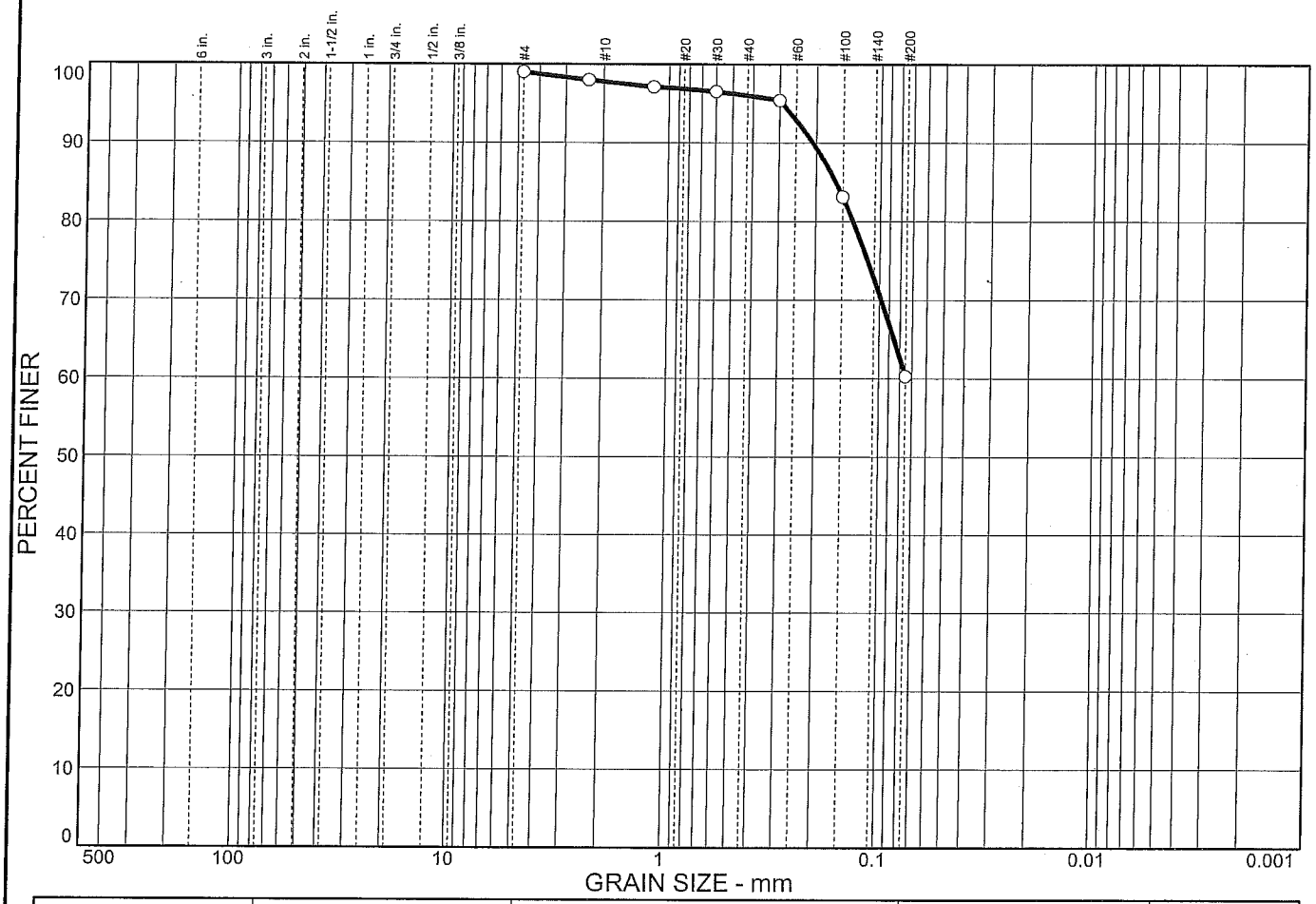
Sample No.: B4-10c **Source of Sample:** **Date:** 7-5-06
Location: **Elev./Depth:** 36.0-36.5 ft

Blackburn Consulting
W. Sacramento, CA

Client: Wood Rodgers
Project: Star Bend Setback Levee

Project No: 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
		38.7	60.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	99.0		
#8	98.0		
#16	97.1		
#30	96.5		
#50	95.4		
#100	83.1		
#200	60.3		

* (no specification provided)

Material Description

Light olive brown silty very fine sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.162 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sample No.: B4-13 **Source of Sample:** **Date:** 8-22-06
Location: **Elev./Depth:** 42.5-43.0'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1

Figure

Particle Size Distribution Report

% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
		70.8	28.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	99.3		
#8	97.6		
#16	96.5		
#30	95.9		
#50	85.3		
#100	45.7		
#200	28.5		

* (no specification provided)

Material Description

Olive brown very fine sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.298 D_{60}= 0.193 D_{50}= 0.163
D_{30}= 0.0837 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

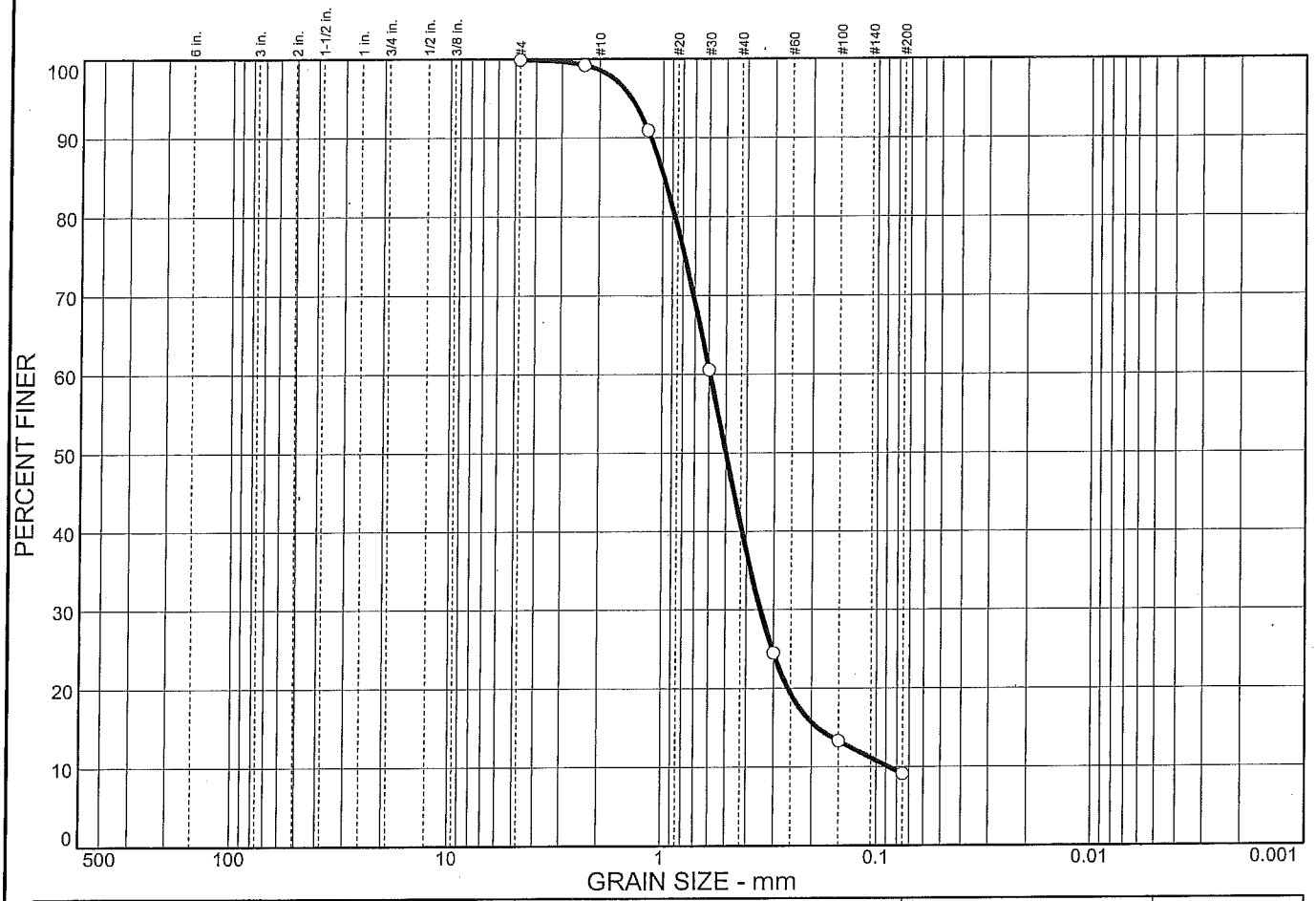
Remarks

Sample No.: B4-14 **Source of Sample:** **Date:** 8-22-06
Location: **Elev./Depth:** 46.5-47.0'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
		90.8	9.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	99.9		
#8	99.2		
#16	90.9		
#30	60.6		
#50	24.5		
#100	13.3		
#200	9.1		

* (no specification provided)

Material Description

Dark yellowish brown/Olive brown very fine sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.988 D_{60}= 0.594 D_{50}= 0.500
D_{30}= 0.344 D_{15}= 0.188 D_{10}= 0.0873
C_u= 6.80 C_c= 2.28

Classification

USCS= AASHTO=

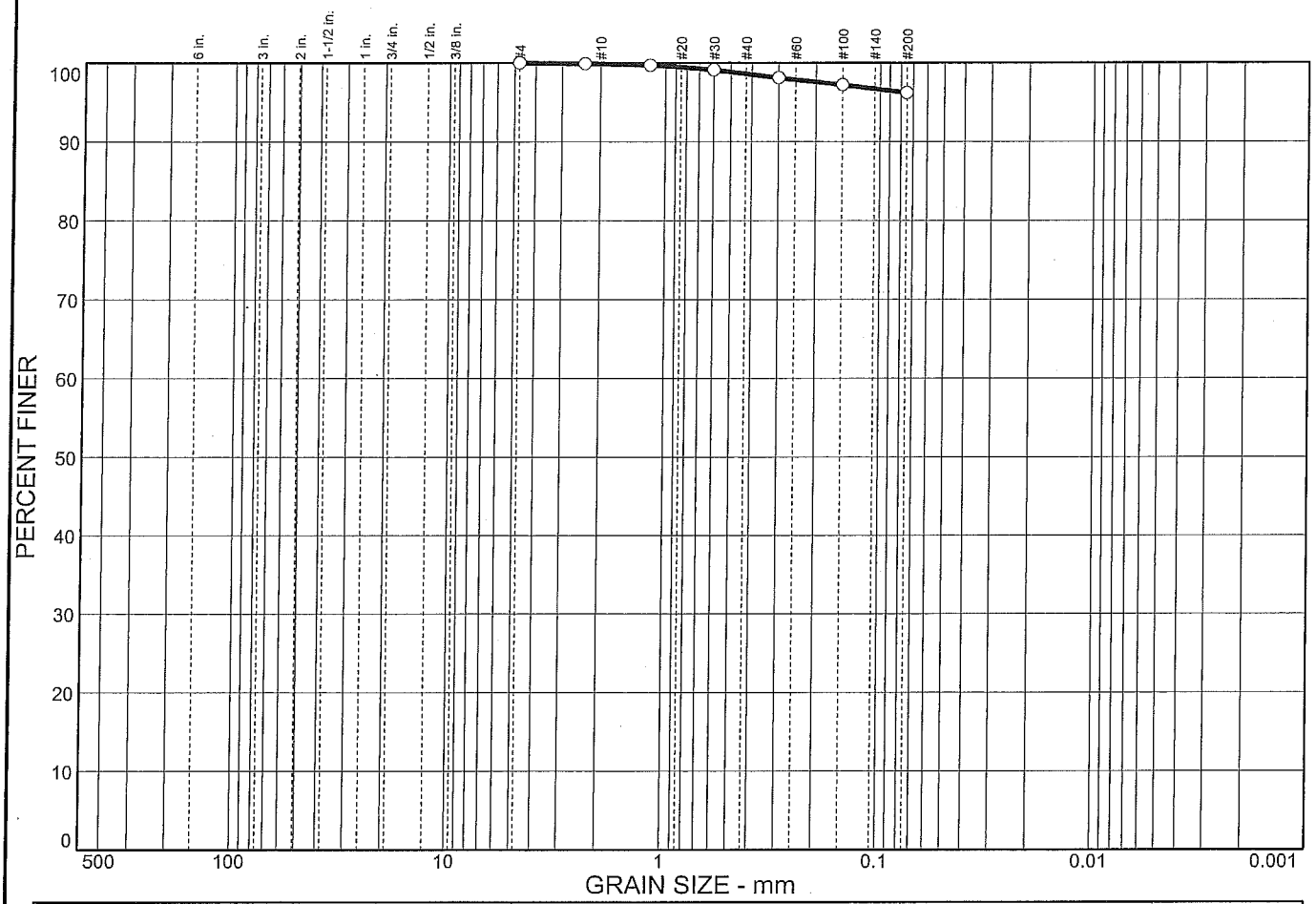
Remarks

Sample No.: B4-16 **Source of Sample:** **Date:** 8-22-06
Location: **Elev./Depth:** 52.0-53.0'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	3.8	96.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.9		
#16	99.7		
#30	99.1		
#50	98.1		
#100	97.2		
#200	96.2		

* (no specification provided)

Material Description

Yellowish brown clayey silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

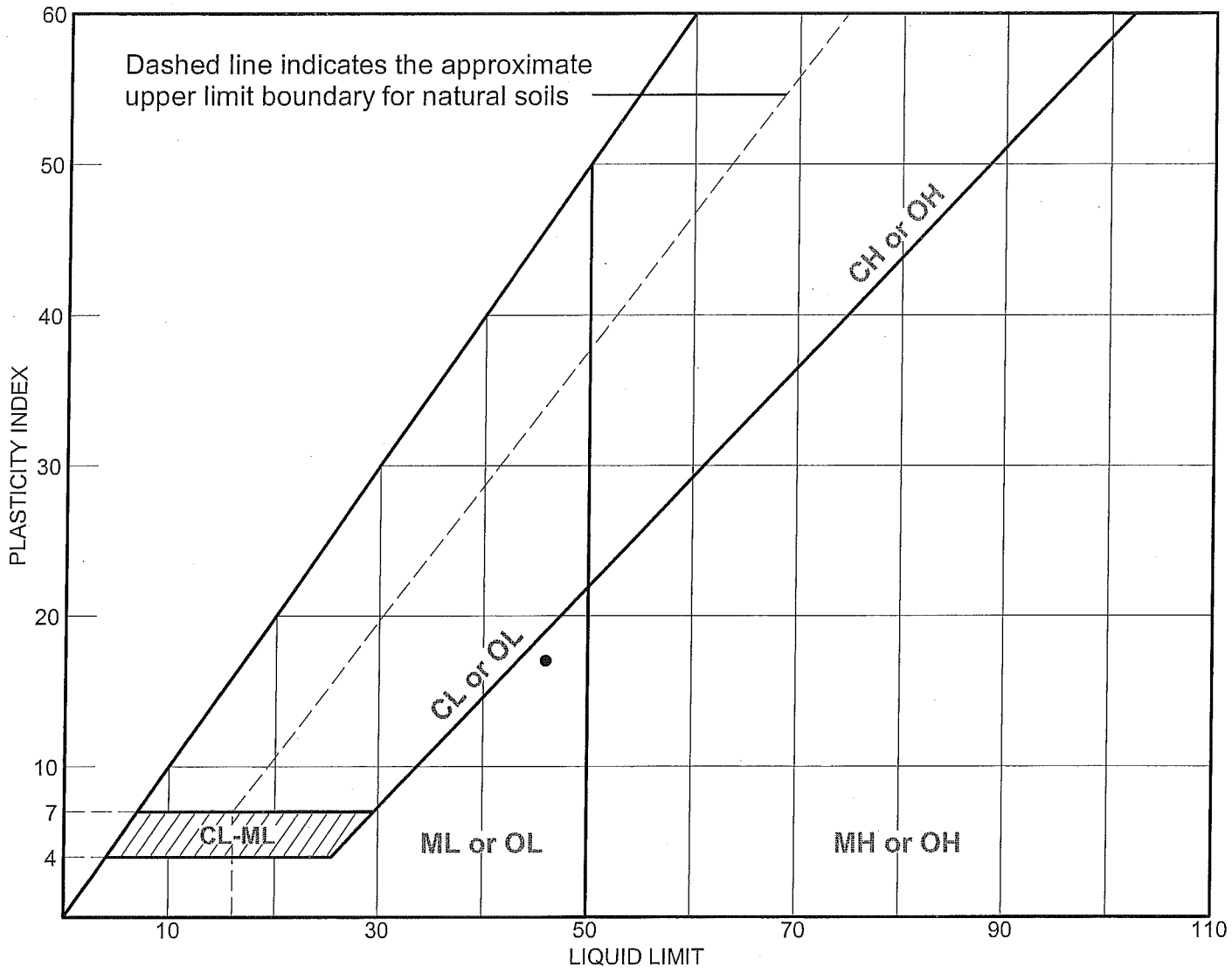
Remarks

Sample No.: B4-19 **Source of Sample:** **Date:** 8-22-06
Location: **Elev./Depth:** 62.0-63.0'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT

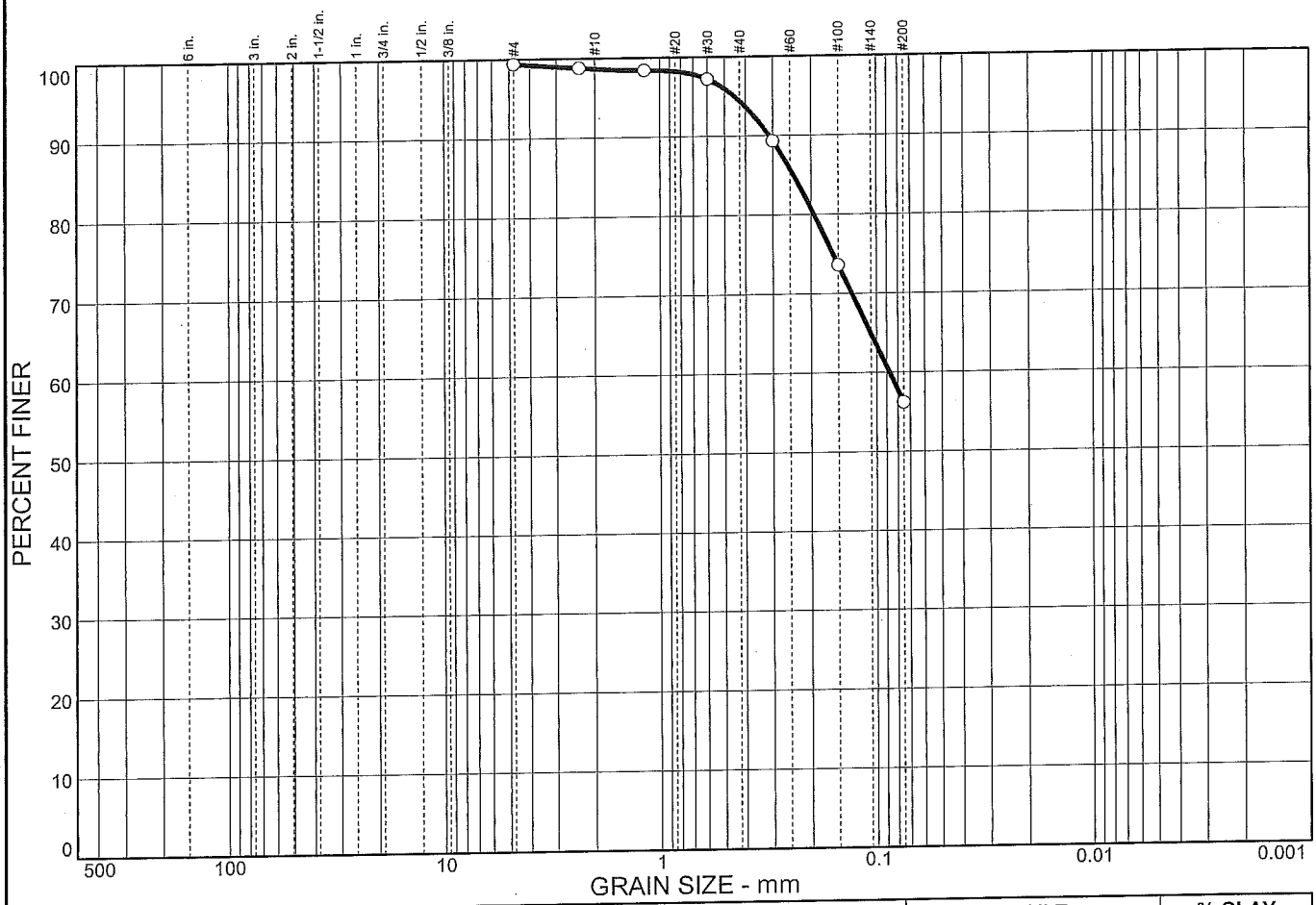


SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		B4-19	62.0-63.0'		29	46	17	ML

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
		43.2	56.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	99.4		
#8	98.8		
#16	98.4		
#30	97.2		
#50	89.3		
#100	73.6		
#200	56.2		

* (no specification provided)

Material Description

Olive brown sandy silty clay

Atterberg Limits

PL= 19 LL= 26 PI= 7

Coefficients

D_{85}= 0.242 D_{60}= 0.0872 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL-ML AASHTO=

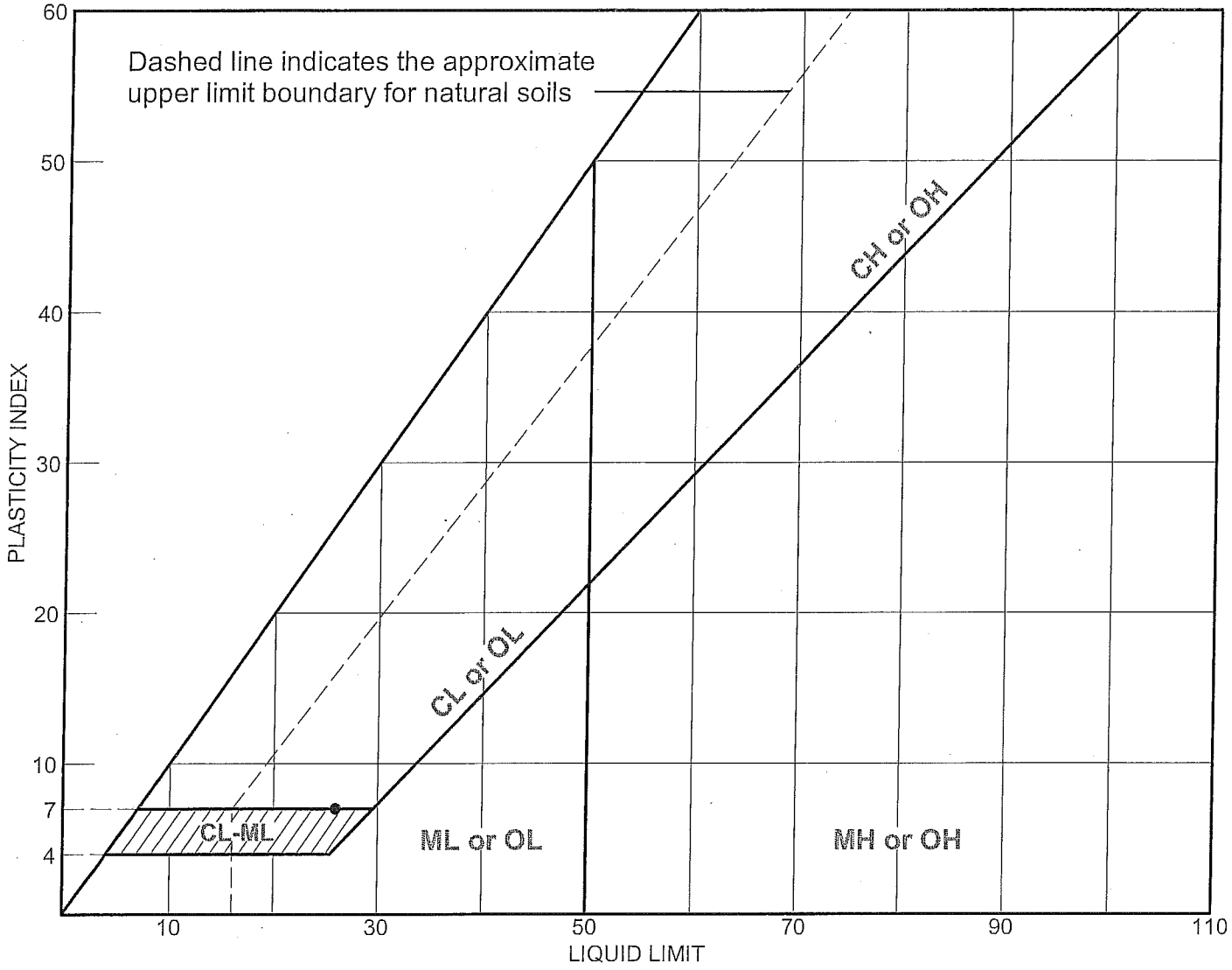
Remarks

Sample No.: Bulk 4 **Source of Sample:** **Date:** 7-5-06
Location: **Elev./Depth:** 1.0-20.0 ft

Blackburn Consulting
W. Sacramento, CA

Client: Wood Rodgers
Project: Star Bend Setback Levee
Project No: 788.1 **Figure**

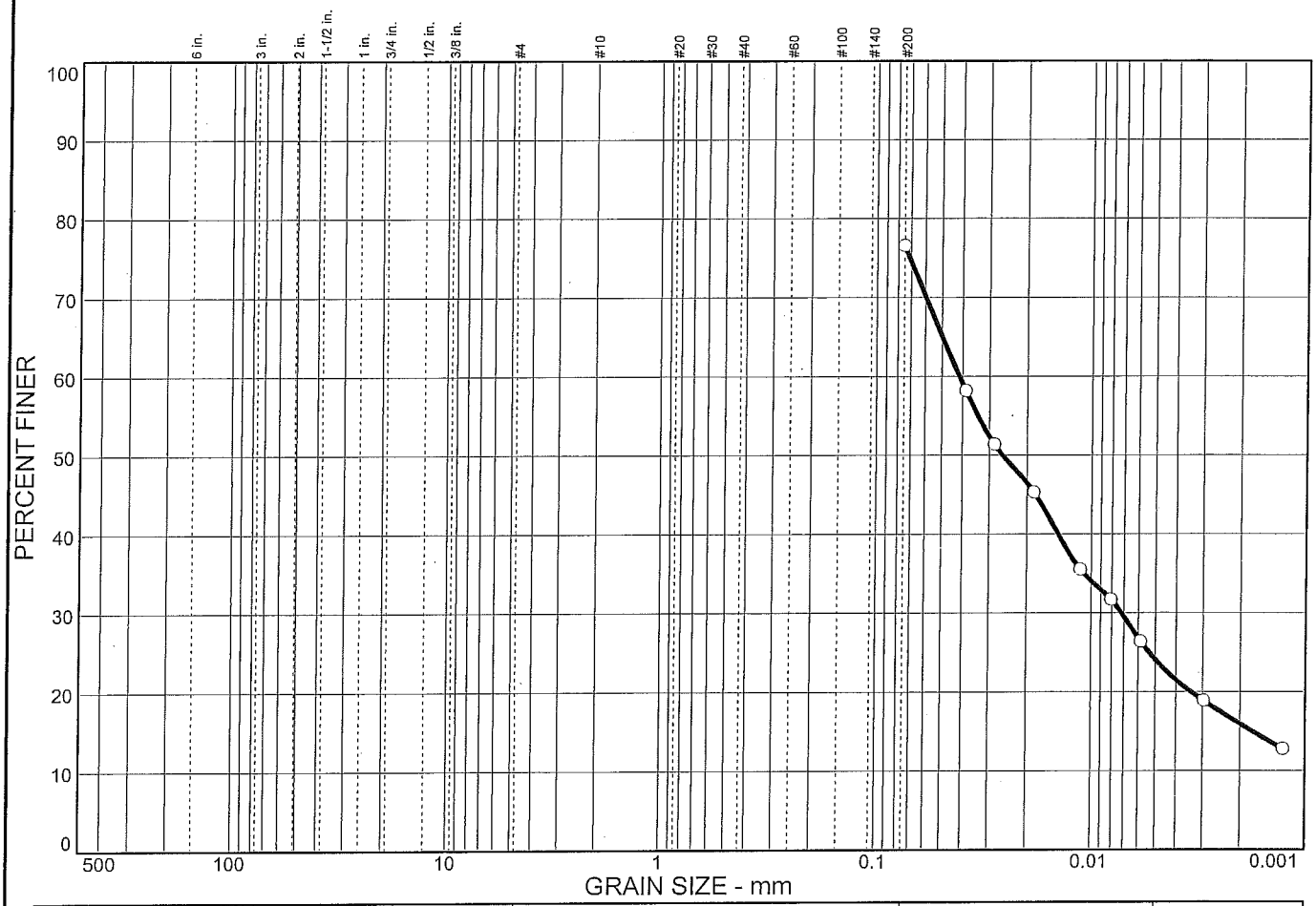
LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		Bulk 4	1.0-20.0 ft		19	26	7	CL-ML

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** Wood Rodgers **Project:** Star Bend Setback Levee **Project No.:** 788.1 Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
			52.5	24.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	76.6		

* (no specification provided)

Material Description

Brown lean Clay with sand (CL)

Atterberg Limits

PL= 19 LL= 30 PI= 11

Coefficients

D_{85}= D_{60}= 0.0414 D_{50}= 0.0260
D_{30}= 0.0072 D_{15}= 0.0017 D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

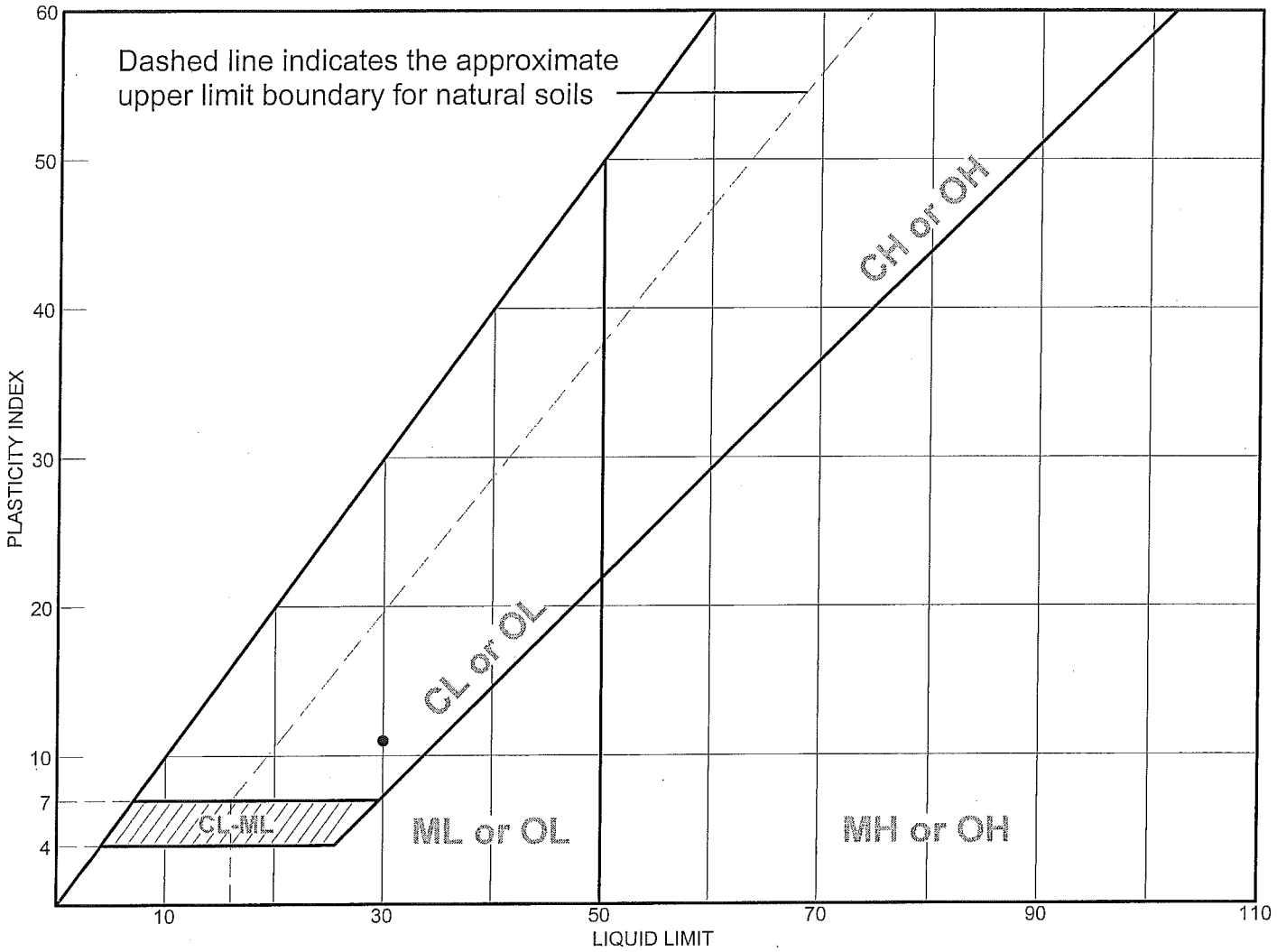
200 Wash only

Sample No.: B5-1b **Source of Sample:** B5 **Date:** 7-1-06
Location: **Elev./Depth:** 5.5-6

Blackburn Consulting
Auburn, California

Client: Wood Rodgers
Project: Star Bend Setback Levee
Project No: 788.1

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown lean Clay with sand (CL)	30	19	11		76.6	CL

Project No. 788.1 **Client:** Wood Rodgers

Project: Star Bend Setback Levee

● **Source:** B5 **Sample No.:** B5-1b **Elev./Depth:** 5.5-6

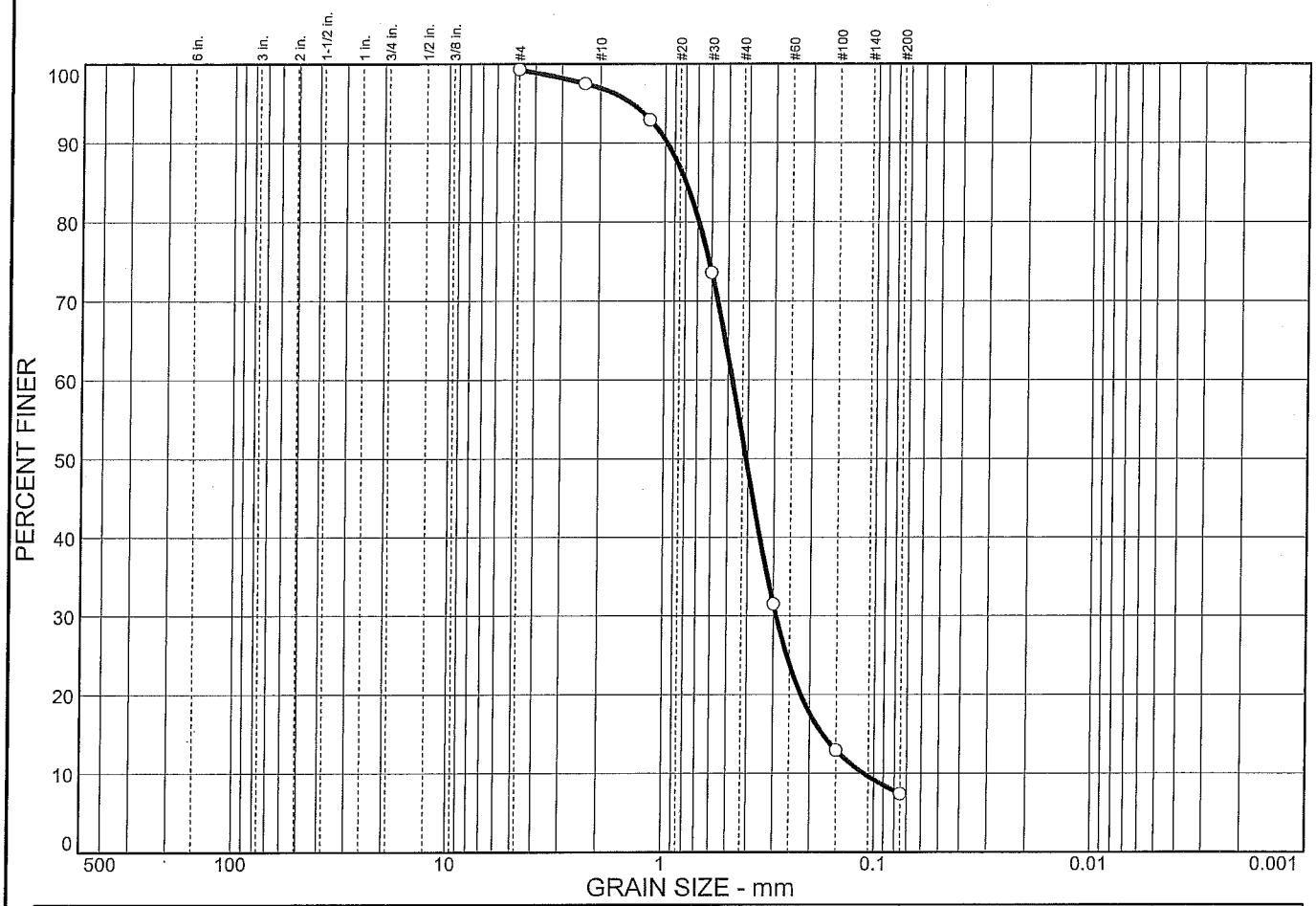
Remarks:

● 7-7-06

Blackburn Consulting

Auburn, California

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
		91.9	7.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	99.3		
#8	97.5		
#16	92.9		
#30	73.6		
#50	31.5		
#100	12.9		
#200	7.4		

* (no specification provided)

Material Description

Olive brown poorly graded sand with clay (or silty clay)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.799 D_{60}= 0.476 D_{50}= 0.409
D_{30}= 0.291 D_{15}= 0.174 D_{10}= 0.112
C_u= 4.26 C_c= 1.59

Classification

USCS= SP-SC AASHTO=

Remarks

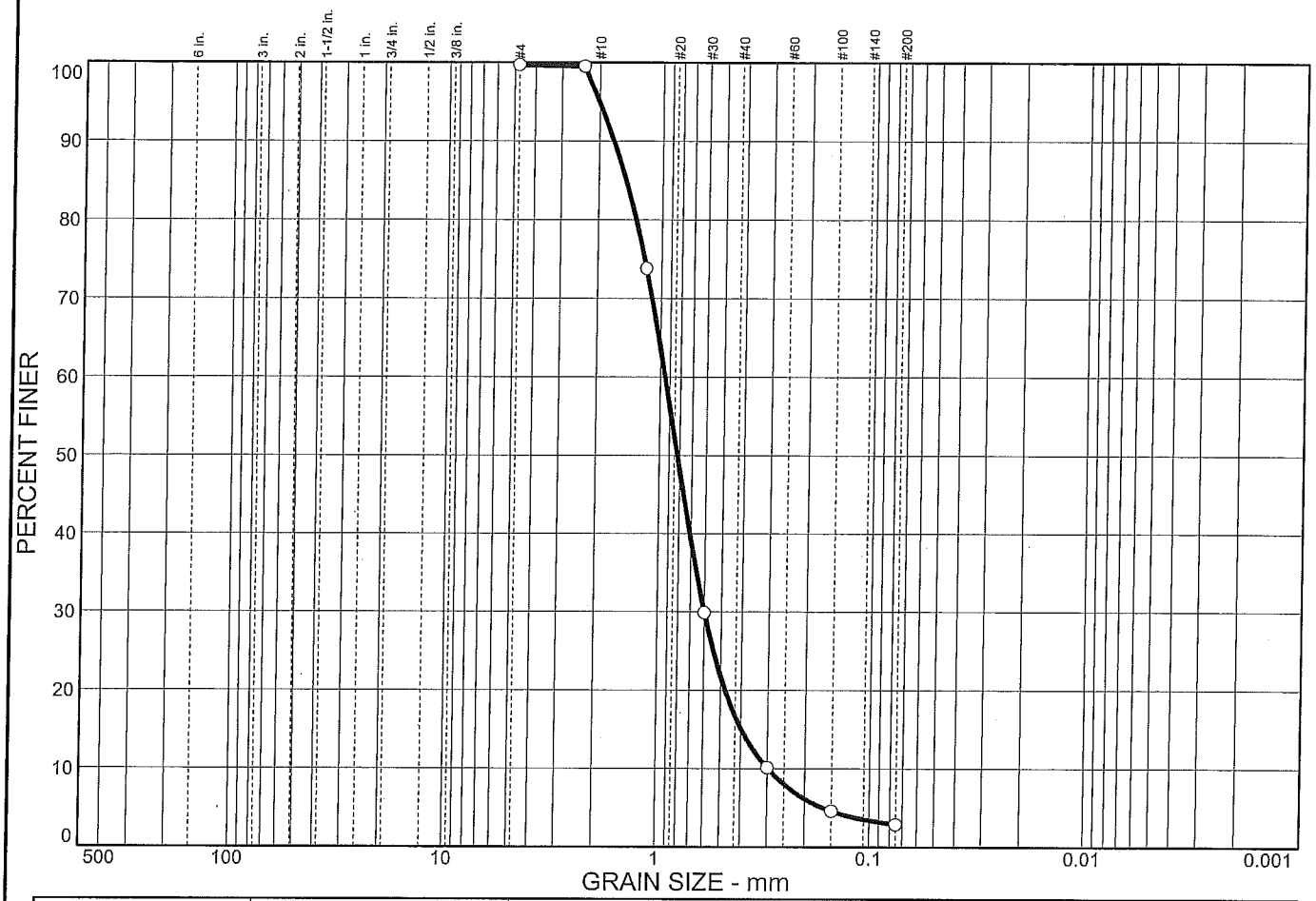
Sample No.: B5-4 **Source of Sample:** **Date:** 7-5-06
Location: **Elev./Depth:** 12.0-13.0 ft

Blackburn Consulting
W. Sacramento, CA

Client: Wood Rodgers
Project: Star Bend Setback Levee

Project No: 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
		96.8	2.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	99.7		
#8	99.5		
#16	73.8		
#30	29.9		
#50	10.1		
#100	4.6		
#200	2.9		

* (no specification provided)

Material Description

Olive brown poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 1.49 D_{60}= 0.950 D_{50}= 0.823
D_{30}= 0.601 D_{15}= 0.398 D_{10}= 0.298
C_u= 3.19 C_c= 1.28

Classification

USCS= SP AASHTO=

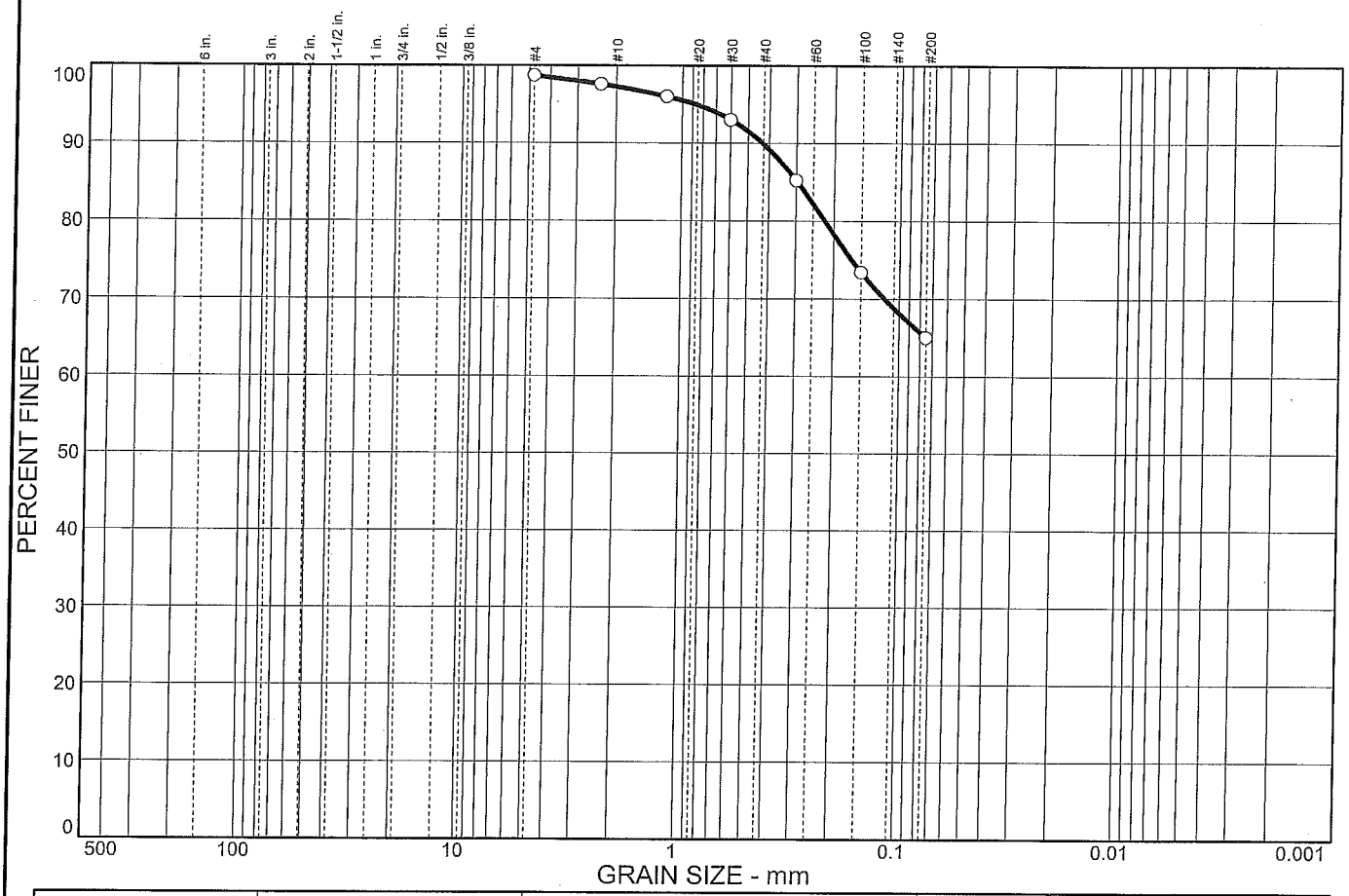
Remarks

Sample No.: B5-7c **Source of Sample:** **Date:** 7-6-06
Location: **Elev./Depth:** 21.0-21.5 ft

Blackburn Consulting
W. Sacramento, CA

Client: Wood Rodgers
Project: Star Bend Setback Levee
Project No: 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
			1.4	7.4	24.9	65.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	98.7		
#8	97.6		
#16	96.0		
#30	93.0		
#50	85.2		
#100	73.4		
#200	65.0		

* (no specification provided)

Material Description

Dark greenish gray sandy elastic silt

Atterberg Limits

PL= 31 LL= 59 PI= 28

Coefficients

D_{85}= 0.296 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

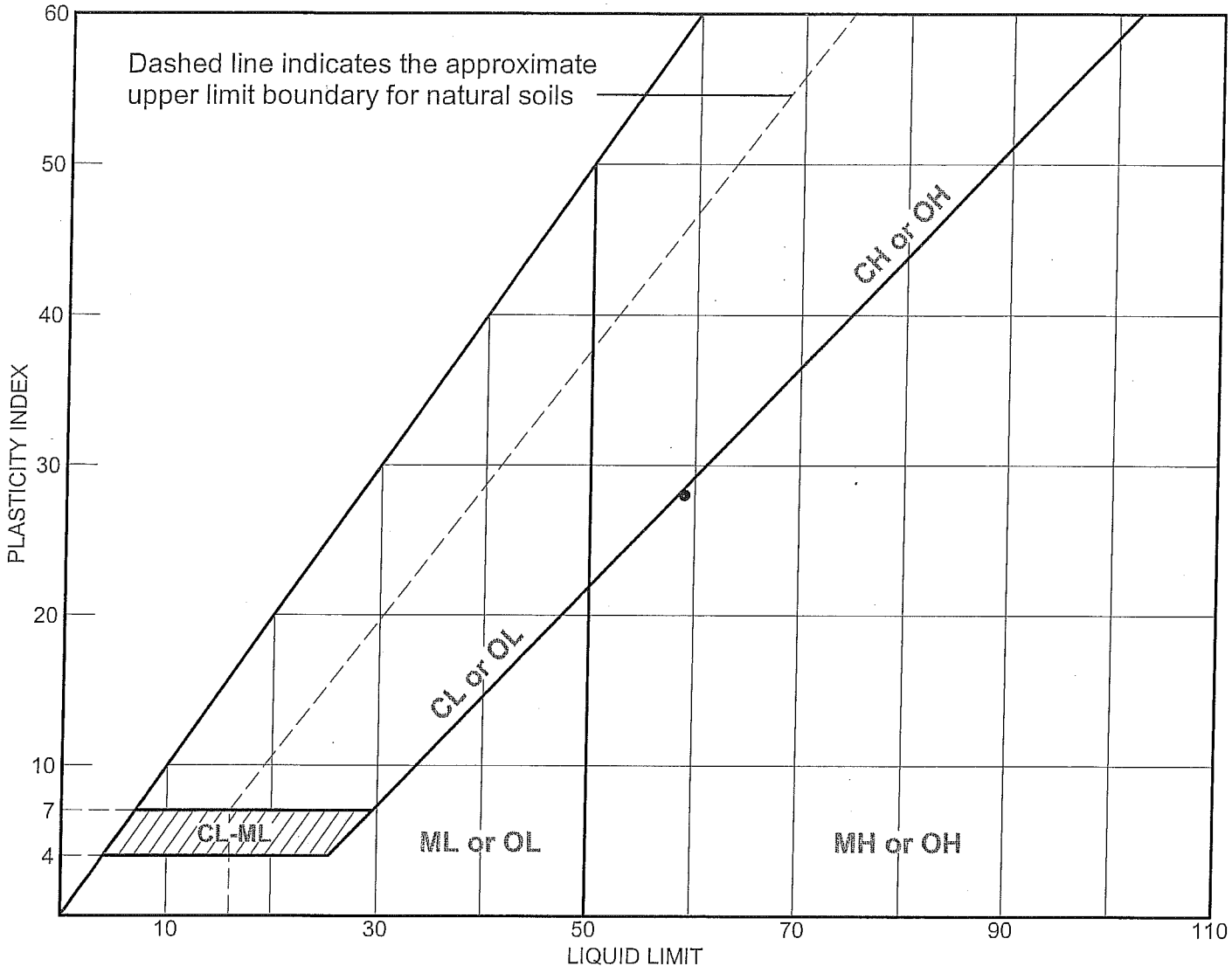
Sample No.: B5-12 **Source of Sample:** **Date:** 7-6-06
Location: **Elev./Depth:** 32.0-33.0ft.

Blackburn Consulting
W. Sacramento, CA

Client: Wood Rodgers
Project: Star Bend Setback Levee

Project No: 788.1 **Figure**

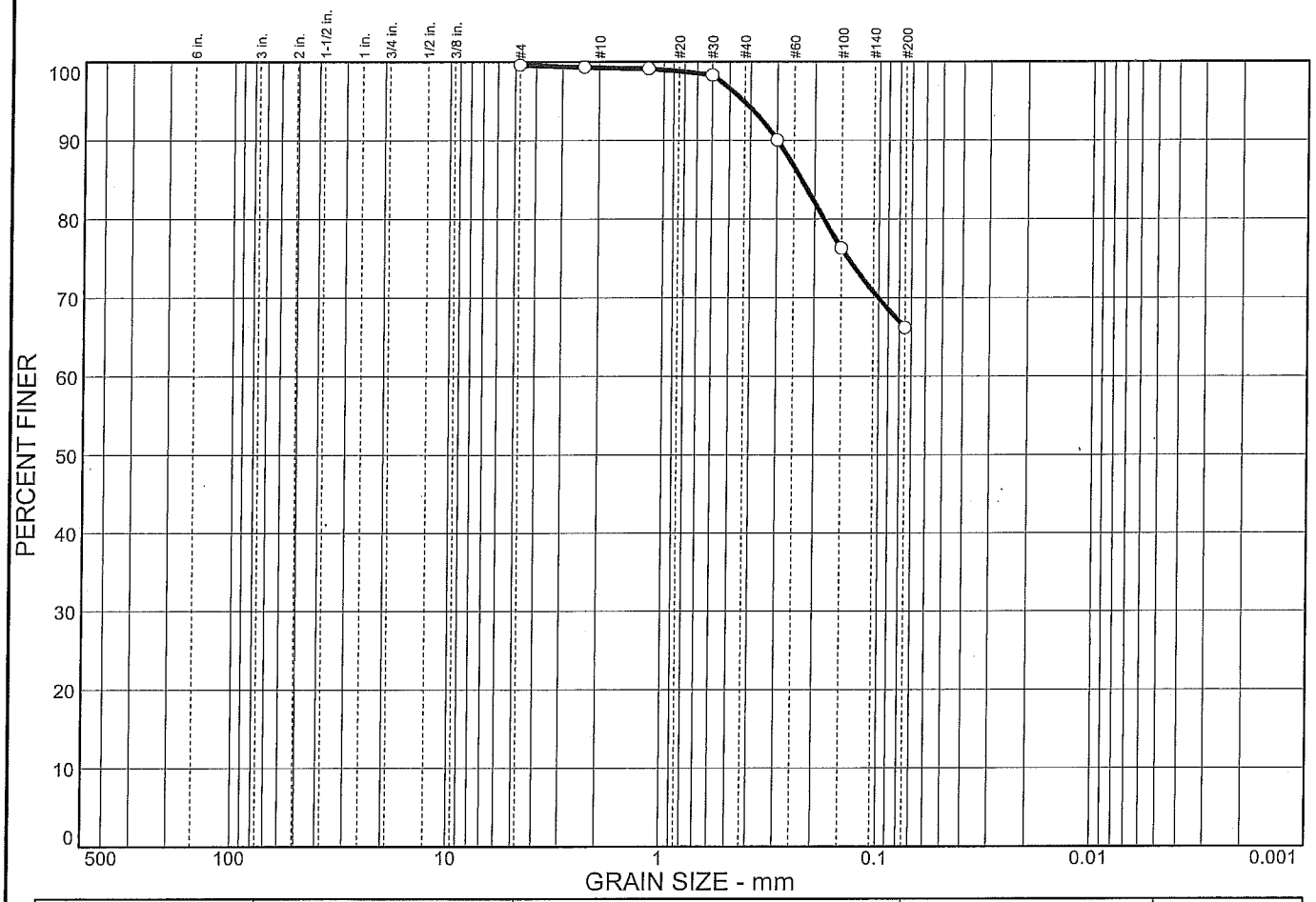
LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		B5-12	32.0-33.0ft.		31	59	28	MH

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** Wood Rodgers **Project:** Star Bend Setback Levee **Project No.:** 788.1 Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
		33.4	66.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	99.6		
#8	99.3		
#16	99.1		
#30	98.3		
#50	90.0		
#100	76.3		
#200	66.2		

* (no specification provided)

Material Description

Dark greenish gray sandy silty clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.231 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL-ML AASHTO=

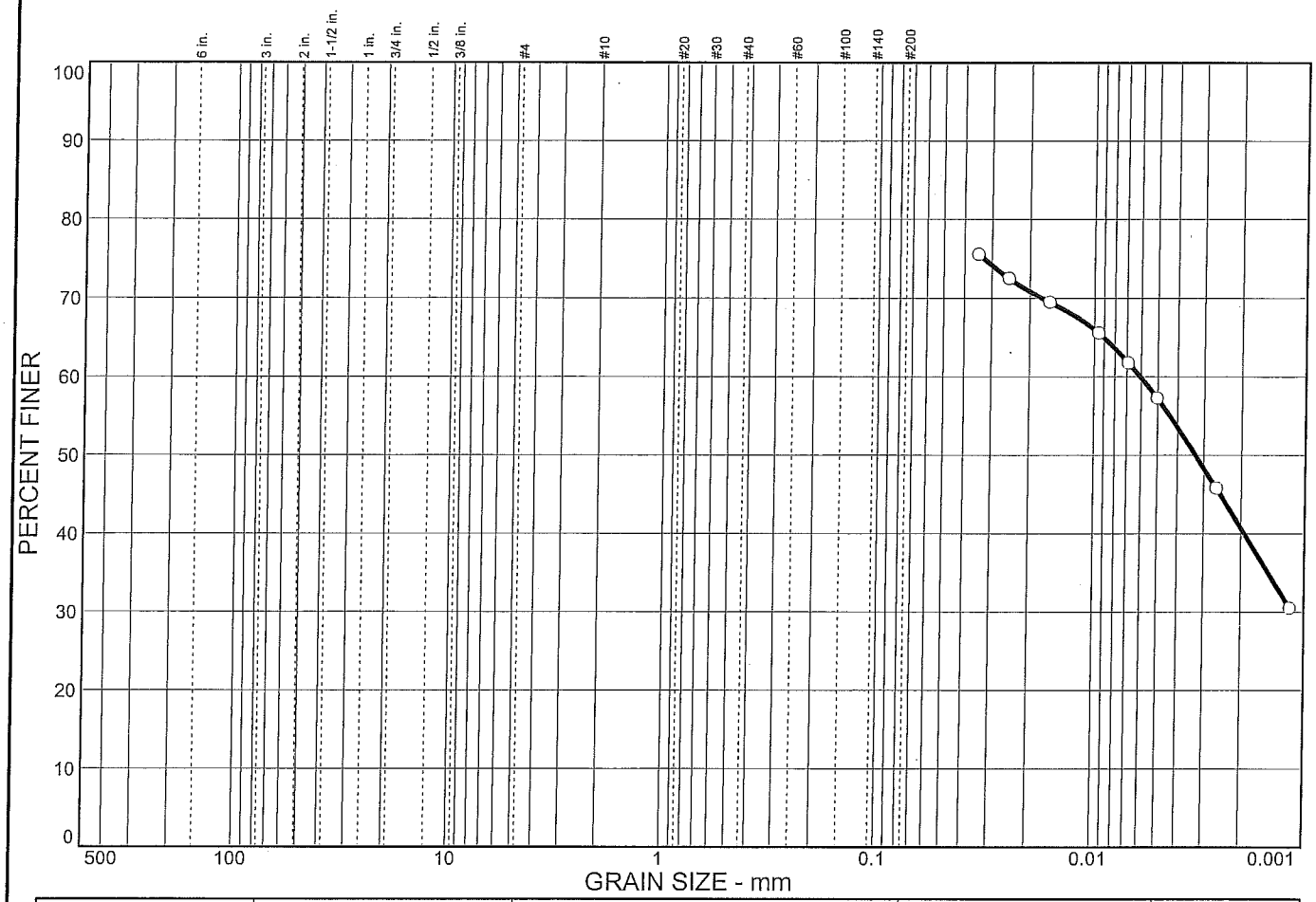
Remarks

Sample No.: B5-15b **Source of Sample:** **Date:** 7-6-06
Location: **Elev./Depth:** 40.5-41.0 ft

Blackburn Consulting
W. Sacramento, CA

Client: Wood Rodgers
Project: Star Bend Setback Levee
Project No: 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)

* (no specification provided)

Material Description

Dark greenish gray fat Clay (CH)

Atterberg Limits

PL= 25 LL= 53 PI= 28

Coefficients

D_{85}= D_{60}= 0.0060 D_{50}= 0.0033
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

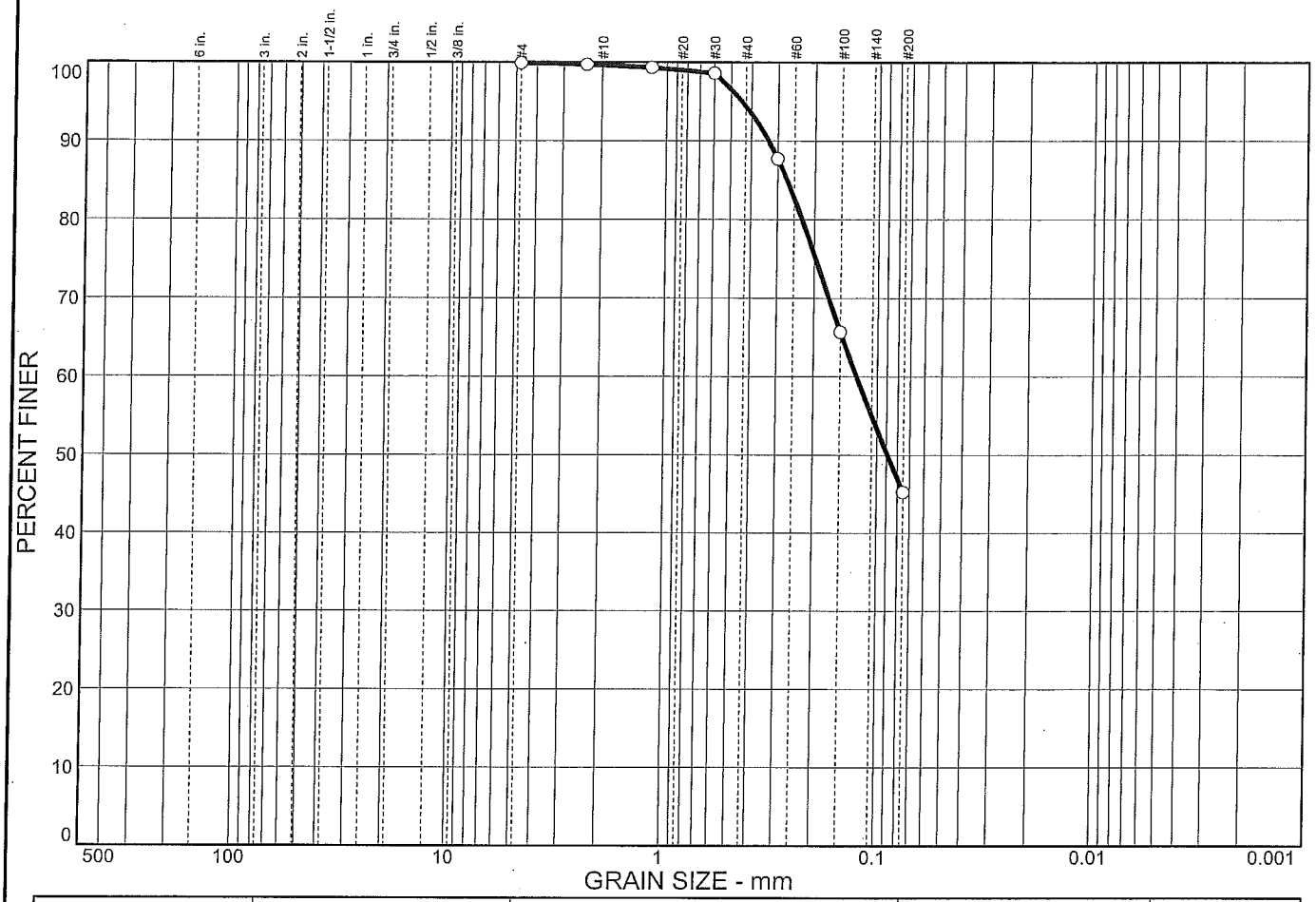
Remarks

Sample No.: B5-15c **Source of Sample:** B5 **Date:** 7-7-06
Location: **Elev./Depth:** 41-41.5

Blackburn Consulting
Auburn, California

Client: Wood Rodgers
Project: Star Bend Setback Levee
Project No: 788.1

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
		54.7	45.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	99.9		
#8	99.7		
#16	99.3		
#30	98.6		
#50	87.7		
#100	65.7		
#200	45.2		

* (no specification provided)

Material Description

Greenish black silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.271 D_{60}= 0.125 D_{50}= 0.0890
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

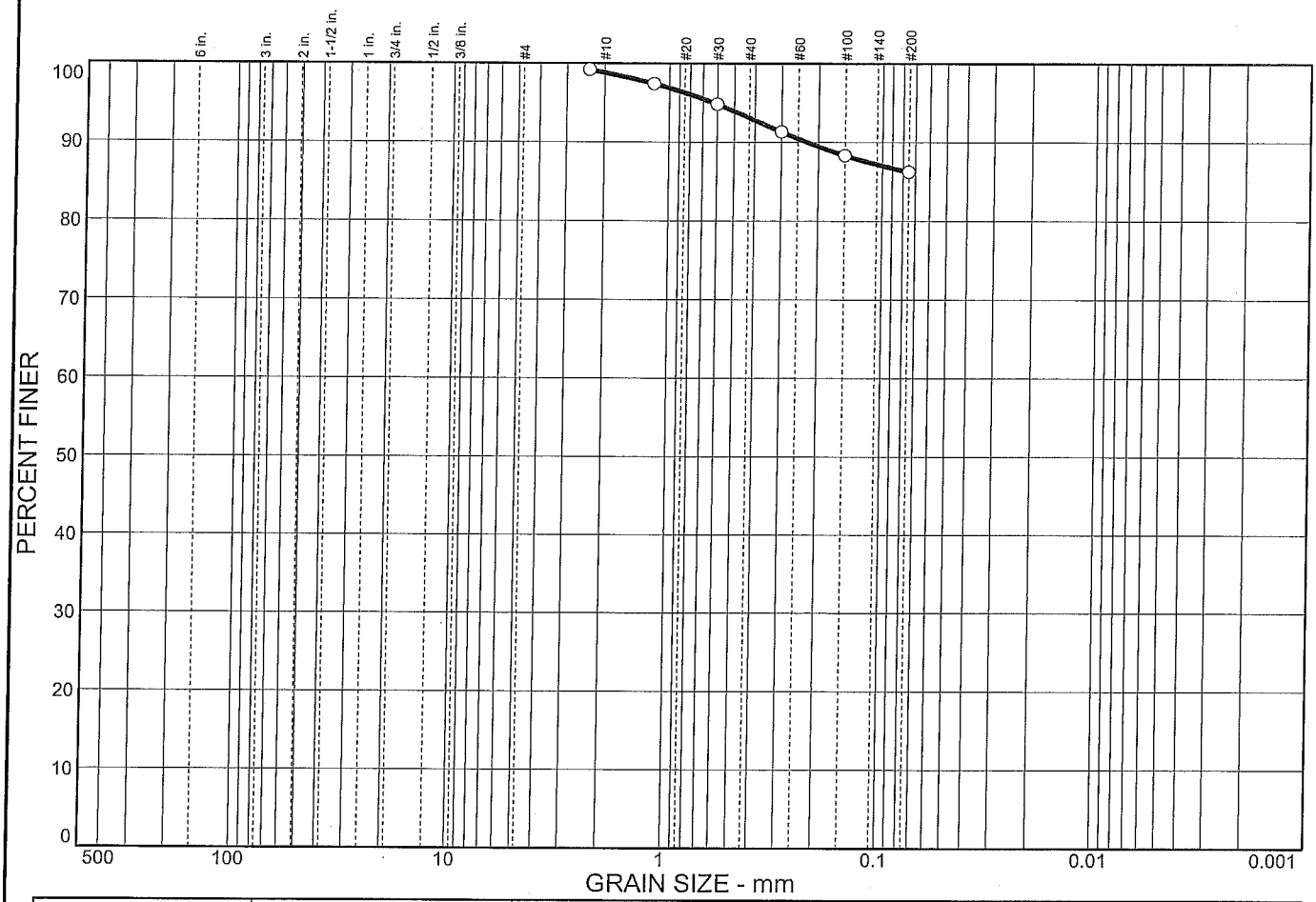
Sample No.: B5-20 **Source of Sample:** **Date:** 7-5-06
Location: **Elev./Depth:** 52.0-53.0 ft

Blackburn Consulting
W. Sacramento, CA

Client: Wood Rodgers
Project: Star Bend Setback Levee

Project No: 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
			86.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#8	99.2		
#16	97.4		
#30	94.8		
#50	91.3		
#100	88.3		
#200	86.2		

* (no specification provided)

Material Description

Light greenish gray fat clay

Atterberg Limits

PL= 26 LL= 58 PI= 32

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO=

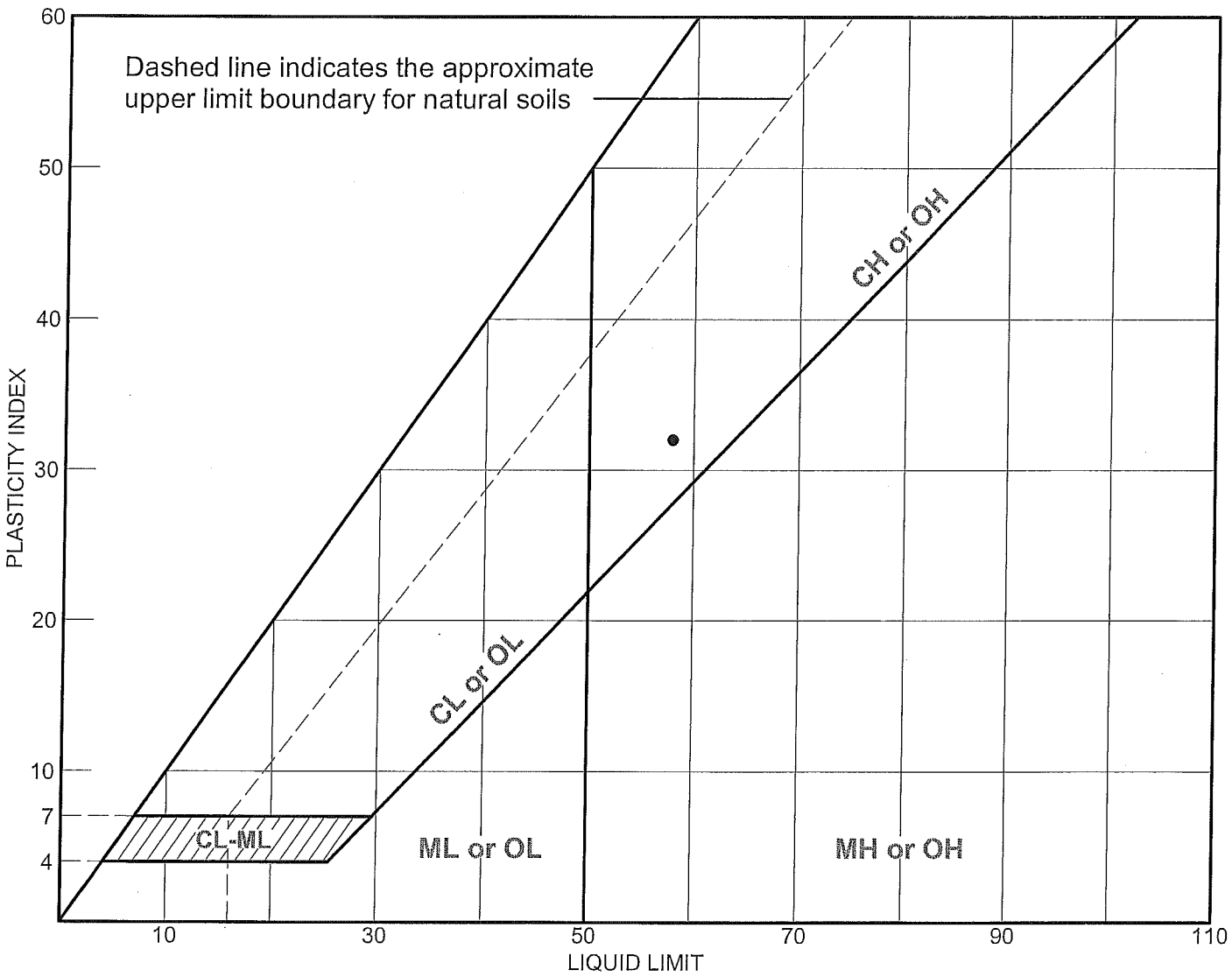
Remarks

Sample No.: B5-23b **Source of Sample:** **Date:** 7-10-06
Location: **Elev./Depth:** 60.5-61.0

Blackburn Consulting
W. Sacramento, CA

Client: Wood Rodgers
Project: Star Bend Setback Levee
Project No: 788.1 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		B5-23b	60.5-61.0		26	58	32	CH

LIQUID AND PLASTIC LIMITS TEST REPORT

Blackburn Consulting

W. Sacramento, CA

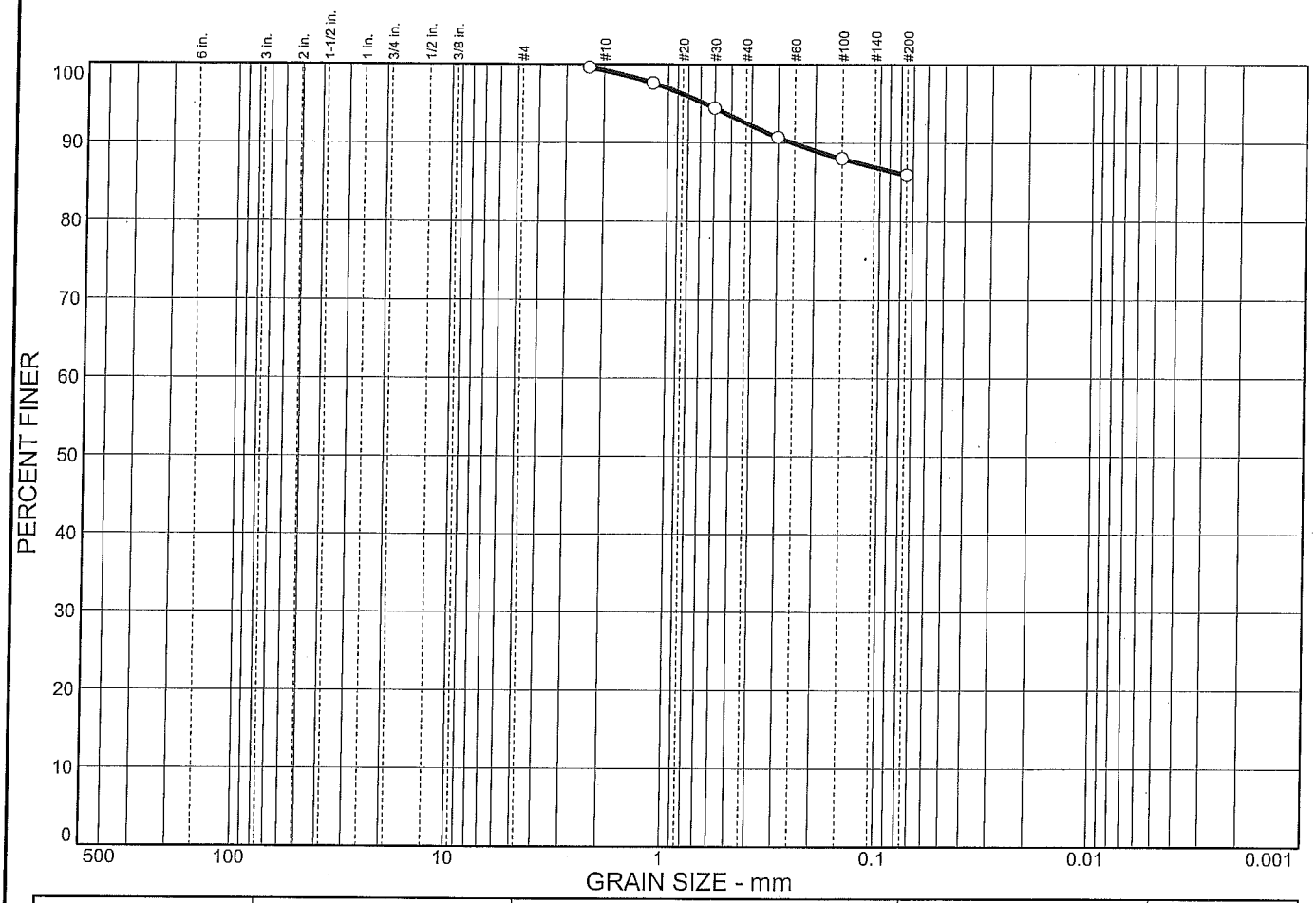
Client: Wood Rodgers

Project: Star Bend Setback Levee

Project No.: 788.1

Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
			85.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#8	99.6		
#16	97.6		
#30	94.4		
#50	90.7		
#100	88.0		
#200	85.9		

* (no specification provided)

Material Description

Light olive brown lean clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

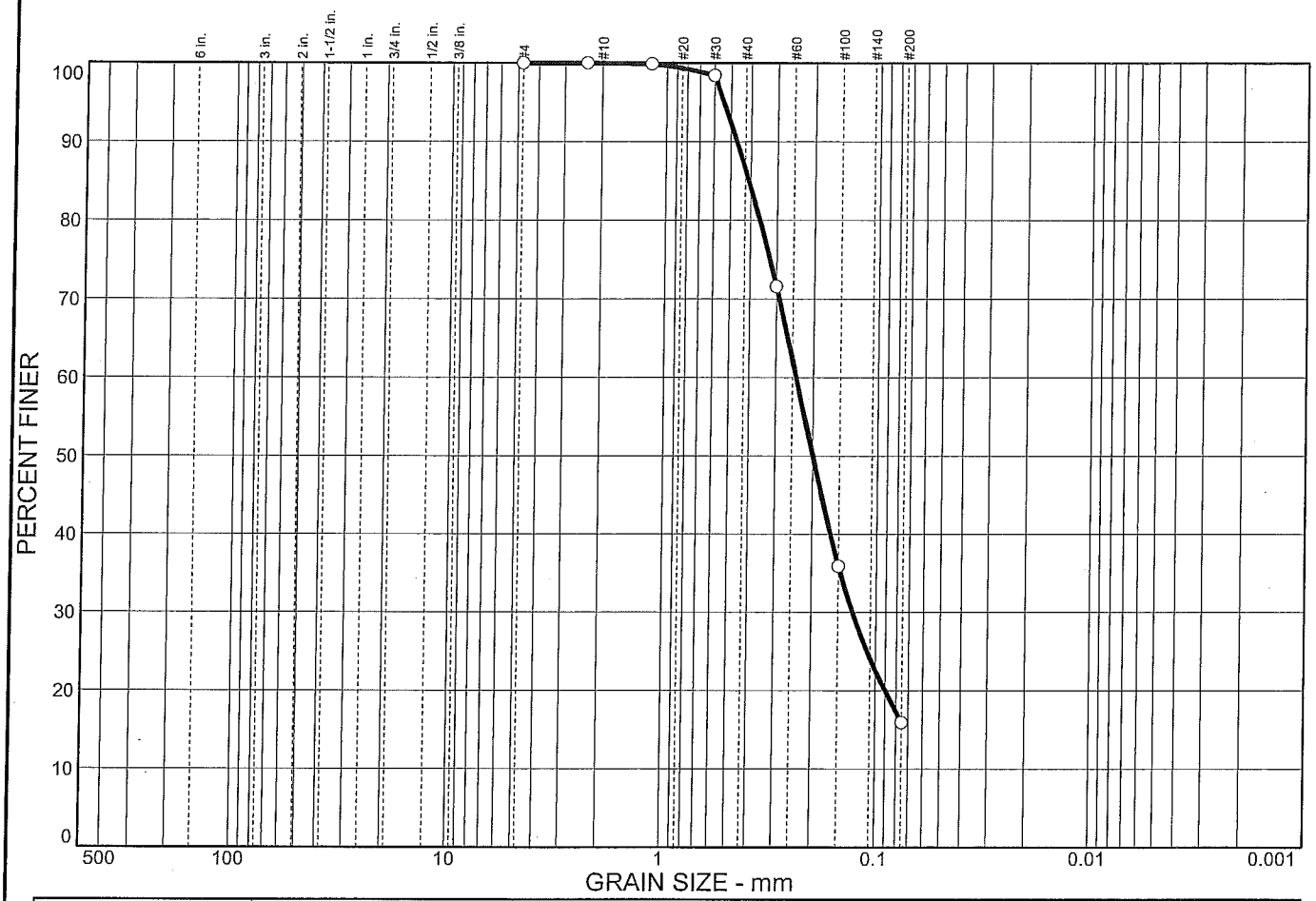
Remarks

Sample No.: B6-6 **Source of Sample:** **Date:** 7-6-06
Location: **Elev./Depth:** 17.0-18.0 ft

Blackburn Consulting
W. Sacramento, CA

Client: Wood Rodgers
Project: Star Bend Setback Levee
Project No: 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	84.1	15.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	100.0		
#16	99.9		
#30	98.4		
#50	71.6		
#100	35.9		
#200	15.9		

* (no specification provided)

Material Description

Olive silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.409 D_{60}= 0.240 D_{50}= 0.200
D_{30}= 0.129 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

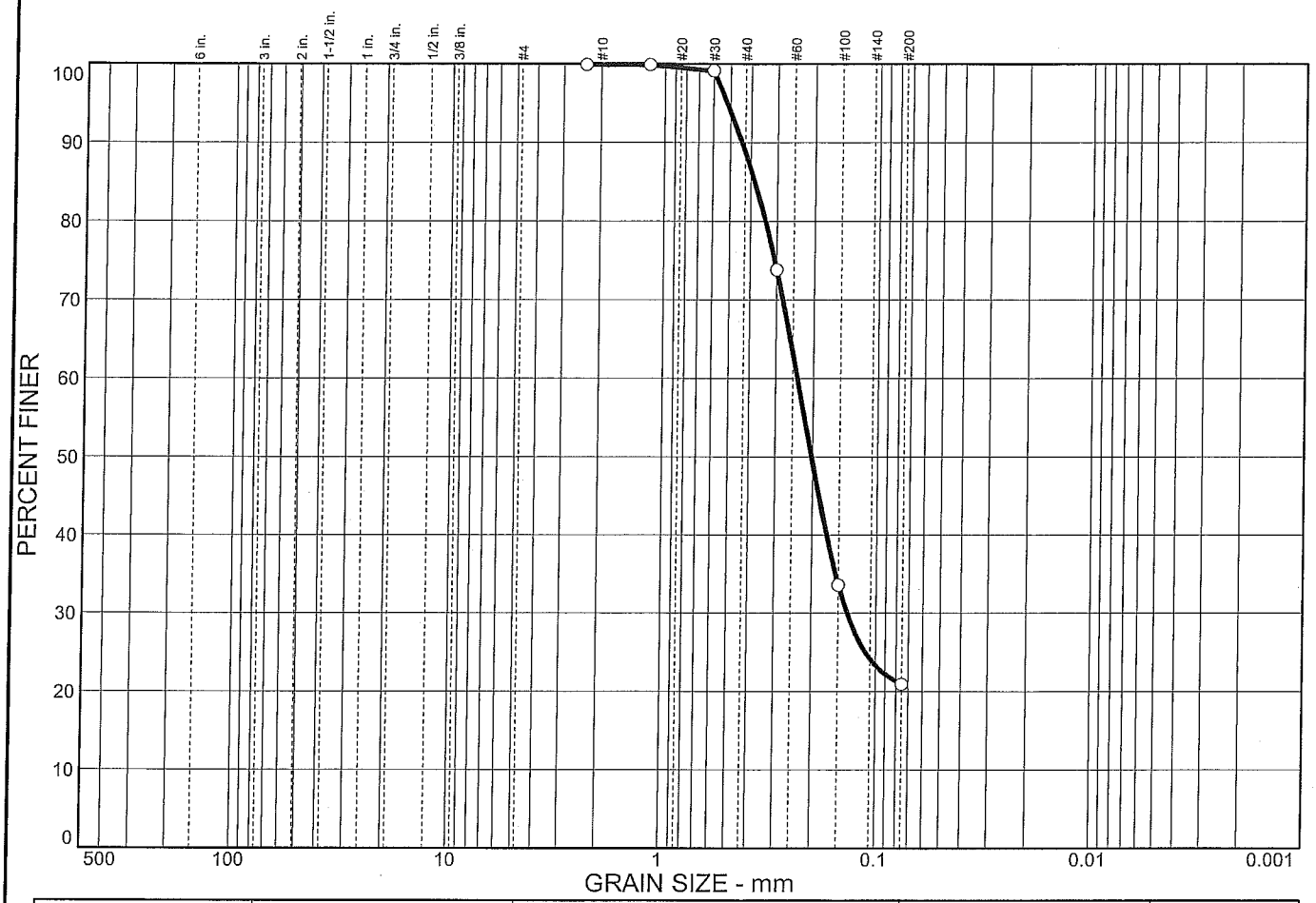
Remarks

Sample No.: B6-8 **Source of Sample:** **Date:** 8-22-06
Location: **Elev./Depth:** 22.0-23.0'

Blackburn Consulting
W. Sacramento, CA

Client:
Project: Star Bend Levee Setback
Project No: 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
			20.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#8	99.9		
#16	99.9		
#30	99.1		
#50	73.8		
#100	33.6		
#200	20.9		

* (no specification provided)

Material Description

Olive brown silty, clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.384 D_{60}= 0.238 D_{50}= 0.203
D_{30}= 0.136 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC-SM AASHTO=

Remarks

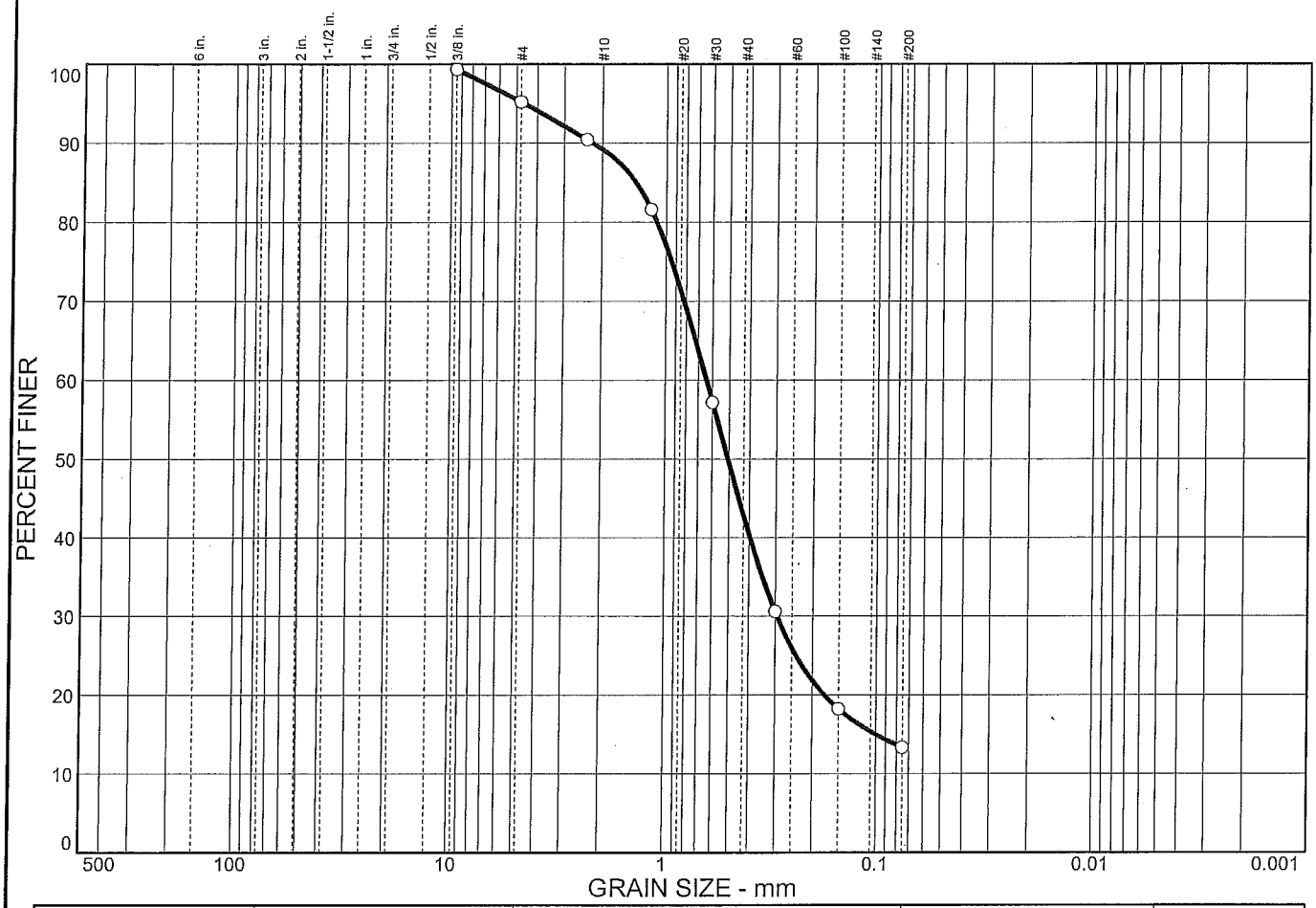
Sample No.: B6-9b **Source of Sample:** **Date:** 7-6-06
Location: **Elev./Depth:** 25.5-26.0 ft

Blackburn Consulting
W. Sacramento, CA

Client: Wood Rodgers
Project: Star Bend Setback Levee

Project No: 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
		81.9	13.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	99.3		
#4	95.2		
#8	90.4		
#16	81.6		
#30	57.2		
#50	30.6		
#100	18.2		
#200	13.3		

* (no specification provided)

Material Description

Olive brown silty, clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 1.39 D_{60}= 0.641 D_{50}= 0.506
D_{30}= 0.294 D_{15}= 0.100 D_{10}=
C_u= C_c=

Classification

USCS= SC-SM AASHTO=

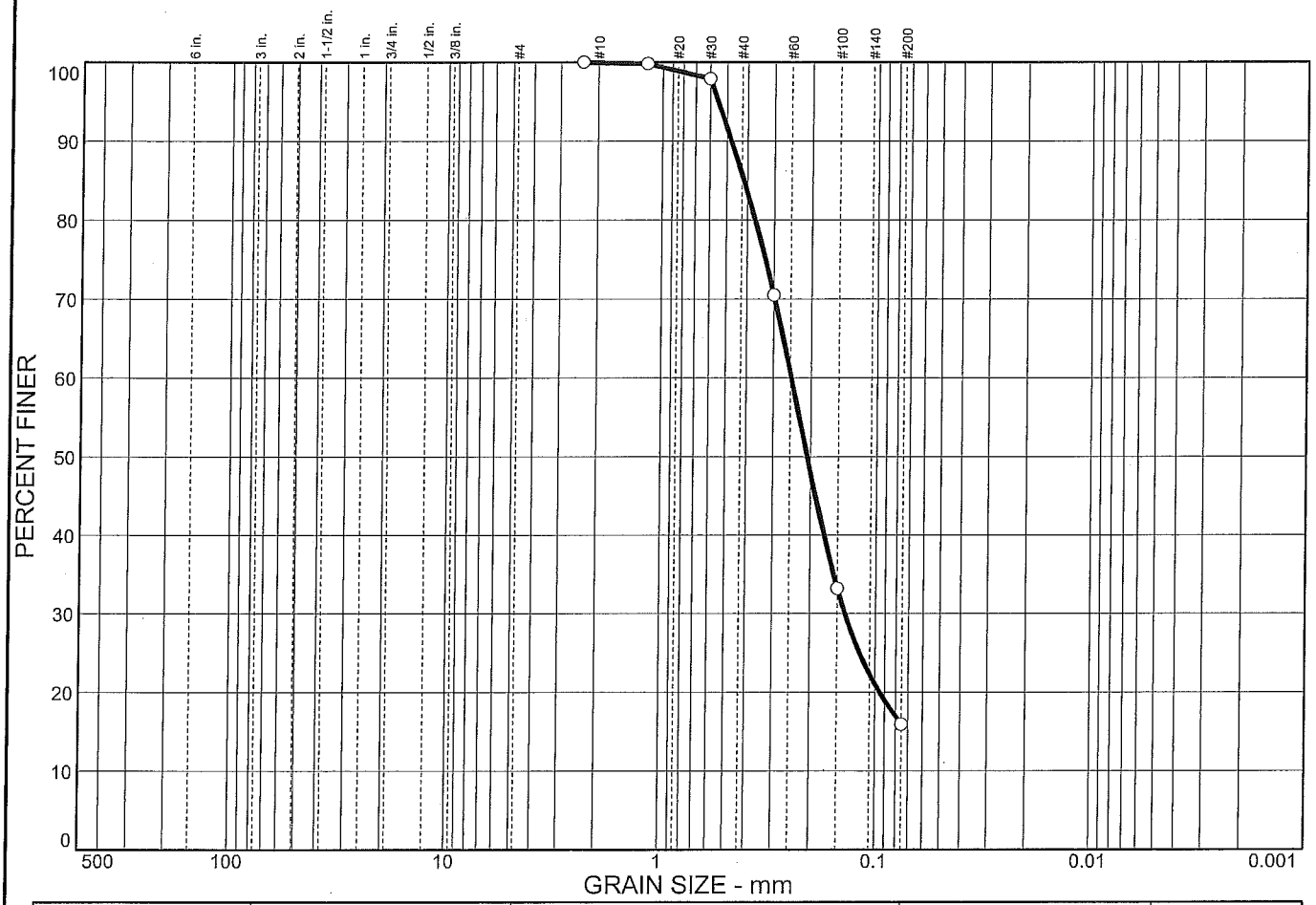
Remarks

Sample No.: B6-12b **Source of Sample:** **Date:** 7-6-06
Location: **Elev./Depth:** 35.5-36.0 ft

Blackburn Consulting
W. Sacramento, CA

Client: Wood Rodgers
Project: Star Bend Setback Levee
Project No: 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	84.1	15.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#8	100.0		
#16	99.8		
#30	97.9		
#50	70.5		
#100	33.2		
#200	15.9		

* (no specification provided)

Material Description

Greenish black silty, clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.417 D_{60}= 0.248 D_{50}= 0.208
D_{30}= 0.138 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC-SM AASHTO=

Remarks

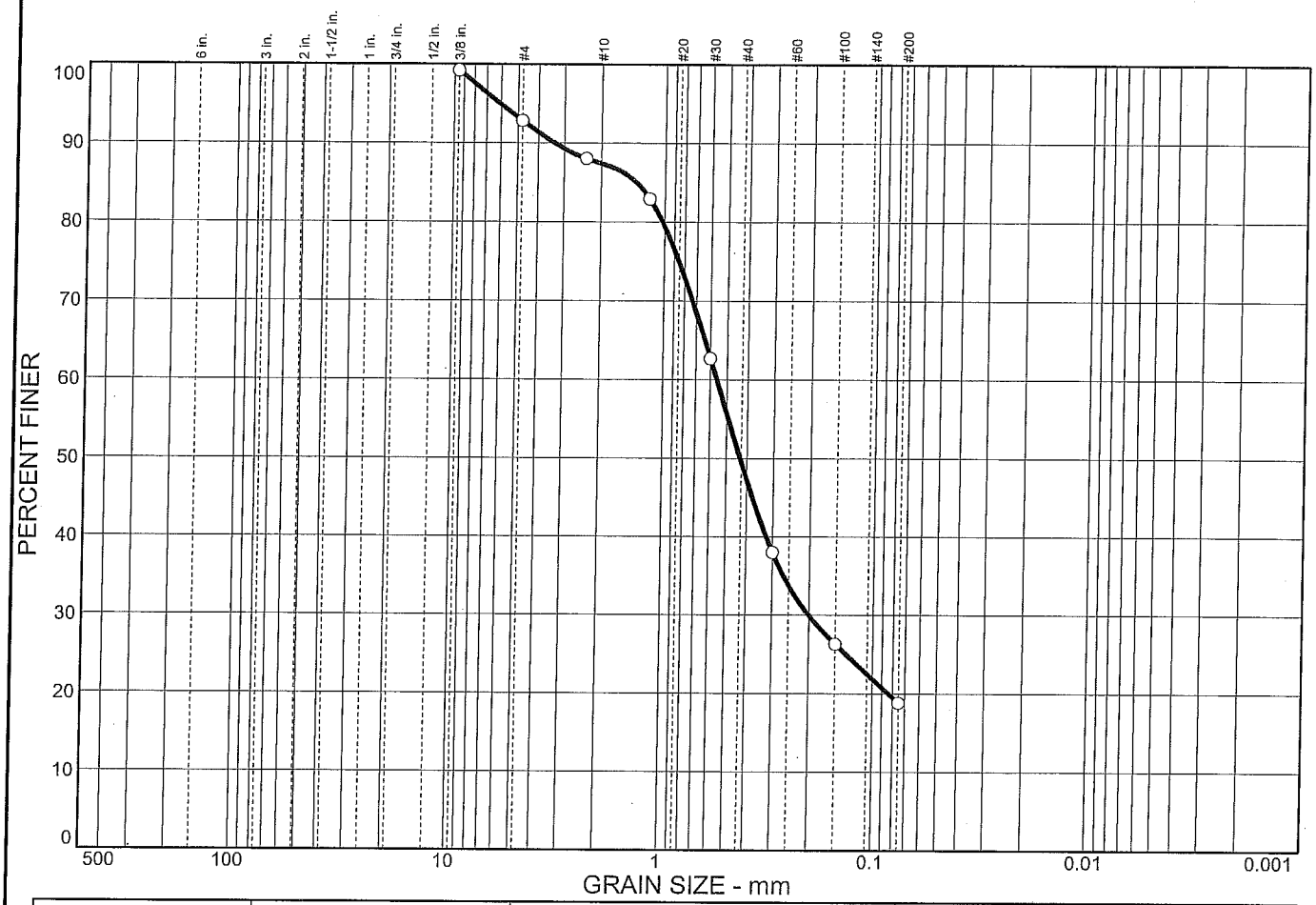
Sample No.: B6-14 **Source of Sample:** **Date:** 7-6-06
Location: **Elev./Depth:** 42.0-43.0 ft

Blackburn Consulting
W. Sacramento, CA

Client: Wood Rodgers
Project: Star Bend Setback Levee

Project No: 788.1 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
		74.0	18.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	99.2		
#4	92.8		
#8	88.0		
#16	82.9		
#30	62.7		
#50	38.0		
#100	26.3		
#200	18.8		

* (no specification provided)

Material Description

Greenish black silty, clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 1.37 D_{60}= 0.559 D_{50}= 0.431
D_{30}= 0.201 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC-SM AASHTO=

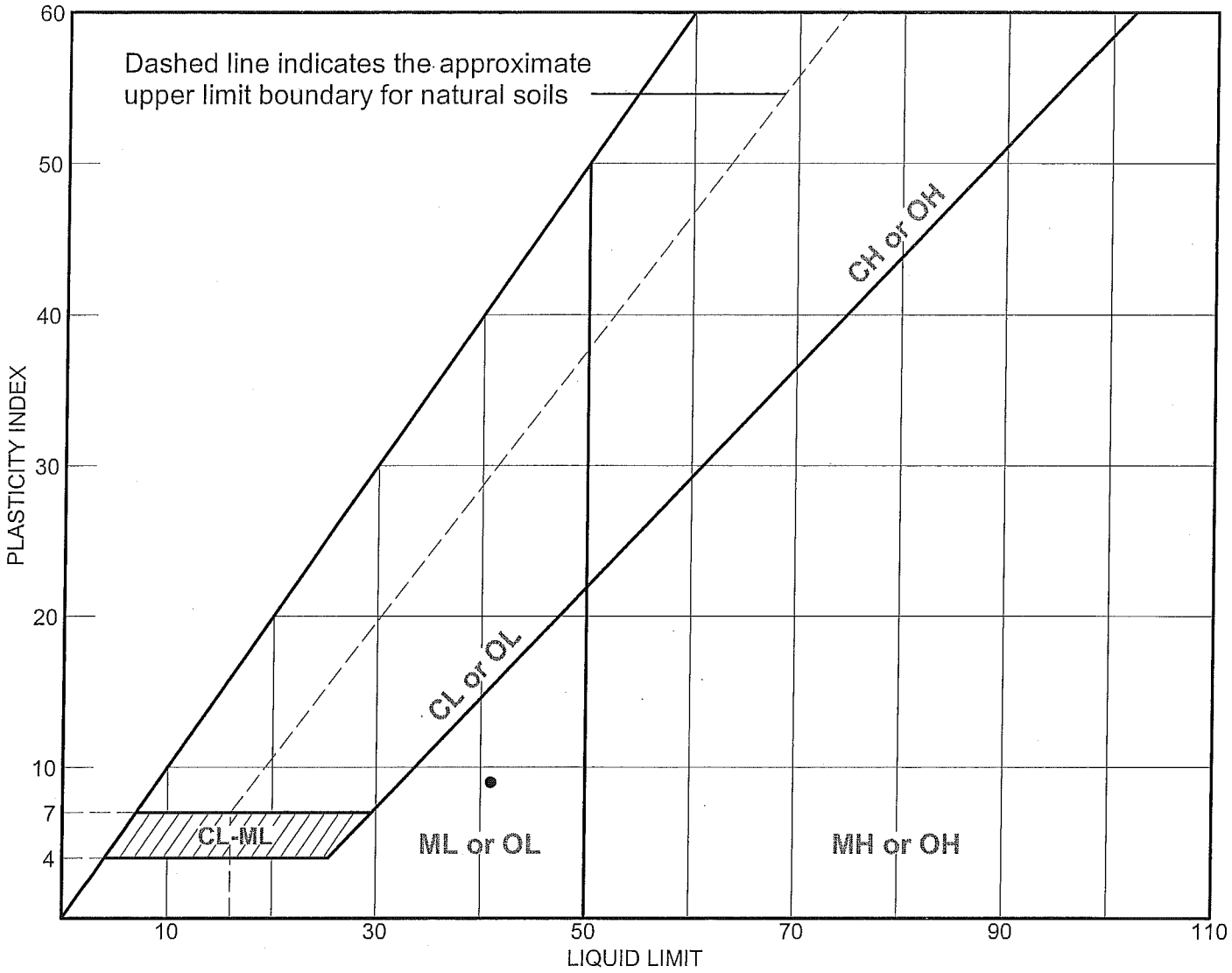
Remarks

Sample No.: B6-16b **Source of Sample:** **Date:** 7-6-06
Location: **Elev./Depth:** 50.5-51.0 ft

Blackburn Consulting
W. Sacramento, CA

Client: Wood Rodgers
Project: Star Bend Setback Levee
Project No: 788.1 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		TP1/Bag B	14.0-15.0'		32	41	9	ML

LIQUID AND PLASTIC LIMITS TEST REPORT

Blackburn Consulting

W. Sacramento, CA

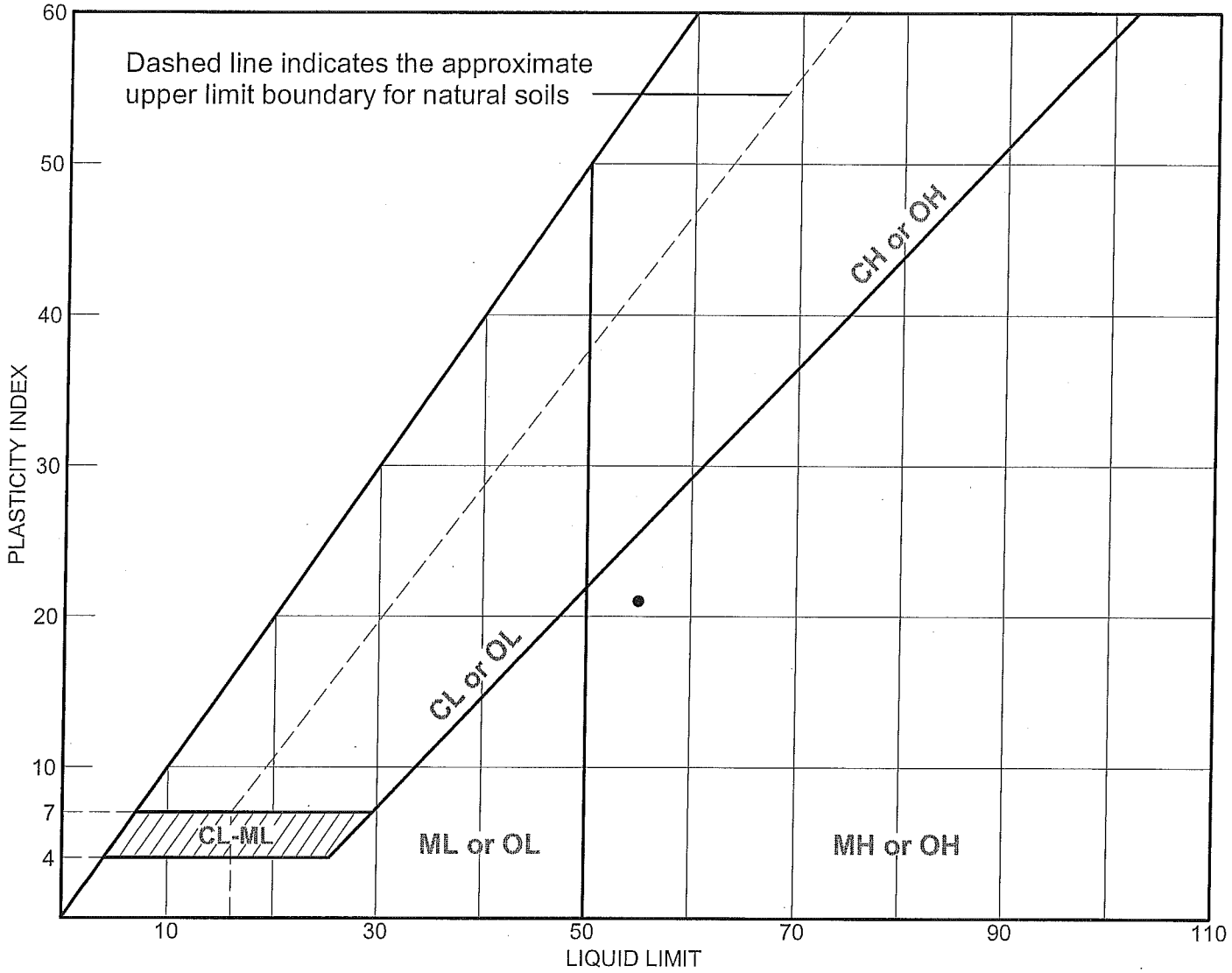
Client:

Project: Star Bend Levee Setback

Project No.: 788.1

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT

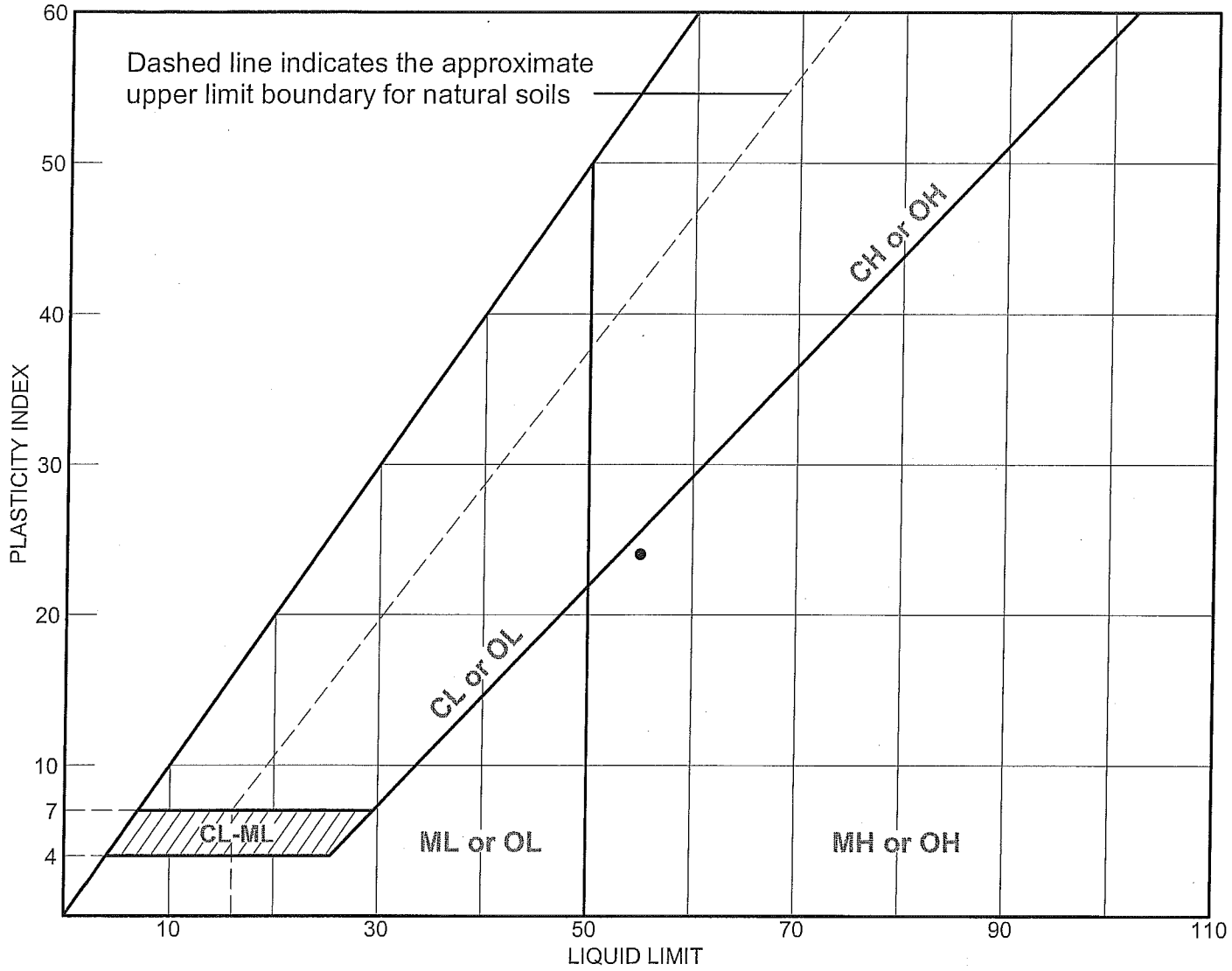


SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		TP2/Bag C	8.0-9.0'		34	55	21	MH

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 **Figure**

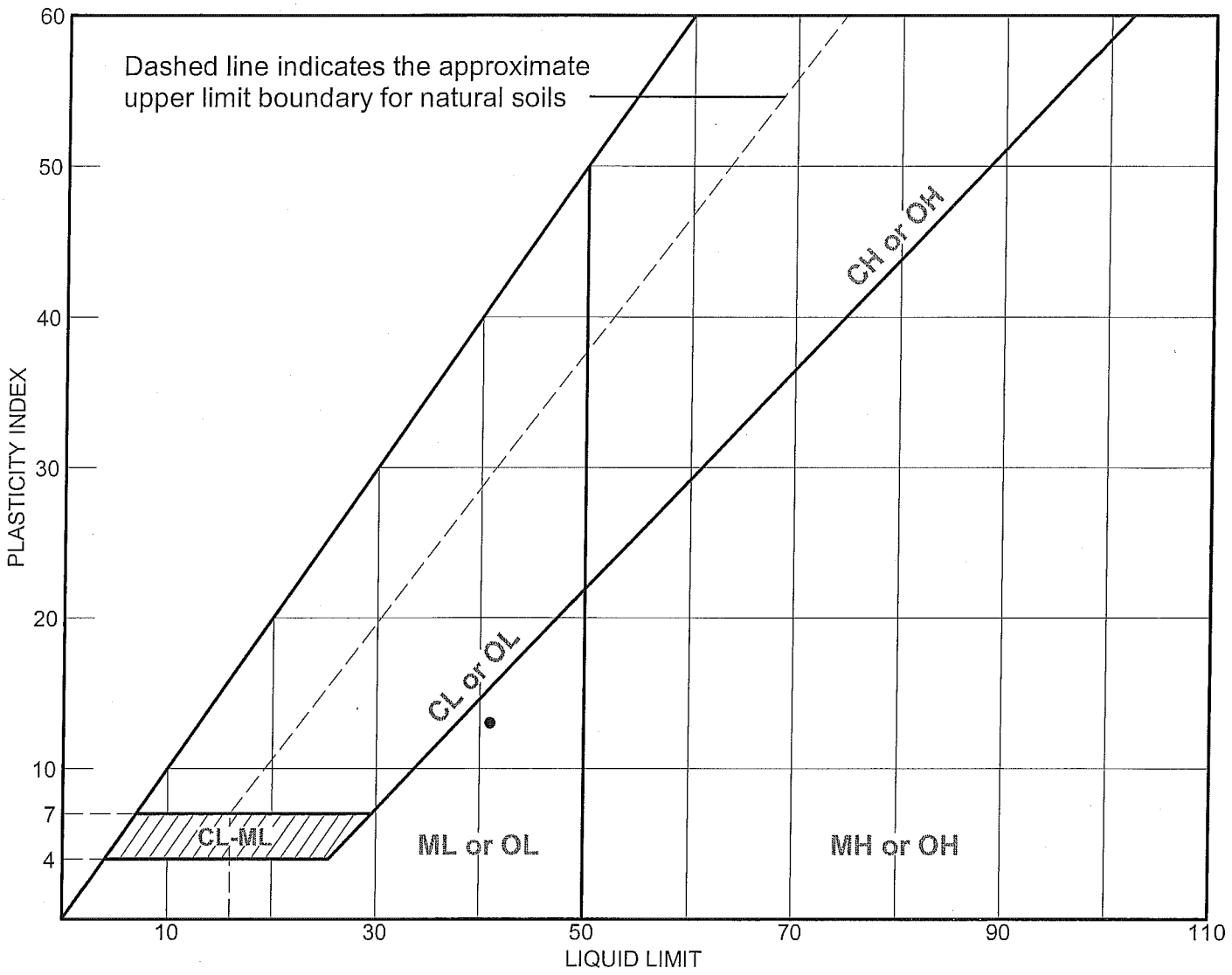
LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		TP3/Bag E	12.0-14.0'		31	55	24	MH

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 **Figure**

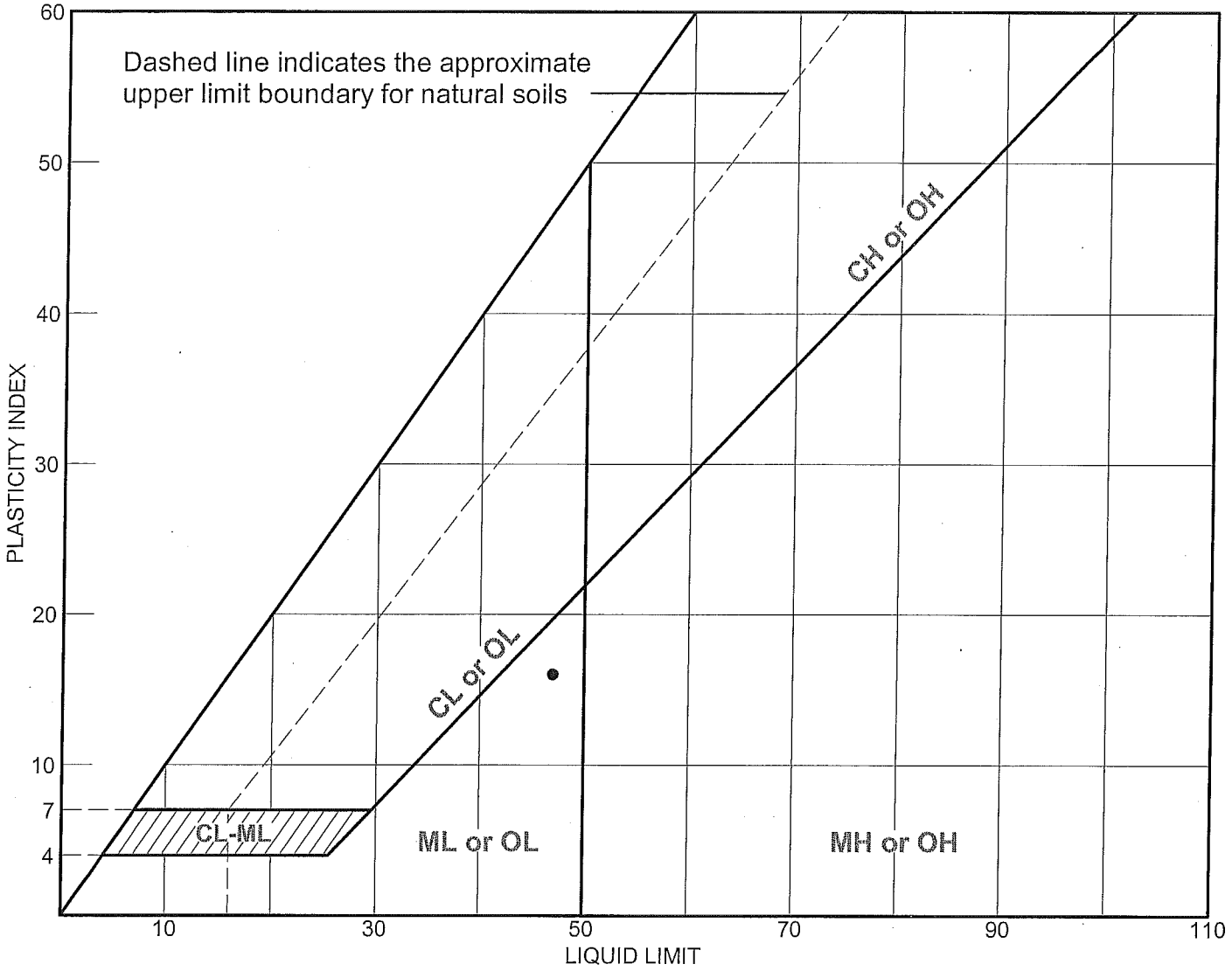
LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		TP4/Bag H	14.0-16.0'		28	41	13	ML

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT

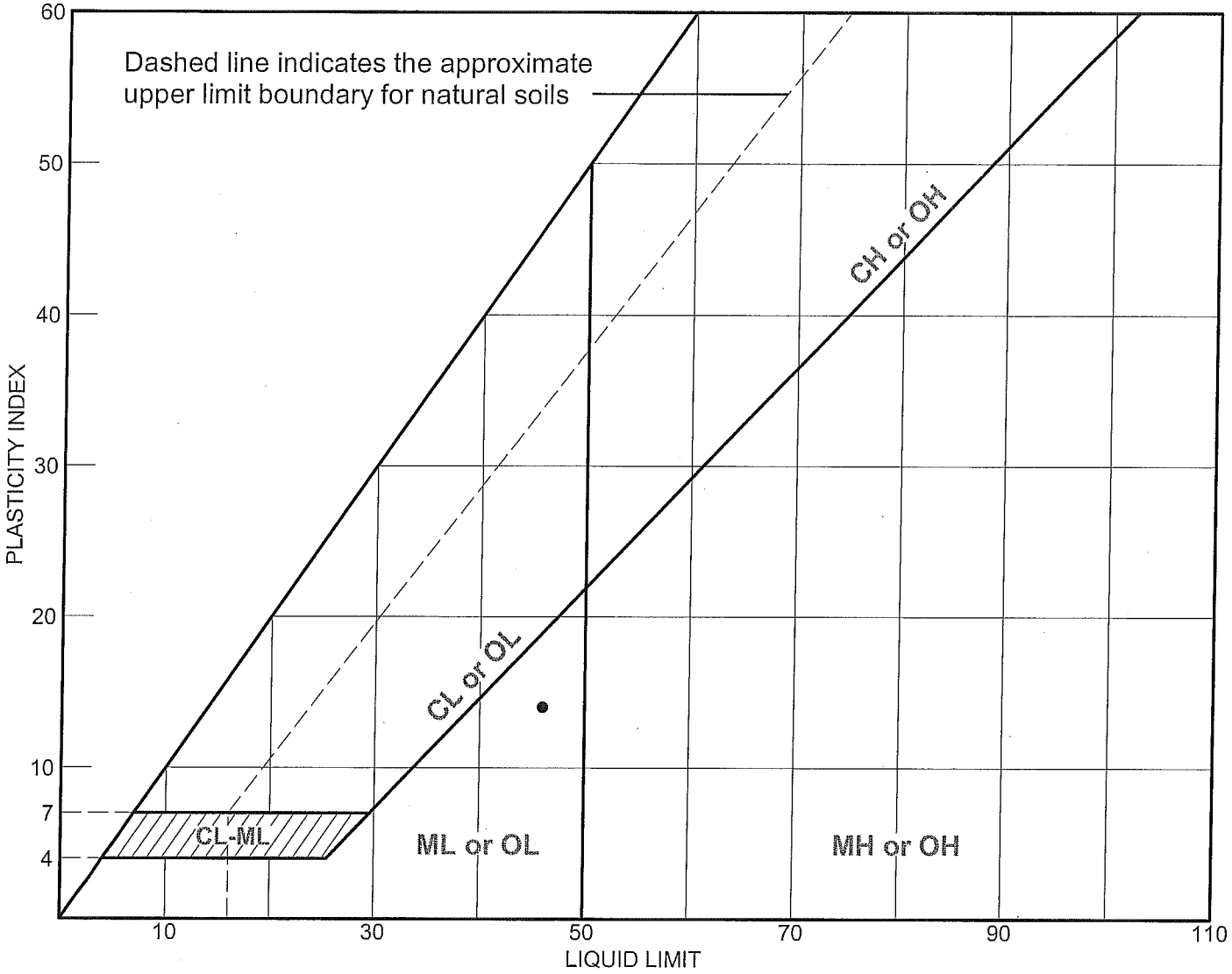


SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		TP4/Bag G	7.0-9.0'		31	47	16	ML

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT

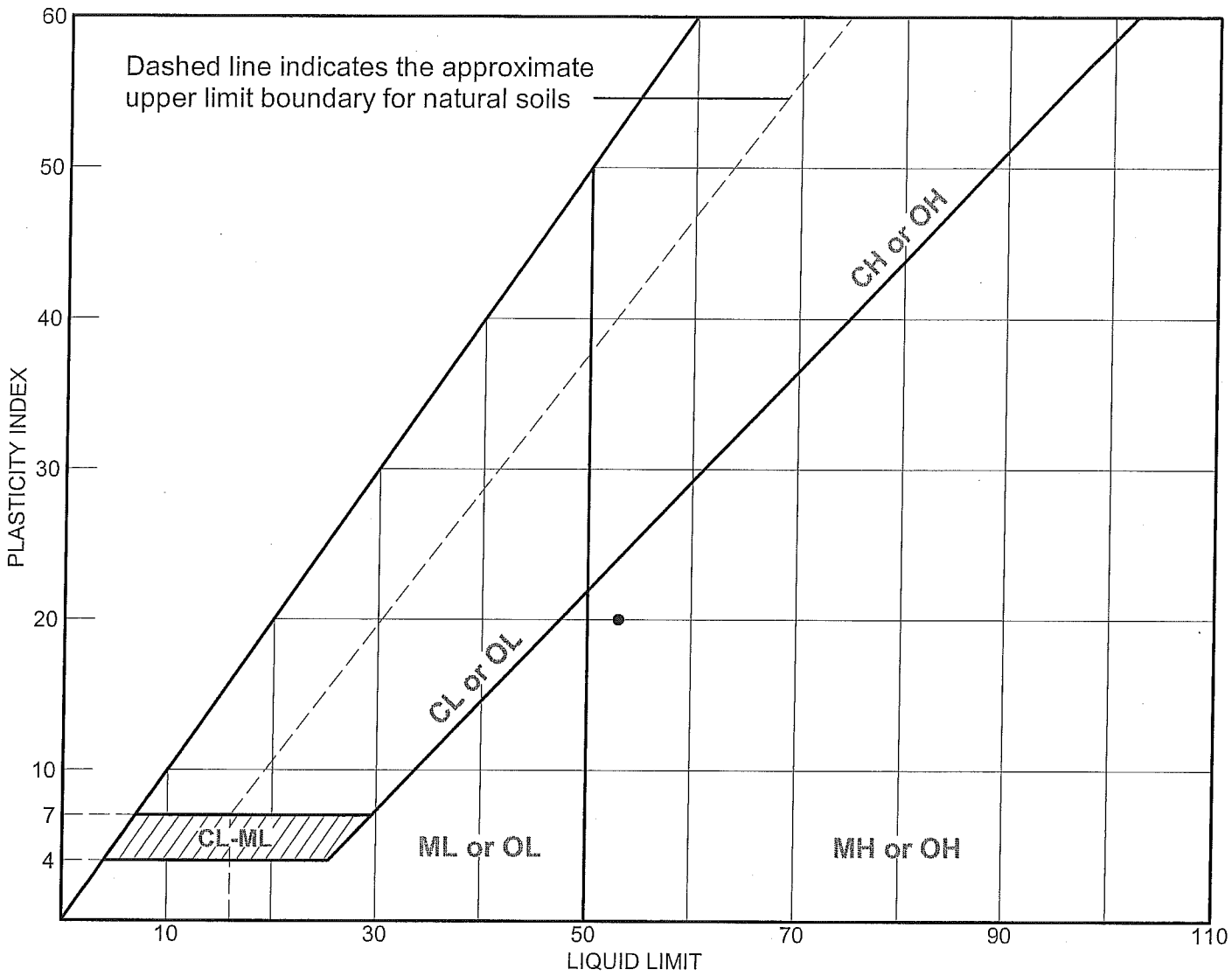


SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		TP5/Bag I	13.0-15.0'		32	46	14	ML

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT

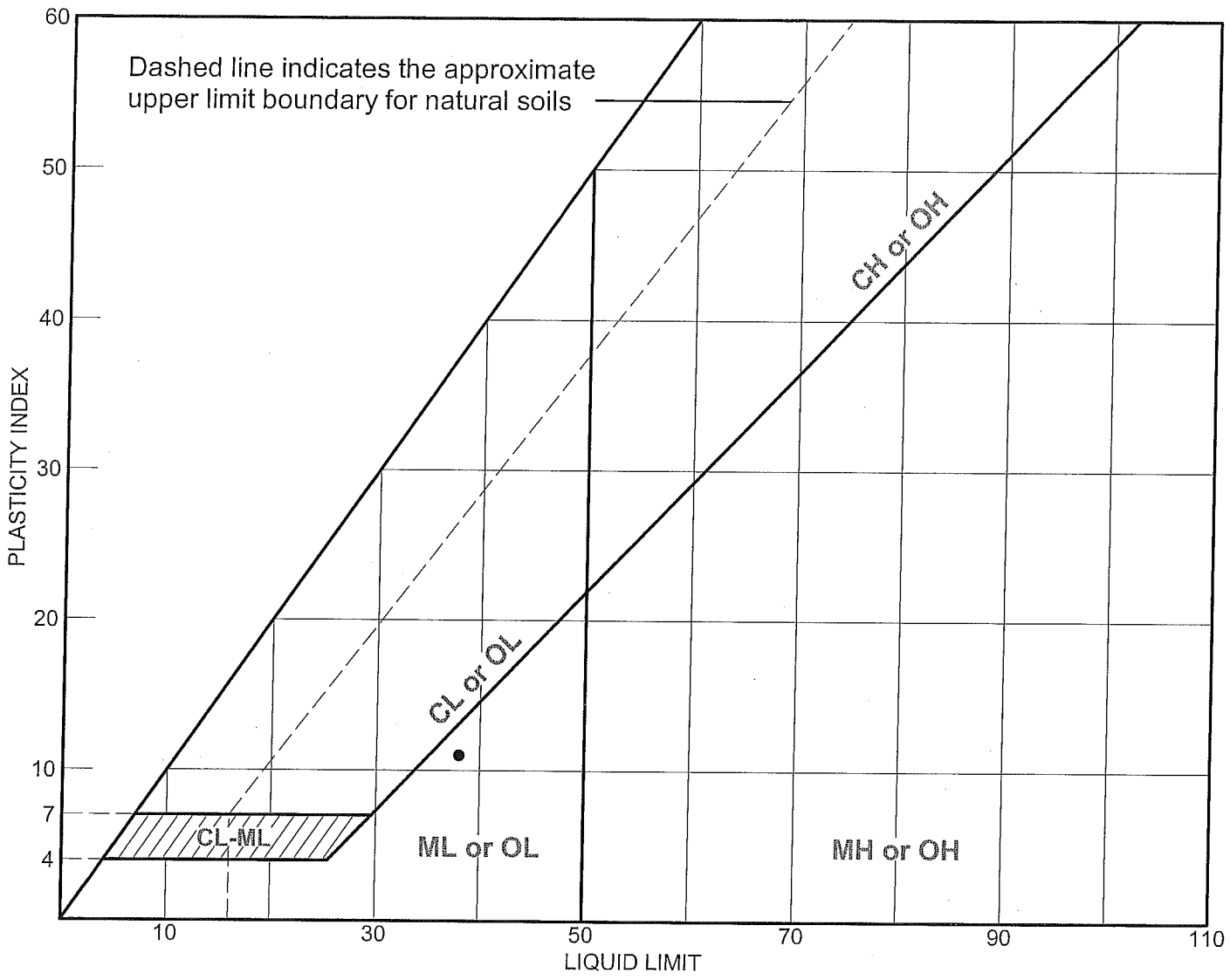


SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		TP6/Bag J	9.0-12.0'		33	53	20	MH

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT

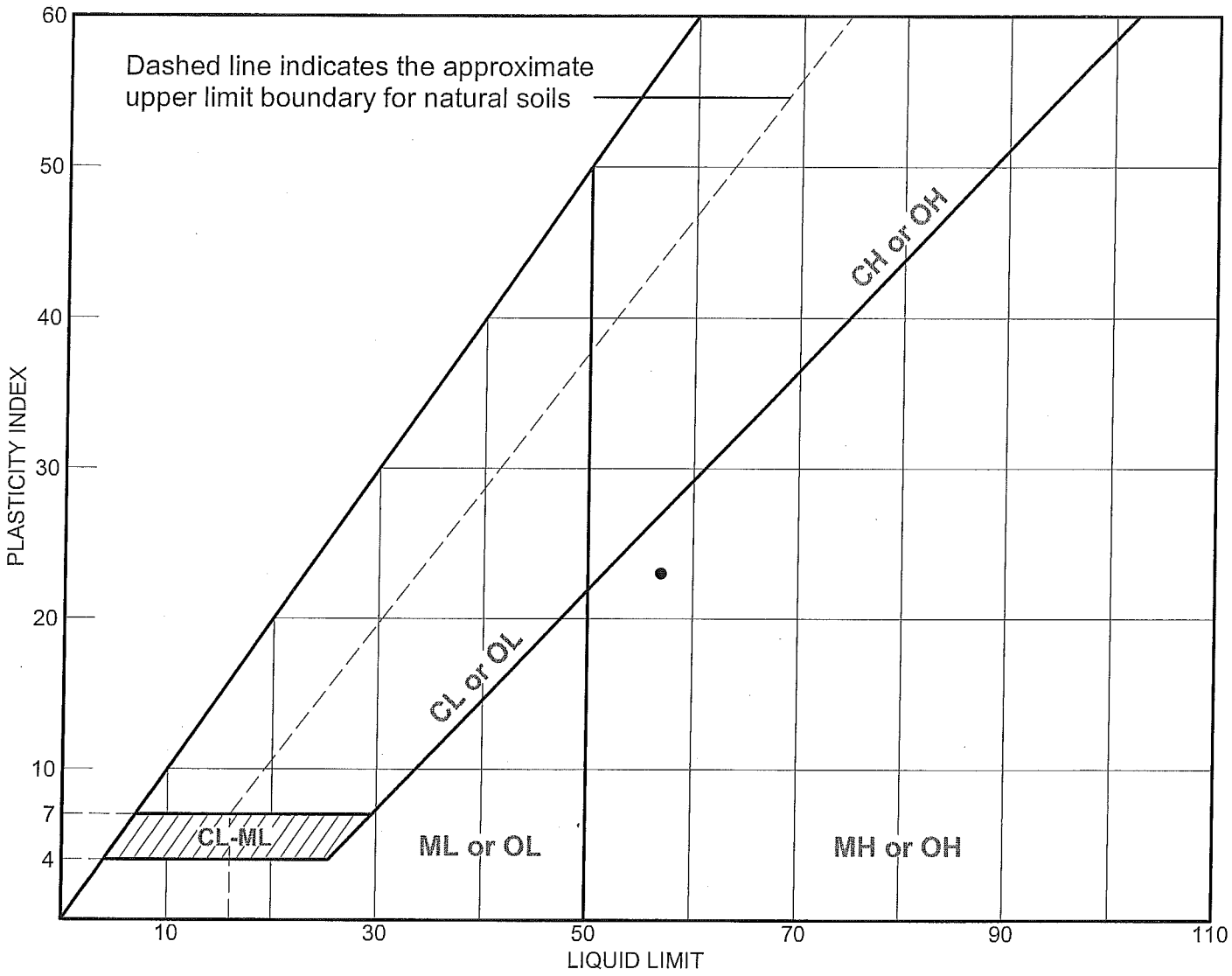


SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		TP7/Bag L	13.0-15.0'		27	38	11	ML

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT

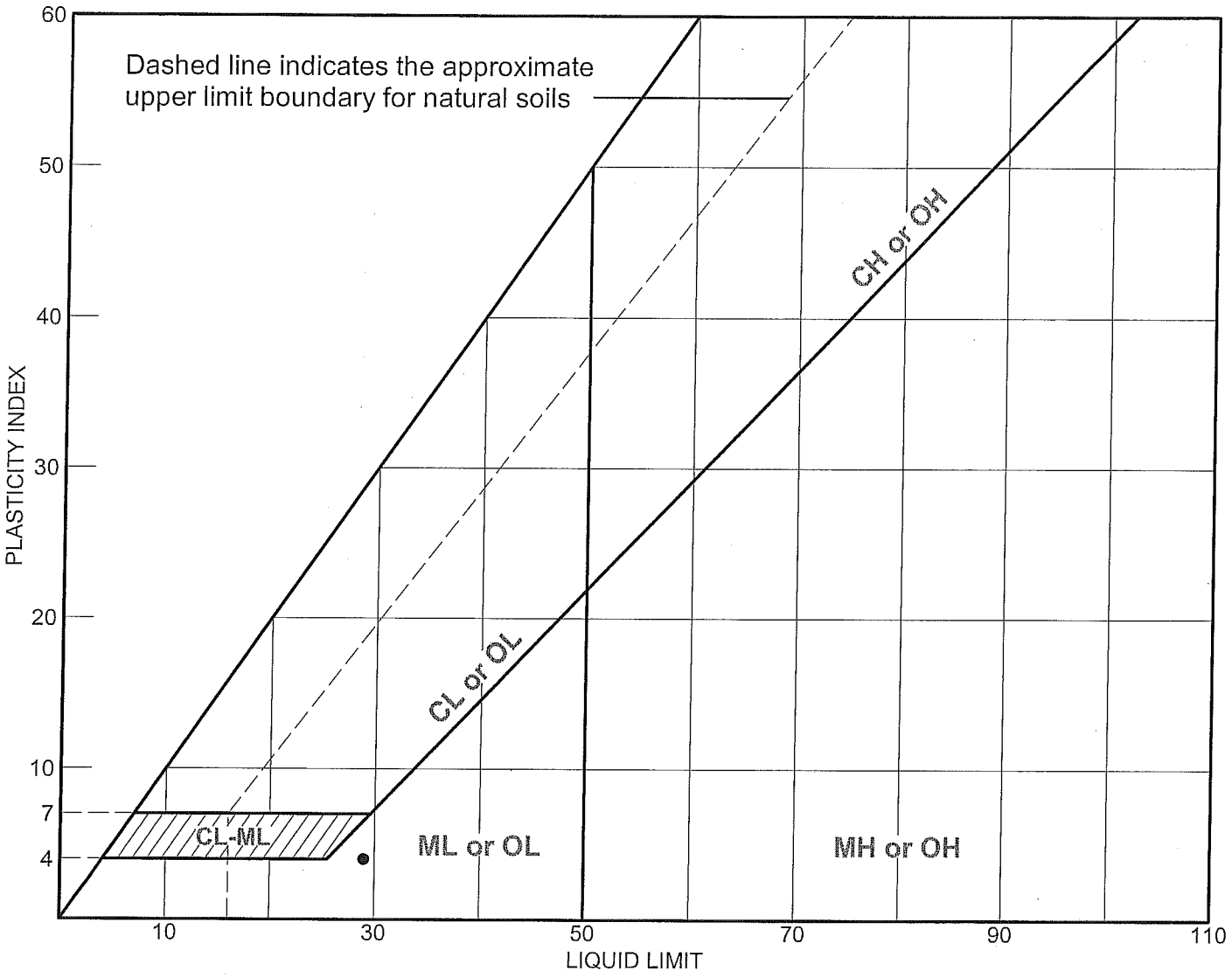


SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		TP-7/Bag K			34	57	23	MH

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		TP11/Bag N	3.0-7.0'		25	29	4	ML

LIQUID AND PLASTIC LIMITS TEST REPORT **Blackburn Consulting** **W. Sacramento, CA**	**Client:** **Project:** Star Bend Levee Setback **Project No.:** 788.1 **Figure**

COMPACTION TEST REPORT

Project No.: 788.1 **Date:** 6-26-06
Project: Star Bend Setback Levee

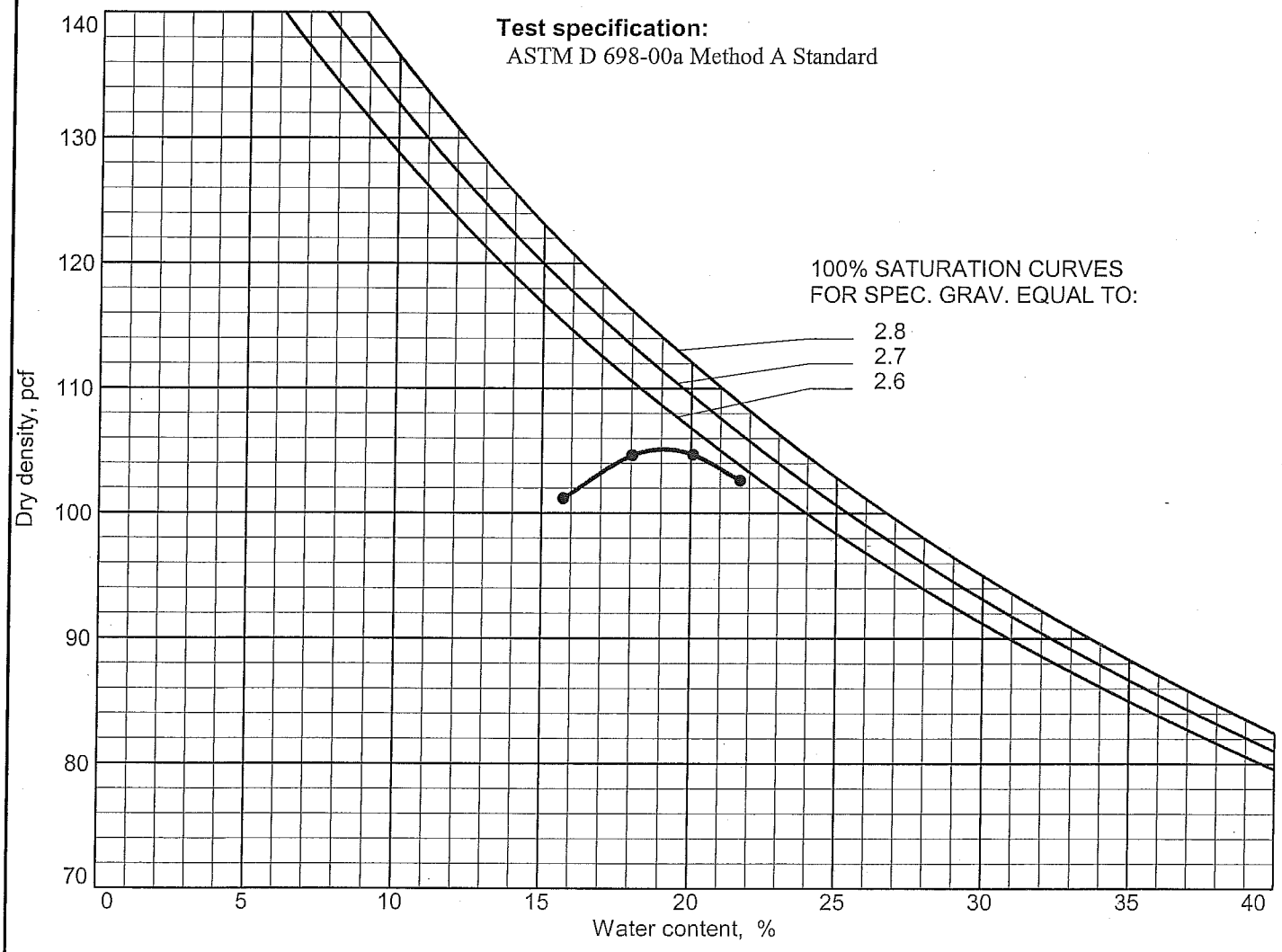
Location:
Elev./Depth: 1.0-20.0 ft **Sample No.** Bulk 1
Remarks:

MATERIAL DESCRIPTION

Description: Olive brown lean clay with sand

Classifications - **USCS:** CL **AASHTO:**
Nat. Moist. = **Sp.G. =**
Liquid Limit = 36 **Plasticity Index =** 13
% > No.4 = 2.1 % **% < No.200 =** 75.1 %

TEST RESULTS
Maximum dry density = 105.1 pcf
Optimum moisture = 19.1 %



Figure

Blackburn Consulting

COMPACTION TEST REPORT

Project No.: 788.1 **Date:** 6-26-06
Project: Star Bend Setback Levee

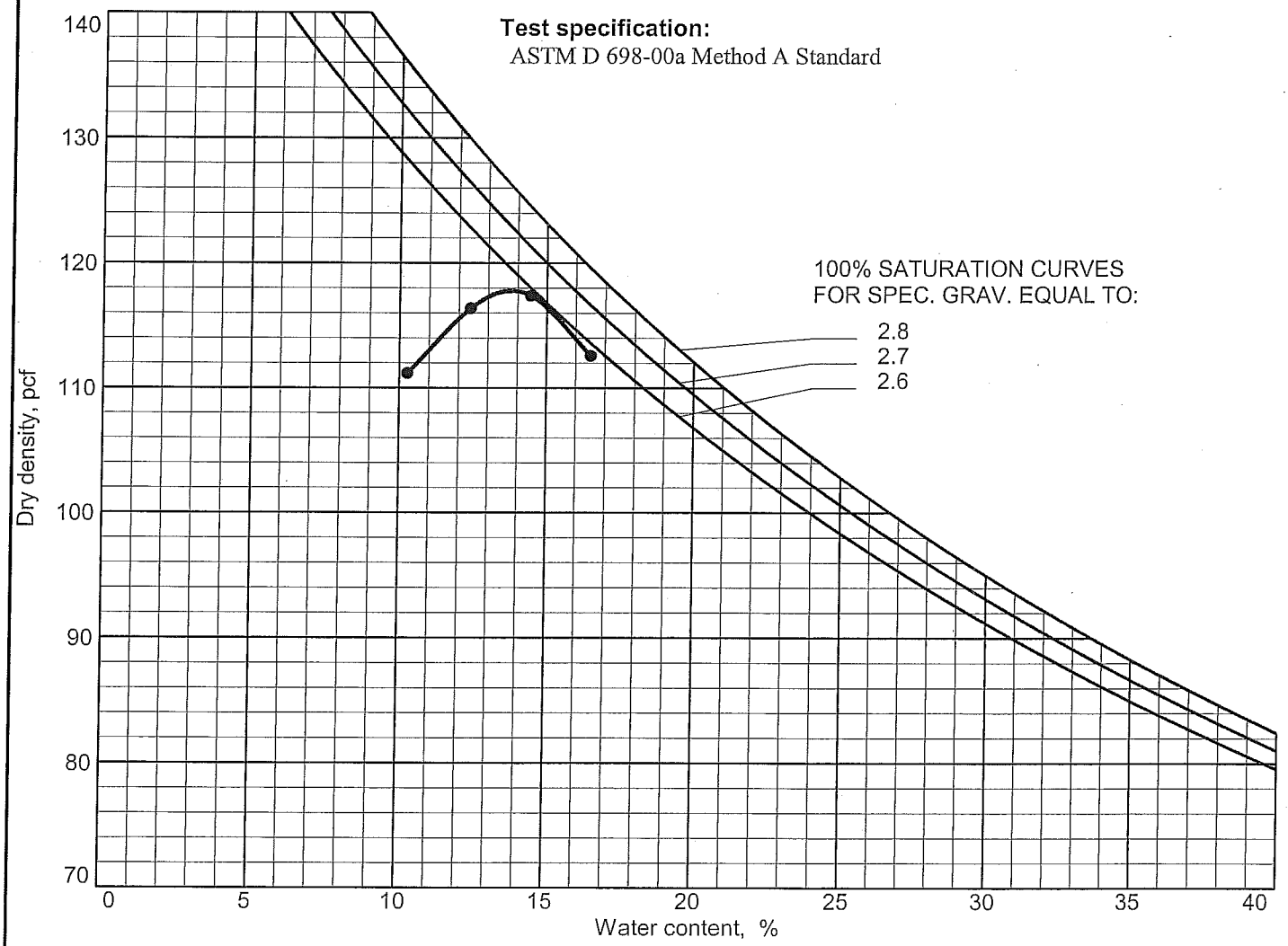
Location:
Elev./Depth: 1.0-20.0 ft **Sample No.** Bulk 2
Remarks:

MATERIAL DESCRIPTION

Description: Olive brown sandy lean clay

Classifications - **USCS:** CL **AASHTO:**
Nat. Moist. = **Sp.G. =**
Liquid Limit = 25 **Plasticity Index =** 7
% > No.4 = 1.7 % **% < No.200 =** 59.6 %

TEST RESULTS
Maximum dry density = 118 pcf
Optimum moisture = 14 %



Figure

Blackburn Consulting

COMPACTION TEST REPORT

Project No.: 788.1 **Date:** 08-01-06
Project: Star Bend Levee Setback

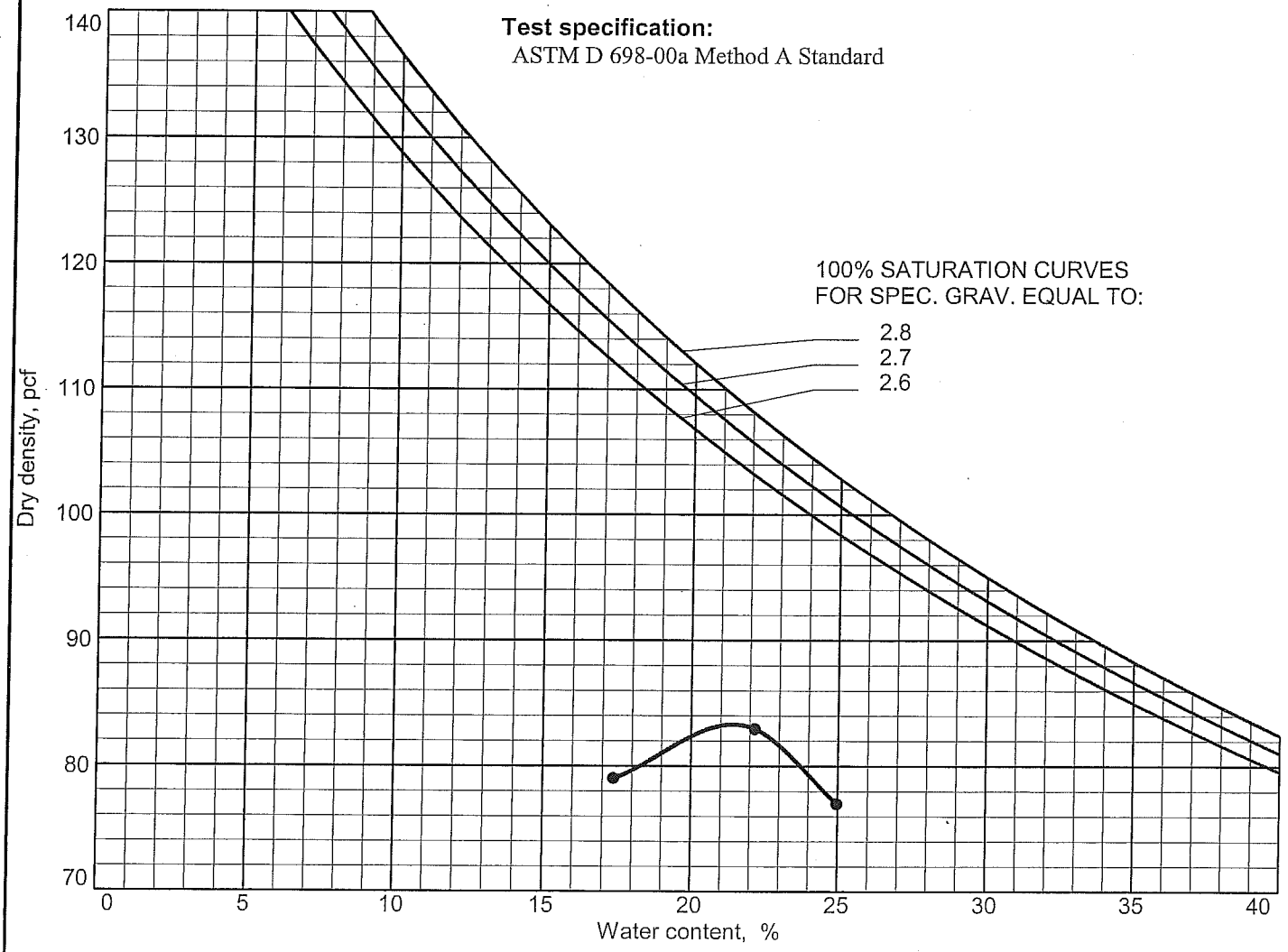
Location:
Elev./Depth: **Sample No.** TP-7/Bag K
Remarks:

MATERIAL DESCRIPTION

Description: Light olive brown elastic silt

Classifications - **USCS:** MH **AASHTO:**
Nat. Moist. = **Sp.G. =**
Liquid Limit = 57 **Plasticity Index =** 23
% > No.4 = 0.0 % **% < No.200 =** 99.8 %

TEST RESULTS
Maximum dry density = 83.3 pcf
Optimum moisture = 21.4 %



Figure

Blackburn Consulting

COMPACTION TEST REPORT

Project No.: 788.1 **Date:** 08-02-06
Project: Star Bend Levee Setback

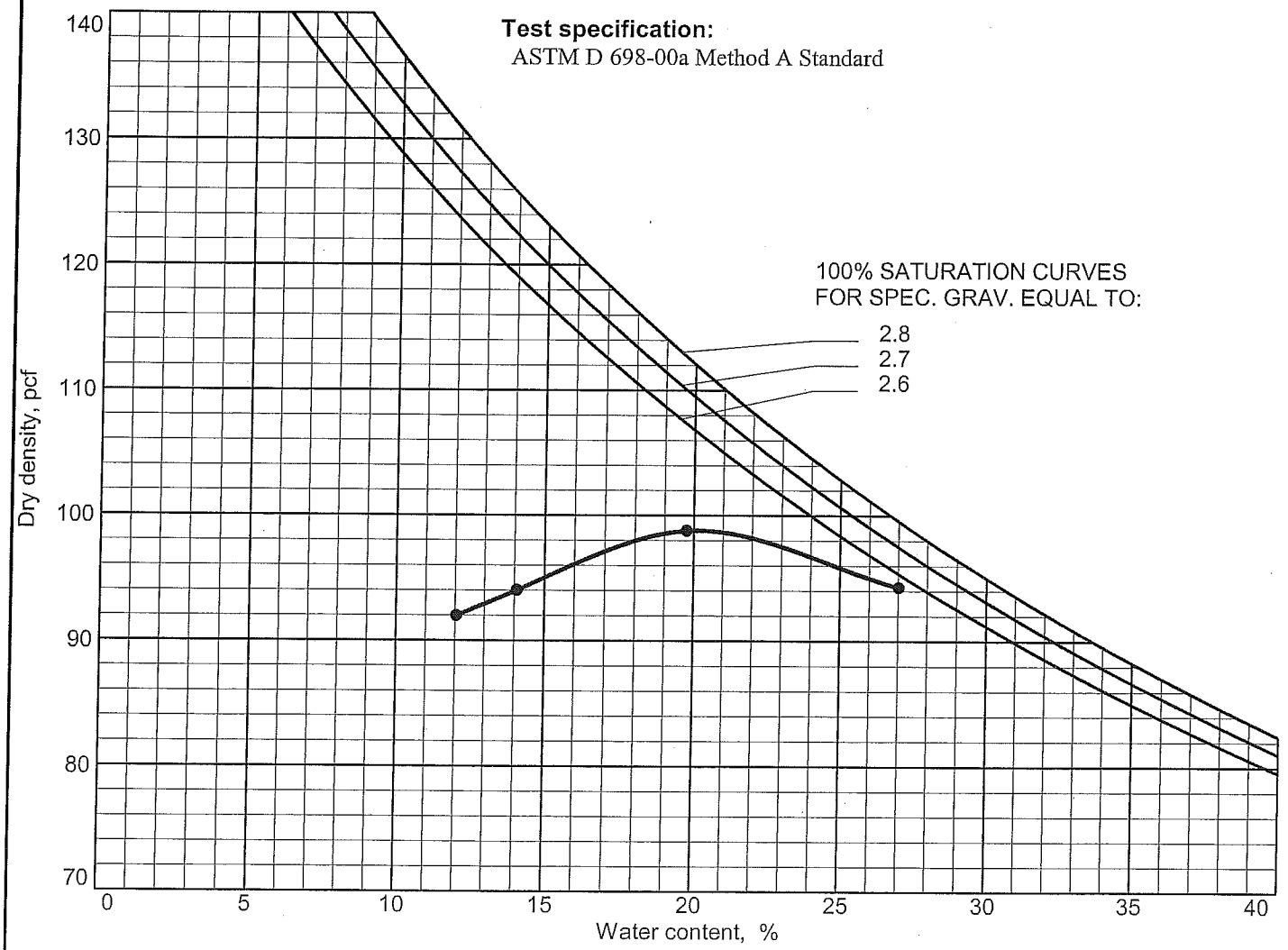
Location:
Elev./Depth: **Sample No.** TP7/Bag L,TP10/Bag M
Remarks:

MATERIAL DESCRIPTION

Description: Dark brown silt with sand

Classifications - **USCS:** ML **AASHTO:**
Nat. Moist. = **Sp.G. =**
Liquid Limit = 33 **Plasticity Index =** 6
% > No.4 = 0.0 % **% < No.200 =** 85.0 %

TEST RESULTS
Maximum dry density = 98.8 pcf
Optimum moisture = 20.1 %

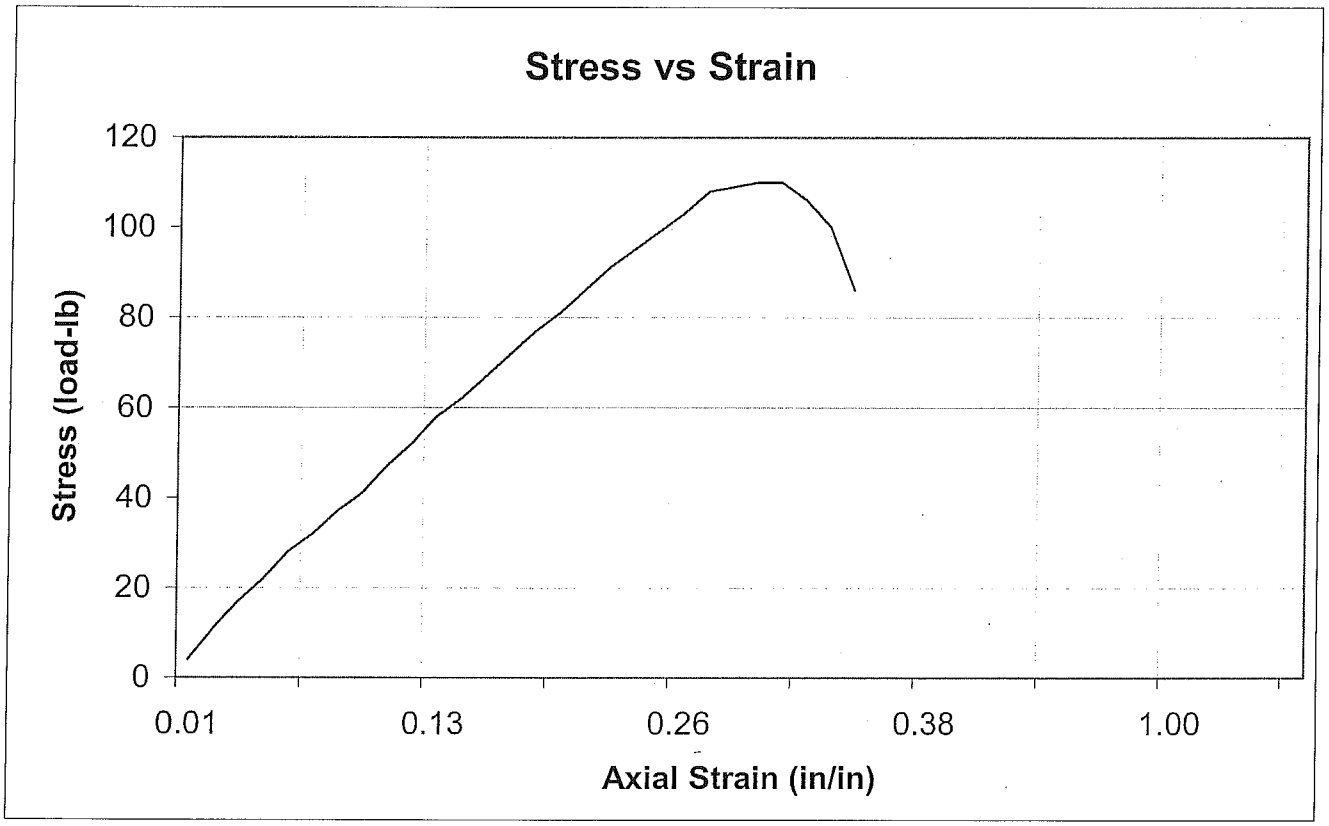


Figure

Blackburn Consulting

Project
Star Bend Setback Levee
Project Number
788.1
Sample Number
B1-13b
Material Description
Dark yellowish brown silty sand, moist
Tested By
KAC

ASTM D 2166-00

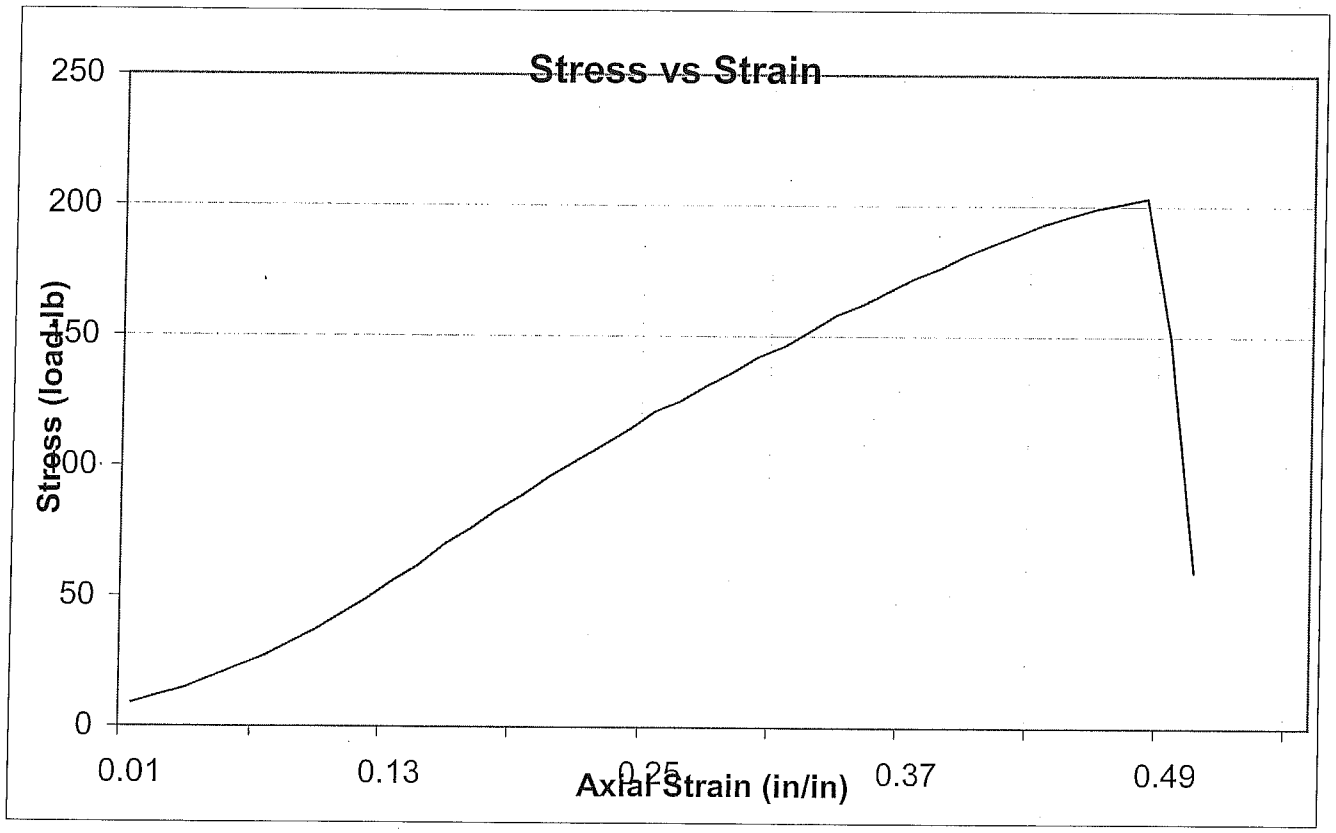


Total Density (pcf)	120.8
Dry Density (pcf)	93.9
% Moisture	28.6

Unconfined Compressive Strength (tsf) 1.63

Project
Star Bend Setback Levee
Project Number
788.1
Sample Number
B5-11b
Material Description
Greenish gray clayey silt, moist
Tested By
KAC

ASTM D 2166-00

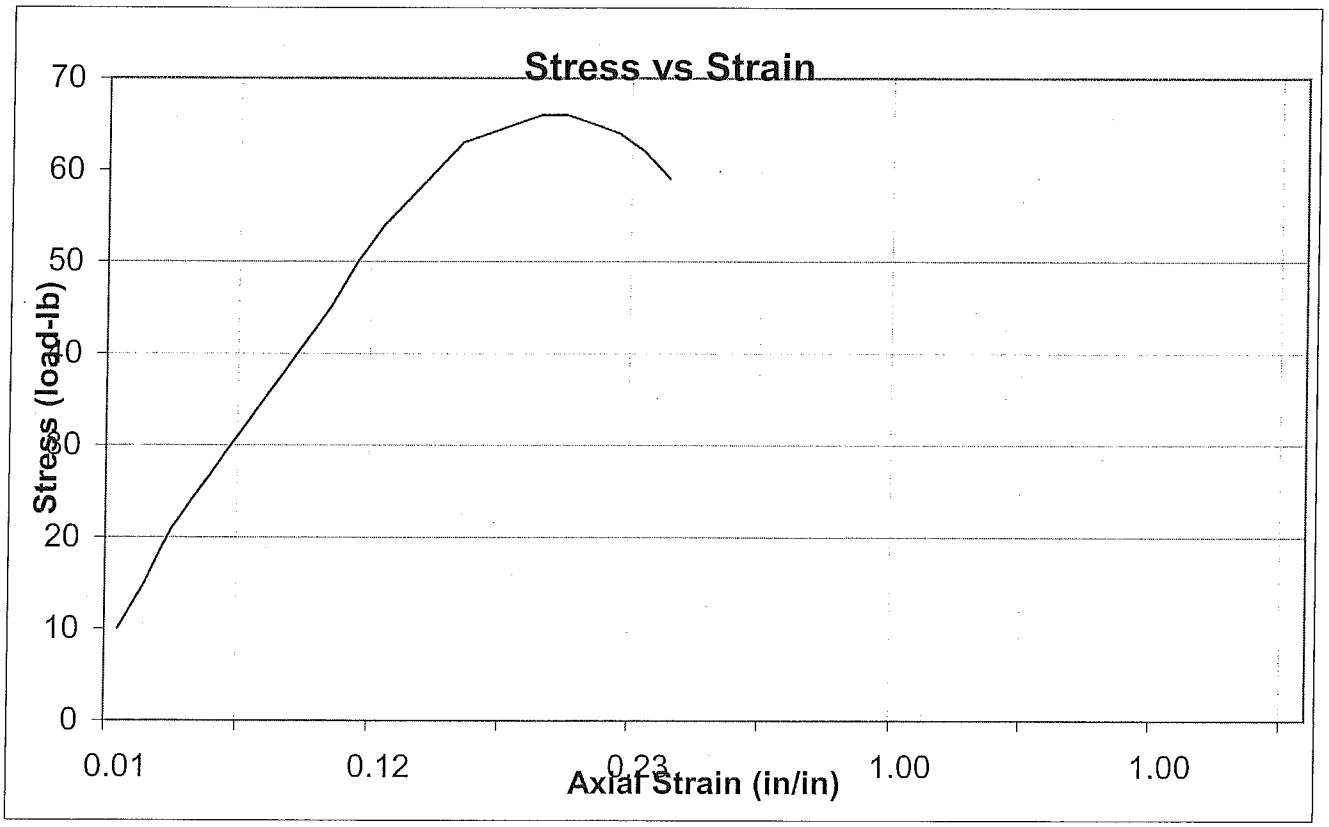


Total Density (pcf)	125.4
Dry Density (pcf)	101.2
% Moisture	23.8

Unconfined Compressive Strength (tsf) 2.92

Project
Star Bend Setback Levee
Project Number
788.1
Sample Number
B5-17b
Material Description
Dark bluish gray clayey silt, moist
Tested By
KAC

ASTM D 2166-00

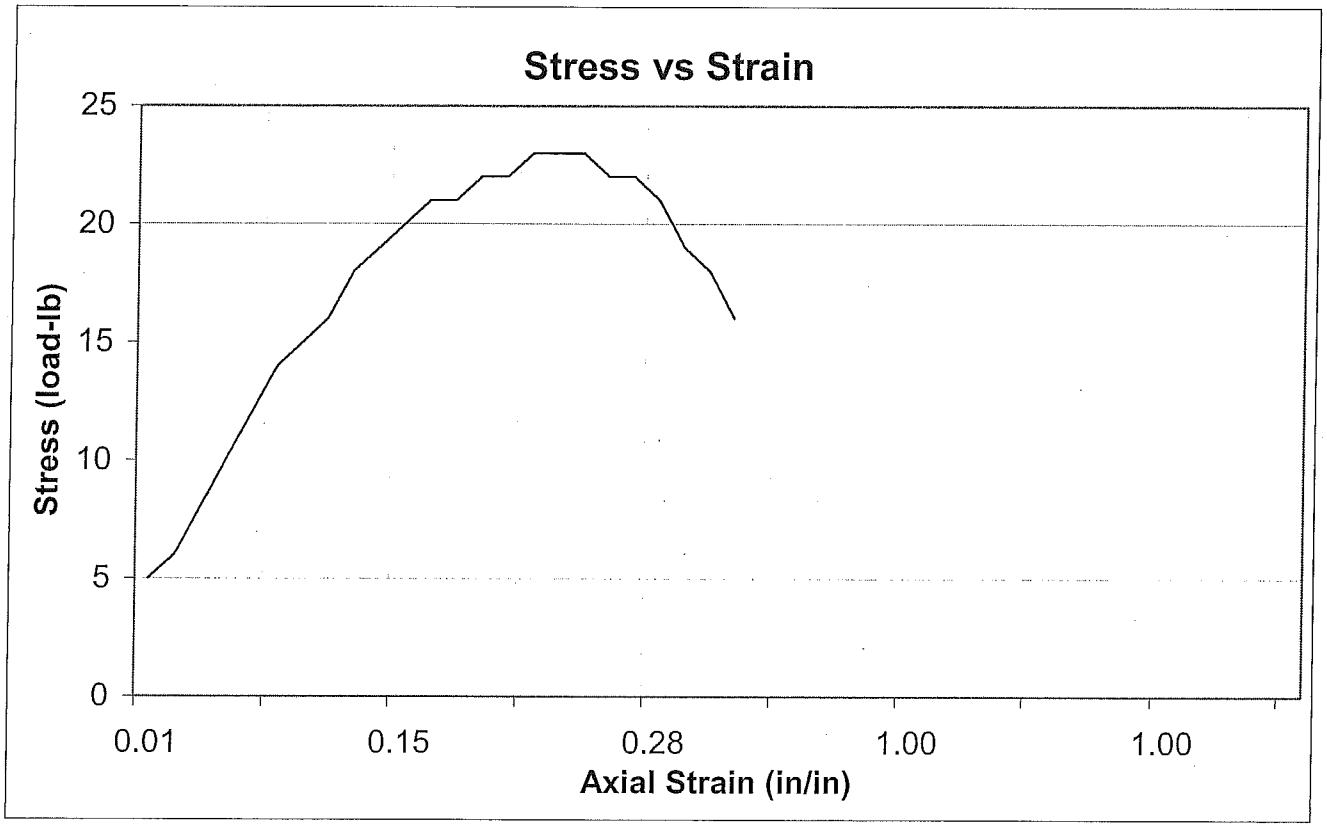


Total Density (pcf)	109.4
Dry Density (pcf)	76.1
% Moisture	43.8

Unconfined Compressive Strength (tsf) 0.99

Project
Star Bend Setback Levee
Project Number
788.1
Sample Number
B4-7b
Material Description
Dark yellowish brown sandy silt, moist
Tested By
KAC

ASTM D 2166-00

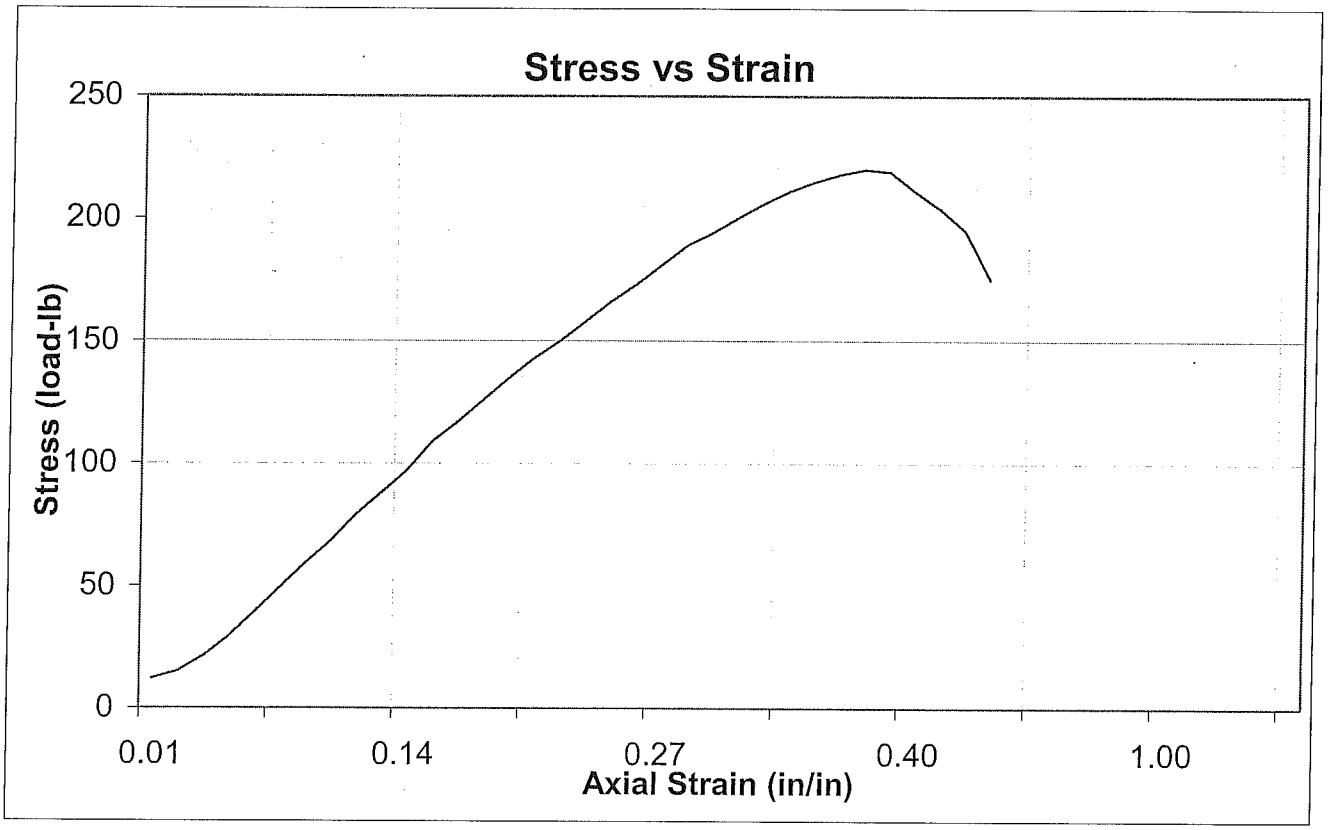


Total Density (pcf)	109.8
Dry Density (pcf)	85.9
% Moisture	27.8

Unconfined Compressive Strength (tsf) 0.34

Project
Star Bend Setback Levee
Project Number
788.1
Sample Number
B4-10c
Material Description
Light olive brown slightly sandy silt, moist
Tested By
KAC

ASTM D 2166-00

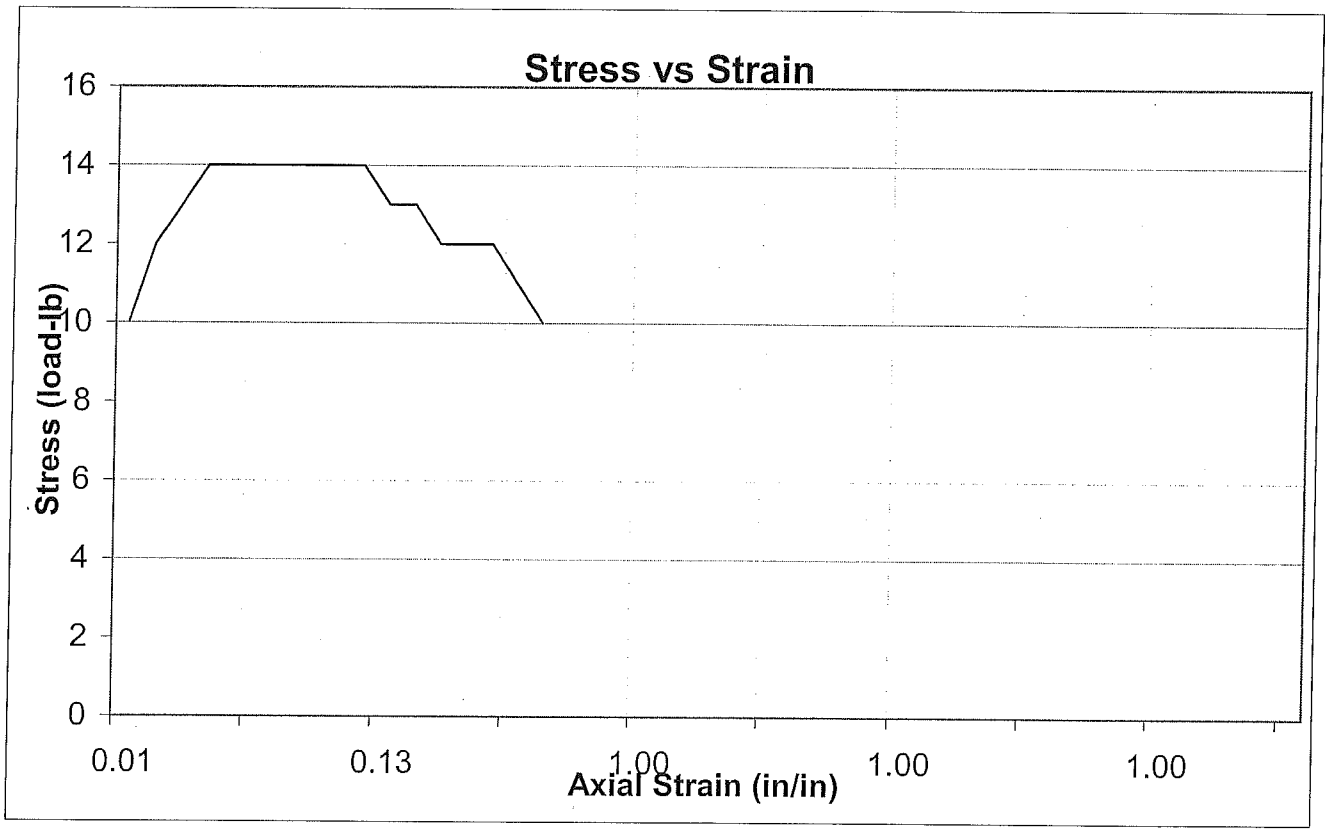


Total Density (pcf)	119.9
Dry Density (pcf)	92.7
% Moisture	29.3

Unconfined Compressive Strength (tsf) 3.23

Project
Star Bend Setback Levee
Project Number
788.1
Sample Number
B4-15b
Material Description
Olive brown silty sand w/ cementation, moist
Tested By
KAC

ASTM D 2166-00

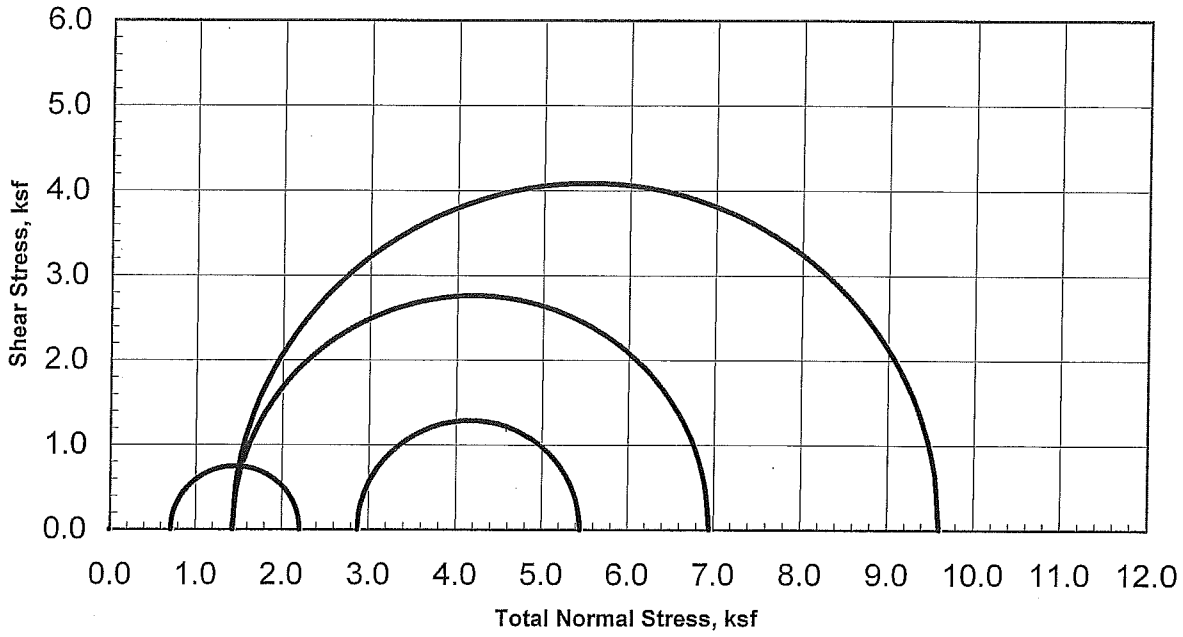


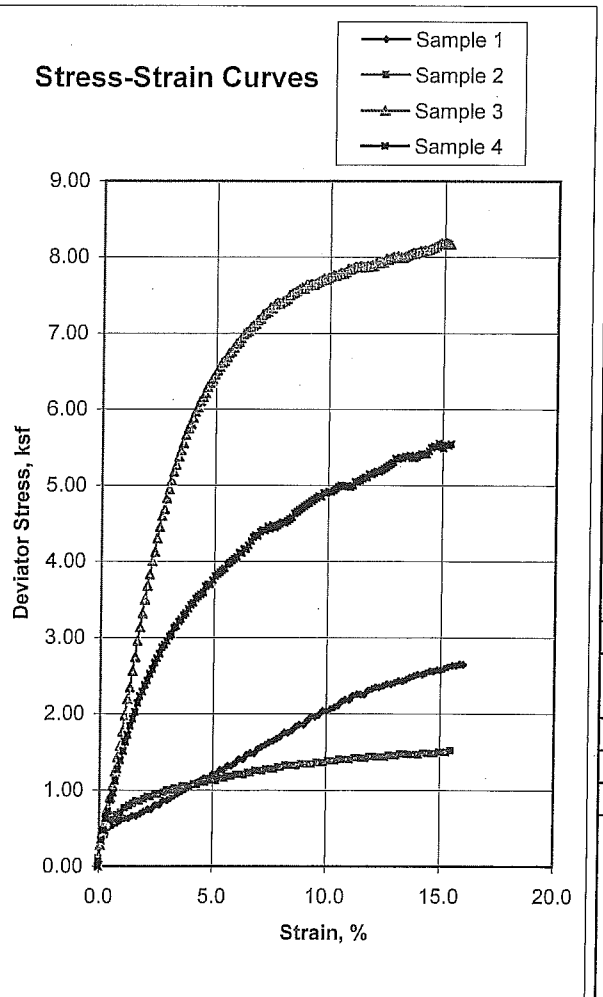
Total Density (pcf)	127.0
Dry Density (pcf)	104.1
% Moisture	22.0

Unconfined Compressive Strength (tsf) 0.21

Unconsolidated-Undrained Triaxial Test

ASTM D-2850

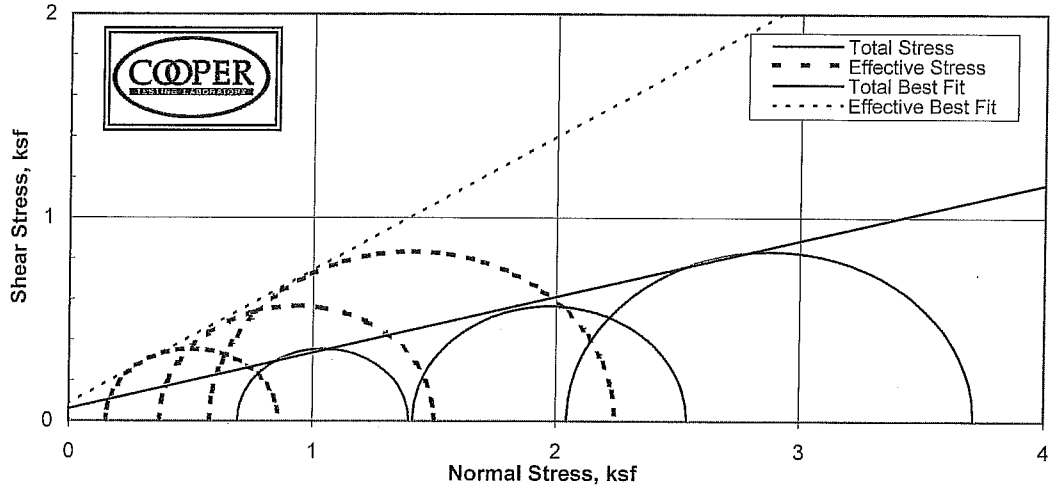


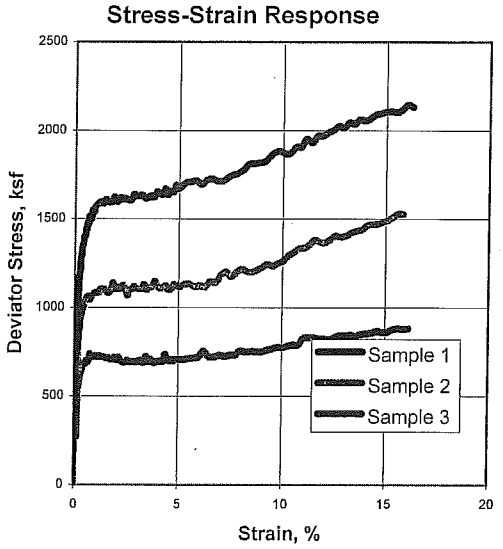


Sample Data				
	1	2	3	4
Moisture %	37.6	22.9	32.9	44.8
Dry Den,pcf	83.9	104.9	90.1	77.4
Void Ratio	1.045	0.636	0.906	1.259
Saturation %	98.9	99.2	99.8	99.5
Height in	4.99	4.95	5.05	5.05
Diameter in	2.40	2.40	2.42	2.43
Cell psi	20.0	5.0	10.0	10.0
Strain %	15.00	15.00	15.00	15.00
Deviator, ksf	2.652	1.513	8.190	5.552
Rate %/min	1.00	1.01	0.99	0.99
in/min	0.050	0.050	0.050	0.050
Job No.:	396-005			
Client:	Blackburn Consultants			
Project:	788.1			
Boring:	B1-9B	B5-1C	B6-1B	B6-5B
Sample:				
Depth ft:	25.5	NA	5.5	15.5

Visual Soil Description	
Sample #	
1	Dark Gray CLAY
2	Brn Clayey SAND/Sandy CLAY (silty)
3	Brown SILT with Sand, slightly plastic
4	Grayish Brown Silty CLAY
Remarks:	Samples back pressure saturated prior to test.

Triaxial ICU, ASTM D4767m





Sample:	1	2	3	4
MC, %	21.7	21.3	21.2	
Dry Den, pcf.	93.9	94.2	94.1	
Sat. %	73.5	72.9	72.5	
Void Ratio	0.795	0.789	0.790	
Diameter in	2.38	2.38	2.38	
Height, in	5.00	5.00	5.00	
	Final			
MC, %	27.4	25.8	25.4	
Dry Den, pcf.	96.8	99.4	99.9	
Sat. %	100.0	100.0	100.0	
Void Ratio	0.740	0.695	0.686	
Diameter, in	2.35	2.32	2.33	
Height, in	4.96	4.95	4.91	
Cell, psi	53.5	68.5	73.5	
BP, psi	48.7	58.7	59.3	
	Effective Stresses At:			
Strain, %	5.0	5.0	5.0	
Deviator ksf	0.707	1.129	1.667	
Excess PP	0.537	1.039	1.469	
Sigma 1	0.863	1.504	2.246	
Sigma 3	0.156	0.375	0.579	
P, ksf	0.509	0.939	1.412	
Q, ksf	0.353	0.564	0.834	
Stress Ratio	5.529	4.010	3.882	
Rate in/min	0.001	0.001	0.001	

Total C	**0.1**	**ksf**
Total Phi	**15.4**	**Degrees**
Eff. C	**0.1**	**ksf**
Eff. Phi	**33.3**	**Degrees**

Job No.: 396-004 **Date:** 7/10/2006

Client: Blackburn Consulting BY:DC

Project: 788.1

Sample 1) Bulk-1 @ 1-20' Dark Brown CLAY w/Sand

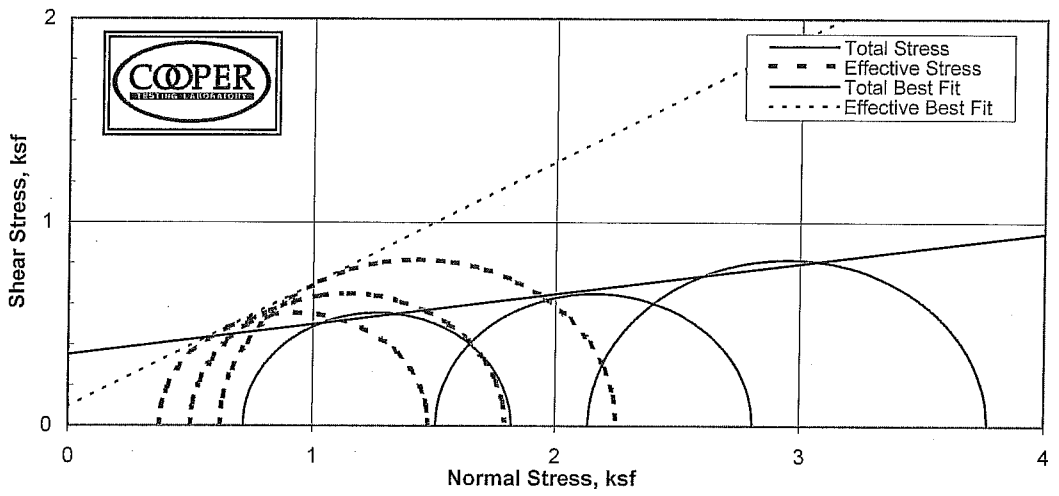
Sample 2)

Sample 3)

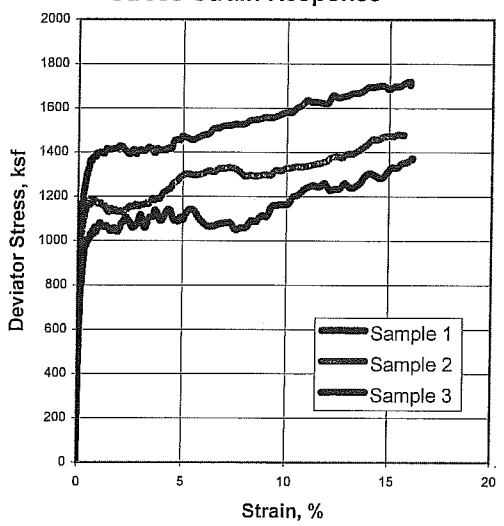
Sample 4)

REMARKS: Values picked at 5% strain. Remolded to 90% of 105 pcf @ 21%, (opt. +2%)

Triaxial ICU, ASTM D4767m



Stress-Strain Response



Sample:	1	2	3	4
MC, %	16.3	16.3	16.0	
Dry Den, pcf.	105.2	105.3	105.5	
Sat. %	73.3	73.1	72.4	
Void Ratio	0.602	0.601	0.597	
Diameter in	2.38	2.38	2.38	
Height, in	5.00	5.00	5.00	
	Final			
MC, %	20.8	20.2	19.7	
Dry Den, pcf.	107.9	109.0	110.0	
Sat. %	100.0	100.0	100.0	
Void Ratio	0.561	0.545	0.531	
Diameter, in	2.35	2.34	2.34	
Height, in	4.98	4.97	4.95	
Cell, psi	63.5	59.0	73.5	
BP, psi	58.5	48.5	58.7	
	Effective Stresses At:			
Strain, %	3.7	6.0	11.0	
Deviator ksf	1.109	1.297	1.632	
Excess PP	0.342	1.013	1.517	
Sigma 1	1.482	1.797	2.253	
Sigma 3	0.372	0.499	0.620	
P, ksf	0.927	1.148	1.436	
Q, ksf	0.555	0.649	0.816	
Stress Ratio	3.977	3.598	3.632	
Rate in/min	0.001	0.001	0.001	

Total C	**0.4**	**ksf**
Total Phi	**8.5**	**Degrees**
Eff. C	**0.1**	**ksf**
Eff. Phi	**31.1**	**Degrees**

Job No.: 396-004 **Date:** 7/10/2006

Client: Blackburn Consulting BY:DC

Project: 788.1

Sample 1) Bulk-2 @ 1-20' Brown Sandy CLAY

Sample 2)

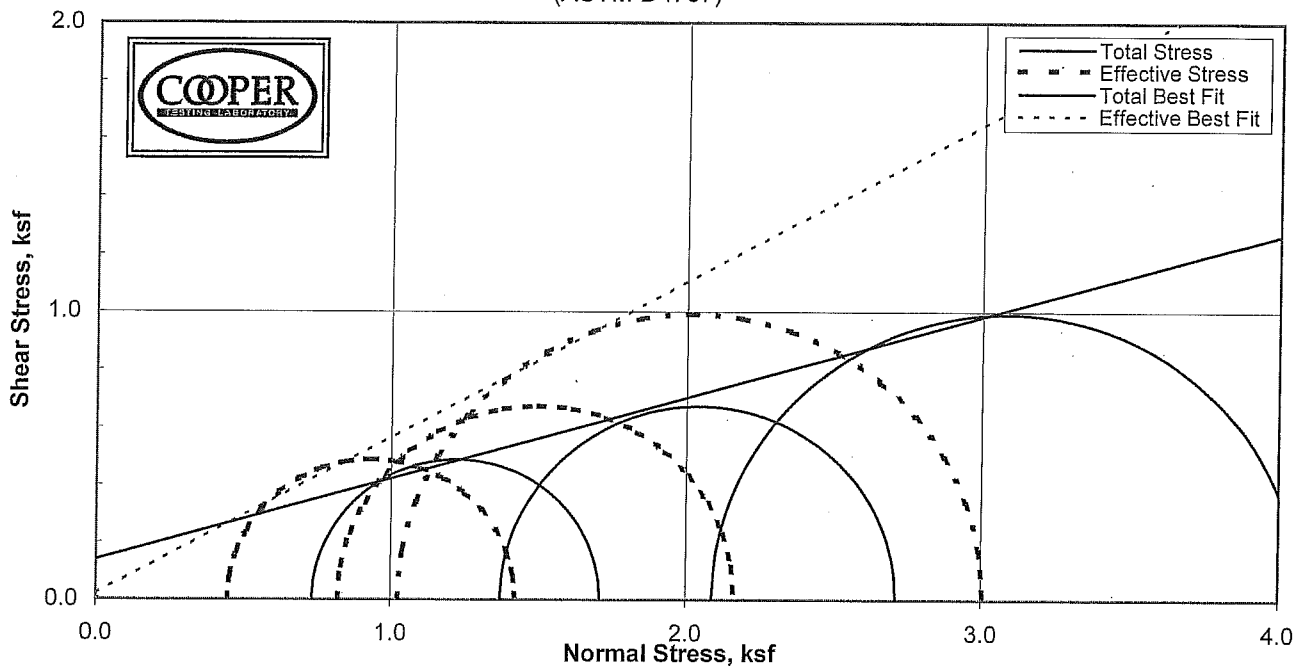
Sample 3)

Sample 4)

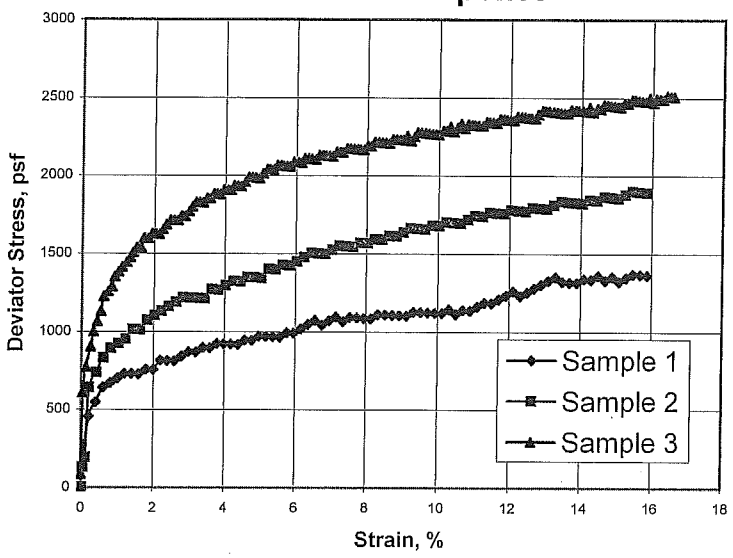
REMARKS: Values picked at the peak stress ratio.
Remolded to 90% of 117.8 pcf @ 15.8%, (opt. +2%)

Triaxial Consolidated Undrained

(ASTM D4767)



Stress-Strain Response



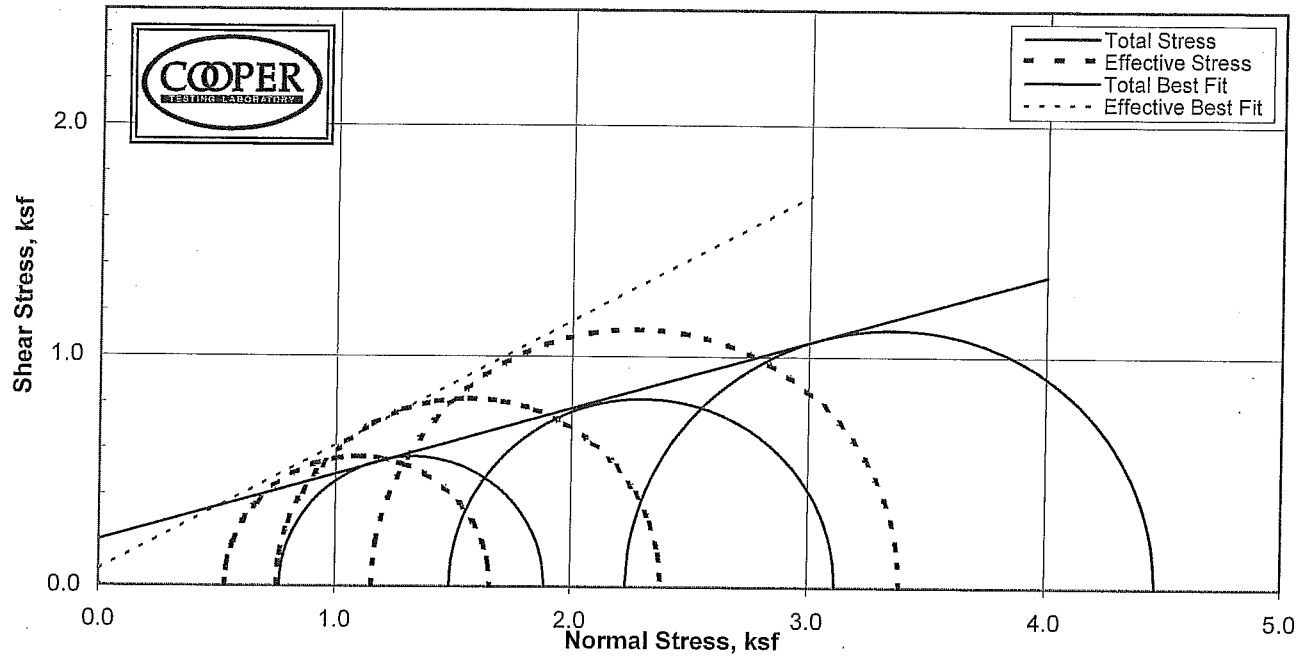
Sample:	1	2	3	4
MC, %	21.4	21.7	21.3	
Dry Dens, pcf	78.7	78.5	78.8	
Sat. %	50.8	51.2	50.5	
Void Ratio	1.140	1.145	1.139	
Diameter in	2.38	2.38	2.38	
Height, in	5.00	5.00	5.00	
	Final			
MC, %	45.6	43.4	41.1	
Dry Dens, pcf	75.5	77.6	79.9	
Sat. %	100.0	100.0	100.0	
Void Ratio	1.231	1.172	1.109	
Diameter, in	2.41	2.39	2.36	
Height, in	5.05	5.00	4.98	
Cell, psi	63.5	68.5	73.5	
BP, psi	58.4	59.0	59.0	
	Effective Stresses At:			
Strain, %	5.0	5.0	5.0	
Deviator ksf	0.972	1.344	1.983	
Excess PP	0.288	0.547	1.066	
Sigma 1	1.418	2.165	3.006	
Sigma 3	0.446	0.821	1.022	
P, ksf	0.932	1.493	2.014	
Q, ksf	0.486	0.672	0.992	
Stress Ratio	3.177	2.637	2.940	
Rate in/min	0.001	0.001	0.001	
Total C	0.1	ksf		
Total Phi	15.7	Degrees		
Eff. C	0.0	ksf		
Eff. Phi	28.5	Degrees		

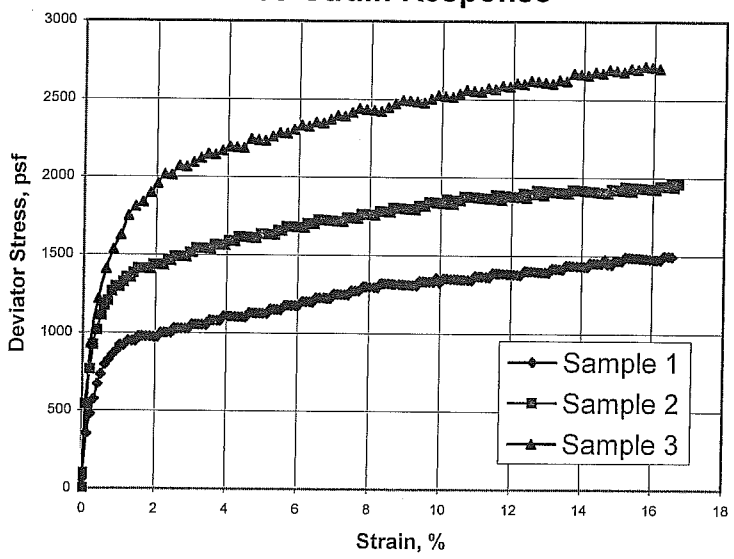
Job No.:	396-006	**Date:**	8/24/2006
Client:	Blackburn Consulting		BY:MD/DC
Project:	788.1		
Sample 1)	Bag K	Reddish Yellow SILT	
Sample 2)	Bag K	Reddish Yellow SILT	
Sample 3)	Bag K	Reddish Yellow SILT	
Sample 4)			

REMARKS: Strengths picked at 5% strain. Remolded to 95% of 83.3 pcf @ 21.4% (opt.)

Triaxial Consolidated Undrained

(ASTM D4767)





Sample:	1	2	3	4
MC, %	20.2	20.3	20.1	
Dry Dens, pcf	93.7	93.6	93.7	
Sat. %	68.4	68.4	68.1	
Void Ratio	0.798	0.800	0.799	
Diameter in	2.38	2.38	2.38	
Height, in	5.00	5.00	5.00	
	Final			
MC, %	30.6	30.6	29.7	
Dry Dens, pcf	92.3	92.2	93.5	
Sat. %	100.0	100.0	100.0	
Void Ratio	0.826	0.827	0.802	
Diameter, in	2.39	2.40	2.39	
Height, in	5.00	4.97	4.96	
Cell, psi	63.5	68.5	73.5	
BP, psi	58.2	58.2	58.0	
	Effective Stresses At:			
Strain, %	5.0	5.0	5.0	
Deviator ksf	1.126	1.633	2.237	
Excess PP	0.230	0.734	1.080	
Sigma 1	1.659	2.382	3.389	
Sigma 3	0.533	0.749	1.152	
P, ksf	1.096	1.565	2.270	
Q, ksf	0.563	0.817	1.118	
Stress Ratio	3.113	3.181	2.941	
Rate in/min	0.001	0.001	0.001	
Total C	0.2	ksf		
Total Phi	16.0	Degrees		
Eff. C	0.1	ksf		
Eff. Phi	28.5	Degrees		

Job No.:	396-006	**Date:**	8/24/2006
Client:	Blackburn Consulting		BY:MD/DC
Project:	788.1		
Sample 1)	Composite Bags L & Brown SILT		
Sample 2)	Composite Bags L & Brown SILT		
Sample 3)	Composite Bags L & Brown SILT		
Sample 4)			

REMARKS: Strengths picked at 5% strain. Remolded to 95% of 98.8 pcf @ 20.1 (opt.)

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 06/28/2006
Date Submitted 06/23/2006

To: Eric Nichols
Blackburn Consulting
2437 Front Street
West Sacramento, CA 95691

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : STAR BEND SETBACK LE Site ID : BAG 3.
Your purchase order number is 788.1.
Thank you for your business.

* For future reference to this analysis please use SUN # 47995-95481.

EVALUATION FOR SOIL CORROSION

Soil pH	7.07	
Minimum Resistivity	3.48 ohm-cm (x1000)	
Chloride	8.2 ppm	00.00082 %
Sulfate	12.2 ppm	00.00122 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 06/28/2006
Date Submitted 06/23/2006

To: Eric Nichols
Blackburn Consulting
2437 Front Street
West Sacramento, CA 95691

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager RH

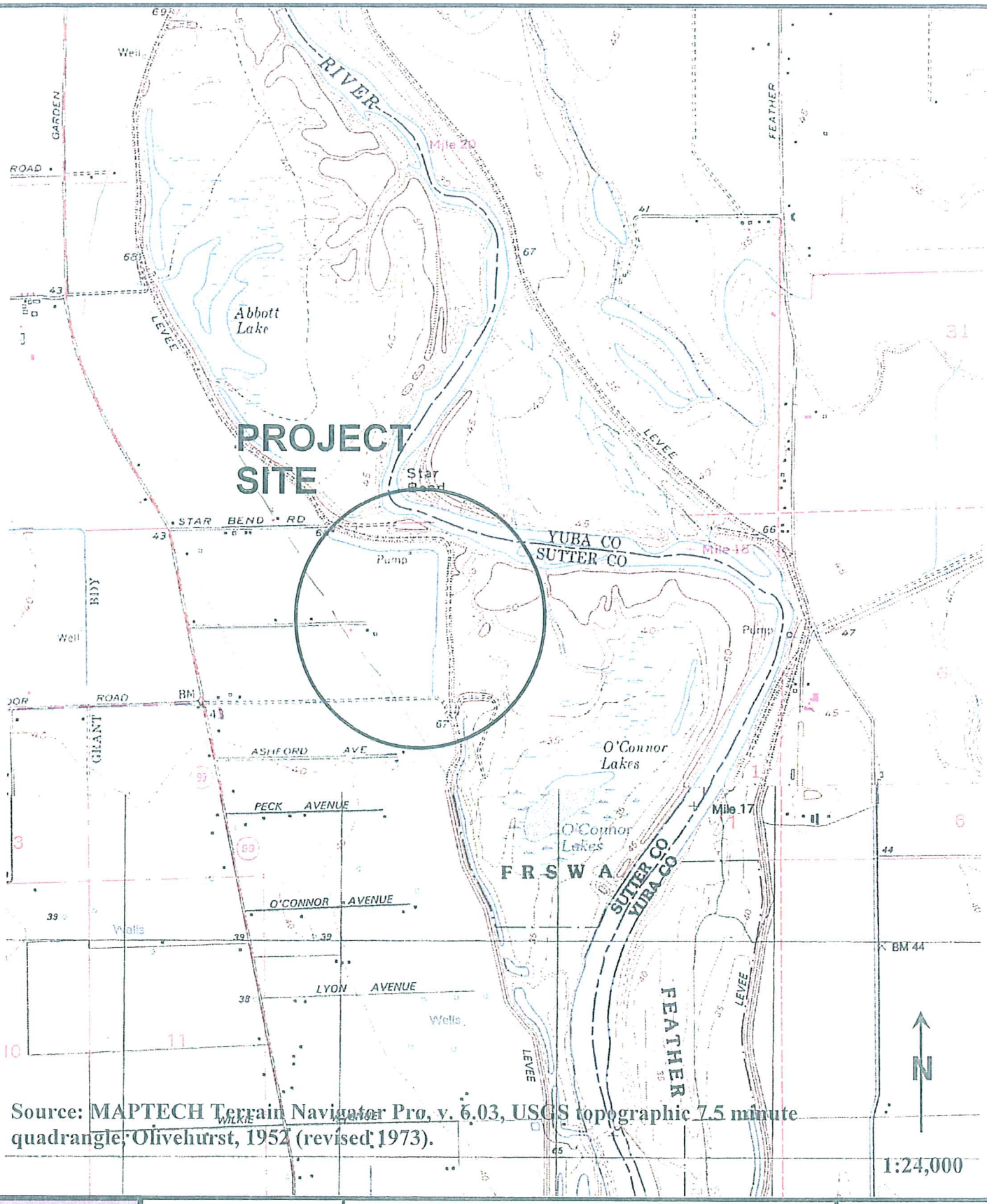
The reported analysis was requested for the following location:
Location : STAR BEND SETBACK LE Site ID : BAG 4.
Your purchase order number is 788.1.
Thank you for your business.

* For future reference to this analysis please use SUN # 47995-95482.

EVALUATION FOR SOIL CORROSION

Soil pH	7.09	
Minimum Resistivity	2.57 ohm-cm (x1000)	
Chloride	14.3 ppm	00.00143 %
Sulfate	15.0 ppm	00.00150 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422



Source: MAPTECH Terrain Navigator Pro, v. 6.03, USGS topographic 7.5 minute quadrangle, Olivehurst, 1952 (revised 1973).

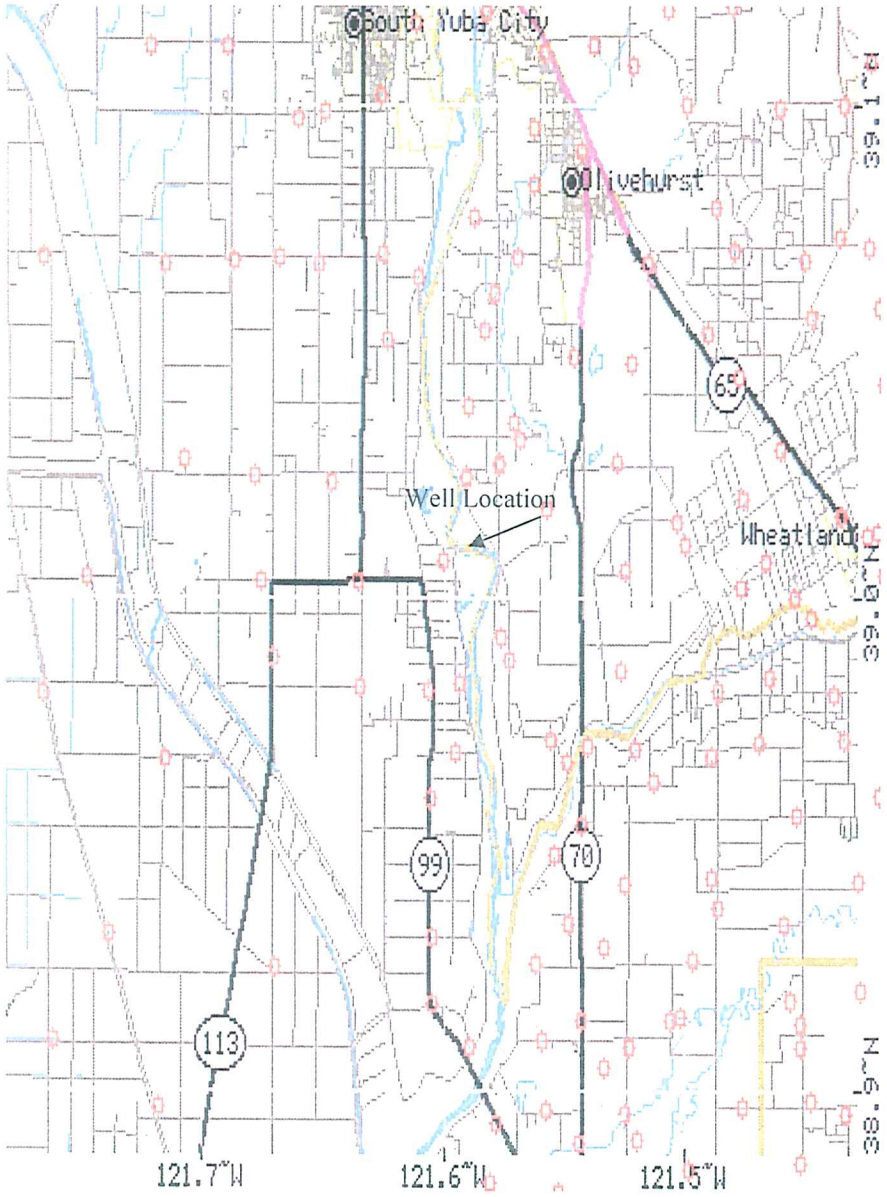
1:24,000

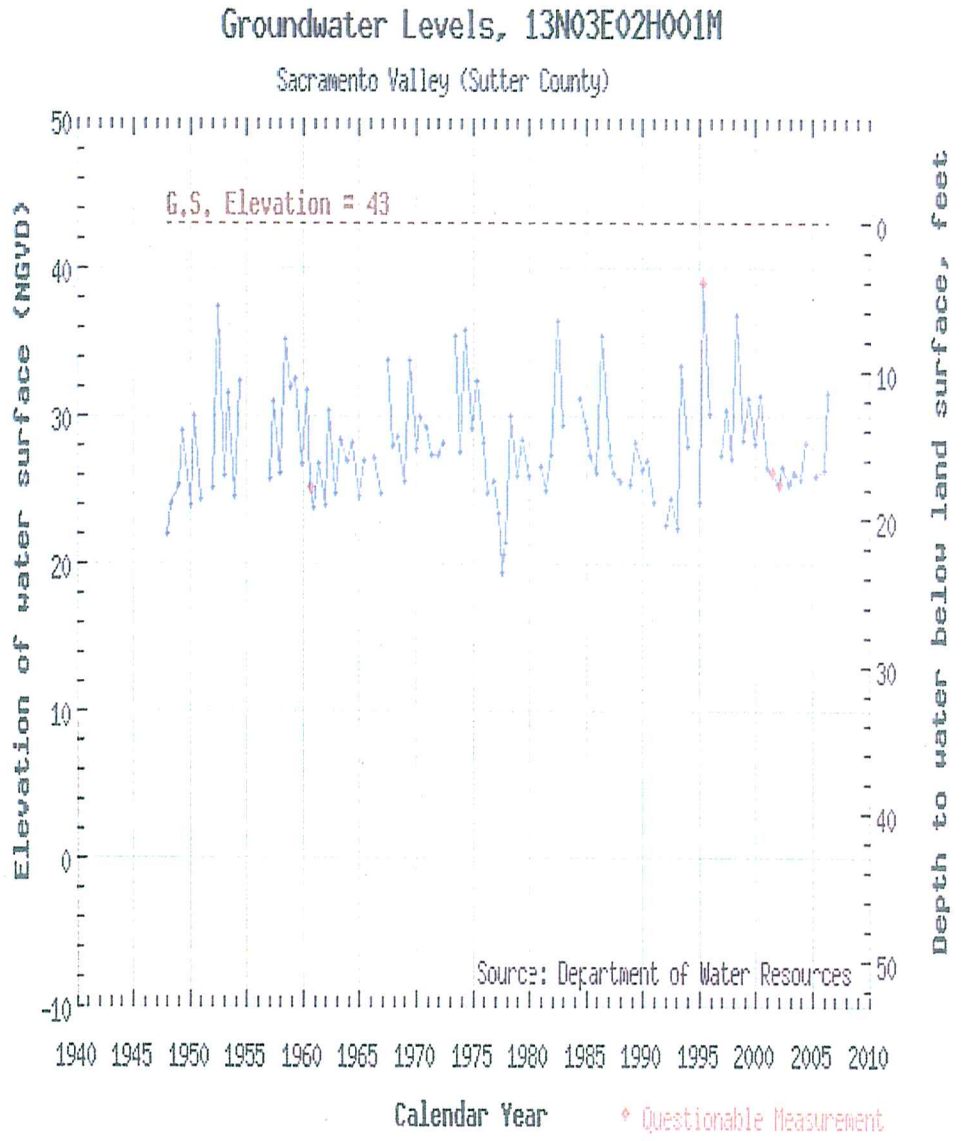
blackburn consulting
11521 Blocker Drive, Suite 110
Auburn, CA 95603
(530) 887-1494
(530) 887-1495-Fax
www.blackburnconsulting.com

VICINITY MAP
Star Bend Setback Levee
Sutter County, CA

Job: 788.1

Figure 1





blackburn consulting
2437 Front Street
West Sacramento, CA 95691
(916) 375-8706
(916) 375-8709-Fax
www.blackburnconsulting.com

Data From California Department of Water Resources
Star Bend Setback Levee
Sutter County, California

File 788.1

October 2006

Figure 6