URS
2870 Gateway Oaks Drive, Suite 150
Sacramento, CA 95833
Tel: 916.679.2000 Fax: 916.679.2900

Technical Memorandum

Prepared For	Mike Inamine, PE SBFCA Christopher Krivanec, PE, GE HDR Engineering, Inc.
Project	Feather River West Levee
Date	May 01, 2013
Subject	Additional Explorations for Project Phase D, Reaches 31 and 34
Prepared By	Mike Turner, CEG
Reviewed By	Michael Hughes, PE

1.0 INTRODUCTION

The HDR team is providing design services to the Sutter Butte Flood Control Agency (SBFCA) for the Feather River West Levee (FRWL) Project. URS Corporation (URS), as a member of the HDR team, has been providing geotechnical engineering services for the FRWL Project.

Based on review comments from DWR, discussions with SBFCA, and evaluation of the existing plans and stick log profiles, the need for two (2) additional explorations in the section of levee within Project Phase D was identified. The purpose of these explorations was to explore the continuity of the aquiclude landward of the levee and also the blanket thickness. The location of the two explorations is presented below.

Boring ID	Reach	Station	Figure
SM0007_018B	31	1911+17	A41
SM0007_034S	34	2144+64	A45

This memorandum presents the findings of the explorations and presents an interpretation of the data.

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2.0 FIELDWORK AND FINDINGS

Explorations were performed in February and March of 2013 using a truck mounted auger/mud rotary drilling rig for boring SM0007_018B and a track mounted Geoprobe rig for boring SM0007_034S. Details of subsurface conditions encountered at each exploration are discussed below. Finalized boring logs, laboratory test results, and plan and profile sheets are included in Appendix A.

SM0007_018B (Reach 31, Station 1911+17)

The levee at this location is approximately 8 feet high, with a crown elevation of approximately +107 feet (NAVD88) and a landside toe elevation of +99 feet. The proposed remediation measure is a soil bentonite cutoff wall extending to an elevation of +44 feet and keying into a fine grained aquiclude layer observed at an elevation of approximately +55 feet. The local geology in this area is mapped as Historical alluvial deposits, which primarily comprises sand, silt, and clay with lenses of fine gravel. (Helley and Harwood, 1985). The geologic mapping also indicates the presence of Historical crevasse splay deposits. These deposits are considered composed of fine to coarse sand with lenses of gravel deposited after breaching of natural levees.

Boring SM0007_018B was drilled at the landside toe of the levee at approximately Station 1911+17 in the vicinity of existing crown exploration SM0007_012B. Boring SM0007_012B identified a fine grained aquiclude layer starting at an elevation of approximately +54 feet and extending to the bottom of the exploration, an elevation of approximately +46.5 feet.

Boring SM0007_018B was drilled to a depth of 65.5 feet below ground surface (bgs). The boring encountered a 10 feet thick clay and clayey silt layer at the surface overlying approximately 13.5 feet of silty sand and sandy silt to an elevation of approximately +75.5 feet. Beneath this, an approximately 19 foot thick zone of gravel was encountered between elevations +75.5 feet and +56.5 feet. Below these gravels the boring encountered interlayered clay, sandy clayey silt, sandy silty clay, and silt to the maximum depth explored, an elevation of +34 feet. These silt and clay layers, observed starting at an elevation of +56.5 feet, tie-in with where the crown boring SM0007_012B indicated the elevation of the top of the aquiclude layer was and confirms the continuity of the aquiclude landward of the levee.

SM0007_034S (Reach 34, Station 2144+64)

The levee at this location is approximately 12.5 feet high, with a crown elevation of approximately +122.5 feet (NAVD88) and a landside toe elevation of +110 feet. The proposed remediation measure is a deep soil bentonite cutoff wall terminating at an elevation of +20 feet. A deep cut off wall is proposed at this location because of a localized thinning of the silt blanket at approximate Station 2141+00. The local geology in this area is mapped as Historical alluvial deposits, which primarily comprises sand, silt, and clay with lenses of fine gravel. (Helley and Harwood, 1985). The geologic mapping also indicates the presence of a Historical cut off channel (chute) deposits in this

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area. These deposits generally occur on insides of meander bends within the river channel and as overflow channels into hydraulic mining debris.

Boring SM0007_034S was drilled at the landside toe of the levee at Station 2144+64 in the vicinity of the existing explorations, SM0007_009S, WM0007_ 056B and WM0007_056S. These explorations identified a thick aquifer layer comprising gravel and clayey gravel between approximately elevations +100 feet and +40 feet in boring SM0007_009S at Station 2141+00, and elevations +91 feet and +55 feet in explorations WM0007_056B and WM0007_056S at Station 2148+00. Beneath the gravel a fine grained aquiclude was encountered.

Boring SM0007_035S was drilled to a depth of 110 feet bgs, elevation +0 feet. The boring encountered approximately 20 feet of sandy silt and silty sand at the surface underlain by approximately 38 feet of poorly graded gravel and clayey gravel to elevation +52 feet. Beneath these gravels the boring encountered approximately 16.5 feet of sandy lean clay and sandy silt with minor lenses of sand to elevation +35.5 feet. Beneath this, the boring encountered sand and gravel to the maximum depth explored. The silt and clay layers encountered between elevations +52 and +35.5 feet coincide with the silt layer encountered in crown boring WM0007_056S at elevation +52 feet, and confirms the continuity of the aquiclude landward of the levee.

3.0 RECOMMENDATIONS

Based on the findings of boring SM0007_018B in Reach 31, Station 1911+17, it is considered that the landward continuity of the aquiclude has been confirmed. Therefore, the existing analyses performed as part of the final GDRR is valid and there is no need for additional analysis or change to the proposed design.

Based on the findings of boring SM0007_034S in Reach 34, Station 2144+64, the landside blanket is thicker than that encountered in boring SM0007_009S at approximately Station 2141+00 and the aquiclude layer starts at a shallower depth corresponding to an elevation of approximately +50 feet. Given these findings it is possible that the wall depth could be reduced. It is recommended that the proposed wall depth presented in the final GDRR remains unchanged, but modifications could be made in the field if the aquiclude layer is found to be shallower during construction.

4.0 LIMITATIONS

This technical memorandum was prepared in accordance with the standard of care commonly used as the state-of-practice in the engineering profession. Standard of care is defined as the ordinary diligence exercised by fellow practitioners in this area performing the same services under similar circumstances during the same period. The limitations section of the final GDRR for the FRWL is applicable for this technical memorandum also.

This technical memorandum is for the use and benefit of the HDR design team and SBFCA. Use by any other party is at their own discretion and risk.

APPENDIX A

A1 – Boring Logs
A2 – Laboratory Results
A3 – Plan and Profiles

APPENDIX A1

Boring Logs

GROUP SYMBOLS AND NAMES

Graphic	Group Names	Graphic	Group Names	Graphic	Group Names
	Lean Clay (CL)		Lean Clay with Sand (CL)		Lean Clay with Gravel (CL)
	Sandy Lean Clay (CL)		Fat Clay (CH)		Fat Clay with Sand (CH)
	Fat Clay with Gravel (CH)		Sandy Fat Clay (CH)		Silty Clay (CL-ML)
	Silty Clay with Sand (CL-ML)		Sandy Silty Clay (CL-ML)		Clayey Silt (ML/CL)
	Silt (ML)		Silt with Sand (ML)		Sandy Silt (ML)
	Elastic Silt (MH)		Sandy Elastic Silt (MH)		Poorly Graded Sand (SP)
	Poorly Graded Sand with Gravel (SP)		Poorly Graded Sand with Clay (SP-SC)		Poorly Graded Sand with Clay and Gravel (SP-SC)
	Poorly Graded Sand with Silt (SP-SM)		Poorly Graded Sand with Silt and Gravel (SP-SM)		Well-Graded Sand (SW)
	Well-Graded Sand with Gravel (SW)		Well-Graded Sand with Clay (SW-SC)		Well-Graded Sand with Clay and Gravel (SW-SC)
	Well-Graded Sand with Silt (SW-SM)		Well-Graded Sand with Silt and Gravel (SW-SM)		Clayey Sand (SC)
	Clayey Sand with Gravel (SC)		Silty Clayey Sand (SC-SM)		Silty Sand (SM)
	Silty Sand with Gravel (SM)		Poorly Graded Gravel (GP)		Poorly Graded Gravel with Sand (GP)
	Poorly Graded Gravel with Clay (GP-GC)		Poorly Graded Gravel with Clay and Sand (GP-GC)		Poorly Graded Gravel with Silt (GP-GM)
	Poorly Graded Gravel with Silt and Sand (GP-GM)		Well-Graded Gravel (GW)		Well-Graded Gravel with Sand (GW)
	Well-Graded Gravel with Clay (GW-GC)		Well-Graded Gravel with Clay and Sand (GW-GC)		Well-Graded Gravel with Silt (GW-GM)
	Well-Graded Gravel with Silt and Sand (GW-GM)		Clayey Gravel (GC)		Clayey Gravel with Sand (GC)
	Silty Clayey Gravel (GC-GM)		Silty Gravel (GM)		Silty Gravel with Sand (GM)

Note: Soils were classified in the field in general accordance with ASTM D2488-06, Standard Practice for Description and Identification of Soils (Visual Manual Procedure). Where laboratory testing was performed, classifications were modified in general accordance with ASTM D2487-06, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

Borderline symbols, two group symbols separated by a slash, may be used in field visual classification when (1) percentage of fines is estimated to be between 45% and 55%, (2) percentages of sand and gravel are estimated to be about the same, (3) soil could be either well graded or poorly graded, (4) soil could be either a silt or a clay, or (5) fine-grained soil has properties indicating that it is at the boundary between low and high plasticity. Refer to DWR Soil and Rock Logging, Classification, and Presentation Manual for guidelines in the use of borderline symbols.

FIELD AND LABORATORY TESTS

AL	Atterberg Limits - Liquid Limit, Plastic Limit, Plasticity Index (AASHTO T 89-02 & T 90-00)
CCRS	One Dimensional Consolidation Controlled-Strain (ASTM D 4186)
CDDS	Consolidated Drained Direct Shear
CL	Collapse Potential (ASTM D 5333-03)
CN	Consolidation (ASTM D 2435-04)
CP	Relative Compaction (CTM 216 - 06)
CR	Corrosion, Sulfates, Chlorides (CTM 643 - 99; CTM 417 - 06; CTM 422 - 06)
CRSC	Constant Rate of Strain Consolidation
CU	Consolidated Undrained Triaxial (ASTM D 4767-02)
CUDS	Consolidated Undrained Direct Simple (ASTM D 6528-07)
DS	Direct Shear (ASTM D 3080-04)
EI	Expansion Index (ASTM D 4829-03)
FWK	Hydraulic Conductivity Flexible Wall Permeameter (ASTM D 5084)
HD	Hydrometer (ASTM)
N_{60}	N_{60}(ASTM)=N_m*(Eri/60)
OC	Organic Content (ASTM D 2974-07)
PA	Particle Size Analysis (ASTM D 422-63 [2002])
PE	Permeability (CTM 220 - 05)
PM	Pressure Meter
PP	Pocket Penetrometer
RV	R-Value (CTM 301 - 00)
SCUDSS	Special Consolidated Undrained Direct Simple Shear (ASTM D 6528)
SE	Sand Equivalent (CTM 217 - 99)
SG	Specific Gravity (AASHTO T 100-06)
SL	Shrinkage Limit (ASTM D 427-04)
SW	Swell Potential (ASTM D 4546-03)
TV	Pocket Torvane
UC	Unconfined Compression (ASTM D 2166-06)
UU	Unconsolidated Undrained Triaxial (ASTM D 2850-03)
UW	Unit Weight (ASTM D 4767-04)
VS	Vane Shear (AASHTO T 223 - 96 [2004])
WC	Water Content (ASTM D 2216-05)

SAMPLER GRAPHIC SYMBOLS

- Standard Penetration Test
- Standard California
- Modified California
- Shelby Tube
- Punch Core
- Sonic Core
- Dry Core
- Bag Sample
- Vane Shear
- Tricone Bit
- NSD — Non Sample Drilling

WATER LEVEL SYMBOLS

- First water encountered during drilling
- Water level measured after drilling
- Static water level reading (short-term)
- Static water leavel reading (long-term)

SBFCA Feather River West Levee

BORING LOG LEGEND

CONSISTENCY OF COHESIVE SOILS (AASHTO 1988)		
Descriptor	**Pocket Penetrometer (tsf)**	**Torvane (tsf)**
Very Soft	< 0.25	< 0.12
Soft	0.25 - 0.50	0.12 - 0.25
Medium Stiff	0.50 - 1.0	0.25 - 0.50
Stiff	1.0 - 2.0	0.50 - 1.0
Very Stiff	2.0 - 4.0	1.0 - 2.0
Hard	> 4.0	> 2.0

APPARENT DENSITY OF COHESIONLESS SOILS (ASTM 6066-96 (2004))	
Descriptor	**SPT N(60) - Value (blows / foot)**
Very Loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

MOISTURE (ASTM D 2488-06)	
Descriptor	**Criteria**
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

SOIL PARTICLE SIZE (ASTM D 2488-06)		
Descriptor		**Size**
Boulder		> 12 inches
Cobble		3 to 12 inches
Gravel	Coarse	3/4 inch to 3 inches
	Fine	No. 4 Sieve to 3/4 inch
Sand	Coarse	No. 10 Sieve to No. 4 Sieve
	Medium	No. 40 Sieve to No. 10 Sieve
	Fine	No. 200 Sieve to No. 40 Sieve
Silt and Clay		Passing No. 200 Sieve

PLASTICITY OF FINE-GRAINED SOILS (ASTM D 2488-06)	
Descriptor	**Criteria**
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll, and not much time is required to reach the plastic limit; it cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

DRY STRENGTH OF FINE-GRAINED SOILS (ASTM D 2488-06)	
Descriptor	**Criteria**
None	Dry specimen crumbles into powder with mere pressure of handling.
Low	Dry specimen crumbles into powder with some finger pressure.
Medium	Dry specimen breaks into pieces or crumbles with considerable finger pressure.
High	Dry specimen cannot be broken with finger pressure; will break into pieces between thumb and a hard surface.
Very High	Dry specimen cannot be broken between thumb and a hard surface.

DILATANCY OF FINE-GRAINED SOILS (ASTM D 2488-06)	
Descriptor	**Criteria**
None	No visible change in the specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear, or disappears slowly, upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

TOUGHNESS OF FINE-GRAINED SOILS (ASTM D 2488-06)	
Descriptor	**Criteria**
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

CEMENTATION (ASTM D 2488-06)	
Descriptor	**Criteria**
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure.

DATE STARTED	DATE COMPLETED	GROUND ELEVATION	ELEVATION DATUM	TOTAL DEPTH OF BORING
3/28/13	3/28/13	99.12 ft	NAVD 88	65.5 ft
DRILLING CONTRACTOR		**DRILLER'S NAME**	**HELPER'S NAME**	**TOTAL DEPTH OF FILL**
Geo-Ex		Thomas Scott	R. Humphreys, D. Hensley	0 ft
DRILLING METHOD		**DRILL RIG MAKE AND MODEL**		**CONSULTANT COMPANY**
Auger, Mud Rotary		CME 75		URS Corporation
DRILL BIT SIZE AND TYPE (HOLE DIAMETER)		**DRILLING ROD TYPE AND DIAMETER**		**FIELD LOGGER**
5.5" CT Auger / 5" CT Punch Core		5" Solid Stem Auger / AWJ 1-3/4" / HWTWL 3-1/2" (OD)		M. Palmer
☒ VERTICAL ☐ INCLINED		**CASING TYPE, DIAMETER, INSTALLATION DEPTH**		**FIELD LOG REVIEWER**
		6.5" x 6' steel to 5 feet		MT
SAMPLER TYPE(S)		**HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP**		**HAMMER EFFICIENCY**
MCal(2.5"), PCore(2.5"), SPT(1.375")		CME autohammer, 140 lb / 30-in drop		70%
BOREHOLE BACKFILL OR COMPLETION		**GROUNDWATER READING: DURING DRILLING**		**AFTER DRILLING (DATE-TIME)**
Neat cement grout		N/A due to rotary wash drilling method		NA

Elevation, feet	Depth, feet	Material Graphics	CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in. [Blows per ft]	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	Liquid Limit	Plasticity Index	Fines, % < #200	Other Lab Tests	REMARKS
	0		LEAN CLAY (CL); dark yellowish brown (10YR 4/6); moist; 90% low to medium plasticity, no dilatancy fines; 10% fine sand; abundant rootlets.	X	1	83	5 7 7 [14]	16							1_0.0_1.5
	1														
	2														
	3		SILT (ML); yellowish brown (10YR 5/6); moist; 95% low plasticity, no dilatancy fines; 5% fine to medium sand; orange mottling throughout; trace roots.												Advanced boring to 20 feet using solid stem auger.
95	4														
	5			X	2	100	6 14 21 [35]	41		28	41	13	94		2_5.0_6.5
	6														
	7														
	8														
90	9														
	10		SILTY SAND (SM); yellowish brown (10YR 5/6); moist; 60% fine sand; 40% no plasticity fines; micaceous; trace medium sand; orange and tan mottling throughout.	X	3	72	6 8 10 [18]	21							3_10.0_11.5
	11														
	12														
	13														
85	14		SANDY SILT (ML); yellowish brown (10YR 5/4); 60% no plasticity fines; 40% fine sand; orange iron oxide staining throughout.												
	15			X	4	83	7 9 13 [22]	26					60	PA	4_15.0_16.5
	16														
	17														
	18														
80	19		SILTY SAND with Gravel (SM); olive brown (2.5Y 4/3); moist; 65% fine sand; 20% no plasticity fines; 15% fine, subangular to subrounded gravel, max. 3/4 in.; micaceous; gravels are thinly interbedded.												At 18.5 feet driller reports gravelly drilling.
	20														

Final Report Version

Borehole Location: Landside toe beyond ditch **County:** Butte
Coordinates: Northing: 2,260,063.17 **Easting:** 6,660,969.41
Latitude: 39.36756 **Longitude:** -121.64874
Levee Station or Milepost: 1911+17 **Levee Mile:**
Levee Segment Reach 31
Survey Method: GPS **Coord. System:**
Channel / River Name / Feature: Feather River

LOG OF BORING
SM0007_018B
Sheet 1 of 3

SBFCA Feather River West Levee

Elevation, feet	Depth, feet	CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in. [Blows per ft]	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	Liquid Limit	Plasticity Index	Fines, % < #200	Other Lab Tests	REMARKS
	20			5A	83	10 11 18 [29]	34							5A_20.0_20.5
	21	Poorly Graded SAND with Silt (SP-SM); dark grayish brown (2.5Y 4/2); moist; 80% fine to coarse sand; 10% fine, subrounded gravel, max. 3/8 in.; 10% no plasticity fines; micaceous.		5B										5B_20.5_21.5
	22													At 21.5 feet set casing to 5 feet BGS, switch to mud rotary-punch core.
	23			6										6_21.5_26.5
75	24	Poorly Graded GRAVEL with Sand (GP); dark grayish brown (2.5Y 4/2); moist; 60% fine to coarse, subrounded to rounded, hard gravel, max. 1-1/2 in.; 35% fine to coarse sand; 5% no plasticity fines; micaceous.			40									
	25													
	26													
	27			7	92	24 50/5"						4	PA	7_26.5_27.5
	28			8	67	[50/5"]								8_27.5_29.0
70	29			9A	83	35 47 40 [87]						3		9A_29.0_30.0
	30	SILTY SAND with Gravel (SM); olive brown (2.5Y 4/3); wet; 60% fine to coarse sand; 20% fine, subangular to subrounded, hard gravel, max. 1/2 in.; 20% no to low plasticity, rapid dilatancy fines; micaceous.		9B										9B_30.0_30.5
	31	Poorly Graded GRAVEL with Sand (GP); greenish gray (10Y 5/1); wet; 70% fine to coarse, subrounded gravel, max. 2 in.; 25% fine to coarse sand; 5% no to low plasticity fines; trace mica.												At 30.5 feet losing circulation, cannot advance boring with punch core due to blocking with gravels. Remove inner punch core barrel, no punch core sampling from 30.5 - 44 feet.
	32													
	33													
65	34			10	100	50/3" [REF]						4	PA	10_34.0_34.25
	35													
	36													
	37													
	38													
60	39			11	88	50 50/2"								11_39.0_39.7
	40					[50/2"]								
	41													
	42													
	43	SILT with Sand (ML); stiff; dark yellowish brown (10YR 4/6); moist; 80% fines; 20% fine to medium sand; variably blocky.												At 42.5 feet drilling action smoothed out, not gravelly.
55	44			12	78	8		1.0P	48	46	12	82		12_44.0_45.5
	45													

Final Report Version

Borehole Location: Landside toe beyond ditch **County:** Butte
Coordinates: Northing: 2,260,063.17 **Easting:** 6,660,969.41
Latitude: 39.36756 **Longitude:** -121.64874
Levee Station or Milepost: 1911+17 **Levee Mile:**
Levee Segment Reach 31
Survey Method: GPS **Coord. System:**
Channel / River Name / Feature: Feather River

LOG OF BORING
SM0007_018B
Sheet 2 of 3

SBFCA Feather River West Levee

Elevation, feet	Depth, feet	CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in. [Blows per ft]	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	Liquid Limit	Plasticity Index	Fines, % < #200	Other Lab Tests	REMARKS
	45			12	78	12 13 [25]		1.0P	48	46	12	82		
	46													At 45.5 begin punch core sampling.
	47	LEAN CLAY with Sand (CL); stiff; yellowish brown (10YR 5/4); moist; 75% low to medium plasticity fines; 25% fine sand; micaceous.		13	0									14A fell out of sampler, put catcher on sampler and redrove through sample interval to 51 feet, no blowcount was recorded for additional 6 inches.
	48													
50	49			14A	0	21 28 34 [62]								
	50			14B	100			1.5P						14B_49.0_51.0
	51	SANDY SILT (ML); stiff; yellowish brown (10YR 5/4); moist; 50% fine to medium sand; 50% slow dilatancy fines; micaceous. At 52 feet very stiff to hard; light olive brown (2.5Y 5/3); 65% low plasticity, no to slow dilatancy fines; 35% fine to medium sand; blocky texture.		15A				1.0P	29	31	7	50		15A_51.0_52.0
	52			15B	100			4.0P						15B_52.0_53.0
	53	SANDY SILTY CLAY (ML/CL); dark yellowish brown (10YR 4/6); moist; 60% low plasticity, slow to rapid dilatancy fines; 40% fine to medium sand; orange mottling throughout; micaceous.		15C										15C_53.0_54.0
45	54	ELASTIC SILT (MH/CL); stiff; dark yellowish brown (10YR 4/6); moist; 95% slow dilatancy fines; 5% fine to medium sand; micaceous; blocky texture; orange mottling throughout. At 55 feet very stiff; medium plasticity.		16	100	10 11 15 [26]		1.5P						16_54.0_55.5
	55													
	56			17A	71			3.25P 3.5P	38	50	15	98		17A_55.5_57.0
	57			17B				2.75P 3.25P						17B_57.0_58.0
	58													No recovery between 58 - 59 feet, sample fell out of core barrel
40	59	SILT (ML); very stiff; light olive brown (2.5Y 5/4); moist; 95% slow dilatancy fines; 5% fine sand; orange iron oxide staining; blocky texture.		18	100	25 50		2.5P				95		18_59.0_60.0
	60	At 60 feet blocky to platy structure.		19A	94				36	48	12	95		19A_60.0_62.0
	61													
	62	SANDY SILTY CLAY (CL/ML); light olive brown (2.5Y 5/4); moist; 70% low plasticity, slow dilatancy fines; 30% fine sand; micaceous; orange iron oxide staining; few 1 inch SILTY SAND (SM) lenses; blocky texture.		19B										19B_62.0_63.0
	63	LEAN CLAY with Sand (CL); light olive brown (2.5Y 5/4); 95% medium plasticity, slow dilatancy fines; 5% fine sand; orange iron oxide staining throughout; poorly indurated; blocky to platy texture.		19C								96		19C_63.0_64.0
35	64			20	100	15 23 31 [54]								20_64.0_65.5
	65													
	66													
	67													
	68													
30	69													
	70													

Borehole terminated at 65.5 feet. Backfilled boring to within 5 feet of ground surface with 50 gallons water, 6-47 lb sacks of portland cement, 15 lb of bentonite powder, and 36 gallons water.

Field classification of percent fines, percent sand, and gravel are estimates. See log legend for ASTM procedures used for field and lab classification.

Sample IDs and corresponding depth ranges are noted in the Remarks column.

Final Report Version

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Survey Method: GPS **Coord. System:**
Channel / River Name / Feature: Feather River

LOG OF BORING
SM0007_018B
Sheet 3 of 3

SBFCA Feather River West Levee

DATE STARTED	DATE COMPLETED	GROUND ELEVATION	ELEVATION DATUM	TOTAL DEPTH OF BORING
2/26/13	2/27/13	109.96 ft	NAVD 88	110.0 ft
DRILLING CONTRACTOR GeoEx		**DRILLER'S NAME** Joshua Murok	**HELPER'S NAME** Gerald Baker/Robert Estrada	**TOTAL DEPTH OF FILL** 0 ft
DRILLING METHOD Sonic		**DRILL RIG MAKE AND MODEL** Geoprobe 81402C		**CONSULTANT COMPANY** URS Corporation
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) 4.5" Core bit, 5-3/4" Casing Bit		**DRILLING ROD TYPE AND DIAMETER** 3-1/2" Sonic		**FIELD LOGGER** M. Palmer
☒ VERTICAL ☐ INCLINED		**CASING TYPE, DIAMETER, INSTALLATION DEPTH** 5-3/4" Steel to 70'		**FIELD LOG REVIEWER** MT
SAMPLER TYPE(S) Sonic(4")		**HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP** NA		**HAMMER EFFICIENCY**
BOREHOLE BACKFILL OR COMPLETION Neat cement grout		**GROUNDWATER READING:**	**DURING DRILLING** 20 ft	**AFTER DRILLING (DATE-TIME)** NA

Elevation, feet	Depth, feet	Material Graphics	CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in. [Blows per ft]	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	Liquid Limit	Plasticity Index	Fines, % < #200	Other Lab Tests	REMARKS
	0		SANDY SILT (ML/SM); dark brown; moist; 50% fine sand; 50% no plasticity fines; micaceous; trace organic fragments scattered throughout.		1	100									1_0.0-5.0
105	5		At 5 feet light brown; 65% no plasticity fines; 35% fine sand.		2	80							65	PA	2_5.0-10.0
100	10		SILTY SAND (SM/ML); light brown; moist; 50% fine sand; 50% slow to rapid dilatancy fines; trace organics; micaceous.		3A	80									3A_10.0-13.0
	14				3B					23	24	NP	48	PA	3B_13.0-15.0
95	15														No recovery 15-16.5'
	17		SANDY SILT (ML/SM); brown; moist; 50% fine sand; 50% low plasticity, rapid dilatancy fines; micaceous.		4A	70									4A_16.5-17.5
	18		Poorly Graded SAND (SP); olive brown; moist; 95% fine sand; 5% no plasticity fines.		4B										4B_17.5-19.0
90	20		Poorly Graded SAND with Gravel (SP); light yellowish												

Final Report Version

Borehole Location: Levee Toe **County:** Butte
Coordinates: Northing: 2,275,258.01 **Easting:** 6,664,777.55
Latitude: 39.40924 **Longitude:** -121.63506
Levee Station or Milepost: 2144+64 **Levee Mile:**
Levee Segment Reach 34
Survey Method: GPS **Coord. System:**
Channel / River Name / Feature: Feather River

LOG OF BORING
SM0007_034S
Sheet 1 of 5

SBFCA Feather River West Levee

Elevation, feet	Depth, feet	CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in. [Blows per ft]	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	Liquid Limit	Plasticity Index	Fines, % < #200	Other Lab Tests	REMARKS
	20	brown; dry; 55% fine sand; 40% fine to coarse, subrounded to rounded, hard gravel, max. 2 in.; 5% no plasticity fines; micaceous.												Caving at 20'
	21	Poorly Graded GRAVEL with Sand and Cobbles (GP); olive gray; wet; 60% hard, subrounded to rounded; fine to coarse gravels to 2.5"; 35% fine to coarse sand; 5% no plasticity fines; trace hard, subrounded cobbles to 4 inches; trace mica.		5										5_20.0-21.5
	22				30									21.5-25 No recovery, core barrel blocked by cobble at 21.5'.
	23													
	24	Poorly Graded GRAVEL with Sand (GP); olive gray; wet; 60% fine to coarse, subrounded to rounded, hard gravel, max. 2.5 in.; 35% fine to medium sand; 5% no plasticity fines; trace coarse sand and mica.												
85	25													
	26													
	27			6	100							2	PA	6_27.0-28.0
	28													
	29	At 29 feet fines slightly clayier; gravels up to 3 inches.												
80	30													Set casing to 30'
	31			7										7_30.5-31.5
	32				90									
	33													
	34	Poorly Graded GRAVEL (GP); olive gray; wet; 60% fine to coarse, subrounded to rounded, hard gravel, max. 3 in.; 35% fine to coarse sand; 5% low plasticity fines; approximately 5% cobbles up to 4 inches.												
75	35													Set casing to 35' Core washed 35-39'
	36													
	37				100									
	38													
	39	CLAYEY GRAVEL with Sand (GC); light olive gray; moist; 50% subrounded to rounded, hard gravel, max. 2 in.; 35% fine to coarse sand; 15% low plasticity fines.		8								16	PA	8_38.5-39.5
70	40													Set casing to 40' Hard drilling 40-45'.
	41			9	100									
	42	At 42 feet as above except variably stained with iron oxide.												
	43			10										10_42.0-43.0
	44				100									Hard drilling
65	45	SILTY SAND (SM); brown; moist; 60% fine to medium												

Final Report Version

Borehole Location: Levee Toe **County:** Butte
Coordinates: Northing: 2,275,258.01 **Easting:** 6,664,777.55
Latitude: 39.40924 **Longitude:** -121.63506
Levee Station or Milepost: 2144+64 **Levee Mile:**
Levee Segment Reach 34
Survey Method: GPS **Coord. System:**
Channel / River Name / Feature: Feather River

LOG OF BORING
SM0007_034S
Sheet 2 of 5

SBFCA Feather River West Levee

Elevation, feet	Depth, feet	Material Graphics	CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in. [Blows per ft]	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	Liquid Limit	Plasticity Index	Fines, % < #200	Other Lab Tests	REMARKS
	45		sand; 40% no to low plasticity fines; micaceous.												
	46		CLAYEY GRAVEL with Sand (GC); light olive gray; moist; 50% subrounded to rounded, hard gravel, max. 2 in.; 35% fine to coarse sand; 15% fines.												
	47					100									
	48														
	49				11						30	10	13	PA	11_48.5-49.5
60	50		SANDY CLAYEY SILT (ML/CL); brown; moist; 55% low plasticity, slow to rapid dilatancy fines; 45% fine sand.												Set casing to 45' 50-50.5' no recovery
	51														
	52		CLAYEY GRAVEL (GC); light olive gray; moist; 50% subrounded to rounded, hard gravel, max. 2 in.; 35% fine to coarse sand; 15% low plasticity fines.		12	98									12_52.0-53.0
	53														
	54		At 54 feet indurated, blocky texture.												
55	55		At 55 feet one 3-inch interbed of Sandy Clayey Silt (ML/CL).												Set casing to 50'
	56														
	57				13A										13A_56.5-57.5
	58		SANDY LEAN CLAY (CL); light brown with scattered orange iron oxide staining; moist; 70% low plasticity fines; 30% fine sand; micaceous; over consolidated; blocky texture.		13B										13B_58.0-59.0
	59														
50	60		At 59.5 feet scattered thin (1-2") lenses of clayey sand. At 60 feet 60% low to medium plasticity fines; 30% fine to coarse sand; 10% fine to coarse gravel, max. 2 in.		14A										14A_60.0-61.0
	61														
	62		SANDY SILT (ML); olive brown with orange iron oxide staining; moist; 60% slow to rapid dilatancy fines; 40% fine sand; micaceous; blocky texture; scattered thin bedding.												
	63														
	64				14B					31	40	10	63	PA	14B_63.5-64.5
45	65														
	66														
	67														
	68														
	69				14C										14C_68.0-69.0
40	70														

Final Report Version

Borehole Location: Levee Toe **County:** Butte
Coordinates: Northing: 2,275,258.01 **Easting:** 6,664,777.55
Latitude: 39.40924 **Longitude:** -121.63506
Levee Station or Milepost: 2144+64 **Levee Mile:**
Levee Segment Reach 34
Survey Method: GPS **Coord. System:**
Channel / River Name / Feature: Feather River

LOG OF BORING
SM0007_034S
Sheet 3 of 5

SBFCA Feather River West Levee

Elevation, feet	Depth, feet	Material Graphics	CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in. [Blows per ft]	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	Liquid Limit	Plasticity Index	Fines, % < #200	Other Lab Tests	REMARKS
	70		SILTY SAND (SM); olive brown; wet; 70% fine to medium sand; 30% no plasticity fines; micaceous; weakly stained with iron oxide.		15					28			32	PA	Set casing to 70' 15_70.0-71.0
	71		SANDY LEAN CLAY (CL/SC); olive brown; moist; 50% fine sand; 50% low to medium plasticity fines; micaceous; over consolidated; blocky texture.												
	72					100									
	73														
	74														
35	75		SILTY SAND (SM); olive brown; moist; 80% fine to medium sand; 20% fines; micaceous.												Set casing to 75'
	76														
	77														
	78					75									
	79				16						33	1	19	PA	16_78.0-79.0
30	80														
	81		CLAYEY SAND (SC); olive brown; moist; 55% fine to coarse sand; 35% low plasticity fines; 10% fine to coarse gravel, max. 2 in.; weathered in place; blocky-friable texture; authigenic clay cement.												
	82					92									
	83				17										17_82.0-83.0
	84														
25	85		SILTY SAND with Gravel (SM); olive brown; moist; 65% fine to coarse sand; 20% slow dilatancy fines; 15% fine to coarse, subrounded to rounded gravel; blocky texture; (fines appear as Elastic Silt).												
	86														
	87				18A	63					53	10	20	PA	18A_87.0-88.0
	88		At 88 feet olive gray; medium plasticity; no to slow dilatancy fines.		18B										18B_88.0-89.0
	89														
20	90		At 90 feet gray.												
	91														
	92		SILTY GRAVEL with Sand (GM); gray; moist; 45% fine to coarse sand; 40% fine to coarse, hard gravel; 15% low to medium plasticity, slow dilatancy fines; compacted; gravels leave "pluck" marks; (fines appear to be Elastic Silt).			100									
	93														
	94												14	PA	
15	95				19										19_93.5-94.5

Final Report Version

Borehole Location: Levee Toe **County:** Butte
Coordinates: Northing: 2,275,258.01 **Easting:** 6,664,777.55
Latitude: 39.40924 **Longitude:** -121.63506
Levee Station or Milepost: 2144+64 **Levee Mile:**
Levee Segment Reach 34
Survey Method: GPS **Coord. System:**
Channel / River Name / Feature: Feather River

LOG OF BORING
SM0007_034S
Sheet 4 of 5

SBFCA Feather River West Levee

Elevation, feet	Depth, feet	Material Graphics	CLASSIFICATION OF MATERIALS (Description)	Sample Location	Sample Number	Recovery, %	Blows per 6 in. [Blows per ft]	N_{60}(ASTM)	PP or TV, tsf	LABORATORY DATA: Water Content, %	Liquid Limit	Plasticity Index	Fines, % < #200	Other Lab Tests	REMARKS
	95														
	96														
	97														
	98				20										20_97.0-98.0
	99														
10	100														
	101														
	102		Poorly Graded SAND with Silt (SP-SM); (hardpan); black; moist; fine to medium gravel; well-cemented; breaks under heavy hammer blow; estimate 90% fine to coarse sand; 10% no to low plasticity fines; silicious cement.			67									
	103				21										21_102.5-103.5 103.5-105 fell out of core barrel during extraction. No recovery
	104														
5	105														
	106				22A								6	PA	22A_106.0-109.0
	107														
	108		At 107.5 feet variably cemented.			70									
	109														
0	110				22B										22B_109.0-110.0
	111														
	112														
	113														
	114														
-5	115														
	116														
	117														
	118														
	119														
-10	120														

Borehole terminated at 110 feet.

Backfilled with neat grout consisting of 105 gallons water and 28-47 lb sacks of portland cement. Last 3 feet backfilled with native soil.

Field classification of percent fines and percent sand are estimates. See log legend for ASTM procedures used for field and lab classification.

Sample IDs and corresponding depth ranges are noted in the Remarks column.

Final Report Version

Borehole Location: Levee Toe **County:** Butte
Coordinates: Northing: 2,275,258.01 **Easting:** 6,664,777.55
Latitude: 39.40924 **Longitude:** -121.63506
Levee Station or Milepost: 2144+64 **Levee Mile:**
Levee Segment Reach 34
Survey Method: GPS **Coord. System:**
Channel / River Name / Feature: Feather River

LOG OF BORING
SM0007_034S
Sheet 5 of 5

SBFCA Feather River West Levee

APPENDIX A2

Laboratory Results

Sample Information				USCS Group Symbol	In Situ Water Content, %	In Situ Dry Unit Weight, pcf	Sieve			Atterberg Limits			Other Tests
Boring Number	Sample Number	Depth, feet	Elevation, feet				Gravel, %	Sand, %	<#200, %	LL	PL	PI	
SM0007_018B	2_5.0_6.5	5	94.1	ML	28				93.5	41	28	13	
SM0007_018B	4_15.0_16.5	15	84.1	ML					59.7				PA
SM0007_018B	7_26.5_27.5	26.5	72.6	GP					4.3				PA
SM0007_018B	9A_29.0-30.0	29.3	69.8	GP					3.2				
SM0007_018B	10_34.0_34.3	34	65.1	GW					4.4				PA
SM0007_018B	12_44.0_45.5	44	55.1	ML	48				82.3	46	34	12	
SM0007_018B	15A_51.0_52.0	51.5	47.6	ML	29				50.2	31	24	7	
SM0007_018B	17A_55.5_57.0	56.5	42.6	MH	38				97.9	50	35	15	
SM0007_018B	18_59.0_60.0	59	40.1	ML					95.5				
SM0007_018B	19A_60.0_62.0	60.5	38.6	ML	36				95.2	48	36	12	
SM0007_018B	19C_63.0_64.0	63.5	35.6	CL					96.2				

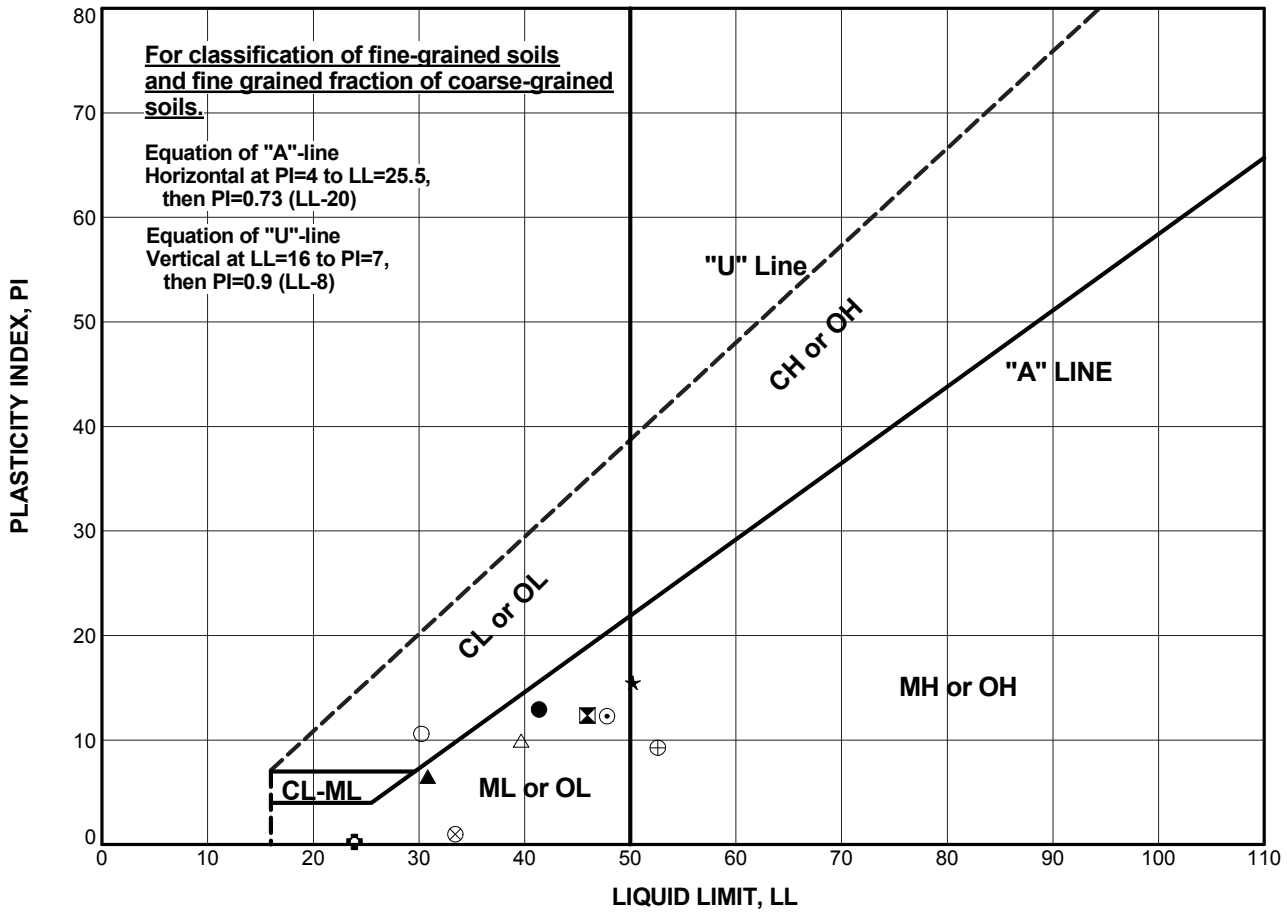
SBFCA Feather River West Levee
Project D, Reaches 31 and 34

SUMMARY OF SOIL LABORATORY DATA

Sample Information				USCS Group Symbol	In Situ Water Content, %	In Situ Dry Unit Weight, pcf	Sieve			Atterberg Limits			Other Tests
Boring Number	Sample Number	Depth, feet	Elevation, feet				Gravel, %	Sand, %	<#200, %	LL	PL	PI	
SM0007_034S	2A_005_010S	5	105.0	ML					64.9				PA
SM0007_034S	3A_010_013S	14	96.0	SM	23				47.7	24	24	NP	PA
SM0007_034S	6A_027_028S	27	83.0	GP					1.8				PA
SM0007_034S	8A_038_039S	39	71.0	GC					15.8				PA
SM0007_034S	11A_048_049S	49	61.0	GC					12.6	30	20	10	PA
SM0007_034S	14B_063_064S	64	46.0	ML	31				63.0	40	30	10	PA
SM0007_034S	15A_070_071S	70.5	39.5	SM	28				31.6				PA
SM0007_034S	16A_078_079S	78.5	31.5	SM					18.7	33	32	1	PA
SM0007_034S	18A_087_088S	87.5	22.5	GM					20.4	53	43	10	PA
SM0007_034S	19A_094_095S	94	16.0	GM					14.2				PA
SM0007_034S	22A_106_107S	106	4.0	SP-SM					6.0				PA

SBFCA Feather River West Levee
Project D, Reaches 31 and 34

SUMMARY OF SOIL LABORATORY DATA

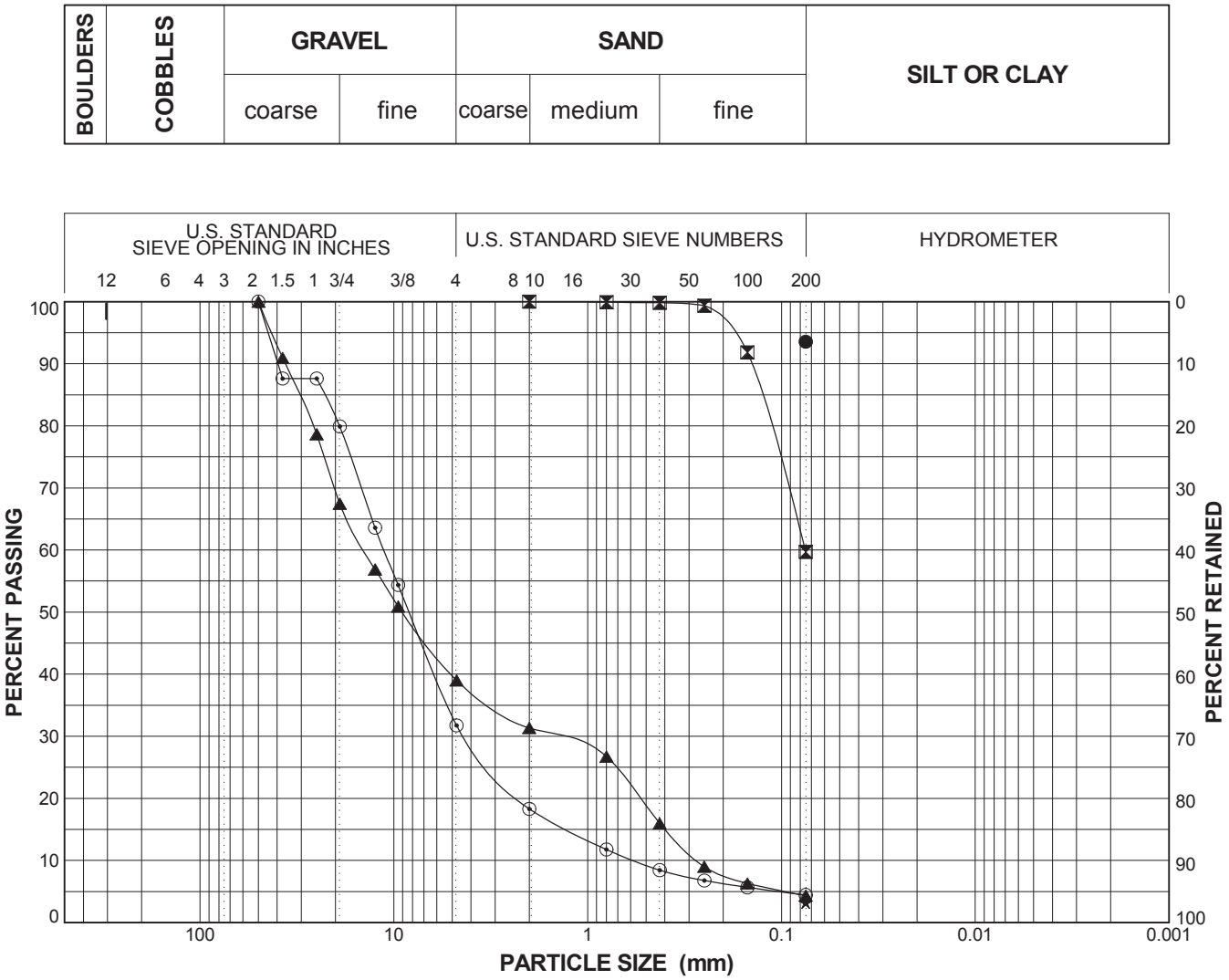


Boring Number	Sample Number	Depth (feet)	Test Symbol	WC (%)	LL	PL	PI	%Fines <#200	Classification
SM0007_018B	2_5.0_6.5	5	●	27.7	41	28	13	94	SILT (ML)
SM0007_018B	12_44.0_45.5	44	⧗	48.2	46	34	12	82	SILT with SAND (ML)
SM0007_018B	15A_51.0_52.0	51.5	▲	29.1	31	24	7	50	SANDY SILT (ML)
SM0007_018B	17A_55.5_57.0	56.5	★	37.9	50	35	15	98	ELASTIC SILT (MH)
SM0007_018B	19A_60.0_62.0	60.5	⊙	36.4	48	36	12	95	SILT (ML)
SM0007_034S	3A_010_013S	14	✿	23.0	24	24	NP	48	SILTY SAND (SM/ML)
SM0007_034S	11A_048_049S	49	○		30	20	10	13	CLAYEY GRAVEL with SAND (GC)
SM0007_034S	14B_063_064S	64	△	31.3	40	30	10	63	SANDY SILT (ML)
SM0007_034S	16A_078_079S	78.5	⊗		33	32	1	19	SILTY SAND (SM)
SM0007_034S	18A_087_088S	87.5	⊕		53	43	10	20	SILTY GRAVEL with SAND (GM)

SBFCA LEVEE ATT. PLOT (U LINE) W/%200; GINTSBFCA; SUTTERBUTTELIBRARY20130404.GLB; 4/15/13

SBFCA Feather River West Levee
Project D, Reaches 31 and 34

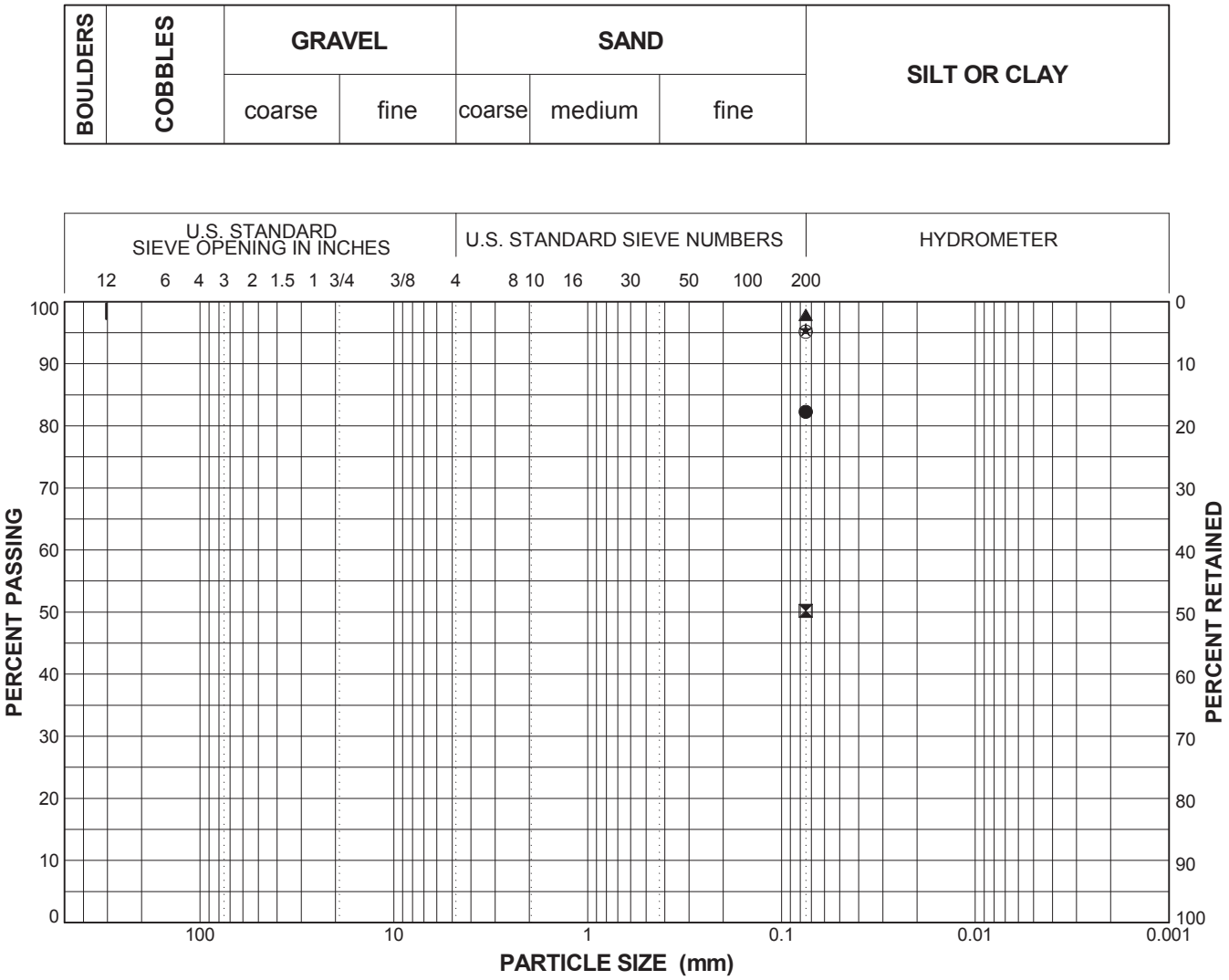
PLASTICITY CHART



Boring Number	Sample Number	Depth (feet)	Symbol	%G	%S	%F	Classification
SM0007_018B	2_5.0_6.5	5	●	0.0	0.0	93.5	SILT (ML)
SM0007_018B	4_15.0_16.5	15	⧗	0.0	40.3	59.7	SANDY SILT (ML)
SM0007_018B	7_26.5_27.5	26.5	▲	61.0	34.7	4.3	POORLY GRADED GRAVEL with SAND (GP)
SM0007_018B	9A_29.0-30.0	29.3	★	0.0	0.0	3.2	POORLY-GRADED GRAVEL with SAND (GP)
SM0007_018B	10_34.0_34.3	34	⊙	68.2	27.3	4.4	POORLY-GRADED GRAVEL with SAND (GP)

SBFCA Feather River West Levee
Project D, Reaches 31 and 34

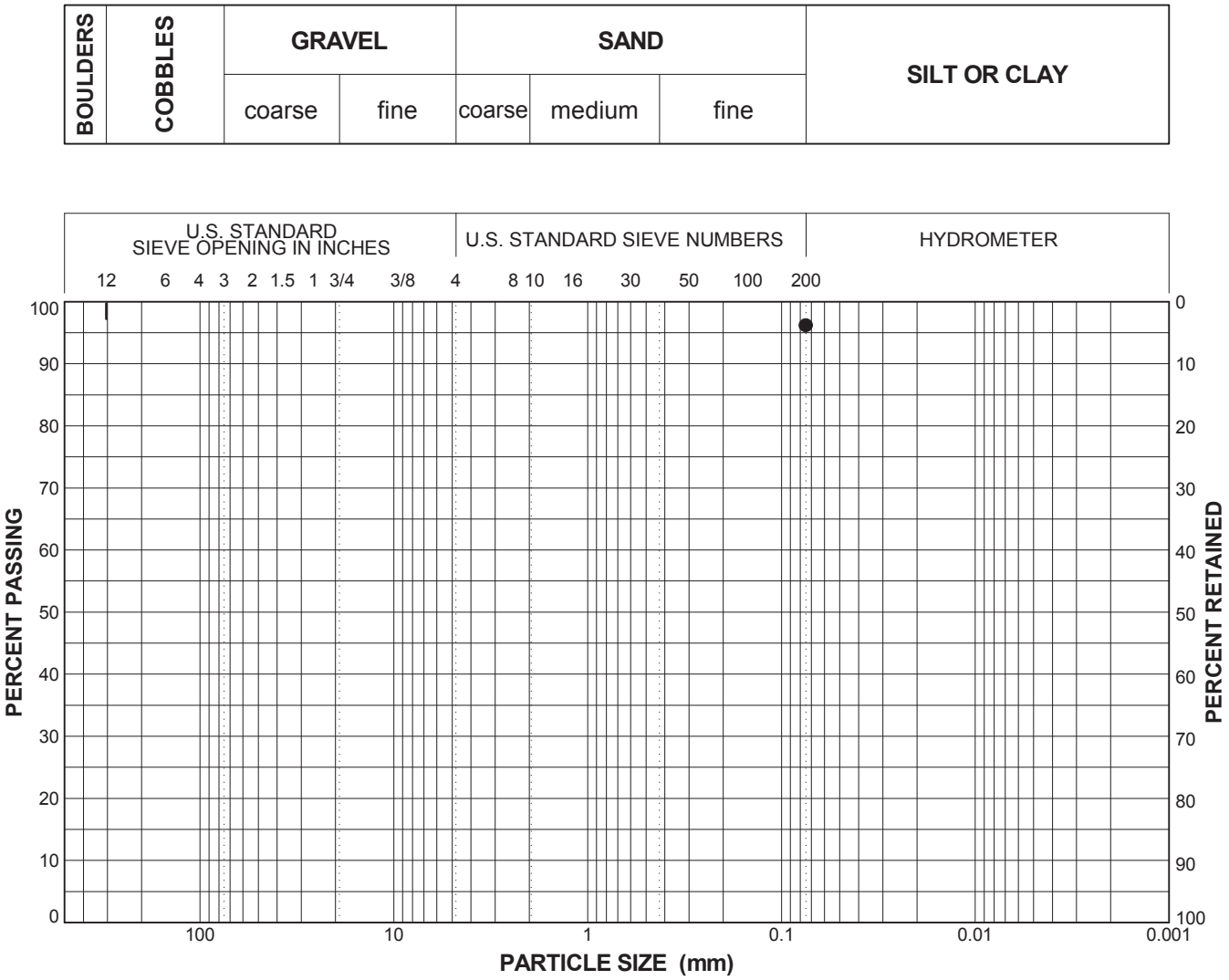
PARTICLE SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	%G	%S	%F	Classification
SM0007_018B	12_44.0_45.5	44	●	0.0	0.0	82.3	SILT with SAND (ML)
SM0007_018B	15A_51.0_52.0	51.5	⧗	0.0	0.0	50.2	SANDY SILT (ML)
SM0007_018B	17A_55.5_57.0	56.5	▲	0.0	0.0	97.9	ELASTIC SILT (MH)
SM0007_018B	18_59.0_60.0	59	★	0.0	0.0	95.5	SILT (ML)
SM0007_018B	19A_60.0_62.0	60.5	⊙	0.0	0.0	95.2	SILT (ML)

SBFCA Feather River West Levee
Project D, Reaches 31 and 34

PARTICLE SIZE DISTRIBUTION CURVES

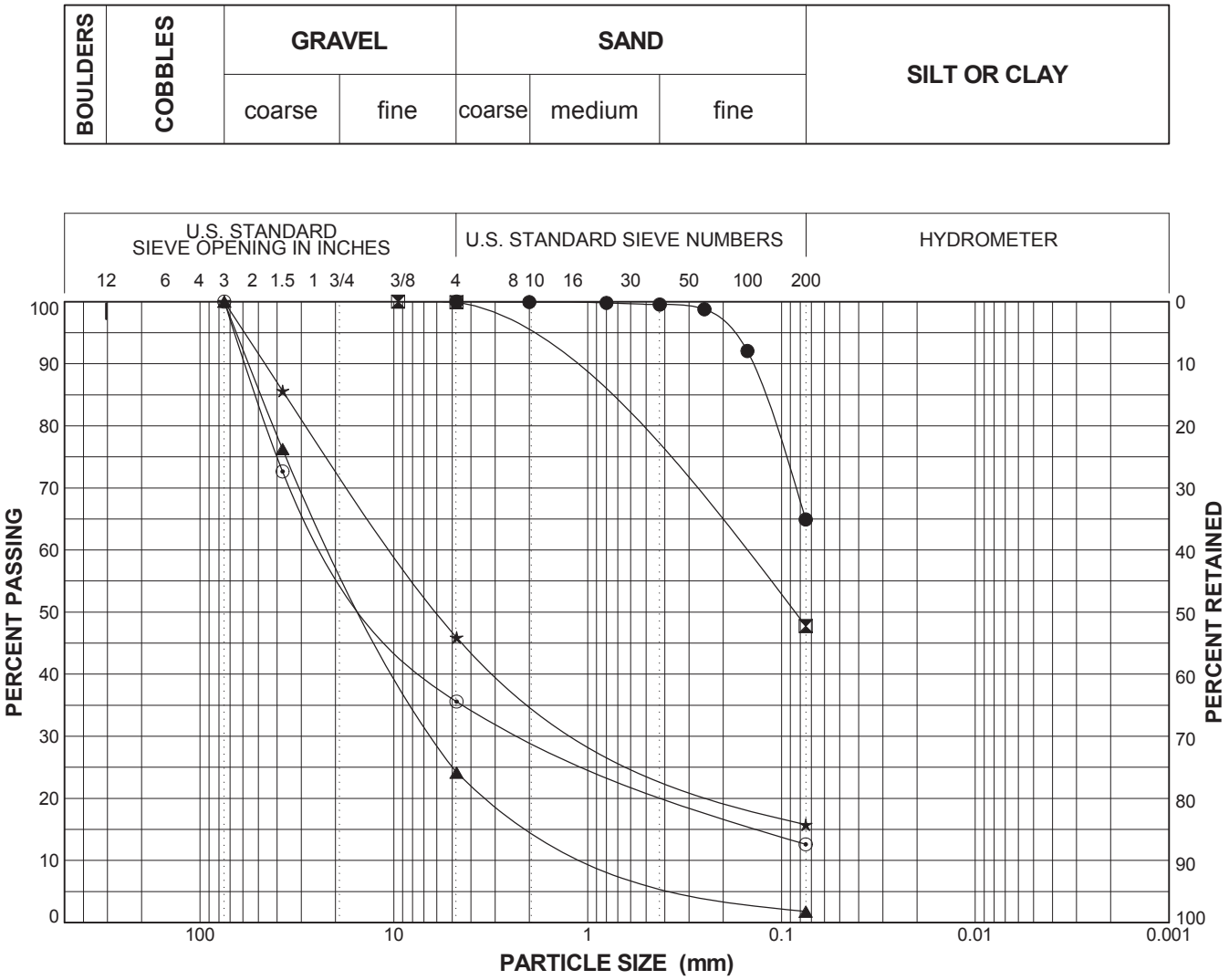


Boring Number	Sample Number	Depth (feet)	Symbol	%G	%S	%F	Classification
SM0007_018B	19C_63.0_64.0	63.5	●	0.0	0.0	96.2	LEAN CLAY with Sand (CL)

SBFCA LEVEE U/NU SIEVE CURVES #200 REV1; GINTSBFCA; SUTTERBUTTELIBRARY20130404.GLB; 4/15/13

SBFCA Feather River West Levee
Project D, Reaches 31 and 34

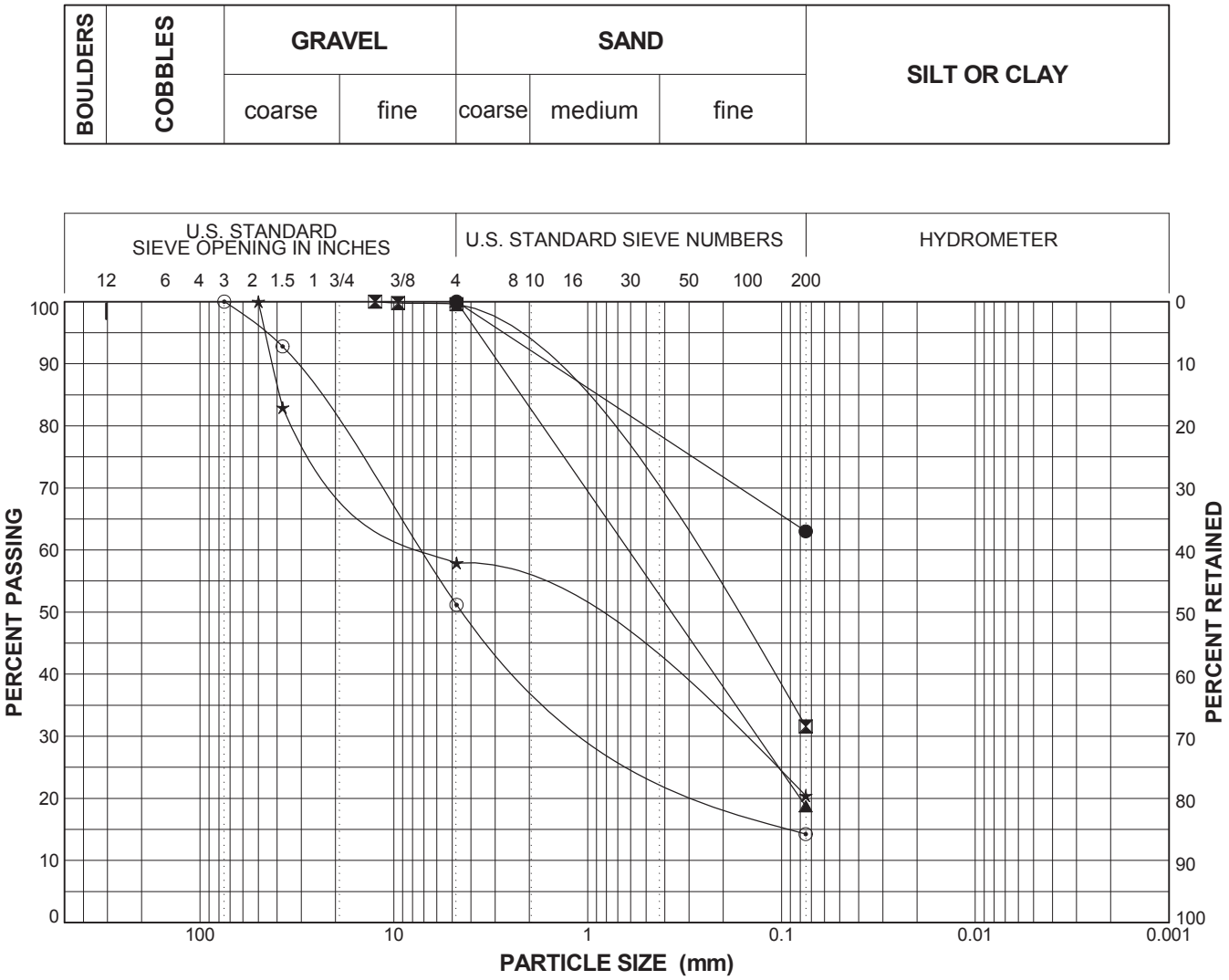
PARTICLE SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	%G	%S	%F	Classification
SM0007_034S	2A_005_010S	5	●	0.0	35.1	64.9	SANDY SILT (ML/SM)
SM0007_034S	3A_010_013S	14	⧗	0.1	52.2	47.7	SILTY SAND (SM/ML)
SM0007_034S	6A_027_028S	27	▲	75.8	22.4	1.8	POORLY GRADED GRAVEL with SAND (GP)
SM0007_034S	8A_038_039S	39	★	54.1	30.1	15.8	CLAYEY GRAVEL with Sand (GC)
SM0007_034S	11A_048_049S	49	⊙	64.4	23.0	12.6	CLAYEY GRAVEL with SAND (GC)

SBFCA Feather River West Levee
Project D, Reaches 31 and 34

PARTICLE SIZE DISTRIBUTION CURVES

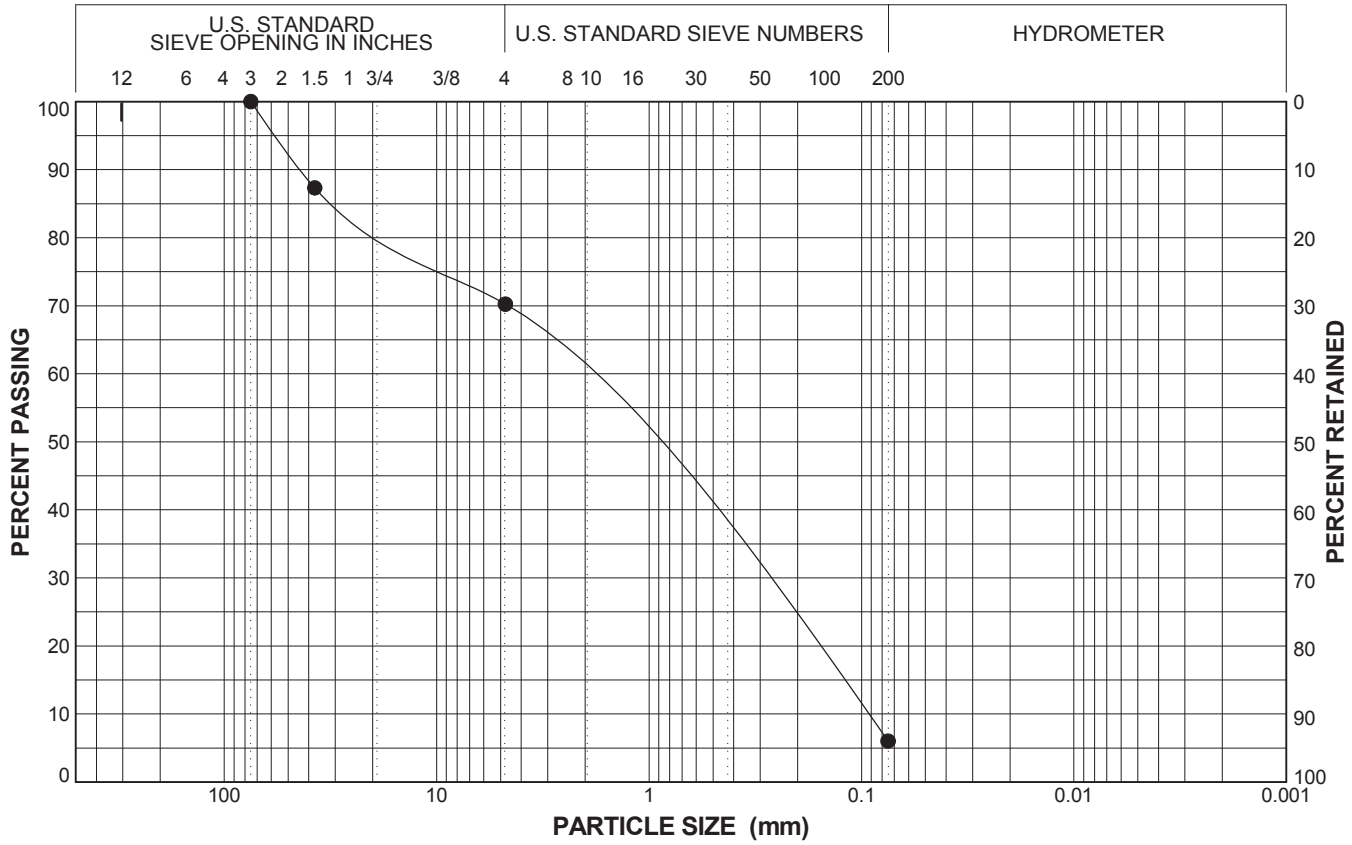


Boring Number	Sample Number	Depth (feet)	Symbol	%G	%S	%F	Classification
SM0007_034S	14B_063_064S	64	●	0.0	37.0	63.0	SANDY SILT (ML)
SM0007_034S	15A_070_071S	70.5	⧗	0.4	68.0	31.6	SILTY SAND (SM)
SM0007_034S	16A_078_079S	78.5	▲	0.0	81.3	18.7	SILTY SAND (SM)
SM0007_034S	18A_087_088S	87.5	★	42.1	37.5	20.4	SILTY GRAVEL with SAND (GM)
SM0007_034S	19A_094_095S	94	⊙	48.8	36.9	14.2	SILTY GRAVEL with Sand (GM)

SBFCA Feather River West Levee
Project D, Reaches 31 and 34

PARTICLE SIZE DISTRIBUTION CURVES

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	



Boring Number	Sample Number	Depth (feet)	Symbol	%G	%S	%F	Classification
SM0007_034S	22A_106_107S	106	●	29.8	64.2	6.0	Poorly Graded SAND with Silt (SP-SM)

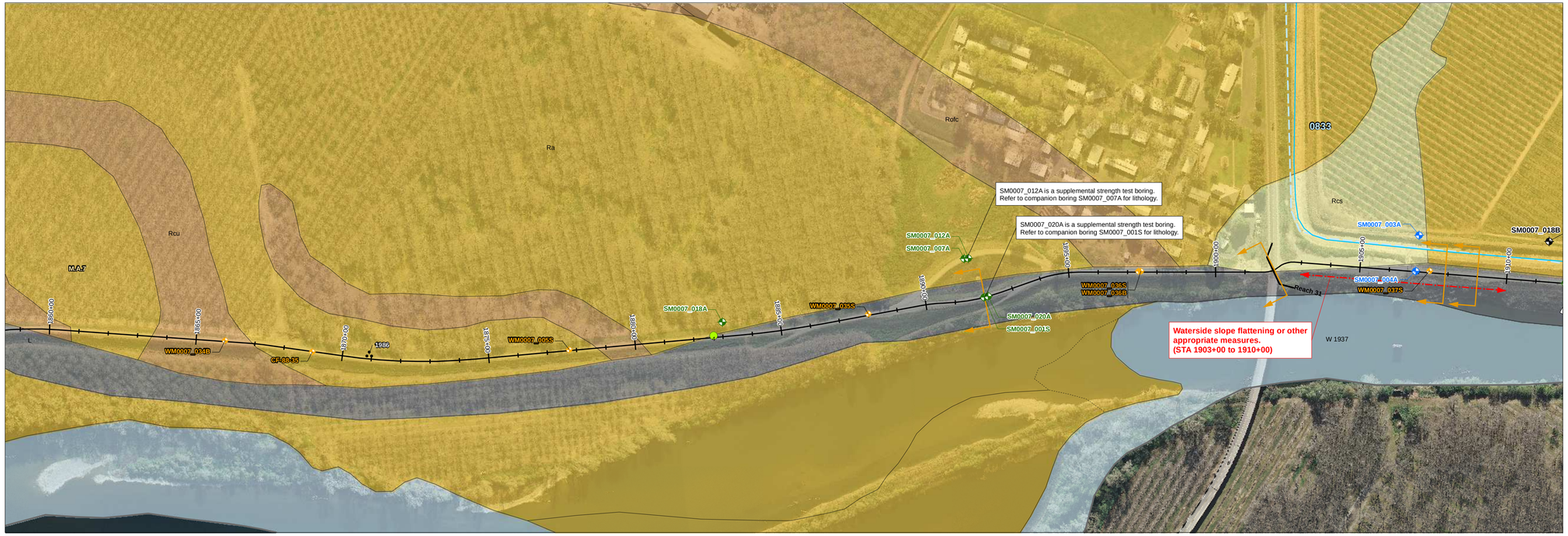
SBFCA LEVEE U/NU SIEVE CURVES #200 REV1; GINTSBFCA; SUTTERBUTTELIBRARY20130404.GLB; 4/15/13

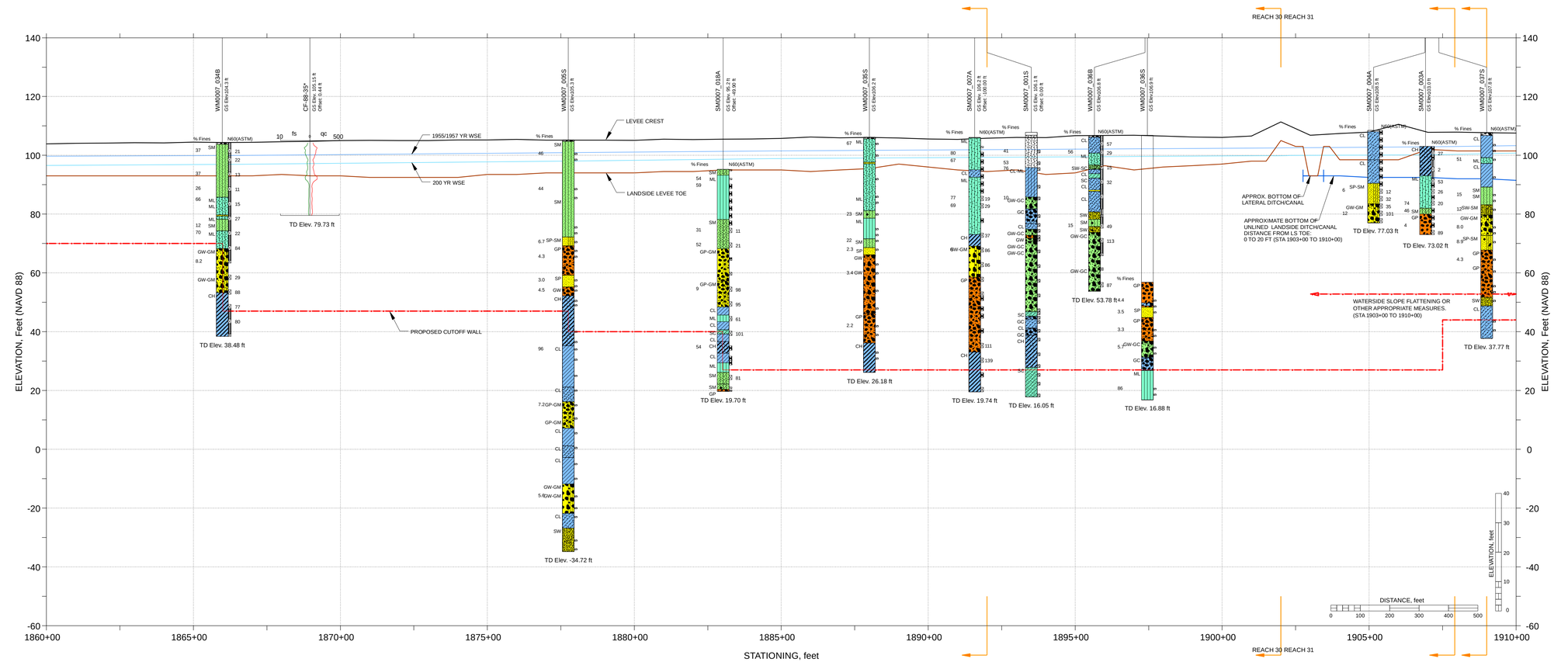
SBFCA Feather River West Levee
Project D, Reaches 31 and 34

PARTICLE SIZE DISTRIBUTION CURVES

APPENDIX A3

Plan and Profiles





NOTES:

1. Elevations of levee crown and landside toe are approximate. These elevations were obtained from DWR CVFED or ULE LIDAR data and used for geotechnical analyses and report purpose only. For detail crown elevation and landside toe information, please refer to the FRWL Project civil drawings.
2. The water surface elevations are based on information provided by Peterson Brustad, Inc. in their July 26, 2012 report entitled "Design Water Surface Profiles for the Feather River West Levee Rehabilitation Project Addendum #1".
3. Locations of explorations are approximate. Stick logs represent general soil conditions encountered at the time of exploration. For more detailed information on the materials encountered, refer to boring and CPT logs in the Geotechnical Data Report for the FRWL Project. No warranty is provided regarding the continuity of soil conditions between individual explorations.
4. When reported, N_{60}(ASTM), refers to N_{60}(ASTM) = N_{field} * Hammer Efficiency (%). See Geotechnical Data Report for the FRWL Project for hammer efficiency data for individual borings.
5. These drawings do not include all historical explorations on the profile view. Historical explorations from the DWR ULE project are shown; "other" historical explorations are identified by an asterisk (*) in the exploration ID. For these "other" historical borings, blow counts are field blow counts (Nf) and USCS classifications are visual classifications.
6. USCS classification labels are not presented on the stick logs for soil lenses (thickness less than 1.5 feet).
7. This is a color figure. Black and white reproduction should not be relied upon as data will be lost.
8. To prevent scale distortion, this map should be printed on a "D" size sheet (22x34 inches).
9. Surficial geology was mapped at 1:20,000 scale. (Source: SGDR for DWR ULE Project, URS,2010).
10. The information provided in these plans and stick-log plates has been compiled from a variety of sources. URS does not attest to the accuracy, completeness, or reliability of geotechnical exploration and other subsurface data by others that are included or referenced in these plates.
11. These plans and stick-log plates are for the use and benefit of HDR, SBFCA, and their consultants in connection with the execution of the FRWL Project. Use by any other party is at their own discretion and risk. These figures should not to be used as the sole basis for design, construction, remedial action, or major capital spending decisions.
12. The canal/ditch elevations are approximate. These elevations were estimated from the topography.

FRWL Project Plan Views and Stick Log Figures

FRWL Project: Station 1860+00 to Station 1910+00

URS

Geotechnical Design
Recommendations Report

Sutter Butte Flood Control Agency

FEATHER RIVER WEST LEVEE PROJECT

Appendix A40

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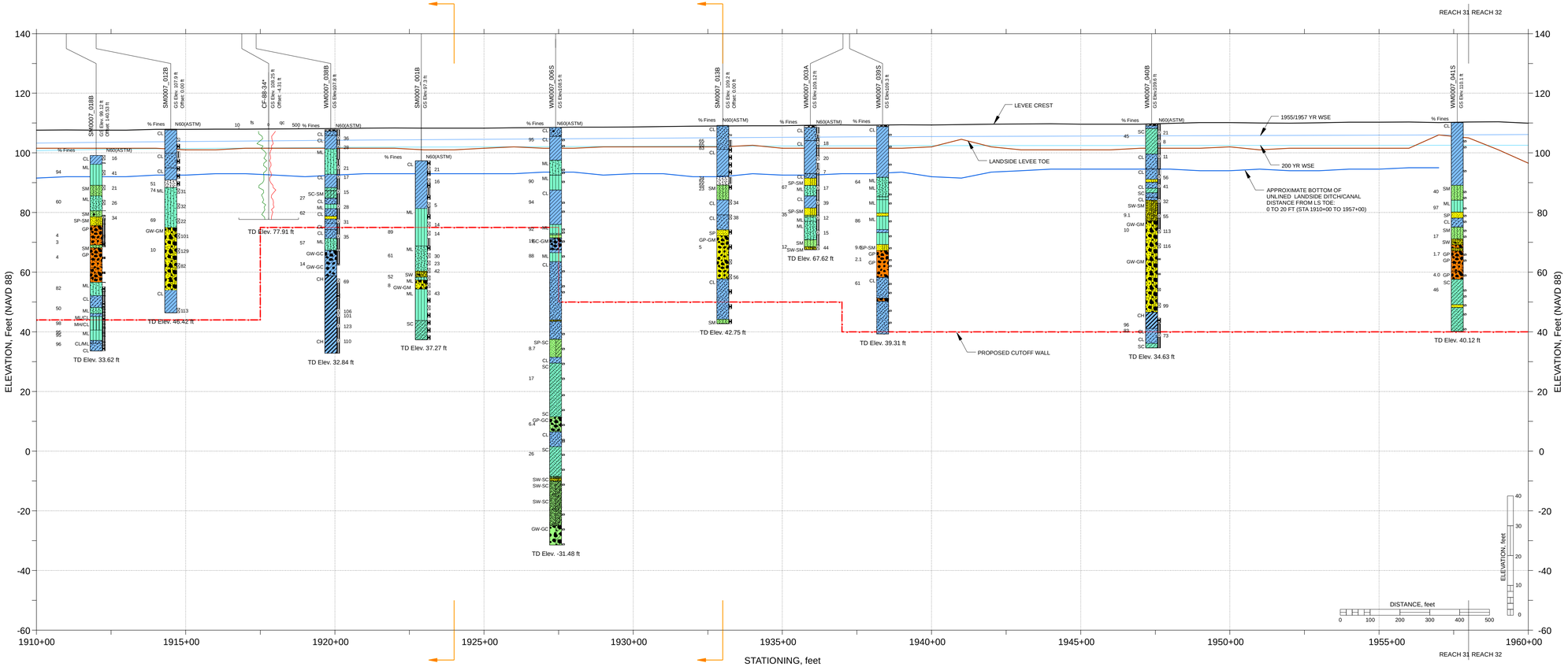

N

0 100 200
Feet

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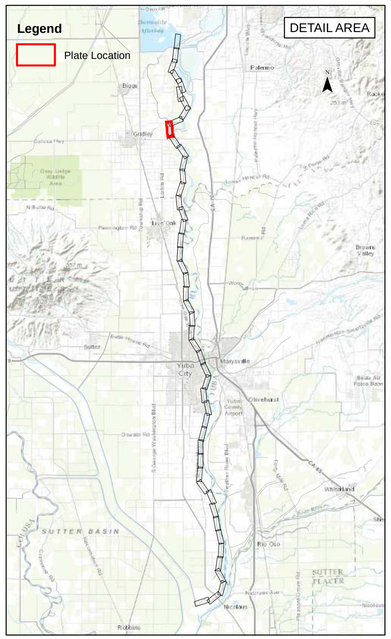

FRWL Project Plan Views and Stick Log Figures

FRWL Project: Station 1910+00 to Station 1960+00

URS

Geotechnical Design
Recommendations Report

Sutter Butte Flood Control Agency
FEATHER RIVER WEST LEVEE PROJECT

Appendix A41

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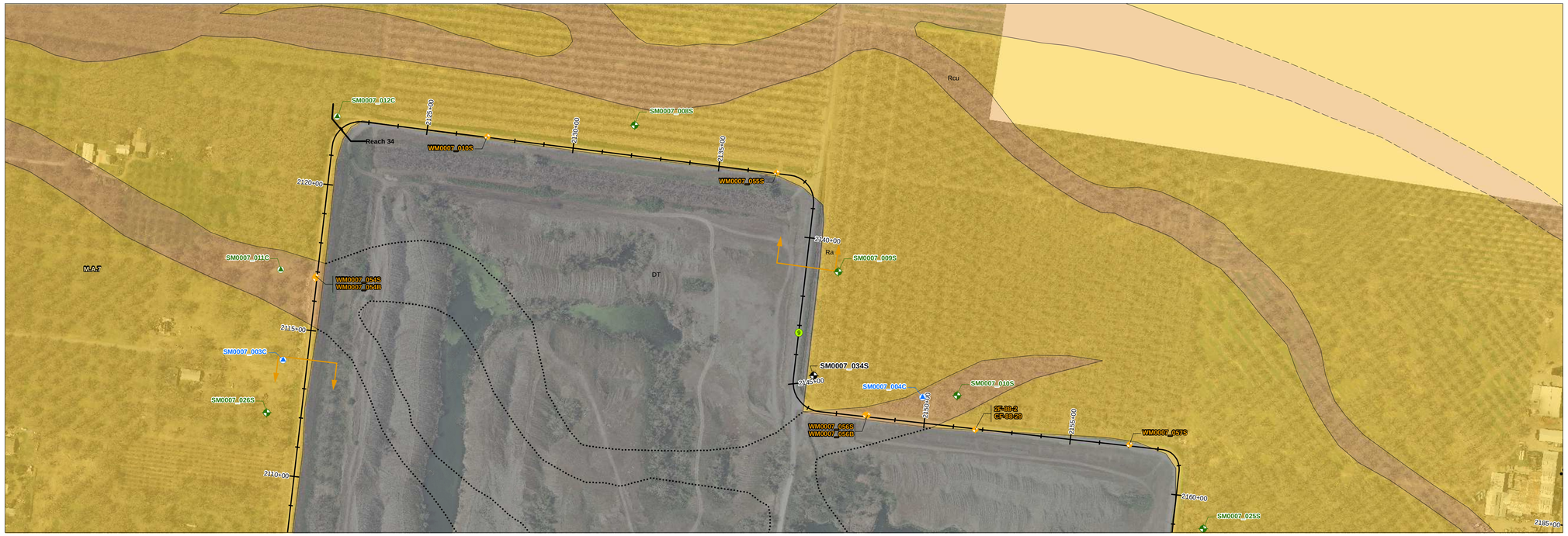

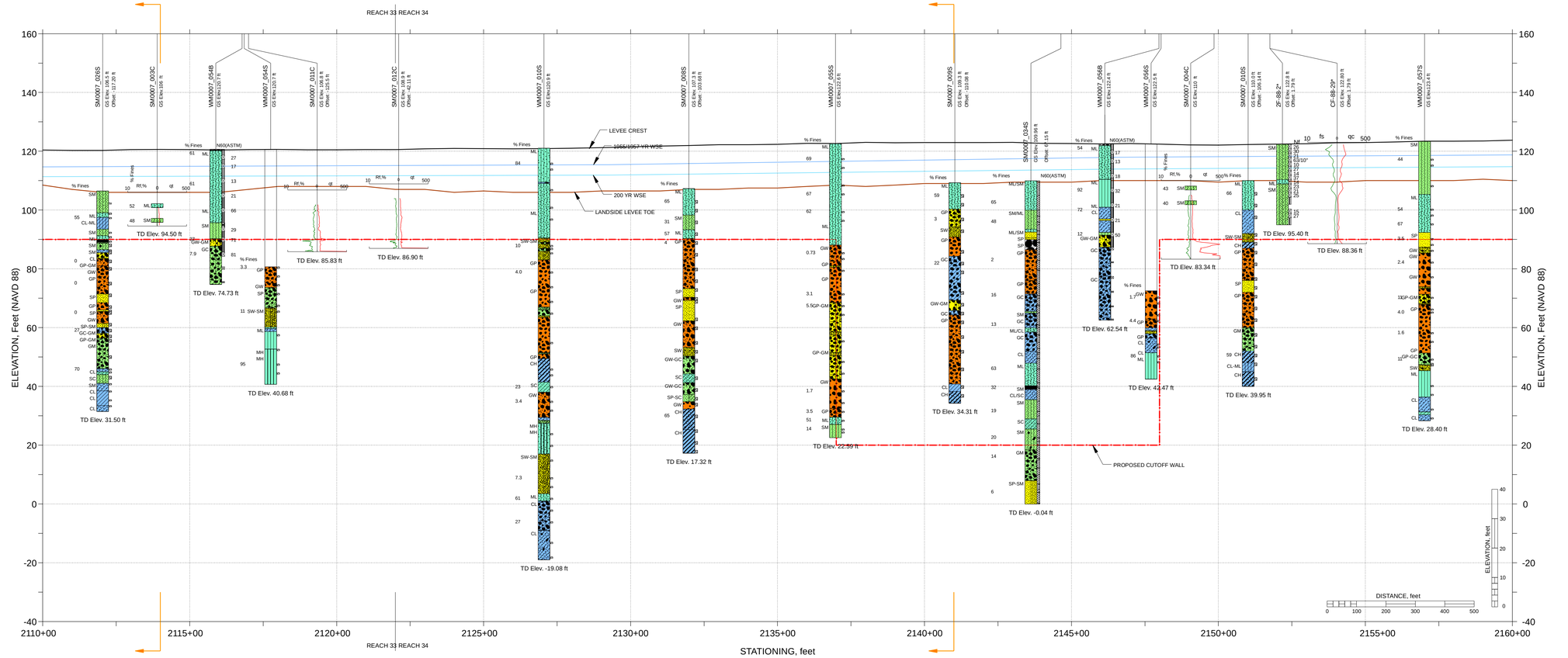

N

0 100 200
Feet

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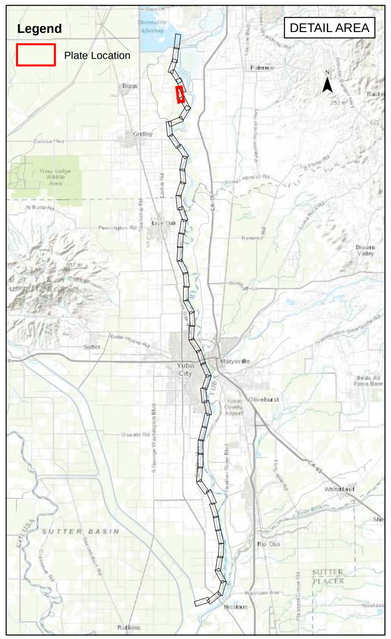

FRWL Project Plan Views and Stick Log Figures

FRWL Project: Station 2110+00 to Station 2160+00

URS

Geotechnical Design
Recommendations Report

Sutter Butte Flood Control Agency

FEATHER RIVER WEST LEVEE PROJECT

Appendix A45

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