URS

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

Addendum 2 to Geotechnical Design Recommendations Report Segments 1 through 6 (Reaches 17,19, 25 and 30) Feather River West Levee Project

Prepared For	Mike Inamine, PE Sutter Butte Flood Control Agency Christopher Krivanec, PE, GE HDR Engineering, Inc.
Project	Feather River West Levee
Date	February 03, 2014
Subject	Evaluation of End Around Effects for Reaches 17, 19, 25 and 30 of the Feather River West Levee Project
Prepared By	Mynul Chowdhury, PE Michael Hughes, PE
Reviewed By	Robert Green, PE, GE Francke Walberg, 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.

This technical memorandum presents geotechnical considerations of end around effects at the transitions between changing cutoff wall depths. Following a review of transitions between deep cutoff wall and shallow cutoff wall locations by the review agencies, a total of 26 locations were identified where seepage could potentially track behind the deeper cutoff wall portion and result in high exit gradients not meeting criteria.

URS looked at all 26 locations identified by the reviewers and performed additional analyses to identify whether end around effects were really a problem. The analysis involved looking at the excess exit gradient calculated from existing conditions analysis and then determining the length of flow path (referred to as flow path distance for the purposes of discussion) required through the aquifer layer in order to reduce the exit gradient to meet criteria. For example, existing conditions analysis indicates an exit gradient of 0.6 for the 200 year + 1 foot water surface elevation (WSE), and the gradient would need to be reduced by 0.1 to meet criteria. If, based on the existing conditions analysis results, it takes a flow path distance of 100 feet to reduce the exit gradient by 0.05, a flow path distance of 200 feet would be required to reduce the exit gradient from 0.6 to 0.5. Additionally, at one transition location a railroad crossing poses cutoff wall constructability issues so other measures were considered at this gap.

Using this approach, each wall transition was assessed on a case by case basis. If the distance to the critical blanket condition from a particular wall transition was greater than the calculated flow

path distance, no wall extension was required. If not, then extension of the deeper wall section would be necessary to achieve the calculated flow path distance.

Following assessment of all 26 locations and discussion with the review agencies, it was concluded that based on the available subsurface information, 20 of the 26 wall transitions were considered to provide adequate protection from end around effects. For the remaining 6 locations wall extensions were required in lieu of providing more definitive subsurface information.

Based on these findings, the design team decided to perform additional explorations to provide more definitive information on the need for cutoff wall extensions. This Technical Memorandum presents the details of the additional explorations undertaken, the analyses performed using this additional subsurface data and the need for cutoff wall extensions.

2.0 BACKGROUND INFORMATION

A cutoff wall system has been analyzed and proposed in the Geotechnical Design Recommendations Report (GDRR) for the FRWL Project in most of the reaches between Reach 7 and 41. The planned tip depth of the proposed cutoff wall varies along the length of the levee and depends on the vertical and lateral extent of fine- and coarse-grained soils encountered during subsurface explorations.

Following a review of the GDRR, DWR requested additional assessment of end around effects at transitions between changing cutoff wall depths at 26 different locations (Table 1). Following this assessment, it was identified that wall extensions were needed at the following 6 cutoff wall transition locations unless further information could be provided to justify that extensions were not needed:

- Reach 17, Station 1125+00.
- Reach 19, Station 1248+00.
- Reach 19, Station 1268+75.
- Reach 25, Station 1625+00.
- Reach 30, Station 1816+50.
- Reach 30, Station 1866+00.

A review of these 6 locations indicated that approximately 2,300 feet of wall extension might be required. As such, additional explorations at these 6 locations were performed to refine the extent of required wall extensions to cover end around effects.

Based on a review of the 6 locations, 9 supplemental explorations were performed and the additional subsurface information was used to evaluate the need for cutoff wall extensions. This Technical Memorandum presents the results of this evaluation and provides recommendations for cutoff wall extensions.

3.0 SUPPLEMENTAL EXPLORATIONS AND LABORATORY TESTING

A total of nine (9) explorations were performed along the levee crown in Reaches 17, 19, 25 and 30, including 5 sonic boings and 4 cone penetration test (CPT) soundings. The sonic borings were performed by National EWP between September 30, 2013 and October 8, 2013. The CPT soundings were performed by Fugro from October 7, 2013 to October 8, 2013. The depths of supplemental explorations varied between 62 and 130 feet.

A laboratory testing program was implemented on selected samples from these supplemental explorations. The laboratory testing program included water content tests, Atterberg limits tests, sieve analyses, and percent passing #200-sieve tests. The laboratory tests were performed at Blackburn Consultant's laboratory in West Sacramento, California.

Plan and stick log profiles for Reaches 17, 19, 25 and 30 were updated with the nine (9) supplemental explorations and copies are included in Attachment A for reference. The CPT and boring logs for these supplemental explorations are included in Attachment B and the laboratory test results are included in Attachment C.

4.0 DISCUSSION OF END AROUND EFFECTS AT CUTOFF WALL TRANSITIONS

Each of the 6 locations identified for potential cutoff wall extension were evaluated based on the new exploration information. As discussed in Section 1.0, the average exit gradient calculated from the existing conditions analyses was used to determine the horizontal flow distance needed through the aquifer layer to generate sufficient head loss to meet underseepage criteria (average exit gradient across the blanket of 0.5 or less) for the 200 year WSE. This data was used to determine whether extension of the deeper portion of cutoff wall was needed. The evaluations for each of the 6 locations are discussed below and details are summarized in Table 2.

Reach 17, Station 1125+00: A cutoff wall tip elevation transition from elevation +35 feet to elevation +0 feet was originally recommended at Station 1125+00. Due to a lack of explorations between this change in wall depth at Station 1125+00 and boring WL0009_007A at Station 1136+00, a question was raised about end around effects. Accordingly, two CPTs were advanced at Stations 1129+00 and 1133+50 to provide coverage in this data gap. Based on the new CPT data at Station 1133+50 (SL0009_012C), an approximately 10 feet thick blanket is underlain by a 20 feet thick shallow aquifer. The new CPT at Station 1129+00 (SL0001_044C), identified an approximately 8 feet blanket overlying sandy silt and sandy clay with interbeds of silty/clayey sand, which are considered to form a composite blanket layer, beneath which there is an approximately 10 feet thick aquifer layer.

Due to issues associated with installing a cutoff wall in proximity to the UPRR crossing, it is now proposed to install relief wells and not extend the cutoff wall through this area. Relief wells have been designed using the existing condition analysis results and based on this the calculations indicate a well spacing of 100 feet. It is proposed to place relief wells between approximately Station 1125+00 and 1138+00, creating a two-well overlap at the end of each wall (an approximate

250 feet overlap either side of the gap between cutoff walls taking into consideration the 100 feet center-to-center well spacing and a radius of influence of 50 feet).

At the end of the cutoff wall at Station 1126+50, the explorations do not indicate a well-defined aquifer layer, but at the end of the cutoff wall at Station 1137+00, the explorations indicate a well-defined aquifer layer approximately 20 feet thick. In this area there is effectively a double row of relief wells, because relief wells are proposed along the toe of the railroad embankment and the toe of the levee embankment, as the two diverge away from each other. The railroad embankment may block the seepage exit at the gap and may cause a concentration of seepage, however the double line of wells should address this.

Based on the fact that relief wells have been designed to address seepage at the gap between the cutoff walls at the UPRR crossing, it is considered that no wall extension is necessary at this location.

Reach 19, Station 1248+00: A cutoff wall tip elevation transition from elevation -42 feet to elevation + 3 feet was originally recommended at Station 1248+00. Due to the lack of deep explorations between Station 1248+00 and boring SL0009_004B at Station 1244+00, one sonic boring was advanced at Station 1246+30. Based on the new sonic boring, a roughly 30 foot thick clay blanket was encountered at Station 1246+30 with a sand and gravel aquifer below to elevation -23 feet.

Based on the new exploration at Station 1246+30 (SL0009_008S), the blanket thickness increases in a northerly direction from 6.5 feet at approximately Station 1242+00 to 30 feet at Station 1246+30 and then thins to 14 feet at approximately Station 1248+00. As such, there is a distance of approximately 600 feet between the thinnest blanket condition at approximately Station 1242+00 and the wall transition at Station 1248+00. Based on the calculated flow path distance of 546 feet, there is sufficient distance to dissipate excess head by flow through the aquifer layer and end around effects are not a concern.

The hydraulic gradient was also checked at Station 1248+00 for the 200-yr WSE, where boring WL_0009_017B shows the blanket is 14 feet thick. The exit gradient at this location based on the existing conditions analysis is 0.56. However, in accordance with the exploration data, there is a rapid change in the thickness and base elevation of the aquifer layer either side of the transition. As such, it is questionable whether a true end-around effects condition exists. As the deeper section of wall will be installed using Deep Mixed methods, contractor explorations will be undertaken to provide subsurface information at 100 feet center spacing prior to construction. Based on discussions with DWR, it was agreed that the contractor's exploration data would be reviewed to make a final decision as to whether a wall extension is needed at this location.

Reach 19, Station 1268+75: A cutoff wall tip elevation transition from elevation +3 feet to elevation + 35 feet was originally recommended at Station 1268+75. Based on the existing explorations, the subsurface conditions between boring WL009_019B at approximately

Station 1268+50 and boring SL0009_002B at Station 1266+00 (a distance of approximately 250 feet) change rapidly with a composite blanket varying in thickness from approximately 35 feet to 12 feet thick.

Two new CPTs, SL0009_013C and SL0009_15C were advanced at Station 1264+75 and 1267+50 respectively to determine the subsurface conditions either side of the 12 foot thick blanket at Station 1266+00. Based on the new CPT data, the blanket at Station 1267+50 is 14 foot thick. At Station 1264+75, there is a 6 foot thick layer of silt/clay overlying approximately 28 feet of sandy silt and sandy clay with interbeds of silty/clayey sand, which are considered to form a composite blanket layer. As such, the thinnest blanket condition still occurs at Station 1266+00, from where calculations indicate a flow path distance of 216 feet is required to generate sufficient head loss for the gradient to meet criteria. The existing wall overlap from Station 1266+00 is approximately 300 feet and so from this perspective no wall extension is required.

The hydraulic gradient at the location of the new CPT at Station 1267+50 for the 200-yr WSE was also checked to see if it met criteria. At this location the blanket is 14 feet thick and the calculated exit gradient is 0.68. A flow path distance of 151 feet is required to produce enough head loss through the aquifer layer to meet underseepage criteria. The current overlap between Station 1267+50 and the wall transition is about 130 feet. Taking into account three-dimensional effects, whereby seepage forces calculated from two-dimensional analyses will actually be less due to radial dissipation around the end of the wall, it is considered that there is adequate wall overlap. Therefore, no wall extension is necessary at this location.

Reach 25, Station 1625+00: The deep cutoff wall from Reach 24 was originally extended into Reach 25 by approximately 100 feet to address potential end around effects associated with the canal at this location, which has the effect of thinning the blanket. Based on existing explorations, the subsurface conditions between CPT SM0016_008C at Station 1622+00 and boring WM0016_004S at Station 1628+50 are variable and the blanket thickness at the end of the cutoff wall at Station 1625+00 is not certain. Therefore, a new sonic boring was performed at Station 1626+40 to determine the blanket conditions between the existing explorations.

Based on new exploration SM0016_002S at Station 1626+40, the foundation soils comprise interbedded silty sand, clayey sand and clay to a depth of approximately 20 feet below the landside toe overlying an approximately 20 feet thick sand and gravel aquifer layer. Based on laboratory testing from explorations in this area, the fines content of the interbedded sand layers ranges from 25% to 42%, and fines content of the underlying sand and gravel aquifer ranges from 4% to 7%. As such, it is considered that there is sufficient permeability contrast between the interbedded zone of silty sand, clayey sand and clay and the underlying sand and gravel aquifer that the upper 20 feet of foundations soil will act as a blanket.

Based on this assumption, a cross-section perpendicular to the canal and the end of the cutoff wall at Station 1625+00 was analyzed. For this model, the seepage gradient across the composite blanket layer is calculated as 0.38 assuming no water in the canal. The seepage gradient across the

uppermost clay layer at the base of the canal is 1.02, but the flux for this condition is very low at 0.53 cubic feet per day per 100 foot length of canal. A sensitivity analysis was run assuming the canal has 5 feet of water in it, which would put the water surface at existing ground level. For this condition the seepage gradient across the uppermost clay layer drops to 0.08.

Taking into account the new boring data and the analysis results, it is considered that the current end point of the wall is adequate, but to provide additional protection it is proposed to extend the end of the wall to Station 1626+00, which would increase the distance between the end of the cutoff wall and the canal to approximately 300 feet.

Reach 30, Station 1816+50: A cutoff wall with a tip elevation of +80 feet was originally recommended from Station 1813+33 to 1816+50 that transitions to a deeper cutoff wall with a tip elevation of +30 feet from Station 1816+50 to 1848+25. A boil was reported at Station 1820+00 during the 1986 flood. A new sonic boring was performed at Station 1816+50 to determine the subsurface conditions between existing explorations SM0007_011B at Station 1815+00 and WM0007_030B at Station 1818+10. Based on the new exploration, a well graded sand layer was encountered at 1816+50 from elevation +78 feet to elevation +70 feet. To avoid potential end around seepage effects, it is proposed to deepen the cutoff wall tip elevation between Station 1813+33 and 1816+50 to elevation +50 feet, which would effectively cutoff the potential for end around effects.

Reach 30, Station 1866+00: A cutoff wall tip elevation transition from elevation +70 feet to elevation +47 feet was originally recommended at Station 1866+00 in Reach 30. Based on the existing explorations, no subsurface information was available between boring WM0007_034B at the start of the deep wall at Station 1866+00 and exploration WM0007_005S at Station 1877+00. Additionally, a boil was reported at Station 1871+00 during the 1986 flood. Due to the lack of subsurface information, two new sonic borings were performed at Stations 1868+00 and 1871+00.

These explorations indicate the foundation soils generally consist of silty sand to elevation +80 feet with interbedded silty sand, silt and sandy silt to an elevation of +70 feet. A clay layer was encountered at elevation +53 feet at Station 1868+00 and at elevation +59 feet at Station 1877+00. As such, the current wall depths and transition points are considered adequate and no wall extension is necessary at this location.

5.0 RECOMMENDATIONS

Using the additional exploration data undertaken at Reaches 17, 19, 25 and 30, the end around effects at cutoff wall transitions has been re-evaluated. Based on this work the following recommendations for cutoff wall extensions are proposed:

- Reach 17, Station 1125+00: It is now proposed to install relief wells in proximity to the UPPR crossing and not extend the cutoff wall. The relief wells have been designed to address seepage directly at this location and will provide approximately 250 feet of coverage at the ends of the walls either side of the UPRR crossing gap. Therefore, no wall extension is recommended.

- Reach 19, Station 1248+00: The originally proposed cutoff wall transition location from tip elevation -42 feet to elevation + 3 feet at Station 1248+00 will be reviewed once contractor explorations are performed as part of the construction contract.
- Reach 19, Station 1268+75: The originally proposed cutoff wall transition location from tip elevation +3 feet to elevation + 35 at Station 1268+75 is considered appropriate and no wall extension is recommended.
- Reach 25, Station 1625+00: It is proposed that the originally proposed end of cutoff wall at Station 1625+00 be extended by 100 feet to Station 1626+00.
- Reach 30, Station 1816+50: It is proposed that the cutoff wall from Station 1813+33 to 1816+50 be deepened by 25 feet to a tip elevation of +55 feet.
- Reach 30, Station 1866+00. The originally proposed cutoff wall transition location from tip elevation +70 feet to elevation +47 feet at station 1866+00 is considered appropriate and no wall extension is recommended.

6.0 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.

The construction of the cutoff wall should be monitored continuously by a representative of the geotechnical engineer of record to confirm that the soil conditions are consistent with those used in developing these recommendations. Variations in soil conditions found during construction may result in adjustments to these recommendations.

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.

TABLES

- Table 1: Initial Evaluation of End Around Effects
- Table 2: Evaluation of End Around Effects following Additional Field Investigation

ATTACHMENTS

Attachment A

- Plans and Stick Log Figures of Reaches 17, 19, 25 and 30 (updated with supplemental explorations)
- Layout of Proposed Relief Wells in Reach 17

Attachment B

- Boring and CPT Logs for Supplemental Explorations in Reaches 17, 19, 25 and 30

Attachment C

- Laboratory Test Results for Supplemental Explorations in Reaches 19, 25 and 30

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

Table 1

Table 1: Initial Evaluation of End Around Effects for the FRWL Project

Location Identified by DWR	Project Phase B,C or D	Reach ID	Existing Condition		Average Exit Gradient (Toe or Near Toe) from Existing Condition Analysis at 200yr WSE i	Excess Gradient Over 0.5 $\Delta i = i - 0.5$	Blanket Thickness at Analysis Station (feet) L	Head Drop to Accommodate Excess Gradient (feet) $\Delta H = \Delta i * L$	Distance Per Foot of Head Loss through Aquifer (feet) R	Flow Distance to Accommodate Required Excess Head Drop (feet) $X = \Delta H * R$	Station of Cutoff Wall Depth Change STA[a]	Closest Exploration with Shallow Blanket			Distance of Shallow Blanket from Cutoff Wall Depth Change (feet) $Y = I\ STA^a - STA^b\ I$	Past Performance	Potential Need to Extend Transition Length (Yes/No)	Comment
			Station	Head (feet)								STATION STA[b]	Head (feet)	Blanket Thickness (feet)				
526+00	B	7	539+30	20.9	1.55 [Toe] with 7.8' thick blanket	1.05	7.8	8.19	45	369	526+00	538+50	19.5	8.0	1250	Widespread seepage and boils 1997	No	The explorations either side of the change in wall depth show that the wall is founded in a continuous clay layer and that there is no granular layers beneath the shallower wall that extend behind the deeper wall portion. Therefore, by observations water can not penetrate behind the deeper wall section and so no wall extension is considered necessary.
595+00	B	7	539+30	20.9	1.55 [Toe] with 7.8' thick blanket 2.0 [Toe] assumed with 6.0' thick blanket	1.5	6	9.00	45	405	595+00	580+00	20.0	6.0	1500	Waterside erosion at Station 592+25 - 1986	No	Calculated 405 feet seepage length based on a 7.8 feet thick blanket. Based on exploration data there is over a 1000 feet of fine grained blanket about 25 feet thick between Station 585+00 and 595+00 and so no wall extension is considered necessary.
827+00	B	11	808+85	14.8	1.38 [Toe] with 9' thick blanket 1.0 [Toe] assumed with 12' thick blanket	0.5	12	6.00	100	600	827+00	817+00	15.0	12.0	1000	_	No	Calculated 600 feet seepage length was based on a 12 feet thick blanket and a thick aquifer layer. Based on explorations, the section between approximately Station 821+00 and 827+50 (a distance of greater then 600 feet) there are multiple fine grained layers resulting in a composite blanket approximately 35 feet to 40 feet thick. Therefore, no wall extension is considered necessary.
844+50[(1)]	C	13	861+33		0.85 [Toe], 1.22 [ditch]	0.72	9.4	6.77	50	338	844+50	-	-	-	-	Widespread seepage and boils and levee breach in 1955	No.	Calculated 338 feet seepage length was based on a 9.4 feet thick blanket and a thick aquifer layer. Based on explorations, the section between approximately Station 844+50 and 851+00, a distance of greater than 500 feet has a composite blanket greater than 20 feet thick. Therefore, no wall extension is considered necessary.
896+00[(1)]	C	13	861+33		0.85 [Toe], 1.22 [ditch]	0.72	9.4	6.77	50	338	896+00	-	-	-	-	Widespread seepage and boils and levee breach in 1956	No.	Calculated 338 feet seepage length was based on a 9.4 feet thick blanket and a thick aquifer layer. Based on explorations, the section between approximately Station 888+50 and 896+00, a distance of greater than 500 feet has a composite blanket greater than 30 feet thick. Therefore, no wall extension is considered necessary.
1125+00	C	17	1138+86	13.4	1.32 [Toe] with 8.8' thick blanket	0.82	8.8	7.22	135	974	1125+00	1136+00	13.0	10.0	1100	_	Yes	Calculated 974 feet seepage length was based on a 8.8 feet thick blanket and a thick aquifer. There are no exploration between the change in wall depth at Station 1125+00 and boring WL0009_007A at Station 1136+00 and so it is not certain where the transition in change in aquifer conditions is. Therefore, it is considered that some extension of the deep cut off wall is warranted. It is proposed to undertake additional explorations in this location to confirm the stratigraphy between existing points of information.
1151+26	C	18	1138+86	13.4	1.32 [Toe] with 8.8' thick blanket 1.16 [Toe] assumed with 10' thick blanket	0.66	10	6.60	135	891	1151+00	1144+00	13.0	10.0	700	Widespread seepage 1996 & 97	No	Calculated 891 feet seepage length was based on a 10 feet thick blanket and a thick aquifer layer. Based on explorations, the section between approximately Station 1151+50 and 1143+00 (a distance of about 850 feet) there are multiple fine grained layers resulting in an intermediate aquiclude layer a approximately 20 feet to greater than 40 feet thick. Therefore, no wall extension is considered necessary.
1224+00	C	19	1238+85	12.4	2.32 with 3.1' thick blanket 1.20 assumed with 6.0' thick blanket	0.7	6	4.20	140	588	1224+00	1230+00	12.0	6.0	600	_	No	Calculated 588 feet seepage length was based on a 6 feet thick blanket and a thick aquifer layer. Based on explorations, the section between approximately Station 1224+00 and 1230+00 (a distance of 600 feet) has an approximately 15 feet thick blanket plus there is a lower fine grained layer at an elevation of +10 feet, which would force the flow of water through a distance of 600 feet before it could migrate upwards. Therefore, no wall extension is considered necessary.
1247+00	C	19	1238+85	12.4	2.32 with 3.1' thick blanket 1.10 assumed with 6.5' thick blanket	0.6	6.5	3.90	140	546	1247+00	1244+50	12.0	6.5	250	Boil at Station 1243+00 in 1995	Yes	Calculated 546 feet seepage length was based on a 6.5 feet thick blanket and a thick aquifer. There are no deep explorations between the change in wall depth at Station 1247+00 and boring SL0009_004B at Station 1244+00 and so it is not certain where the transition in change in aquifer conditions is. Therefore, it is considered that some extension of the deep cut off wall is warranted. It is proposed to undertake additional explorations in this location to confirm the stratigraphy between existing points of information.
1268+75	C	19	1238+85	12.4	2.32 with 3.1' thick blanket 0.80 [Toe] with 12.0' thick blanket	0.3	12	3.60	60	216	1268+75	1266+00	12.5	12.0	275	Seepage (unknown) and waterside erosion (1974).	Yes	Calculated 216 feet seepage length was based on a 12 feet thick blanket and a thick aquifer. Based on explorations, the subsurface conditions between approximately Station 1268+50 and boring SL0009_0028 at Station 1266+00 (a distance of approximately 250 feet) change rapidly with a composite blanket varying in thickness from approximately 35 feet to 12 feet thick. Therefore, it is considered that some extension of the deep cut off wall may be warranted. It is proposed to undertake additional explorations in this location to confirm the stratigraphy between existing points of information.
1387+00	C	21	1378+83	4.5	2.79 [Ditch near toe] with 2.6' thick blanket 2.42 [ditch near toe] assumed with 3.0' thick blanket	1.92	3	5.76	65	374	1387+00	1378+00	5.0	3.0	900	Widespread seepage. Boil at station 1850+00 - 1955	No	Calculated 374 feet seepage length was based on a 3 feet thick blanket. Based on explorations 5F4E-4, 2F-07-10 and WL0009_029C, there is a 20 feet thick composite blanket that extends approximately 700 feet beyond the thin blanket to the end of the deep wall. Furthermore, explorations 2F-07-10 shows a virtual block to end around seepage except for a small SP-SM window with a reported 41 percent fines. Therefore, no wall extension is considered necessary.
1625+00	C	25	1615+62	6.7	4.14 with 1.4' thick blanket [Ditch] 0.97 assumed with 6.0' thick blanket	0.47	6	2.82	170	479	1625+00	1622+00	8.0	6.0	300	_	Yes	Calculated 479 feet seepage length was based on a 6 feet thick blanket, 6.7 feet head and a thick aquifer. Based on explorations between Station 1622+00 and 1628+50, there is a change in blanket thickness, plus there is an locally increased head condition (10 feet) at Station 1623+00. Therefore, it is considered that some extension of the deep cut off wall may be warranted. It is proposed to undertake additional explorations in this location to confirm the stratigraphy between existing points of information.
1817+00	D	30	1826+94	5.5	0.48 [Toe] with 2.3' thick blanket	-	-	-	-	-	-	-			-	Boil at Station 1820+00 - 1986	Yes	Calculation indicates adequate gradient with 2.3 feet thick blanket, but there has been a reported boil at this location in 1986. Therefore, it is considered that some extension of the deep cut off wall may be warranted. It is proposed to undertake additional explorations in this location to confirm the stratigraphy between existing points of information.
1848+00	D	30	1826+94	5.5	0.48 [Toe] with 2.3' thick blanket	-	-	-	-	-	-	-			-	_	No	No overlap is considered necessary as calculated gradient assuming 2.3 feet thick blanket meets criteria.
1866+00	D	30	1826+94	5.5	0.48 [Toe] with 2.3' thick blanket	-	-	-	-	-	-	-			-	Boil at Station 1871 - 1986	Yes	Calculated gradient meets criteria for a 2.3 feet thick blanket, but no explorations between start of deep wall at Station 1866+00 and exploration WM0007_005S at Station 1877+00. Therefore, it is recommended to extend the wall by 200 feet to Station 1864+00.
1907+00	D	31			-	-	-	-	-	-	-	-			-	_	No	Explorations between Station 1897+50 and 1917+00, there is a continuous fine grained aquiclude that would prevent water from penetrating behind the deeper wall section. Therefore, no wall extension is considered necessary.

Location Identified by DWR	Project Phase B,C or D	Reach ID	Existing Condition		Average Exit Gradient (Toe or Near Toe) from Existing Condition Analysis at 200yr WSE i	Excess Gradient Over 0.5 Δi = i - 0.5	Blanket Thickness at Analysis Station (feet) L	Head Drop to Accommodate Excess Gradient (feet) ΔH=Δi * L	Distance Per Foot of Head Loss through Aquifer (feet) R	Flow Distance to Accommodate Required Excess Head Drop (feet) X=ΔH * R	Station of Cutoff Wall Depth Change STA[a]	Closest Exploration with Shallow Blanket			Distance of Shallow Blanket from Cutoff Wall Depth Change (feet) Y = I STA[a]-STA[b] I	Past Performance	Potential Need to Extend Transition Length (Yes/No)	Comment
			Station	Head (feet)								STATION STA[b]	Head (feet)	Blanket Thickness (feet)				
1987+00	D	32	1965+80	13	0.83 [Toe] with 8.4' thick blanket 0.58 [Toe] assumed with 12.0' thick blanket	0.08	12	0.96	230	221	1987+00	1996+50	6.0	12.0	950	_	No	Calculated 221 feet seepage length was based on a 12 feet thick blanket and a thick aquifer. Hydraulic head at deep wall transition is significantly less than at calculation section and assuming the SM layer to be the blanket it is significantly thicker than 12 feet. Therefore, it is considered that no wall extension is required.
2002+00	D	33	1965+80	13	0.83 [Toe] with 8.4' thick blanket 0.58 [Toe] assumed with 12.0' thick blanket	0.08	12	0.96	230	221	2002+00	1996+50	6.0	12.0	550	_	No	Same response as above.
2017+00	D	33	2076+90[(1)]	6	0.65 [Toe] with 7.8' thick blanket	0.15	7.8	1.17	400	468	2017+00	2031+00	3.5	13.0	1400	_	No	Calculated 468 feet seepage length was based on a 7.8 feet thick blanket and a thick aquifer. Blanket is thicker at wall transition (minimum 12-feet) and hydraulic head at is less than at calculation section (3 to 4 feet versus 6 feet) Therefore, it is considered that no wall extension is required.
2037+00	D	33	2076+90[(1)]	6	0.65 [Toe] with 7.8' thick blanket	0.15	7.8	1.17	400	468	2037+00	2031+00	3.5	13.0	600	_	No	Calculated 468 feet seepage length was based on a 7.8 feet thick blanket and a thick aquifer. Composite blanket is thicker at wall transition (minimum 15-feet) and hydraulic head at is less than at calculation section (3 to 4 feet versus 6 feet) Therefore, it is considered that no wall extension is required.
2041+00	D	33	2076+90[(1)]	6	0.65 [Toe] with 7.8' thick blanket	0.15	7.8	1.17	400	468	2041+00	2047+50	6.0	8.0	650	_	No	Given the high fines content of the SM layer in boring WM0007_048B, it is considered that the blanket is much thicker in this area and relative to a head of about 6 feet we do not think seepage is an issue. Therefore, it is considered that no wall extension is needed.
2088+00	D	33	2076+90[(1)]	6	0.65 [Toe] with 7.8' thick blanket	0.15	7.8	1.17	400	468	2088+00	2076+90	6.0	7.8	1110	_	No	Calculated 468 feet seepage length was based on a 7.8 feet thick blanket and a thick aquifer. At a distance of 400 feet from the end of the deep wall the blanket is 14 feet thick and the head is only 4.5 feet compared to 6 feet at th calculation section. Therefore, it is considered that no wall extension is required.
2137+00	D	34	2076+90[(1)]	6	0.65 with 7.8' thick blanket 0.58 assumed with 8.8' thick blanket	0.08	8.8	0.70	400	282	2137+00	2141+00	4.0	8.8	400	_	No	Calculated 282 feet seepage length was based on a 7.8 feet thick blanket and a thick aquifer. At a distance of 400 feet from the end of the deep wall the blanket is 9 feet thick and the head is only 4 feet compared to 6 feet at the calculation section. Therefore, it is considered that no wall extension is required.
2148+00	D	34	2211+30[(1)]	11	0.70 [Field 60 ' from Toe] with 13.9' thick blanket 1.11 [Field 60' from toe] assumed with 8.8' thick blanket	0.49	8.8	4.31	125	539	2148+00	2141+00	4.0	8.8	700	_	No	By observation the head is about 4 feet and the blanket is a minimum of 10 feet. Therefore, it is considered that no wall extension is required.
2164+00	D	34	2211+30[(1)]	11	0.70 [Field 60 ' from Toe] with 13.9' thick blanket Sensitivity Analysis with 4 feet head result in; 0.16 [Toe] and 0.36 [60' from toe]	_	_	_	_	_	2164+00	Near 2164+00	4.0	14.0	_	_	No	By observation the head is about 4 feet and the blanket is a minimum of 16 feet. Therefore, it is considered that no wall extension is required.
2292+00	D	38	2276+76[(1)]	8	0.63 [Toe]	_	_	_	_	_	-	-	_	_	_	_	No	Seepage Berm overlaps by 200 feet in the cutoff wall area, at which point the blanket is 13 feet thick and the head i 6 feet.

NOTE:
(1) Updated with New WSE (July 2012)

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

Table 2

Table 2: Evaluation of End Around Effect following Additional Field Exploration

Location Identified by DWR	Reach ID	Existing Condition		Average Exit Gradient (Toe or Near Toe) from Existing Condition Analysis at 200yr WSE i	Excess Gradient Over 0.5 $\Delta i = i - 0.5$	Blanket Thickness at Analysis Station (feet) L	Head Drop to Accommodate Excess Gradient (feet) $\Delta H = \Delta i * L$	Distance Per Foot of Head Loss through Aquifer (feet) R	Flow Distance to Accommodate Required Excess Head Drop (feet) $X = \Delta H * R$	Station of Cutoff Wall Depth Change STA^a	Closest Exploration with Shallow Blanket			Distance of Shallow Blanket from Cutoff Wall Depth Change (feet) $Y = I\ STA^a - STA^b\ I$	Past Performance	Potential Need to Extend Transition Length (Yes/No)	Comment
		Station	Head (feet)								STATION STA^b	Head (feet)	Blanket Thickness (feet)				
1125+00	17	1138+86	13.4	1.32 [Toe] with 8.8' thick blanket	0.82	8.8	7.22	135	974	1125+00	1136+00	13.0	10.0	1100	_	No	Calculated 974 feet seepage length was based on a 8.8 feet thick blanket and a thick aquifer. There are no exploration between the change in wall depth at Station 1125+00 and boring WL0009_007A at Station 1136+00 and so it is not certain where the transition in change in aquifer conditions is. Therefore, it is considered that some extension of the deep cut off wall is warranted. It is proposed to undertake additional explorations in this location to confirm the stratigraphy between existing points of information. Due to issues associated with installing a cutoff wall in proximity to the UPRR crossing, it is now proposed to install relief wells and not extend the cutoff wall through this area. Relief wells have been designed using the existing condition analysis results and based on this the calculations indicate a well spacing of 100 feet. It is proposed to place relief wells between approximately Station 1125+00 and 1138+00 creating a two-well overlap at the end of each wall (an approximate 250 feet overlap either side of the gap between cutoff walls taking into consideration the 100 feet center-to-center well spacing and a radius of influence of 50 feet). Taking into account the relief well overlap and the double row of relief wells on the upstream side, no wall extension is necessary at this location.
1247+00	19	1238+85	12.4	2.32 with 3.1' thick blanket 1.10 with 6.5' thick blanket	0.6	6.5	3.90	140	546	1247+50	1244+50	12.0	6.5	300	Boil at Station 1243+00 in 1995	To be determined.	Calculated 546 feet seepage length was based on a 6.5 feet thick blanket and a thick aquifer. There are no deep explorations between the change in wall depth at Station 1247+00 and boring SL0009_004B at Station 1244+00 and so it is not certain where the transition in change in aquifer conditions is. Therefore, it is considered that some extension of the deep cut off wall is warranted. It is proposed to undertake additional explorations in this location to confirm the stratigraphy between existing points of information.
				0.56 with 14' thick blanket	0.06	14	0.84	140	118	1247+50	1248+00	12.4	14.0	0			Based on the new exploration at Station 1246+30 (SL0009_008S), a roughly 30 foot thick clay blanket was encountered with a sand and gravel aquifer below to elevation -23 feet. As such, there is a distance of approximately 600 feet between the thin blanket condition at approximately Station 1242+00 and the wall transition at Station 1248. Therefore, based on the calculated seepage path length of 546 feet end around effects are not a concern. The hydraulic gradient was also checked at Station 1248+00 for the 200-yr WSE, where boring WL_0009_017B shows the blanket is 14 feet thick. The exit gradient at this location based on the existing conditions analysis is 0.56. However, in accordance with the exploration data, there is a rapid change in the thickness and base elevation of the aquifer layer either side of the transition. As such, it is questionable whether a true end-around effects condition exists. As the deeper section of wall will be installed using Deep Mixed methods, contractor explorations will be undertaken to provide subsurface information at 100 feet center spacing prior to construction. Based on discussions with DWR, it was agreed that the contractor's exploration data would be reviewed to make a final decision as to whether a wall extension was needed at this location.
1268+75	19	1238+85	12.5	2.32 with 3.1' thick blanket 0.80 [Toe] with 12.0' thick blanket	0.3	12	3.60	60	216	1268+75	1266+00	12.5	12.0	275		No	Calculated 216 feet seepage length was based on a 12 feet thick blanket and a thick aquifer. Based on explorations, the subsurface conditions between approximately Station 1268+50 and boring SL0009_002B at Station 1266+00 (a distance of approximately 250 feet) change rapidly with a composite blanket varying in thickness from approximately 35 feet to 12 feet thick. Therefore, it is considered that some extension of the deep cut off wall may be warranted. It is proposed to undertake additional explorations in this location to confirm the stratigraphy between existing points of information.
				0.68 with 14' thick blanket	0.18	14	2.52	60	151	1268+75	1266+00	12.5	14.0	275			Two new CPTs, SL0009_013C and SL0009_15C were advanced at Station 1264+75 and 1267+50 respectively to determine the subsurface conditions either side of the 12 foot thick blanket at Station 1266+00. Based on the new CPT data, the blanket at Station 1267+50 is 14 foot thick. At Station 1264+75, there is a 6 foot thick layer of silt/clay overlying approximately 28 feet of sandy silt and sandy clay with interbeds of silty/clayey sand, which are considered to form a composite blanket layer. As such, the thinnest blanket condition still occurs at Station 1266+00, from where calculations indicate a flow path distance of 216 feet is required to generate sufficient head loss for the gradient to meet criteria. The existing wall overlap from Station 1266+00 is approximately 300 feet and so from this perspective no wall extension is required. The hydraulic gradient at the location of the new CPT at Station 1267+50 for the 200-yr WSE was also checked to see if it met criteria. At this location the blanket is 14 feet thick and the calculated exit gradient is 0.68. A minimum seepage path length of 151 feet is required to produce enough head loss to meet the underseepage criteria. The current overlap between Station 1267+50 and the wall transition is about 130 feet. Taking into account 3D effects, it is considered that there is adequate wall overlap. Therefore, no wall extension is necessary at this location.

Location Identified by DWR	Reach ID	Existing Condition		Average Exit Gradient (Toe or Near Toe) from Existing Condition Analysis at 200yr WSE i	Excess Gradient Over 0.5 Δi = i - 0.5	Blanket Thickness at Analysis Station (feet) L	Head Drop to Accommodate Excess Gradient (feet) ΔH=Δi * L	Distance Per Foot of Head Loss through Aquifer (feet) R	Flow Distance to Accommodate Required Excess Head Drop (feet) X=ΔH * R	Station of Cutoff Wall Depth Change STA[a]	Closest Exploration with Shallow Blanket			Distance of Shallow Blanket from Cutoff Wall Depth Change (feet) Y = I STA[a]-STA[b] I	Past Performance	Potential Need to Extend Transition Length (Yes/No)	Comment
		Station	Head (feet)								STATION STA[b]	Head (feet)	Blanket Thickness (feet)				
1625+00	25	1615+62	6.7	4.14 with 1.4' thick blanket [Ditch] 0.97 assumed with 6.0' thick blanket (Ditch)	0.47	6	2.82	170	479	1625+00	1622+00	8.0	6.0	300	_	Yes	Calculated 479 feet seepage length was based on a 6 feet thick blanket, 6.7 feet head and a thick aquifer. Based on explorations between Station 1622+00 and 1628+50, there is a change in blanket thickness, plus there is an locally increased head condition (10 feet) at Station 1623+00. Therefore, it is considered that some extension of the deep cut off wall may be warranted. It is proposed to undertake additional explorations in this location to confirm the stratigraphy between existing points of information.
				1.03 assumed with 13.0' thick blanket (Ditch relocated at 200 ft. from toe) No positive gradient at toe.	0.23	13	2.99	170	508	1625+00	1622+00	8.0	13.0	300			Based on new exploration SM0016_002S at Station 1626+40, the foundation soils comprise interbedded silty sand, clayey sand and clay to a depth of approximately 20 feet below the landside toe overlying an approximately 20 feet thick sand and gravel aquifer layer. Based on laboratory testing from explorations in this area, the fines content of the interbedded sand layers ranges from 25% to 42%, and fines content of the underlying sand and gravel aquifer ranges from 4% to 7%. As such, it is considered that there is sufficient permeability contrast between the interbedded zone of silty sand, clayey sand and clay and the underlying sand and gravel aquifer that the upper 20 feet of foundations soil will act as a blanket. Based on this assumption, a cross-section perpendicular to the canal and the end of the cutoff wall at Station 1625+00 was analyzed. For this model, the seepage gradient across the composite blanket layer is calculated as 0.38 assuming no water in the canal. The seepage gradient across the uppermost clay layer at the base of the canal is 1.02, but the flux for this condition is very low at 0.53 cubic feet per day per 100 foot length of canal. A sensitivity analysis was run assuming the canal has 5 feet of water in it, which would put the water surface at existing ground level. For this condition the seepage gradient across the uppermost clay layer drops to 0.08. Taking into account the new boring data and the analysis results, it is considered that the current end point of the wall is adequate, but to provide additional protection it is proposed to extend the end of the wall to Station 1626+00, which would increase the distance between the end of the cutoff wall and the canal to approximately 300 feet.
1816+50	30	1826+94	5.5	0.48 [Toe] with 2.3' thick blanket	-	-	-	-	-	-	-			-	Boil at Station 1820+00 in 1986	Yes	Calculation indicates adequate gradient with 2.3 feet thick blanket, but there has been a reported boil at this location in 1986. Therefore, it is considered that some extension of the deep cut off wall may be warranted. It is proposed to undertake additional explorations in this location to confirm the stratigraphy between existing points of information. A new sonic boring was performed at Station 1816+50 to determine the subsurface conditions between existing explorations SM0007_011B at Station 1815+00 and WM0007_030B at Station 1818+10. Based on the new exploration, a well graded sand layer was encountered at 1816+50 from elevation +78 feet to elevation +70 feet. To avoid potential end around seepage effects, it is proposed to deepen the cutoff wall tip elevation between Station 1813+33 and 1816+50 to elevation +50 feet, which would effectively cutoff the potential for end around effects.
1866+00	30	1826+94	5.5	0.48 [Toe] with 2.3' thick blanket	-	-	-	-	-	-	-			-	Boil at Station 1871+00 in 1986	No	Calculated gradient meets criteria for a 2.3 feet thick blanket, but no explorations between start of deep wall at Station 1866+00 and exploration WM0007_005S at Station 1877+00. Two new sonic borings were performed at Stations 1868+00 and 1871+00. These explorations indicate the foundation soils generally consist of silty sand to elevation +80 feet with interbedded silty sand, silt and sandy silt to an elevation of +3 feet. A clay layer was encountered at elevation +53 feet at Station 1868+00 and at elevation +59 feet at Station 1877+00. As such, the current wall depths and transition points are considered adequate. Therefore, no wall extension is necessary at this location.

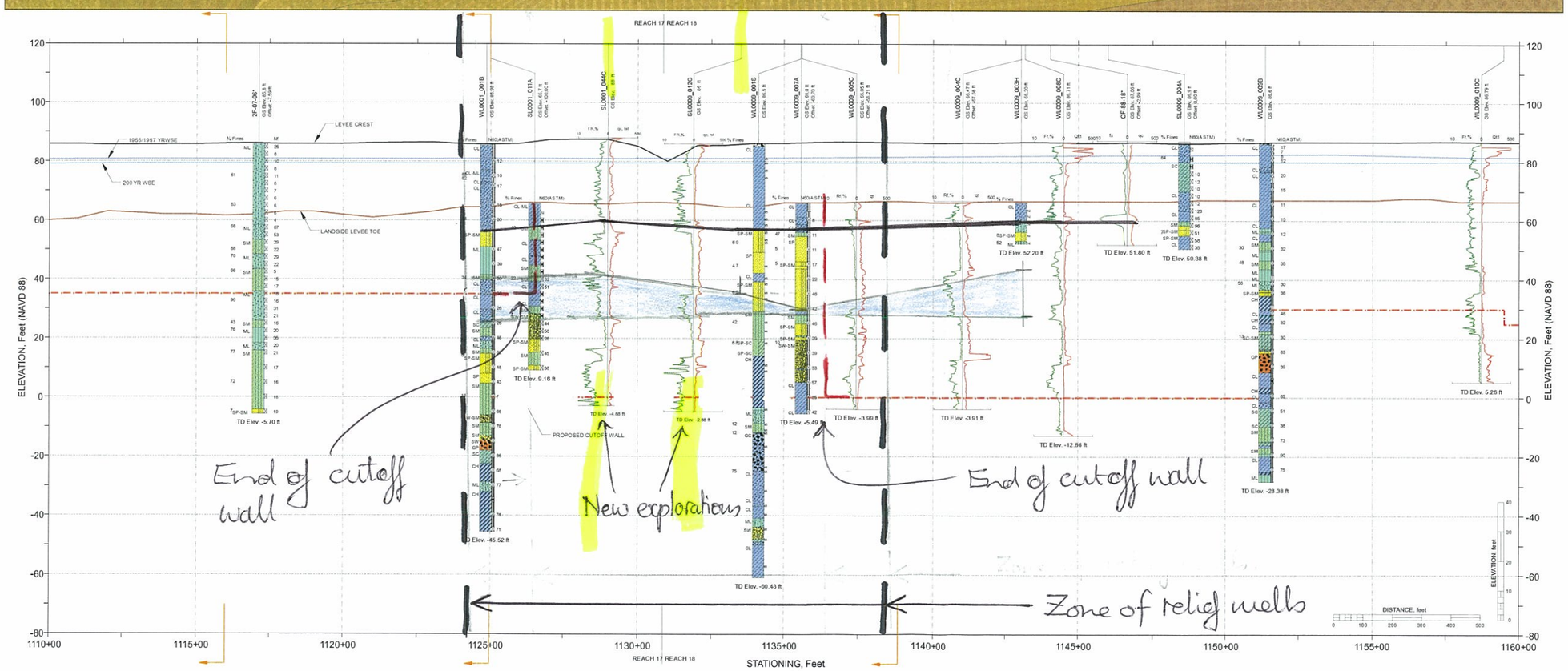
NOTE:
(1) Updated with New WSE (July 2012)

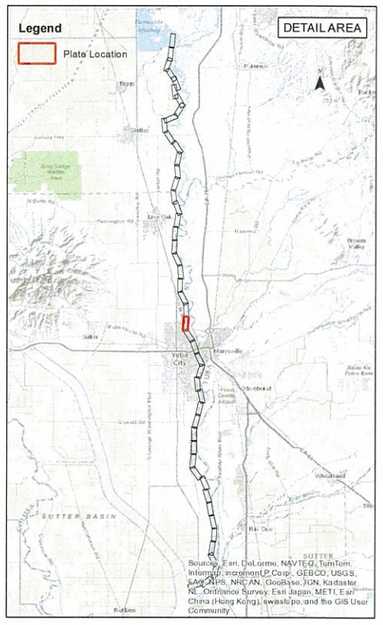
URS
2870 Gateway Oaks Drive, Suite 150
Sacramento, CA 95833
Tel: 916.679.2000 Fax: 916.679.2900

Attachment A

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 1110+00 to Station 1160+00

URS

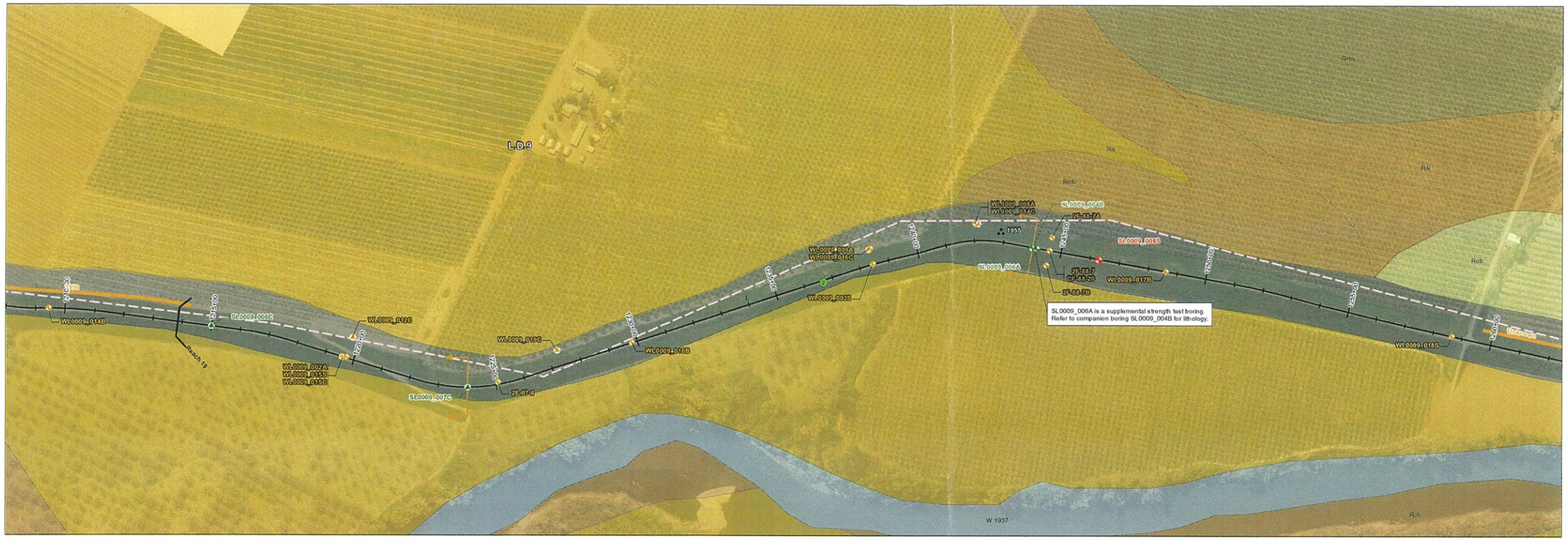
Geotechnical Design Recommendations Report

Sutter Butte Flood Control Agency

FEATHER RIVER WEST LEVEE PROJECT

Appendix A25

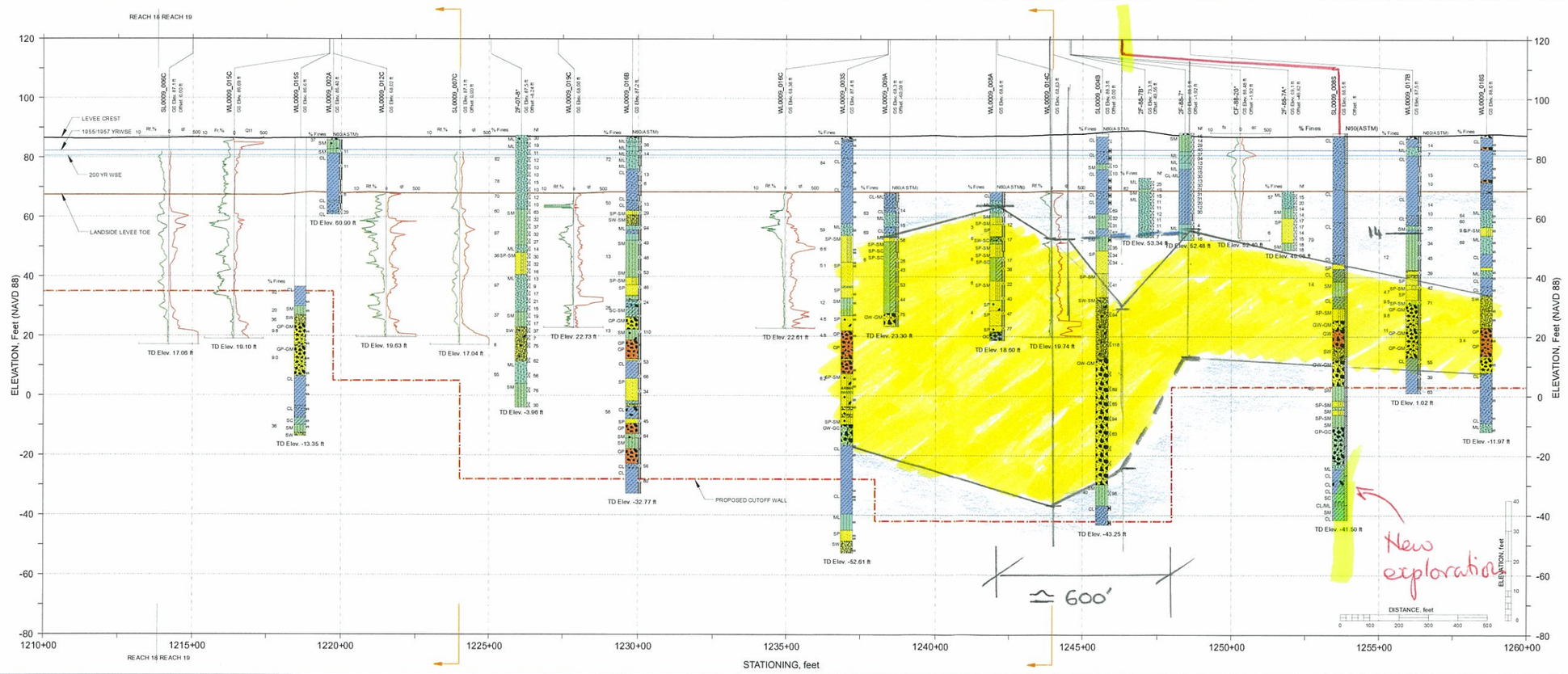
I:\Projects\SBFCA\Maps\SBFCA_FRP_Mapbook.mxd AVS 10/25/2013 SAC

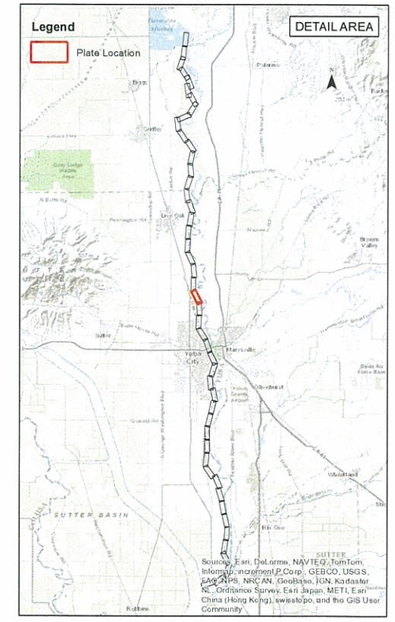


0 100 200
Feet

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 1210+00 to Station 1260+00

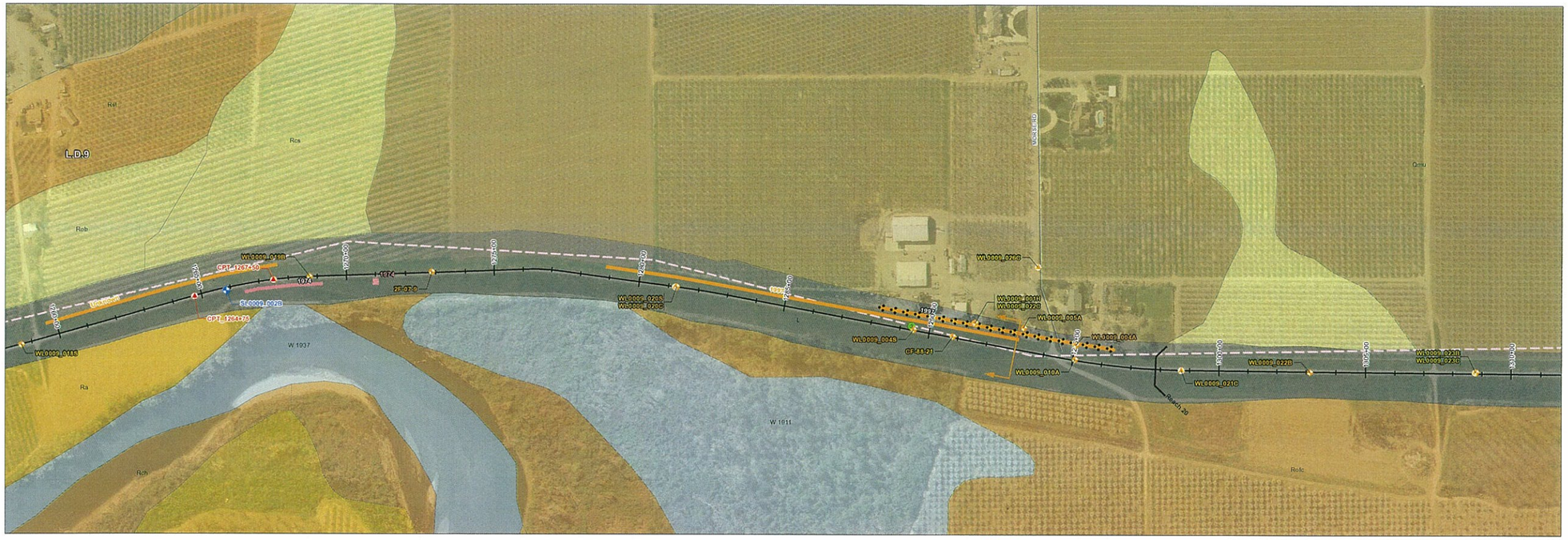
URS

Geotechnical Design Recommendations Report

Sutter Butte Flood Control Agency

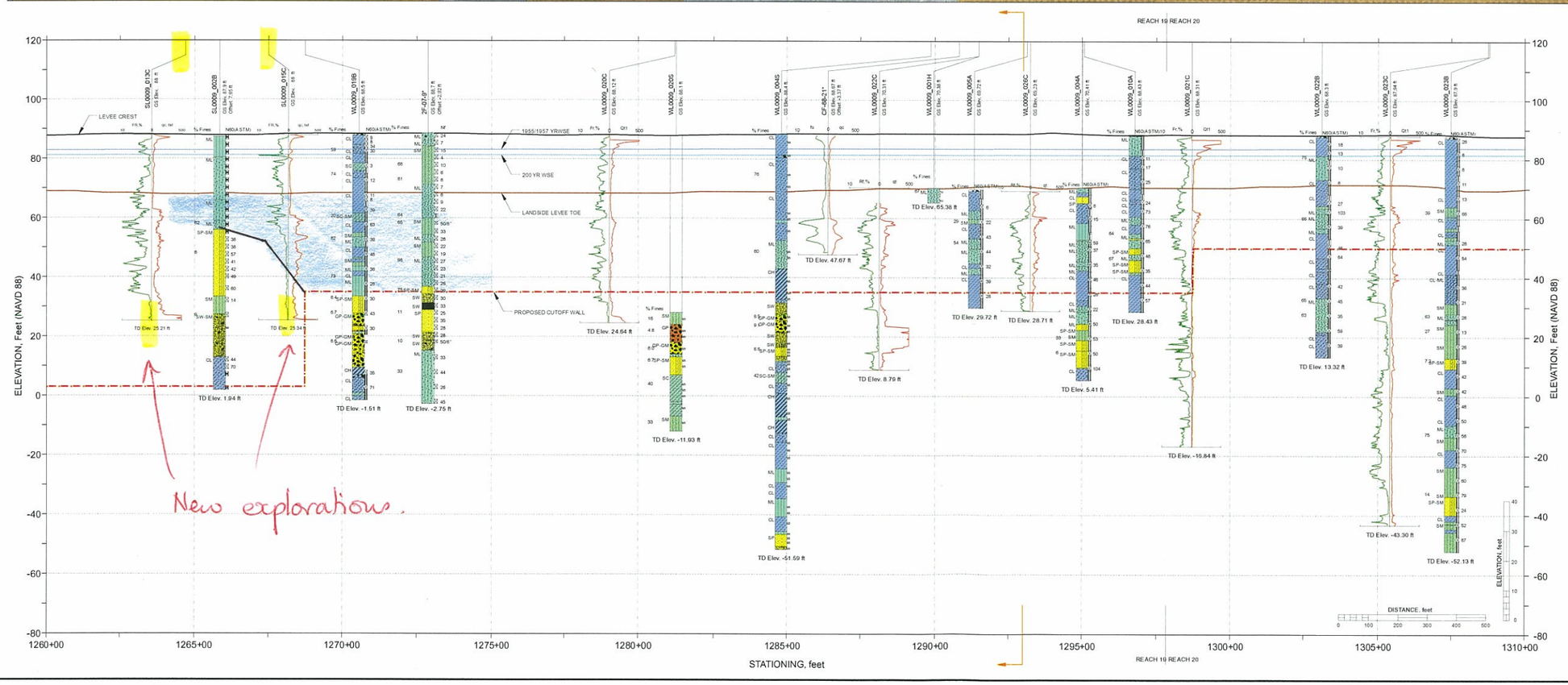
FEATHER RIVER WEST LEVEE PROJECT

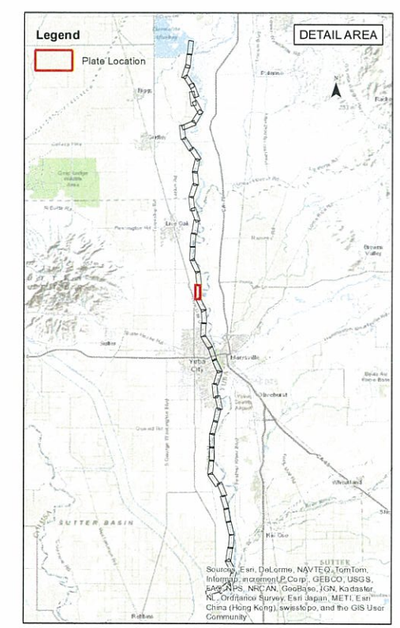
Appendix A27



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 1260+00 to Station 1310+00

URS

Geotechnical Design Recommendations Report

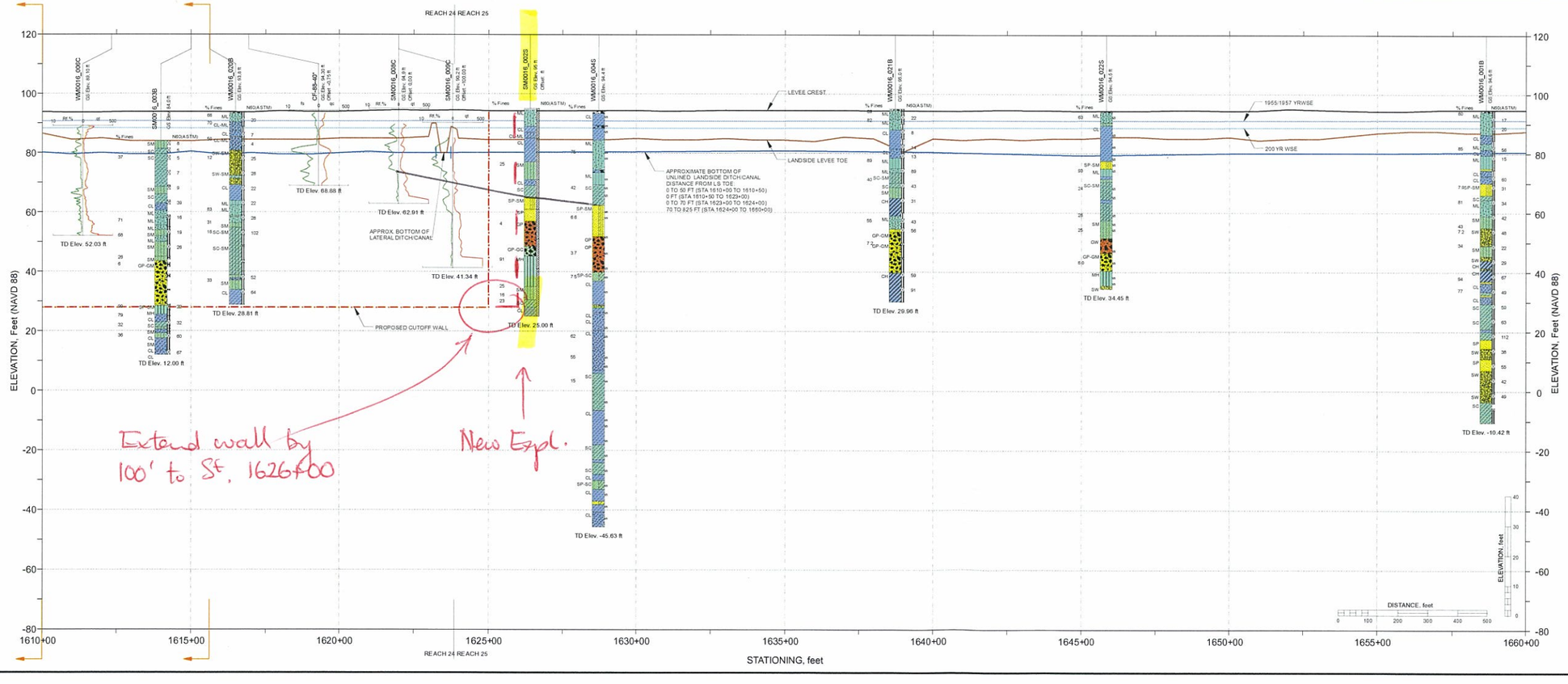
Sutter Butte Flood Control Agency

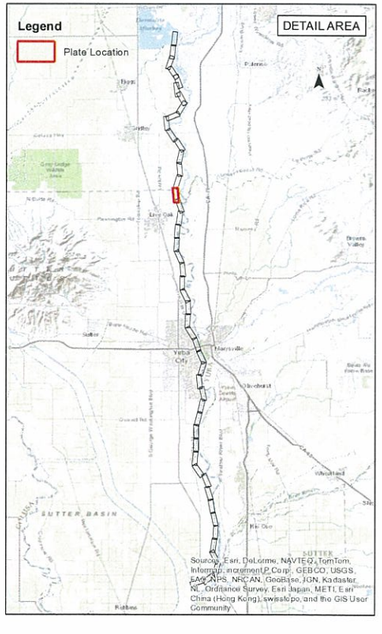
FEATHER RIVER WEST LEVEE PROJECT

Appendix A28

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 1610+00 to Station 1660+00

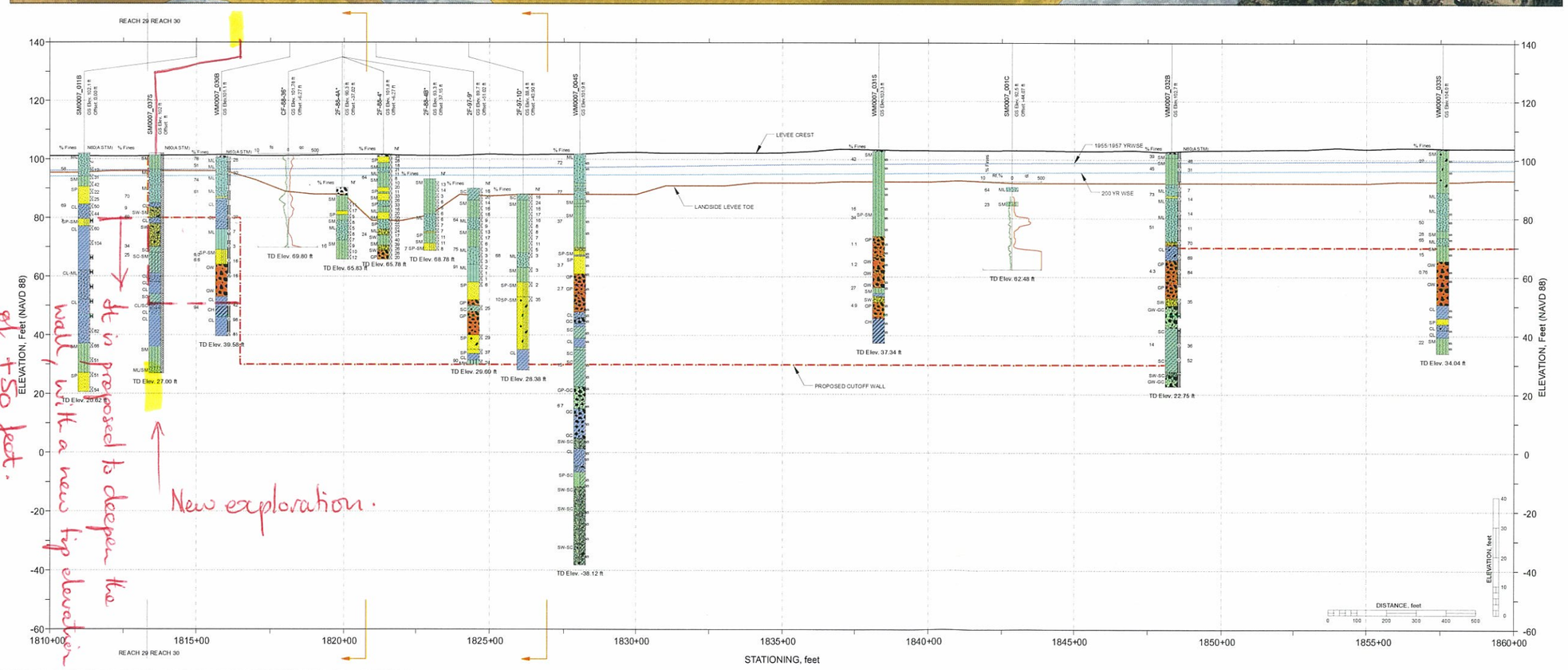
URS

Geotechnical Design Recommendations Report

Sutter Butte Flood Control Agency

FEATHER RIVER WEST LEVEE PROJECT

Appendix A35

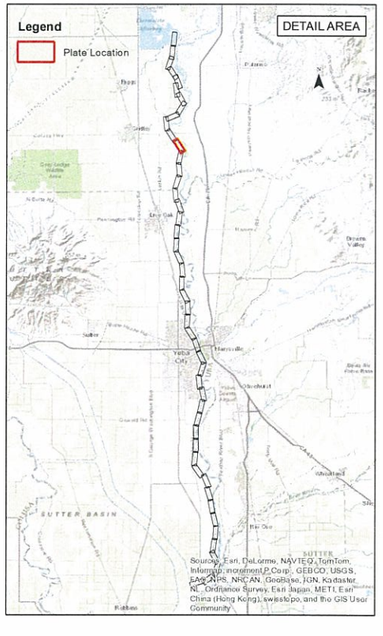


It is proposed to deepen the wall, with a new tip elevation of +50 feet.

New exploration.

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 1810+00 to Station 1860+00

URS

Geotechnical Design Recommendations Report

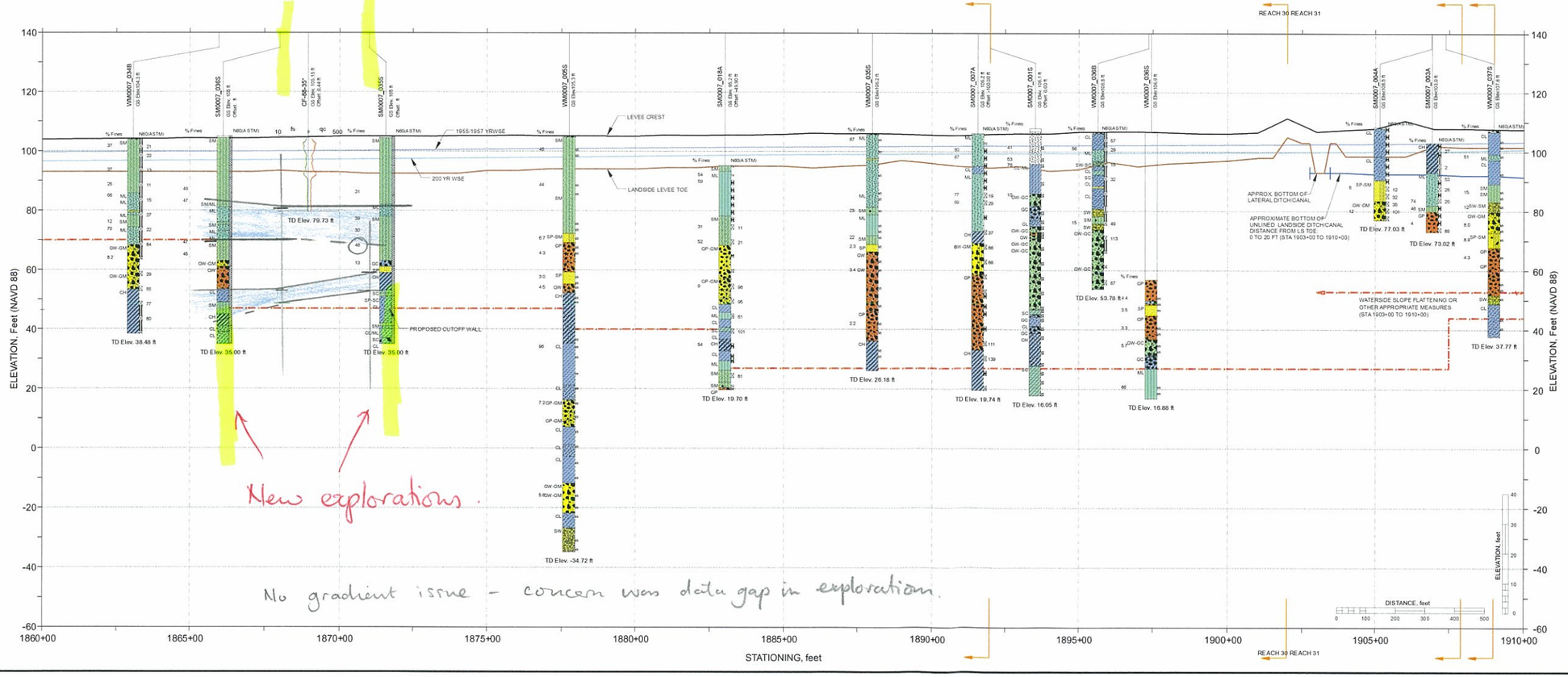
Sutter Butte Flood Control Agency

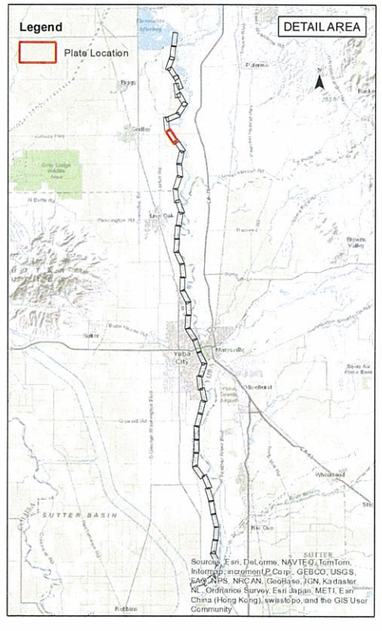
FEATHER RIVER WEST LEVEE PROJECT

Appendix A39

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

SBFCA - FEATHER RIVER WEST LEVEE PROJECT

GAP CLOSURE - UPRR CROSSING

OCTOBER 2013

ALTERNATIVE 5 - RELIEF WELLS AT 100 FOOT MAX SPACING

80' 40' 0' 80' 160'

SCALE: 1" = 80'
(22" x 34")

LEGEND

- ⊕ RELIEF WELL
- NEW DRAIN PIPE
- WATERSIDE SLOPE CLAY BLANKET
- EXISTING PG&E
- EXISTING CENTURYLINK
- EXISTING KINDER MORGAN

FIGURE 14

WOOD RODGERS
DEVELOPING INNOVATIVE DESIGN SOLUTIONS
3301 C St, Bldg. 100-B Tel 916.341.7760
Sacramento, CA 95816 Fax 916.341.7767

J:\Jobs\9455_JKR_Sutter_Butte_FCA\9455.001_FeatherRiverLevee_EIP\Civil\Dwg\Reports\Wat_Dep_Closure\2013 Gap Closure Update TM\C_Exh_GapClosure_01\10_Alt5_RevisedSpacing.dwg 10/24/2013 1:28 PM Peter Blum

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

Attachment B

DATE STARTED	DATE COMPLETED	GROUND ELEVATION	ELEVATION DATUM	TOTAL DEPTH OF BORING
10/18/12	10/19/12	81.7743 ft	NAVD 88	135.0 ft
DRILLING CONTRACTOR National		**DRILLER'S NAME** J. Marok	**HELPER'S NAME** N. Castro/M. Woolcott	**TOTAL DEPTH OF FILL** 24.7 ft
DRILLING METHOD Sonic		**DRILL RIG MAKE AND MODEL** Geoprobe 8140 LC #34		**CONSULTANT COMPANY** URS Corporation
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) 4-1/2" Sonic Corebarrel/6-1/4" csg bit		**DRILLING ROD TYPE AND DIAMETER** 3-1/2" Sonic		**FIELD LOGGER** M. Palmer
☒ VERTICAL ☐ INCLINED		**CASING TYPE, DIAMETER, INSTALLATION DEPTH** 5-7/8" OD, 5-1/8" ID Steel		**FIELD LOG REVIEWER** G.T. HONG
SAMPLER TYPE(S) 4-1/2" OD, 3-1/2" ID Core Barrel		**HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP** NA		**HAMMER EFFICIENCY**
BOREHOLE BACKFILL OR COMPLETION Neat cement grout		**GROUNDWATER READING:**	**DURING DRILLING** NA	**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		12-inch Aggregate Base.			0									0-1' Sonic
	1		[LEVEE FILL] Poorly Graded SAND with Silt and Gravel (SP-SM); light olive brown; dry; 60% fine to coarse sand; 30% fine to coarse gravel, max. 3 in.; 10% no plasticity fines; presence of mica.			100									Hand Auger 1-2.5', refusal at 2.5'.
80	2														
	3														Run 1
	4		[LEVEE FILL] Poorly Graded SAND with Silt (SP-SM); light yellowish brown; dry; 90% fine to medium sand; 10% no plasticity fines; trace mica.			100									
	5		[LEVEE FILL] LEAN CLAY with Sand (CL); yellowish brown; moist; 80% low to medium plasticity, no dilatancy fines; 20% fine sand; trace mica; trace fine organics.												At 5' set casing to 5'. Run 2
	6														
75	7		[LEVEE FILL] SANDY LEAN CLAY (CL); yellowish brown; moist; 55% low plasticity, no to slow dilatancy fines; 45% fine sand; trace mica.			50									
	8														
	9														
	10		[LEVEE FILL] LEAN CLAY with Sand (CL); yellowish brown; moist; 80% fine sand; 20% low to medium plasticity, no to slow dilatancy fines; presence of mica.												Run 3
	11														
70	12					60									
	13														
	14														
	15														At 15' set casing to 10'. Run 4
	16														
65	17					80									
	18		[LEVEE FILL] Poorly Graded SAND with Silt (SP-SM); light yellowish brown; dry; 90% fine to medium sand; 10% no plasticity fines; presence of mica.												
	19														
	20														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,221,852.77 **Easting:** 6,656,328.16
Latitude: 39.09819 **Longitude:** -121.60229
Levee Station or Milepost: 848+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_002S
Sheet 1 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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
	20														Run 5
	21														
60	22														
	23					70									
FILL	24														
	25		CLAYEY SILT with Sand (ML/CL); dark gray; moist; 85% low to medium plasticity, no to slow dilatancy fines; 15% fine sand; presence of mica; presence of roots.												Run 6 Sample fell out, went back in and recovered.
	26		At 26 feet yellowish brown; trace organics.							29	39	12			
55	27		Poorly Graded SAND with Silt (SP-SM); light yellowish brown; dry; 90% fine to medium sand; 10% no plasticity fines; presence of mica.												
	28					70									
	29														
	30														At 30' set casing to 25'. Run 7 No recovery 30-32'
	31		CLAYEY SILT with Sand (ML/CL); yellowish brown; 85% low plasticity, slow to rapid dilatancy fines; 15% fine sand; orange-red iron oxide staining throughout.												
50	32														
	33					60									
	34														
	35														Run 8
	36														
45	37														Use flapper bit. Upper 2.5' of 3.5 recovered totally disturbed and not saved.
	38					20									
	39														
	40														At 40' set casing to 35'. Run 9 No recovery 40-43' Completely disturbed and soupy.
	41														
40	42		SILTY CLAY with Sand (CL/ML); very soft; dark gray; moist; 80% low plasticity, slow dilatancy fines; 20% fine sand; moderate organic odor; some organic fragments.												
	43					34									
	44														
	45														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,221,852.77 **Easting:** 6,656,328.16
Latitude: 39.09819 **Longitude:** -121.60229
Levee Station or Milepost: 848+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_002S
Sheet 2 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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		SANDY SILT (ML); very dark gray; wet; 55% no to low plasticity, rapid dilatancy fines; 45% fine sand; slight organic odor; presence of woody organic fragments; presence of mica.												Run 10 Use open bit.
	46														
35	47					60				40	33	3			
	48														
	49														
	50														At 50' set casing to 45'. Run 11 No recovery Core barrel fell off three times during extraction from borehole, sample lost out of sampler.
	51														
30	52					0									
	53		LEAN CLAY with Sand (CL); olive brown; moist; 55% low plasticity, no to slow dilatancy fines; 45% fine sand; presence of mica; trace organic fragments.												
	54														
	55														At 55' set casing to 50'. Run 12
	56														
25	57					100									
	58														
	59		SANDY LEAN CLAY (CL/SC); olive brown; moist; 50% fine sand; 50% low plasticity, no to slow dilatancy fines; presence of mica and organics.												
	60		SILTY SAND (SM); very dark greenish gray; wet; 70% fine to medium sand; 30% no to low plasticity, rapid dilatancy fines.												At 60' set casing to 55'. Run 13
	61		SANDY SILT (ML/SM); very dark greenish gray; wet; 50% fine sand; 50% low plasticity, rapid dilatancy fines; micaceous.												
20	62		SILTY SAND with Gravel (SM); very dark greenish gray; moist; 46% fine to coarse sand; 40% fine to coarse, rounded, hard gravel, max. 1.5 in.; 14% low plasticity, no to slow dilatancy fines; micaceous.			90				14	27	3	14		
	63														
	64														
	65														At 65' set casing to 60'. Run 14
	66														
15	67					90									
	68														
	69		At 68.5 feet 65% fine to coarse sand; 20% fines; 15% gravel.												
	70		At 69.5 feet 0.8' interbedded with Clayey Sand (SC); 70%												

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,221,852.77 **Easting:** 6,656,328.16
Latitude: 39.09819 **Longitude:** -121.60229
Levee Station or Milepost: 848+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_002S
Sheet 3 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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		fine to coarse sand; 30% low plasticity fines; trace fine gravel.												At 70' set casing to 65'. Run 15 No recovery 70-72'
	71														
10	72		Poorly Graded GRAVEL with Silt and Sand (GP-GM); very dark greenish gray; wet; 60% fine to coarse, rounded gravel; 30% fine to coarse sand; 10% no to low plasticity fines.			60									
	73														
	74														
	75														At 75' set casing to 70'. Run 16
	76		Poorly Graded SAND (SP); very dark greenish gray; wet; 95% fine to coarse sand; 5% no plasticity fines; trace gravel, max. 1.5 in.												
5	77														
	78														
	79														
	80		Poorly Graded SAND with Silt (SP-SM); very dark greenish gray; wet; 90% fine to coarse sand; 10% no plasticity fines; trace fine to coarse gravel, max. 1.5 in.			95									
	81		SILTY GRAVEL (GM); very dark greenish gray; moist; 40% fine to coarse gravel, max. 1.25 in.; 30% fine to coarse sand; 30% no plasticity fines; well consolidated; blocky to friable texture.												
0	82														
	83		At 82.5 feet 0.3-0.5' thick interbeds; micaceous; Silty Sand (SM); 75% fine to medium sand; 25% no plasticity fines; Sandy Silt (ML); 70% no to low plasticity fines; 30% fine sand; Poorly graded Sand with Silt (SP-SM); 90% fine to medium sand; 10% no plasticity fines.												
	84														
	85		Poorly Graded SAND (SP); greenish black; wet; 95% fine to medium sand; 5% no plasticity fines; presence of mica.												At 85' set casing to 80'. Run 17
	86														
-5	87														
	88														
	89														
	90					100									
	91														
-10	92		SILT with Sand (ML); very dark greenish gray; moist; 75% low plasticity, rapid dilatancy fines; 25% fine sand; micaceous.												
	93														
	94		SANDY LEAN CLAY (CL); very dark greenish gray; moist; 70% low to medium plasticity, slow dilatancy fines; 30% fine sand; micaceous. At 94.5 feet poorly-well indurated to 95.7'.												
	95														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,221,852.77 **Easting:** 6,656,328.16
Latitude: 39.09819 **Longitude:** -121.60229
Levee Station or Milepost: 848+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_002S
Sheet 4 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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														Run 18
	96		SANDY SILT (ML); very dark greenish gray; moist; 65% low plasticity, rapid dilatancy fines; 35% fine sand.												
-15	97														
	98		SILTY SAND (SM); very dark greenish gray; moist; 60% fine sand; 40% no to low plasticity fines; presence of mica; fine grained organic fragments.			90									Gradational content.
	99		SILTY SAND with Gravel (SM); very dark greenish gray; moist; 50% fine to coarse sand; 30% fine to coarse, rounded, hard gravel, max. 1 in.; 20% no to low plasticity, slow dilatancy fines; poorly indurated; friable to crumbly texture.												
	100														At 100' set casing to 95'. Run 19
	101														
-20	102														
	103		SILTY GRAVEL with Sand (GM); very dark greenish gray; moist; 50% fine to coarse, rounded, hard gravel, max. 3 in.; 35% fine to coarse sand; 15% no plasticity fines.												
	104														
	105					95									
	106														
-25	107														
	108														
	109		At 109 feet 0.5' lens of (SM) similar to Silty Sand with Gravel from 98.8 to 103 feet; friable texture.												
	110														At 110' set casing to 100'. Run 20
	111														
-30	112														
	113														
	114														
	115					80									
	116														
-35	117														
	118														
	119														
	120														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,221,852.77 **Easting:** 6,656,328.16
Latitude: 39.09819 **Longitude:** -121.60229
Levee Station or Milepost: 848+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_002S
Sheet 5 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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
	120														At 120' set casing to 110'. Run 21
	121		Poorly Graded SAND (SP); greenish black; wet; 100% fine to coarse sand; trace fine gravel, max. 1/8 in.; presence of mica.												
-40	122														
	123		CLAYEY SAND (SC); dark greenish gray; moist; 80% fine to coarse sand; 20% low plasticity, no dilatancy fines; micaceous; poorly indurated; friable texture.												
	124		SANDY LEAN CLAY (CL/SC); very dark greenish gray; moist; 55% low to medium plasticity, no dilatancy fines; 45% fine sand; very hard; blocky texture; poorly indurated; micaceous.												
	125					100									
	126		SILT with Sand (ML); very dark greenish gray; moist; 80% medium plasticity, no dilatancy fines; 20% fine sand; very hard; blocky texture variably crumbly; poorly indurated; micaceous.												
-45	127									30	46	12			
	128														
	129		SANDY CLAYEY SILT (ML/CL); very dark greenish gray; moist; 50% fine sand; 50% low plasticity, slow to rapid dilatancy fines; blocky texture; poorly indurated; micaceous.												
	130														Run 22
	131														
-50	132		At 131.5 feet to 134 feet well indurated; blocky texture; too hard to manually work to soil (similar to mudstone).			74									Upper 1.3 disturbed and mixed with slough and tossed out.
	133														
	134														
	135														
	136		Borehole terminated at 135 feet. Backfilled boring with 250 gallons of neat grout consisting of 185 gallons water, 25 pounds of bentonite powder, 40-47 lb sacks of portland cement.												
-55	137														
	138														
	139														
	140														
	141														
-60	142														
	143														
	144														
	145														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,221,852.77 **Easting:** 6,656,328.16
Latitude: 39.09819 **Longitude:** -121.60229
Levee Station or Milepost: 848+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_002S
Sheet 6 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

DATE STARTED 10/2/12 **DATE COMPLETED** 10/4/12	**GROUND ELEVATION** 54.1853 ft **ELEVATION DATUM** NAVD 88		**TOTAL DEPTH OF BORING** 95.0 ft
DRILLING CONTRACTOR National	**DRILLER'S NAME** J. Marok **HELPER'S NAME** R. Estrado/E. Jasso		**TOTAL DEPTH OF FILL** 0 ft
DRILLING METHOD Sonic	**DRILL RIG MAKE AND MODEL** Geoprobe 8140 LC #34		**CONSULTANT COMPANY** URS Corporation
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) 4-1/2" Sonic Corebarrel/6-1/4" csg bit	**DRILLING ROD TYPE AND DIAMETER** 3-1/2" Sonic		**FIELD LOGGER** GT Hong
[X] **VERTICAL** [ ] **INCLINED**	**CASING TYPE, DIAMETER, INSTALLATION DEPTH** 5-7/8" OD, 5-1/8" ID Steel		**FIELD LOG REVIEWER** M. PALMER
SAMPLER TYPE(S) 4-1/2" OD, 3-1/2" ID Core Barrel	**HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP** NA		**HAMMER EFFICIENCY**
BOREHOLE BACKFILL OR COMPLETION Cement with 5% Bentonite	**GROUNDWATER READING: DURING DRILLING** NA		**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		Poorly Graded SAND with Silt (SP-SM); loose; dark yellowish brown; dry; 90% fine sand; 10% no plasticity fines.												Run 1
	1														
	2														
	3														
50	4														
	5														Run 2
	6														
	7		SILTY SAND (SM); dark yellowish brown; dry; 77% fine sand; 23% no plasticity fines.												
	8												23		
45	9														
	10														Run 3
	11														
	12														
	13														
40	14		SANDY SILT (ML); yellowish brown; moist; 60% medium plasticity, slow dilatancy fines; 40% fine sand.												
	15		Poorly Graded SAND (SP); yellowish brown; moist; 95% fine sand; 5% no plasticity fines.												Run 4
	16														
	17		CLAYEY SILT (ML/CL); dark yellowish brown; moist; 90% medium plasticity, slow dilatancy fines; 10% fine sand.												
	18									42	44	15			
35	19														
	20														

Final Report Version

Borehole Location: Landside Toe **County:** Sutter
Coordinates: Northing: 2,162,621.88 **Easting:** 6,673,997.64
Latitude: 39.09988 **Longitude:** -121.60416
Levee Station or Milepost: 856+04 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_003S
Sheet 1 of 5

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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
	20		Poorly Graded SAND (SP); dark yellowish brown; wet; 95% medium sand; 5% no plasticity fines.												Run 5
	21														
	22														
	23		SILTY SAND (SM); dark yellowish brown; wet; 77% medium sand; 23% no plasticity fines.										23		
30	24														
	25														Run 6
	26														
	27		Poorly Graded GRAVEL with Sand (GP); very dark greenish gray; wet; 65% gravel; 30% sand; 5% no plasticity fines.												
	28		At 28 feet tree trunk to 30'; 40% of composition.												
25	29														
	30		At 30 feet 60% gravel; 35% sand; 5% fines.												Run 7
	31														
	32														
	33														
20	34														
	35		SILTY SAND with Gravel (SM); dark greenish gray; wet; 59% sand; 28% gravel; 13% no plasticity fines.												Run 8
	36														
	37														
	38												13		
15	39														
	40		Poorly Graded SAND with Gravel (SP); dark greenish gray; wet; 80% sand; 15% gravel; 5% no plasticity fines.												Run 9
	41														
	42														
	43														
10	44														
	45														

Final Report Version

Borehole Location: Landside Toe **County:** Sutter
Coordinates: Northing: 2,162,621.88 **Easting:** 6,673,997.64
Latitude: 39.09988 **Longitude:** -121.60416
Levee Station or Milepost: 856+04 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_003S
Sheet 2 of 5

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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		Poorly Graded GRAVEL with Sand (GP); dark greenish gray; wet; 55% gravel; 40% sand; 5% no plasticity fines.												Run 10
	46														
	47														
	48														
5	49														
	50		At 50 feet 70% gravel; 25% sand; 5% no plasticity fines.												Run 11 No recovery 50-51'
	51														
	52					80									
	53														
0	54														
	55														Run 12 No recovery 55-56'
	56														
	57					20									
	58														
-5	59														
	60		At 60 feet grading with less fines, more sand.												Run 13
	61														
	62					100									
	63														
-10	64		LEAN CLAY with Sand (CL); dark greenish gray; moist; 85% medium plasticity, no dilatancy fines; 15% fine sand.												
	65		Poorly Graded SAND with Silt (SP-SM); dark greenish gray; wet; 90% medium sand; 10% no plasticity fines.												Run 14 No recovery 65-66'
	66														
	67					80									
	68														
-15	69														
	70														

Final Report Version

Borehole Location: Landside Toe **County:** Sutter
Coordinates: Northing: 2,162,621.88 **Easting:** 6,673,997.64
Latitude: 39.09988 **Longitude:** -121.60416
Levee Station or Milepost: 856+04 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_003S
Sheet 3 of 5

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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														Run 15
	71														
	72		CLAYEY GRAVEL with Sand (GC); dark greenish gray; wet; 40% fine to coarse gravel; 39% fine sand; 21% fines.			100									
	73												21		
-20	74														
	75														Run 16 No recovery 75-76'
	76														
	77					80									
	78														
-25	79														
	80		FAT CLAY (CH); greenish gray; moist; 95% high plasticity, no dilatancy fines; 6% fine sand.												Run 17
	81		SILT (ML); greenish gray; moist; 95% medium plasticity, no to slow dilatancy fines; 5% fine sand.												
	82					100				31	41	9			
	83														
-30	84														
	85		SILTY SAND (SM); greenish gray; wet; 64% fine sand; 36% no plasticity fines.												Run 18
	86												36		
	87		FAT CLAY (CH); greenish gray; moist; 97% high plasticity, no dilatancy fines; 3% fine sand.			100									
	88												97		
-35	89														
	90		LEAN CLAY with Sand (CL); hard; greenish gray; moist; 75% low plasticity fines; 25% fine sand.												Run 19
	91														
	92					100			4.5+P						
	93														
-40	94														
	95														

Final Report Version

Borehole Location: Landside Toe **County:** Sutter
Coordinates: Northing: 2,162,621.88 **Easting:** 6,673,997.64
Latitude: 39.09988 **Longitude:** -121.60416
Levee Station or Milepost: 856+04 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_003S
Sheet 4 of 5

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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		Borehole terminated at 95 feet. Backfilled boring with neat grout consisting of 70 gallons water and 18-47 lb sacks of portland cement.												
	97														
	98														
-45	99														
	100														
	101														
	102														
	103														
-50	104														
	105														
	106														
	107														
	108														
-55	109														
	110														
	111														
	112														
	113														
-60	114														
	115														
	116														
	117														
	118														
-65	119														
	120														

Final Report Version

Borehole Location: Landside Toe **County:** Sutter
Coordinates: Northing: 2,162,621.88 **Easting:** 6,673,997.64
Latitude: 39.09988 **Longitude:** -121.60416
Levee Station or Milepost: 856+04 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_003S
Sheet 5 of 5

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

DATE STARTED 10/19/12	**DATE COMPLETED** 10/20/12	**GROUND ELEVATION** 81.9978 ft	**ELEVATION DATUM** NAVD 88	**TOTAL DEPTH OF BORING** 135.0 ft
DRILLING CONTRACTOR National		**DRILLER'S NAME** J. Marok	**HELPER'S NAME** N. Castro/J. Woolcott	**TOTAL DEPTH OF FILL** 24.5 ft
DRILLING METHOD Sonic		**DRILL RIG MAKE AND MODEL** Geoprobe 8140 LC #34		**CONSULTANT COMPANY** URS Corporation
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) 4-1/2" Sonic Corebarrel/6-1/4" csg bit		**DRILLING ROD TYPE AND DIAMETER** 3-1/2" Sonic		**FIELD LOGGER** M. Palmer
[X] **VERTICAL** [ ] **INCLINED**		**CASING TYPE, DIAMETER, INSTALLATION DEPTH** 5-7/8" OD, 5-1/8" ID Steel		**FIELD LOG REVIEWER** G.T. HONG
SAMPLER TYPE(S) 4-1/2" OD, 3-1/2" ID Core Barrel		**HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP** NA		**HAMMER EFFICIENCY**
BOREHOLE BACKFILL OR COMPLETION Neat cement grout		**GROUNDWATER READING:**	**DURING DRILLING** NA	**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		3-inch Asphalt concrete.												
			9-inch Aggregate Base.			100									Advance boring to 1' with casing bit. Run 1
	1		[LEVEE FILL] CLAYEY SAND (SC); olive brown; dry; 75% fine to medium sand; 25% low plasticity, slow dilatancy fines; micaceous.												
80	2														Blocked with 4" cobble at 2'. No recovery 2-5'
	3					25									
	4														
	5		[LEVEE FILL] Poorly Graded SAND with Silt (SP-SM); yellowish brown; dry; 90% fine to medium sand; 10% no plasticity fines; micaceous.												Run 2 No recovery 5-8' 5-8' disturbed by slough from above.
	6														
75	7					40									
	8														
	9														
	10														At 10' set casing to 5'. Run 3
	11														
70	12					76									
	13														
	14														
	15														At 15' set casing to 10'. Run 4 No recovery 15-19'
	16														
65	17					60									
	18														
	19														
	20														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,163,543.05 **Easting:** 6,673,552.11
Latitude: 39.10241 **Longitude:** -121.60572
Levee Station or Milepost: 866+19 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_004S
Sheet 1 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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
	20		[LEVEE FILL] SILTY SAND (SM); olive brown; moist; 70% fine to medium sand; 30% no to low plasticity, slow dilatancy fines; presence of mica and fine organic fragments.												
	21														
60	22		[LEVEE FILL] CLAYEY SAND (SC); hard; olive brown; moist; 60% fine to medium sand; 40% low plasticity, slow dilatancy fines; presence of mica and organic fragments.			60									
FILL	23														
	24														
	25		SANDY LEAN CLAY (CL); light olive brown; moist; 55% low plasticity, no to slow dilatancy fines; 45% fine to medium sand; micaceous and fine organic fragments.												At 25' set casing to 15'. Run 5
	26														
55	27		SANDY LEAN CLAY (CL); light olive brown; moist; 55% low plasticity, no to slow dilatancy fines; 45% fine to medium sand; trace of mica; presence of roots.			100				23	33	11			
	28														
	29														
	30		SILTY SAND (SM); dark yellowish brown; dry; 87% fine to medium sand; 13% no plasticity fines; micaceous.												At 30' set casing to 25'. Run 6 No recovery 30-32.2' washed out
	31														
50	32					56									
	33														
	34												13		
	35														At 35' set casing to 30'. Run 7 No recovery 35-36' washed out
	36		LEAN CLAY (CL); yellowish brown; 90% low plasticity, slow dilatancy fines; 10% fine sand; orange-red iron oxide staining.												
45	37					80									
	38														
	39		SILTY SAND (SM); light yellowish brown; moist; 75% fine sand; 25% no plasticity fines; micaceous.												
	40														At 40' set casing to 35'. Run 8 No recovery 40-40.8' washed out
	41														
40	42					84									
	43		At 43 feet 85% fine to medium sand; 15% fines.												
	44														
	45														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,163,543.05 **Easting:** 6,673,552.11
Latitude: 39.10241 **Longitude:** -121.60572
Levee Station or Milepost: 866+19 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_004S
Sheet 2 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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														At 45' set casing to 40'. Run 9 No recovery 45-47' washed out
	46														
35	47		At 47 feet 80% fine to medium sand; 20% fines; predominantly fine sand.			60									
	48														
	49		At 48.5 feet 0.5' lens of Sandy Silt (ML); light olive brown. Poorly Graded SAND (SP); olive gray; wet; 95% fine to medium sand; 5% no plasticity fines; presence of mica.												
	50														Run 10 No recovery 50-55' washed out
	51														
30	52														
	53														
	54														
	55					50									
	56														
25	57		At 57 feet 98% sand; 2% fines.										2		Hard drilling 57-59'.
	58														
	59														
	60														At 60' set casing to 55'. Run 11 No recovery 60-61' washed out 61-63' highly disturbed.
	61		At 61 feet dark gray.												
20	62														
	63														
	64														
	65					90									
	66														
15	67		Poorly Graded SAND with Gravel (SP); dark gray; wet; 55% fine to coarse sand; 40% fine to coarse, subrounded to rounded, hard gravel, max. 1.25 in.; 5% no plasticity fines; presence of mica.												
	68														
	69														
	70														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,163,543.05 **Easting:** 6,673,552.11
Latitude: 39.10241 **Longitude:** -121.60572
Levee Station or Milepost: 866+19 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_004S
Sheet 3 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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														At 70' set casing to 65'. Run 12
	71														
10	72		Well-Graded GRAVEL with Sand (GW); dark bluish gray; wet; 67% fine to coarse, subrounded to rounded gravel, max. 2.5 in.; 30% fine to coarse sand; 3% no plasticity fines; presence of mica.												
	73														
	74												3		
	75					100									
	76														
5	77														
	78														
	79														
	80		SILTY SAND (SM); gray; wet; 85% fine to medium sand; 15% no to low plasticity, rapid dilatancy fines; micaceous.												At 80' set casing to 75'. Run 13 No recovery 80-89.5' washed out sample. No gravel just sand in shoe.
	81														
0	82														
	83														
	84														
	85					5									
	86														
-5	87														
	88														
	89														
	90														Run 14 No recovery 90-98.5' washed out sample
	91														
-10	92					15									
	93														
	94														
	95														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,163,543.05 **Easting:** 6,673,552.11
Latitude: 39.10241 **Longitude:** -121.60572
Levee Station or Milepost: 866+19 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_004S
Sheet 4 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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														
-15	97					15									
	98		Poorly Graded SAND with Silt (SP-SM); dark gray; wet; 90% fine to coarse sand; 10% no plasticity fines; micaceous.												
	99														
	100		Poorly Graded SAND with Gravel (SP); dark gray; wet; 55% fine to coarse sand; 40% fine gravel; 5% no plasticity fines.												At 100' set casing to 95'. Run 15 No recovery 100-101.5'. Washed away; 101.5-104' highly disturbed.
	101														
-20	102		Poorly Graded GRAVEL with Sand (GP); dark gray; wet; 80% fine to coarse, subrounded to rounded, hard gravel, max. 3 in.; 15% fine to coarse sand; 5% no plasticity fines.												
	103														
	104		LEAN CLAY with Sand (CL); dark gray; moist.												
			SILTY SAND (SM); dark gray; wet; 78% fine to medium sand; 14% no plasticity fines; 8% fine to coarse gravel; micaceous.												
	105					85							14		
	106		Poorly Graded GRAVEL (GP); 100% fine to coarse gravel, max. 2.5 in..												
-25	107		LEAN CLAY with Sand (CL); dark gray; moist; 75% medium plasticity, no dilatancy fines; 25% fine sand.												
	108														
	109		SILTY SAND (SM); dark gray; wet; 77% fine to coarse sand; 23% no to low plasticity, slow dilatancy fines; micaceous; top and bottom of layer is boarded by 0.1' lenses of fine to coarse gravel, max. 1 in.										23		
	110		LEAN CLAY with Sand (CL); greenish gray; moist; 85% medium plasticity, no dilatancy fines; 15% fine sand.												Run 16 No recovery. Upper 1.5' disturbed and destroyed by gravelly slough.
	111		SILTY SAND (SM/ML); hard; very dark greenish gray; moist; 55% fine sand; 45% low plasticity, slow dilatancy fines; micaceous; over consolidated friable texture.												
-30	112					70				24	29	3	45		
	113		SILTY SAND (SM); very dark greenish gray; moist; 85% fine sand; 15% no plasticity fines.												
	114														
	115														Run 17 No recovery. 115-118' destroyed by slough; 118-119 highly disturbed. Did not save 118-118.5'.
	116														
-35	117					30									
	118														
	119														
	120														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,163,543.05 **Easting:** 6,673,552.11
Latitude: 39.10241 **Longitude:** -121.60572
Levee Station or Milepost: 866+19 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_004S
Sheet 5 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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
	120														Run 18
	121		At 121 feet 75% sand; 25% fines.										25		
-40	122					100									
	123		CLAYEY SAND (SC); very dark greenish gray; moist; 70% fine sand; 30% low plasticity, no to slow dilatancy fines; micaceous.												
	124														
	125		SILTY SAND (SM); very dark greenish gray; moist; 85% fine to medium sand; 15% no plasticity fines; micaceous; crumbly texture.												Run 19
	126		SANDY FAT CLAY (CH/SC); very dark greenish gray; moist; 50% low to medium plasticity, no dilatancy fines; 50% fine sand and very hard; fine to coarse sand size indurated (CL) fragments; poorly indurated; blocky texture.							37	71	37			
-45	127														
	128		SILTY SAND (SM); very dark greenish gray; moist; 80% fine sand; 20% no plasticity fines; micaceous; crumbly-friable texture.												
	129		SANDY SILT (ML); dark greenish gray; moist; 70% fine sand and fine to coarse sand size indurated (ML/CL) fragments; 30% low plasticity, no dilatancy fines; micaceous; poorly to well indurated; blocky texture; induration increases with depth. Sand fraction (70%) breaks down to 30% fine sand and 40% indurated lean clay (ML/CL) fragments.											
	130					100				30	40	9			
	131														
-50	132														
	133		CLAYEY SAND (SC); dark greenish gray; moist; 65% fine sand; 35% low plasticity, slow dilatancy fines; presence of mica; friable to crumbly texture; poorly indurated.												
	134		SANDY SILTY CLAY (CL/ML); dark greenish gray; moist; 65% low plasticity, no dilatancy fines; 35% fine sand and fine to medium sand size indurated (CL) fragments; poorly indurated to trace well indurated.												
	135														
	136		Borehole terminated at 135 feet. Backfilled boring with 250 gallons of neat grout consisting of 185 gallons water, 30 pounds of bentonite powder, 37-47 lb sacks of portland cement.												
-55	137														
	138														
	139														
	140														
	141														
-60	142														
	143														
	144														
	145														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,163,543.05 **Easting:** 6,673,552.11
Latitude: 39.10241 **Longitude:** -121.60572
Levee Station or Milepost: 866+19 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_004S
Sheet 6 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

DATE STARTED	DATE COMPLETED	GROUND ELEVATION	ELEVATION DATUM	TOTAL DEPTH OF BORING
10/4/12	10/5/12	52.6943 ft	NAVD 88	90.0 ft
DRILLING CONTRACTOR National		**DRILLER'S NAME** J. Marok	**HELPER'S NAME** R. Estrado/E. Jasso	**TOTAL DEPTH OF FILL** 0 ft
DRILLING METHOD Sonic		**DRILL RIG MAKE AND MODEL** Geoprobe 8140 LC #34		**CONSULTANT COMPANY** URS Corporation
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) 4-1/2" Sonic Corebarrel/6-1/4" csg bit		**DRILLING ROD TYPE AND DIAMETER** 3-1/2" Sonic		**FIELD LOGGER** M. Weil
☒ VERTICAL ☐ INCLINED		**CASING TYPE, DIAMETER, INSTALLATION DEPTH** 5-7/8" OD, 5-1/8" ID Steel		**FIELD LOG REVIEWER** M. PALMER
SAMPLER TYPE(S) 4-1/2" OD, 3-1/2" ID Core Barrel		**HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP** NA		**HAMMER EFFICIENCY**
BOREHOLE BACKFILL OR COMPLETION Cement with 5% Bentonite		**GROUNDWATER READING:**	**DURING DRILLING** NA	**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		Poorly Graded SAND with Silt (SP-SM); loose; dark yellowish brown; moist; 92% fine sand; 8% no plasticity fines.												Run 1 Hand auger to 5'
	1														
	2														
50	3					100							8		
	4														
	5														Run 2
	6														
	7														
45	8					100									
	9														
	10		SILT (ML); soft; olive gray; moist; 95% low plasticity, no dilatancy fines; 5% medium sand.												Run 3
	11									33	42	14			
	12														
40	13					100			<0.5P						
	14														
	15		Poorly Graded SAND with Clay (SP-SC).												Run 4 No recovery 15-19', driller indicated sand lost due to water used to advance casing.
	16														
	17														
35	18					100									
	19		SANDY LEAN CLAY (CL); dark olive gray; moist; 55% low plasticity fines; 45% fine to medium sand.												
	20														

Final Report Version

Borehole Location: Landside Toe **County:** Sutter
Coordinates: Northing: 2,164,673.03 **Easting:** 6,672,931.45
Latitude: 39.10552 **Longitude:** -121.60789
Levee Station or Milepost: 878+83 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_005S
Sheet 1 of 4

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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
	20														Run 5
	21		SILT (ML); soft; olive gray; moist; 95% low plasticity fines; 5% fine sand.												
	22									49	47	14			
30						100									
	23														
	24		At 24 feet with decomposing tree core fragments.												
	25														Run 6
	26		SANDY SILT (ML); olive gray; moist; 55% low plasticity fines; 45% fine sand.												
	27		Tree core section.							40	32	4			
25						100									
	28		Poorly Graded SAND with Clay (SP-SC); very dark greenish gray; moist; 90% fine to coarse sand; 10% low plasticity fines.												
	29														
	30														Run 7
	31														
	32														
20						100									
	33														
	34														
	35														Run 8
	36														
	37														
15						100									
	38														
	39														
	40														Run 9 No recovery 40-42.5'. Loose sand, loss of sample in hole.
	41														
	42												10		
10						100									
	43														
	44														
	45		CLAYEY SAND with Gravel (SC); medium dense; very												

Final Report Version

Borehole Location: Landside Toe **County:** Sutter
Coordinates: Northing: 2,164,673.03 **Easting:** 6,672,931.45
Latitude: 39.10552 **Longitude:** -121.60789
Levee Station or Milepost: 878+83 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_005S
Sheet 2 of 4

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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		dark greenish gray; moist; 60% fine to coarse sand; 20% gravel; 20% low plasticity fines.												Run 10 1st attempt to recovery (rock in bit) 2nd attempt full recovery.
	46														
	47														
5	48					100									
	49		Well-Graded GRAVEL with Sand (GW); very dark gray; moist; 59% gravel and cobbles; 36% coarse sand; 5% low plasticity fines.												
	50														Run 11
	51														
	52												5		
0	53					100									
	54														
	55														Run 12
	56														
	57														
-5	58					100									
	59		Well-Graded SAND with Silt (SW-SM); very dark gray; moist; 90% fine to coarse sand; 10% no plasticity fines.												
	60														Run 13
	61														
	62														
-10	63		Poorly Graded SAND with Silt (SP-SM); very dark gray; moist; 90% fine to medium sand; 10% no plasticity fines.												
	64														
	65														Run 14
	66		Well-Graded SAND (SW); very dark gray; moist; 95% fine to coarse sand; 5% no plasticity fines.												
	67														
-15	68												5		
	69														
	70														

Final Report Version

Borehole Location: Landside Toe **County:** Sutter
Coordinates: Northing: 2,164,673.03 **Easting:** 6,672,931.45
Latitude: 39.10552 **Longitude:** -121.60789
Levee Station or Milepost: 878+83 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_005S
Sheet 3 of 4

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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														Run 15
	71														
	72														
-20	73														
	74		SILT (ML); stiff; dark greenish gray; moist; 95% low plasticity fines; 5% fine sand.												
	75														Run 16
	76														
	77									44	46	14			
-25	78														
	79														
	80														Run 17
	81														
	82														
-30	83		SANDY LEAN CLAY (CL); dark greenish gray; moist; 55% low plasticity, no dilatancy fines; 45% medium sand.												
	84														
	85		LEAN CLAY (CL); dark greenish gray; moist; 95% low plasticity, no dilatancy fines; 5% fine sand.												Run 18
	86														
	87														
-35	88														
	89														
	90														
	91		Borehole terminated at 90 feet. Backfilled boring with neat grout consisting of 85 gallons water, 25 pounds of bentonite powder, 24-47 lb sacks of portland cement.												
	92														
-40	93														
	94														
	95														

Final Report Version

Borehole Location: Landside Toe **County:** Sutter
Coordinates: Northing: 2,164,673.03 **Easting:** 6,672,931.45
Latitude: 39.10552 **Longitude:** -121.60789
Levee Station or Milepost: 878+83 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_005S
Sheet 4 of 4

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

DATE STARTED 10/12/12	**DATE COMPLETED** 10/17/12	**GROUND ELEVATION** 80.3234 ft	**ELEVATION DATUM** NAVD 88	**TOTAL DEPTH OF BORING** 133.0 ft
DRILLING CONTRACTOR National		**DRILLER'S NAME** J. Marok	**HELPER'S NAME** N. Castro/M. Walker	**TOTAL DEPTH OF FILL** 25.5 ft
DRILLING METHOD Sonic		**DRILL RIG MAKE AND MODEL** Geoprobe 8140 LC #34		**CONSULTANT COMPANY** URS Corporation
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) 4-1/2" Sonic Corebarrel/6-1/4" csg bit		**DRILLING ROD TYPE AND DIAMETER** 3-1/2" Sonic		**FIELD LOGGER** M. Palmer
☒ **VERTICAL** ☐ **INCLINED**		**CASING TYPE, DIAMETER, INSTALLATION DEPTH** 5-7/8" OD, 5-1/8" ID Steel to 115'		**FIELD LOG REVIEWER** G.T. HONG
SAMPLER TYPE(S) 4-1/2" OD, 3-1/2" ID Core Barrel		**HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP** NA		**HAMMER EFFICIENCY**
BOREHOLE BACKFILL OR COMPLETION Neat cement grout		**GROUNDWATER READING:**	**DURING DRILLING** NA	**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
80	0		3-inch Asphalt Concrete.												Sonic 0-0.5'
			9-inch Aggregate Base.			0									0.5 to 5' Hand auger
	1		[LEVEE FILL] SILTY SAND with Gravel (SM); yellowish brown; moist; 50% fine to coarse sand; 30% fine to coarse, subangular gravel; 20% no plasticity fines; presence of mica.												
	2														
	3					100									
	4														
75	5		[LEVEE FILL] SILTY GRAVEL with Sand (GM); yellowish brown; moist; 50% fine to coarse, subangular to subrounded, hard gravel; 35% fine to coarse sand; 15% no to low plasticity, slow to rapid dilatancy fines.												Run 1
	6														
	7					100									
	8														
	9														
70	10														At 10' set casing to 10'. Run 2 Hard advancing core barrel to 12/5'.
	11		[LEVEE FILL] SILTY SAND (SM); olive brown; moist; 55% fine to medium sand; 45% no to low plasticity, slow to rapid dilatancy fines; presence of mica.			100									
	12														
	13		[LEVEE FILL] SILTY SAND with Gravel (SM); dark yellowish brown; moist; 65% fine to coarse sand; 20% no plasticity fines; 15% fine to coarse, subangular to rounded, hard gravel, max. 1.25 in.; presence of mica.												Run 3
	14					100									
65	15														Run 4
	16														
	17														
	18					100									
	19														
	20														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,166,097.89 **Easting:** 6,673,123.92
Latitude: 39.10943 **Longitude:** -121.60719
Levee Station or Milepost: 893+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_006S
Sheet 1 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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
60	20		[LEVEE FILL] SILTY SAND (SM); olive gray; moist; 80% fine to coarse sand; 20% no plasticity fines; presence of mica.												Run 5 No recovery 20.5-22'
	21					100									
	22														Difficult drilling, sands very compact. Run 6
	23		At 23 feet 70% fine to coarse sand; 30% no plasticity fines.			100									
FILL	24														
55	25														At 25' set casing to 25'. Run 7
	26		CLAYEY SAND (SC); dark gray; moist; 70% fine sand; 30% low plasticity, no to slow dilatancy fines; organic odor; presence of mica and fine grained size organic fragments.												
	27					100									
	28														
	29														
50	30														Run 8 30-32 disturbed and soupy; 32-34 fines washed away; core variably disturbed.
	31		SILTY SAND (SM); light olive brown; moist; 50% fine to coarse sand; 45% no to low plasticity, slow dilatancy fines; 5% fine, rounded, hard gravel.												
	32												45		
	33														
	34														
45	35					60									
	36														
	37		SILT with Sand (ML); dark yellowish brown; moist; 85% no plasticity, rapid dilatancy fines; 15% fine sand; micaceous.												
	38									27	26	NP			
	39														
40	40														At 40 set casing to 30'. Run 9 No recovery 40-45' completely disturbed (liquid).
	41														
	42														
	43					50									
	44														
	45														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,166,097.89 **Easting:** 6,673,123.92
Latitude: 39.10943 **Longitude:** -121.60719
Levee Station or Milepost: 893+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_006S
Sheet 2 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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
35	45														
	46														
	47		LEAN CLAY with Sand (CL); dark yellowish brown; moist; 80% low to medium plasticity, no dilatancy fines; 20% fine to coarse sand; micaceous.			50									
	48														
	49														
	50		SILTY SAND (SM/SC); dark yellowish brown; moist; 63% fine to coarse sand; 37% low plasticity, slow to rapid dilatancy fines.												Run 10 At 50' set casing to 45'.
30	51														
	52												37		
	53														
	54		Poorly Graded SAND (SP); very dark greenish gray; wet; 95% fine to medium sand; 5% no plasticity fines; micaceous.												
	55					88									
25	56		SANDY SILT (ML/SM); dark yellowish brown; wet; 50% fine sand; 50% low plasticity, slow to rapid dilatancy fines; micaceous.												
	57									30	27	1			
	58														
	59		SILTY SAND (SM); olive; moist; 60% fine to medium sand; 40% no plasticity fines; micaceous.										40		
	60														At 60' set casing to 55'. Run 11 No recovery 60-65'
20	61														
	62														
	63														
	64														
	65		SILTY SAND with Gravel (SM); very dark greenish gray; 55% fine to coarse sand; 30% fine to coarse gravel, max. 1.5 in.; 15% no plasticity fines; presence of mica.			50									
15	66														
	67														
	68														
	69														
	70														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,166,097.89 **Easting:** 6,673,123.92
Latitude: 39.10943 **Longitude:** -121.60719
Levee Station or Milepost: 893+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_006S
Sheet 3 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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
10	70														At 70' set casing to 65'. Run 12
	71		Poorly Graded GRAVEL with Sand (GP); dark greenish gray; wet; 80% fine to coarse, subrounded to rounded gravel, max. 2 in.; 17% fine to coarse sand; 3% no plasticity fines.												
	72					86									
	73												3		
	74														
5	75														At 75' set casing to 70'. Run 13
	76														
	77														
	78														
	79														
0	80					89									
	81														
	82														
	83														
	84		SILTY SAND (SM); greenish black; moist; 80% fine to medium sand; 20% no plasticity fines; micaceous; friable texture.												
-5	85														Run 14 No recovery 85-88.5'
	86														
	87														
	88														
	89														
-10	90					65									
	91		SILTY SAND with Gravel (SM); greenish black; moist; 60% fine to coarse sand; 20% fine to coarse, rounded, hard gravel, max. 1.5 in.; 20% no plasticity fines.												
	92														
	93		SILTY SAND (SM); greenish black; moist; 65% fine to medium sand; 30% no plasticity fines; 5% fine gravel; poorly indurated; friable texture.												
	94														
	95														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,166,097.89 **Easting:** 6,673,123.92
Latitude: 39.10943 **Longitude:** -121.60719
Levee Station or Milepost: 893+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_006S
Sheet 4 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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
-15	95		Poorly Graded GRAVEL with Sand (GP); very dark greenish gray; wet; 65% fine to coarse, subrounded to rounded, hard gravel, max. 1 in.; 30% fine to coarse sand; 5% no plasticity fines.												At 95' set casing to 85'. Run 15
	96														
	97														
	98														
	99														
-20	100		Poorly Graded GRAVEL (GP); very dark greenish gray; wet; 85% fine to coarse, subrounded to rounded, hard gravel, max. 2 in.; 10% fine to coarse sand; 5% no plasticity fines.			100									
	101														
	102		SILTY SAND with Gravel (SM); very dark greenish gray; wet; 42% fine to coarse sand; 38% fine, subangular to subrounded, hard gravel, max. .75 in.; 20% no plasticity fines; poorly indurated; friable texture.												
	103														
	104												20		
-25	105														At 105' set casing to 95'. Run 16 No recovery 105-107' Rig broke, core barrel in hole at 115'.
	106														
	107														
	108														
	109														
-30	110		SILTY SAND (SM); very dark greenish gray; moist; 55% fine sand; 45% no to low plasticity, low dry strength, slow to rapid dilatancy fines; micaceous; variably thin bedded to massive bedding; no to weakly indurated.			80									
	111														
	112														
	113														
	114														Recover core barrel continue coring.
-35	115		At 114.5 feet 75% fine to medium sand; 25% no to low plasticity, slow to rapid dilatancy fines; micaceous; friable texture.			100									Run 17 Clean out and advance to 116. Run 18
	116		CLAYEY GRAVEL with Sand (GC); very dark greenish gray; moist; 50% fine to coarse, rounded, hard gravel, max. 1.25 in.; 35% fine to coarse sand; 15% low plasticity, medium to high dry strength, no dilatancy fines; blocky texture; poorly indurated.												
	117														
	118		SILTY SAND with Gravel (SM); very dark greenish gray; moist; 40% fine to medium sand; 35% fine to coarse gravel, max. 1.5 in.; 25% low plasticity, no to slow dilatancy fines; micaceous.			100				12	30	6			
	119		CLAYEY SAND (SC); very dark greenish gray; moist; 75% fine to coarse sand; 25% low plasticity, no to slow dilatancy fines; micaceous.												
	120														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,166,097.89 **Easting:** 6,673,123.92
Latitude: 39.10943 **Longitude:** -121.60719
Levee Station or Milepost: 893+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_006S
Sheet 5 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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
-40	120		SANDY SILTY CLAY (CL/ML); very dark greenish gray; moist; 65% low plasticity, no to slow dilatancy fines; 35% fine sand; micaceous.												At 120' set casing to 115'. Run 19
	121		LEAN CLAY (CL); very hard; very dark greenish gray; moist; 1% fine sand and sand size indurated soil fragments; 99% low plasticity, no dilatancy fines; micaceous; blocky; weakly indurated.												
	122					100							99		
	123														
	124														
-45	125		At 125 feet poorly indurated to well indurated (similar to a mudstone).												Run 20
	126														
	127														
	128		SILTY SAND (SM); very dense; very dark greenish gray; moist; 70% fine sand and fine to coarse sand size indurated fragments of (SM); 30% low plasticity, slow dilatancy fines; micaceous; poorly indurated; friable texture.												
	129					100									
-50	130		SANDY SILTY CLAY (CL/ML); very hard; very dark greenish gray; moist; 50% fine sand and fine to coarse sand size indurated soil fragments; 50% low plasticity, no to slow dilatancy fines; well indurated (similar to a mudstone).												
	131														
	132														Driller over drilled by 3'.
	133														
	134		Borehole terminated at 133 feet. Backfilled boring with 225 gallons of neat grout consisting of 170 gallons water, 25 pounds of bentonite powder, 38-47 lb sacks of portland cement.												
-55	135														
	136														
	137														
	138														
	139														
-60	140														
	141														
	142														
	143														
	144														
	145														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,166,097.89 **Easting:** 6,673,123.92
Latitude: 39.10943 **Longitude:** -121.60719
Levee Station or Milepost: 893+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_006S
Sheet 6 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

DATE STARTED	DATE COMPLETED	GROUND ELEVATION	ELEVATION DATUM	TOTAL DEPTH OF BORING
10/11/12	10/12/12	81.8208 ft	NAVD 88	120.0 ft
DRILLING CONTRACTOR National		**DRILLER'S NAME** J. Marok	**HELPER'S NAME** N. Castro/G. Becker	**TOTAL DEPTH OF FILL** 28 ft
DRILLING METHOD Sonic		**DRILL RIG MAKE AND MODEL** Geoprobe 8140 LC #34		**CONSULTANT COMPANY** URS Corporation
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) 4-1/2" Sonic Corebarrel/6-1/4" csg bit		**DRILLING ROD TYPE AND DIAMETER** 3-1/2" Sonic		**FIELD LOGGER** M. Palmer
☒ **VERTICAL** ☐ **INCLINED**		**CASING TYPE, DIAMETER, INSTALLATION DEPTH** 5-7/8" OD, 5-1/8" ID Steel to 100'		**FIELD LOG REVIEWER** G.T. HONG
SAMPLER TYPE(S) 4-1/2" OD, 3-1/2" ID Core Barrel		**HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP** NA		**HAMMER EFFICIENCY**
BOREHOLE BACKFILL OR COMPLETION Neat cement grout		**GROUNDWATER READING:**	**DURING DRILLING** NA	**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		3-inch Asphalt Concrete.												0-0.5' sonic
			9-inch Aggregate Base.												Hand auger to 5'
	1		[LEVEE FILL] SILTY SAND with Gravel yellowish brown; moist; 60% fine to coarse sand; 25% fine to coarse, subrounded to rounded, hard gravel; 15% no plasticity fines; presence of mica.												
80	2														
	3														
	4														
	5		[LEVEE FILL] SILTY SAND (SM); yellowish brown; moist; 81% fine to coarse sand; 14% no plasticity fines; 5% fine, subrounded to rounded, hard gravel, max. 3/8 in.; presence of mica.												Run 1
	6														
75	7					92									
	8												14		
	9		At 9 feet olive gray; 80% fine to coarse sand; 20% no plasticity fines.												
	10														Run 2
	11														
70	12		At 12 feet 70% fine to coarse sand; 20% no plasticity fines; 10% fine to coarse gravel, max. 1 in.			88									
	13														
	14		At 14 feet 80% fine to coarse sand; 20% no plasticity fines.			100									Run 3
	15		At 15 feet dark olive gray; 60% fine to medium sand; 40% no to low plasticity, rapid dilatancy fines; micaceous; trace fine organic fragments with 3.5" lifts of Silt with Sand (ML); 75% no plasticity fines; 25% fine sand; trace fine organic fragments and Silty Sand (SM); 85% fine to medium sand; 15% no plasticity fines.												At 15' set casing to 10'. Run 4
65	16														
	17					65									
	18														
	19														
	20														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,166,793.84 **Easting:** 6,673,197.52
Latitude: 39.11134 **Longitude:** -121.60692
Levee Station or Milepost: 900+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_007S
Sheet 1 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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
	20														Run 5
	21														
60	22														
	23					80									
	24														
	25														Run 6
	26														
55	27														
FILL						90									
	28		CLAYEY SAND (SC); hard; olive gray; 60% fine to coarse sand; 40% low to medium plasticity, no to slow dilatancy fines; micaceous.												Original ground at 28'.
	29														
	30														Run 7
	31		SILTY SAND (SM); light olive brown; moist; 80% fine to medium sand; 20% no plasticity fines; micaceous.												
50	32												20		Hard drilling to 34'.
	33														No recovery 33-40'
	34														
	35					30									At 35-36 soft/quick advance.
	36														
45	37														
	38														
	39														
	40														At 40' set casing to 30'. Run 8 40-50' no vibration used, sample advanced to depth under weight of rods.
	41		At 41 feet interbeds of Silty Sand as in 31-41 feet and Silt (ML) as in 43-44 feet..												
40	42														
	43					80									
	44		SILT with Sand (ML); black; moist; 79% low plasticity, slow to rapid dilatancy fines; 21% fine sand; micaceous; presence of fine organic matter; slight organic odor. At 44 feet very dark grayish brown; no organics or organic odor.							37	35	7	79		
	45														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,166,793.84 **Easting:** 6,673,197.52
Latitude: 39.11134 **Longitude:** -121.60692
Levee Station or Milepost: 900+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_007S
Sheet 2 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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														
	46														
35	47														
	48					80									
	49														
	50														At 50' set casing to 50'. Run 9 Initial recovery 3'/10' some sample fell out of core barrel. Re-cored interval to 60' and recovered 5'/10', however, 2' were disturbed appears as slough.
	51														
30	52														
	53		SILTY SAND (SM); dark olive gray; wet; 86% fine to medium sand; 14% no plasticity fines; trace coarse sand; micaceous.												
	54												14		
	55					50									No recovery 55-59.5'
	56														
25	57														
	58														
	59														
	60		SILTY SAND with Gravel (SM); olive gray; wet; 65% fine to coarse sand; 25% no to low plasticity fines; 15% fine to coarse, rounded, hard gravel; presence of mica.												At 60' set casing to 60'. Run 10
	61														
20	62		Poorly Graded SAND with Silt and Gravel (SP-SM); dark greenish gray; wet; 60% fine to coarse sand; 30% fine to coarse, rounded, hard gravel, max. 1 in.; 10% no plasticity fines.			70									Flapper bit is disturbing sample, request to use open bit.
	63														
	64														No recovery 63.5-65'
	65		Poorly Graded GRAVEL with Sand (GP); very dark greenish gray; wet; 80% fine to coarse, rounded, hard gravel; 15% fine to coarse sand; 5% no plasticity fines.												Run 11
	66														
15	67					90									
	68														
	69														
	70		Poorly Graded SAND with Silt (SP-SM); very dark												

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,166,793.84 **Easting:** 6,673,197.52
Latitude: 39.11134 **Longitude:** -121.60692
Levee Station or Milepost: 900+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_007S
Sheet 3 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

Elevation, feet	Depth, feet	CLASSIFICATION OF MATERIALS (Description)	Recovery, %	Fines, % < #200	REMARKS
	70	greenish gray; wet; 90% fine to medium sand; 10% no plasticity fines.			Run 12
	71				
10	72	At 72 feet 90% fine to coarse sand; 10% no plasticity fines; trace fine gravel.	98		
	73	SILTY SAND (SM); greenish gray; wet; 70% fine to coarse sand; 30% no to low plasticity, slow dilatancy fines; presence of mica.			
	74	SILTY SAND with Gravel (SM); greenish gray; wet; 55% fine to coarse sand; 30% fine to coarse gravel, max. 1 in.; 15% no to low plasticity, slow dilatancy fines.			
	75				At 75' set casing to 70'. Run 13
	76	SILTY GRAVEL with Sand (GM); dark greenish gray; moist; 65% fine to coarse, rounded gravel, max. 2.25 in.; 26% fine to coarse sand; 14% no to low plasticity fines; consolidated, gravels leave pluck marks (casts) in matrix when removed.			
5	77				
	78		86		
	79			14	
	80				At 80' set casing to 75'. Run 14
	81				
0	82				
	83		90		
	84	Poorly Graded SAND (SP); dark greenish gray; moist; 95% fine to medium sand; 5% no plasticity fines.			
	85				At 85' set casing to 80'. Run 15
	86				
-5	87				
	88	SILTY SAND (SM); dark greenish gray; moist; 80% fine to medium sand; 20% no plasticity fines; friable texture.	92		
	89	Well-Graded SAND with Silt and Gravel (SW-SM); dark greenish gray; moist; 66% fine to coarse sand; 25% fine to coarse gravel, max. 1.5 in.; 9% no plasticity fines.		9	
	90				At 90' set casing to 85'. Run 16
	91				
-10	92				
	93		100		
	94	CLAYEY SILT with Sand (ML/CL); dark gray; moist; 85% low plasticity, slow to rapid dilatancy fines; 15% fine			
	95				

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,166,793.84 **Easting:** 6,673,197.52
Latitude: 39.11134 **Longitude:** -121.60692
Levee Station or Milepost: 900+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_007S
Sheet 4 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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		sand; micaceous; slight organic odor; trace organic fragments. At 94.5 feet one 1/4 in. diameter root.												At 95' set casing to 90'. Run 17
	96		SILTY SAND (SM); dark gray; moist; 30% no plasticity fines; micaceous; presence of finely disseminated organics; friable texture; interbedded (0.3'-1.0' thick) with Poorly graded Sand (SP): dark gray; moist; 95% fine to medium sand; 5% no plasticity fines.												
-15	97					96									
	98														
	99														
	100														At 100' set casing to 95'. Run 18
	101		Poorly Graded SAND (SP); dark gray; moist; 95% fine to medium sand; 5% no plasticity fines; micaceous.												
-20	102														
	103		Poorly Graded GRAVEL with Sand (GP); dark gray; moist; 60% fine to coarse, subrounded to rounded gravel, max. 1.5 in.; 35% fine to coarse sand; 5% no plasticity fines.			100									
	104														
	105		SILTY SAND (SM); dark gray; moist; 80% fine sand; 20% no plasticity fines; micaceous; poorly indurated; friable. At 105 feet 85% fine to medium sand; 15% no plasticity fines; non-indurated.												Run 19 Upper 3' disturbed.
	106		Poorly Graded SAND with Silt (SP-SM); dark gray; moist; 93% fine sand; 6% no plasticity fines; 1% fine, rounded, hard gravel.										6		
-25	107		Poorly Graded GRAVEL with Sand (GP); dark gray; wet; 60% fine to coarse, subrounded to rounded, hard gravel, max. 1.25 in.; 35% fine to coarse sand; 5% no plasticity fines.			100									
	108														
	109		SILTY SAND (SM); dark gray; wet; 85% fine to medium sand; 15% no plasticity fines. At 108.9 feet lens of fine to coarse gravel, max. 1.25 in.												
	110		CLAYEY SAND (SC); very dark greenish gray; moist; 75% fine to coarse sand; 25% low plasticity, no dilatancy fines; micaceous; over consolidated texture.												At 110' set casing to 100'. Run 20
	111		SILTY SAND (SM); dark gray; moist; 80% fine to medium sand; 20% no plasticity fines; micaceous.												
-30	112		SILTY SAND with Gravel (SM); dark gray; moist; 70% fine to coarse sand; 15% fine to coarse, rounded, hard gravel, max. 3 in.; 15% no plasticity fines.												
	113														
	114		FAT CLAY (CH); dark greenish gray; 90% high plasticity, no dilatancy fines; 10% fine sand; micaceous; blocky texture.												
	115					100									
	116		SANDY SILT (ML); dark greenish gray; 60% low plasticity, slow dilatancy fines; 40% fine sand; micaceous.												
-35	117														
	118									29	37	7			
	119														
	120														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,166,793.84 **Easting:** 6,673,197.52
Latitude: 39.11134 **Longitude:** -121.60692
Levee Station or Milepost: 900+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_007S
Sheet 5 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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
	120														
	121		Borehole terminated at 120 feet. Backfilled boring with 230 gallons of neat grout consisting of 170 gallons water, 0 pounds of bentonite powder, 28-47 lb sacks of portland cement.												
-40	122														
	123														
	124														
	125														
	126														
-45	127														
	128														
	129														
	130														
	131														
-50	132														
	133														
	134														
	135														
	136														
-55	137														
	138														
	139														
	140														
	141														
-60	142														
	143														
	144														
	145														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,166,793.84 **Easting:** 6,673,197.52
Latitude: 39.11134 **Longitude:** -121.60692
Levee Station or Milepost: 900+00 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_007S
Sheet 6 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

DATE STARTED 10/5/12	**DATE COMPLETED** 10/9/12	**GROUND ELEVATION** 81.0599 ft	**ELEVATION DATUM** NAVD 88	**TOTAL DEPTH OF BORING** 120.0 ft
DRILLING CONTRACTOR National		**DRILLER'S NAME** J. Marok	**HELPER'S NAME** R. Estrado/E. Jasso	**TOTAL DEPTH OF FILL** 23 ft
DRILLING METHOD Sonic		**DRILL RIG MAKE AND MODEL** Geoprobe 8140 LC #34		**CONSULTANT COMPANY** URS Corporation
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) 4-1/2" Sonic Corebarrel/6-1/4" csg bit		**DRILLING ROD TYPE AND DIAMETER** 3-1/2" Sonic		**FIELD LOGGER** M. Weil/G. Hong
[X] **VERTICAL** [ ] **INCLINED**		**CASING TYPE, DIAMETER, INSTALLATION DEPTH** 5-7/8" OD, 5-1/8" ID Steel		**FIELD LOG REVIEWER** M. PALMER
SAMPLER TYPE(S) 4-1/2" OD, 3-1/2" ID Core Barrel		**HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP** NA		**HAMMER EFFICIENCY**
BOREHOLE BACKFILL OR COMPLETION Cement with Bentonite		**GROUNDWATER READING:**	**DURING DRILLING** NA	**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		3-inch Asphalt Concrete.												Run 1
80	1		14-inch Aggregate Base.												
	2		[LEVEE FILL] SILTY SAND (SM); brown; moist; 70% fine to medium sand; 30% no plasticity fines.			100									
	3														
	4														
	5														Run 2 Difficult drilling, very stiff soil, low recovery, 2nd attempt additional 20" recovered.
75	6														
	7					67									
	8														
	9														
	10														Run 3
70	11														
	12		At 12 feet 78% sand; 22% fines.			100							22		
	13														
	14														
	15														Run 4
65	16		[LEVEE FILL] SANDY SILT (ML); very dark gray; moist; 55% low plasticity, slow dilatancy fines; 45% fine sand.												
	17					100									
	18														
	19														
	20														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,168,172.15 **Easting:** 6,673,571.75
Latitude: 39.11512 **Longitude:** -121.60558
Levee Station or Milepost: 914+40 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_008S
Sheet 1 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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
	20														Run 5
60	21														
FILL	22					60									
	23		SILTY SAND (SM); olive brown; wet; 70% medium sand; 30% low plasticity fines.												
	24														
	25														Run 6
55	26		At 26 feet moist; very dark gray; 80% medium sand; 20% low plasticity fines.												
	27					100									
	28		At 28 feet 62% sand; 37% fines; 1% fine gravel.										37		
	29														
	30														No Recovery 30-35'
50	31														
	32					0									
	33														
	34														
	35		SANDY SILT (ML); very dark gray; wet; 68% low plasticity, slow dilatancy fines; 32% fine sand.												Run 7
45	36														
	37					40				30	25	3	68		
	38														
	39														
	40														No Recovery 40-45'
40	41														
	42					0									
	43														
	44														
	45														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,168,172.15 **Easting:** 6,673,571.75
Latitude: 39.11512 **Longitude:** -121.60558
Levee Station or Milepost: 914+40 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_008S
Sheet 2 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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		SILTY SAND (SM); brown; wet; 70% medium sand; 30% low plasticity fines.												Run 8
35	46														
	47														
	48					100									
	49														
	50		SANDY SILT (ML); brown; wet; 56% low plasticity fines; 44% fine to medium sand.												Run 9
30	51														
	52										20	2	56		
	53					60									
	54														
	55														Run 10
25	56														
	57														
	58		SILTY SAND (SM); very dark greenish gray; wet; 85% medium sand; 15% low plasticity fines.			40									
	59		Well-Graded GRAVEL with Sand (GW); very dark greenish gray; wet; 80% gravel; 15% coarse sand; 5% no plasticity fines.												
	60		Poorly Graded SAND with Silt and Gravel (SP-SM); very dark greenish gray; wet; 53% medium to coarse sand; 37% gravel; 10% no plasticity fines.												Run 11
20	61														
	62														
	63					50							10		
	64														
	65		Well-Graded GRAVEL with Sand (GW); very dark gray; wet; 70% gravel; 25% coarse sand; 5% no plasticity fines.												Run 12 Low recovery due to large cobble at tip (not good for sieve analysis).
15	66														
	67														
	68					30									
	69														
	70														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,168,172.15 **Easting:** 6,673,571.75
Latitude: 39.11512 **Longitude:** -121.60558
Levee Station or Milepost: 914+40 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_008S
Sheet 3 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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		Poorly Graded SAND (SP); very dark greenish gray; wet; 90% medium to coarse sand; 5% gravel; 5% no plasticity fines.												Run 13
10	71														
	72					100									
	73		Poorly Graded GRAVEL with Silt and Sand (GP-GM); dark gray; wet; 65% gravel; 25% coarse sand; 10% low plasticity fines.												
	74														
	75														Run 14
5	76														
	77														
	78														
	79														
	80		Poorly Graded GRAVEL with Sand (GP); dark greenish gray; wet; 65% gravel; 31% coarse sand; 4% no plasticity fines.												Run 15
0	81														
	82					100							4		
	83		SILT (ML); dark greenish gray; moist; 95% no dilatancy fines; 5% fine sand.												
	84														
	85														Run 16
-5	86														
	87					42				32	43	12			
	88														
	89														
	90														Run 17 At 90' add casing from 75' to 90'.
-10	91														
	92		SILTY SAND (SM); very dark gray; moist; 80% fine to medium sand; 20% no plasticity fines; micaceous; with a few 1" thick interbeds of Sandy Silt (ML); 60% no plasticity fines; 40% sand.			80									
	93														
	94		At 93.5 feet a 2" lens of fine to coarse, round, hard gravel, max. 1.5 in.												
	95														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,168,172.15 **Easting:** 6,673,571.75
Latitude: 39.11512 **Longitude:** -121.60558
Levee Station or Milepost: 914+40 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_008S
Sheet 4 of 6

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														
-15	96														
	97														
	98					80									
	99														
	100														Run 18
-20	101		At 101 feet 75% fine to medium sand; 15% no plasticity fines 10% fine, round, hard gravel.												
	102														
	103														
			Poorly Graded GRAVEL with Silt and Sand (GP-GM); very dark gray; moist; 50% fine to coarse, rounded, hard gravel; 40% fine to coarse sand; 10% no plasticity fines.												
	104		FAT CLAY (CH); grayish green; moist; 90% slow dilatancy fines; 10% fine sand.												
	105					58				33	59	31			
-25	106														105.75' bit blocked off, no recovery to 110'.
	107														
	108														
	109		SANDY SILTY CLAY (CL/ML); grayish green; moist; 70% low plasticity, medium to high dry strength, slow dilatancy fines; 30% fine sand.												
	110														Run 19 Upper 18" (110-111.5') lost due to mixing with slough.
-30	111														
	112														
	113														
	114														
	115					85									
-35	116		SILTY SAND (SM); grayish green; moist; 65% fine sand; 35% no to low plasticity, medium dry strength, slow to rapid dilatancy fines.												
	117														
	118		At 118 feet a 6" lens of (SM) 75% fine to coarse sand; 25% no plasticity fines; (SM) as in 115.5 with 1-3" interbeds of (SM) as in 118 to 118.5.												
	119														
	120		SANDY LEAN CLAY (CL); grayish green; moist; 70% low												

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,168,172.15 **Easting:** 6,673,571.75
Latitude: 39.11512 **Longitude:** -121.60558
Levee Station or Milepost: 914+40 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_008S
Sheet 5 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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
	120		to medium plasticity fines; 30% fine sand.												
-40	121														
	122		Borehole terminated at 120 feet. Backfilled boring with 250 gallons of neat grout consisting of 200 gallons water, 45 pounds of bentonite powder, 40-47 lb sacks of portland cement..												
	123														
	124														
	125														
-45	126														
	127														
	128														
	129														
	130														
-50	131														
	132														
	133														
	134														
	135														
-55	136														
	137														
	138														
	139														
	140														
-60	141														
	142														
	143														
	144														
	145														

Final Report Version

Borehole Location: Levee Crest **County:** Sutter
Coordinates: Northing: 2,168,172.15 **Easting:** 6,673,571.75
Latitude: 39.11512 **Longitude:** -121.60558
Levee Station or Milepost: 914+40 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_008S
Sheet 6 of 6

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

DATE STARTED	DATE COMPLETED	GROUND ELEVATION	ELEVATION DATUM	TOTAL DEPTH OF BORING
10/9/12	10/10/12	58.5248 ft	NAVD 88	97.5 ft
DRILLING CONTRACTOR National		**DRILLER'S NAME** J. Marok	**HELPER'S NAME** N. Castro/G. Becker	**TOTAL DEPTH OF FILL** 0 ft
DRILLING METHOD Sonic		**DRILL RIG MAKE AND MODEL** Geoprobe 8140 LC #34		**CONSULTANT COMPANY** URS Corporation
DRILL BIT SIZE AND TYPE (HOLE DIAMETER) 4-1/2" Sonic Corebarrel/6-1/4" csg bit		**DRILLING ROD TYPE AND DIAMETER** 3-1/2" Sonic		**FIELD LOGGER** M. Palmer
☒ VERTICAL ☐ INCLINED		**CASING TYPE, DIAMETER, INSTALLATION DEPTH** 5-7/8" OD, 5-1/8" ID Steel to 80'		**FIELD LOG REVIEWER** G.T. HONG
SAMPLER TYPE(S) 4-1/2" OD, 3-1/2" ID Core Barrel		**HAMMER TYPE, MAKE/MODEL, WEIGHT/DROP** NA		**HAMMER EFFICIENCY**
BOREHOLE BACKFILL OR COMPLETION Neat cement Bentonite grout		**GROUNDWATER READING: DURING DRILLING** NA		**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		3-inch Asphalt Concrete.												0-0.5' sonic core
	1		SILTY SAND (SM); dark yellowish brown; moist; 55% fine sand; 45% no to low plasticity, rapid dilatancy fines; micaceous.												0.5-6' hand auger, bagged
	2														
	3					100									
55	4														
	5														
	6														Run 1
	7														
	8					50									
50	9														
	10														At 10' set casing to 10'. Run 2
	11														
	12					90									
	13		At 13 feet moist to wet.												
45	14														
	15		At 14.5 feet low plasticity, slow to rapid dilatancy fines. At 15 feet wet.												Run 3
	16														
	17					20				31	28	3			
	18														
40	19		SILT (ML); dark yellowish brown; wet; 89% no plasticity fines; 11% fine to medium sand; micaceous.												
	20														

Final Report Version

Borehole Location: Landside Toe **County:** Sutter
Coordinates: Northing: 2,168,876.02 **Easting:** 6,673,792.83
Latitude: 39.11705 **Longitude:** -121.60479
Levee Station or Milepost: 921+69 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_009S
Sheet 1 of 5

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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
	20														Run 4
	21														
	22														
	23					95									
35	24												89		
	25														Run 5
	26														
	27														
	28					100									
30	29		At 28.5 feet 86% no to low plasticity fines; 14% fine to medium sand.							35	32	2	86		
	30														Run 6
	31														
	32														
	33					90									
25	34														
	35														Run 7
	36														
	37														
	38					100									
20	39		SILTY SAND (SM); very dark greenish gray; moist; 80% fine sand; 20% low plasticity, rapid dilatancy fines; organic odor; micaceous.												
	40		SILTY GRAVEL with Sand (GM); very dark greenish gray; wet; 65% fine to coarse, rounded, hard gravel, max. 1.5 in.; 20% fine to coarse sand; 15% no plasticity fines; micaceous.												At 40' set casing to 35'. Run 8
	41														
	42		Poorly Graded GRAVEL with Sand (GP); wet; 75% fine to coarse gravel; 20% fine to coarse sand; 5% no plasticity fines; micaceous; slight organic odor.												
	43					60									
15	44														
	45														

Final Report Version

Borehole Location: Landside Toe **County:** Sutter
Coordinates: Northing: 2,168,876.02 **Easting:** 6,673,792.83
Latitude: 39.11705 **Longitude:** -121.60479
Levee Station or Milepost: 921+69 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_009S
Sheet 2 of 5

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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														At 45' set casing to 45'. Run 9 Upper 18-24" disturbed and contaminated with slough from casing advancement.
	46														
	47		Poorly Graded SAND with Silt (SP-SM); olive brown; moist; 90% fine to medium sand; 10% no plasticity fines; few thin (1") interbeds of Sandy Silt (ML); presence of mica.			100									
	48														
10	49														
	50														Run 10
	51		Poorly Graded SAND with Gravel (SP); greenish gray; wet; 60% fine to coarse, rounded to subangular, hard sand; 35% fine to coarse, rounded to subangular gravel, max. 1 in.; 5% no plasticity fines.												
	52					84									
	53		SILTY SAND (SM); greenish gray; wet; 70% fine to medium sand; 30% no plasticity fines; micaceous; several 0.1' lenses of coarse sand with gravels, max. 3/4 in.												
5	54														
	55		ELASTIC SILT (MH); gray; wet; 95% low to medium plasticity, medium dry strength, slow dilatancy fines; 5% fine sand; slight organic odor.												At 55' set casing to 50'. Run 11
	56		Poorly Graded SAND with Silt (SP-SM); very dark greenish gray; wet; 90% fine to medium sand; 10% no plasticity fines; micaceous; scattered thin (0.1-0.2') lenses of Silty Sand (SM); 85% fine to medium sand; 15% no plasticity fines; and Sandy Silt (ML); 60% no to low plasticity fines; 40% sand.												
	57					100									
	58														
0	59														
	60														At 60' set casing to 55'. Run 11
	61														
	62		At 61.99 feet one hard, subangular 3" cobble.												
	63		SILTY SAND (SM); very dark greenish gray; wet; 83% fine to medium sand; 17% no plasticity fines; micaceous; slight organic odor.			92							17		
-5	64														
	65		At 64.8 feet one hard, rounded 2 in. gravel.												At 65' set casing to 60'. Run 12
	66		LEAN CLAY with Sand (CL); soft; dark greenish gray; wet; 85% low to medium plasticity, no to slow dilatancy fines; 15% fine sand; slight organic odor.												
	67		SILTY SAND (SM); very dark greenish gray; wet; 60% fine sand; 40% no plasticity fines; micaceous.												
	68		Interbedded (SM) and (SP); 6"-12" beds; very dark greenish gray; wet; micaceous; Silty Sand (SM); 80% fine to medium sand; 20% no plasticity fines and Poorly Graded Sand with Silt (SP-SM); 90% fine to medium sand; 10% no plasticity fines.			100								
-10	69														
	70														

Final Report Version

Borehole Location: Landside Toe **County:** Sutter
Coordinates: Northing: 2,168,876.02 **Easting:** 6,673,792.83
Latitude: 39.11705 **Longitude:** -121.60479
Levee Station or Milepost: 921+69 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_009S
Sheet 3 of 5

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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														At 70' set casing to 65'. Run 13
	71		Poorly Graded SAND with Silt (SP-SM); very dark greenish gray; wet; 90% fine to medium sand; 10% no plasticity fines; micaceous.												
	72														
	73					100									
-15	74		Poorly Graded GRAVEL with Silt and Sand (GP-GM); very dark greenish gray; 70% fine to coarse, subangular to subrounded gravel, max. 1.25 in.; 20% fine to coarse sand; 10% no to low plasticity fines; presence of mica.												
	75														At 75' set casing to 70'. Run 14
	76														
	77														
	78					94									
-20	79		SILTY SAND with Gravel (SM); very dark greenish gray; moist; 50% fine to coarse sand; 30% no to low plasticity fines; 20% fine to coarse, subangular to subrounded gravel; micaceous.												
	80														Run 15
	81		Poorly Graded SAND with Gravel (SP); very dark greenish gray; moist; 80% fine to medium sand; 15% fine to coarse gravel, max. 1.25 in.; 5% no plasticity fines; presence of mica.												
	82		SILTY SAND with Gravel (SM/SC); very dark greenish gray; 58% fine to medium sand; 22% gravel; 20% low plasticity, slow dilatancy fines; micaceous; friable.										20		
	83					90									
-25	84		0.1-0.2' interbeds grayish green; moist; micaceous; Silty Sand (SM/SC); friable; 60% fine to medium sand; 40% low plasticity, slow dilatancy fines and Sandy Lean Clay (CL); hard 65% low plasticity fines; 35% fine sand.												
	85														At 85' set casing to 80'. Run 16
	86					100									
	87														Stopped coring, driller thought core barrel was full, just hard ground. Run 17
	88		SILT with Sand (ML); grayish green; moist; 75% low to medium plasticity, no to slow dilatancy fines; 25% fine sand; over consolidated; blocky texture.												
-30	89														
	90									27	39	9			
	91					85									
	92														
	93														
-35	94		CLAYEY SAND (SC); grayish green; moist; 55% fine to coarse sand; 45% low to medium plasticity, no to slow												
	95														

Final Report Version

Borehole Location: Landside Toe **County:** Sutter
Coordinates: Northing: 2,168,876.02 **Easting:** 6,673,792.83
Latitude: 39.11705 **Longitude:** -121.60479
Levee Station or Milepost: 921+69 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_009S
Sheet 4 of 5

SBFCA Feather River West Levee

SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

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		dilatancy fines; presence of mica; blocky texture; over consolidated.												
	96		LEAN CLAY with Sand (CL); grayish green; moist; 75% low to medium plasticity, no to slow dilatancy fines; 25% fine sand; over consolidated; blocky texture.			85									
	97														
	98		Borehole terminated at 97.5 feet. Backfilled boring with 185 gallons of neat grout consisting of 148 gallons water, 30 pounds of bentonite powder, 30-47 lb sacks of portland cement.												
-40	99														
	100														
	101														
	102														
	103														
-45	104														
	105														
	106														
	107														
	108														
-50	109														
	110														
	111														
	112														
	113														
-55	114														
	115														
	116														
	117														
	118														
-60	119														
	120														

Final Report Version

Borehole Location: Landside Toe **County:** Sutter
Coordinates: Northing: 2,168,876.02 **Easting:** 6,673,792.83
Latitude: 39.11705 **Longitude:** -121.60479
Levee Station or Milepost: 921+69 **Levee Mile:**
Levee Segment Reach 13
Survey Method: GIS/LiDAR **Coord. System:** CA State Plane Zone II
Channel / River Name / Feature: Feather River

LOG OF BORING
SL0001_009S
Sheet 5 of 5

SBFCA Feather River West Levee

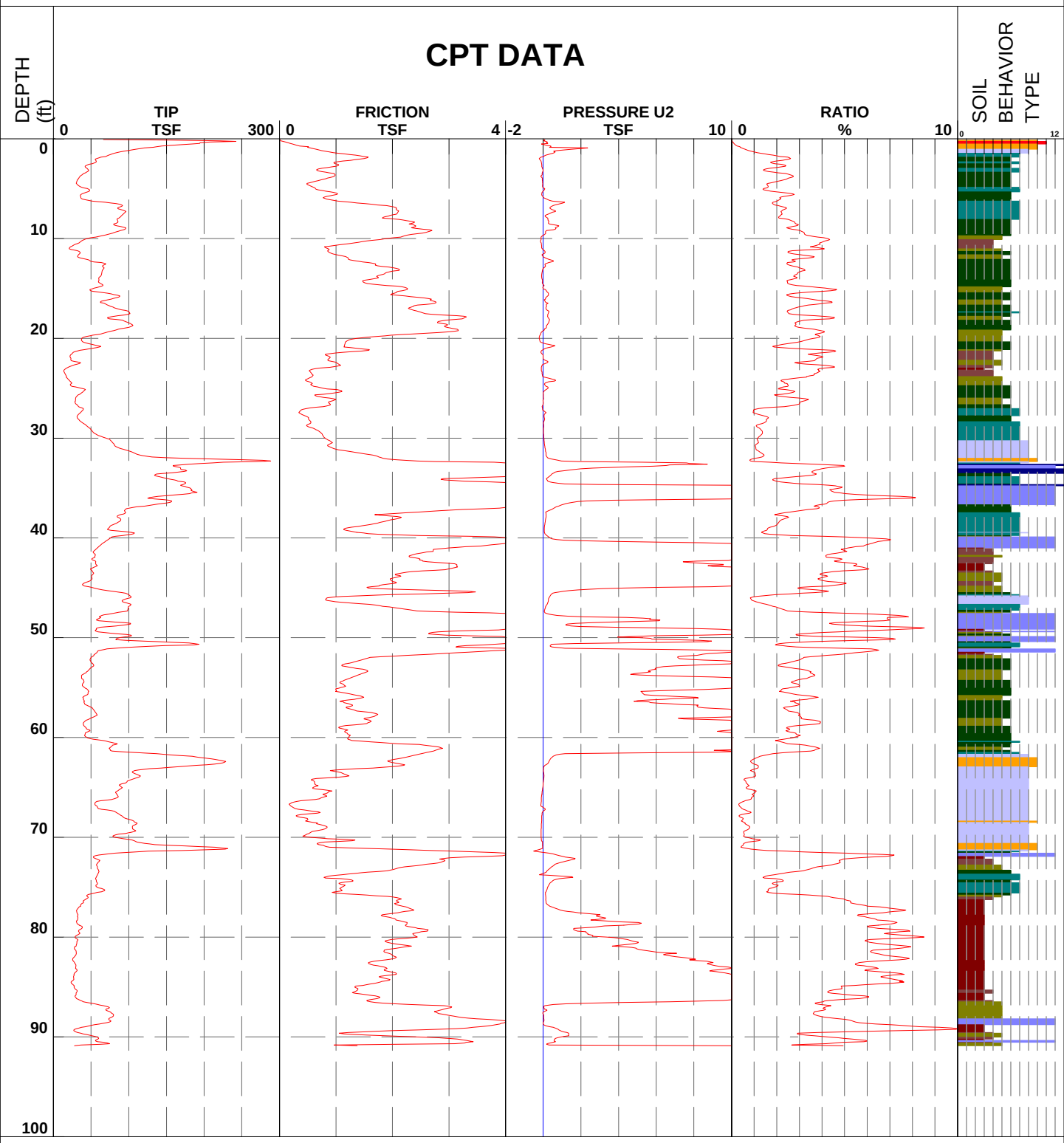
SUTTER BUTTE SOIL LOG REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 1/29/14

Job Number 04.0913-0019 | CPT Number 1129+00 | Location Feather River Yuba City, CA

Operator Daniel Garza | Date 07-Oct-2013 16:56:43 | Cone Number F7.5CKE2HAW22404

Client URS Corporation

CPT DATA



1 - sensitive fine grained
2 - organic material
3 - clay
4 - silty clay to clay
5 - clayey silt to silty clay
6 - sandy silt to clayey silt
7 - silty sand to sandy silt
8 - sand to silty sand
9 - sand
10 - gravelly sand to sand
11 - very stiff fine grained (*)
12 - sand to clayey sand (*)

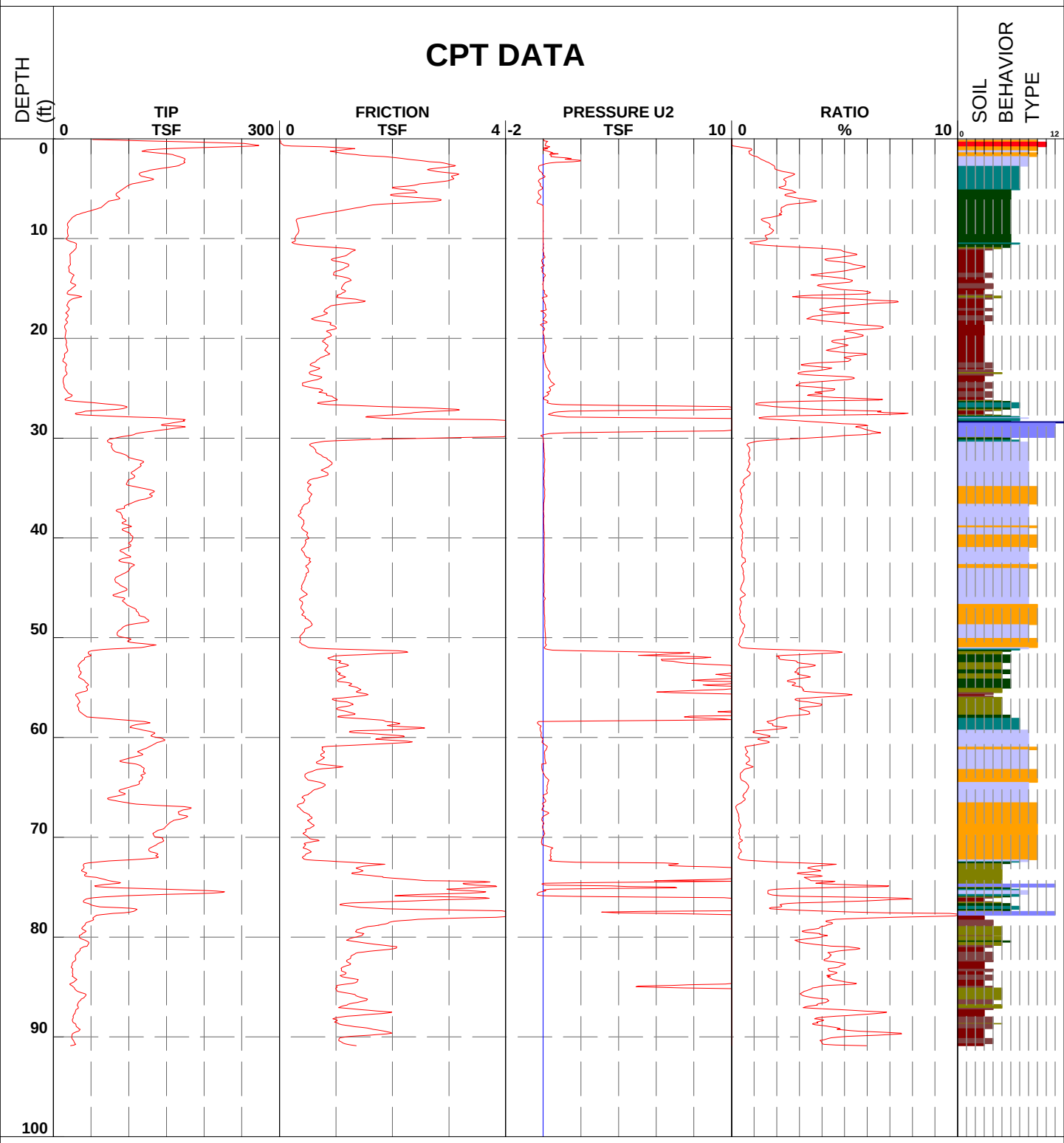
Robertson et al. 1986 * Overconsolidated or Cemented

Job Number 04.0913-0019 CPT Number 1133+50 Location Feather River Yuba City, CA

Operator Daniel Garza Date 07-Oct-2013 14:30:08 Cone Number F7.5CKE2HAW22404

Client URS Corporation

CPT DATA



1 - sensitive fine grained
2 - organic material
3 - clay
4 - silty clay to clay
5 - clayey silt to silty clay
6 - sandy silt to clayey silt
7 - silty sand to sandy silt
8 - sand to silty sand
9 - sand
10 - gravelly sand to sand
11 - very stiff fine grained (*)
12 - sand to clayey sand (*)

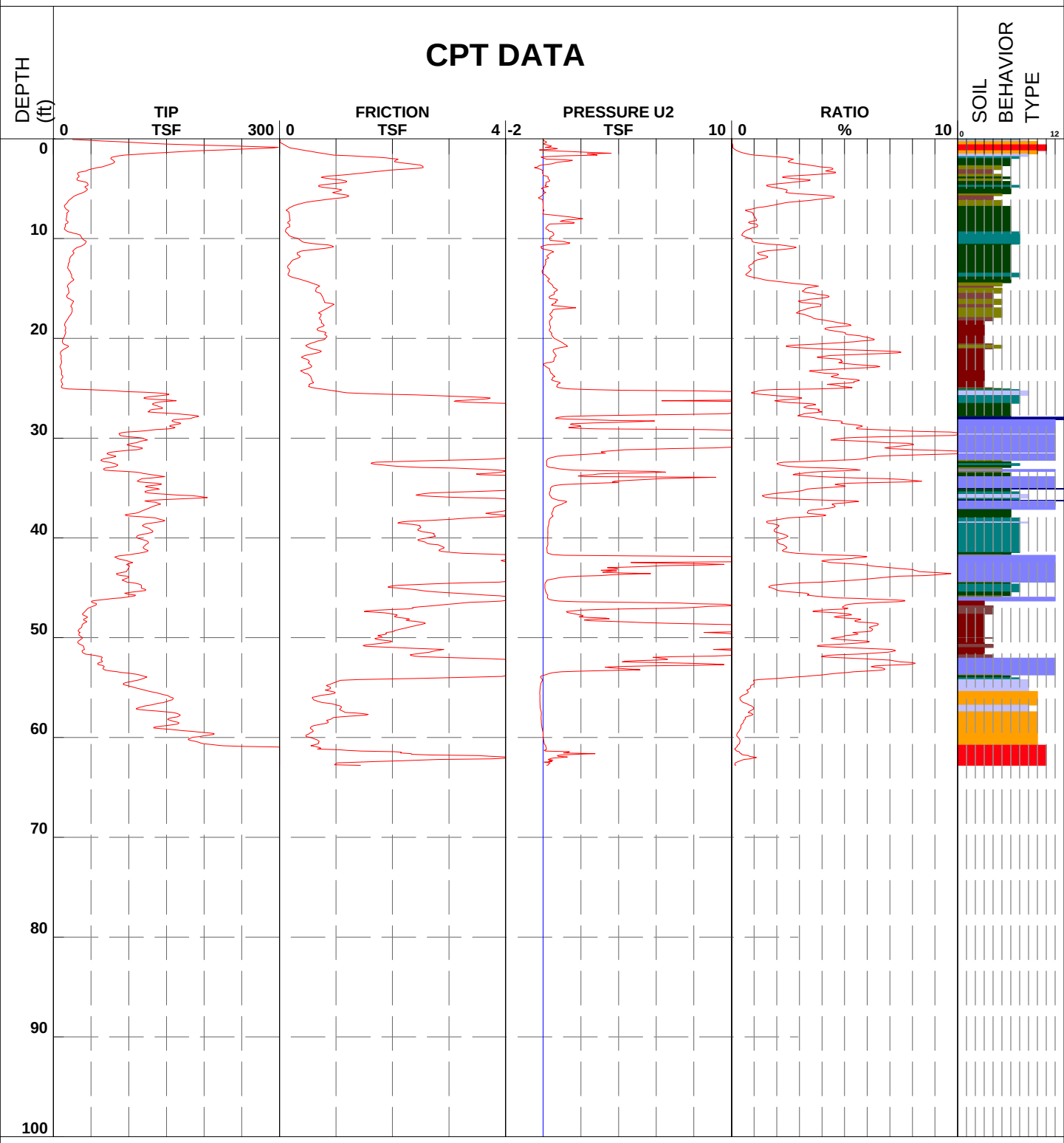
Robertson et al. 1986 * Overconsolidated or Cemented

Job Number 04.0913-0019 | CPT Number 1264+75 | Location Feather River Yuba City, CA

Operator Daniel Garza | Date 08-Oct-2013 12:07:20 | Cone Number F7.5CKE2HAW22404

Client URS Corporation

CPT DATA



1 - sensitive fine grained
2 - organic material
3 - clay
4 - silty clay to clay
5 - clayey silt to silty clay
6 - sandy silt to clayey silt
7 - silty sand to sandy silt
8 - sand to silty sand
9 - sand
10 - gravelly sand to sand
11 - very stiff fine grained (*)
12 - sand to clayey sand (*)

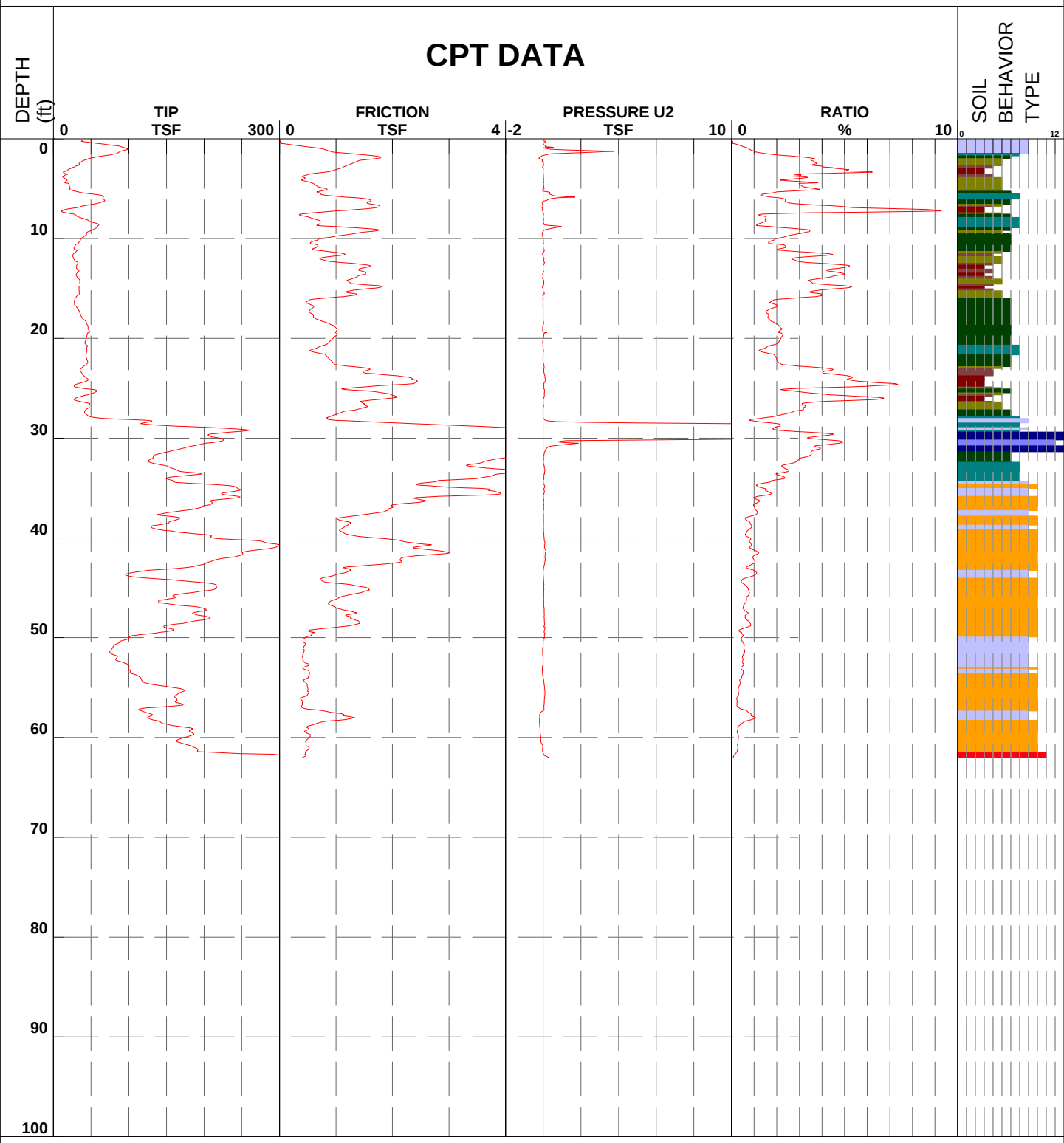
Robertson et al. 1986 * Overconsolidated or Cemented

Job Number 04.0913-0019 | CPT Number 1267+50 | Location Feather River Yuba City, CA

Operator Daniel Garza | Date 08-Oct-2013 08:33:09 | Cone Number F7.5CKE2HAW22404

Client URS Corporation

CPT DATA



1 - sensitive fine grained
2 - organic material
3 - clay
4 - silty clay to clay
5 - clayey silt to silty clay
6 - sandy silt to clayey silt
7 - silty sand to sandy silt
8 - sand to silty sand
9 - sand
10 - gravelly sand to sand
11 - very stiff fine grained (*)
12 - sand to clayey sand (*)

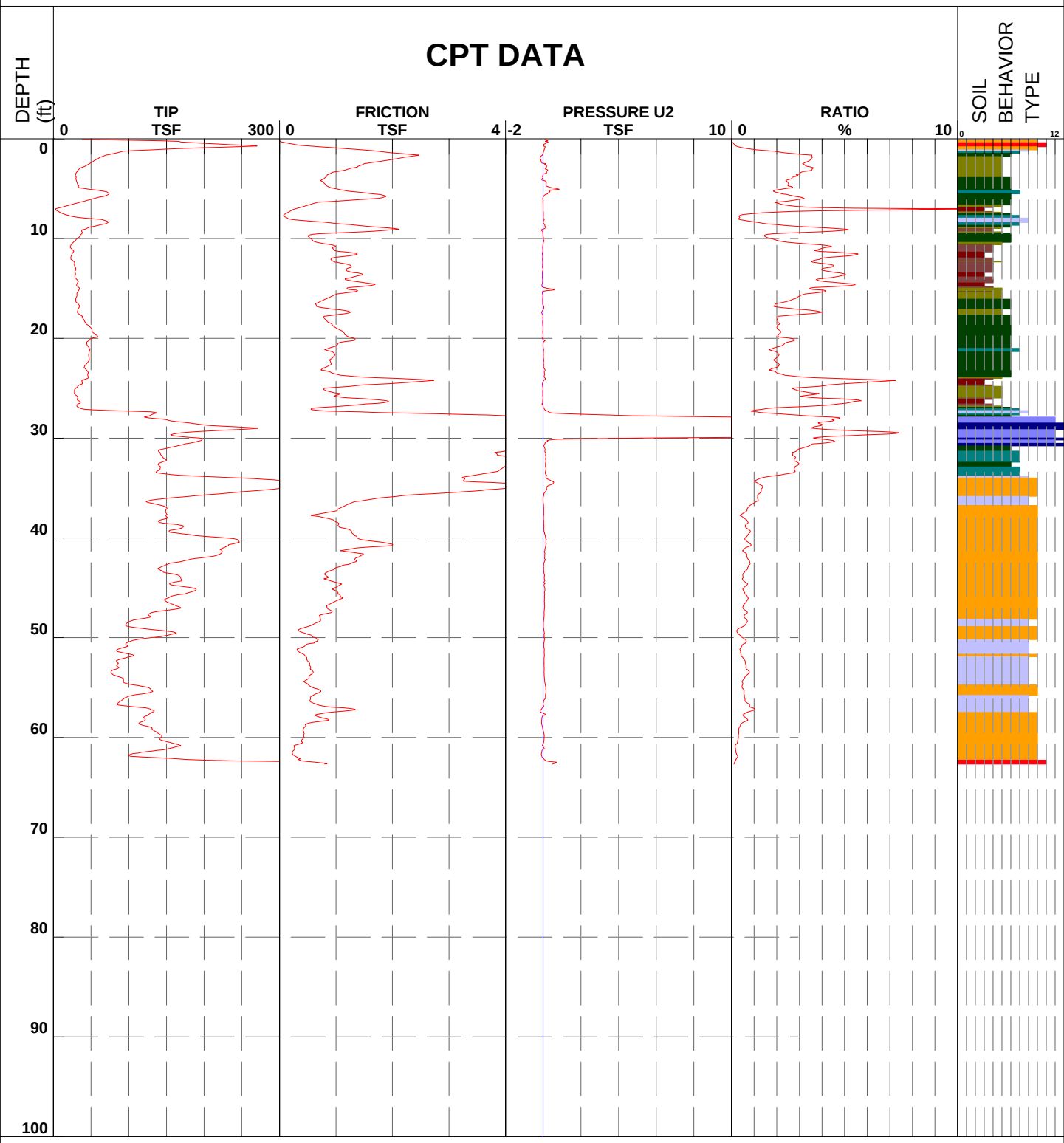
Robertson et al. 1986 * Overconsolidated or Cemented

Job Number 04.0913-0019 | CPT Number 1267+55 | Location Feather River Yuba City, CA

Operator Daniel Garza | Date 08-Oct-2013 10:04:30 | Cone Number F7.5CKE2HAW22404

Client URS Corporation

CPT DATA



1 - sensitive fine grained
2 - organic material
3 - clay
4 - silty clay to clay
5 - clayey silt to silty clay
6 - sandy silt to clayey silt
7 - silty sand to sandy silt
8 - sand to silty sand
9 - sand
10 - gravelly sand to sand
11 - very stiff fine grained (*)
12 - sand to clayey sand (*)

Robertson et al. 1986 * Overconsolidated or Cemented

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

Attachment C

TABLE A-15

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	
SL0009_008S		36	52.5	ML	20				79.0	35	26	9	
SL0009_008S		51	37.5	SM	7				13.6				
SL0009_008S		86	2.5	SM	37				46.2	33	27	6	

SBFCA Feather River West Levee
Evaluation of End Around Effects

SUMMARY OF SOIL LABORATORY DATA

TABLE A-15

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_035S		19	86.0	SM	10				30.6				
SM0007_035S		28	77.0	SM	15				38.6				
SM0007_035S		32	73.0	SM	21				29.8				
SM0007_035S		37	68.0	SC-SM	11				48.2	22	17	5	
SM0007_035S		43	62.0	GC	5				12.6				

TABLE A-15

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_036S		18	87.0	SM	13				49.4				
SM0007_036S		22	83.0	SM	10				47.3				
SM0007_036S		36	69.0	SM	17				47.4	22	NP	22	
SM0007_036S		40	65.0	SM	11				45.3				

SBFCA Feather River West Levee
Evaluation of End Around Effects

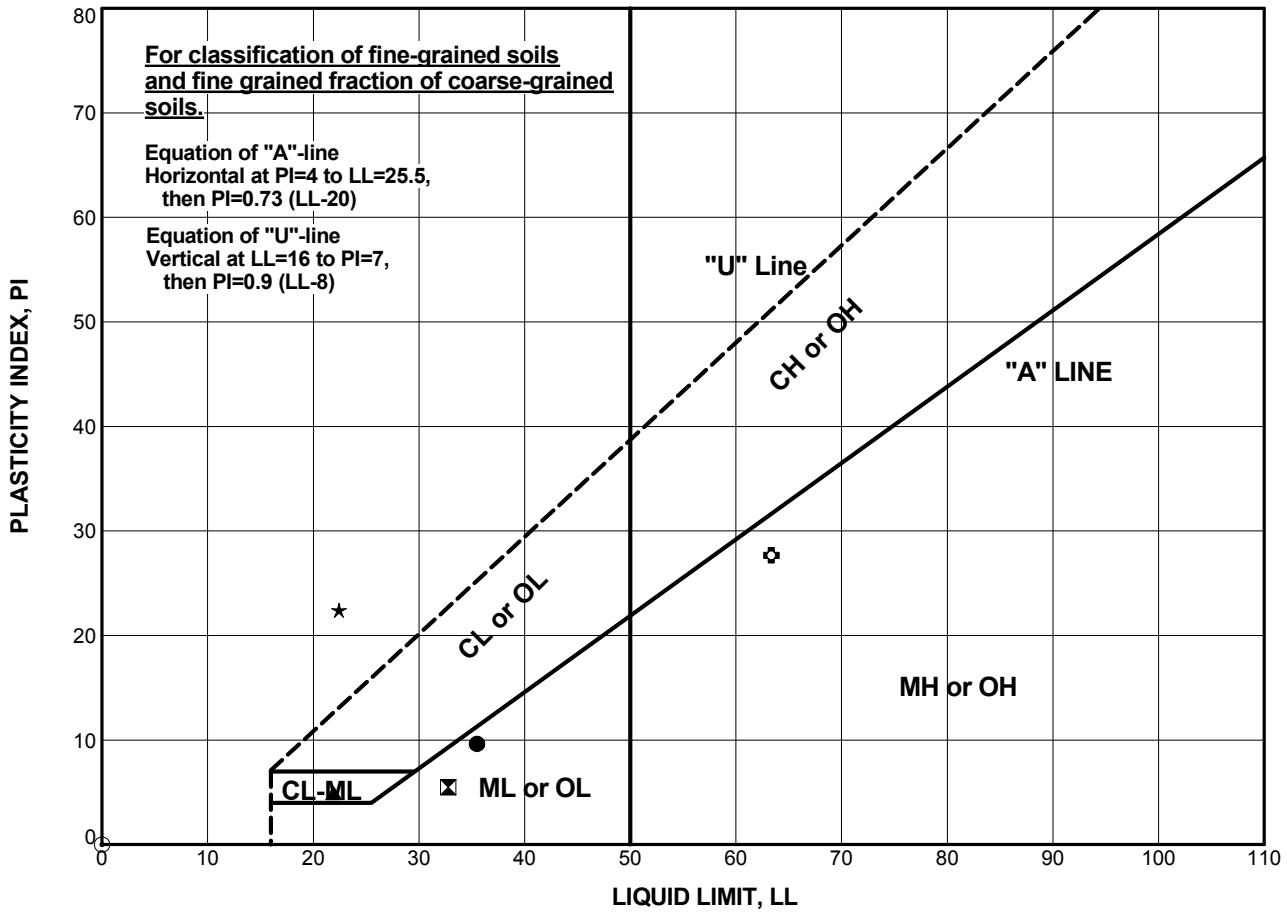
SUMMARY OF
SOIL LABORATORY DATA

TABLE A-15

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_037S		15	87.0	ML	10				69.5				
SM0007_037S		19	83.0	SW-SM	2				8.7				
SM0007_037S		22.25	79.8	CL	17				69.4				
SM0007_037S		32.25	69.8	SC	29				33.5				
SM0007_037S		35	67.0	SC-SM	37				25.2				

TABLE A-15

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	
SM0016_002S		19	76.0	SM	15				24.7	NP	NP	NP	
SM0016_002S		39	56.0	GP	6				3.5				
SM0016_002S		51	44.0	MH	37				91.0	63	36	27	
SM0016_002S		60.5	34.5	SM	24				25.2				
SM0016_002S		63	32.0	SM	18				16.2				
SM0016_002S		65	30.0	SC	20				22.7				



Boring Number	Sample Number	Depth (feet)	Test Symbol	WC (%)	LL	PL	PI	Classification
SL0009_008S		36	●	20.0	35	26	9	SILT with SAND (ML)
SL0009_008S		86	⧗	37.3	33	27	6	SILTY SAND (SM)
SM0007_035S		37	▲	10.6	22	17	5	SILTY, CLAYEY SAND (SC-SM)
SM0007_036S		36	★	17.4	22	NP	22	SILTY SAND (SM)
SM0016_002S		19	⊙	14.9	NP	NP	NP	SILTY SAND (SM)
SM0016_002S		51	✿	36.7	63	36	27	ELASTIC SILT (MH)

SBFCA LEVEE U/NU ATT. PLOT (U LINE) REV1; GINTSBFCA; SUTTERBUTTELIBRARY20131111.GLB; 11/12/13

SUTTER BUTTE FLOOD CONTROL AGENCY

SBFCA Feather River West Levee
Evaluation of End Around Effects

PLASTICITY CHART