URBAN LEVEE DESIGN CRITERIA EVALUATION

MOSSDALE TRACT
RECLAMATION DISTRICT NO. 17
SAN JOAQUIN COUNTY, CALIFORNIA

Submitted to:
Mr. Dave Peterson
Peterson Brustad Inc.
1180 Ironpoint Road, Suite 260
Folsom, CA 95630

Prepared by:
ENGEO Incorporated

October 30, 2015

Project No:
5747.005.000

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Mr. David Peterson
Peterson Brustad, Inc.
1180 Iron Point Road, Suite 260
Folsom, CA 95630

Subject: Mossdale Tract
Reclamation District No. 17
San Joaquin County, California

URBAN LEVEE DESIGN CRITERIA EVALUATION

Dear Mr. Peterson:

In conjunction with the project team, we performed a geotechnical levee evaluation of the Reclamation District No. 17 levee system using Urban Levee Design Criteria (ULDC); our evaluation studies seepage, slope stability, settlement, and seismic vulnerability. This study is tied to California Senate Bill 5 (SB5), which outlines that urban or urbanizing areas provide a 200-year level of flood risk protection by July 2016. Our detailed findings are presented in this report.

It is a pleasure to be of service to this project and significant study. If you have any questions regarding the contents of this report, please do not hesitate to contact us.

Sincerely,

ENGEO Incorporated

Josef J. Tootle, GE

Cale Crawford, PE

Nicholas S. Broussard, PE

Jonathan C. Boland, GE

jjt/cc/nsb/jcb/jf

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1.0 INTRODUCTION

1.1 SCOPE

In 2007, California Senate Bill 5 (SB5) was signed into law, which mandates that urban and urbanizing areas provide a 200-year level of flood risk (0.005 Annual Exceedance Probability - AEP) protection in the Central Valley of California by July 2016. The Urban Levee Design Criteria (ULDC) and Urban Level of Flood Protection (ULOP) requirements were developed by the California Department of Water Resources (DWR) pursuant to SB5.

This report presents our levee evaluation of the Project levee portion as well as the northern and southern Non-Project levee portions of the Reclamation District No. 17 (RD 17) levee system. We used ULDC criteria to develop the documentation needed to allow the City of Lathrop and the City of Manteca (Cities) to make a "Finding" that an Urban Level of Flood Protection exists within the area that approximately follows the limits of RD 17.

Our authorized scope of services included evaluation of the following ULDC Section tasks and preparation of this report with the results of our evaluation:

- Section 7.3: Soil Sampling, Testing and Logging
- Section 7.4: Slope Stability for Intermittently Loaded Levees
- Section 7.5: Underseepage for Intermittently Loaded Levees
- Section 7.7: Seismic Vulnerability

This report was prepared for the exclusive use of our client and their design team consultants. In the event that any changes are made in the character, design or layout of the project, we must be contacted to review the conclusions and recommendations contained in this report to determine whether modifications are necessary.

1.2 REACH LIMIT SUMMARY

As part of our ULDC evaluation, the project team divided up the levee alignment into 56 separate reaches characterized by similar surface features, subsurface soil conditions, and/or past levee performance. The reaches and stationing limits for this evaluation are summarized in Table 1.2-1.

TABLE 1.2-1
Reach Summary

Project Reach	Approximate Station Limits	Project Reach	Approximate Station Limits
NPL	(-)35+00 to 00+00	J1A	506+00 to 515+50
A1	00+00 to 15+00	J1B	515+50 to 534+00
A2	15+00 to 60+00	J2	534+00 to 544+50
B	60+00 to 90+00	J3A	544+50 to 548+50

Project Reach	Approximate Station Limits	Project Reach	Approximate Station Limits
C1	90+00 to 121+00	J3B	548+50 to 555+70
C2	121+00 to 142+00	J3C	555+70 to 569+50
C3A	142+00 to 158+00	J4A	569+50 to 574+50
C3B	158+00 to 161+00	J4B	574+50 to 585+50
C4A	161+00 to 174+45	K	585+50 to 608+00
C4B	174+45 to 192+00	L1	608+00 to 655+00
D1	192+00 to 212+00	L2	655+00 to 703+00
D2A	212+00 to 247+00	M1	703+00 to 724+50
D2B	247+00 to 255+50	M2A	724+50 to 741+30
D2C	255+50 to 259+50	M2B	741+30 to 760+50
E1A	259+50 to 270+00	M3A	760+50 to 763+00
E1B	270+00 to 297+75	M3B	763+00 to 768+00
E2	297+75 to 305+75	M3C	775+00 to 781+00
F1A	305+75 to 312+30	M4	781+00 to 799+50
F1B	312+30 to 315+00	N1	799+50 to 806+00
F1C	315+00 to 321+00	N2	806+00 to 825+00
F2	321+00 to 339+00	O1	825+00 to 835+00
F3	339+00 to 362+50	O2A	835+00 to 849+65
G	362+50 to 388+00	O2B	849+65 to 853+50
H1A	388+00 to 411+00	P1	853+50 to 867+00
H1B	411+00 to 420+00	P2	867+00 to 909+00
H2	420+00 to 445+00	Q1	909+00 to 944+00
H3	445+00 to 466+00	R1	944+00 to 959+00
I	466+00 to 506+00	S1	959+00 to 972+00

2.0 BACKGROUND

2.1 DISTRICT DESCRIPTION

RD 17 is situated along the south bank of French Camp Slough, the east bank of the San Joaquin River, and the north bank of Walthall Slough. The continuous levee extends approximately 19 miles from Stockton to Manteca, California.

The RD 17 levee system protects approximately 10,698 residential units, and 182 nonresidential (commercial/industrial and public) properties with a total floor area of approximately 11,858,000 square feet. Examples of some large commercial facilities within RD 17 include the Del Monte Foods Distribution Center, In and Out Burger Distribution Center, Ghirardelli Chocolate Factory Outlet, and Daimler Chrysler. Main transportation arteries within RD 17 include Interstate 5 and State Route 120. Other facilities within RD 17 include Lathrop City Hall, San Joaquin General Hospital, San Joaquin County Jail, San Joaquin County Honor Farm,

San Joaquin County Juvenile Hall, two high schools, six elementary schools, and 28 other facilities that house and/or provide services to special needs populations. RD 17 contains over 6,345 acres of agricultural lands that produce tomatoes, alfalfa, and corn (among other crops). The potential structural and content value of property damages for a levee breach within the area protected by the RD 17 levee system is estimated to be greater than $900 million.

2.2 PREVIOUS STUDIES

The RD 17 levee system has been previously studied by many agencies and consulting firms.

In March 2008, ENGEO published a preliminary evaluation of RD 17, which included the Phase III Project elements. In February 2009, ENGEO published a report evaluating the potential for under seepage throughout RD 17. Both reports evaluated probable under seepage and provided mitigation improvements that consisted mostly of landside seepage berms. In January 2010, ENGEO published Preliminary Seepage Evaluation reports for all LSRP Phase III Project Elements. In 2011, ENGEO published the Phase 3 Levee Seepage Project report, a single 60 percent design report encompassing all of the LSRP Phase III Project Elements. Similarly, in 2014, ENGEO published the Reclamation District 17 – Mossdale Tract, Phase III Levee Seepage Repair Program, Seepage Evaluation; the proposed improvements recommended in that report have been incorporated into this evaluation. The engineering analyses contained in this report consider recent and previous subsurface explorations and laboratory analysis that were published in the following reports:

1. Urban Levee Evaluations, April 2014 – Supplemental Geotechnical Data Report Addendum, Reclamation District 17.

2. ENGEO, 2014 – Reclamation District 17, Mossdale Tract, Phase III Levee Seepage Repair Program, Seepage Evaluation.

3. ENGEO, 2011 – Reclamation District 17, Mossdale Tract, Phase 3 Levee Seepage Project.

4. Urban Levee Evaluations, July 2010 – Supplemental Geotechnical Data Report, Reclamation District 17, Draft 2.

5. Urban Levees Evaluations, October 2008 – Phase 1 Geotechnical Data Report, Reclamation District 17.

6. Kleinfelder West, Inc. 1989 - Geotechnical Exploration for the Weston Ranch project.

7. Kleinfelder West, Inc. 1987 – Evaluation of Levees Bordering Reclamation District 17.

8. William Lettis & Associates, Inc. 2008 – Surficial Geologic Map of the Eastern Side of the San Joaquin River, along RD 17 Levee System near Stockton and Lathrop, California. (provided by DWR)

9. ENGEO, 2004 – Draft Preliminary Geotechnical Report of the 220-Acre Mixed Use development along the eastern side of the San Joaquin River in South Lathrop.

10. ENGEO, 2004 – Geotechnical Exploration, Central Lathrop Specific Plan.

11. ENGEO, 2006 – Geotechnical Exploration and Levee Evaluation for the River Run Project.

Subsurface explorations and laboratory analysis by others that were published in the ENGEO 2014 report are included in Appendices A and B, respectively. The current subsurface explorations and laboratory analysis conducted by ENGEO are presented in Appendices C and D, respectively. Locations of explorations are presented on the Plan and Profile, Figures 2A through 2MM.

2.3 DISTRICT HISTORY

The RD 17 levee system, like other flood protection systems in the San Joaquin Valley, was initially designed to reduce the risk of flooding for the purposes of facilitating agricultural development of the extensive floodplains encompassed by the San Joaquin Valley. Like much of the Delta, RD 17 was originally designated swamp and overflow lands prior to levee construction; during times of high flows, water overflowed the banks and inundated adjacent lands. Natural high ground was formed adjacent to the San Joaquin River due to sedimentation of the materials carried by the high river flows. Farmers constructed levees on top of the high ground deposits; horses and hand labor were utilized to construct the levees out of readily available material adjacent to the river. Once levees were in place, the protected lands were reclaimed for agriculture use. Starting in about 1863, Reclamation District 17 was formed to maintain the RD 17 levee system (Reference 17).

Several decades later, Congress authorized the Lower San Joaquin River and Tributaries Project (LSRTP) in the Flood Control Act of 1944. The USACE (U.S. Army Corps of Engineers) subsequently commenced work to improve the RD 17 levee system. The LSRTP was completed by the USACE in 1963, and included the following RD 17 levee segment.

- Left bank of French Camp Slough
- Right bank of the San Joaquin River
- Right bank of Walthall Slough

These levee segments thereby became Federal Project Levees; the continuous dry land levees to the north (*upstream* of Station 0+00) and southeast (*upstream* of Station 853+50) of these Project levee segments are considered Non-Project levees.

During a high-water event on the San Joaquin River in January 1997, seepage and boils occurred at a number of locations along the RD 17 levees. The United States Army Corps of Engineers (USACE), the California Department of Water Resources (DWR), the California Central Valley Flood Protection Board (formerly known as the Reclamation Board) (CVFPB), and RD 17 actively and successfully contained the seepage and boils and the levees were not breeched.

After the 1997 event, USACE, CVFPB, and RD 17 funded a project to repair the seepage and boil areas under the Public Law 84-99 Rehabilitation Assistance Program (PL 84-99). The project referred to as "Reconstruction of the California Central Valley Levees San Joaquin Basin #4, Reclamation District #17" consisted of the installation of landside drained seepage berms. The berms generally consisted of soil placed on drain rock, with woven geotextile fabrics lining the top and bottom of the drain rock layer. Design and construction was performed by the USACE. In October 2004, the USACE provided an addendum to the Standard Operation and Maintenance Manual for the PL 84-99 work completed as of October 2001.

2.4 PAST PERFORMANCE

Seepage-related distress has been the primary detrimental issue identified at RD 17; this was the likely cause of the most recent levee breach that occurred in 1950, which involved a breach south of Dos Reis Road, between reaches J3B and J3C.

The State of California Urban Levee Evaluation (ULE) of the RD 17 levees, the Addendum to the 2014 SGDR by URS, provides a comprehensive historical distress history that compiles both DWR's and RD 17's understanding of the past performance of the levees. The majority of the information regarding performance history comes from observations during the 1997 high water event. Specific historic distress and performance history interpretations for this ULDC evaluation are discussed in the Conclusions Section of this report, with specific reference to discrete levee reaches.

2.5 RD 17 LEVEE SEEPAGE REPAIR PROGRAM

2.5.1 Purpose and Background

The overall purpose of the LSRP is to implement levee improvement projects at various and specific locations throughout the RD 17 Levee System with the intent of reducing flood risk associated with under and through seepage. By reducing flood risk through this program and RD 17's continued maintenance of the approximately 19-mile levee system in compliance with applicable Federal standards, the RD 17 has been working towards the ultimate goal of meeting 200-year ULDC standards for levees protecting urban areas.

The approach to meet the purpose of the LSRP is to assess the entire Project levee system, develop strategies for improvement, and provide a basis for partnerships with Federal and State agencies to implement these strategies. The objectives under this approach are to:

- Construct levee repairs as soon as possible to reduce flood risk as quickly as possible.
- Construct repairs that are politically, socially, economically, and environmentally acceptable.

The intent of the improvement projects is to design and construct projects that do not strand funds; projects are to be expandable to adapt to changing standards as practically necessary.

RD 17, in cooperation with DWR and the CVFPB, is the local project sponsor for the ongoing LSRP.

In the fall of 2007, RD 17 initiated the LSRP. To identify repair locations (segments of the levee system) for the LSRP and facilitate the EIP funding agreement, RD 17 contracted with ENGEO to prepare an Under Seepage Evaluation Report (ENGEO, 2009). In addition to those areas identified by geotechnical evaluation as requiring under seepage repair, historical seepage locations identified by RD 17 maintenance and inspection crews were also included in the LSRP.

Design and construction of the LSRP was undertaken in three phases (Phases I, II, and III). Construction of the first two phases has been completed and design of Phase III was at a 65 percent state of completion at the time of the publication of this report. Further details of the LSRP project phasing is provided in Section 2.6.7.

2.5.2 Project Design Team

The Project Design Team for the LSRP consists of a number of consultants working directly for RD 17. The LSRP team members consist of survey, hydraulic, geotechnical, environmental, permitting, real estate, legal, civil design, and construction management consultants.

The team's responsibilities include the preparation of construction documents utilizing data, analyses, and design recommendations provided by the Design Team and government agencies including RD 17. The project teams, with their respective responsibilities and contact information, are listed in the following table.

TABLE 2.5.2-1
RD 17 Project Design Team

Responsibility	Company	Primary Contact	Phone #	E-Mail
EIP Program Manager	Nomellini, Grilli & McDaniel, PLCS	Dante Nomellini	209.465.5883	ngmplcs@pacbell.net
District Engineer	Kjeldsen, Sinnock & Neudeck, Inc.	Chris Neudeck	209.946.0268	cneudeck@ksninc.com
EIP Project Manager	Kjeldsen, Sinnock & Neudeck, Inc.	Barry O'Regan	209.323.9864	boregan@pbieng.com
Construction Management	Kjeldsen, Sinnock & Neudeck, Inc.	Jerry Hadley	209.946.0268	jhadley@ksninc.com
Civil Engineering Design Lead	MacKay & Somps Civil Engineers Inc.	Chris Gunther	925.225.0690	cguenther@msce.com
Geotechnical Design Lead	ENGEO	Joe Tootle	209.684.7602	jtootle@engeo.com
Environmental Team Lead	AECOM	Andrea Shephard	916.414.5800	Andrea.Shephard@aecom.com

2.5.3 Safety Assurance Review

The purpose of a Safety Assurance Review (SAR) Plan is to review the adequacy, appropriateness, and acceptability of the design and construction activities in assuring public health, safety, and welfare for the design of the proposed LSRP. The SAR Plan includes an Independent External Peer Review (IEPR) by impartial experts in the fields of geotechnical and hydraulic engineering. The IEPR team consists of the Board of Senior Consultants (BOSC). The LSRP BOSC includes Dr. Robert Pyke, Mr. Edwin M. Hultgren, Mr. Don Babbitt, and Dr. John DeGeorge. Dr. Pyke, Mr. Hultgren and Mr. Babbit are recognized experts in civil engineering and geotechnical engineering related to the planning, design and construction of flood control projects. Dr. DeGeorge is a recognized expert in hydrologic and hydraulic engineering.

The panel has provided independent review of the engineering design, geotechnical reports, and the project alternatives descriptions, and they have provided a letter commenting on the adequacy, appropriateness, and acceptability of the final engineering for Phases I and II of the LSRP. It is very likely that the future Phase III of the LSRP will utilize this current BOSC.

2.5.4 Quality Assurance/Quality Control Program

RD 17 has implemented a quality assurance/quality control (QA/QC) program for all planning and design documents for the LSRP. The QA/QC program includes reviews at three levels:

1. Consultant and internal quality control reviews.
2. Reviews by RD 17 and other LSRP team members.
3. Reviews by other agencies and an independent Board of Senior Consultants.

Agencies that are involved in reviewing the geotechnical reports, construction documents and project specifications include USACE, DWR, CVFPB and the LSRP BOSC. The BOSC consists of four technical experts that provide technical guidance and reviews of levee improvement evaluations and designs. As part of the QA/QC process, all external QC review comments on key deliverables are documented, responded to and closed out for each deliverable.

2.5.5 Design Guidance

Levee design and/or construction guideline criteria have been developed, for varying purposes, by several State and Federal agencies, including the USACE, FEMA, DWR, and CVFPB. Primarily as a result of Hurricane Katrina and the court decision in Paterno vs. The State of California, levee design standards are being reevaluated and revised by a number of associated agencies. The design criteria chosen for the RD 17 LSRP Phase III are primarily based on the following documents:

- Code of Federal Regulations 44, Section 65.10
- Title 23 – California Code of Regulations
- USACE Engineering Manual 1110-2-1913

- USACE Engineering Technical Letter 1110-2-569
- DWR's Urban Levee Design Criteria

2.5.6 LSRP Considered Mitigation Alternatives

Mitigation alternatives for LSRP work were evaluated based on their ability to achieve the following results:

- Mitigation of historic performance concerns
- Reduction in underseepage exit gradient at the levee toe
- Reduction in through seepage induced slope instability
- Flood fighting flexibility
- Seismic resiliency
- Adaptability to varying water surface elevations (higher than the DWSE)
- Reduction of long-term maintenance
- Reduction of hydraulic impacts

Where mitigations have been recommended based on the LSRP evaluation and input from stakeholders, alternatives have been considered both independently and/or in combination. In general, seepage berms to mitigate underseepage and drained stability berms or chimney drains to mitigate through seepage are the preferred mitigation alternatives. In locations where seepage berms are not feasible due to landside encroachments or construction constraints, seepage cutoff walls were generally considered as the preferred alternative for both underseepage and through seepage.

2.5.7 Design and Construction Phasing

The RD 17 LSRP has divided the design and construction of the improvement projects into three separate construction phases: Phases I, II, and III. The construction phasing plan was developed to facilitate accelerated construction schedules for those elements thought to have the highest seepage concerns and were perceived as being the most ready for construction.

Phase I underseepage improvements were completed in 2009 and consisted of drained seepage berms at Project Elements III-a and VI-b. The construction of these improvements was permitted by the Central Valley Flood Protection Board under a USACE Section 208.10 permit.

Phase II improvements were completed in 2010 and consisted of drained seepage berms, a drainage trench, and chimney drains. Similar to the preceding construction phase, Phase II was completed under Section 208.10 authority.

Previously, ENGEO published seepage evaluation reports in support of the Phase III improvement projects for 30 percent, 60 percent, and 65 percent design levels. ENGEO's 65 percent design report was published and submitted for review in May 2014. Construction of the LSRP Phase III is scheduled to begin after 2015.

Constructed and proposed levee repairs associated with the LSRP include drained seepage berms, cutoff walls and setback levees to address under seepage, chimney drains and cutoff walls to address through seepage, and modification of levee slopes and crown widths where identified by the Civil Engineer to achieve ULDC levee geometry requirements. To date, the constructed and proposed LSRP improvement projects do not consist of raising of the existing levee or performing any work on the waterside of the levee with the exception of vegetation control and minor degradation of the levee crown during cutoff wall construction.

2.5.8 LSRP Levee Segmenting

To facilitate the implementation of the LSRP improvement projects, the RD 17 levees have been divided into seven distinct "reaches", known as Project Areas. The Project Areas are generally based on similar subsurface soil stratigraphy (identified by Roman numerals I through VII). The Project Areas are further subdivided into "elements", known as Project Elements. Elements are identified by the reach number followed by a lower case letter and, in some cases, a decimal and Arabic number.

In the case of Project Areas I and II, Project Elements were defined at specific locations where levee improvements were proposed within the larger Project Area. Project Areas III through VII generally have improvement projects either constructed and/or proposed throughout their limits. In these areas, Project Elements are generally a segment, or sub-area, of an improvement throughout the Project Area. The decision to segment the levee system Project Areas into smaller Project Elements largely considers the following:

- Political boundaries and right-of-ways.
- Land ownership.
- Land use adjacent to the levee (agricultural, urbanizing, urban, park, etc.).
- Type of levee improvement (drained berm, drainage trench, cutoff wall, etc.).
- Ease of construction (being that a certain Project Element may have an improvement project that is capable of being *fast tracked* to construction).

Project Area and Project Element (and the Element's associated LSRP phase) stationing limits, as well as constructed and proposed improvements, are presented in the following table. To date, the LSRP has only considered the Project Levee portion of the RD 17 system: the Non-Project levee reaches *upstream* of Station 0+00 and *upstream* of Station 853+50 have not been included in Phases I, II, and III of the LSRP. It should be noted that some of the Project Elements overlap between LSRP Phases to account for transitions between improvements.

TABLE 2.5.8-1
LSRP Project Area and Project Element Summary

Project Area	Approximate Station Limits	Project Element	Approximate Station Limits	LSRP Phase	Improvement
Area 1	0+00 to 362+50	I-a	247+00 to 252+90	III	Proposed Drained Seepage Berm with Chimney Drain
		I-b	254+00 to 255+25	III	Proposed Fill and Drained Seepage Berm with Chimney Drain

Project Area	Approximate Station Limits	Project Element	Approximate Station Limits	LSRP Phase	Improvement
		I-c	259+50 to 267+00	II	Constructed Drained Seepage Berm with Chimney Drain
		I-d	297+75 to 306+00	II	Constructed Drained Seepage Berm with Chimney Drain
		I-e	305+75 to 312+30	III	Proposed Drained Seepage Berm with Chimney Drain
Area 2	362+50 to 515+50	II-a/b	362+50 to 388+00	III	Proposed Cutoff Wall
Area 3	515+50 to 569+50	III-a (North)	515+50 to 548+50	I & III*	Constructed Drained Seepage Berm Proposed Chimney Drain
		III-b	548+50 to 555+70	III	Proposed Drained Seepage Berm with Chimney Drain
		III-a (South)	555+70 to 569+50	I & III*	Constructed Drained Seepage Berm Proposed Chimney Drain
Area 4	569+50 to 608+00	IV-a	569+50 to 574+80	III	Proposed Drained Seepage Berm with Chimney Drain
		IV-b	574+50 to 587+00	II	Constructed Drainage Trench with Chimney Drain
		IV-c	585+50 to 608+00	III	Proposed Setback Levee with Cutoff Wall
Area 5	608+00 to 684+50	V-a	608+00 to 684+50	III	Proposed Cutoff Wall
Area 6	684+50 to 769+00	VI-a.1	684+50 to 703+00	III	Proposed Cutoff Wall
		VI-a.2	700+15 to 723+50	II	Constructed Drained Seepage Berm with Chimney Drain
		VI-a.3	723+50 to 741+00	II	Constructed Drained Seepage Berm with Chimney Drain
		VI-a.4	740+60 to 741+30	III	Proposed Cutoff Wall
		VI-b	741+00 to 760+50	I & III*	Constructed Drained Seepage Berm Proposed Cutoff Wall
		VI-c	760+50 to 763+00	III	Proposed Cutoff Wall
		VI-d	763+00 to 765+40	III	Proposed Cutoff Wall
		VI-e	765+40 to 769+00	III	Proposed Cutoff Wall
Area 7	769+00 to 853+50	VII-a	769+00 to 775+00	N/A	N/A – Roadway Approach Fills
		VII-b	775+00 to 778+00	III	Proposed Drained Seepage Berm with Chimney Drain
		VII-c	778+00 to 799+50	II	Constructed Drained Seepage Berm with Chimney Drain
		VII-d	799+50 to 803+00	N/A	N/A – Previous Study Found Levee to Meet Minimum Criteria
		VII-e	803+00 to 828+00	III	Proposed Cutoff Wall
		VII-f	825+00 to 850+00	II	Constructed Drained Seepage Berm with Chimney Drain
		VII-g	849+65 to 853+50	III	Proposed Fill and Drained Seepage Berm with Chimney Drain

* Phase 1 construction only involved under seepage mitigation; through seepage improvements for Phase 1 (Project Elements III and VI-b) is part of the LSRP Phase III.

2.6 RECENT DWR ACTIVITIES

2.6.1 Urban Levee Evaluations Program

The following excerpt is taken from ULE's 2013 Supplemental Geotechnical Data Report Addendum for the RD 17 Study Area; some form of this standardized language is generally included in the ULE publications to establish a brief purpose, general scope, and progression of the ULE Program's work.

> *The California Department of Water Resources (DWR) Urban Levee Evaluations (ULE) Project evaluates levee systems estimated to protect more than 10,000 people. The ULE Project, through investigation and analyses:*
>
> - *Evaluates levees relative to established United States Army Corps of Engineers (USACE) and DWR Urban Levee Design Criteria (ULDC) dated May 2012.*
> - *Identifies potential levee deficiencies with recommended improvements.*
> - *Identifies potential levee repair alternatives and associated costs.*
>
> *The project team performs levee system evaluations progressively, incorporating the results of each step into the planning and execution of subsequent tasks. The project team prepares reports documenting the task results and planning subsequent work.*

The following table identifies the ULE publications that study RD 17 levees, and provides generalized descriptions of the documents.

TABLE 2.6.1-1
ULE Tasks and Deliverables Relative to RD 17

Deliverable	General Description	Date Published
Phase 1 Geotechnical Data Report (P1GDR)	Reports the Phase 1 field investigation, associated lab testing results, and other paper study findings. Typically, the field investigation was conducted along the levee crown with CPT's every 1,000 feet on center and borings every 5,000 feet on center.	Oct 2008 (Field activities occurred from Dec 2006 to Mar 2007)
Phase 1 Geotechnical Evaluation Report (P1GER)	Utilized information and data published in the P1GDR, preliminary geotechnical analyses were conducted; perceived data gaps were assessed and identified.	DRAFT 1 – Dec 2007
Supplemental Geotechnical Data Report (SGDR)	A supplemental field and laboratory soil testing program was conducted to supplement the P1GDR; the supplemental data was intended to resolve perceived data gaps identified by the P1GER assessment.	DRAFT 2 – July 2010 (Field activities occurred from Nov 2007 to May 2008)

Deliverable	General Description	Date Published
Supplemental Geotechnical Data Report Addendum (SGDR Addendum)	Further supplemental field and laboratory soil testing program was conducted as an addendum to the SGDR; the addendum data was intended to further resolve perceived data gaps identified by the P1GER assessment following the SGRD. The SGDR Addendum often follows a revised P1GER draft that had incorporated SGDR information.	April 2014 (Field activities occurred from May through September 2012)
Geotechnical Evaluation Report (GER)	Utilizing the data from the P1GDR, SGDR, and SGDR Addendum, the levee system is again evaluated (in similar fashion as the P1GER). GER publishes analytical results regarding seepage, stability, erosion, settlement, and seismic vulnerability. Finding results that do not meet the ULE criteria, mitigations are proposed and associated project costs are estimated.	April 2015

2.6.2 DWR Involvement with the RD 17 LSRP

Following the submittal of the LSRP 60 percent design plans and geotechnical evaluation in 2011, the report was reviewed by DWR and their consultants and there was a desire by the ULE team to have additional subsurface information collected prior to project completion. At the time, ULE had not published their SGDR and were just beginning to plan their SGDR Addendum program. Completion of the planned ULE SGDR Addendum explorations was believed to result in the collection of sufficient subsurface information to further inform the Phase III LSRP design.

In 2012, ENGEO began working in conjunction with ULE on their SDGR Addendum. The cooperative work involved selecting exploration locations, observing ULE field operation, and collaborating on laboratory testing selection. Following the SGDR Addendum work, ENGEO was also involved with ULE's GER work. ENGEO was included in the discussion for seepage and slope stability analysis, with the goal that ENGEO's design report would be consistent with the results published in the forthcoming GER. Source and analytical files prepared as part of the ULE Program were shared with ENGEO; often, the same seepage and slope stability model utilized in the ULE program was also utilized in the LSRP 65 percent evaluation.

2.7 CALIFORNIA 200-YEAR FINDING

The Central Valley Flood Protection Act of 2008, primarily enacted by the 2007 Senate Bill 5, puts into State law that local stakeholders of levee systems operating in urban and urbanizing areas provide a 200-year level of protection. California Government Code Section 65007(n) defines an urban level of flood protection as follows:

> *"Urban level of flood protection" means the level of protection that is necessary to withstand flooding that has a 1-in-200 chance of occurring in any given year using criteria consistent with, or developed by, the Department of Water Resources. "Urban level of flood protection" shall not mean shallow flooding or*

flooding from local drainage that meets the criteria of the national Federal Emergency Management Agency standard of flood protection.

A levee system with an urban level of flood protection is established upon a Finding, as defined in the 2013 Urban Level of Flood Protection Criteria (ULOP) and the 2012 Urban Levee Design Criteria (ULDC), both published by DWR. Without an adequate 200-year Finding, land use limitations will be placed upon the affected locals. At this time, a 200-year Finding has not been made for any areas within RD 17.

Local stakeholders in RD 17 system, which include the Cities of Lathrop and Manteca, have a goal to arrive at a 200-Year Finding for the RD 17 levee system, as evidenced by the authorization and submission of this report. In a continued cooperative effort between the local stakeholders and DWR, source and analytical files prepared as part of the ULE Program were shared with ENGEO for the LSRP evaluation.

3.0 REGIONAL GEOLOGY

The RD 17 levee system is located in the Great Valley Geomorphic Province of California. This valley is an asymmetric trough filled with a thick sequence of sediments from the Jurassic (180 million years ago) to Recent age. The sediments within the Valley are reported to vary between 5 and 10 kilometers in thickness and were mostly derived from erosion of the Sierra Nevada mountain range to the east, with lesser material from the Coast Range Mountains to the west.

Most of the sediments deposited in the Sacramento-San Joaquin Delta more than 25 million years ago were accumulated in marine environments and the younger deposits (less than 25 million years) are generally described as non-marine (Burroughs 1967). However, Hackel (1966) indicates that some of the younger deposits must have formed in shallow seas and estuaries as marine deposits. According to Atwater (1982), the depositional history of the Delta during the late Quaternary period was probably controlled by several cycles related to fluctuations in regional and global climate in which each cycle consisted of a period of deposition followed by a period of non-deposition and erosion. Thus, according to Atwater (1982), the Delta region during the late Quaternary time experienced scenarios of wetlands and flood plain creation as the tidewater rose in the valley from the west; areas of erosion when tidewaters receded; deposition of alluvial fans that were reworked by wind to create extensive sand dunes; and alluvial fan deposition from streams emanating from the adjacent mountain ranges (Atwater, 1982).

4.0 GEOMORPHOLOGY

Within RD 17 and to the west, the San Joaquin River splits into several distributary channels as it enters the Sacramento – San Joaquin Delta. Prior to levee construction in the late 1800s, the distributary channels flowed into and through tidal marshes. According to Atwater (1982) and WLA (2003), the modern San Joaquin River system flows along the western edge of older alluvial fan deposits (Modesto Formation). The RD 17 Levees are located along the eastern edge

of Holocene deposits or on older Modesto Formation. The distribution of Holocene alluvium and the morphology of the river channels has been influenced over the last several thousand years by rising sea levels, tidal effects from the adjacent Delta, and by man-made modifications.

On the 1913 and 1915 United States Geological Survey (USGS) topographic maps, the locations of the main channel of the San Joaquin River and the bifurcation to the Old River appear to be essentially the same as the modern condition. The locations of the levees on the 1915 map also appear to be essentially the same as the modern condition, although the original levees were widened and raised in the 1960s. Review of aerial images from 1937 and 2010 show that the channel morphology and levee conditions have remained relatively stable over the last three decades. Modifications to the levee system during that time have included local maintenance of rip-rap levee toe protection, repairs of local areas of sloughing, and construction of seepage berms at the landside toe of the levee at several locations.

WLA (2007, 2010) performed detailed surficial mapping of the east bank of the San Joaquin River, presented as Figure 5 of this report. They identified map units of recent (historic) age, including crevasse splays, channel deposits and overbank deposits, and units of Holocene age, including channel and point bar deposits associated with the modern and prehistoric channels of the San Joaquin River, and basin deposits formed by overbank flooding away from the main channel. These map units were defined on the basis of aerial image analysis, review of soil survey maps and limited field reconnaissance.

We evaluated the mapping of WLA based on review of surficial mapping by Atwater (1982), the 1915 and 1913 USGS topographic maps for the Lathrop and Stockton quadrangles, aerial photography flown in 1937, modern aerial imagery and maps, and the available subsurface explorations. Based on our review, we concur with the surficial mapping by WLA. The subtle geomorphic features used by WLA to define map units have been largely obscured on recent aerial images by man-made activities such as field leveling and tilling, construction of drainage and irrigation canals, road construction and land development. However, many of the original geomorphic features are visible in the 1937 aerial photographs, including small channels on the alluvial fan east of the levees and crevasse splays/levee breaches adjacent to the river channel. In general, the density of obscured channel and crevasse splay deposits is much greater on the western side of the San Joaquin River, on Stewart Tract and Upper Roberts Island, relative to the east side within RD 17.

5.0 SEISMIC HAZARDS

Potential seismic hazards resulting from a nearby moderate to major earthquake can generally be classified as primary and secondary. The primary effect is ground rupture, also called surface faulting. The common secondary seismic hazards include ground shaking and liquefaction. The following sections present a discussion of these hazards as they apply to the site. Based on topographic and lithologic data, the risk of seismically induced landslides or tsunamis is considered low at the site.

5.1 REGIONAL FAULTING

Numerous active earthquake faults are located in the Northern California region and within relatively close proximity to the Sacramento – San Joaquin Delta. An active fault is defined by the California Geologic Survey as one that has had surface displacement within Holocene time, considered about the last 11,000 years (Hart, 1997). Table 5.1-1 below provides a summary of nearby active and potentially active faults including their proximity to the project.

TABLE 5.1-1
Active and Potentially Active Faults

Fault Name	Approximate Distance and Direction From Site	Characteristic Magnitude	California Building Code Classification	Estimated Age of Most Recent Activity
Great Valley 7 fault	15 miles west	6.9	Not Classified (Blind Thrust fault)	unknown
Greenville Connected fault	25 miles west	7.0	A	Late Quaternary
Mount Diablo Thrust faults	33 miles west	6.7	Not Classified (Blind Thrust fault)	unknown
Pittsburg Kirby Hills fault	38 miles northwest	6.7	Not Classified (Reverse Fault)	unknown
Green Valley Connected fault	47 miles northwest	6.8	A	Late Quaternary
Calaveras fault	36 miles west	7.0	A	Late Quaternary
Ortigalita fault	41 miles south	7.1	A	Late Quaternary
Hayward – Rodgers Creek fault	67 miles northwest	7.3	A	Holocene
San Andreas fault	63 miles west	7.9	A	Holocene

5.2 GROUND RUPTURE

The RD 17 levee system, in its existing alignment, is not located within a currently designated Alquist-Priolo Earthquake Fault Zone and no known surface expression of active faults is believed to exist along the alignment. Fault rupture through the levee, therefore, is not anticipated.

5.3 GROUND SHAKING

An earthquake of moderate to high magnitude generated within the Northern California region could cause ground shaking at the site. To quantify potential ground shaking acceleration we determined site-specific Peak Ground Accelerations (PGA) along the levee alignments at

10,000-foot stationing intervals using a Probabilistic Seismic Hazard deaggregation from the United States Geological Survey. Seismic parameters were evaluated using an exceedance probability of 20 percent in 50 years, which is equivalent to a 224-year return period. Our opinion is that the PGA from a 224-year seismic event is approximately equivalent to the 200-year seismic event specified by the ULDC. Based on existing CPT and boring data and previous reports regarding RD 17, we used a shear wave velocity (V_{s30}) of 335 m/s, which corresponds to a Site Class D, stiff soil condition. We selected a moment magnitude of 6.8, which consists of the weighted average of the characteristic moment magnitudes of the faults contributing more than 2 percent to the probabilistic seismic event. A summary of the PGAs selected for our analysis is provided in Table 5.3-1 below. For reference, we have also included a factored acceleration (K) used in seismic slope stability analyses, which is discussed later in this report.

TABLE 5.3-1
PGA and K Values

Stationing	Latitude (degrees)	Longitude (degrees)	PGA* (g)	K (0.5*PGA)
0+00	37.9092	-121.2909	0.182	0.09
100+00	37.9157	-121.3204	0.187	0.09
200+00	37.8915	-121.3275	0.193	0.10
300+00	37.8666	-121.3268	0.198	0.10
400+00	37.8492	-121.3219	0.201	0.10
500+00	37.8283	-121.3100	0.201	0.10
600+00	37.8143	-121.3188	0.207	0.10
700+00	37.8027	-121.3120	0.208	0.10
800+00	37.7798	-121.3002	0.210	0.11
900+00	37.7645	-121.2767	0.207	0.10
1000+00	37.7654	-121.2507	0.201	0.10
1079+00	37.7665	-121.2249	0.195	0.10

* PGA values were obtained from USGS Website and assume a Shear Wave Velocity (Vs) of 335 m/s and a return period of 20% in 50 years: http://geohazards.usgs.gov/deaggint/2008/

5.4 LIQUEFACTION AND LATERAL SPREADING

Seismically induced soil liquefaction is a process by which soil undergoes a significant loss of strength due to cyclic loading and corresponding increase in pore water pressure. The effects of liquefaction can be a decrease in soil shear strength, reduction in soil volume, ground settlement, and lateral spreading. Soils most susceptible to liquefaction are clean, loose, saturated, uniformly graded fine sands below the groundwater table. Empirical evidence and laboratory testing indicates that loose to medium dense gravels, silty sands, low-plasticity silts, and some low-plasticity clays are also potentially liquefiable.

Seismic vulnerability analyses, in the form of seismic slope stability analyses, have been considered in this evaluation. If an intermittently loaded urban levee is found to be seismically vulnerable, DWR 2012 ULDC states that a plan should be in place to "restore grade and dimensions for at least the 10-year WSE plus 3 feet of freeboard or higher for wind setup and wave runup within 8 weeks" (DWR, 2012). Provided that a sufficient plan can be prepared and implemented, mitigation of potential liquefaction and lateral spreading impacts prior to the occurrence of a design-level earthquake is not required.

6.0 GEOTECHNICAL HAZARDS

Potential geotechnical hazards resulting from long-term settlement or instability can occur because of time-dependent soil deformation or a degradation of soil strength or embankment integrity, with time. Reduction in levee height over time can result from imposing new surcharge pressure on potentially compressible soil. A loss in soil strength, or integrity, can result in failure of the levee embankment and inland inundation. The following sections present a discussion of these hazards as they apply to the site.

6.1 FLOODING DUE TO SOIL INTEGRITY DEGRADATION

The soil strengths and associated integrity, assumed as part of this levee evaluation, are based on the characteristics observed and tested as part of this, and the previously referenced, evaluations. These soil characteristics can change with time, generally as a result of insufficient maintenance and abatement of erosion, vegetation, and bioturbation.

Waterways adjacent to RD 17 include French Camp Slough, the San Joaquin River, and Walthall Slough. These waterways have been identified as potential sources of floodwaters. It should be understood that with any levee system there is an inherit risk of flooding, as previously discussed in this report. This risk increases if the previously mentioned lack of maintenance is allowed to degrade the existing soil integrity characteristics.

6.2 COMPRESSIBLE SOIL

Potentially compressible layers of soft clay were encountered in our explorations in both the levee prism and foundation soils. When subjected to additional loads from fills, these soils are susceptible to consolidation settlement that could result in ground surface settlement. However, based on our experience with consolidation settlement due to fill placement at this project, and in the general project vicinity, we do not anticipate future settlement due to compressible soils to occur under the existing levee geometry and improvements. Settlement from seismically induced settlement is discussed in Section 5.4.

7.0 PROJECT DATUM

Several previously published documents utilize National Geodetic Vertical Datum 1929 (NGVD29). If necessary, to convert the vertical datum to National Geodetic Vertical Datum

1929 (NGVD29) from North American Vertical Datum 1988 (NAVD88), 2.46 feet should be subtracted.

8.0 FIELD EXPLORATION AND LABORATORY TESTING – ULDC SECTION 7.3

Our field exploration, for the current ULDC evaluation, included drilling 20 borings and advancing 135 Cone Penetration Test (CPT) soundings at various locations on both the levee crown, landside toe and landside field locations along the RD 17 levee alignment. We performed our current field explorations between October 2014 and July 2015.

The location and elevations of our explorations are approximate and were estimated using handheld GPS equipment; they should be considered accurate only to the degree implied by the method used.

8.1 BORINGS

We observed drilling of 20 borings at the locations shown on the Site Plan and Geologic Profile, Figures 2A though 2MM. An ENGEO representative observed the drilling and logged the subsurface conditions at each location. We retained truck-mounted Mayhew 1000 and CME-75 drill rigs and crew to advance the borings using 8-inch-diameter mud rotary and hollow-stem auger drilling methods. The borings were advanced to depths ranging from 40½ to 116½ feet below existing grade. We permitted and backfilled the borings in accordance with the requirements of the San Joaquin County Environmental Health Department. The borings were also drilled and backfilled in general conformance with the methodology outlined in the USACE guidance for drilling in earth embankment dams and levees (ER 1110-1-1807).

We obtained bulk soil samples from drill cuttings and retrieved both disturbed and relatively undisturbed soil samples at various intervals in the borings using standard penetration tests, 2½-inch O.D. Modified California Sampler, and 3 inch O.D. Shelby Tubes.

The blow counts were obtained using an auto-trip 140-pound hammer with a 30-inch free fall. The 2-inch O.D. split-spoon sampler was driven 18 inches and the number of blows was recorded for each 6 inches of penetration. In addition, 2.5-inch I.D. samples were obtained using a Modified California Sampler driven into the soil with the 140-pound hammer previously described. Unless otherwise indicated, the blows per foot recorded on the boring log represent the accumulated number of blows to drive the last 1 foot of penetration; the blow counts have not been converted using any correction factors. When sampler driving was difficult, penetration was recorded only as inches penetrated for 50 hammer blows.

We used the field logs to develop the report logs in Appendix C. The logs depict subsurface conditions at the exploration locations for the date of exploration; however, subsurface conditions may vary with time.

8.2 CONE PENETRATION TESTING

We retained a CPT rig to push the cone penetrometer to a maximum depth of about 100 feet. The CPT has a 20-ton compression-type cone with a 15-square-centimeter (cm2) base area, an apex angle of 60 degrees, and a friction sleeve with a surface area of 225 cm^2. The cone, connected with a series of rods, is pushed into the ground at a constant rate. Cone readings are taken at approximately 5-cm intervals with a penetration rate of 2 cm per second in accordance with ASTM D-3441. Measurements include the tip resistance to penetration of the cone (Qc), the resistance of the surface sleeve (Fs), and pore pressure (U) (Robertson and Campanella, 1988). CPT logs are presented in Appendix C.

8.3 LABORATORY TESTING

We performed laboratory tests on selected soil samples to evaluate their engineering properties. For this project, we performed moisture content, dry density, unconfined compression, plasticity index, gradation, hydrometer, direct shear, triaxial compression, and consolidation testing. Moisture contents and dry densities are recorded on the boring logs in Appendix C; other laboratory data is included in Appendix D.

9.0 ENGINEERING EVALUATION

Using the information from recent and previously published geotechnical and levee-related reports, accompanied by our current subsurface evaluation and laboratory testing, ENGEO evaluated settlement, seepage, slope stability, and seismic vulnerability (seismic slope stability) for the reaches within the RD 17 levee system. Our evaluation assumed that all the improvements associated with the Phase III LSRP, described in Section 2.5 of this report, had been completed as recommended in the associated 2014 ENGEO report. We summarize our engineering evaluations below.

9.1 WATER SURFACE ELEVATIONS

Numerous hydraulic analyses have been performed for this section of the San Joaquin River system. For this evaluation, we are using a 200-year Design Water Surface Elevation (DWSE) provided by PBI. The 200-year DWSE is plotted in profile on Figures 2A through 2MM and Figures 7A through 7G.

In addition to evaluation of the 200-year DWSE, the levees are evaluated for seepage and slope stability for a flood elevation at the hydraulic top of levee (HTOL). The purpose of the HTOL analysis is to evaluate the stability of the levee during extreme loading conditions and to demonstrate the primary anticipated mode of failure during such an event would be erosion due to overtopping. The ULDC defines the HTOL as the higher water surface of option A or B, described below:

A. The lower flood elevation of:
   1. The median 200-year water surface elevation plus 3 feet.
   2. The median 500-year water surface elevation.
   3. The minimum top of levee (MTOL).

B. The DWSE

In general, the HTOL elevation was controlled by the 200-year water surface elevation plus 3 feet, with the exception of the southern non-project levee (Walthall Slough), which was generally controlled by the 500-year water surface elevation.

PBI utilized the FEMA approach in modeling the various design water surfaces. In addition, PBI utilized existing water level data to conclude that the RD 17 levees are intermittently loaded (Peterson, Brustad Inc., 2014).

9.2 REACH SELECTION

Similar to what has been done for the LSRP and the ULE studies, continuous segments of the levee system have been selected for this evaluation; each continuous segment is designated as a reach. The limits of the reaches are generally based on similar subsurface soil stratigraphy, but also consider:

- Political boundaries and right-of-ways.
- Land ownership.
- Land use adjacent to the levee (agricultural, urbanizing, urban, park, etc.).
- LSRP Project Element and Project Area limits.
- ULE reach limits.

Reach stationing limits are tabulated in the Conclusions section of this report; reach limits are also identified on the Plan and Profile figures (Figures 2A through 2MM). Please note that the reach limits identified for this evaluation have a naming/numeration scheme separate, but not entirely independent, from the LSRP. The reaches are, however, similar to those selected by the ULE studies. Political boundaries, land ownership, and adjacent land use do not dictate the identification and/or limits of levee improvement projects; they are, however, considered in the construction phasing of the LSRP's implementation and are thereby considered in the reach selections for this evaluation.

9.3 IDEALIZED SUBSURFACE STRATIGRAPHY

An idealized subsurface stratigraphy is a modeling or depiction of the various soil layers and their respective thicknesses and depths. Exploration logs, lab data, and geologic conditions were interpreted to develop a subsurface cross section representative of the location being analyzed. These analytical locations, identified by stationing, were chosen as representations of the respective reach based largely on their geometry, soil stratigraphy, and historical seepage

performance. Seepage and stability analyses for this evaluation incorporate idealizations of the subsurface stratigraphy as well as geometric surface information.

ENGEO reviewed and updated the geometry and subsurface stratigraphy for some models that DWR used for ULE Project Levees. A summary of the DWR models that were modified are listed below; details of geometry and subsurface stratigraphy are provided in the figures and appendices.

TABLE 9.3-1
ULE Models with Geometric Modifications

Reach	Station	Geometric Modification*	Substantiation for Change
H3	455+55	Surface Geometry	Removed berm due to limited lateral extent
C2	130+85	Subsurface Stratigraphy	New ENGEO boring

To supplement the models we received from DWR, we developed new seepage and stability models both within and outside of the ULE study area.

9.4 SEEPAGE EVALUATIONS – ULDC SECTION 7.5

We performed an evaluation of levee under and through seepage incorporating new and existing subsurface information and laboratory data along with existing, or proposed, LSRP Phases I, II and III levee improvements. Our models do not incorporate landside berms associated with PL84-99 improvements.

9.4.1 Analytical Software

We performed seepage calculations using the GeoStudio 2012 v8.13.1.9253 software program Seep/w in this levee evaluation. Seep/w is a two-dimensional finite element software program that is widely used in soil and other material seepage evaluations.

9.4.2 Steady State Seepage

The effect that steady state seepage has on the stability of the levee is evaluated in a steady state seepage scenario. The steady state condition occurs when a water level remains long enough for the embankment soils to become fully saturated, resulting in a condition of steady seepage. Seep/w was used to perform steady state evaluations for the sections modeled in this evaluation. When necessary to perform slope stability analysis, the pore water pressures determined by Seep/w were incorporated into the Slope/w analysis for stability calculations. Boundary conditions and model limits in these analyses were consistent with those recommended in the Version 14 - 2013 URS Guidance Document for Geotechnical Analysis. It is our opinion that the modeling parameters recommended by this publication are suitable for this evaluation, and are summarized as follows:

- The model was extended 2,000 feet landward of the levee centerline and to the approximate center of the river, on the waterside of the levee centerline.

- No-flow boundary conditions were assigned along the vertical face of the model on the waterside, and along the bottom of the model.

- The water level was assumed to be at the ground surface on the landside; a total head boundary condition, corresponding to the landside ground level, was applied along the vertical face of the model on the landside.

9.4.3 Under Seepage Analysis and Criteria

Under seepage occurs when hydraulic head forces water to seep through the foundation soils. A hydraulic gradient is the drop in head over a given distance; an exit gradient is the vertical hydraulic gradient of the modeled condition where seepage exists onto a ground surface. Where a blanketing/confining soil layer occurs above a more permeable soil, average gradients (drop in head across the thickness of a blanket layer) were calculated and reported as representing the exit gradient. The calculation for average gradient is shown here.

$$i_{avg} = \frac{\Delta h}{t}$$

i_{avg}, Average Gradient
Δh, Drop In Head Across Blanketing Soil
t, Vertical Thickness of Blanketing Soil

Where a blanketing soil was not present, we reported the local y gradient (as representing the exit gradient) by selecting a Gaussian area along the surface of the Seep/w model with limited influence from calculated points of singularity. If modeled conditions are such that seepage does not exit onto the ground surface, the gradient is negative (indicating seepage as not exiting) and reported as *no positive y-gradient.*

Factors of safety against under seepage instability can be determined by comparing the calculated exit gradient to the critical gradient. Critical gradients are dependent upon the saturated unit weight of the surface material. For our analysis, we used a saturated unit weight of soil equal to 112 pcf, and therefore, the associated critical gradient is approximately 0.8 (factor of safety, FS = 1.0). If the factor of safety against under seepage is less than 1.0, the calculation is indicative of a *quick* condition.

$FS = i_{critical} / i_{exit}$ $i_{critical}$, Critical Gradient i_{exit}, Exit Gradient	$i_{critical} = (\gamma_{sat} - \gamma_w) / \gamma_w$ $i_{critical} = (112\ pcf - 62.4\ pcf) / 62.4\ pcf$ $i_{critical} = (49.6\ pcf) / 62.4\ pcf$ $i_{critical} = 0.8$ γ_{sat}, Saturated soil unit weight γ_w, Unit weight of water

Based on USACE Engineering Manual 1110-2-1913 (as modified by ETL 1110-2-569) and the ULDC, the current guidance for acceptable exit gradients through soils with a minimum saturated unit weight of 112 pcf at the toe of the levee (average exit gradient) should be no greater than 0.5 and no greater than 0.8 at the toe of a seepage berm with a minimum width equal to four times the height of the levee crown above the landside toe. When modeling a scenario that incorporates the HTOL, the allowable exit gradient is no greater than 0.6 at the levee toe. At the toe of a seepage berm for berms less than 100 feet wide for HTOL, the allowable gradient is a less than 20 percent degradation of the calculated DWSE exit gradient (note that there are no berms within the limits of the study area that are 100 feet or greater in width). For cases where a ditch, canal, or depression is located beyond the landside toe of the levee, the maximum allowable exit gradient specified by the ULDC is linearly interpolated between 0.5 at the levee toe and 0.8 at, and beyond, 150 feet from the landside toe. Where drained or undrained seepage berms exist or are proposed, the landside ground surface is not assumed to represent a "ditch, canal, or depression" condition as described in Section 7.5 of the ULDC. A summary of our under seepage criteria is provided in Section 9.7.

9.4.4 Through Seepage Analysis and Criteria

Through seepage is a condition that occurs when the upstream water stage in a cross section rises above the landside embankment toe elevation and the phreatic water surface through the levee embankment daylights onto the landside slope. This can cause localized instability, unraveling of the landside levee slope soils, and potentially progressive erosion of embankment soils causing levee failure.

Where the analyses show through seepage, the reported through seepage height is the difference in elevation between the landside toe of slope and the elevation at which the phreatic water surface daylights on the slope. Where applicable, the creep ratio, or the ratio of seepage path length through the embankment and the head difference on either side of an erodible layer, was calculated. The allowable creep ratio represents the minimum seepage path length per unit of head, and is controlled by the soil type through which the water is seeping. We selected allowable creep ratios based on the International Levee Handbook (USACE, 2013).

Considerations for through seepage evaluation are:

- Exit height of through seepage above the landside levee toe of the embankment (also called the "breakout" point).

- The types of soil in the embankment and what type of soil the through seepage is exiting onto the surface from.

- Slope of the embankment over which the through seepage is exiting onto.

- The allowable creep ratio though an erodible layer.

- Quantity of through seepage flow.

9.4.5 Hydraulic Conductivity

To determine appropriate soil hydraulic conductivities (K) of the levee and the foundation soils for seepage analyses, we utilized the following resources:

- Previous hydraulic conductivity evaluations in the region, and
- Specific hydraulic conductivity laboratory test results.

In sedimentary units, it is common to have anisotropic porous media. This occurs when the geometry of the voids between the soil particles is not uniform in all directions; therefore, the permeability in one direction may be greater. The ratio of horizontal conductivity to vertical conductivity, or anisotropy ratio (Kv/Kh), is generally based on the values determined through model calibration and laboratory soil testing in relation to gradational and plasticity characterization. Most soils were modeled with an anisotropy ratio of 0.25; however, each soil model was evaluated on a case-by-case basis with respect to depositional environment and sensitivity of the model.

The hydraulic conductivities of the materials in this evaluation were determined for saturated materials; hydraulic conductivities are generally much higher for saturated soils and, therefore, represent a more conservative condition by calculating a greater amount of flow through the soils. The specific hydraulic conductivities used in the analyses are presented on the seepage analysis figures in Appendix E.

9.4.6 Three-Dimensional Seepage Effects

In 2012, URS published a Technical Memorandum to provide guidance for assessing the three dimensional effects associated with a waterway meander. The concern at the time was that additional hydraulic head would be generated at the toe of levee on an inside bend, with a high-water stage potentially surrounding an area landside. The memorandum proposed that an additional 10 to 30 percent of the calculated exit gradient be added to account for the additional head that potentially could have been generated due to a river bend. We recognize that this methodology is intended for screening level evaluations; however, it is our opinion that this conservative approach to three-dimensional effects is acceptable for our current design analyses. At locations where this method of analysis could be applied, an additional percentage of exit gradient has been included, and noted, in the analyses presented in Appendix E.

9.4.7 Seepage Model Calibration

Consistent with previous evaluations by both ENGEO and ULE, sensitivity analyses were performed on the Seep/w models used in this evaluation. The anisotropic ratio and hydraulic conductivity of the blanket and/or landside surface soils were varied and the resulting exit gradient was then compared to other variations of the model and the observed historic performance. This process occurred through workshop meetings held for the ULE Program (in which models generated by the ULE Program were considered), as well as through internal review meetings at ENGEO (for models that were generated by ENGEO). Multiple iterations of this analysis were performed for each of the models to develop confidence in how the variation of the material properties in the models affected the results of the evaluation.

Based on the sensitivity analyses conducted on the sections published in this report, the analyses presented herein consider the observed historical performance of the levee system and can be considered a reasonable representation of the actual existing conditions.

9.5 SLOPE STABILITY EVALUATION – ULDC SECTION 7.4

We performed levee slope stability analysis by incorporating new and existing subsurface information and laboratory data along with existing or proposed LSRP Phases I, II and III levee improvements. Our models did not incorporate landside berms associated with PL84-99 improvements.

9.5.1 Analytical Software

We performed slope stability analyses using the GeoStudio 2012 v8.13.1.9253 software program Slope/w in this levee evaluation. Slope/w is a two-dimensional limit equilibrium program that is widely used in slope stability evaluations.

9.5.2 Soil Strength Parameters

As part of a cooperative effort between ENGEO and ULE, soil strength parameters were discussed and a general methodology for selecting strength parameters in workshop meetings. The SGDR Addendum discusses the special strength testing program that was conducted in support of the ULE GER evaluation. Ultimately, the ULE Program determined the soil strength parameters for the cross sectional slope stability models utilized in their screening level evaluation. The soil strength parameters used in our study are in general accordance with those values utilized by ULE for their screening level analysis, and are, in our opinion, conservative. Where analytical results revealed apparent over-conservative results, more appropriate soil strength parameters were determined to more closely model the actual conditions. The specific soil strength parameters used in the ULDC analyses are presented on the analytical figures in Appendix E.

In selecting strength parameters, we distinguished between free-draining materials and non-free-draining materials. Free-draining materials are defined as coarse-grained materials with

little or no plastic fines such that when sheared these materials do not generate excess pore water pressure.

Free-draining materials were assumed to remain drained and hence their shear strength was characterized with a Mohr-Coulomb failure envelope for effective stress parameters for all loading conditions. The effective cohesion intercept (c') was assumed to be zero for all drained materials. In general, SPT blow counts and the results and findings of a special laboratory soil testing program were utilized in selecting the effective drained friction angle (ϕ') of cohesionless soils.

Fine-grained soils were also modeled using Mohr-Coulomb failure envelopes. Effective soil strengths, used for steady state stability conditions, were defined by the effective friction angle, ϕ' and the effective cohesion intercept, c'; undrained soil strengths, used for rapid drawdown loading conditions, are defined by the total stress friction angle, ϕ and the total stress cohesion intercept, c. Soil strength parameters for fine-grained soils were selected and largely based on SPT blow counts, results of a special and laboratory soil testing.

For seismic loading, the use of the Stress History and Normalized Soil Engineering Properties (SHANSEP) method was utilized. The SHANSEP method is based upon the undrained strength as a function of stress history and effective overburden stresses. We performed three Triaxial Isotropically Consolidated Undrained (TXICU) tests on fine-grained deposits at different levels of overconsolidation to understand the behavior of the soil under rapid loading and undrained conditions. We compared the results of our laboratory testing with TXICU tests performed in previous studies of RD 17, from ENGEO and from DWR, and used the results to develop a strength profile based on the current stress state and the maximum past pressure of the soil.

We calibrated the correlations of undrained shear strength from CPTs with the laboratory data and our SHANSEP results.

9.5.3 Levee Slope Stability Analyses and Criteria

Circular and non-circular slope stability analyses were performed in Slope/w using Spencer's Method. This analytical method is an iterative solution that satisfies both force and moment equilibrium and assumes all slice side forces have the same inclination. This method is appropriate for both circular and non-circular failure surfaces, both of which are utilized in this study. However, because Spencer's method does not discriminate between realistic side force inclinations and instead only selects the inclination that provides the most critical inter-wedge forces, the results of non-circular slope stability analyses can be overly conservative; when this occurred, we used the Morgenstern-Price method for non-circular slope stability analyses. Similar to Spencer's Method, the Morgestern-Price method is also an iterative solution except the method assumes the direction of inter-slice forces varies across the slip surface as a function of distance. The results of either method of analysis were then compared to evaluate the level of conservatism for each.

The Factor of Safety (FS) is defined as the sum of available resisting forces divided by driving forces along a failure plane. A FS value less than 1.0 indicates slope instability, and the greater the FS, the greater the anticipated stability of the slope. For this levee evaluation, we are considering a non-circular failure surface for cross sections that incorporate a cutoff wall or contain a relatively thin weak soil layer that could provide a preferential failure plane.

Our stability analyses considered various loading conditions and water surface elevations. Our analysis framework was based on ULDC guidance. The minimum acceptable slope stability factors of safety are tabulated here:

TABLE 9.5.3-1
Minimum Acceptable Slope Stability Factors of Safety (FS)

Rapid Drawdown	Steady Seepage		Pseudostatic	Post Earthquake
	DWSE	HTOL		
1.0 – 1.2*	1.4	1.2	1.0	1.0

* FS ≥ 1.0 applies to pool levels prior to drawdown for conditions where the water levels are unlikely to persist for long periods preceding drawdown. FS ≥ 1.2 applies to pool level, likely to persist for long periods prior to drawdown. For this evaluation, a FS ≥ 1.0 is being utilized for Rapid Drawdown analyses, per USACE Guidance.

The ULDC specifies that the rapid drawdown shall be considered from the DWSE, and that the amount of drawdown should be established based on site-specific hydrologic data. For the purposes of this study, we utilized a drawdown water surface elevation provided by PBI. It is our understanding that this drawdown water surface elevation was based on a specific hydrologic and river hydraulic study for RD 17.

9.5.3.1 Steady State Seepage

This condition occurs when the water remains at or near full-flood stage long enough so the embankment becomes fully saturated and steady seepage is achieved. Pore water pressures used during steady state seepage were based on the DWSE or HTOL, respective to the analysis conducted. Steady state seepage pore pressures were calculated in Seep/w and then incorporated directly into Slope/w for slope stability analysis.

9.5.3.2 Rapid Drawdown

Rapid drawdown occurs when prolonged flood stage water levels saturate waterside embankment slope and then the water surface falls faster than the soil can drain. For this study, we utilized a specific drawdown water surface elevation provided by PBI. It is our understanding that this drawdown is based on a specific hydrologic and river hydraulic study on RD 17. Based on information provided by PBI, the flood water levels may persist for several weeks preceding a drawdown condition.

9.5.3.3 Pseudostatic Seismic Analysis

We utilized the higher of the average summer water surface elevation and the average winter water surface elevation provided by PBI to evaluate the levees under seismic conditions. Using undrained soil strengths due to the rapid seismic loading, we analyzed the stability of both the land and waterside slopes using a horizontal ground acceleration equal to one-half of the 200-year return period peak ground acceleration (PGA), as defined in Section 5.2, to simulate earthquake shaking. Where potentially liquefiable soils were identified in the subsurface profile, we performed a liquefaction triggering analysis and then assigned reduced post-earthquake strengths to these layers and ran stability analyses on both land and waterside slopes.

9.5.3.4 Post-Earthquake Slope Stability

We evaluated the liquefaction potential of the foundation soils utilizing the methodology presented in Youd et al., 2001. Liquefaction triggering was also considered using the methodologies proposed by Cetin et al. (2004) and Boulanger and Idriss (2014). In accordance with the ULDC, the higher of the average summer water surface elevation and the average winter water surface elevation was used for both liquefaction triggering analysis and limit equilibrium slope stability analysis.

The factor of safety against liquefaction triggering (FS_{liq}) was defined as the cyclic resistance of the soil to the cyclic stress acting on the soil due to the seismic loading. We considered a FS_{liq} less than 1.0 to indicate liquefaction triggering and a FS_{liq} between 1.0 and 1.4 to be "marginally liquefiable." When different methodologies yielded different liquefaction potential results for a given soil layer, we generally chose the conservative lower factor of safety in our analyses.

Liquefied soils for the "post-earthquake" condition were modeled in our stability analyses with residual undrained shear strength proportional to the effective overburden stress, according to the methodology proposed in Olson and Stark (2002). Marginally liquefiable soils were modeled in our stability analyses with a reduced friction angle (ϕ') to account for a reduced shear strength caused by the buildup of pore water pressure due to cyclic loading. Soil strengths used in our analyses are shown on the analysis figures in Appendix E.

9.6 SEISMIC VULNERABILITY – ULDC SECTION 7.7

We evaluated the deformation anticipated from the 200-year seismic event, both from inertial lateral displacement and from post-earthquake loss of shear strength to estimate the total volume of soil needed to restore grades to the 10-year WSE plus 3 feet of freeboard elevation. We used the pseudostatic accelerations discussed in Section 5.3 to evaluate the stability of the levee under the design seismic loads. For cross sections that indicated a factor of safety less than 1.0 with respect to slope stability, we performed a Newmark-type displacement analysis based on the methodology proposed by Bray and Travasarou (2007) to estimate lateral deformations.

Locations that indicated significant or marginal liquefaction triggering were modeled with the reduced soils strengths discussed in Section 9.5.3.4. The cross sections were modeled to include

liquefiable soils layers that were identified at the model cross section, or were modified to include liquefiable layers that are indicated to exist in other locations within the same reach. Where the analysis indicated a factor of safety less than 1.0 with respect to slope stability, lateral deformations were estimated using the methodology proposed by Zhang et al (2004). The free face height and the lateral distance to free face was measured from the ground surface at each exploration location analyzed.

As a qualitative estimate of loss of freeboard, the vertical deformation of the levee crown was estimated for both pseudostatic and post-earthquake conditions as approximately 70 percent of the total lateral deformation. For cross sections that indicated both landside and waterside factors of safety less than 1.0, the total vertical deformation was assumed to be the sum of both the landside and waterside estimates of vertical deformation.

Using the vertical deformation data tabulated above, we compared the post-earthquake settlement levee crown elevation with the 10-year WSE plus 3 feet. This is minimum elevation required for flood protection that must be maintained following a seismic event. If the post-earthquake crown elevation was calculated to be higher than the 10-year WSE plus 3 feet, normal operations and maintenance are acceptable to restore the levee crown with no time constraint. If the post-earthquake crown elevation was calculated to be lower than the 10-year WSE plus 3 feet, we anticipate the volume of soil needed to restore the levee prism to at least this elevation within 8 weeks, as required by the ULDC.

The results of our lateral deformation evaluation and estimated fill volumes are presented in Table 10.0-3.

9.7 SUMMARY OF DESIGN CRITERIA

A summary of the analytical design criteria is provided here, which is identical to the ULDC's Table 7.2 – Urban Levee Design Criteria Summary for Intermittently Loads Levees.

TABLE 9.7-1
Summary of Analytical Criteria for 200-Year Analysis

Evaluation	Analysis	Analysis Case / Condition	Criteria
Seepage	Through Seepage	---	Phreatic water surface exits onto the landside levee slope in erodible material, above the landside levee toe.
	Under Seepage	Hydraulic Top of Levee (HTOL)	Exit Gradient ≤ 0.6 at the Levee Landside Toe <20% FS Degradation for Berms Less Than 100 feet
		Design Water Surface Elevation (DSWE)	Exit Gradient ≤ 0.5 at the Levee Landside Toe Exit Gradient ≤ 0.8 at a Seepage Berm Toe

Evaluation	Analysis	Analysis Case / Condition	Criteria
Landside Slope Stability	Steady State Seepage	DWSE	Factor of Safety ≥ 1.4 (for both circular and non-circular failure planes)
Waterside Slope Stability	Rapid Drawdown	Drawdown Water Elevation Provided by PBI	Factor of Safety ≥ 1.0 to 1.2* (for both circular and non-circular failure planes)

* FS ≥ 1.0 applies to pool levels prior to drawdown for conditions where the water levels are unlikely to persist for long periods preceding drawdown. FS ≥ 1.2 applies to pool level, likely to persist for long periods prior to drawdown. For this evaluation, a FS ≥ 1.0 is being utilized for Rapid Drawdown analyses, per USACE Guidance.

9.8 REPORTING SEEPAGE AND SLOPE STABILITY

The results of the seepage and slope stability analyses are presented on graphics in Appendix E as well as well as in Section 10 in a tabular summary format.

9.8.1 Idealized Subsurface Graphic

For each cross section analyzed, an initial graphic is presented showing the surface geometry, idealized subsurface stratigraphy, the exploration(s) utilized, the DWSE, and material parameters. Specific details regarding the boring logs (blow counts, percent fines content, laboratory test result, etc.) are not provided on these graphics since the addition of this information makes the graphic difficult to read. Subsurface explorations and associated laboratory testing results are provided in the appendices of this report.

9.8.2 Analytical Seepage Graphics

The seepage results figures present a "Geometry Model" showing the idealized stratigraphy utilized in the Seep/w software. Below that graphic is a "Total Head Contours" cross section showing the idealized stratigraphy and the calculated total head contours. This total head graphic is where potential through seepage breakouts are identified (relative to the landside levee toe), and exit gradients are calculated/called out.

On the total head graphic, where the ground surface soils are free-draining non-cohesive materials (sands), the local y-gradient was noted. Where a blanketing layer exists, an average gradient was calculated and reported across the blanketing layer. Either the average gradient or local gradient can be considered the exit gradient. Where occurring, a negative gradient was indicative of seepage flows not exiting on the ground surface; for this condition, we reported "*no positive y-gradient*".

The critical locations to determine exit gradients are the landside levee toe, seepage berm toe (where one is modeled), and ditch or depression within 150 feet of the levee toe. Multiple gradients are presented on the seepage analysis figures; this has been done to convey a better understanding of the model to the reader. When a drained seepage berm was incorporated into

the seepage model, the resulting total head at the ground surface was typically less than the elevation at the same point. This is because the phreatic surface was below the ground surface.

Also noted on the total head graphic is the occurrence of calculated through seepage. A breakout point is indicated on the graphic and the approximate height of the through seepage relative to the landside levee toe is noted.

When a drained seepage berm was modeled, the location of the phreatic water surface within the berm section was checked to determine if the drainage section had sufficient capacity to convey seepage flows. If the drainage section of the berm has sufficient capacity to convey the seepage flows collected by the filter and drainage layer, the phreatic surface will remain below the surface of the berm. Should a positive gradient be measured between the drain rock section and the top of the berm fill material, the capacity of the drainage section in the berm is considered to be fully utilized.

9.8.3 Factor of Safety Calculations

The results of the slope stability analyses are presented on graphics showing the idealized subsurface stratigraphy and existing or proposed improvements (if any). A factor of safety against failure that was calculated by Slope/w is also presented on this graphic. As previously discussed, potential failure surfaces were forced to intersect the levee crest to prevent the program from converging to shallow slumps on the levee slopes; results of slope stability analysis represent the occurrence of a potential slide plane of sufficient size to potentially impact levee integrity. Particularly in non-circular slope stability calculations, the most critical and *reasonable* failure plane was reported, which may not necessarily be the lowest factor of safety calculated by Slope/w. Engineering judgment was utilized when reporting the appropriate of safety.

9.9 INTERFACES AND TRANSITIONS – ULDC SECTION 7.9

Interfaces and transition designs of future improvements were not evaluated as part of this evaluation. Transitions between different mitigation methods, such as cutoff walls and seepage berms, should overlap sufficiently for the system to perform holistically, such that no reach is more susceptible to seepage or stability issues than any adjacent reach. Once final mitigation alternatives for each reach have been selected, final interface and transition evaluations should be performed.

9.10 FLOODWALL, RETAINING WALLS, AND CLOSURE STRUCTURES – ULDC SECTION 7.14

There are currently no floodwalls, retaining walls, or closure structures within the RD 17 levee system; therefore, no evaluations for these structures were performed. If floodwalls, retaining walls, and/or closure structures are incorporated into the levee system in the future, they should be evaluated, as necessary.

9.11 QUALITY ASSURANCE/QUALITY CONTROL

ENGEO implemented a detailed framework for quality assurance and quality control as part of our RD 17 levee evaluation. We set up quality assurance systems to intentionally generate quality deliverables. Our quality assurance protocols include many facets, a few of which are summarized below:

1. Field work (drilling and CPTs) performed by California licensed contractors using calibrated and current equipment and ASTM procedures (where applicable).

2. Use of in-house Army Corps and AASHTO accredited laboratory facilities following ASTM test procedures.

3. Utilizing tested and approved engineering design and analysis programs, including Geostudios (Seep/W and Slope/W) and CPeT-IT.

4. Engineering analyses performed and/or overseen by degreed and California licensed engineering and geology professionals.

Quality control procedures were used to check engineering analyses, boring logs, laboratory data, calculations, figures, and report text. Our process included an independent review by at least one other person with tasks tracked on a spreadsheet. This served as an independent quality control check for accuracy, thoroughness, and overall presentation. Refer to Appendix G for details on our quality control documentation.

10.0 CONCLUSIONS

With the inclusion of the proposed and constructed LSRP improvements, the Reclamation District 17 levee system does not meet the ULDC within the limits of the following reaches:

TABLE 10.0-1
Reaches Found Not Meeting ULDC - Seepage

Reach	Approximate Station Limits	Analyses Not Meeting Steady State Criteria
C2	121+00 to 142+00	Through seepage
C3A	142+00 to 158+00	Under seepage
C4B	174+45 to 192+00	Through seepage
D1	192+00 to 212+00	Under seepage
D2A	212+00 to 247+00	Through and under seepage
D2C	255+00 to 259+50	Through and under seepage
E1B	270+00 to 297+75	Through seepage
F1B	312+30 to 315+00	Through seepage
F1C	215+00 to 321+00	Through and under seepage
F2	321+00 to 339+00	Through and under seepage

Reach	Approximate Station Limits	Analyses Not Meeting Steady State Criteria
F3	339+00 to 362+50	Through and under seepage
H1A	388+00 to 411+00	Through and under seepage
H1B	411+00 to 420+00	Under seepage
H2	420+00 to 445+00	Through and under seepage
H3	445+00 to 466+00	Through seepage
I	466+00 to 506+00	Through and under seepage
J1A	506+00 to 515+50	Through seepage
P2	867+00 to 909+00	Through seepage
Q1	909+00 to 944+00	Through seepage
R1	944+00 to 959+00	Through seepage
S1	959+00 to 972+00	Through seepage

Pursuant to the ULDC, a plan should be in place to "restore grade and dimensions for at least 10-year WSE plus 3 feet of freeboard or higher for wind setup and wave runup within 8 weeks" (DWR, 2012) for urban levees found to be seismically vulnerable. Based on our seismic vulnerability analysis, we conclude that a seismic restoration plan should be prepared for the following reaches:

TABLE 10.0-2
Reaches Found to be Seismically Vulnerable

Reach	Approximate Station Limits	Analysis(es) Not Meeting Seismic Criteria
C3A	142+00 to 158+00	Waterside Pseudo Static, Waterside Liquefaction
D1	192+00 to 212+00	Waterside Pseudo Static, Waterside/Landside Liquefaction
F1B	312+30 to 315+00	Waterside Liquefaction
F2	321+00 to 339+00	Waterside Liquefaction
G	362+50 to 388+00	Waterside Liquefaction
H1B	411+00 to 420+00	Waterside Pseudo Static
H3	455+00 to 466+00	Waterside Liquefaction
L2	655+00 to 703+00	Waterside Liquefaction
M2B	741+30 to 760+50	Waterside Liquefaction
M3A	760+50 to 763+00	Waterside Liquefaction
M3B	763+00 to 768+00	Waterside Liquefaction
M3C	775+00 to 781+00	Waterside Liquefaction
M4	781+00 to 799+50	Waterside Liquefaction
N2	806+00 to 825+00	Waterside Liquefaction
O1	825+00 to 835+00	Waterside Liquefaction

TABLE 10.0-3
Anticipated Restoration Following a 200-Year Seismic Event

Reach	Estimated Length of Damaged Levee (feet)	Estimated Lateral Displacement (feet)	Estimated Vertical Displacement (feet)	Fill Volume* (10-Year WSE + 3 feet Freeboard) (cubic yards)	Fill Volume* (Fully Restored Levee Geometry) (cubic yards)
C3A	2,000	7	5	No Fill Anticipated	2,600
D1	1,235	3.5	2	No Fill Anticipated	350
F1B	650	2	1.5	No Fill Anticipated	100
F2	750	2	1.5	No Fill Anticipated	100
G	1,700	3.5	2.5	No Fill Anticipated	575
H1B	2,000	2	1.5	No Fill Anticipated	250
H3	1,600	3	2	No Fill Anticipated	375
L2	2,000	5.5	4	No Fill Anticipated	1,650
M2B	1,350	7.5	5.5	No Fill Anticipated	2,100
M3A	250	23	16	1,500	3,400
M3B	500	9	6	No Fill Anticipated	1,000
M3C	600	30	21	7,000	14,000
M4	1,850	3	2	No Fill Anticipated	450
N1	650	9	6	No Fill Anticipated	1,300
N2	1,900	11	8	200	6,200
O1	745	14	10	1,500	3,900
			Total Estimated Fill	**10,200**	**38,350**

* Fill volumes are based on limited information and are only provided as estimates to allow for development of an appropriate emergency response plan.

To summarize pertinent information relevant to each analytical cross section and associated reach (including geometry, subsurface conditions, physical constraints and seepage and slope stability results), we created cutsheets for each of the 71 transverse cross sections analyzed as part of our scope. Each cutsheet summarizes the results of the seepage and slope stability analyses and a general description of the reach including levee dimensions, previous improvements and subsurface conditions. This data is presented in the subsequent report sections.

Based on the results of our evaluation, KSN has provided a technical memorandum specifying the improvements required to meet criteria specified in ULDC Sections 7.4, 7.5, 7.9 and 7.14 (KSN, 2016) for deficient reaches. The memorandum identifies the type of remediation selected and the approximate dimensions required to mitigate the adverse effects of seepage for each reach, as identified in this report. With the implementation of these improvements, we anticipate that the identified deficiencies will meet the criteria specified by the ULDC.

10.1 PROJECT REACH A1, STATION 7+56

REACH A1 - STA 7+56

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	0+00	to	15+00
Feature(s) at Upstream Station Limit:	South Manthey Road/dry land levee		
Feature(s) at Downstream Station Limit:	Downing Ave		
Approx. Crown Elevation Range (feet, NAVD88):	19.5	to	22
Approx. Levee Height Range (feet):	8	to	10.5
Approx. Crown Width Range (feet):	17	to	47
Approx. Landside Slope (H:V) Range:	2:1	to	4.5:1
Approx. Waterside Slope (H:V) Range:	1.7:1	to	3:1
Waterside Constraint(s):	Waterside bench between STA 0+00 and 8+00, overhead power lines		
Landside Constraint(s):	STA 0+00 to 3+00 - agricultural land, STA 3+00 to 15+00 - commercial development		
Landside repairs associated with PL84-99:	Levee raised in 1989 along French Camp Slough		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	SILT and Silty SAND
Landside Surface Layer:	Silty SAND, approx. 8 feet thick at levee toe
Soils below surface layer:	Approx. 10 to 15 feet of Silty SAND over Lean CLAY

Historic Performance

No recorded events in ULE's 2014 SGDR Addendum

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
7+56	200-Year	E-2-B	0.02	---	---	Yes**	0.2
	HTOL	E-2-C	0.03	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

**Exits onto slope flatter than 5:1 (H:V), therefore we report "meets criteria" for through seepage.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
7+56	SS - 200yr	14.5	E-2-D	---	4.9	n/a	n/a
	SS - HTOL	15.7	E-2-E	---	4.8	n/a	n/a
	RDD	10.8	E-2-D	1.3	---	n/a	n/a
	PS	2.9	E-2-F	1.2	3.3	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.2 PROJECT REACH A2, STATION 28+05

REACH A2 - STA 28+05

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	15+00	to	60+00
Feature(s) at Upstream Station Limit:	High tension power pole alignment		
Feature(s) at Downstream Station Limit:	Downing Avenue crossing		
Approx. Crown Elevation Range (feet, NAVD88):	19.5	to	22
Approx. Levee Height Range (feet):	9	to	14
Approx. Crown Width Range (feet):	10	to	53
Approx. Landside Slope (H:V) Range:	1.9:1	to	5.5:1
Approx. Waterside Slope (H:V) Range:	1:1	to	4.4:1
Waterside Constraint(s):	Extensive vegetated waterside bench		
Landside Constraint(s):	STA 15+00 to 30+00 open space STA 30+00 to 60+00 residential		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Lean CLAY
Landside Surface Layer:	Lean Clay, approx. 10 feet thick at levee toe
Soils below surface layer:	Interbedded layers of SAND, Silty SAND and Lean CLAY

Historic Performance

Seepage and erosion during the 1997 flood event were reported in ULE's 2014 SGDR Addendum

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
28+05	200-Year	E-2-B	0.21	---	---	Yes**	2
	HTOL	E-2-C	0.30	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

**Exits onto fine grained slope flatter than 5:1 (H:V), therefore we report "meets criteria" for through seepage.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
28+05	SS - 200yr	14.5	E-3-D	---	2.8	n/a	n/a
	SS - HTOL	15.7	E-3-E	---	2.5	n/a	n/a
	RDD	10.8	E-3-D	2.1	---	n/a	n/a
	PS	2.9	E-3-F	1.6	2.2	n/a	n/a
	Post-EQ	2.9	E-3-G/H	2.0	3.1	2.1	3.7

10.3 PROJECT REACH B, STATION 79+72

REACH B - STA 79+72

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	60+00	to	90+00
Feature(s) at Upstream Station Limit:	None		
Feature(s) at Downstream Station Limit:	Levee access ramp/overhead high tension lines		
Approx. Crown Elevation Range (feet, NAVD88):	20.5	to	23
Approx. Levee Height Range (feet):	10.5	to	13
Approx. Crown Width Range (feet):	10	to	27
Approx. Landside Slope (H:V) Range:	2.2:1	to	6:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	4.1:1
Waterside Constraint(s):	None		
Landside Constraint(s):	Residential development		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Lean CLAY and Silty SAND
Landside Surface Layer:	Silty SAND at toe STA 79+72, Lean CLAY throughout other areas of the Reach and Lean CLAY in the field
Soils below surface layer:	Lean CLAY with Silty SAND lenses, approx. 5 feet thick at a depth of approx. 25 feet.

Historic Performance

None noted

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
79+72	200-Year	E-4-B	No Positive Gradient	---	0.18	No	n/a
	HTOL	E-4-C	0.01	---	0.22	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
79+72	SS - 200yr	14.5	E-4-D	---	3.3	n/a	n/a
	SS - HTOL	15.6	E-4-E	---	3.1	n/a	n/a
	RDD	10.8	E-4-D	2.2	---	n/a	n/a
	PS	2.6	E-4-F	1.8	2.7	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.4 PROJECT REACH C1, STATION 100+10

REACH C1 - STA 100+10

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

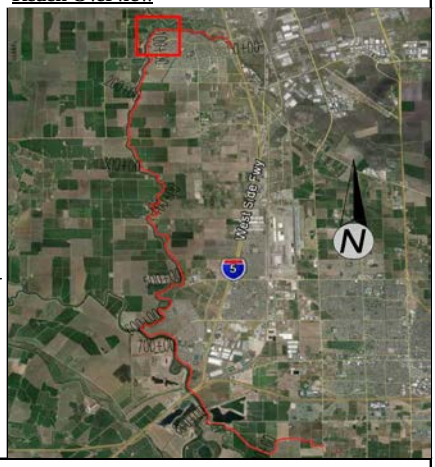
Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	90+00	to	121+00
Feature(s) at Upstream Station Limit:	Transition to thinner blanket, landside park area		
Feature(s) at Downstream Station Limit:	Transition to thinner blanket in Reach B		
Approx. Crown Elevation Range (feet, NAVD88):	21	to	24
Approx. Levee Height Range (feet):	10	to	16
Approx. Crown Width Range (feet):	12	to	40
Approx. Landside Slope (H:V) Range:	1.6:1	to	6.9:1
Approx. Waterside Slope (H:V) Range:	1.7:1	to	4.2:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	None - agricultural land.		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview



Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND to Lean Clay
Landside Surface Layer:	Lean CLAY, approx. 15 feet thick at toe of levee
Soils below surface layer:	Approx. 12 feet of Lean CLAY, over 4 feet of Silty SAND, over 50 feet of Lean CLAY

Historic Performance

No recorded events in ULE's 2014 SGDR Addendum

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
100+10	200-Year	E-5-B	0.03	---	0.02	Yes**	0.6
	HTOL	E-5-C	0.05	---	0.02	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

**Exits onto slope flatter than 5:1 (H:V), therefore we report "meets criteria" for through seepage.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
100+10	SS - 200yr	14.8	E-5-D	---	3.2	n/a	n/a
	SS - HTOL	15.8	E-5-E	---	3.1	n/a	n/a
	RDD	10.7	E-5-D	1.8	---	n/a	n/a
	PS	2.7	E-5-F	1.4	2.4	n/a	n/a
	Post-EQ	2.7	E-5-G/H	1.8	3.7	2.0	4.2

10.5 PROJECT REACH C2, STATION 130+85

REACH C2 - STA 130+85

Based on our evaluation, this reach does not meet ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Meets Criteria

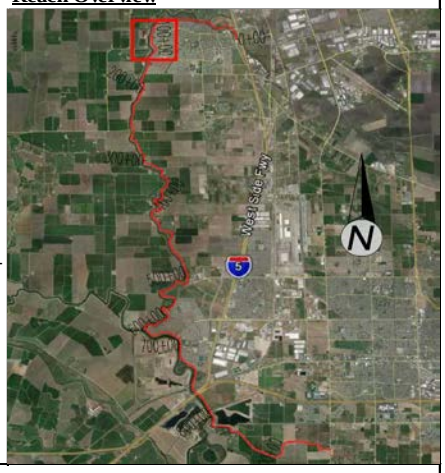
Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	121+00	to	142+00
Feature(s) at Upstream Station Limit:	Pump Station levee penetrations		
Feature(s) at Downstream Station Limit:	William Moss Boulevard		
Approx. Crown Elevation Range (feet, NAVD88):	23.3	to	25
Approx. Levee Height Range (feet):	12	to	20
Approx. Crown Width Range (feet):	11	to	46
Approx. Landside Slope (H:V) Range:	1.5:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	2.8:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	Residential improvements, gravel trench drain		
Landside Repairs associated with PL84-99:	Partial LS subdrain, 3 LS Berms		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview



Generalized Subsurface Conditions

Levee Prism Soils:	Poorly Graded SAND, SILT & Silty SAND transitioning to Lean Clay towards south
Landside Surface Layer:	Lean CLAY , approx. 10 to 40 feet thick at toe of levee
Soils below surface layer:	Interlayered Silty SAND and Lean CLAY

Historic Performance

Seepage,landside boils, and waterside erosion during 1997 flood event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
130+85	200-Year	E-6-B	0.0	---	0.06	Yes	1.7
	HTOL	E-6-C	0.01	---	0.06	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (feet)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
130+85	SS - 200yr	15.8	E-6-D	---	1.6	n/a	n/a
	SS - HTOL	16.8	E-6-E	---	1.5	n/a	n/a
	RDD	11.2	E-6-D	1.7	---	n/a	n/a
	PS	3.1	E-6-F	1.5	1.6	n/a	n/a
	Post-EQ	3.1	E-6-G/H	1.9	2.0	2.0	3.3

10.6 PROJECT REACH C2, STATION 138+25

REACH C2 - STA 138+25

Based on our evaluation, this reach does not the meet ULDC criteria at Sta 130+85.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	121+00	to	142+00
Feature(s) at Upstream Station Limit:	Pump Station levee penetrations		
Feature(s) at Downstream Station Limit:	William Moss Boulevard		
Approx. Crown Elevation Range (feet, NAVD88):	23.3	to	25
Approx. Levee Height Range (feet):	12	to	20
Approx. Crown Width Range (feet):	11	to	46
Approx. Landside Slope (H:V) Range:	1.5:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	2.8:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	Residential improvements, gravel trench drain		
Landside Repairs associated with PL84-99:	Partial LS subdrain, 3 LS Berms		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Poorly Graded SAND, SILT & Silty SAND in north to Lean Clay towards south
Landside Surface Layer:	Lean CLAY , approx. 10 to 40 feet thick at toe of levee
Soils below surface layer:	Interlayered Silty SAND and Lean CLAY

Historic Performance

Seepage,landside boils and waterside erosion during 1997 flood event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
138+25	200-Year	E-7-B	0.38	---	0.35	Yes**	2.5
	HTOL	E-7-C	0.44	---	0.40	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

**Exits onto a fine grained slope, therefore we report "meets criteria" for through seepage.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (feet)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
138+25	SS - 200yr	15.8	E-7-D	---	1.7	n/a	n/a
	SS - HTOL	16.8	E-7-E	---	1.6	n/a	n/a
	RDD	11.2	E-7-D	1.4	---	n/a	n/a
	PS	3.1	E-7-F	1.1	1.6	n/a	n/a
	Post-EQ	3.1	E-7-G/H	1.4	1.8	1.2	1.8

10.7 PROJECT REACH C3A, STATION 150+99

REACH C3A - STA 150+99

Based on our evaluation, this reach does not meet the ULDC criteria. Seismic deformations are not anticipated to degrade below 10-Year WSE + 3 feet.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Fails Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Fails Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Fails Criteria
Steady State Seepage HTOL , LS:	Fails Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	142+00	to	158+00
Feature(s) at Upstream Station Limit:	Approx. 100' south of Abruzzi Ct (gate)		
Feature(s) at Downstream Station Limit:	Pump station at Aso Taro Road		
Approx. Crown Elevation Range (feet, NAVD88):	22.5	to	24
Approx. Levee Height Range (feet):	10	to	16
Approx. Crown Width Range (feet):	12	to	40
Approx. Landside Slope (H:V) Range:	1.6:1	to	6.9:1
Approx. Waterside Slope (H:V) Range:	1.7:1	to	4.2:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	Residential improvements		
Repairs associated with PL84-99:	Yes, berm constructed near STA 153+00		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: Silty SAND and Lean CLAY
Landside Surface Layer: Lean CLAY , approx. 3 to 16 feet thick at toe of levee
Soils below surface layer: Interlayered Silty SAND and Lean CLAY

Historic Performance

Landside seepage and ponded water during 1997 flood event in addition to three areas of waterside erosion from the 2006 event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
150+99	200-Year	E-8-B	0.60	---	0.76	Yes**	2.2
	HTOL	E-8-C	0.77	---	0.86	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

**Exits onto a fine grained slope, therefore we report "meets criteria" for through seepage.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (feet)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
150+99	SS - 200yr	16.2	E-8-D	---	1.2	n/a	n/a
	SS - HTOL	17.3	E-8-E	---	1.0	n/a	n/a
	RDD	11.4	E-8-D	1.1	---	n/a	n/a
	PS	3.3	E-8-F	0.8	1.7	n/a	n/a
	Post-EQ	3.3	E-8-G/H	0.9	2.1	0.9	2.3

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
C3A	2,000	7	5	No Fill Anticipated	2,600

10.8 PROJECT REACH C3B, STATION 158+00

REACH C3B - STA 158+00

Based on our evaluation, this reach meets ULDC criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	158+00	to	161+00
Feature(s) at Upstream Station Limit:	Transition to agricultural land on the landside		
Feature(s) at Downstream Station Limit:	Transition to residential development approx. 100' south of Abruzzi Court		
Approx. Crown Elevation Range (feet, NAVD88):	22	to	23
Approx. Levee Height Range (feet):	13	to	15
Approx. Crown Width Range (feet):	15	to	30
Approx. Landside Slope (H:V) Range:	2:1	to	2:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	2:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	Residential / Farm improvements		
Landside Repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Lean CLAY
Landside Surface Layer:	Lean CLAY , approx. 14 to 20 feet thick at toe of levee
Soils below surface layer:	Interlayered Silty SAND, Poorly Graded SAND and Lean CLAY

Historic Performance

No events were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
158+00	200-Year	E-9-B	0.20	---	---	Yes**	3
	HTOL	E-9-C	0.23	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

**Exits onto a fine grained slope flatter than 5:1 (H:V), therefore we report "meets criteria" for through seepage.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (feet)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
158+00	SS - 200yr	16.4	E-9-D	---	1.6	n/a	n/a
	SS - HTOL	17.5	E-9-E	---	1.6	n/a	n/a
	RDD	11.6	E-9-D	1.3	---	n/a	n/a
	PS	3.4	E-9-F	1.1	1.6	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.9 PROJECT REACH C4A, STATION 174+45

REACH C4A - STA 174+45

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	161+00	to	174+45
Feature(s) at Upstream Station Limit:	Levee access ramp from Galley Way		
Feature(s) at Downstream Station Limit:	Transition to farm structures landside		
Approx. Crown Elevation Range (feet, NAVD88):	22	to	25
Approx. Levee Height Range (feet):	12	to	20
Approx. Crown Width Range (feet):	11	to	46
Approx. Landside Slope (H:V) Range:	1.5:1	to	3.3:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	2.8:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	Agricultural land beteen STA 161+00 to 165+50, Residential between		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: Uppe 5 feet SAND, a 5-foot layer of Lean CLAY, and a 5-foot Silty SAND layer beneath.

Landside Surface Layer: Silty SAND at toe and Lean CLAY in the field

Soils below surface layer: beneath the Silty SAND approx. 10 feet of Lean CLAY with a thin (3-foot) layer of Silty SAND with LEAN CLAY at depth

Historic Performance

Seepage and sand boils reported during the 1997 flood event in ULE's 2014 SGDR Addendum

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
174+45	200-Year	E-10-B	0.07	---	0.26	No	n/a
	HTOL	E-10-C	0.11	---	0.31	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
174+45	SS - 200yr	16.9	E-10-D	---	2.1	n/a	n/a
	SS - HTOL	18	E-10-E	---	1.9	n/a	n/a
	RDD	12	E-10-D	1.5	---	n/a	n/a
	PS	3.6	E-10-F	1.3	1.9	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.10 PROJECT REACH C4B, STATION 181+00

REACH C4B - STA 181+00

Based on our evaluation, this reach fails to meet ULDC criteria based on the cross section at Sta 191+45.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	174+45	to	192+00
Feature(s) at Upstream Station Limit:	Galley Way		
Feature(s) at Downstream Station Limit:	Drainage Ditches (lined and unlined)		
Approx. Crown Elevation Range (feet, NAVD88):	22.5	to	23.5
Approx. Levee Height Range (feet):	11	to	14.5
Approx. Crown Width Range (feet):	20	to	46
Approx. Landside Slope (H:V) Range:	2:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	4:1
Waterside Constraint(s):	Levee pipe penetrations at STA 179+50 and STA 189+00		
Landside Constraint(s):	Residential/agricultural land		
Landside Repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Lean CLAY with some Silty SAND
Landside Surface Layer:	Silty SAND and Lean CLAY (approx. 12 to 14 feet thick)
Soils below surface layer:	Lean CLAY with interlayered Poorly Graded SAND with SILT

Historic Performance

Waterside erosion, low to medium seepage and pin boils, and longitudinal cracking on waterside crown reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
181+00	200-Year	E-11-B	0.27	---	0.55	No	n/a
	HTOL	E-11-C	0.32	---	0.60	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (feet)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
181+00	SS - 200yr	17.2	E-11-D	---	1.7	n/a	n/a
	SS - HTOL	18.2	E-11-E	---	1.7	n/a	n/a
	RDD	12.2	E-11-D	1.3	---	n/a	n/a
	PS	3.8	E-11-F	1.1	1.8	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.11 PROJECT REACH C4B, STATION 191+45

REACH C4B - STA 191+45

Based on our evaluation, this reach does not meet ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	174+45	to	192+00
Feature(s) at Upstream Station Limit:	Galley Way		
Feature(s) at Downstream Station Limit:	Drainage Ditches (lined and unlined)		
Approx. Crown Elevation Range (feet, NAVD88):	22.5	to	23.5
Approx. Levee Height Range (feet):	11	to	14.5
Approx. Crown Width Range (feet):	20	to	46
Approx. Landside Slope (H:V) Range:	2:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	4:1
Waterside Constraint(s):	Levee pipe penetrations at STA 179+50 and STA 189+00		
Landside Constraint(s):	Residential/agricultural land		
Landside Repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Lean CLAY with some Silty SAND
Landside Surface Layer:	Silty SAND and Lean CLAY (approx. 12 to 14 feet thick)
Soils below surface layer:	Lean CLAY with interlayered Poorly Graded SAND with SILT

Historic Performance

Waterside erosion, low to medium seepage and pin boils, and longitudinal cracking on waterside crown reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
191+45	200-Year	E-12-B	0.16	---	---	Yes	3
	HTOL	E-12-C	0.18	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (feet)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
191+45	SS - 200yr	17.5	E-12-D	---	1.5	n/a	n/a
	SS - HTOL	18.6	E-12-E	---	1.5	n/a	n/a
	RDD	12.5	E-12-D	1.5	---	n/a	n/a
	PS	3.9	E-12-F	1.1	1.4	n/a	n/a
	Post-EQ	3.9	E-12-G/H	1.2	1.7	1.0	1.4

10.12 PROJECT REACH D1, STATION 201+57

REACH D1 - STA 201+57

Based on our evaluation, this reach does not meet the ULDC Criteria. Seismic deformations are not anticipated to degrade below 10-Year WSE + 3 feet.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Fails Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Fails Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Fails Criteria
Steady State Seepage HTOL , LS:	Fails Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Fails Criteria

Reach Description

Station Limits:	192+00	to	212+00
Feature(s) at Upstream Station Limit:	Agricultural land		
Feature(s) at Downstream Station Limit:	Agricultural land		
Approx. Crown Elevation Range (feet, NAVD88):	23	to	25
Approx. Levee Height Range (feet):	16	to	18
Approx. Crown Width Range (feet):	30	to	48
Approx. Landside Slope (H:V) Range:	1.6:1	to	2.3:1
Approx. Waterside Slope (H:V) Range:	1.4:1	to	2.1:1
Waterside Constraint(s):	Levee penetration near STA 209+00		
Landside Constraint(s):	None - agricultural land		
Landside repairs associated with PL84-99:	Yes, berms at STA 201+00 and STA 204+00		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Lean CLAY to SILT
Landside Surface Layer:	Lean CLAY, approx. 7 feet thick at toe of levee
Soils below surface layer:	Interbedded layers of silty SAND and poorly-graded SAND and CLAY

Historic Performance

Seepage and pin boils reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
201+57	200-Year	E-13-B	1.11	---	1.86	Yes**	4.5
	HTOL	E-13-C	1.24	---	2.03	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

**Exits onto a fine grained slope, therefore we report "meets criteria" for through seepage.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
201+57	SS - 200yr	17.8	E-13-D	---	0.7	n/a	n/a
	SS - HTOL	18.9	E-13-E	---	0.6	n/a	n/a
	RDD	12.7	E-13-D	1.3	---	n/a	n/a
	PS	4.1	E-13-F	0.8	1.0	n/a	n/a
	Post-EQ	4.1	E-133-G/H	0.7	0.8	0.7	0.7

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
D1	1,235	3.5	2	No Fill Anticipated	350

10.13 PROJECT REACH D2A, STATION 231+75

REACH D2A - STA 231+75

Based on our evaluation, this reach does not meet the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Fails Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Fails Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	212+00	to	247+00
Feature(s) at Upstream Station Limit:	Just south of levee pipe penetration		
Feature(s) at Downstream Station Limit:	Agricultural land		
Approx. Crown Elevation Range (feet, NAVD88):	23	to	25
Approx. Levee Height Range (feet):	14	to	18.5
Approx. Crown Width Range (feet):	11	to	34
Approx. Landside Slope (H:V) Range:	1.4:1	to	2.5:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	2.9:1
Waterside Constraint(s):	Platform at STA 218+60, 241+00, and 246+30.		
Landside Constraint(s):	None - agricultural land.		
Landside repairs associated with PL84-99:	Yes, multiple berms constructed		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty to Clayey SAND
Landside Surface Layer:	Lean CLAY, approx. 5 feet thick at toe of levee
Soils below surface layer:	Approx. 5 feet of Silty SAND underlain by interbedded layers of Lean CLAY and Poorly-graded SAND

Historic Performance

Landside seepage and pin boils reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
231+75	200-Year	E-14-B	0.54	---	0.83	Yes	3.5
	HTOL	E-14-C	0.62	---	0.86	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
231+75	SS - 200yr	18.8	E-14-D	---	1.5	n/a	n/a
	SS - HTOL	19.9	E-14-E	---	1.4	n/a	n/a
	RDD	13.5	E-14-D	1.2	---	n/a	n/a
	PS	4.6	E-14-F	1.0	1.3	n/a	n/a
	Post-EQ	4.6	E-14-G/H	1.0	1.7	1.0	1.7

10.14 PROJECT REACH D2B, STATION 251+50

REACH D2B - STA 251+50

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	247+00	to	255+50
Feature(s) at Upstream Station Limit:	Levee access ramp from farm road		
Feature(s) at Downstream Station Limit:	Just south of levee pipe penetration		
Approx. Crown Elevation Range (feet, NAVD88):	24	to	25
Approx. Levee Height Range (feet):	14	to	18.5
Approx. Crown Width Range (feet):	17	to	48
Approx. Landside Slope (H:V) Range:	1.4:1	to	2.5:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	2.9:1
Waterside Constraint(s):	None		
Landside Constraint(s):	High voltage towers STA 248+00 to 250+00 and Howard Road STA 253+00		
Landside repairs associated with PL84-99:	Yes, berms between STA 248+00 and 252+00		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Drained seepage berm and chimney drain, fill low area south of Howard Rd		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: Silty SAND to Clayey SAND
Landside Surface Layer: Silty to Clayey SAND near levee toe, approx. 12 feet of CLAY near berm toe
Soils below surface layer: Approx. 5 feet of Silty SAND underlain by interbedded layers of CLAY and Poorly-graded SAND

Historic Performance

Seepage and six to eight pin boils reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
251+50	200-Year	E-15-B	No Positive Gradient	0.18	---	No	n/a
	HTOL	E-15-C	No Positive Gradient	0.20	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
251+50	SS - 200yr	19.2	E-15-D	---	2.2	n/a	n/a
	SS - HTOL	20.3	E-15-E	---	2.2	n/a	n/a
	RDD	13.6	E-15-D	1.3	---	n/a	n/a
	PS	4.8	E-15-F	1.0	1.6	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.15 PROJECT REACH D2B, STATION 254+50

REACH D2B - STA 254+50

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	247+00	to	255+50
Feature(s) at Upstream Station Limit:	Levee access ramp from farm road		
Feature(s) at Downstream Station Limit:	Just south of levee pipe penetration		
Approx. Crown Elevation Range (feet, NAVD88):	24	to	25
Approx. Levee Height Range (feet):	14	to	18.5
Approx. Crown Width Range (feet):	17	to	48
Approx. Landside Slope (H:V) Range:	1.4:1	to	2.5:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	2.9:1
Waterside Constraint(s):	None		
Landside Constraint(s):	High voltage towers (STA 248+00 to 250+00) and Howard Road (STA 253+00)		
Landside repairs associated with PL84-99:	Yes, berms between STA 248+00 and 252+00		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Drained seepage berm and chimney		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty to Clayey SAND
Landside Surface Layer:	Silty to Clayey SAND near levee toe, approx. 12 feet of CLAY near berm toe
Soils below surface layer:	Approx. 5 feet of Silty SAND underlain by interbedded layers of CLAY and Poorly-graded SAND

Historic Performance

Low to medium landside seepage and six to eight pin boils reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
254+50	200-Year	E-16-B	0.06	0.34	---	No	n/a
	HTOL	E-16-C	0.10	0.37	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
254+50	SS - 200yr	19.4	E-16-D	---	2.2	n/a	n/a
	SS - HTOL	20.5	E-16-E	---	2.1	n/a	n/a
	RDD	13.6	E-16-D	1.2	---	n/a	n/a
	PS	4.9	E-16-F	1.1	1.6	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.16 PROJECT REACH D2C, STATION 259+00

REACH D2C - STA 259+00

Based on our evaluation, this reach does not meet the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Fails Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Fails Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Fails Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	255+50	to	259+50
Feature(s) at Upstream Station Limit:	Transition to Phase II drained seepage berm assocaited with Rach E1A		
Feature(s) at Downstream Station Limit:	Levee access ramp near Howard Road crossing		
Approx. Crown Elevation Range (feet, NAVD88):	23	to	25
Approx. Levee Height Range (feet):	14	to	18.5
Approx. Crown Width Range (feet):	17	to	21.5
Approx. Landside Slope (H:V) Range:	1.4:1	to	2.5:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	2.9:1
Waterside Constraint(s):	Levee penetration at STA 259+00		
Landside Constraint(s):	Farm road/ramp at STA 255+50		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: Silty to Clayey SAND

Landside Surface Layer: Approx. 10 feet of CLAY near levee toe

Soils below surface layer: Approx. 5 feet of Silty SAND underlain by interbedded layers of CLAY and Poorly-graded SAND

Historic Performance

No events reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
259+00	200-Year	E-17-B	0.54	---	---	Yes	3.7
	HTOL	E-17-C	0.61	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
259+00	SS - 200yr	19.5	E-17-D	---	1.3	n/a	n/a
	SS - HTOL	20.7	E-17-E	---	1.3	n/a	n/a
	RDD	13.6	E-17-D	1.9	---	n/a	n/a
	PS	5.0	E-17-F	1.2	1.4	n/a	n/a
	Post-EQ	5.0	E-17-G/H	1.5	1.7	1.0	2.4

10.17 PROJECT REACH E1A, STATION 281+41 WITH BERM

REACH E1A - STA 281+41 WITH BERM

Based on our evaluation, this reach meets the ULDC criteira.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	259+50	to	270+00
Feature(s) at Upstream Station Limit:	End of Phase II drained berm for Reach E1A		
Feature(s) at Downstream Station Limit:	Ends at raised grade or PL84-99 berm		
Approx. Crown Elevation Range (feet, NAVD88):	24	to	25
Approx. Levee Height Range (feet):	14	to	18
Approx. Crown Width Range (feet):	16	to	40
Approx. Landside Slope (H:V) Range:	2:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.2:1	to	2:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	Agricultural fields/occasional overhead poles		
Landside Repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	Drained Seepage Berm & Chimney Drain - STA 259+50 to 270+00		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: Silty SAND and Clayey SAND
Landside Surface Layer: Lean CLAY (10 to 30 feet thick) and Silty SAND
Soils below surface layer: Lean CLAY and Silty SAND

Historic Performance

Landside seepage and pin boils reported during 1997 flood event in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient**			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
281+41 W/BERM	200-Year	E-18-B	No Positive Gradient	0.06	0.16	No	n/a
	HTOL	E-18-C	No Positive Gradient	0.07	0.16	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.
**Exit Gradient includes 3D effects

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (feet)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
281+41 W/BERM	SS - 200yr	20.1	E-18-D	---	2.3	n/a	n/a
	SS - HTOL	21.2	E-18-E	---	2.2	n/a	n/a
	RDD	14.0	E-18-D	1.2	---	n/a	n/a
	PS	5.2	E-18-F	1.1	1.7	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.18 PROJECT REACH E1B, STATION 281+41 WITHOUT BERM

REACH E1B - STA 281+41 WITHOUT BERM

Based on our evaluation, this reach does not meet the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	270+00	to	297+75
Feature(s) at Upstream Station Limit:	Begin Phase II drained seepage berm associated with Reach E2		
Feature(s) at Downstream Station Limit:	End of Phase II drained berm associated with Reach E1A		
Approx. Crown Elevation Range (feet, NAVD88):	24	to	25
Approx. Levee Height Range (feet):	14	to	18
Approx. Crown Width Range (feet):	16	to	40
Approx. Landside Slope (H:V) Range:	2:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.2:1	to	2:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	Agricultural field		
Landside Repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND and Lean CLAY
Landside Surface Layer:	Lean CLAY (10 to 30 feet thick) and Silty SAND
Soils below surface layer:	Lean CLAY and Silty SAND

Historic Performance

Low to medium landside seepage and pin boils reported during 1997 flood event in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
281+41 NO BERM	200-Year	E-19-B	0.18	---	---	Yes	2.0
	HTOL	E-19-C	0.20	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (feet)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
281+41 NO BERM	SS - 200yr	20.1	E-19-D	---	1.5	n/a	n/a
	SS - HTOL	21.2	E-19-E	---	1.4	n/a	n/a
	RDD	14	E-19-D	1.2	---	n/a	n/a
	PS	5.2	E-19-F	1.1	1.4	n/a	n/a
	Post-EQ	5.2	E-19-G/H	1.3	1.9	1.2	3.0

10.19 PROJECT REACH E2, STATION 301+07

REACH E2 - STA 301+07

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	297+75	to	305+75
Feature(s) at Upstream Station Limit:	Transition to Phase III drained seepage berm associated with Reach F		
Feature(s) at Downstream Station Limit:	End of Phase II seepage berm associated with Reach E2		
Approx. Crown Elevation Range (feet, NAVD88):	25	to	26
Approx. Levee Height Range (feet):	15	to	16
Approx. Crown Width Range (feet):	19	to	48
Approx. Landside Slope (H:V) Range:	2:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.6:1	to	3.4:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	None - agricultural land.		
Landside repairs associated with PL84-99:	Yes, berms between STA 303+00 and		
Improvements associated with LSRP P1:	Drained Seepage Berm w/chimney drain from STA 297+75 to 305+75 - the Reach Limits		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND, SAND and Lean CLAY
Landside Surface Layer:	Lean CLAY, approx. 17 feet thick at toe of berm
Soils below surface layer:	Interbedded layers of Silty SAND, SAND and Lean CLAY

Historic Performance

Seepage, pin boils and scour reported during 1997 flood event in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient**			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
301+07	200-Year	E-20-B	0.10	0.58	---	No	n/a
	HTOL	E-20-C	0.14	0.65	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.
**Exit Gradient includes 3D effects

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
301+07	SS - 200yr	20.4	E-20-D	---	2.1	n/a	n/a
	SS - HTOL	21.5	E-20-E	---	2.1	n/a	n/a
	RDD	14.1	E-20-D	2.1	---	n/a	n/a
	PS	5.2	E-20-F	1.1	1.5	n/a	n/a
	Post-EQ	5.2	E-20-G/H	1.3	2.1	1.7	3.4

10.20 PROJECT REACH F1A, STATION 311+00

REACH F1A - STA 311+00

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	305+75	to	312+30
Feature(s) at Upstream Station Limit:	Transition to landside farm improvements		
Feature(s) at Downstream Station Limit:	End of Phase II drained seepage berm associated with Reach E2		
Approx. Crown Elevation Range (feet, NAVD88):	25	to	26
Approx. Levee Height Range (feet):	16	to	18
Approx. Crown Width (feet):	20		
Approx. Landside Slope (H:V) Range:	2.5:1	to	3:1
Approx. Waterside Slope (H:V) Range:	2:1	to	2:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	None - agricultural land		
Landside repairs associated with PL84-99:	Yes, berms constructed between STA 305+75 and 307+00		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Drained Seepage Berm		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Sandy CLAY to Silty SAND
Landside Surface Layer:	Lean CLAY, approx. 30 feet thick at toe of levee with thin seams of Silty SAND
Soils below surface layer:	Approx. 50 feet of interbedded layers of Silty SAND, SAND and Lean CLAY

Historic Performance

Landside seepage and pin boils reported during 1997 flood event in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
311+00	200-Year	E-21-B	No Positive Gradient	0.08	---	No	n/a
	HTOL	E-21-C	No Positive Gradient	0.10	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
311+00	SS - 200yr	20.7	E-21-D	---	2.2	n/a	n/a
	SS - HTOL	21.9	E-21-E	---	2.2	n/a	n/a
	RDD	14.3	E-21-D	1.9	---	n/a	n/a
	PS	5.2	E-21-F	1.4	1.7	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.21 PROJECT REACH F1B, STATION 313+75

REACH F1B - STA 313+75

Based on our evaluation, this reach does not meet the ULDC Criteria. Seismic deformations are not anticipated to degrade below 10-Year WSE + 3 feet.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	312+30	to	315+00
Feature(s) at Upstream Station Limit:	Bowman Road		
Feature(s) at Downstream Station Limit:	Transition to Phase III Seepage berm		
Approx. Crown Elevation Range (feet, NAVD88):	25	to	26
Approx. Levee Height Range (feet):	12	to	13
Approx. Crown Width Range (feet):	12	to	30
Approx. Landside Slope (H:V) Range:	2:1	to	3.5:1
Approx. Waterside Slope (H:V) Range:	2:1	to	3:1
Waterside Constraint(s):	Levee penetration near STA 314+50		
Landside Constraint(s):	Rural farm improvements, structures		
Landside repairs associated with PL84-99:	Possibly, either berm or raised grades		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND to poorly graded SAND
Landside Surface Layer:	Silty SAND, approx. 6 feet thick at toe of levee
Soils below surface layer:	Approx. 20 feet of interbedded layers of Silty SAND and Lean CLAY, over 60 feet of Poorly Graded SAND

Historic Performance

Landside seepage and pin boils reported during 1997 flood event in ULE's 2014 SGDR Addendum

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
313+75	200-Year	E-22-B	0.26	---	0.14	Yes	2.5
	HTOL	E-22-C	0.27	---	0.14	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
313+75	SS - 200yr	20.9	E-22-D	---	1.7	n/a	n/a
	SS - HTOL	22.0	E-22-E	---	1.6	n/a	n/a
	RDD	14.5	E-22-D	1.7	---	n/a	n/a
	PS	5.2	E-22-F	1.1	1.7	n/a	n/a
	Post-EQ	5.2	E-22-G/H	0.9	2.1	0.9	2.0

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
F1B	650	2	1.5	No Fill Anticipated	100

10.22 PROJECT REACH F1C, STATION 320+65

REACH F1C - STA 320+65

Based on our evaluation, this reach does not meet the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Fails Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Fails Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Fails Criteria
Steady State Seepage HTOL , LS:	Fails Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	315+00	to	321+00
Feature(s) at Upstream Station Limit:	Gate on levee near mill		
Feature(s) at Downstream Station Limit:	Bowman Road		
Approx. Crown Elevation Range (feet, NAVD88):	25	to	26
Approx. Levee Height Range (feet):	19	to	20
Approx. Crown Width Range (feet):	20	to	35
Approx. Landside Slope (H:V) Range:	2:1	to	2.2:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	2.4:1
Waterside Constraint(s):	None		
Landside Constraint(s):	None - open land		
Landside repairs associated with PL84-99:	Yes, berms constructed between STA		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND to Lean CLAY
Landside Surface Layer:	Lean CLAY, approx. 15 feet thick at toe of levee
Soils below surface layer:	Approx. 8 feet of Silty SAND, over 18 feet Lean CLAY, over 40 feet of SAND

Historic Performance

Landside seepage and pin boils reported during 1997 flood event in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
320+65	200-Year	E-23-B	1.2	---	0.42	Yes	6.8
	HTOL	E-23-C	1.3	---	0.46	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
320+65	SS - 200yr	21.9	E-23-D	---	1.1	n/a	n/a
	SS - HTOL	22.1	E-23-E	---	1.0	n/a	n/a
	RDD	14.4	E-23-D	1.5	---	n/a	n/a
	PS	5.2	E-23-F	1.1	1.2	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.23 PROJECT REACH F2, STATION 329+00

REACH F2 - STA 329+00

Based on our evaluation, this reach does not meet the ULDC Criteria. Seismic deformations are not anticipated to degrade below 10-Year WSE + 3 feet.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Fails Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Fails Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	321+00	to	339+00
Feature(s) at Upstream Station Limit:	Between two levee access ramps		
Feature(s) at Downstream Station Limit:	Gate on levee crown		
Approx. Crown Elevation Range (feet, NAVD88):	25	to	26
Approx. Levee Height Range (feet):	11	to	19.5
Approx. Crown Width Range (feet):	12	to	22.5
Approx. Landside Slope (H:V) Range:	2.1:1	to	3.8:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	3.1:1
Waterside Constraint(s):	Platform (STA 331+80)		
Landside Constraint(s):	Existing structures (STA 322+00 to 329+00), small structure (STA 331+80)		
Landside repairs associated with PL84-99:	Seepage berm repairs between STA		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: Silty SAND
Landside Surface Layer: Lean CLAY, approx. 5 feet thick at toe of levee with silty SAND lens
Soils below surface layer: Interbedded layers of silty SAND, Lean CLAY, and Poorly Graded SAND with Silt

Historic Performance

Landside seepage and pin boils reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient**			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
329+00	200-Year	E-24-B	1.19	---	0.34	Yes	1
	HTOL	E-24-C	1.33	---	0.38	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.
**Exit Gradient includes 3D effects

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
329+00	SS - 200yr	21.0	E-24-D	---	1.6	n/a	n/a
	SS - HTOL	22.1	E-24-E	---	1.5	n/a	n/a
	RDD	14.4	E-24-D	1.7	---	n/a	n/a
	PS	5.3	E-24-F	1.3	1.5	n/a	n/a
	Post-EQ	5.3	E-24-G/H	0.8	2.1	0.7	2.0

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
F2	750	2	1.5	No Fill Anticipated	100

10.24 PROJECT REACH F3, STATION 350+00

REACH F3 - STA 350+00

Based on our evaluation, this reach does not meet the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Fails Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Fails Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL, LS:	Fails Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	339+00	to	362+50
Feature(s) at Upstream Station Limit:	Transition to Phase III cutoff wall		
Feature(s) at Downstream Station Limit:	Near levee access ramp from farm road		
Approx. Crown Elevation Range (feet, NAVD88):	26	to	27.5
Approx. Levee Height Range (feet):	11	to	19.5
Approx. Crown Width Range (feet):	13	to	25
Approx. Landside Slope (H:V) Range:	2:1	to	3.8:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	3.1:1
Waterside Constraint(s):	Levee penetration (STA 354+00)		
Landside Constraint(s):	None - agricultural land		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: Silty SAND
Landside Surface Layer: Lean CLAY, approx. 15 feet thick at toe of levee
Soils below surface layer: Interbedded layers of Silty SAND, Clayey SAND, Lean CLAY, and Poorly Graded SAND

Historic Performance

No observations reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient**			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
350+00	200-Year	E-25-B	0.81	---	0.78	Yes	2
	HTOL	E-25-C	0.91	---	0.86	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.
**Exit Gradient includes 3D effects

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
350+00	SS - 200yr	21.6	E-25-D	---	1.3	n/a	n/a
	SS - HTOL	22.8	E-25-E	---	1.2	n/a	n/a
	RDD	14.8	E-25-D	1.5	---	n/a	n/a
	PS	5.3	E-25-F	1.0	1.4	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.25 PROJECT REACH G, STATION 375+50

REACH G - STA 375+50

Based on our evalaution, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	362+50	to	388+00
Feature(s) at Upstream Station Limit:	Waterside mobile home park/waterside		
Feature(s) at Downstream Station Limit:	Near levee access ramp from farm road		
Approx. Crown Elevation Range (feet, NAVD88):	27	to	28
Approx. Levee Height Range (feet):	13.5	to	21
Approx. Crown Width Range (feet):	17	to	37
Approx. Landside Slope (H:V) Range:	1.8:1	to	2.7:1
Approx. Waterside Slope (H:V) Range:	1.7:1	to	3.2:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - waterside bench begins at STA 377+75		
Landside Constraint(s):	Lake and equestrian arena		
Landside repairs assocaited with PL84-99:	Yes, berm constructed from STA 374+50 to 382+00		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Fully penetrating cutoff wall STA 362+50 to 388+00		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Clayey SAND to Sitly SAND
Landside Surface Layer:	Lean CLAY approx. 6 feet thick at levee toe
Soils below surfcae layer:	Approx. 4 feet of Silty SAND, over 4 feet of Lean Clay, over 23 feet of Silty SAND

Historic Performance

Seepage and boils reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
375+50	200-Year	E-26-B	No Positive Gradient	---	---	No	n/a
	HTOL	E-26-C	No Positive Gradient	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
375+50	SS - 200yr	22.0	E-26-D/E	---	1.5	---	1.7
	SS - HTOL	23.1	E-26-F	---	1.5	---	1.7
	RDD	14.8	E-26-D/E	1.6	---	1.7	---
	PS	5.3	E-26-G/H	1.4	1.2	1.3	1.4
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.26 PROJECT REACH G, STATION 377+65

REACH G - STA 377+65

Based on our evaluation, this reach meets the ULDC criteria. Seismic deformations are not anticipated to degrade below 10-Year WSE + 3 feet.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	362+50	to	388+00
Feature(s) at Upstream Station Limit:	Waterside mobile home park/waterside		
Feature(s) at Downstream Station Limit:	Near levee access ramp from farm road		
Approx. Crown Elevation Range (feet, NAVD88):	27	to	28
Approx. Levee Height Range (feet):	13.5	to	21
Approx. Crown Width Range (feet):	17	to	37
Approx. Landside Slope (H:V) Range:	1.8:1	to	2.7:1
Approx. Waterside Slope (H:V) Range:	1.7:1	to	3.2:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - waterside bench begins at STA 377+75		
Landside Constraint(s):	Lake and equestrian arena		
Landside repairs assocaited with PL84-99:	Yes, berm constructed from STA 374+50		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Fully penetrating cutoff wall STA		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Clayey SAND to Sitly SAND
Landside Surface Layer:	Lean CLAY approx. 6 feet thick at levee toe
Soils below surfcae layer:	Approx. 4 feet of Silty SAND, over 4 feet of Lean Clay, over 23 feet of Silty SAND

Historic Performance

Seepage and boils reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
377+65	200-Year	E-27-B	No Positive Gradient	---	---	No	n/a
	HTOL	E-27-C	No Positive Gradient	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
377+65	SS - 200yr	22.1	E-27-D/E	---	1.8	---	1.9
	SS - HTOL	23.2	E-27-F	---	1.8	---	2.0
	RDD	14.8	E-27-D/E	1.6	---	1.6	---
	PS	5.3	E-27-G/H	1.3	1.4	1.1	1.5
	Post-EQ	5.3	E-27-I/J	0.8	1.5	0.7	1.5

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
G	1,700	3.5	2.5	No Fill Anticipated	600

10.27 PROJECT REACH H1A, STATION 408+00

REACH H1A - STA 408+00

Based on our evaluation, this reach does not meet the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Fails Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Fails Criteria

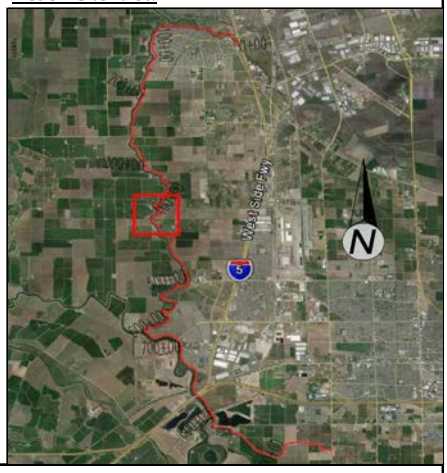
Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Fails Criteria
Steady State Seepage HTOL , LS:	Fails Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	388+00	to	411+00
Feature(s) at Upstream Station Limit:	End of PL84-99 berm within Reach H1B		
Feature(s) at Downstream Station Limit:	Terminous of LSRP Phase III cutoff wall in Reach G		
Approx. Crown Elevation Range (feet, NAVD88):	27	to	28
Approx. Levee Height Range (feet):	11	to	17
Approx. Crown Width Range (feet):	14	to	30
Approx. Landside Slope (H:V) Range:	1.8:1	to	2.5:1
Approx. Waterside Slope (H:V) Range:	1.7:1	to	3.2:1
Waterside Constraint(s):	Waterside residential improvements		
Landside Constraint(s):	None - Agricultural/undeveloped land		
Landside repairs associated with PL84-99:	Yes, berm constructed between STA 402+00 and 411+00		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview



Generalized Subsurface Conditions

Levee Prism Soils: Silty SAND with Lean CLAY lenses
Landside Surface Layer: Lean CLAY to Fat CLAY, approx. 5 feet thick at toe of levee
Soils below surface layer: 7 feet of Silty SAND, over 12 feet of Poorly Graded SAND, over interbedded layers of Lean CLAY and Silty SAND

Historic Performance

Seepage and boils reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
408+00	200-Year	E-28-B	0.99	---	1.06	Yes	1.5
	HTOL	E-28-B	1.13	---	1.21	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
408+00	SS - 200yr	22.5	E-28-D	---	1.3	n/a	n/a
	SS - HTOL	23.6	E-28-E	---	1.1	n/a	n/a
	RDD	14.3	E-28-D	1.8	---	n/a	n/a
	PS	5.3	E-28-F	1.2	1.3	n/a	n/a
	Post-EQ	5.3	E-28-G/H	1.2	1.6	1.4	3.0

10.28 PROJECT REACH H1B, STATION 416+86

REACH H1B - STA 416+86

Based on our evaluation, this reach does not meet the ULDC criteria. Seismic deformations are not anticipated to degrade below 10-Year WSE + 3 feet.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Fails Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Fails Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	411+00	to	420+00
Feature(s) at Upstream Station Limit:	Gate and levee access road		
Feature(s) at Downstream Station Limit:	End of PL84-99 berm within Reach H1B		
Approx. Crown Elevation Range (feet, NAVD88):	27	to	28
Approx. Levee Height Range (feet):	10.5	to	11.5
Approx. Crown Width Range (feet):	18	to	30
Approx. Landside Slope (H:V) Range:	1.8:1	to	2.5:1
Approx. Waterside Slope (H:V) Range:	1.7:1	to	3.2:1
Waterside Constraint(s):	Levee penetration at STA 413+40		
Landside Constraint(s):	Existing structures at toe of levee		
Landside repairs associated with PL84-99:	Yes, berm constructed between STA 411+00 and 420+00		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Variable layers of Silty Lean CLAY and Silty SAND
Landside Surface Layer:	Lean CLAY to Fat CLAY, approx. 4 feet thick at toe of levee, less than 1 foot thick landward of levee toe
Soils below surface layer:	Approx. 16-feet of Silty SAND to Poorly Graded SAND, underlain by approximately 25 feet of Lean CLAY

Historic Performance

Seepage and boils reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
416+86	200-Year	E-29-B	1.62	---	2.48	Yes**	6.6
	HTOL	E-29-C	1.82	---	2.74	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

**Exits onto slope flatter than 5:1 (H:V), therefore we report "meets criteria" for through seepage.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
416+86	SS - 200yr	22.7	E-29-D	---	1.8	n/a	n/a
	SS - HTOL	23.8	E-29-E	---	1.8	n/a	n/a
	RDD	14.5	E-29-D	1.6	---	n/a	n/a
	PS	5.3	E-29-F	0.8	1.8	n/a	n/a
	Post-EQ	5.3	E-29-G/H	1.3	2.3	1.4	3.0

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
H1B	2,000	2	1.5	No Fill Anticipated	250

10.29 PROJECT REACH H2, STATION 437+26

REACH H2 - STA 437+26

Based on our evaluation, this reach does not meet the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Fails Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Fails Criteria

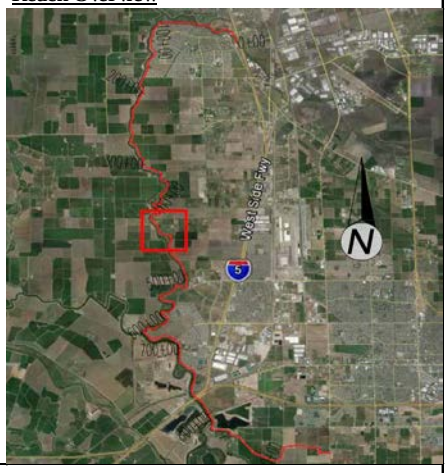
Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL, LS:	Fails Criteria
Steady State Seepage HTOL , LS:	Fails Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	420+00	to	445+00
Feature(s) at Upstream Station Limit:	250 feet north of levee access ramp		
Feature(s) at Downstream Station Limit:	End of PL84-99 berm within Reach H1B		
Approx. Crown Elevation Range (feet, NAVD88):	28	to	29
Approx. Levee Height Range (feet):	16	to	18
Approx. Crown Width Range (feet):	15	to	40
Approx. Landside Slope (H:V) Range:	1.9:1	to	2.5:1
Approx. Waterside Slope (H:V) Range:	1.7:1	to	7.5:1
Waterside Constraint(s):	Waterside bench/residence from STA 438+00 to 445+00		
Landside Constraint(s):	Pond approx. 300 feet from levee centerline from STA 423+00 to 443+00		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview



Generalized Subsurface Conditions

Levee Prism Soils:	Imterbedded Silty SAND and Lean CLAY
Landside Surface Layer:	Lean CLAY, approx. 3 feet thick at toe of levee
Soils below surface layer:	Approx. 20 feet of Silty SAND to Poorly Graded Sand with Silt, over 30 feet of Lean CLAY

Historic Performance

No data reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
437+26	200-Year	E-30-B	1.62	---	2.12	Yes	6
	HTOL	E-30-C	1.81	---	2.35	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
437+26	SS - 200yr	23.2	E-30-D	---	0.9	n/a	n/a
	SS - HTOL	24.4	E-30-E	---	0.7	n/a	n/a
	RDD	14.9	E-30-D	1.6	---	n/a	n/a
	PS	5.3	E-30-F	1.0	1.5	n/a	n/a
	Post-EQ	5.3	E-30-G/H	1.0	2.0	1.0	2.7

10.30 PROJECT REACH H3, STATION 455+55

REACH H3 - STA 455+55

Based on our evaluation, this reach does not meet the ULDC criteria. Seismic deformations are not anticipated to degrade below 10-Year WSE + 3 feet.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Fails Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Fails Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Fails Criteria
Steady State Seepage HTOL , LS:	Fails Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	445+00	to	466+00
Feature(s) at Upstream Station Limit:	Small waterside bench		
Feature(s) at Downstream Station Limit:	250' north of levee access ramp		
Approx. Crown Elevation Range (feet, NAVD88):	28	to	29
Approx. Levee Height Range (feet):	15	to	17
Approx. Crown Width Range (feet):	15	to	50
Approx. Landside Slope (H:V) Range:	2.0:1	to	2.8:1
Approx. Waterside Slope (H:V) Range:	1.4:1	to	3.6:1
Waterside Constraint(s):	Waterside bench/residence from STA		
Landside Constraint(s):	Well/levee penetration at STA 459+00		
Landside repairs associated with PL84-99:	Possibly, berm constructed from STA 452+00 to 456+00		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Lean Clay to Clayey SILT
Landside Surface Layer:	Silty SAND, approx. 5 feet thick at toe of levee
Soils below surface layer:	Approx. 20 feet of Poorly Graded SAND with Silt, over Lean CLAY

Historic Performance

Seepage, boils and erosion reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
455+55	200-Year	E-31-B	0.66	---	---	Yes**	2.3
	HTOL	E-31-C	0.75	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

**Exits onto a fine grained slope, therefore we report "meets criteria" for through seepage.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
455+55	SS - 200yr	23.3	E-31-D	---	1.1	n/a	n/a
	SS - HTOL	24.6	E-31-E	---	1.0	n/a	n/a
	RDD	14.9	E-31-D	2.1	---	n/a	n/a
	PS	5.3	E-31-F	1.7	1.5	n/a	n/a
	Post-EQ	5.3	E-31-G/H	1.8	1.2	0.9	1.1

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
H3	1,600	3	2	No Fill Anticipated	400

10.31 PROJECT REACH I, STATION 476+00

REACH I - STA 476+00

Based on our evaluation, this reach does not meet ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Fails Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Fails Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Fails Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	466+00	to	506+00
Feature(s) at Upstream Station Limit:	Lathrop High School Improvements		
Feature(s) at Downstream Station Limit:	500 feet north of De Lima Road		
Approx. Crown Elevation Range (feet, NAVD88):	28	to	30
Approx. Levee Height Range (feet):	15.5	to	18
Approx. Crown Width Range (feet):	15	to	42
Approx. Landside Slope (H:V) Range:	1.7:1	to	3.8:1
Approx. Waterside Slope (H:V) Range:	1.6:1	to	4.6:1
Waterside Constraint(s):	Penetration near STA 478+50 and		
Landside Constraint(s):	Dos Reis Rd. and parking lot from STA 483+00 to 493+00		
Landside Repairs associated with PL84-99:	Yes, berm constructed from STA 472+00 to 477+00		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Drained seepage berm with chimney		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND
Landside Surface Layer:	Lean CLAY approx. 2 ft thick at toe of levee
Soils below surface layer:	Alternating layers of Silty SAND and Lean CLAY

Historic Performance

Seepage, landside boils, and waterside erosion during 1997 flood event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
476+00	200-Year	E-32-B	1.61	---	---	Yes	6
	HTOL	E-32-C	1.75	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (feet)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
476+00	SS - 200yr	23.6	E-32-D	---	1.3	n/a	n/a
	SS - HTOL	24.9	E-32-E	---	1.2	n/a	n/a
	RDD	15	E-32-D	1.5	---	n/a	n/a
	PS	5.3	E-32-F	1.1	1.4	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.32 PROJECT REACH I, STATION 496+28

REACH I - STA 496+28

Based on our evaluation, this reach does not meet ULDC criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Fails Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Fails Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	466+00	to	506+00
Feature(s) at Upstream Station Limit:	Lathrop High School Improvements		
Feature(s) at Downstream Station Limit:	500 feet north of De Lima Road		
Approx. Crown Elevation Range (feet, NAVD88):	28	to	30
Approx. Levee Height Range (feet):	15.5	to	18
Approx. Crown Width Range (feet):	15	to	42
Approx. Landside Slope (H:V) Range:	1.7:1	to	3.8:1
Approx. Waterside Slope (H:V) Range:	1.6:1	to	4.6:1
Waterside Constraint(s):	Penetration near STA 478+50 and dock/boat ramp near STA 491+00		
Landside Constraint(s):	Dos Reis Rd. and parking lot from STA 483+00 to 493+00		
Landside Repairs associated with PL84-99:	Yes, berm constructed from STA 472+00 to 477+00		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Drained seepage berm with chimney drain		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Clayey SAND and Poorly Graded SAND with Silt
Landside Surface Layer:	Lean CLAY, approx. 10 ft thick at toe of levee
Soils below surface layer:	Alternating layers of Poorly Graded SAND to Silty SAND and Lean CLAY

Historic Performance

Seepage, landside boils, and waterside erosion during 1997 flood event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
496+28	200-Year	E-33-B	0.97	---	---	Yes	4
	HTOL	E-33-C	1.08	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (feet)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
496+28	SS - 200yr	23.6	E-33-D	---	1.7	n/a	n/a
	SS - HTOL	24.9	E-33-E	---	1.5	n/a	n/a
	RDD	15	E-33-D	2.0	---	n/a	n/a
	PS	5.3	E-33-F	1.2	1.9	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.33 PROJECT REACH J1A, STATION 511+00

REACH J1A - STA 511+00

Based on our evaluation, this reach does not meet the ULDC criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	506+00	to	515+50
Feature(s) at Upstream Station Limit:	Begin Phase 1 drained seepage berm associate with Reach J1B		
Feature(s) at Downstream Station Limit:	Levee pipe penetration		
Approx. Crown Elevation Range (feet, NAVD88):	29	to	30
Approx. Levee Height Range (feet):	14.5	to	18.5
Approx. Crown Width Range (feet):	15	to	35
Approx. Landside Slope (H:V) Range:	1.9:1	to	2.5:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	3.1:1
Waterside Constraint(s):	Bench from STA 510+00 to 515+50 and penetration at STA 509+20		
Landside Constraint(s):	None		
Landside Repairs associated with PL84-99:	Possibly, berm or raised grade between STA 508+00 and 512+00		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Seepage berm with chimney drain		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty to Clayey SAND and Lean CLAY
Landside Surface Layer:	Lean CLAY and SILT, approx. 12 feet thick at toe of levee
Soils below surface layer:	Approx. 30 feet of Lean CLAY layers of Silty SAND and Poorly Graded SAND over 30 feet Silty SAND

Historic Performance

Waterside scour/erosion between stations 506+00 and 507+00 during 1997 flood event was reported in ULE's 2015 GER Volume 1.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
511+00	200-Year	E-34-B	0.41	---	---	Yes	3
	HTOL	E-34-C	0.49	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (feet)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
511+00	SS - 200yr	24.1	E-34-D	---	1.4	n/a	n/a
	SS - HTOL	25.4	E-34-E	---	1.3	n/a	n/a
	RDD	15.3	E-34-D	2.6	---	n/a	n/a
	PS	5.3	E-34-F	2.2	1.5	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.34 PROJECT REACH J1B, STATION 516+00

REACH J1B - STA 516+00

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	515+50	to	534+00
Feature(s) at Upstream Station Limit:	Landside agricultural land		
Feature(s) at Downstream Station Limit:	Levee access ramp		
Approx. Crown Elevation Range (feet, NAVD88):	29	to	30
Approx. Levee Height Range (feet):	14.5	to	18.5
Approx. Crown Width Range (feet):	15	to	35
Approx. Landside Slope (H:V) Range:	1.9:1	to	2.5:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	3.1:1
Waterside Constraint(s):	Bench between STA 515+00 to 529+00		
Landside Constraint(s):	None - agricultural land		
Landside Repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	Drained seepage berm from STA 151+50 to 534+00 - the reach limits		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Chimney Drain		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty to Clayey SAND and Lean CLAY
Landside Surface Layer:	Silty SAND, approx. 20 feet thick at levee toe
Soils below surface layer:	Alternating layers of Lean CLAY and Poorly Graded SAND with Silt

Historic Performance

No records of documented seepage, slope stability, or erosion events according to ULE's 2015 GER Volume 1.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
516+00	200-Year	E-35-B	No Positive Gradient	0.14	---	No	n/a
	HTOL	E-35-C	No Positive Gradient	0.14	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (feet)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
516+00	SS - 200yr	24.1	E-35-D	---	2.3	n/a	n/a
	SS - HTOL	25.4	E-35-E	---	2.3	n/a	n/a
	RDD	15.3	E-35-D	1.8	---	n/a	n/a
	PS	5.3	E-35-F	1.4	1.7	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.35 PROJECT REACH J1B, STATION 528+45

REACH J1B - STA 528+45

Based on our evaluation, this reach meets the ULDC criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	515+50	to	534+00
Feature(s) at Upstream Station Limit:	Landside agricultural land		
Feature(s) at Downstream Station Limit:	Levee access ramp		
Approx. Crown Elevation Range (feet, NAVD88):	29	to	30
Approx. Levee Height Range (feet):	14.5	to	18.5
Approx. Crown Width Range (feet):	15	to	35
Approx. Landside Slope (H:V) Range:	1.9:1	to	2.5:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	3.1:1
Waterside Constraint(s):	Bench between STA 515+00 to 529+00		
Landside Constraint(s):	None - agricultural land		
Landside Repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	Drained seepage berm from STA 151+50 to 534+00 - the reach limits		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Chimney Drain		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: Silty to Clayey SAND and Lean CLAY
Landside Surface Layer: Silty SAND, approx. 20 feet thick at levee toe
Soils below surface layer: Alternating layers of Lean CLAY and Poorly Graded SAND with Silt

Historic Performance

No records of documented seepage, slope stability, or erosion events according to ULE's 2015 GER Volume 1.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient**			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
528+45	200-Year	E-36-B	No Positive Gradient	0.47	---	No	n/a
	HTOL	E-36-C	No Positive Gradient	0.51	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.
**Exit Gradient includes 3D effects

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (feet)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
528+45	SS - 200yr	24.1	E-36-D	---	2.3	n/a	n/a
	SS - HTOL	25.4	E-36-E	---	2.3	n/a	n/a
	RDD	15.3	E-36-D	1.6	---	n/a	n/a
	PS	5.3	E-36-F	1.1	1.7	n/a	n/a
	Post-EQ	5.3	E-36-G	1.1	2.3	1.1	3.0

10.36 PROJECT REACH J2, STATION 544+33

REACH J2 - STA 544+33

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description (Same cross section used for Reach J3A)

Station Limits:	534+00	to	544+50
Feature(s) at Upstream Station Limit:	Adjoining Phase 1 LSRP drained seepage berm - Reach J3A		
Feature(s) at Downstream Station Limit:	Adjoining Phase 1 LSRP drained seepage berm - Reach J1B		
Approx. Crown Elevation Range (feet, NAVD88):	29	to	30
Approx. Levee Height Range (feet):	18	to	19
Approx. Crown Width Range (feet):	16	to	27
Approx. Landside Slope (H:V) Range:	3:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	3:1
Waterside Constraint(s):	Waterside toe of slope at the waterway		
Landside Constraint(s):	Existing seepage berm and agricultural land.		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	Drained Seepage Berm		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Chimney Drain		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND to Clayey SAND
Landside Surface Layer:	Lean CLAY, approx. 15 feet thick at toe of levee
Soils below surface layer:	Approx. 30 feet of interlayered Silty SAND, SAND and Silty CLAY, over 30 feet of Lean CLAY

Historic Performance

Seepage and landside boils were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
544+33	200-Year	E-37-B	0.11	0.45	0.47	No	n/a
	HTOL	E-37-C	0.16	0.50	0.53	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
544+33	SS - 200yr	24.4	E-37-D	---	2.3	n/a	n/a
	SS - HTOL	25.8	E-37-E	---	2.3	n/a	n/a
	RDD	15.5	E-37-D	1.5	---	n/a	n/a
	PS	5.3	E-37-F	1.1	1.7	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.37 PROJECT REACH J3A, STATION 544+33

REACH J3A - STA 544+33

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description (Same cross section used for Reach J2)

Station Limits:	544+50	to	548+50
Feature(s) at Upstream Station Limit:	Southern end Phase 1 LSRP drained seepage berm - Reach J3A		
Feature(s) at Downstream Station Limit:	Adjoining Phase 1 LSRP drained seepage berm - Reach J2		
Approx. Crown Elevation Range (feet, NAVD88):	29	to	30
Approx. Levee Height Range (feet):	18	to	19
Approx. Crown Width Range (feet):	16	to	27
Approx. Landside Slope (H:V) Range:	3:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	3:1
Waterside Constraint(s):	Waterside toe of slope at the waterway		
Landside Constraint(s):	Existing seepage berm and agricultural land.		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	Drained Seepage Berm		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Chimney Drain		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND to Clayey SAND
Landside Surface Layer:	Lean CLAY, approx. 15 feet thick at toe of levee
Soils below surface layer:	Approx. 30 feet of interlayered Silty SAND, SAND and Silty CLAY, over 30 feet of Lean CLAY

Historic Performance

Extensive seepage and landside boils were reported in ULE's 2014 SGDR Addendum, in addition to waterside erosion.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
544+33	200-Year	E-37-B	0.11	0.45	0.47	No	n/a
	HTOL	E-37-C	0.16	0.50	0.53	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
544+33	SS - 200yr	24.4	E-37-D	---	2.3	n/a	n/a
	SS - HTOL	25.8	E-37-E	---	2.3	n/a	n/a
	RDD	15.5	E-37-D	1.5	---	n/a	n/a
	PS	5.3	E-37-F	1.1	1.7	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.38 PROJECT REACH J3B, STATION 553+71

REACH J3B - STA 553+71

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	**Meets Criteria**
200-Year DWSEL, Through Seepage:	**Meets Criteria**
HTOL, Under Seepage:	**Meets Criteria**

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	**Meets Criteria**
Steady State Seepage HTOL , LS:	**Meets Criteria**
Rapid Drawdown, WS:	**Meets Criteria**
Seismic Slope Stability, WS:	**Meets Criteria**
Seismic Slope Stability, LS:	**Meets Criteria**

Reach Description

Station Limits:	548+50	to	555+70
Feature(s) at Upstream Station Limit:	Northern end Phase 1 LSRP drained seepage berm - Reach J3C		
Feature(s) at Downstream Station Limit:	Southern end Phase 1 LSRP drained seepage berm - Reach J3A		
Approx. Crown Elevation Range (feet, NAVD88):	29	to	31
Approx. Levee Height Range (feet):	15	to	18
Approx. Crown Width Range (feet):	18	to	20
Approx. Landside Slope (H:V) Range:	3:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	3:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	Oak Trees		
Landside repairs associated with PL84-99:	None definitively documented		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Drained seepage berm with chimney drain		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Sandy SILT to Silty SAND
Landside Surface Layer:	Silty SAND, approx. 3 feet thick at toe of levee
Soils below surface layer:	Approx. 15 feet of Silty SAND, over 10 feet of Lean CLAY, over interbedded Silty SAND, SAND and Lean CLAY

Historic Performance

Extensive seepage, landside boils and erosion were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient**			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
553+71	200-Year	E-38-B	No Positive Gradient	0.46	---	No	n/a
	HTOL	E-38-C	No Positive Gradient	0.50	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.
**Exit Gradient includes 3D effects

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
553+71	SS - 200yr	24.5	E-38-D	---	2.1	n/a	n/a
	SS - HTOL	26.0	E-38-E	---	2.1	n/a	n/a
	RDD	15.5	E-38-D	1.6	---	n/a	n/a
	PS	5.3	E-38-F	1.1	1.5	n/a	n/a
	Post-EQ	5.3	E-38-G/H	1.3	1.9	1.3	3.0

10.39 PROJECT REACH J3C, STATION 557+50

REACH J3C - STA 557+50

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	555+70	to	569+50
Feature(s) at Upstream Station Limit:	Southern end of Phase 1 LSRP drained seepage berm (at oak trees)		
Feature(s) at Downstream Station Limit:	Northern end of Phase 1 LSRP drained seepage berm (at oak trees)		
Approx. Crown Elevation Range (feet, NAVD88):	29	to	30
Approx. Levee Height Range (feet):	18	to	19
Approx. Crown Width Range (feet):	16	to	27
Approx. Landside Slope (H:V) Range:	3:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	3:1
Waterside Constraint(s):	Waterside bench from STA 565+00 to 569+50		
Landside Constraint(s):	None - agricultural land		
Landside repairs associated with PL84-99:	Yes, berm constructed from STA 555+70 to 564+00		
Improvements associated with LSRP P1:	Drained Seepage Berm		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Chimney Drain		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Clayey SILT to SAND
Landside Surface Layer:	Silty SAND, approx. 2 feet thick at toe of levee
Soils below surface layer:	Approx. 21 feet of Lean CLAY, over interbeded layers of Silty SAND, Lean CLAY and SAND

Historic Performance

Extensive seepage and landside boils were reported in ULE's 2014 SGDR Addendum. An approximate 400 foot wide levee breach was reported between STA 560+00 to 564+00 associated with the 1950 flood event. Waterside erosion was reported at two locations during the 1997 event.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient**			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
557+50	200-Year	E-39-B	No Positive Gradient	0.09	---	No	n/a
	HTOL	E-39-C	No Positive Gradient	0.11	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.
**Exit Gradient includes 3D effects

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
557+50	SS - 200yr	24.6	E-39-D	---	2.1	n/a	n/a
	SS - HTOL	26.0	E-39-E	---	2.2	n/a	n/a
	RDD	15.6	E-39-D	1.6	---	n/a	n/a
	PS	5.3	E-39-F	1.1	1.4	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.40 PROJECT REACH J3C, STATION 564+00

REACH J3C - STA 564+00

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	555+70	to	569+50
Feature(s) at Upstream Station Limit:	Southern end of Phase 1 LSRP drained seepage berm (at oak trees)		
Feature(s) at Downstream Station Limit:	Northern end of Phase 1 LSRP drained seepage berm (at oak trees)		
Approx. Crown Elevation Range (feet, NAVD88):	29	to	30
Approx. Levee Height Range (feet):	18	to	19
Approx. Crown Width Range (feet):	16	to	27
Approx. Landside Slope (H:V) Range:	3:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	3:1
Waterside Constraint(s):	Waterside bench from STA 565+00 to 569+50		
Landside Constraint(s):	None - agricultural land		
Landside repairs associated with PL84-99:	Yes, berm constructed from STA 555+70 to 564+00		
Improvements associated with LSRP P1:	Drained Seepage Berm		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Chimney Drain		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Clayey SILT to SAND
Landside Surface Layer:	Silty SAND, approx. 2 feet thick at toe of levee
Soils below surface layer:	Approx. 21 feet of Lean CLAY, over interbeded layers of Silty SAND, Lean CLAY and SAND

Historic Performance

Extensive seepage and landside boils were reported in ULE's 2014 SGDR Addendum. An approximate 400 foot wide levee breach was reported between STA 560+00 to 564+00 associated with the 1950 flood event. Waterside erosion was reported at two locations during the 1997 event.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient**			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
564+00	200-Year	E-40-B	No Positive Gradient	0.32	---	No	n/a
	HTOL	E-40-C	No Positive Gradient	0.36	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.
**Exit Gradient includes 3D effects

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
564+00	SS - 200yr	24.7	E-40-D	---	2.1	n/a	n/a
	SS - HTOL	26.2	E-40-E	---	2.1	n/a	n/a
	RDD	15.6	E-40-D	1.5	---	n/a	n/a
	PS	5.3	E-40-F	1.3	1.6	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.41 PROJECT REACH J4A, STATION 573+10

REACH J4A - STA 573+10

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	569+50	to	574+50
Feature(s) at Upstream Station Limit:	Levee access ramp, Begin north end of Phase II landside berm/trench for J4B		
Feature(s) at Downstream Station Limit:	Southern end of Phase 1 LSRP drained seepage berm (at oak trees)		
Approx. Crown Elevation Range (feet, NAVD88):	29.5	to	30.5
Approx. Levee Height Range (feet):	15	to	17
Approx. Crown Width Range (feet):	40	to	42
Approx. Landside Slope (H:V) Range:	3:1	to	3:1
Approx. Waterside Slope (H:V) Range:	2:1	to	2:1
Waterside Constraint(s):	Approx. 40 ft wide waterside bench at downstream end		
Landside Constraint(s):	Oak trees		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Drained seepage berm with chimney		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND to Silty CLAY
Landside Surface Layer:	Lean CLAY, approx. 24 feet thick at toe of levee
Soils below surface layer:	Approx. 4 feet of Silty SAND, over 12 feet of Lean CLAY, over 32 feet of SAND, over 28 feet of Lean CLAY

Historic Performance

Seepage and landside boils during the 1986 and 1997 flood events were reported in ULE's 2014 SGDR Addendum

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
573+10	200-Year	E-41-B	0.09	0.34	---	No	n/a
	HTOL	E-41-C	0.13	0.39	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
573+10	SS - 200yr	24.9	E-41-D	---	2.3	n/a	n/a
	SS - HTOL	26.5	E-41-E	---	2.3	n/a	n/a
	RDD	15.8	E-41-D	1.5	---	n/a	n/a
	PS	5.3	E-41-F	1.2	1.8	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.42 PROJECT REACH J4B, STATION 579+70

REACH J4B - STA 579+70

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	574+50	to	585+50
Feature(s) at Upstream Station Limit:	Landside park/begin waterside bench		
Feature(s) at Downstream Station Limit:	Levee access ramp, Begin north end of Phase II landside berm/trench for J4B		
Approx. Crown Elevation Range (feet, NAVD88):	30	to	30.5
Approx. Levee Height Range (feet):	17	to	22
Approx. Crown Width Range (feet):	26	to	32
Approx. Landside Slope (H:V) Range:	2.1:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.8:1	to	2.8:1
Waterside Constraint(s):	None		
Landside Constraint(s):	Lathrop Road and residential improvements		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	Drainage trench, drained seepage berm,		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	SILT to Silty SAND
Landside Surface Layer:	Lean CLAY and SILT, approx. 15 feet thick at toe of seepage berm
Soils below surface layer:	Interbedded layers of Silty SAND and Lean CLAY

Historic Performance

No events were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
579+70	200-Year	E-42-B	No Positive Gradient	0.30	---	No	n/a
	HTOL	E-42-C	No Positive Gradient	0.34	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
579+70	SS - 200yr	25.0	E-42-D	---	2.2	n/a	n/a
	SS - HTOL	26.6	E-42-E	---	2.1	n/a	n/a
	RDD	15.9	E-42-D	1.7	---	n/a	n/a
	PS	5.3	E-42-F	1.2	1.5	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.43 PROJECT REACH K, STATION 17+00

Reach K - STA 017+00 {600+00}

Based on our evalaution, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Siesmic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	585+50	to	608+00
Feature(s) at Upstream Station Limit:	Approx. 400 ft west of Old Wharf Court		
Feature(s) at Downstream Station Limit:	Seepage berm, drainage trench, and chimney drain, Approx. 200 ft northwest		
Approx. Crown Elevation Range (feet, NAVD88):	30	to	30.5
Approx. Levee Height Range (feet):	16	to	18
Approx. Crown Width Range (feet):	20	to	20
Approx. Landside Slope (H:V) Range:	3:1	to	3:1
Approx. Waterside Slope (H:V) Range:	3:1	to	3:1
Waterside Constraint(s):	Agricultural land between existing levee and setback levee		
Landside Constraint(s):	None - agricultural land.		
Landside repairs assocaited with PL84-99:	Drained seepage berm from STA 591+00		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Setback levee with cutoff wall		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Engineered Levee Fill
Landside Surface Layer:	Lean CLAY at setback levee toe, approx. 2 feet thick
Soils below surface layer:	Clayey SAND over Lean CLAY and Poorly Graded SAND with SILT

Historic Performance

Heavy seepage and landside boils adjacent to existing levee during 1997 flood event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
017+00 {600+00}	200-Year	E-43-B	0.30	---	---	Yes**	1.5
	HTOL	E-43-C	0.35	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

**Exits onto engineered fine grained setback levee fill slope, therefore we report "meets criteria" for through seepage.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
017+00 {	SS - 200yr	25.1	E-43-D	---	1.8	n/a	n/a
	SS - HTOL	26.7	E-43-E	---	1.7	n/a	n/a
	RDD	15.9	E-43-D	2.1	---	n/a	n/a
	PS	5.3	E-43-F	1.8	1.8	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.44 PROJECT REACH L1, STATION 615+10

REACH L1 - STA 615+10

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	608+00	to	655+00
Feature(s) at Upstream Station Limit:	Agricultural land		
Feature(s) at Downstream Station Limit:	Transition to setback levee (Reach K)		
Approx. Crown Elevation Range (feet, NAVD88):	30	to	31.5
Approx. Levee Height Range (feet):	15.5	to	24.5
Approx. Crown Width Range (feet):	14	to	67
Approx. Landside Slope (H:V) Range:	1.9:1	to	3.6:1
Approx. Waterside Slope (H:V) Range:	1.2:1	to	5:1
Waterside Constraint(s):	Waterside bench from approximately STA 625+00 to 636+00		
Landside Constraint(s):	None - agricultural land		
Landside repairs associated with PL84-99:	Yes. Berms at STA 610+50 to 619+50 and 640+00 to 650+00.		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Cutoff Wall		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	15 to 20 feet of Silty SAND, Lean Clay and Sandy SILT
Landside Surface Layer:	Lean CLAY to Clayey SILT, approx. 6-12 feet thick at toe of levee
Soils below surface layer:	Approx. 35-40 feet of SAND to Silty Sand (w/occasional clay lenses), over Lean CLAY

Historic Performance

Extensive seepage and landside boils (1986 & 1997), a waterside slide (1997 - STA 646+00) and waterside scour (1997, 2006) were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analysis in the vicinity of 615+10. Refer to the

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
615+10	200-Year	E-44-B	0.09	---	0.21	No	n/a
	HTOL	E-44-C	0.10	---	0.22	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
615+10	SS - 200yr	25.4	E-44-D/E	---	1.6	---	1.6
	SS - HTOL	27.1	E-44-F	---	1.6	---	1.6
	RDD	16.1	E-44-D/E	1.4	---	1.4	---
	PS	5.3	E-44-G/H	1.3	1.2	1.2	1.4
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.45 PROJECT REACH L1, STATION 620+00

REACH L1 - STA 620+00

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	608+00	to	655+00
Feature(s) at Upstream Station Limit:	Agricultural land		
Feature(s) at Downstream Station Limit:	Transition to setback levee (Reach K)		
Approx. Crown Elevation Range (feet, NAVD88):	30	to	31.5
Approx. Levee Height Range (feet):	15.5	to	24.5
Approx. Crown Width Range (feet):	14	to	67
Approx. Landside Slope (H:V) Range:	1.9:1	to	3.6:1
Approx. Waterside Slope (H:V) Range:	1.2:1	to	5:1
Waterside Constraint(s):	Waterside bench from approximately STA 625+00 to 636+00		
Landside Constraint(s):	None - agricultural land		
Landside repairs associated with PL84-99:	Yes. Berms at STA 610+50 to 619+50 and 640+00 to 650+00.		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Cutoff Wall		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: 15 to 20 feet of Silty SAND, Lean Clay and Sandy SILT

Landside Surface Layer: Lean CLAY to Clayey SILT, approx. 6-12 feet thick at toe of levee

Soils below surface layer: Approx. 35-40 feet of SAND to Silty Sand (w/occasional clay lenses), over Lean CLAY

Historic Performance

Extensive seepage and landside boils (1986 & 1997), a waterside slide (1997 - STA 646+00) and waterside scour (1997, 2006) were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analysis in the vicinity of 620+00. Refer to the

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
620+00	200-Year	E-45-B	No Positive Gradient	---	0.22	No	n/a
	HTOL	E-45-C	No Positive Gradient	---	0.24	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
620+00	SS - 200yr	25.4	E-45-D/E	---	1.7	---	2.0
	SS - HTOL	27.2	E-45-F	---	1.6	---	2.0
	RDD	16.1	E-45-D/E	1.2	---	1.3	---
	PS	5.3	E-45-G/H	1.1	1.3	1.1	1.5
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

ENGEO
Expect Excellence

10.46 PROJECT REACH L1, STATION 631+50

REACH L1 - STA 631+50

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	608+00	to	655+00
Feature(s) at Upstream Station Limit:	Agricultural land		
Feature(s) at Downstream Station Limit:	Transition to setback levee (Reach K)		
Approx. Crown Elevation Range (feet, NAVD88):	30	to	31.5
Approx. Levee Height Range (feet):	15.5	to	24.5
Approx. Crown Width Range (feet):	14	to	67
Approx. Landside Slope (H:V) Range:	1.9:1	to	3.6:1
Approx. Waterside Slope (H:V) Range:	1.2:1	to	5:1
Waterside Constraint(s):	Waterside bench from approximately STA 625+00 to 636+00		
Landside Constraint(s):	None - agricultural land		
Landside repairs associated with PL84-99:	Yes. Berms at STA 610+50 to 619+50 and 640+00 to 650+00.		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Cutoff Wall		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	15 to 20 feet of Silty SAND, Lean Clay and Sandy SILT
Landside Surface Layer:	Lean CLAY to Clayey SILT, approx. 6-12 feet thick at toe of levee
Soils below surface layer:	Approx. 35-40 feet of SAND to Silty Sand (w/occasional clay lenses), over Lean CLAY

Historic Performance

Extensive seepage and landside boils (1986 & 1997), a waterside slide (1997 - STA 646+00) and waterside scour (1997, 2006) were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient**			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
631+50	200-Year	E-46-B	0.17	---	0.21	No	n/a
	HTOL	E-46-C	0.19	---	0.22	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.
**Exit Gradient includes 3D effects

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
631+50	SS - 200yr	25.6	E-46-D/E	---	1.8	---	1.8
	SS - HTOL	27.4	E-46-F	---	1.7	---	1.8
	RDD	16.2	E-46-D/E	1.9	---	2.2	---
	PS	5.3	E-46-G/H	1.5	1.3	1.6	1.5
	Post-EQ	5.3	E-46-I/J	1.2	1.7	1.2	2.0

10.47 PROJECT REACH L1, STATION 644+00

REACH L1 - STA 644+00

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	608+00	to	655+00
Feature(s) at Upstream Station Limit:	Agricultural land		
Feature(s) at Downstream Station Limit:	Transition to setback levee (Reach K)		
Approx. Crown Elevation Range (feet, NAVD88):	30	to	31.5
Approx. Levee Height Range (feet):	15.5	to	24.5
Approx. Crown Width Range (feet):	14	to	67
Approx. Landside Slope (H:V) Range:	1.9:1	to	3.6:1
Approx. Waterside Slope (H:V) Range:	1.2:1	to	5:1
Waterside Constraint(s):	Waterside bench from approximately STA 625+00 to 636+00		
Landside Constraint(s):	None - agricultural land		
Landside repairs associated with PL84-99:	Yes. Berms at STA 610+50 to 619+50 and 640+00 to 650+00.		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Cutoff Wall		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	15 to 20 feet of Silty SAND, Lean Clay and Sandy SILT
Landside Surface Layer:	Lean CLAY to Clayey SILT, approx. 6-12 feet thick at toe of levee
Soils below surface layer:	Approx. 35-40 feet of SAND to Silty Sand (w/occasional clay lenses), over Lean CLAY

Historic Performance

Extensive seepage and landside boils (1986 & 1997), a waterside slide (1997 - STA 646+00) and waterside scour (1997, 2006) were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
644+00	200-Year	E-47-B	No Positive Gradient	---	0.01	No	n/a
	HTOL	E-47-C	No Positive Gradient	---	0.02	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
644+00	SS - 200yr	25.8	E-47-D/E	---	3.1	---	3.4
	SS - HTOL	27.6	E-47-F	---	3.1	---	3.3
	RDD	16.3	E-47-D/E	2.7	---	2.4	---
	PS	5.3	E-47-G/H	1.6	2.1	1.7	2.4
	Post-EQ	5.3	E-47-I/J	1.8	3.1	1.7	5.3

10.48 PROJECT REACH L2, STATION 658+00

REACH L2 - STA 658+00

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	655+00	to	703+00
Feature(s) at Upstream Station Limit:	Transition to Phase II Seepage Berm		
Feature(s) at Downstream Station Limit:	Agricultural land		
Approx. Crown Elevation Range (feet, NAVD88):	31	to	32
Approx. Levee Height Range (feet):	13	to	19
Approx. Crown Width Range (feet):	13	to	35
Approx. Landside Slope (H:V) Range:	2:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	3.2:1
Waterside Constraint(s):	River Islands Parkway Bridge (Approx. STA 689+00)		
Landside Constraint(s):	Landside improvements (residential, approach fills, etc.) between approx.		
Waterside repairs associated with PL84-99:	Riprap waterside (2006)		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Cutoff Wall		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND to SAND
Landside Surface Layer:	Lean CLAY, approx. 5 to 10 feet thick at toe of levee
Soils below surface layer:	Approx. 15 to 20 feet of Silty SAND, over 25 to 30 feet of Poorly Graded SAND

Historic Performance

Seepage and landside boils (STA 668+00 to 669+00) during 1997 flood event and waterside erosion (STA 699+71 to 700+51) during 2006 flood event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analysis in the vicinity of 658+00. Refer to the tables for 684+50 and 700+00 for areas of Reach L2, where our liquefaction assessment indicates potentially liquefiable soils exist.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient**			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
658+00	200-Year	E-48-B	0.11	---	---	No	n/a
	HTOL	E-48-C	0.12	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.
**Exit Gradient includes 3D effects

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
658+00	SS - 200yr	25.8	E-48-D/E	---	1.5	---	1.7
	SS - HTOL	27.6	E-48-F	---	1.5	---	1.6
	RDD	16.1	E-48-D/E	1.7	---	1.7	---
	PS	5.3	E-48-G/H	1.3	1.2	1.3	1.4
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.49 PROJECT REACH L2, STATION 671+00

REACH L2 - STA 671+00

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	655+00	to	703+00
Feature(s) at Upstream Station Limit:	Transition to Phase II Seepage Berm		
Feature(s) at Downstream Station Limit:	Agricultural land		
Approx. Crown Elevation Range (feet, NAVD88):	31	to	32
Approx. Levee Height Range (feet):	13	to	19
Approx. Crown Width Range (feet):	13	to	35
Approx. Landside Slope (H:V) Range:	2:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	3.2:1
Waterside Constraint(s):	River Islands Parkway Bridge (Approx. STA 689+00)		
Landside Constraint(s):	Landside improvements (residential, approach fills, etc.) between approx.		
Waterside repairs associated with PL84-99:	Riprap waterside (2006)		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Cutoff Wall		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND to SAND
Landside Surface Layer:	Lean CLAY, approx. 5 to 10 feet thick at toe of levee
Soils below surface layer:	Approx. 15 to 20 feet of Silty SAND, over 25 to 30 feet of Poorly Graded SAND

Historic Performance

Seepage and landside boils (STA 668+00 to 669+00) during 1997 flood event and waterside erosion (STA 699+71 to 700+51) during 2006 flood event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analysis in the vicinity of 671+00. Refer to the tables for 684+50 and 700+00 for areas of Reach L2, where our liquefaction assessment indicates potentially liquefiable soils exist.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
671+00	200-Year	E-49-B	0.02	---	0.05	No	n/a
	HTOL	E-49-C	0.04	---	0.05	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
671+00	SS - 200yr	26.2	E-49-D/E	---	1.5	---	1.6
	SS - HTOL	28.1	E-49-F	---	1.5	---	1.7
	RDD	16.4	E-49-D/E	2.2	---	2.3	---
	PS	5.3	E-49-G/H	1.7	1.2	1.8	1.4
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.50 PROJECT REACH L2, STATION 684+50

REACH L2 - STA 684+50

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	655+00	to	703+00
Feature(s) at Upstream Station Limit:	Transition to Phase II Seepage Berm		
Feature(s) at Downstream Station Limit:	Agricultural land		
Approx. Crown Elevation Range (feet, NAVD88):	31	to	32
Approx. Levee Height Range (feet):	13	to	19
Approx. Crown Width Range (feet):	13	to	35
Approx. Landside Slope (H:V) Range:	2:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	3.2:1
Waterside Constraint(s):	River Islands Parkway Bridge (Approx. STA 689+00)		
Landside Constraint(s):	Landside improvements (residential, approach fills, etc.) between approx STA		
Waterside repairs associated with PL84-99:	Riprap waterside (2006)		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Cutoff Wall		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND to SAND
Landside Surface Layer:	Lean CLAY, approx. 5 to 10 feet thick at toe of levee
Soils below surface layer:	Approx. 15 to 20 feet of Silty SAND, over 25 to 30 feet of Poorly Graded SAND

Historic Performance

Seepage and landside boils (STA 668+00 to 669+00) during 1997 flood event and waterside erosion (STA 699+71 to 700+51) during 2006 flood event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
684+50	200-Year	E-50-B	No Positive Gradient	---	0.59	No	n/a
	HTOL	E-50-C	No Positive Gradient	---	0.62	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
684+50	SS - 200yr	26.4	E-50-D/E	---	1.9	---	2.2
	SS - HTOL	28.5	E-50-F	---	1.9	---	2.2
	RDD	16.6	E-50-D/E	2.3	---	2.4	---
	PS	5.4	E-50-G/H	1.7	1.5	1.8	1.6
	Post-EQ	5.4	E-50 - I/J	2.2	2.0	2.0	3.7

10.51 PROJECT REACH L2, STATION 700+00

REACH L2 - STA 700+00

Based on our evaluation, this reach meets the ULDC Criteria. Seismic deformations are not anticipated to degrade below 10-Year WSE + 3 feet.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	655+00	to	703+00
Feature(s) at Upstream Station Limit:	Transition to Phase II Seepage Berm		
Feature(s) at Downstream Station Limit:	Agricultural land		
Approx. Crown Elevation Range (feet, NAVD88):	31	to	32
Approx. Levee Height Range (feet):	13	to	19
Approx. Crown Width Range (feet):	13	to	35
Approx. Landside Slope (H:V) Range:	2:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	3.2:1
Waterside Constraint(s):	River Islands Parkway Bridge (Approx. STA 689+00)		
Landside Constraint(s):	Landside improvements (residential, approach fills, etc.) between approx.		
Waterside repairs associated with PL84-99:	Riprap waterside (2006)		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Cutoff Wall		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: Silty SAND to SAND
Landside Surface Layer: Lean CLAY, approx. 5 to 10 feet thick at toe of levee
Soils below surface layer: Approx. 15 to 20 feet of Silty SAND, over 25 to 30 feet of Poorly Graded SAND

Historic Performance

Seepage and landside boils (STA 668+00 to 669+00) during 1997 flood event and waterside erosion (STA 699+71 to 700+51) during 2006 flood event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
700+00	200-Year	E-51-B	No Positive Gradient	---	0.12	No	n/a
	HTOL	E-51-C	No Positive Gradient	---	0.13	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
700+00	SS - 200yr	26.7	E-51-D/E	---	2.3	---	2.5
	SS - HTOL	28.8	E-51-F	---	2.2	---	2.5
	RDD	16.9	E-51-D/E	1.6	---	1.6	---
	PS	5.4	E-51-G/H	1.4	1.7	1.4	1.8
	Post-EQ	5.4	E-51-I/J	1.0	2.3	0.9	3.0

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
C3A	2,000	7	5	No Fill Anticipated	2,600

10.52 PROJECT REACH M1, STATION 704+92

REACH M1 - STA 704+92

Based on our evaluation, this reach meets ULDC criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	703+00	to	724+50
Feature(s) at Upstream Station Limit:	Levee access ramp, transition to Element VI.a.3 seepage berm (Phase II)		
Feature(s) at Downstream Station Limit:	Transition between Phase II berm and Phase II cutoff wall		
Approx. Crown Elevation Range (feet, NAVD88):	31.5	to	32.5
Approx. Levee Height Range (feet):	14	to	18
Approx. Crown Width Range (feet):	23	to	60
Approx. Landside Slope (H:V) Range:	3:1	to	5:1
Approx. Waterside Slope (H:V) Range:	1.3:1	to	3.2:1
Waterside Constraint(s):	Waterside bench between STA 717+00		
Landside Constraint(s):	Phase II berm and residential development		
Landside repairs associated with PL84-99:	Yes, berms at STA 710+00 to 713+00 and 722+00 to 724+50.		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	Drained seepage berm		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Lean CLAY and Poorly Graded SAND
Landside Surface Layer:	Lean CLAY, approx. 10 feet thick at toe of levee
Soils below surface layer:	Approx. 10 to 25 feet of Silty SAND to SAND, over 20 feet of Lean CLAY

Historic Performance

Seepage and landside boils were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
704+92	200-Year	E-52-B	No Positive Gradient	0.21	0.71	No	n/a
	HTOL	E-52-C	No Positive Gradient	0.27	0.80	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
704+92	SS - 200yr	26.8	E-52-D	---	1.8	n/a	n/a
	SS - HTOL	28.9	E-52-E	---	1.8	n/a	n/a
	RDD	17.0	E-52-D	2.1	---	n/a	n/a
	PS	5.4	E-52-F	1.5	1.4	n/a	n/a
	Post-EQ	5.4	E-52-G/H	1.2	1.8	1.3	3.3

10.53 PROJECT REACH M2A, STATION 734+45

REACH M2A - STA 734+45

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL, LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	724+50	to	741+30
Feature(s) at Upstream Station Limit:	Begin Phase 1 drained seepage berm for Reach M2B, Sadler Oak Rd, end		
Feature(s) at Downstream Station Limit:	Levee access ramp, transition to Element VI.a.2 seepage berm (Phase II)		
Approx. Crown Elevation Range (feet, NAVD88):	32	to	33
Approx. Levee Height Range (feet):	16.5	to	19
Approx. Crown Width Range (feet):	30	to	50
Approx. Landside Slope (H:V) Range:	3:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.6:1	to	4:1
Waterside Constraint(s):	Waterside bench between STA 725+50 to 728+00		
Landside Constraint(s):	Phase II berm and residential improvements		
Landside repairs associated with PL84-99:	Yes, berm along entire reach		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	Drained Seepage Berm		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: Silty SAND to Clayey SAND
Landside Surface Layer: Lean CLAY, approx. 20 feet thick at toe of levee
Soils below surface layer: Approx. 60 feet of Silty SAND to SAND, over Lean CLAY

Historic Performance

Seepage and flooded field conditions (STA 728+30 to 732+00) during 1997 flood event and waterside erosion (STA 737+55 to 739+45) during the 2006 flood event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
734+45	200-Year	E-53-B	0.07	0.51	0.67	No	n/a
	HTOL	E-53-C	0.16	0.62	0.79	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
734+45	SS - 200yr	27.9	E-53-D	---	2.2	n/a	n/a
	SS - HTOL	30.4	E-53-E	---	2.0	n/a	n/a
	RDD	18.0	E-53-D	1.7	---	n/a	n/a
	PS	5.5	E-53-F	1.3	1.7	n/a	n/a
	Post-EQ	5.5	E-53-G/H	1.5	2.2	1.7	3.4

10.54 PROJECT REACH M2B, STATION 744+73

REACH M2B - STA 744+73

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	741+30	to	760+50
Feature(s) at Upstream Station Limit:	End of Phase 1 drained seepage berm		
Feature(s) at Downstream Station Limit:	Beginning of Phase 1 drained seepage berm, Sadler Oak Rd, residential		
Approx. Crown Elevation Range (feet, NAVD88):	33	to	34
Approx. Levee Height Range (feet):	15	to	16.5
Approx. Crown Width Range (feet):	15	to	30
Approx. Landside Slope (H:V) Range:	1.8:1	to	2.8:1
Approx. Waterside Slope (H:V) Range:	1.8:1	to	3.1:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	None - agricultural land		
Landside repairs associated with PL84-99:	Yes - drained berms constructed		
Improvements associated with LSRP P1:	Drained Seepage Berm		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Cutoff wall		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND to Lean CLAY
Landside Surface Layer:	Lean CLAY to SILT, approx. 6 to 12 feet thick at toe of levee
Soils below surface layer:	Approx. 40-feet of Silty SAND to SAND (with occasional interbeded SILT/CLAY layers), over Lean to Sandy CLAY.

Historic Performance

Seepage and landside boils during 1997 flood event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
744+73	200-Year	E-54-B	No Positive Gradient	0.09	---	No	n/a
	HTOL	E-54-C	No Positive Gradient	0.11	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
744+73	SS - 200yr	28.0	E-54-D/E	---	1.9	---	2.1
	SS - HTOL	30.6	E-54-F	---	1.9	---	2.1
	RDD	18.0	E-54-D/E	2.0	---	2.1	---
	PS	5.5	E-54-G/H	1.7	1.5	1.7	1.8
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.55 PROJECT REACH M2B, STATION 755+00

REACH M2B - STA 755+00

Based on our evaluation, this reach meets the ULDC Criteria. Seismic deformations are not anticipated to degrade below 10-Year WSE + 3 feet.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	741+30	to	760+50
Feature(s) at Upstream Station Limit:	End of Phase 1 drained seepage berm		
Feature(s) at Downstream Station Limit:	Beginning of Phase 1 drained seepage berm, Sadler Oak Rd, residential		
Approx. Crown Elevation Range (feet, NAVD88):	32.5	to	34
Approx. Levee Height Range (feet):	15	to	16.5
Approx. Crown Width Range (feet):	15	to	30
Approx. Landside Slope (H:V) Range:	1.8:1	to	2.8:1
Approx. Waterside Slope (H:V) Range:	1.8:1	to	3.1:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	None - agricultural land		
Landside repairs associated with PL84-99:	Yes - drained berms constructed		
Improvements associated with LSRP P1:	Drained Seepage Berm		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Cutoff wall		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND to Lean CLAY
Landside Surface Layer:	Lean CLAY to SILT, approx. 6 to 12 feet thick at toe of levee
Soils below surface layer:	Approx. 40 feet of Silty SAND to SAND (with occasional interbeded SILT/CLAY layers), over Lean to Sandy CLAY.

Historic Performance

Seepage and landside boils during 1997 flood event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
755+00	200-Year	E-55-B	No Positive Gradient	0.09	---	No	n/a
	HTOL	E-55-C	No Positive Gradient	0.12	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
755+00	SS - 200yr	28.0	E-55-D/E	---	2.0	---	2.1
	SS - HTOL	30.6	E-55-F	---	2.0	---	2.3
	RDD	18.0	E-55-D/E	1.3	---	1.4	---
	PS	5.4	E-55-G/H	1.1	1.6	1.2	1.6
	Post-EQ	5.4	E-55-I/J	0.6	2.0	0.4	2.4

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
M2B	1,350	7.5	5.5	No Fill Anticipated	2,100

10.56 PROJECT REACH M3A, STATION 761+00

REACH M3A - STA 761+00

Based on our evaluation, this reach meets the ULDC Criteria. An Operations and Maintenance plan should be implemented for seismic deformations following the 200-year event.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

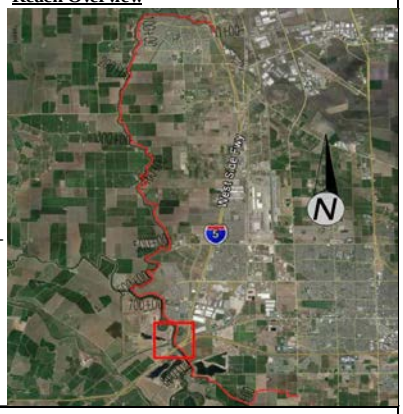
Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	760+50	to	763+00
Feature(s) at Upstream Station Limit:	Railroad bridge approach fill		
Feature(s) at Downstream Station Limit:	End of Phase 1 drained seepage berm		
Approx. Crown Elevation Range (feet, NAVD88):	32	to	33
Approx. Levee Height Range (feet):	13	to	14
Approx. Crown Width Range (feet):	20	to	30
Approx. Landside Slope (H:V) Range:	2.5:1	to	3:1
Approx. Waterside Slope (H:V) Range:	3:1	to	3.5:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench. Railroad bridge		
Landside Constraint(s):	None - agricultural land		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Cutoff wall		

Reach Overview



Generalized Subsurface Conditions

Levee Prism Soils:	Poorly graded SAND to Silty SAND
Landside Surface Layer:	Lean CLAY, approx. 7 feet thick at toe of levee
Soils below surface layer:	Approx. 45 feet of SAND, over 30 feet of Lean CLAY

Historic Performance

Seepage and landside boils (STA 762+00 to 764+00) during 1997 flood event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
761+00	200-Year	E-56-B	No Positive Gradient	---	0.12	No	n/a
	HTOL	E-56-C	No Positive Gradient	---	0.14	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
761+00	SS - 200yr	28.4	E-56-D/E	---	2.0	---	2.2
	SS - HTOL	31.0	E-56-F	---	2.0	---	2.3
	RDD	18.4	E-56-D/E	1.9	---	1.9	---
	PS	5.5	E-56-G/H	1.3	1.5	1.1	1.6
	Post-EQ	5.5	E-56-I/J	0.5	1.6	0.5	1.6

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
M3A	250	23	16	1,500	3,400

10.57 PROJECT REACH M3B, STATION 764+13

REACH M3B - STA 764+13

Based on our evaluation, this reach meets the ULDC criteria. Seismic deformations are not anticipated to degrade below 10-Year WSE + 3 feet.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	763+00	to	768+00
Feature(s) at Upstream Station Limit:	Manthey Road, I-5 approach fill/crossing		
Feature(s) at Downstream Station Limit:	Railroad bridge approach fill		
Approx. Crown Elevation Range (feet, NAVD88):	32	to	33
Approx. Levee Height Range (feet):	12	to	17
Approx. Crown Width Range (feet):	20	to	33
Approx. Landside Slope (H:V) Range:	2:1	to	3:1
Approx. Waterside Slope (H:V) Range:	2:1	to	3:1
Waterside Constraint(s):	Boat launch ramp, railroad bridge		
Landside Constraint(s):	Mossdale County Park improvements		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Cutoff Wall/Drained Berm at RR Tracks		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: Silty SAND to SAND
Landside Surface Layer: Lean CLAY to Clayey SILT, approx. 3 to 13 feet thick at toe of levee
Soils below surface layer: Approx. 40 to 50 feet of Silty SAND to SAND, over Lean CLAY

Historic Performance

Seepage and landside boils during 1997 flood event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
764+13	200-Year	E-57-B	No Positive Gradient	---	0.49	No	n/a
	HTOL	E-56-C	No Positive Gradient	---	0.52	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
764+13	SS - 200yr	28.5	E-57-D/E	---	1.7	---	1.9
	SS - HTOL	31.2	E-57-F	---	1.7	---	1.9
	RDD	18.5	E-57-D/E	2.1	---	2.2	---
	PS	5.6	E-57-G/H	1.5	1.3	1.7	1.6
	Post-EQ	5.6	E-57-I/J	0.7	1.7	0.7	1.7

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
M3B	500	9	6	No Fill Anticipated	1,000

10.58 PROJECT REACH M3B, STATION 767+00

REACH M3B - STA 767+00

Based on our evaluation, this reach meets the ULDC criteria. Seismic deformations are not anticipated to degrade below 10-Year WSE + 3 feet.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	763+00	to	768+00
Feature(s) at Upstream Station Limit:	Manthey Road, I-5 approach fill/crossing		
Feature(s) at Downstream Station Limit:	Railroad bridge approach fill		
Approx. Crown Elevation Range (feet, NAVD88):	32	to	33
Approx. Levee Height Range (feet):	12	to	17
Approx. Crown Width Range (feet):	20	to	33
Approx. Landside Slope (H:V) Range:	2:1	to	3:1
Approx. Waterside Slope (H:V) Range:	2:1	to	3:1
Waterside Constraint(s):	Boat launch ramp, railroad bridge		
Landside Constraint(s):	Mossdale County Park improvements		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Cutoff Wall/Drained Berm at RR Tracks		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: Silty SAND to SAND
Landside Surface Layer: Lean CLAY to Clayey SILT, approx. 3 to 13 feet thick at toe of levee
Soils below surface layer: Approx. 40 to 50-feet of Silty SAND to SAND, over Lean CLAY

Historic Performance

Seepage and landside boils during 1997 flood event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
767+00	200-Year	E-58-B	No Positive Gradient	---	---	No	n/a
	HTOL	E-58-C	No Positive Gradient	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
767+00	SS - 200yr	28.6	E-58-D/E	---	2.6	---	2.9
	SS - HTOL	31.3	E-58-F	---	2.6	---	2.6
	RDD	18.6	E-58-D/E	1.9	---	1.9	---
	PS	5.6	E-58-G/H	1.3	1.7	1.3	1.9
	Post-EQ	5.6	E-58-I/J	0.7	2.1	0.5	2.0

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
M3B	500	9	6	No Fill Anticipated	1,000

10.59 PROJECT REACH M3C, STATION 777+00

REACH M3C - STA 777+00

Based on our evaluation, this reach meets the ULDC Criteria. An Operations and Maintenance plan should be implemented for seismic deformations following the 200-year event.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	775+00	to	781+00
Feature(s) at Upstream Station Limit:	Landside berm/agricultural areas		
Feature(s) at Downstream Station Limit:	I-5 Bridge Crossing Approach		
Approx. Crown Elevation Range (feet, NAVD88):	32 1/2	to	34.5
Approx. Levee Height Range (feet):	11	to	17
Approx. Crown Width Range (feet):	25	to	40
Approx. Landside Slope (H:V) Range:	3:1	to	3:1
Approx. Waterside Slope (H:V) Range:	2.5:1	to	3.5:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - isolated 35 foot wide waterside bench.		
Landside Constraint(s):	Phase II berm and agricultural land		
Landside repairs associated with PL84-99:	Yes - drained seepage berm		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	Drained Seepage Berm from STA 778+50 to 781+00		
Proposed Improvements associated with LSRP P3:	Drained Seepage Berm from STA 775+00 to 778+50		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: Silty SAND to SAND
Landside Surface Layer: SAND
Soils below surface layer: Approx. 45 feet of SAND, over interlayered Lean CLAY and Clayey SAND

Historic Performance

Seepage and landside boils were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
777+00	200-Year	E-59-B	0.01	0.09	---	No	n/a
	HTOL	E-59-C	0.01	0.10	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
777+00	SS - 200yr	28.9	E-59-D	---	2.4	n/a	n/a
	SS - HTOL	31.8	E-59-E	---	2.3	n/a	n/a
	RDD	18.9	E-59-D	2.0	---	n/a	n/a
	PS	5.8	E-59-F	1.4	1.7	n/a	n/a
	Post-EQ	5.8	E-59-G/H	0.5	2.3	0.5	2.1

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
M3C	600	30	21	7,000	14,000

10.60 PROJECT REACH M4, STATION 795+87

REACH M4 - STA 795+87

Based on our evaluation, this reach meets the ULDC Criteria. Seismic deformations are not anticipated to degrade below 10-Year WSE + 3 feet.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

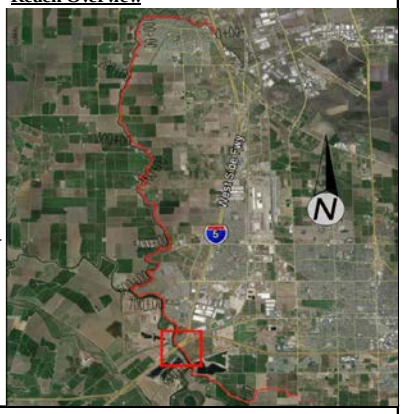
Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL, LS:	Meets Criteria
Steady State Seepage HTOL, LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	781+00	to	799+50
Feature(s) at Upstream Station Limit:	Railroad alignment/approach		
Feature(s) at Downstream Station Limit:	Phase II Berm, agricultural land		
Approx. Crown Elevation Range (feet, NAVD88):	33	to	34
Approx. Levee Height Range (feet):	13	to	18
Approx. Crown Width Range (feet):	30	to	44
Approx. Landside Slope (H:V) Range:	3:1	to	3:1
Approx. Waterside Slope (H:V) Range:	2.5:1	to	3.3:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	High tension power lines and ag land		
Landside repairs associated with PL84-99:	Gravel berm at STA 788+00 to 799+50		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	Drained Seepage Berm		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview



Generalized Subsurface Conditions

Levee Prism Soils: Silty SAND and Lean CLAY
Landside Surface Layer: Lean CLAY, approx. 15 feet thick at toe of levee
Soils below surface layer: Approx. 40 feet of Silty SAND and SAND, over 10 feet of lean CLAY

Historic Performance

Seepage and landside boils were reported during the 1997 high-water event and minor wave wash erosion on waterside slope between Station 790+00 to 799+00 during 1998 high-water event in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
795+87	200-Year	E-60-B	0.03	0.58	---	No	n/a
	HTOL	E-60-C	0.13	0.71	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
795+87	SS - 200yr	29.0	E-60-D	---	1.9	n/a	n/a
	SS - HTOL	31.9	E-60-E	---	2.0	n/a	n/a
	RDD	19.0	E-60-D	1.9	---	n/a	n/a
	PS	6.0	E-60-F	1.6	1.5	n/a	n/a
	Post-EQ	6.0	E-60-G/H	0.8	2.0	0.9	2.9

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
M4	1,850	3	2	No Fill Anticipated	450

10.61 PROJECT REACH N1, STATION 804+50

REACH N1 - STA 804+50

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	799+50	to	806+00
Feature(s) at Upstream Station Limit:	LSRP Phase 3 Cutoff Wall		
Feature(s) at Downstream Station Limit:	RR-Xing		
Approx. Crown Elevation Range (feet, NAVD88):	34	to	35
Approx. Levee Height Range (feet):	9	to	12
Approx. Crown Width Range (feet):	50	to	50
Approx. Landside Slope (H:V) Range:	3:1	to	5:1
Approx. Waterside Slope (H:V) Range:	1.5:1	to	2:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	Pond, RR X-ing		
Landside repairs associated with PL84-99:	Gravel berm at STA 799+50 to 806+00 (excluding RR X-ing)		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND
Landside Surface Layer:	Lean CLAY, approx. 5 to 15 feet thick near toe of levee
Soils below surface layer:	Approx. 20 feet of lean CLAY, over 60 feet of Poorly Graded SAND

Historic Performance

Seepage and landside boils (sandbag rings) were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
804+50	200-Year	E-61-B	No Positive Gradient	---	0.06	No	n/a
	HTOL	E-61-C	No Positive Gradient	---	0.08	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
804+50	SS - 200yr	29.0	E-61-D	---	2.4	n/a	n/a
	SS - HTOL	32.0	E-61-E	---	2.2	n/a	n/a
	RDD	19.0	E-61-D	1.6	---	n/a	n/a
	PS	6.0	E-61-F	1.3	1.8	n/a	n/a
	Post-EQ	6.0	E-61-G/H	1.1	2.5	1.1	4.6

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
N1	650	9	6	No Fill Anticipated	1,300

10.62 PROJECT REACH N2, STATION 813+05

REACH N2 - STA 813+05

Based on our evaluation, this reach meets the ULDC Criteria. Seismic deformations are not anticipated to degrade below 10-Year WSE +3 feet.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	806+00	to	825+00
Feature(s) at Upstream Station Limit:	Beginning of Phase II Seepage Berm		
Feature(s) at Downstream Station Limit:	End of landside residential		
Approx. Crown Elevation Range (feet, NAVD88):	34	to	35
Approx. Levee Height Range (feet):	12.5	to	20
Approx. Crown Width Range (feet):	12	to	18
Approx. Landside Slope (H:V) Range:	2.5:1	to	2.5:1
Approx. Waterside Slope (H:V) Range:	2:1	to	2.5:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	Residential/Oakwood Lake		
Landside repairs associated with PL84-99:	Gravel berm from 1806+00 to 1808+00		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Fully Penetrating Cutoff Wall		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Clayey SAND
Landside Surface Layer:	Lean CLAY, approx. 20 feet thick at toe of levee
Soils below surface layer:	Approx. 35 feet of SAND, over 30 feet of lean CLAY

Historic Performance

Seepage and landside boils during 1997 flood event were reported in ULE's 2014 SGDR Addendum. In the mid 2000's a 24 foot deep sheet pile wall was installed in levee crown between Station 822+00 to 825+50.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
813+05	200-Year	E-62-B	No Positive Gradient	---	---	No	n/a
	HTOL	E-62-C	No Positive Gradient	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
813+05	SS - 200yr	29.1	E-62-D/E	---	2.2	---	2.0
	SS - HTOL	32.0	E-62-F	---	2.1	---	2.0
	RDD	19.1	E-62-D/E	1.5	---	1.8	---
	PS	6.0	E-62-G/H	1.2	1.5	1.2	1.6
	Post-EQ	6.0	E-62-I/J	0.7	1.8	0.7	1.7

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
N2	1,900	11	8	No fill anticipated	6,200

10.63 PROJECT REACH N2, STATION 820+69

REACH N2 - STA 820+69

Based on our evaluation, this reach meets the ULDC Criteria. An Operations and Maintenance plan should be implemented for seismic deformations following the 200-year event.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	806+00	to	825+00
Feature(s) at Upstream Station Limit:	Beginning of Phase II Seepage Berm		
Feature(s) at Downstream Station Limit:	End of landside residential /RR Crossing		
Approx. Crown Elevation Range (feet, NAVD88):	34	to	35
Approx. Levee Height Range (feet):	12.5	to	20
Approx. Crown Width Range (feet):	12	to	18
Approx. Landside Slope (H:V) Range:	2.5:1	to	2.5:1
Approx. Waterside Slope (H:V) Range:	2:1	to	2.5:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	Residential/Oakwood lake		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Fully Penetrating Cutoff Wall		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Clayey SAND to Lean CLAY
Landside Surface Layer:	Lean CLAY, approx. 13 feet thick at toe of levee
Soils below surface layer:	Approx. 40 feet of SAND, over 12 feet of Lean CLAY

Historic Performance

Seepage and landside boils during 1997 flood event were reported in ULE's 2014 SGDR Addendum. In the mid 2000's a 24 foot deep sheet pile wall was installed in levee crown between Station 822+00 to 825+50.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
820+69	200-Year	E-63-B	No Positive Gradient	---	---	No	n/a
	HTOL	E-63-C	No Positive Gradient	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
820+69	SS - 200yr	29.1	E-63-D/E	--	2.2	---	2.4
	SS - HTOL	32.0	E-63-F	---	2.2	---	2.4
	RDD	19.1	E-63-D/E	1.6	---	1.6	---
	PS	6.0	E-63-G/H	1.4	1.5	1.4	1.6
	Post-EQ	6.0	E-63-I/J	0.6	2.0	0.6	1.6

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
N2	1,900	11	8	200	6,200

10.64 PROJECT REACH NPL, STATION -12+00

REACH NPL - STA (-)12+00

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	(-)35+00	to	00+00
Feature(s) at Upstream Station Limit:	South Manthey Road/power lines		
Feature(s) at Downstream Station Limit:	South Manthey Road (North)		
Approx. Crown Elevation Range (feet, NAVD88):	19	to	23
Approx. Levee Height Range (feet):	8	to	10.5
Approx. Crown Width Range (feet):	17	to	47
Approx. Landside Slope (H:V) Range:	2:1	to	4.5:1
Approx. Waterside Slope (H:V) Range:	1.7:1	to	3:1
Waterside Constraint(s):	Overhead power lines, waterway near William Moss Blvd.		
Landside Constraint(s):	STA -30+00 to -6+50 - agricultural land, STA 0+00 to -6+50 - residential development		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND
Landside Surface Layer:	Silty SAND, approx. 8 feet thick at levee toe
Soils below surface layer:	Interlayered SILT, Lean CLAY and SAND

Historic Performance

No recorded events in ULE's 2014 SGDR Addendum

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
825+86	200-Year	E-1-B	No Positive Gradient	---	0.01	No	n/a
	HTOL	E-1-C	No Positive Gradient	---	0.04	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
-12+00	SS - 200yr	14.5	E-1-D	---	3.2	n/a	n/a
	SS - HTOL	15.7	E-1-E	---	3.1	n/a	n/a
	RDD	10.8	E-1-D	1.6	---	n/a	n/a
	PS	2.9	E-1-F	1.3	2.6	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.65 PROJECT REACH O1, STATION 825+86

REACH O1 - STA 825+86

Based on our evaluation, this reach meets the ULDC Criteria. An Operations and Maintenance plan should be implemented for seismic deformations following the 200-year event.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Fails Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	825+00	to	835+00
Feature(s) at Upstream Station Limit:	Residential Lots and Street		
Feature(s) at Downstream Station Limit:	Begin LSRP P2 Berm		
Approx. Crown Elevation Range (feet, NAVD88):	34	to	35
Approx. Levee Height Range (feet):	14.5	to	16.5
Approx. Crown Width Range (feet):	32	to	42
Approx. Landside Slope (H:V) Range:	3:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.7:1	to	2.3:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	Seepage Berm and Residential		
Landside repairs associated with PL84-99:	Berm		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	Drained Seepage Berm		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Clayey SAND to SILT
Landside Surface Layer:	Lean CLAY, approx. 20 feet thick at levee toe, Approx. 4 feet of Silty SAND at Berm toe
Soils below surface layer:	Approx. 40 feet of silty SAND, over 12 feet of Lean CLAY

Historic Performance

Seepage, landside boils, and waterside wavewash erosion during 1997 flood event, along with longitudinal cracking in 1993 were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we identified potentially liquefiable soils within this Reach (Refer to Appendix E and Appendix F)

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
825+86	200-Year	E-64-B	No Positive Gradient	0.35	0.46	No	n/a
	HTOL	E-64-C	No Positive Gradient	0.47	0.59	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
825+86	SS - 200yr	30	E-64-D	---	2.4	n/a	n/a
	SS - HTOL	32.6	E-64-E	---	2.1	n/a	n/a
	RDD	18.7	E-64-D	1.1	---	n/a	n/a
	PS	10.4	E-64-F	1.0	1.6	n/a	n/a
	Post-EQ	10.4	E-64-G/H	0.6	1.7	0.6	1.8

Post 200-Year Seismic Event Restoration Estimates

Reach	Damage Length (feet)	Estimated Lateral Movement (feet)	Estimated Vertical Movement (feet)	Fill Volume (10 year WSE+3 feet Freeboard) (cubic yards)	Fill Volume (Fully Restored Levee Geometry) (cubic yards)
O1	745	14	10	1,500	3,900

10.66 PROJECT REACH O2A, STATION 844+81

REACH O2A - STA 844+81

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

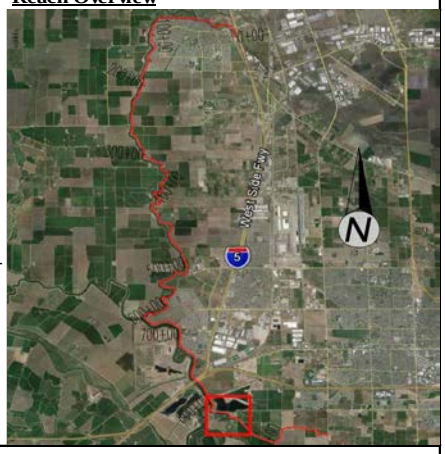
Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	835+00	to	849+65
Feature(s) at Upstream Station Limit:	End of LSRP P2 berm, Start of LSRP P3		
Feature(s) at Downstream Station Limit:	LSRP P2 Berm continuation		
Approx. Crown Elevation Range (feet, NAVD88):	34	to	35
Approx. Levee Height Range (feet):	13.5	to	16
Approx. Crown Width Range (feet):	35	to	37
Approx. Landside Slope (H:V) Range:	3:1	to	3:1
Approx. Waterside Slope (H:V) Range:	1.9:1	to	3:1
Waterside Constraint(s):	Waterside toe of slope at the waterway - no waterside bench.		
Landside Constraint(s):	Graded residential lots and streets		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	Drained Seepage Berm w/chimney drain		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview



Generalized Subsurface Conditions

Levee Prism Soils:	Clayey SAND and Lean CLAY
Landside Surface Layer:	FAT CLAY, approx. 10 to15 feet thick
Soils below surface layer:	Poorly Graded SAND

Historic Performance

Seepage, landside boils, and waterside wavewash erosion at Station 845+00 to 846+00 during 1997 flood event were reported in ULE's 2014 SGDR Addendum.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
844+81	200-Year	E-65-B	No Positive Gradient	No Positive Gradient	---	No	n/a
	HTOL	E-65-C	No Positive Gradient	No Positive Gradient	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
844+81	SS - 200yr	29.7	E-65-D	---	2.1	n/a	n/a
	SS - HTOL	32.7	E-65-E	---	2.1	n/a	n/a
	RDD	18.8	E-65-D	1.6	---	n/a	n/a
	PS	10.4	E-65-F	1.0	1.6	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.67 PROJECT REACH O2B, STATION 850+50

REACH O2B - STA 850+50

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	849+65	to	853+50
Feature(s) at Upstream Station Limit:	Approach fill for S. Williamson Road		
Feature(s) at Downstream Station Limit:	Phase II Berm improvement transition		
Approx. Crown Elevation Range (feet, NAVD88):	34	to	35
Approx. Levee Height Range (feet):	13.5	to	16
Approx. Crown Width Range (feet):	12	to	12
Approx. Landside Slope (H:V) Range:	3:1	to	3:1
Approx. Waterside Slope (H:V) Range:	2:1	to	2:1
Waterside Constraint(s):	Waterside bench/docks/pipe penetration		
Landside Constraint(s):	Trees and residental lots, retaining walls		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Drained Seepage Berm w/chimney drain		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND, SAND and SILT
Landside Surface Layer:	Lean CLAY and SILT, approx. 10-13 feet thick at toe of levee
Soils below surface layer:	Approx. 40 feet of SAND, over 15 feet of Lean CLAY

Historic Performance

No seepage or slope stabilty performance issues reported.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
850+50	200-Year	E-66-B	No Positive Gradient	0.19	---	No	n/a
	HTOL	E-66-C	No Positive Gradient	0.36	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
850+50	SS - 200yr	29.8	E-66-D	---	2.4	n/a	n/a
	SS - HTOL	32.8	E-66-E	---	2.4	n/a	n/a
	RDD	18.9	E-66-D	1.7	---	n/a	n/a
	PS	10.4	E-66-F	1.5	1.7	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.68 PROJECT REACH O2B, STATION 851+20

REACH O2B - STA 851+20

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	849+65	to	853+50
Feature(s) at Upstream Station Limit:	South Williamson Road		
Feature(s) at Downstream Station Limit:	End of LSRP Phase 2 / Start of Phase 3		
Approx. Crown Elevation Range (feet, NAVD88):	34	to	35
Approx. Levee Height Range (feet):	13.5	to	16
Approx. Crown Width Range (feet):	12	to	12
Approx. Landside Slope (H:V) Range:	3:1	to	3:1
Approx. Waterside Slope (H:V) Range:	2:1	to	2:1
Waterside Constraint(s):	Waterside bench/docks/pipe penetration		
Landside Constraint(s):	Trees and residental lots, retaining walls and Oakwood Shore lake 400 to 700 ft		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	Drained Seepage Berm w/chimney drain		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND, SAND and SILT
Landside Surface Layer:	Lean CLAY and SILT, approx. 10-13 feet thick at toe of levee
Soils below surface layer:	Approx. 40 feet of SAND, over 15 feet of Lean CLAY

Historic Performance

No seepage or slope stabilty performance issues reported.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
851+20	200-Year	E-67-B	No Positive Gradient	No Positive Gradient	---	No	n/a
	HTOL	E-67-C	No Positive Gradient	No Positive Gradient	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
851+20	SS - 200yr	29.8	E-67-D	---	2.5	n/a	n/a
	SS - HTOL	32.8	E-67-E	---	2.5	n/a	n/a
	RDD	18.9	E-67-D	1.8	---	n/a	n/a
	PS	10.4	E-67-F	1.5	1.8	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.69 PROJECT REACH P1, STATION 866+50

REACH P1 - STA 866+50

Based on our evaluation, this reach meets the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Meets Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	853+50	to	867+00
Feature(s) at Upstream Station Limit:	Approx. 450 feet south of irrigation ditch		
Feature(s) at Downstream Station Limit:	South Williamson Road		
Approx. Crown Elevation Range (feet, NAVD88):	34.5	to	35
Approx. Levee Height Range (feet):	11	to	15
Approx. Crown Width Range (feet):	15	to	20
Approx. Landside Slope (H:V) Range:	2.5:1	to	3.5:1
Approx. Waterside Slope (H:V) Range:	2.5:1	to	3.5:1
Waterside Constraint(s):	Dryland levee		
Landside Constraint(s):	Agricultural land		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: Lean CLAY, SILT, Clayey SAND and Silty SAND
Landside Surface Layer: SILT with sand, Sandy SILT and Lean CLAY
Soils below surface layer: Silty SAND and Poorly Graded SAND with SILT

Historic Performance

According to the DWR Walthall Slough GER Draft 2, wave wash erosion was recorded between approximate Stations 1853+50 to 1858+30 during a high-water event caused by a breach of an upstream levee in 1996-1997. Some underseepage was observed by KSN somewhere along the dryland levee during the same 1996-1997 high-water event along the dryland levee, however the locations of underseepage are unknown.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
866+50	200-Year	E-68-B	0.34	---	---	Yes**	2.5
	HTOL	E-68-C	0.44	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

**Exits onto fine grained slope, therefore we report "meets criteria" for through seepage.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
866+50	SS - 200yr	29.9	E-68-D	---	1.8	n/a	n/a
	SS - HTOL	32.8	E-68-E	---	1.7	n/a	n/a
	RDD	19.0	E-68-D	2.0	---	n/a	n/a
	PS	10.4	E-68-F	1.7	1.7	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.70 PROJECT REACH P2, STATION 876+00

REACH P2 - STA 876+00

Based on our evaluation, this reach does not meet the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	867+00	to	909+00
Feature(s) at Upstream Station Limit:	Agriculture road		
Feature(s) at Downstream Station Limit:	Approx. 450 feet south of irrigation ditch		
Approx. Crown Elevation Range (feet, NAVD88):	34	to	37
Approx. Levee Height Range (feet):	9	to	14
Approx. Crown Width Range (feet):	16.5	to	42
Approx. Landside Slope (H:V) Range:	2.5:1	to	5:1
Approx. Waterside Slope (H:V) Range:	2.5:1	to	5:1
Waterside Constraint(s):	Dryland levee, agricultural land		
Landside Constraint(s):	Agriculture land		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: Silty SAND, SILT, Lean CLAY
Landside Surface Layer: Lean Clay, SILT, Silty SAND and Clayey SAND
Soils below surface layer: Silty SAND over Poorly Graded SAND with SILT

Historic Performance

According to the DWR Walthall Slough GER Draft 2, some underseepage was observed by KSN somewhere along the dryland levee after an upstream levee breached during the 1996-1997 high-water event. The locations of underseepage are unknown however.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
876+00	200-Year	E-69-B	No Positive Gradient	---	0.05	Yes	2.6
	HTOL	E-69-C	No Positive Gradient	---	0.07	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
876+00	SS - 200yr	29.9	E-69-D	---	1.4	n/a	n/a
	SS - HTOL	32.9	E-69-E	---	1.2	n/a	n/a
	RDD	19.0	E-69-D	1.8	---	n/a	n/a
	PS	10.4	E-69-F	1.3	1.4	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.71 PROJECT REACH Q1, STATION 915+50

REACH Q1 - STA 915+50

Based on our evaluation, this reach does not meet the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	909+00	to	944+00
Feature(s) at Upstream Station Limit:	Agriculture road		
Feature(s) at Downstream Station Limit:	Agriculture road		
Approx. Crown Elevation Range (feet, NAVD88):	34	to	35
Approx. Levee Height Range (feet):	11	to	14
Approx. Crown Width Range (feet):	16	to	42
Approx. Landside Slope (H:V) Range:	4:1	to	7:1
Approx. Waterside Slope (H:V) Range:	3.5:1	to	7:1
Waterside Constraint(s):	Orchards		
Landside Constraint(s):	Agriculture		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND and Poorly Graded SAND with SILT
Landside Surface Layer:	Silty Sand, approx. 15 feet thick
Soils below surface layer:	SILT and CLAY

Historic Performance

According to the DWR Walthall Slough GER Draft 2, some underseepage was observed by KSN somewhere along the dryland levee after an upstream levee breached during the 1996-1997 high-water event. The locations of underseepage are unknown however.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
915+50	200-Year	E-70-B	0.34	---	---	Yes	2.5
	HTOL	E-70-C	0.40	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope. Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
915+50	SS - 200yr	30.4	E-70-D	---	2.3	n/a	n/a
	SS - HTOL	33.0	E-70-E	---	2.1	n/a	n/a
	RDD	19.5	E-70-D	3.4	---	n/a	n/a
	PS	10.4	E-70-F	2.6	2.1	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.72 PROJECT REACH R1, STATION 955+00

REACH R1 - STA 955+00

Based on our evaluation, this reach does not meet the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	944+00	to	959+00
Feature(s) at Upstream Station Limit:	Agriculture road		
Feature(s) at Downstream Station Limit:	Agriculture road		
Approx. Crown Elevation Range (feet, NAVD88):	32	to	35
Approx. Levee Height Range (feet):	9	to	13
Approx. Crown Width Range (feet):	13	to	23
Approx. Landside Slope (H:V) Range:	2.5:1	to	3.5:1
Approx. Waterside Slope (H:V) Range:	2.9:1	to	5:1
Waterside Constraint(s):	Dryland levee, orchard		
Landside Constraint(s):	None - agricultural land		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils: Silty SAND
Landside Surface Layer: Silty Sand, approx. 4.5 feet thick
Soils below surface layer: Silty CLAY, Poorly Graded SAND, and Silty SAND

Historic Performance

According to the DWR Walthall Slough GER Draft 2, some underseepage was observed by KSN after an upstream levee breached during the 1996-1997 high-water event. The locations of underseepage are unknown however.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
955+00	200-Year	E-71-B	0.49	---	---	Yes	2.8
	HTOL	E-71-C	0.64	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
955+00	SS - 200yr	30.4	E-71-D	---	1.7	n/a	n/a
	SS - HTOL	33.0	E-71-E	---	1.5	n/a	n/a
	RDD	19.5	E-71-D	3.0	---	n/a	n/a
	PS	10.4	E-71-F	2.2	1.8	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

10.73 PROJECT REACH S1, STATION 965+00

REACH S1 - STA 965+00

Based on our evaluation, this reach does not meet the ULDC Criteria.

Seepage Evaluation Summary

200-Year DWSEL, Under Seepage:	Meets Criteria
200-Year DWSEL, Through Seepage:	Fails Criteria
HTOL, Under Seepage:	Meets Criteria

Slope Stability Evaluation Summary

Steady State Seepage 200-Year DWSEL , LS:	Meets Criteria
Steady State Seepage HTOL , LS:	Meets Criteria
Rapid Drawdown, WS:	Meets Criteria
Seismic Slope Stability, WS:	Meets Criteria
Seismic Slope Stability, LS:	Meets Criteria

Reach Description

Station Limits:	959+00	to	972+00
Feature(s) at Upstream Station Limit:	90 degree bend in levee		
Feature(s) at Downstream Station Limit:	90 degree bend in levee		
Approx. Crown Elevation Range (feet, NAVD88):	34	to	35
Approx. Levee Height Range (feet):	9	to	11
Approx. Crown Width Range (feet):	12	to	14
Approx. Landside Slope (H:V) Range:	2.0:1	to	4.5:1
Approx. Waterside Slope (H:V) Range:	2.5:1	to	3.0:1
Waterside Constraint(s):	Orchard and ditch at waterside toe, 15 to 34 feet wide, 3 to 4 feet deep		
Landside Constraint(s):	None - agricultural land		
Landside repairs associated with PL84-99:	None		
Improvements associated with LSRP P1:	None		
Improvements associated with LSRP P2:	None		
Proposed Improvements associated with LSRP P3:	None		

Reach Overview

Generalized Subsurface Conditions

Levee Prism Soils:	Silty SAND
Landside Surface Layer:	Silty Sand, approx. 2 to 10 feet thick
Soils below surface layer:	Poorly Graded SAND and Lean CLAY

Historic Performance

According to the DWR Walthall Slough GER Draft 2, some underseepage was observed by KSN after an upstream levee breached during the 1996-1997 high-water event. The locations of underseepage are unknown however.

Liquefiable Soils

Based on our liquefaction assessment, we are not considering liquefiable soils in our slope stability analyses.

Seepage Analysis Results

Station	Water Surface	Figure	Exit Gradient			Through Seepage	Breakout Height (ft)*
			Levee Toe	Toe of Berm	Field		
965+00	200-Year	E-72-B	0.26	---	---	Yes	1
	HTOL	E-72-C	0.45	---	---	n/a	n/a

*Vertical distance from the toe of the levee (ground surface) to where the phreatic surface is calculated to daylight on the levee slope.
Through seepage under HTOL conditions are not part of this evaluation.

Slope Stability Analysis Results

Station	Case Analyzed	Water Surface (ft)	Figure	Factor of Safety (Circular)		Factor of Safety (Non-Circular)	
				Waterside	Landside	Waterside	Landside
965+00	SS - 200yr	30.5	E-72-D	---	1.5	n/a	n/a
	SS - HTOL	33.0	E-72-E	---	1.3	n/a	n/a
	RDD	19.5	E-72-D	1.9	---	n/a	n/a
	PS	10.4	E-72-F	1.7	1.5	n/a	n/a
	Post-EQ	n/a	n/a	n/a	n/a	n/a	n/a

11.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

This report presents geotechnical findings related to Reclamation District No. 17 Urban Levee Design Criteria. If changes occur in the conditions, layout, or scope of the levee system, we should be allowed to review this report and provide additional conclusions, if any. It is the responsibility of the owner to transmit the information of this report to the appropriate organizations or people involved in evaluation of the project. The conclusions contained in this report are solely professional opinions and are valid for a period of no more than 20 years from the date of applicable findings.

We strived to perform our professional services in accordance with generally accepted geotechnical engineering principles and practices currently employed in the area; no warranty is expressed or implied. There are risks of earth movement and property damages inherent in building with earth materials. We are unable to eliminate all risks or provide insurance; therefore, we are unable to guarantee or warrant the results of our services.

This report is based upon field and other conditions discovered at the time of report preparation. We developed this report with limited subsurface exploration data. We assumed that our subsurface exploration data is representative of the actual subsurface conditions across the site. Our services did not include excavation sloping or shoring, soil volume change factors, or a complete geohazard exploration. In addition, our geotechnical exploration did not include work to determine the existence of possible hazardous materials.

For explorations performed by ENGEO, we determined the lines designating the interface between layers on the exploration logs using visual observations. The transition between the materials may be abrupt or gradual. The exploration logs contain information concerning samples recovered, indications of the presence of various materials such as clay, sand, silt, rock, existing fill, etc., and observations of groundwater encountered. The field logs also contain our interpretation of the subsurface conditions between sample locations. Therefore, the logs contain both factual and interpretative information. Our recommendations are based on the contents of the final logs, which represent our interpretation of the field logs.

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13.0 ACRONYMS AND ABBREVIATIONS

BOSC	Board of Senior Consultants
CVFPB	Central Valley Flood Protection Board
DWR	California Department of Water Resources
DWSE	Design Water Surface Elevation
FIRM	Flood Insurance Rate Map
GER	Geotechnical Evaluation Report
HTOL	Hydraulic Top of Levee
IEPR	Independent External Peer Review
LSRP	Levee Seepage Repair Program
LSRTP	Lower San Joaquin River and Tributaries Project
P1GDR	Phase 1 Geotechnical Data Report
P1GER	Phase 1 Geotechnical Evaluation Report
Post-EQ	Post Earthquake
PS	Pseudo Static
QA/QC	Quality Assurance / Quality Control
RD 17	Reclamation District 17
RDD	Rapid Drawdown
SAR	Safety Assurance Review
SGDR	Supplemental Geotechnical Data Report
SHANSEP	Stress History and Normalized Soil Engineering Properties
SS	Steady State
STA	Stations
ULDC	Urban Levee Design Criteria
ULE	Urban Levee Evaluation
ULOP	Urban Level of Flood Protection Criteria
USACE	U.S. Army Corps of Engineers

FIGURES

Figure 1 – Vicinity Map and Explanation
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Figures 3A - 3I – Under Seepage Evaluation Summary
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Figures 5A - 5I – Slope Stability Evaluation Summary
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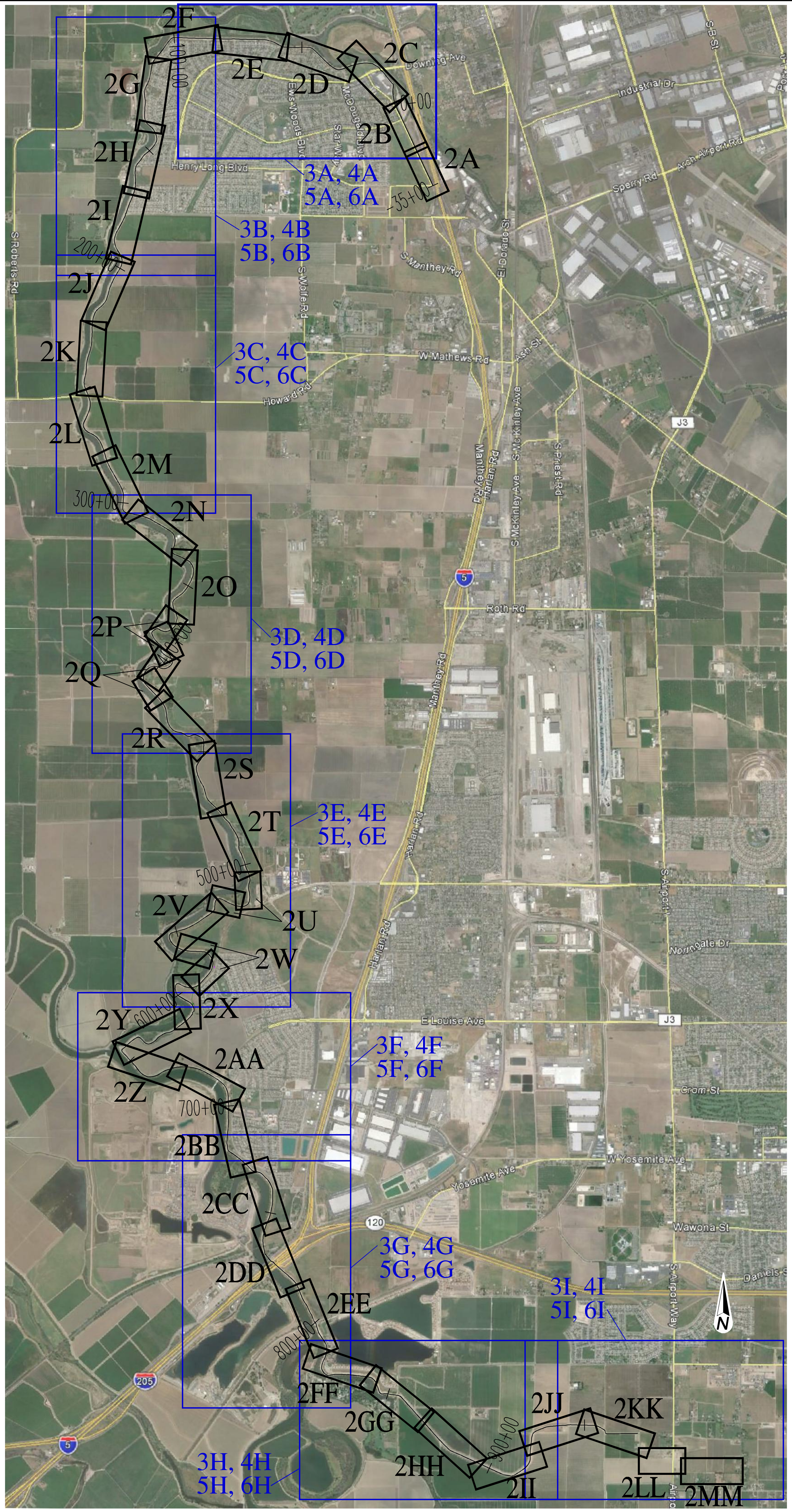
Figures 7A - 7G – Water Surface Profiles

FIGURES



VICINITY MAP - FIGURE LAYOUT

ULDC EVALUATION - RECLAMATION DISTRICT NO. 17

SAN JOAQUIN COUNTY, CALIFORNIA

FIGURE INDEX

FIGURE NUMBER	TITLE
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3A-3I	UNDER SEEPAGE EVALUATION PLAN
4A-4I	THROUGH SEEPAGE EVALUATION PLAN
5A-5I	SLOPE STABILITY EVALUATION PLAN
6A-6I	SEISMIC EVALUATION PLAN
7A-7G	WATER SURFACE PROFILES

EXPLANATION

ALL LOCATIONS ARE APPROXIMATE

Symbol	Description
WR0017_177B	BORING (ULE, 2006-2013)
B-5	SOIL BORING (VALLENTYNE PROPERTY, KLEINFELDER, 2003)
K-B-103	BORING (TRAILS OF MANTECA, TERRASEARCH, 2002)
5-B-14	BORING (RD17, KLEINFELDER, 1986-1989)
1-B8	SOIL BORING (RD17, ENGEO, 2010)
4-B-6	SOIL BORING (MARKETPLACE AT WESTON RANCH, ENGEO, 2009)
3-B-105	SOIL BORING (RD17, ENGEO, 2009)
CS2-B3	SOIL BORING (RD17, ENGEO, 2008-2009)
2-B-16	SOIL BORING (RD17, ENGEO, 2007)
B-3	SOIL BORING (RIVER RUN LEVEE EVALUATION, ENGEO, 2006)
1-B-15	SOIL BORING (LAND PARK WATER TANK, ENGEO, 2006)
B-4	SOIL BORING (RIVER RUN DEVELOPMENT, ENGEO, 2005)
B-10	SOIL BORING (SOUTH LATHROP SPECIFIC PLAN, ENGEO, 2004)
B-33	SOIL BORING (CENTRAL LATHROP SPECIFIC PLAN, ENGEO, 2004)
B-8	SOIL BORING (TERRY & HARRIS PROPERTY, KLEINFELDER, 2003)
B-7	SOIL BORING (LUCKEY & MCKEE PROPERTY, KLEINFELDER, 2003)
B-4	SOIL BORING (MCKEE PROPERTY, KLEINFELDER, 2003)
B-5	SOIL BORING (LATHROP ASSOCIATES, KLEINFELDER, 2003)
WR0017_004H	HAND AUGER BORING (ULE, 2006-2013)
CPT-107	CONE PENETRATION TEST (TERRY & HARRIS PROPERTY, KLEINFELDER, 2003)
1-B3	CONE PENETRATION TEST (CERRI PROPERTY, 2013)
WR0017_097C	CONE PENETRATION TEST (ULE, 2006-2013)
5-CPT-31	CONE PENETRATION TEST (RD17, ENGEO, 2010)
4-CPT-31	CONE PENETRATION TEST (RD17, ENGEO, 2009)
3-CPT-118	CONE PENETRATION TEST (RD17, ENGEO, 2008-2009)
2-CPT-40	CONE PENETRATION TEST (RIVER RUN LEVEE EVALUATION, ENGEO, 2006)
105C	CONE PENETRATION TEST (DWR/ULE, FUGRO, 2006-2007)
1-CPT-82	CONE PENETRATION TEST (RIVER RUN DEVELOPMENT, ENGEO, 2005)
CPT-5	CONE PENETRATION TEST (LUCKEY & MCKEE PROPERTY, KLEINFELDER, 2003)
WR0017_023M	MONITORING WELL (ULE, 2006-2013)
MW-S4	MONITORING WELL (SOUTH LATHROP SPECIFIC PLAN, ENGEO, 2004)
MW-10	MONITORING WELL (CENTRAL LATHROP SPECIFIC PLAN, ENGEO, 2004)
MW-8	MONITORING WELL (TERRY PROPERTY, KLEINFELDER, 2003)
MW-6	MONITORING WELL (MCKEE PROPERTY, KLEINFELDER, 2003)
MW-3	MONITORING WELL (TRAILS OF MANTECA, TERRA SEARCH, 2002)
1-CPT2	TEST PIT (CERRI PROPERTY, 2013)
WR0017_TP-15	TEST PIT (ULE, 2006-2013)
TP-4	TEST PIT (CENTRAL LATHROP SPECIFIC PLAN, ENGEO, 2004)
TP-6	TEST PIT (TERRY PROPERTY, KLEINFELDER, 2003)
REACH A	REACH DESIGNATION
A B	REACH END AND START POINT, LEFT (END) RIGHT (BEGIN)
164+60	CROSS SECTION LOCATION
5+00	LEVEE ALIGNMENT AND STATIONING
(green line)	UNDER SEEPAGE WITHIN REACH - MEETS CRITERIA
(red line)	UNDER SEEPAGE WITHIN REACH - DOES NOT MEET CRITERIA
(grey line)	UNDER SEEPAGE WITHIN REACH - NOT CALCULATED
(green fill)	PHASE 1 IMPROVEMENT PROJECT
(blue fill)	PHASE 3 IMPROVEMENT PROJECT
SP, SM-SP, SC-SP	POORLY GRADED SAND TO SILTY OR CLAYEY SAND
SM	SILTY SAND
SC-SM	SILTY SAND TO CLAYEY SAND
SM-ML	SILTY SAND TO SILT
ML	SILT, CLAYEY SILT, AND SANDY SILT
CL-ML	SILTY CLAY TO CLAYEY SILT WITH LOW PLASTICITY
CL	SILTY TO SANDY CLAY WITH LOW TO HIGH PLASTICITY
CH	SILTY TO SANDY CLAY WITH HIGH PLASTICITY

KEY TO BORING LOGS

MAJOR TYPES			DESCRIPTION
COARSE-GRAINED SOILS MORE THAN HALF OF MAT'L LARGER THAN #200 SIEVE	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS WITH LESS THAN 5% FINES	GW - Well graded gravels or gravel-sand mixtures GP - Poorly graded gravels or gravel-sand mixtures
		GRAVELS WITH OVER 12 % FINES	GM - Silty gravels, gravel-sand and silt mixtures GC - Clayey gravels, gravel-sand and clay mixtures
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LESS THAN 5% FINES	SW - Well graded sands, or gravelly sand mixtures SP - Poorly graded sands or gravelly sand mixtures
		SANDS WITH OVER 12 % FINES	SM - Silty sand, sand-silt mixtures SC - Clayey sand, sand-clay mixtures
FINE-GRAINED SOILS MORE THAN HALF OF MAT'L SMALLER THAN #200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50 % OR LESS		ML - Inorganic silt with low to medium plasticity CL - Inorganic clay with low to medium plasticity OL - Low plasticity organic silts and clays
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50 %		MH - Elastic silt with high plasticity CH - Fat clay with high plasticity OH - Highly plastic organic silts and clays
	HIGHLY ORGANIC SOILS		PT - Peat and other highly organic soils

For fine-grained soils with 15 to 29% retained on the #200 sieve, the words "with sand" or "with gravel" (whichever is predominant) are added to the group name.

For fine-grained soil with > 30% retained on the #200 sieve, the words "sandy" or "gravelly" (whichever is predominant) are added to the group name.

GRAIN SIZES

U.S. STANDARD SERIES SIEVE SIZE: 200, 40, 10, 4 — CLEAR SQUARE SIEVE OPENINGS: 3/4", 3", 12"

SILTS AND CLAYS	SAND FINE	SAND MEDIUM	SAND COARSE	GRAVEL FINE	GRAVEL COARSE	COBBLES	BOULDERS

RELATIVE DENSITY

SANDS AND GRAVELS	BLOWS/FOOT (S.P.T.)
VERY LOOSE	0-4
LOOSE	4-10
MEDIUM DENSE	10-30
DENSE	30-50
VERY DENSE	OVER 50

CONSISTENCY

SILTS AND CLAYS	STRENGTH*
VERY SOFT	0-1/4
SOFT	1/4-1/2
MEDIUM STIFF	1/2-1
STIFF	1-2
VERY STIFF	2-4
HARD	OVER 4

MOISTURE CONDITION

DRY	Dusty, dry to touch
MOIST	Damp but no visible water
WET	Visible freewater

SAMPLER SYMBOLS

- Modified California (3" O.D.) sampler
- California (2.5" O.D.) sampler
- S.P.T. - Split spoon sampler
- Shelby Tube
- Continuous Core
- Bag Samples
- Grab Samples
- NR No Recovery

LINE TYPES

- Solid - Layer Break
- Dashed - Gradational or approximate layer break

GROUND-WATER SYMBOLS

- Groundwater level during drilling
- Stabilized groundwater level

(S.P.T.) Number of blows of 140 lb. hammer falling 30" to drive a 2-inch O.D. (1-3/8 inch I.D.) sampler

* Unconfined compressive strength in tons/sq. ft., asterisk on log means determined by pocket penetrometer

CONSISTENCY OF COHESIVE SOILS			
Descriptor	**Pocket Penetrometer (tsf)**	**Torvane (tsf)**	**Field Approximation**
Very Soft	< 0.25	< 0.12	Easily penetrated several inches by fist
Soft	0.25 - 0.50	0.12 - 0.25	Easily penetrated several inches by thumb
Medium Stiff	0.50 - 1.0	0.25 - 0.50	Can be penetrated several inches by thumb with moderate effort
Stiff	1.0 - 2.0	0.50 - 1.0	Readily indented by thumb but penetrated only with great effort
Very Stiff	2.0 - 4.0	1.0 - 2.0	Readily indented by thumbnail
Hard	> 4.0	> 2.0	Indented by thumbnail with difficulty

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

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

PERCENT OR PROPORTION OF SOILS	
Descriptor	**Criteria**
Trace	Particles are present but estimated to be less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

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

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

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

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

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

CEMENTATION	
Descriptor	**Criteria**
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure.

ENGEO — Expect Excellence

VICINITY MAP AND EXPLANATION ULDC EVALUATION - RECLAMATION DISTRICT NO. 17 SAN JOAQUIN COUNTY, CALIFORNIA	PROJECT NO.: 5747.005.000 SCALE: AS SHOWN DRAWN BY: MES CHECKED BY: JJT	FIGURE NO. 1

ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION

PLAN
SCALE: 1"=100'

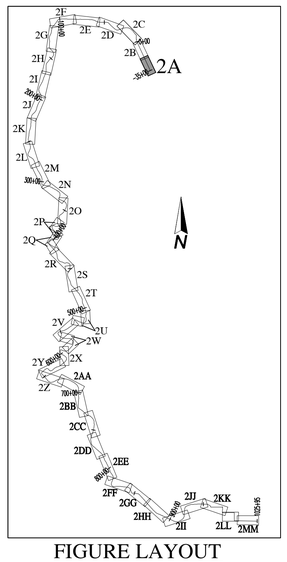
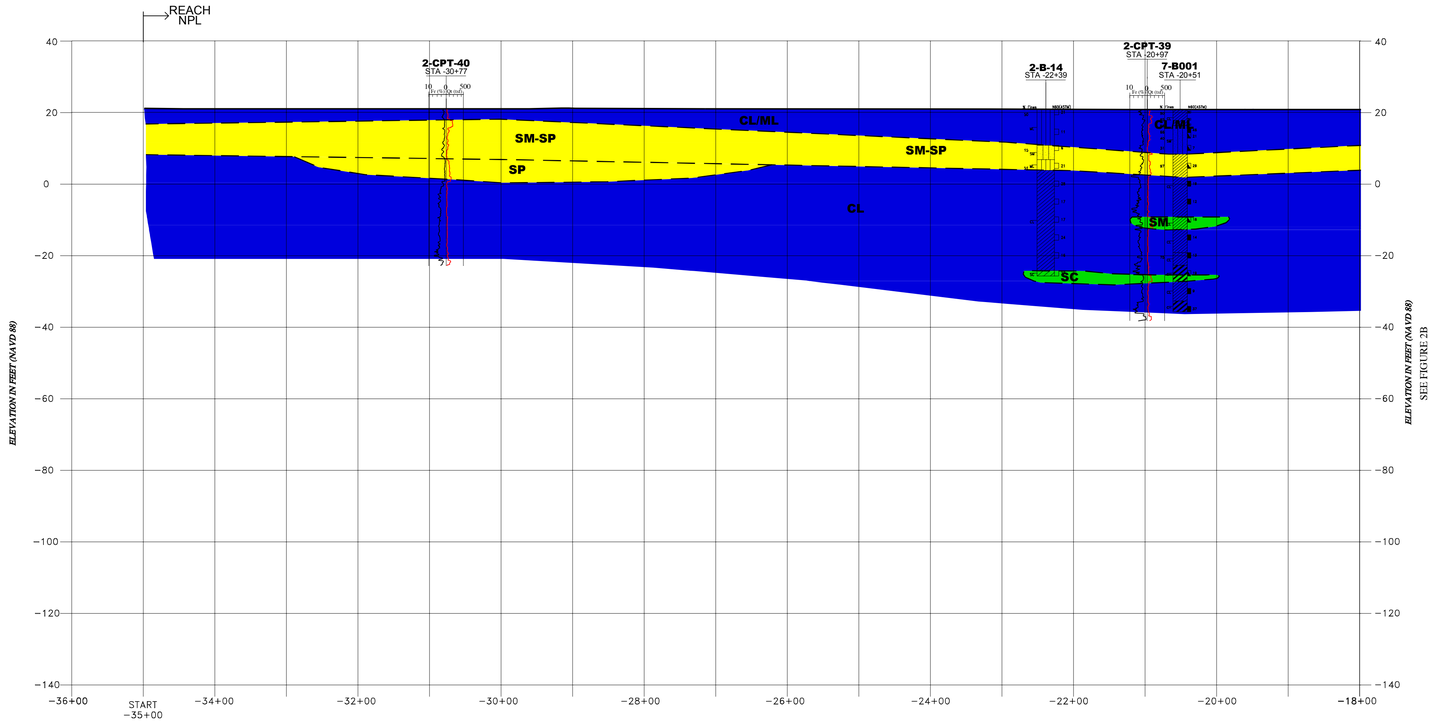


FIGURE LAYOUT
NO SCALE



PROFILE
SCALE: H:1"=100', V:1"=20'

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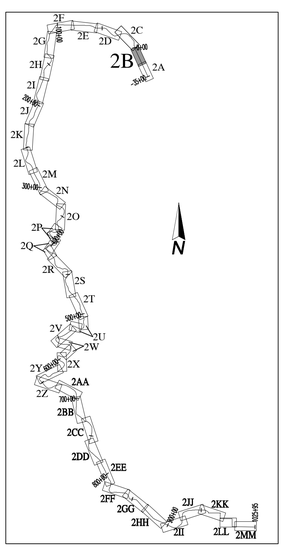
PLAN AND PROFILE - STATION -36+00 TO -18+00
ULDC EVALUATION - RECLAMATION DISTRICT NO. 17
SAN JOAQUIN COUNTY, CALIFORNIA

PROJECT NO:	5747.005.000		FIGURE NO. 2A
SCALE:	AS SHOWN		
DRAWN BY:	MES	CHECKED BY: JJT	

ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION

PLAN
SCALE: 1"=100'



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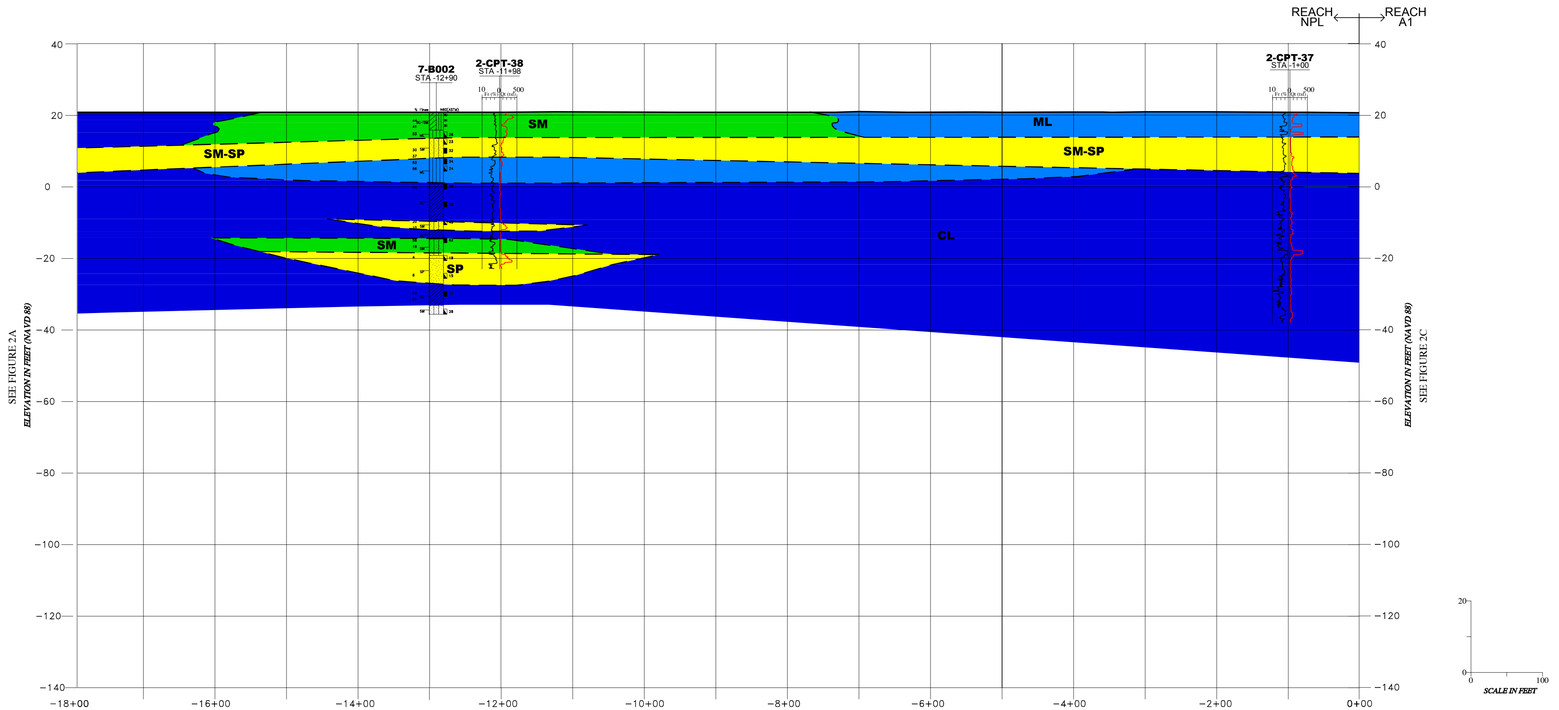

PROFILE
SCALE: H:1"=100', V:1"=20'

ENGEO Expect Excellence

PLAN AND PROFILE - STATION -18+00 TO 0+00
ULDC EVALUATION - RECLAMATION DISTRICT NO. 17
SAN JOAQUIN COUNTY, CALIFORNIA

PROJECT NO: 5747.005.000
SCALE: AS SHOWN
DRAWN BY: MES
CHECKED BY: JJT

FIGURE NO. 2B

ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION

PLAN
SCALE: 1"=100'

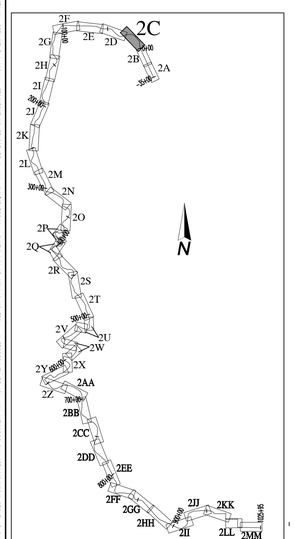

FIGURE LAYOUT
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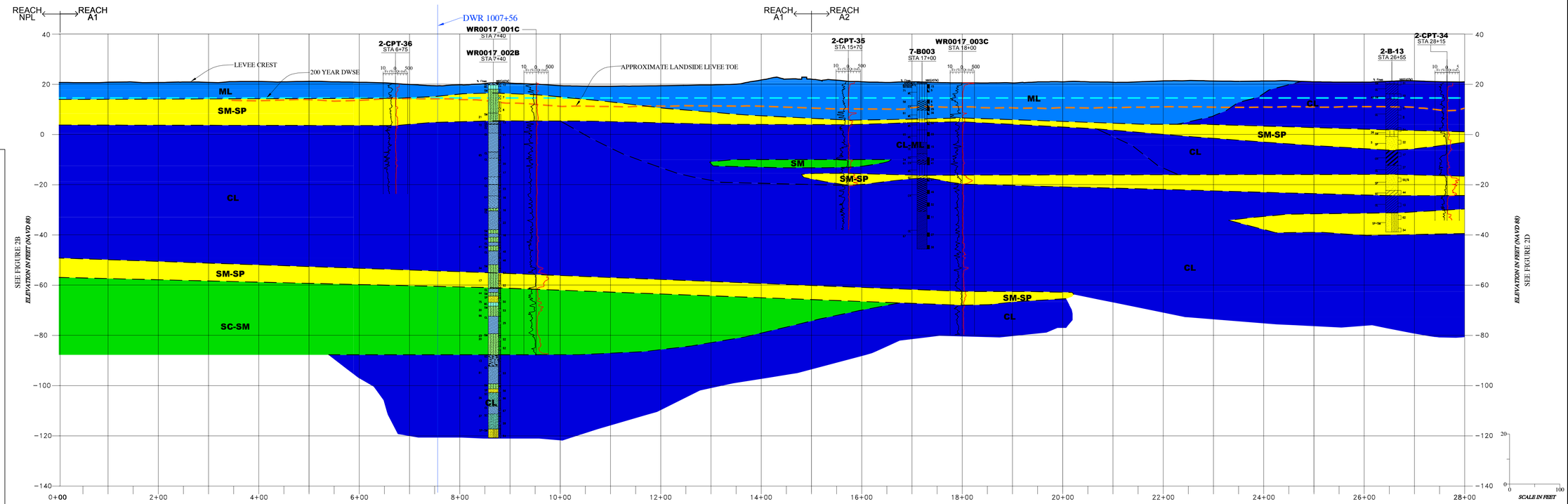

PROFILE
SCALE: H:1"=100', V:1"=20'

ENGEO Expect Excellence

PLAN AND PROFILE - STATION 0+00 TO 28+00
ULDC EVALUATION - RECLAMATION DISTRICT NO. 17
SAN JOAQUIN COUNTY, CALIFORNIA

PROJECT NO.: 5747.005.000
SCALE: AS SHOWN
DRAWN BY: MES
CHECKED BY: JJT
FIGURE NO. 2C
ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION

PLAN
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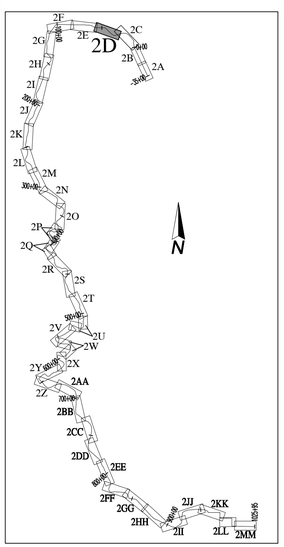

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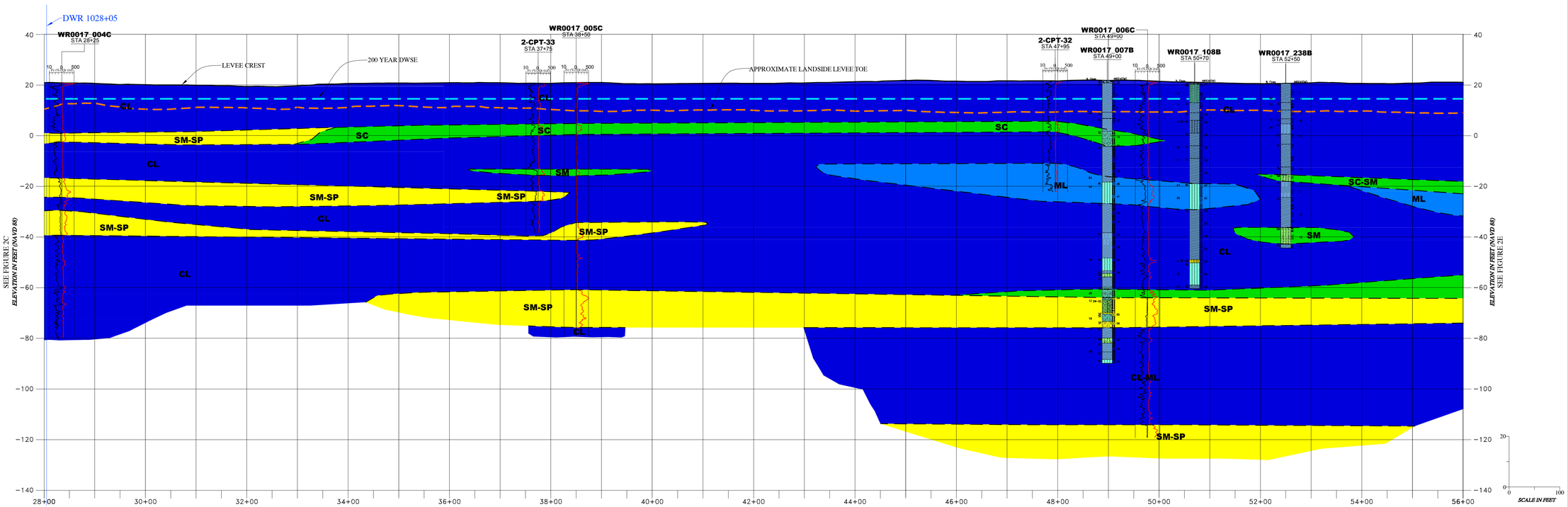

PROFILE
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ENGEO Expect Excellence

PLAN AND PROFILE - STATION 28+00 TO 56+00
ULDC EVALUATION - RECLAMATION DISTRICT NO. 17
SAN JOAQUIN COUNTY, CALIFORNIA

PROJECT NO: 5747.005.000
SCALE: AS SHOWN
DRAWN BY: MES
CHECKED BY: JJT
FIGURE NO. 2D
ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION

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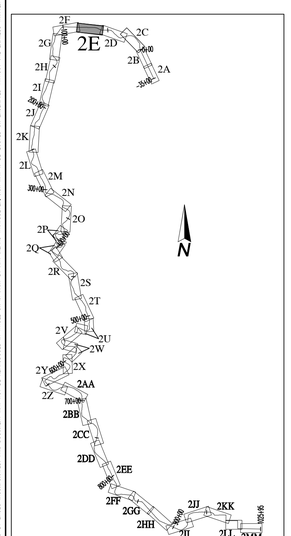

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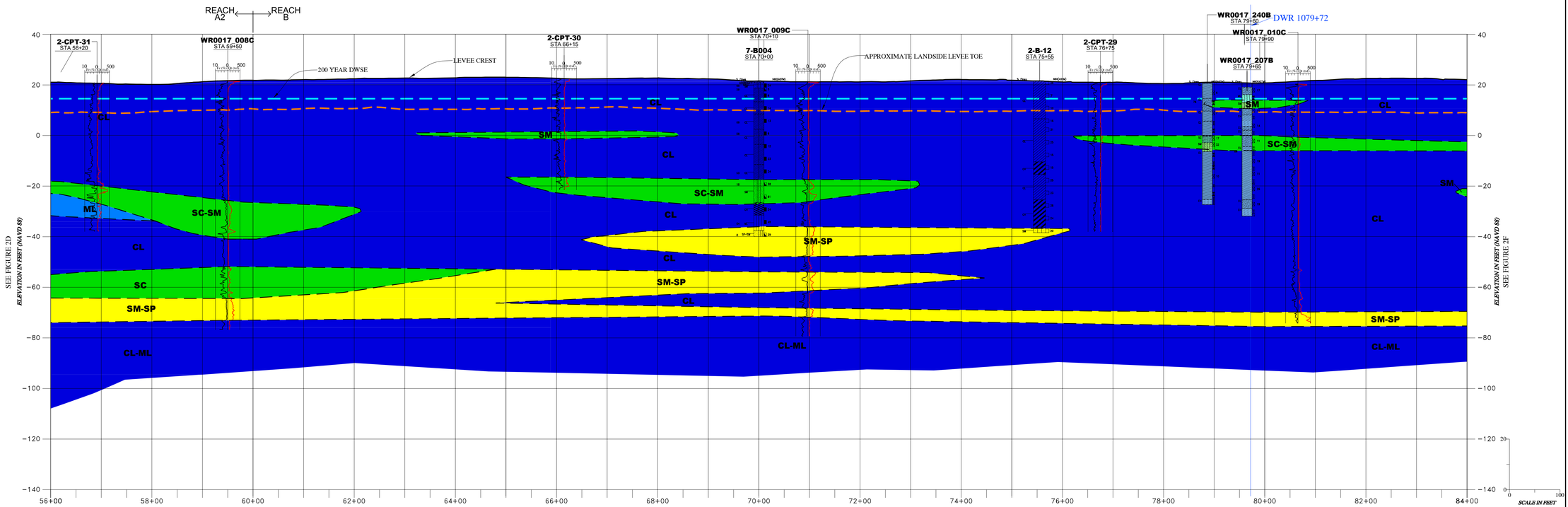

PROFILE
SCALE: H:1"=100', V:1"=20'

ENGEO Expect Excellence	PLAN AND PROFILE - STATION 56+00 TO 84+00 ULDC EVALUATION - RECLAMATION DISTRICT NO. 17 SAN JOAQUIN COUNTY, CALIFORNIA	PROJECT NO.: 5747.005.000 SCALE: AS SHOWN DRAWN BY: MES / CHECKED BY: JJT	FIGURE NO. 2E

ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION

PLAN
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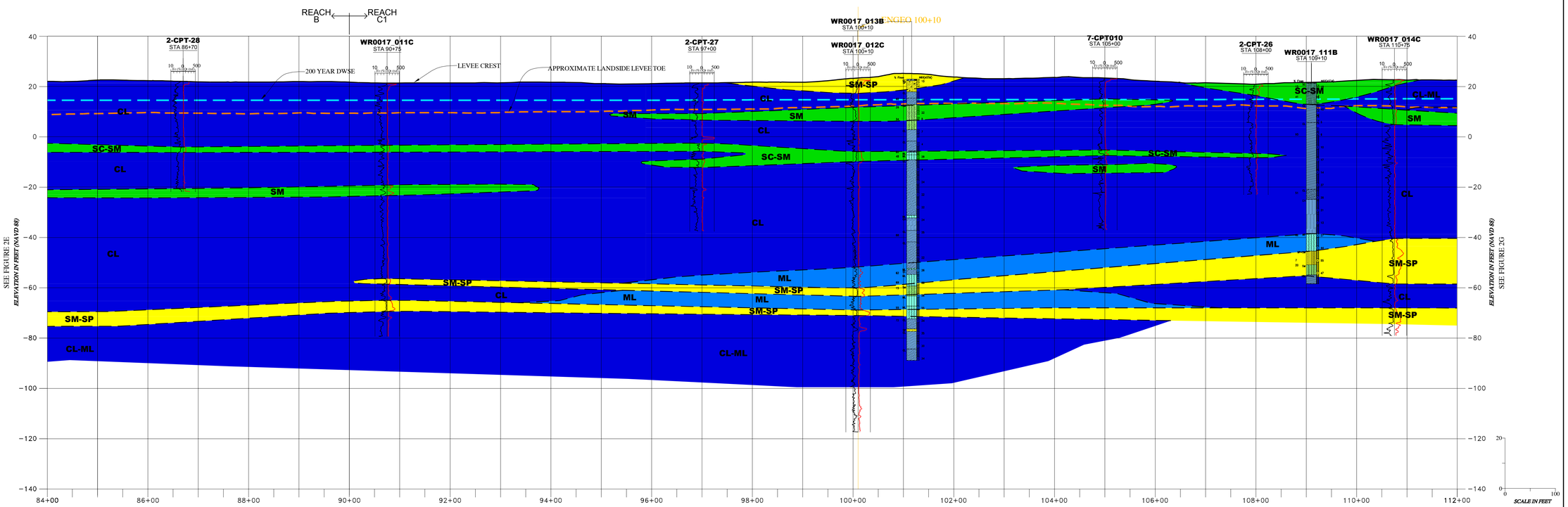

PROFILE
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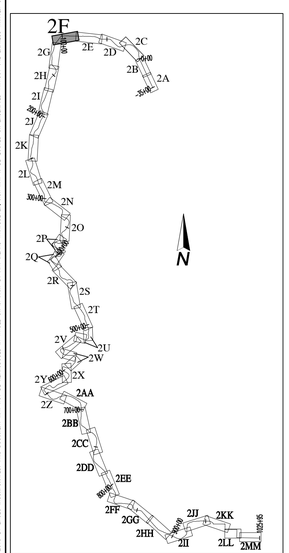

FIGURE LAYOUT
NO SCALE

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PLAN AND PROFILE - STATION 84+00 TO 112+00
ULDC EVALUATION - RECLAMATION DISTRICT NO. 17
SAN JOAQUIN COUNTY, CALIFORNIA

PROJECT NO:	5747.005.000	FIGURE NO.	2F
SCALE:	AS SHOWN		
DRAWN BY:	MES	CHECKED BY:	JJT

ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION

PLAN
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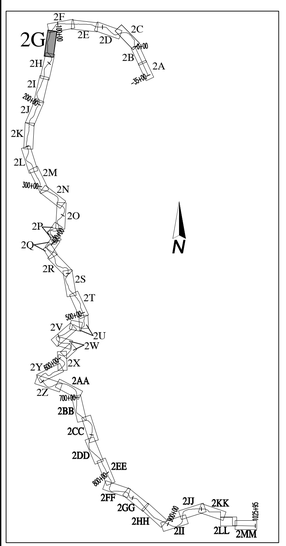

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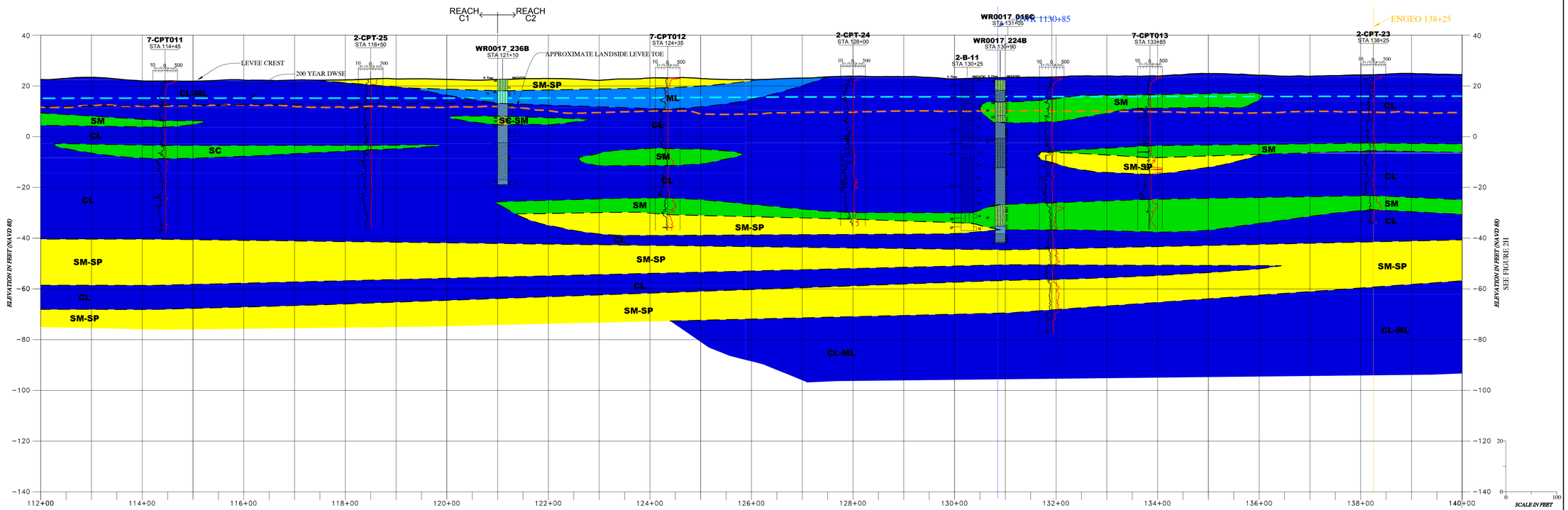


PROFILE
SCALE: H:1"=100', V:1"=20'

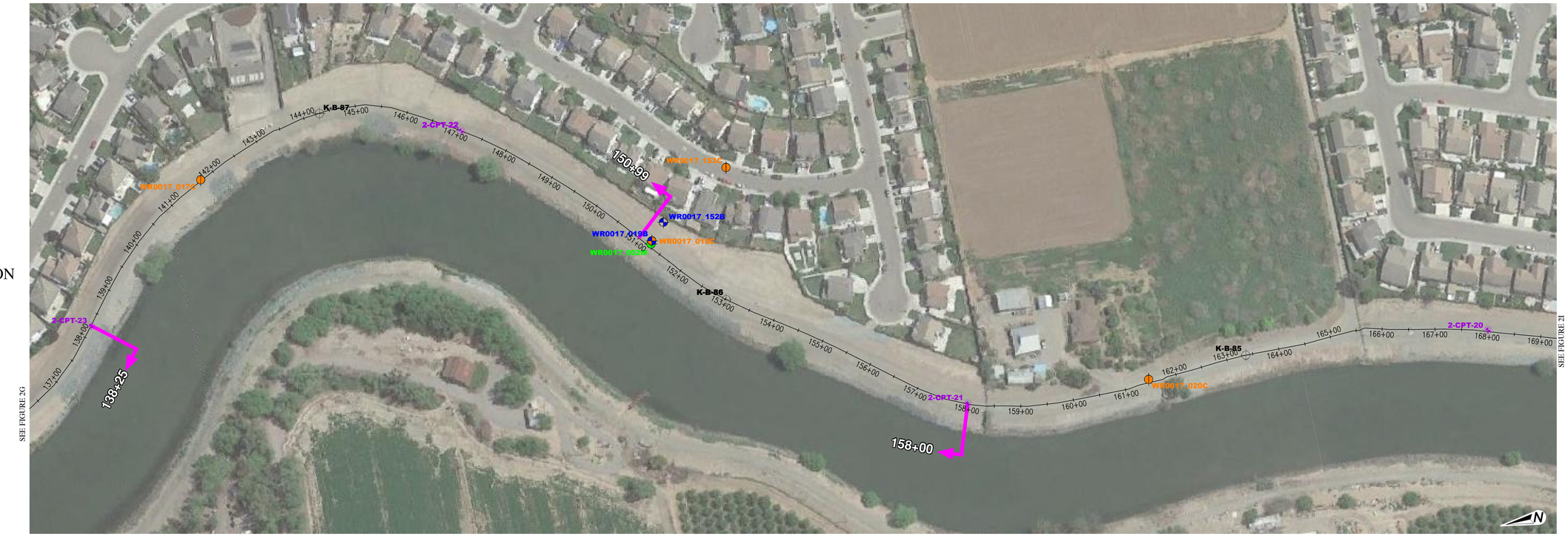
ENGEO Expect Excellence

PLAN AND PROFILE - STATION 112+00 TO 140+00
ULDC EVALUATION - RECLAMATION DISTRICT NO. 17
SAN JOAQUIN COUNTY, CALIFORNIA

PROJECT NO.: 5747.005.000	FIGURE NO. 2G
SCALE: AS SHOWN	
DRAWN BY: MES	CHECKED BY: JJT

ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION



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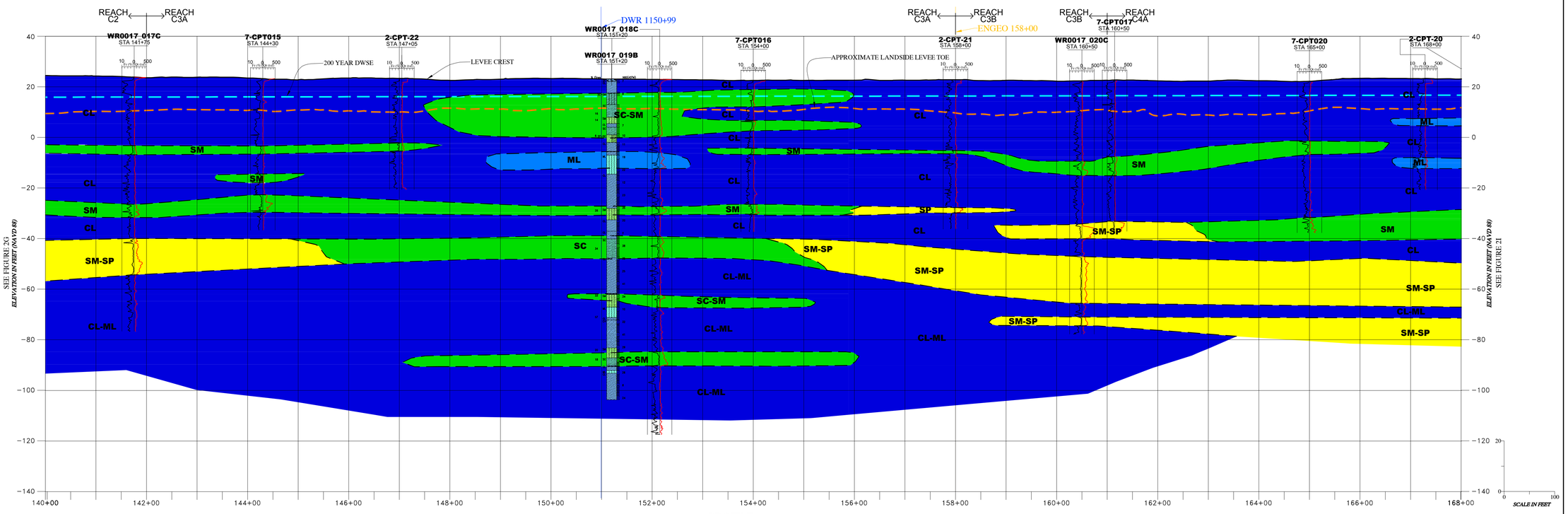

PROFILE
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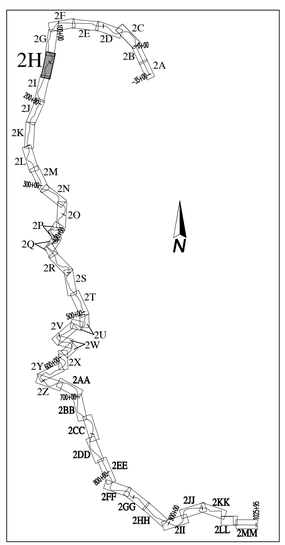
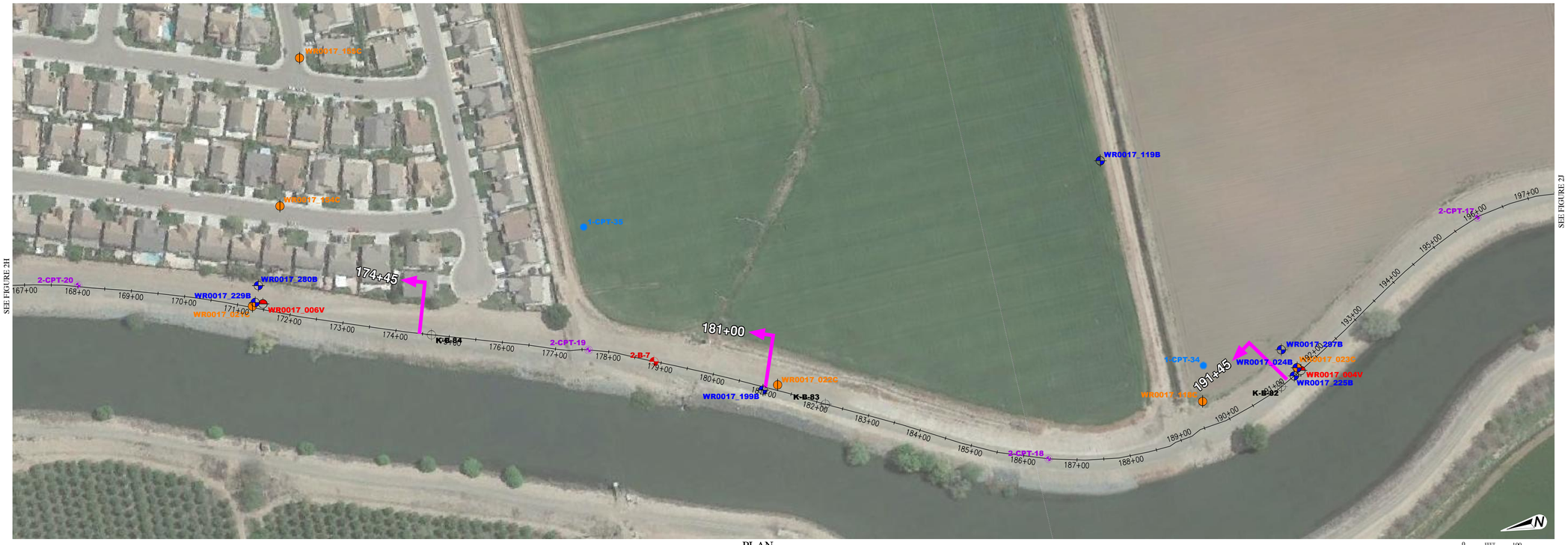


FIGURE LAYOUT
NO SCALE

ENGEO Expect Excellence	PLAN AND PROFILE - STATION 140+00 TO 168+00 ULDC EVALUATION - RECLAMATION DISTRICT NO. 17 SAN JOAQUIN COUNTY, CALIFORNIA	PROJECT NO: 5747.005.000 SCALE: AS SHOWN DRAWN BY: MES / CHECKED BY: JJT	FIGURE NO. 2H

ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION



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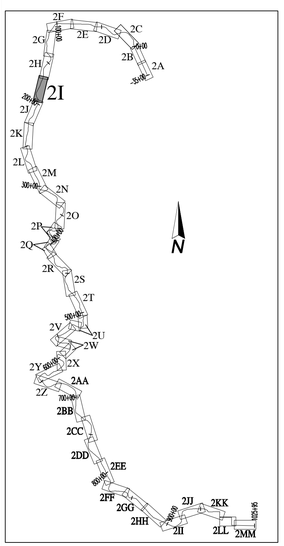

FIGURE LAYOUT
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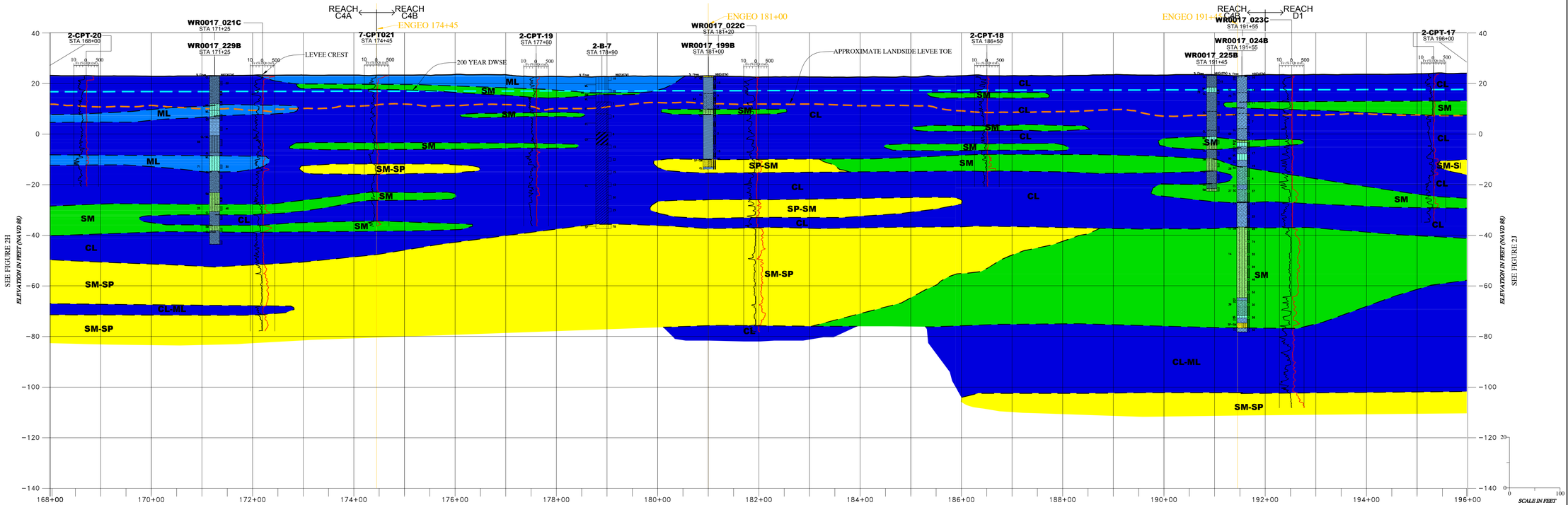


PROFILE
SCALE: H:1"=100', V:1"=20'

ENGEO Expect Excellence

PLAN AND PROFILE - STATION 168+00 TO 196+00
ULDC EVALUATION - RECLAMATION DISTRICT NO. 17
SAN JOAQUIN COUNTY, CALIFORNIA

PROJECT NO.: 5747.005.000
SCALE: AS SHOWN
DRAWN BY: MES
CHECKED BY: JJT
FIGURE NO. 2I
ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION

PLAN
SCALE: 1"=100'

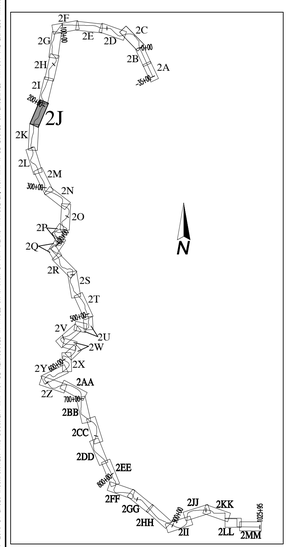
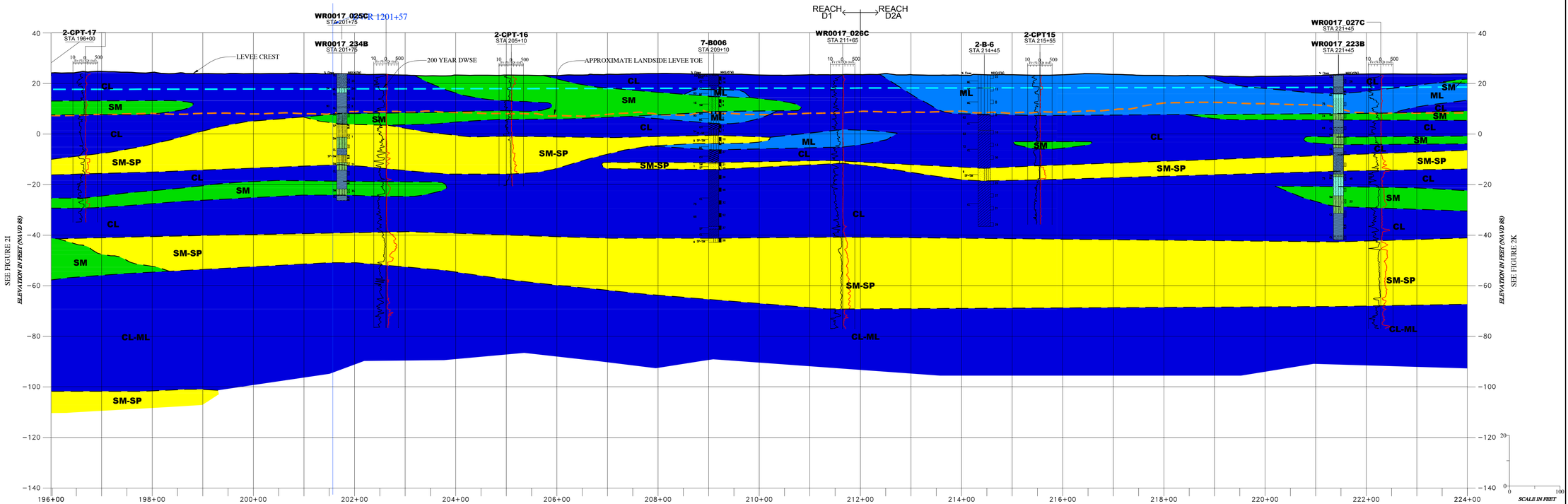


FIGURE LAYOUT
NO SCALE



PROFILE
SCALE: H:1"=100', V:1"=20'

ENGEO Expect Excellence

PLAN AND PROFILE - STATION 196+00 TO 224+00
ULDC EVALUATION - RECLAMATION DISTRICT NO. 17
SAN JOAQUIN COUNTY, CALIFORNIA

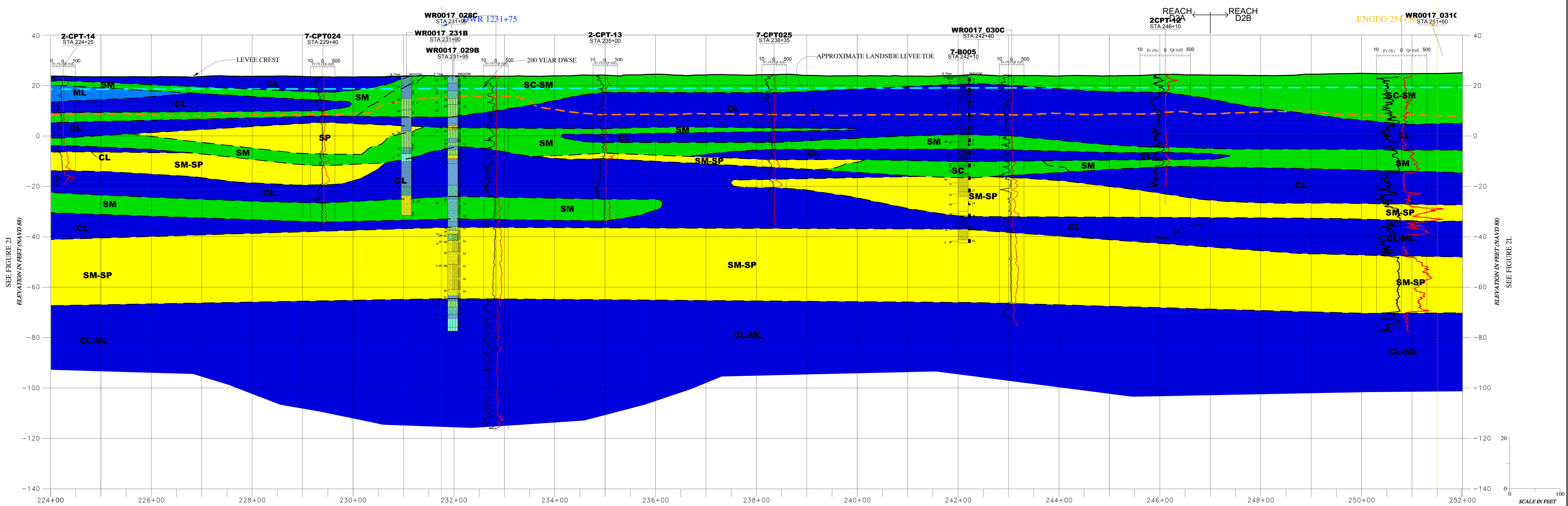
PROJECT NO.: 5747.005.000
SCALE: AS SHOWN
DRAWN BY: MES
CHECKED BY: JJT

FIGURE NO. 2J

ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION

PLAN
SCALE: 1"=100'



PROFILE
SCALE: H:1"=100', V:1"=20'

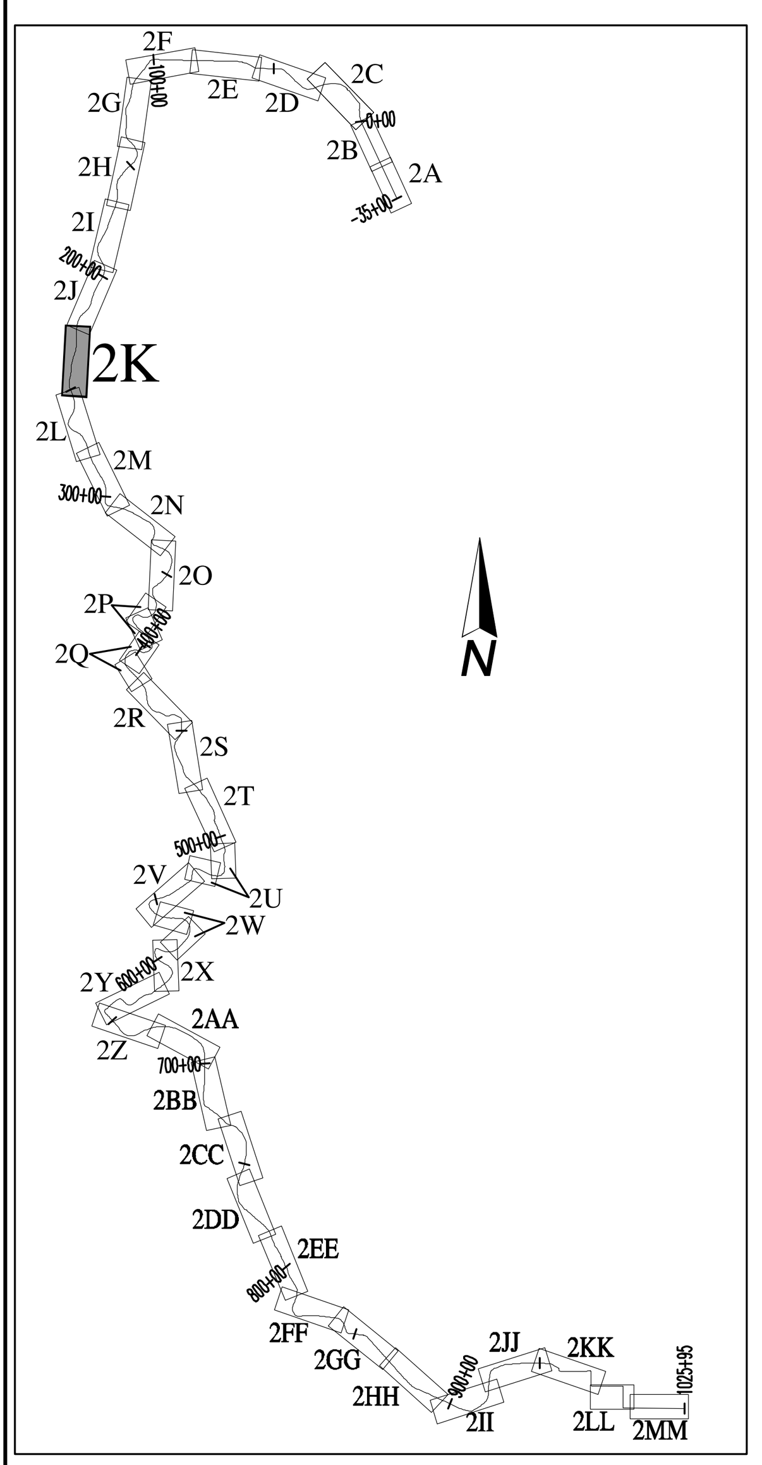


FIGURE LAYOUT
NO SCALE

ENGEO
Expect Excellence

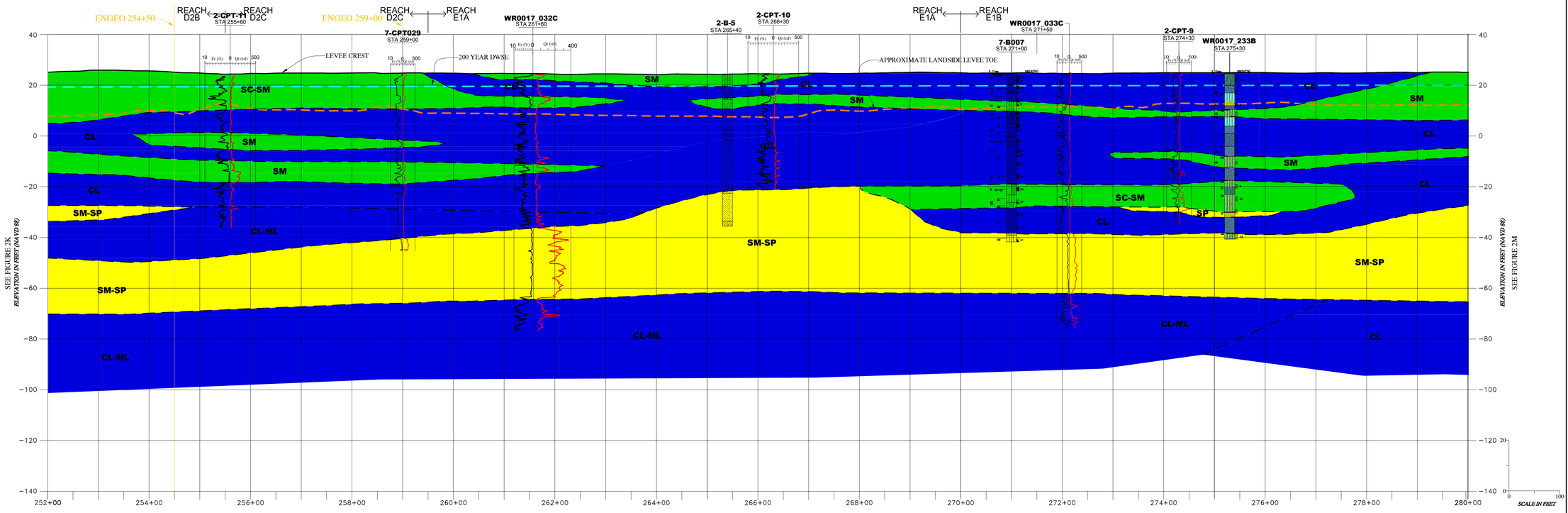
PLAN AND PROFILE - STATION 224+00 TO 252+00
ULDC EVALUATION - RECLAMATION DISTRICT NO. 17
SAN JOAQUIN COUNTY, CALIFORNIA

PROJECT NO.: 5747.005.000	FIGURE NO. 2K
SCALE: AS SHOWN	
DRAWN BY: MES	CHECKED BY: JJT

ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION

PLAN
SCALE: 1"=100'



PROFILE
SCALE: H:1"=100', V:1"=20'

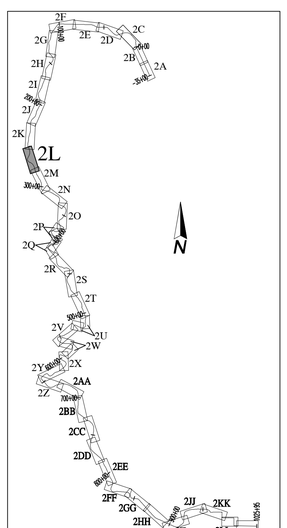


FIGURE LAYOUT
NO SCALE

ENGEO Expect Excellence

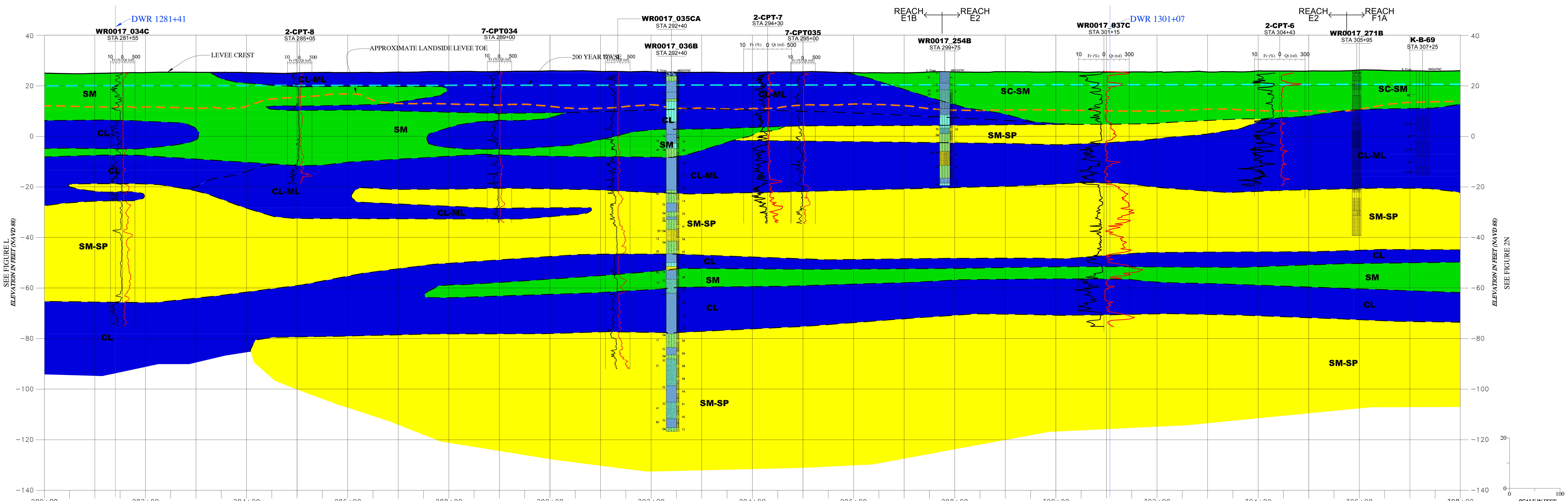
PLAN AND PROFILE - STATION 252+00 TO 280+00
ULDC EVALUATION - RECLAMATION DISTRICT NO. 17
SAN JOAQUIN COUNTY, CALIFORNIA

PROJECT NO.:	5747.005.000	FIGURE NO.	2L
SCALE:	AS SHOWN		
DRAWN BY:	MES	CHECKED BY:	JJT

ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION

PLAN
SCALE: 1"=100'



PROFILE
SCALE: H:1"=100', V:1"=20'

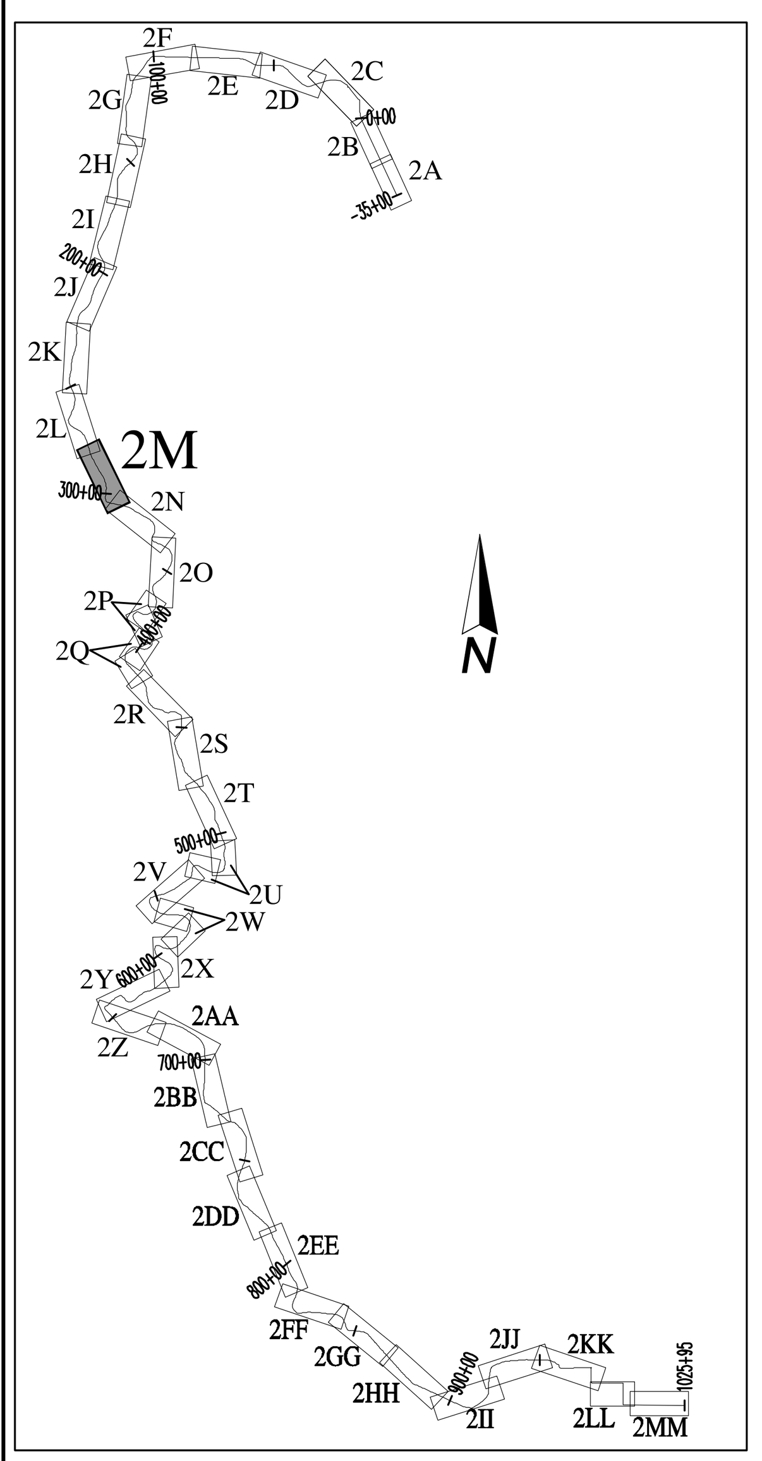


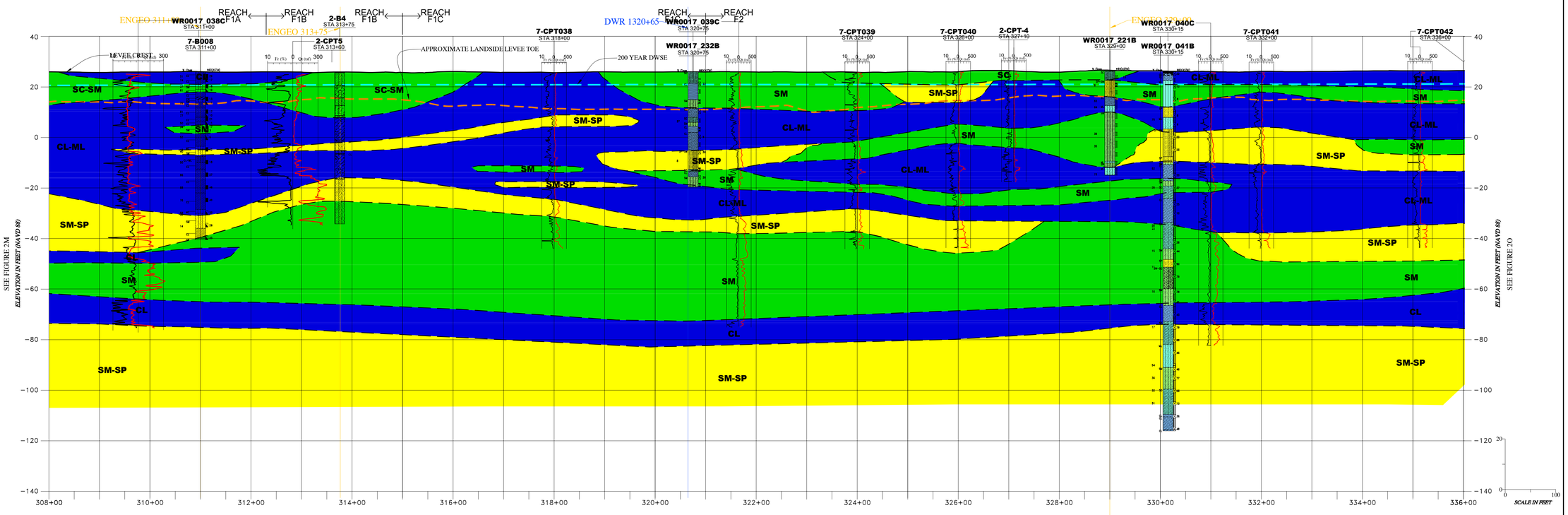
FIGURE LAYOUT
NO SCALE

ENGEO Expect Excellence	PLAN AND PROFILE - STATION 280+00 TO 308+00 ULDC EVALUATION - RECLAMATION DISTRICT NO. 17 SAN JOAQUIN COUNTY, CALIFORNIA	PROJECT NO.: 5747.005.000 SCALE: AS SHOWN DRAWN BY: MES CHECKED BY: JJT	FIGURE NO. 2M

ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION

PLAN
SCALE: 1"=100'



PROFILE
SCALE: H:1"=100', V:1"=20'

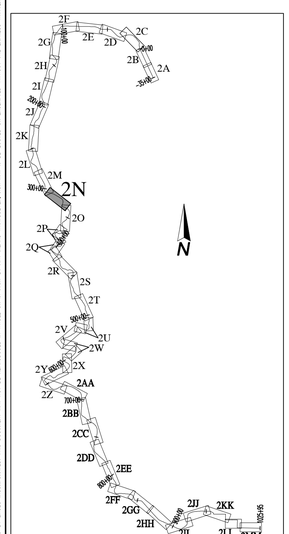


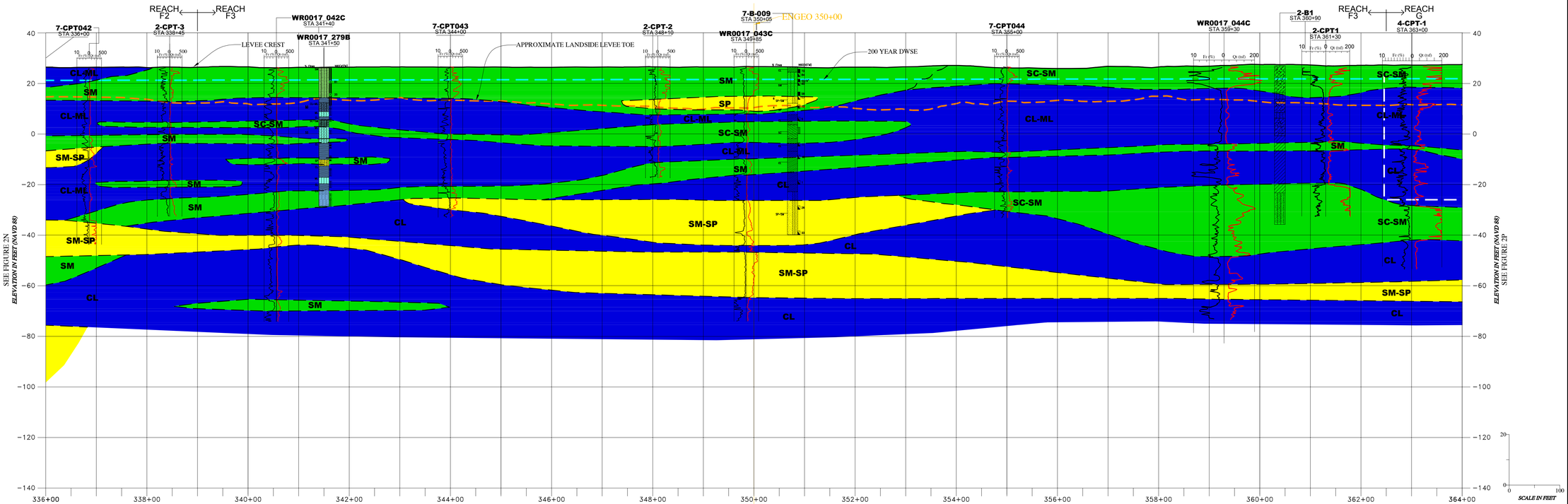
FIGURE LAYOUT
NO SCALE

ENGEO Expect Excellence	PLAN AND PROFILE - STATION 308+00 TO 336+00 ULDC EVALUATION - RECLAMATION DISTRICT NO. 17 SAN JOAQUIN COUNTY, CALIFORNIA	PROJECT NO.: 5747.005.000 SCALE: AS SHOWN DRAWN BY: MES / CHECKED BY: JJT	FIGURE NO. 2N

ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION

PLAN
SCALE: 1"=100'



PROFILE
SCALE: H:1"=100', V:1"=20'

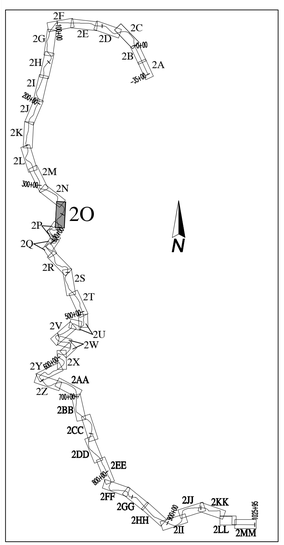


FIGURE LAYOUT
NO SCALE

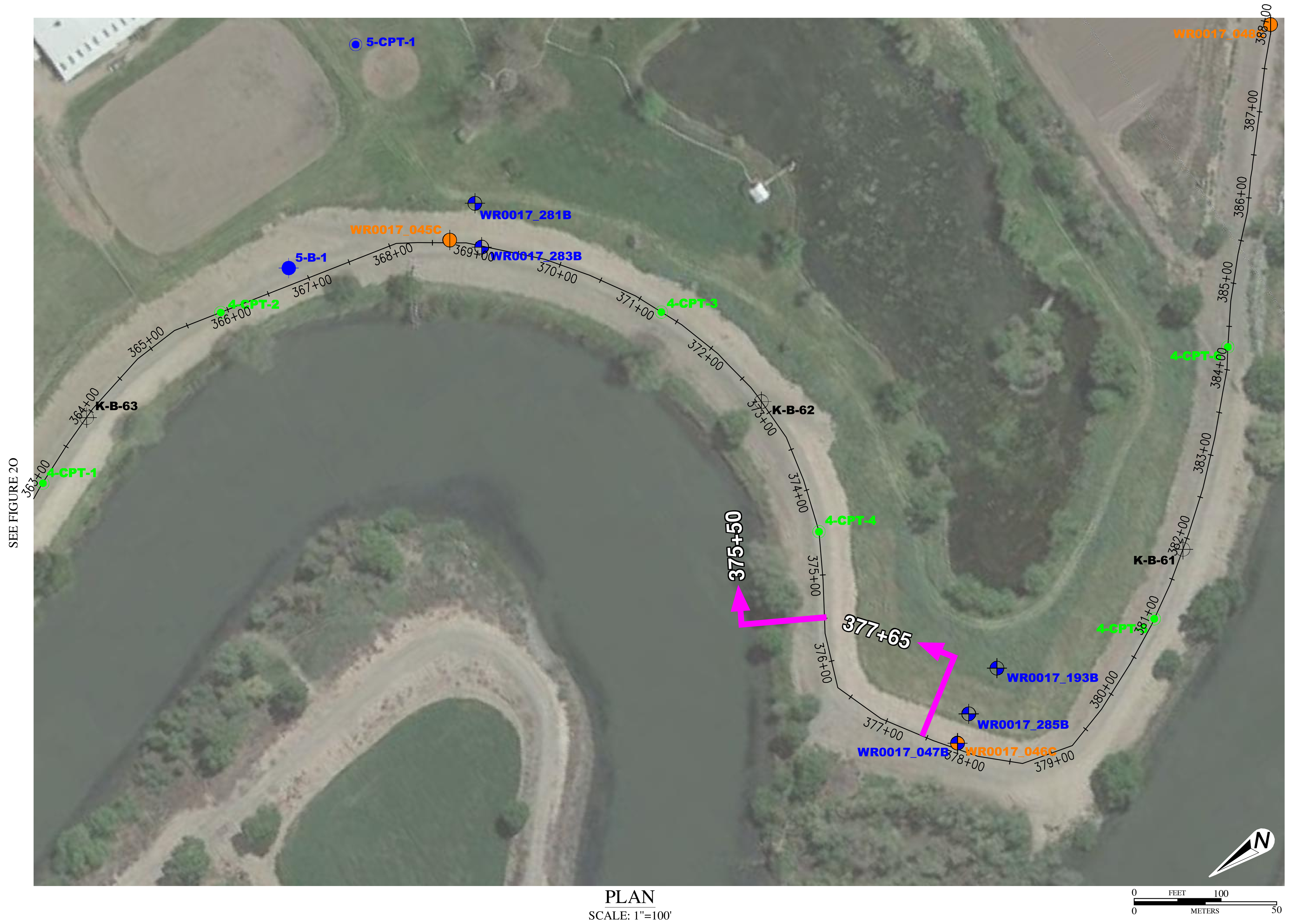
ENGEO Expect Excellence

PLAN AND PROFILE - STATION 336+00 TO 364+00
ULDC EVALUATION - RECLAMATION DISTRICT NO. 17
SAN JOAQUIN COUNTY, CALIFORNIA

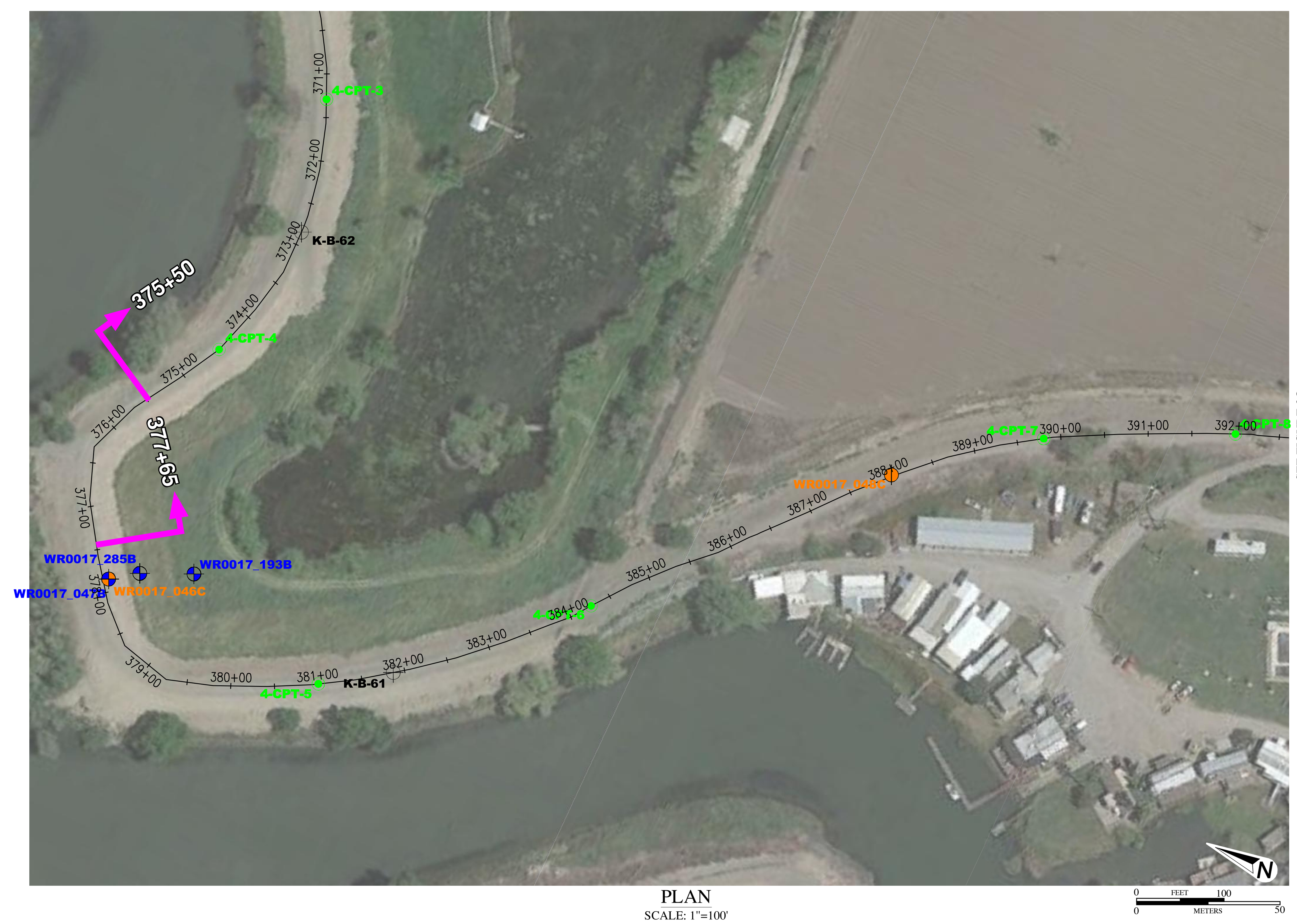
PROJECT NO.: 5747.005.000		FIGURE NO. 2O
SCALE: AS SHOWN		
DRAWN BY: MES	CHECKED BY: JJT	

ORIGINAL FIGURE PRINTED IN COLOR

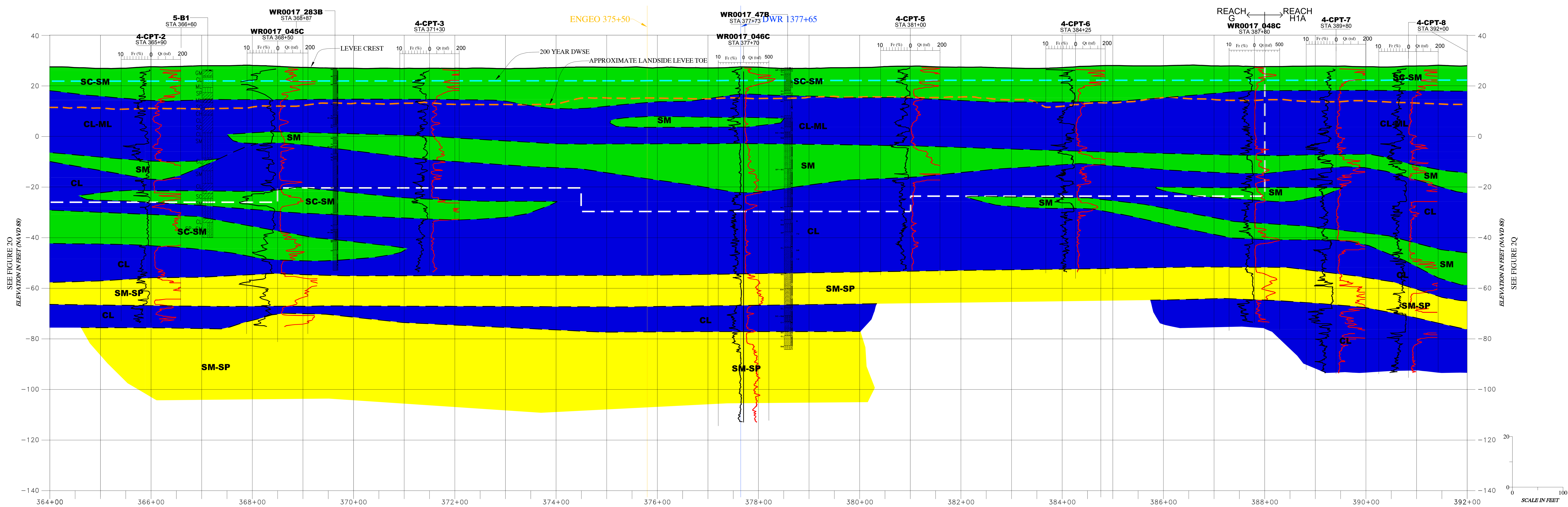
SEE FIGURE 1
FOR EXPLANATION



PLAN
SCALE: 1"=100'



PLAN
SCALE: 1"=100'



PROFILE
SCALE: H:1"=100', V:1"=20'

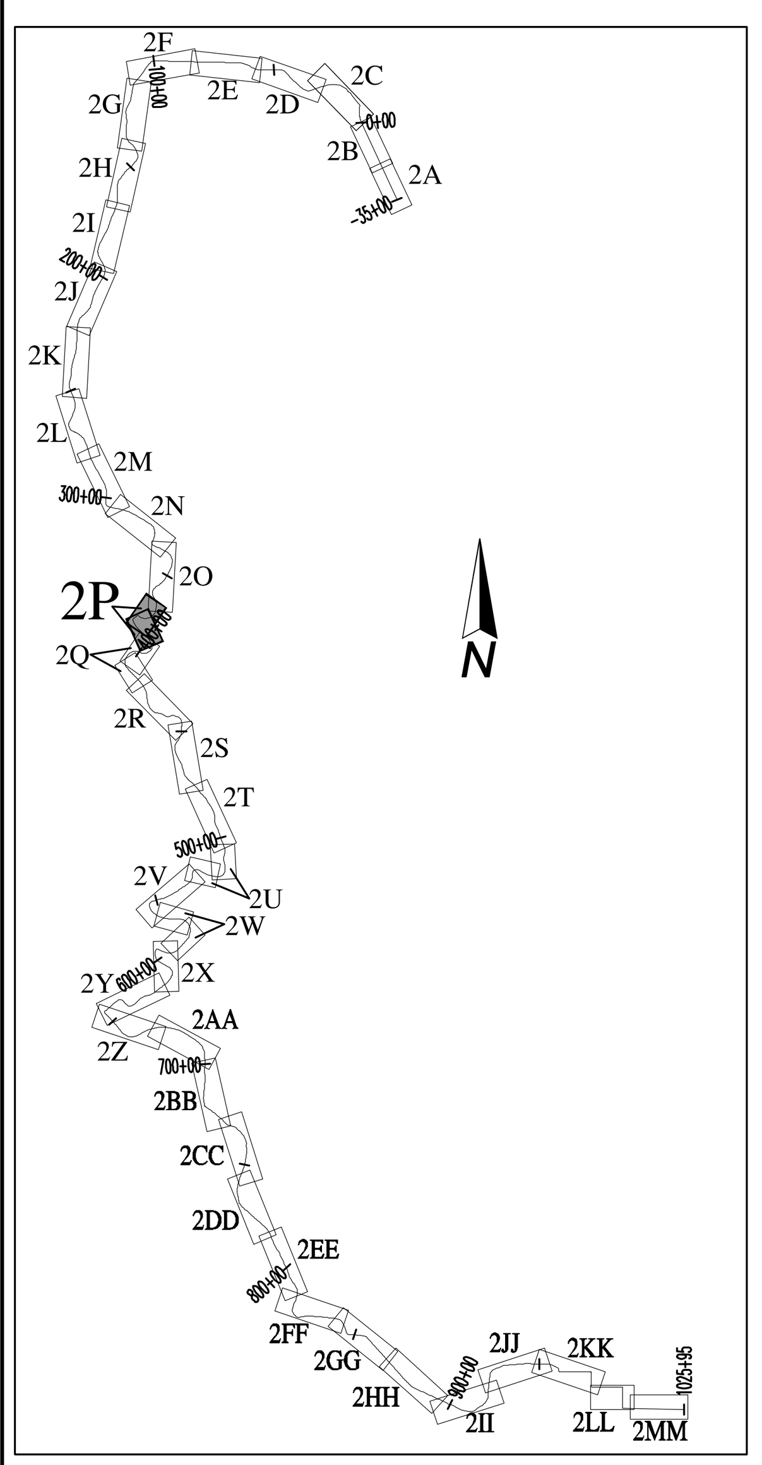


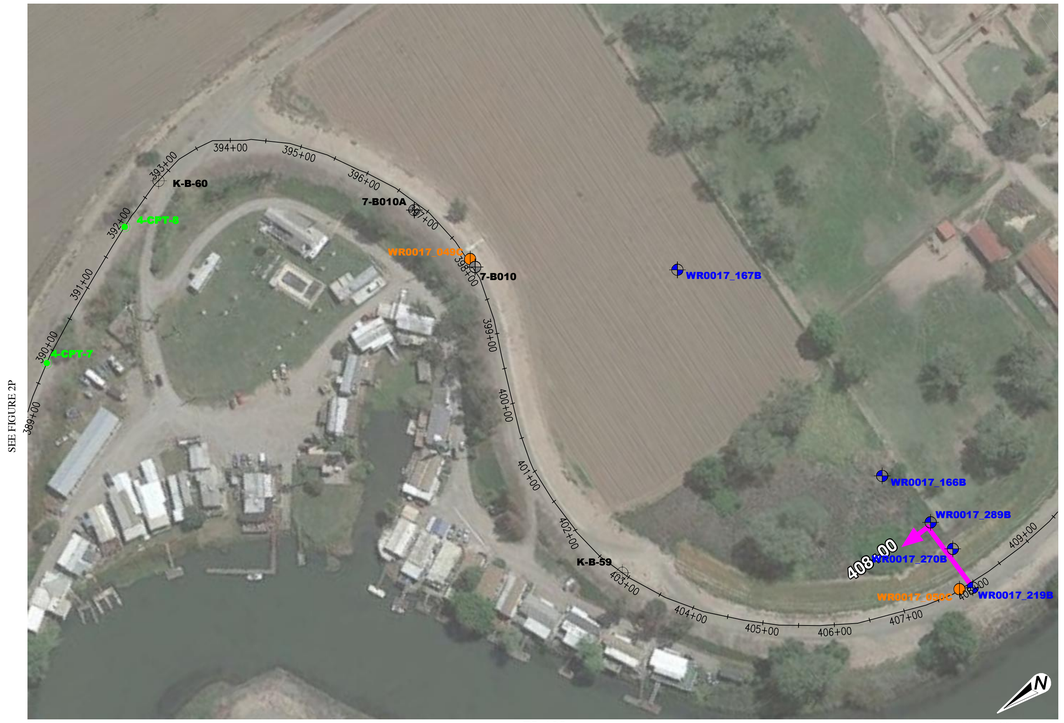
FIGURE LAYOUT
NO SCALE

ENGEO Expect Excellence

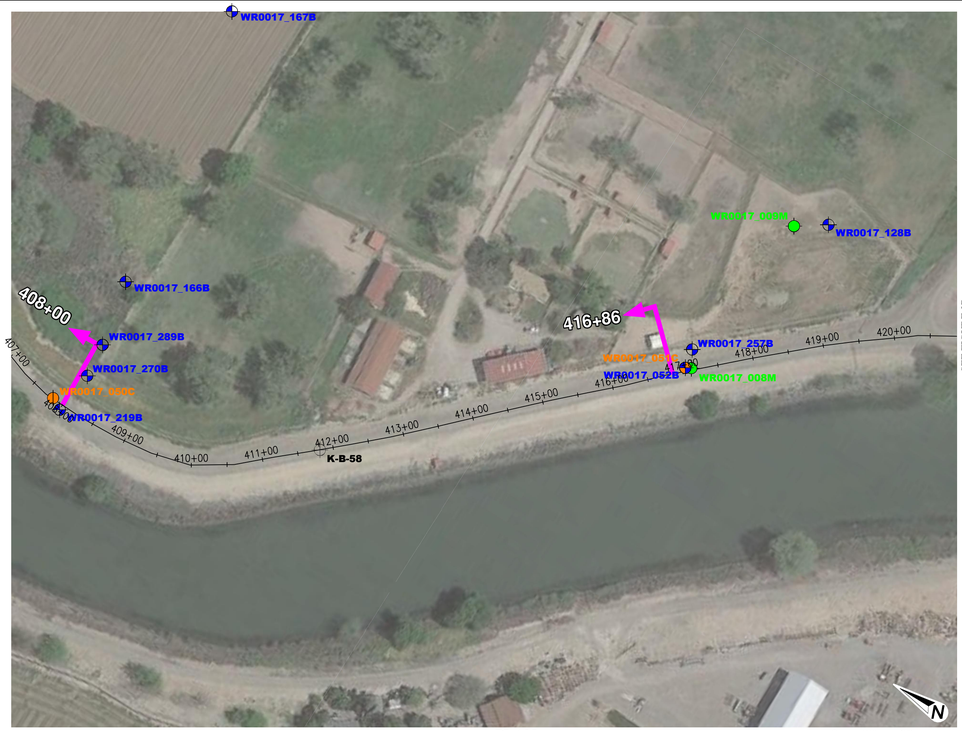
PLAN AND PROFILE - STATION 364+00 TO 392+00
ULDC EVALUATION - RECLAMATION DISTRICT NO. 17
SAN JOAQUIN COUNTY, CALIFORNIA

PROJECT NO.: 5747.005.000
SCALE: AS SHOWN
FIGURE NO. 2P

SEE FIGURE 1
FOR EXPLANATION



PLAN
SCALE: 1"=100'



PLAN
SCALE: 1"=100'

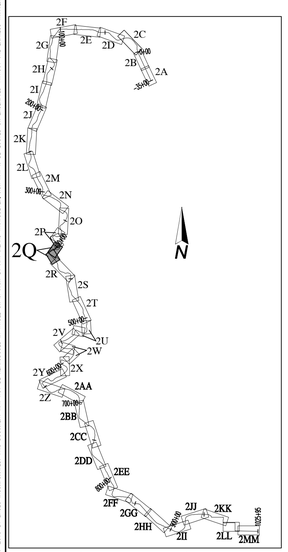
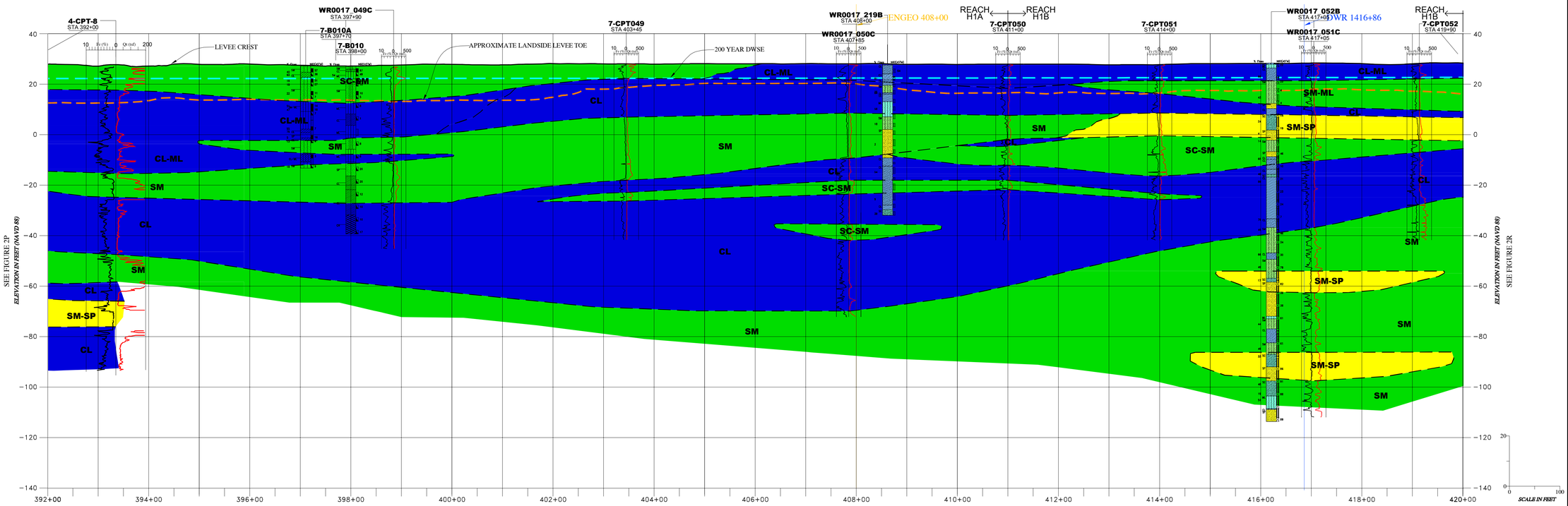


FIGURE LAYOUT
NO SCALE



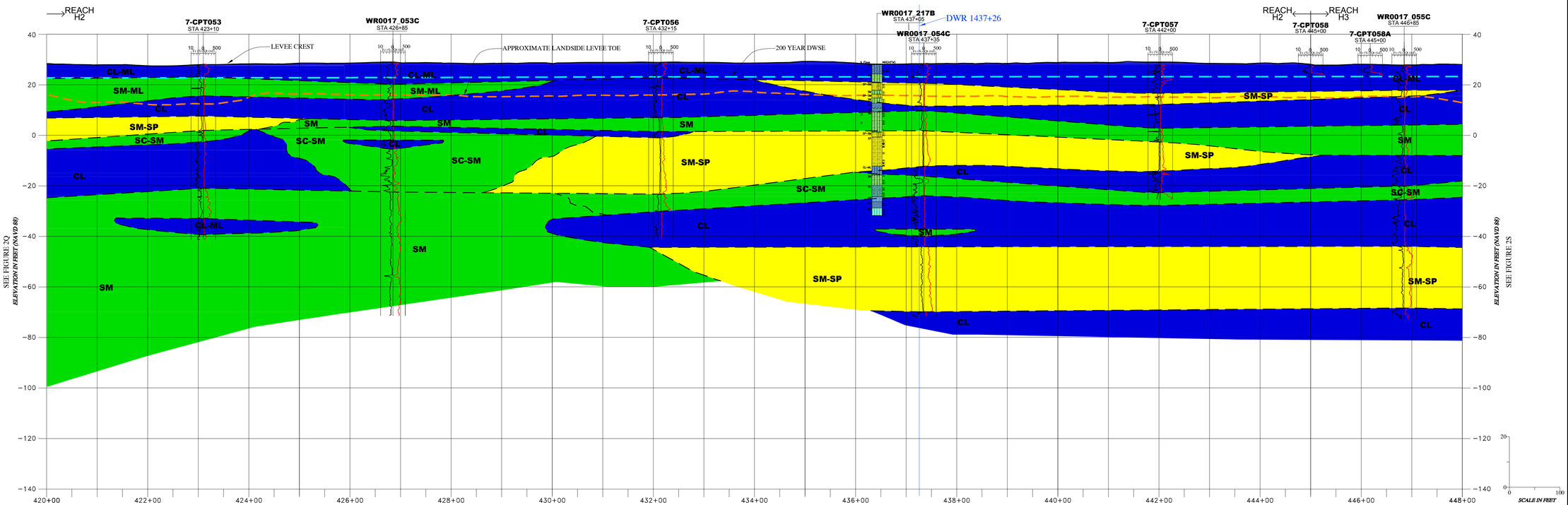
PROFILE
SCALE: H:1"=100', V:1"=20'

ENGEO Expect Excellence	PLAN AND PROFILE - STATION 392+00 TO 420+00 ULDC EVALUATION - RECLAMATION DISTRICT NO. 17 SAN JOAQUIN COUNTY, CALIFORNIA	PROJECT NO.: 5747.005.000 SCALE: AS SHOWN DRAWN BY: MES / CHECKED BY: JJT	FIGURE NO. 2Q

ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION

PLAN
SCALE: 1"=100'



PROFILE
SCALE: H:1"=100', V:1"=20'

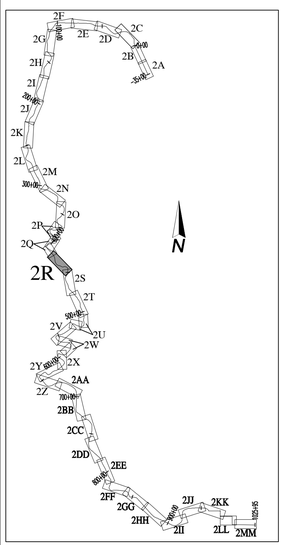


FIGURE LAYOUT
NO SCALE

ENGEO Expect Excellence

PLAN AND PROFILE - STATION 420+00 TO 448+00
ULDC EVALUATION - RECLAMATION DISTRICT NO. 17
SAN JOAQUIN COUNTY, CALIFORNIA

PROJECT NO.: 5747.005.000
SCALE: AS SHOWN
DRAWN BY: MES
CHECKED BY: JJT
FIGURE NO. 2R
ORIGINAL FIGURE PRINTED IN COLOR

SEE FIGURE 1
FOR EXPLANATION

PLAN
SCALE: 1"=100'

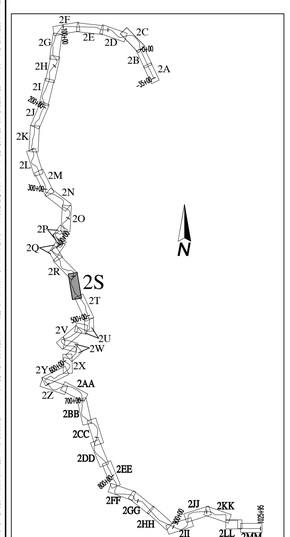
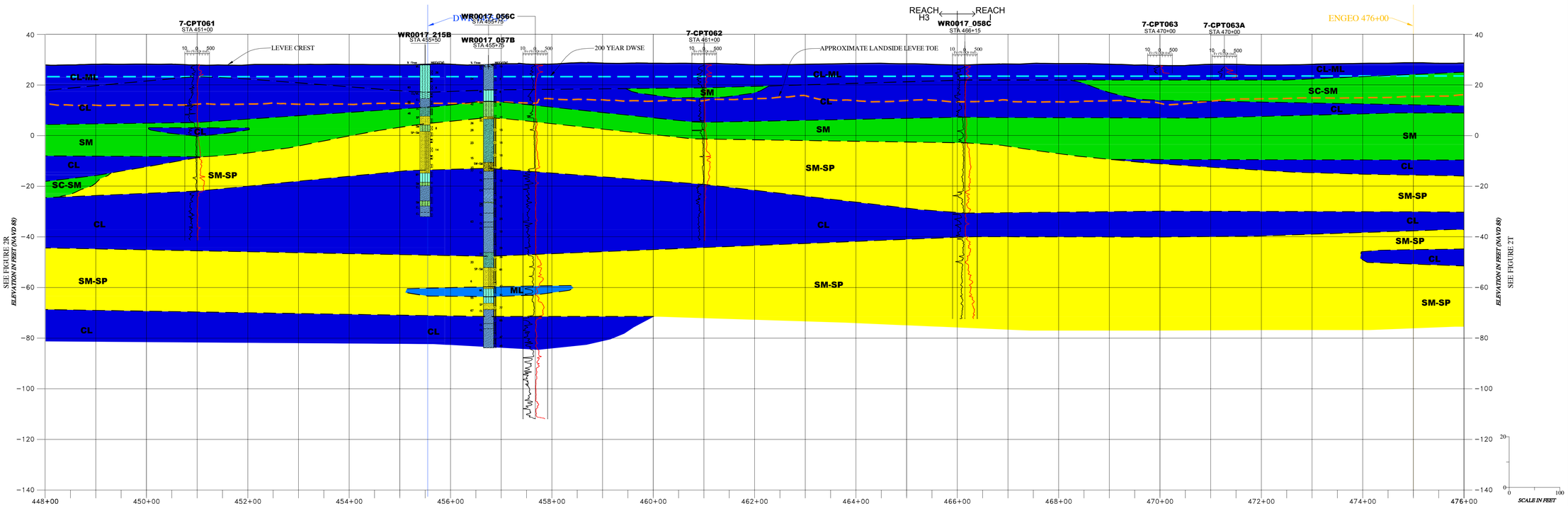


FIGURE LAYOUT
NO SCALE



PROFILE
SCALE: H:1"=100', V:1"=20'

ENGEO Expect Excellence

PLAN AND PROFILE - STATION 448+00 TO 476+00
ULDC EVALUATION - RECLAMATION DISTRICT NO. 17
SAN JOAQUIN COUNTY, CALIFORNIA

PROJECT NO.: 5747.005.000
SCALE: AS SHOWN
DRAWN BY: MES
CHECKED BY: JJT
FIGURE NO. 2S
ORIGINAL FIGURE PRINTED IN COLOR