

WEST Sacramento Levee Improvement Program
Board of Senior Consultants

Comments and Recommendations
Following Meeting No. 5
Of the Board of Senior Consultants
On August 30-31, 2011

Report Prepared by:

Board of Senior Consultants:

Dr. David T. Williams
Dr. Ray E. Martin
Mr. George L. Sills

October 20, 2011

October 20, 2011

Mr. Ken Ruzich
General Manager
West Sacramento Area Flood Control Agency (WSAFCA)
1110 W. Capitol Ave.
Sacramento, CA 95691

Dear Mr. Ruzich:

I. Introduction

This report presents the comments and recommendations for the West Sacramento Levee Improvement Program (WSLIP) by the Program's Board of Senior Consultants (BOSC) following a meeting held for, and with, the BOSC on August 30 - 31, 2011. This meeting was the fifth formal meeting of the Board and was held to provide detailed background on the WSLIP portion of the project known as Southport. As with other portions of the WSLIP, the analyses and designs being developed are part of the effort to provide 200-year flood protection to the Program.

During the meeting, presentations were made to the Board regarding the following major subjects (the agenda is Attachment 1):

- 1) Draft Problem Identification Report;
- 2) Draft Alternatives Analysis Report;
- 3) Southport EIP Task Order No.1 Interim Preliminary Design Report;
- 4) Southport EIP Task Order No. 2 Final Preliminary Design Report;
- 5) Southport EIP Task Order No.3, Project Design
 - a. Civil Design
 - b. Hydraulics
 - c. Geomorphic Studies
 - d. Geotechnical Studies

The BOSC also responded to the Charge to the Board (Attachment 2 with BOSC) and addressed the instructions to the Board (Attachment 3 with BOSC comments).

The detailed Meeting notes, taken by MBK Engineers and HDR, are included in Attachment 4.

Prior to the meeting, the BOSC reviewed the HDR Southport Sacramento River Levee (SSR Levee) Final Preliminary Design Report (FPD Report), dated June 30, 2011 and these comments were provided to the design team prior to the meeting. The BOSC's comments and suggestions have been expanded to

Board of Senior Consultants – Report from Meeting No. 5 (August 30-31, 2011)

include hydraulic considerations are included in Attachment 5. Note that some of the comments were discussed in the meeting presentation and may have been addressed to the BOSC's satisfaction.

II. General Comments

The BOSC is pleased with the presentations on the preliminary status of the project and with the opportunity to work with WSAFCA's design team at such an early stage of the project.

The BOSC anticipates that the proposed geotechnical meeting on October 25-26, 2011 in West Sacramento will be fruitful and assure that all are going in the same direction and are in agreement with the design assumptions.

IV. Closing Remarks

Please note that in Attachment 3, Instructions to the Board, has been responded to.

The Board appreciates the efforts of the design team members who prepared and presented numerous valuable summaries of the assumption for the proposed design. The various presentations and discussions were informative to the Board and helped introduce and clarify the design teams' thought processes.


The Board looks forward to future meetings, briefings, and discussions on this project and is excited about the next phase of the project.

Very truly yours,

**West Sacramento Levee Improvement Program
Board of Senior Consultants**



Dr. David T. Williams, P.E. CFM.



Mr. George L. Sills, P.E.



Dr. Ray E. Martin, P.E.

Attachments:

- Attachment 1: Meeting Agenda
- Attachment 2: Charge to the Board
- Attachment 3: Instructions to the Board
- Attachment 4: Minutes of BOSC #5 meeting
- Attachment 5: BOSC Preliminary Design Report

Attachment 1

**WEST SACRAMENTO AREA FLOOD CONTROL AGENCY
MEETING AGENDA**

**WEST SACRAMENTO LEVEE IMPROVEMENT PROGRAM
BOARD OF SENIOR CONSULTANTS
MEETING NO. 5**

Date: August 30-31 2011
Time: 8:00 am to 5:00 pm
Location: Boathouse at Bridgeway Lakes
3560 Southport Pkwy
West Sacramento, CA 95691

DAY 1

- I. INTRODUCTION 8:00 AM**
- Welcome and Opening Remarks (WSAFCA)
 - Meeting Purpose & Expectations (MBK)
 - Agenda Overview (HDR)
- II. PROGRAM CONTEXT AND BACKGROUND 8:30 AM**
- Draft Problem Identification Report (HDR)
 - Draft Alternatives Analysis Report (HDR)
 - Hydraulic Analysis Report (MBK)
- III. OVERVIEW DESIGN METHODOLOGY & APPROACH 9:15 AM**
- TO 1 (HDR)
 - TO 2 (HDR)
 - TO 3 (HDR)
- IV. LUNCH (Catered in City Hall) 11:30 AM**
- Introduction to EIP sites (DWR, RD 900, HDR)

V. SAC. RIVER SOUTHPORT EIP (Design Considerations) 1:00 PM

- Reach A
- Reach B
- Reach C
- Reach D
- Reach E
- Reach F
- Reach G

DAY 2

VI. EIP SITE VISIT (Meet @ City Hall) 8:30 AM

- CHP Academy EIP Site
- River EIP Site

VII. LUNCH/BOSC Working Session 11:30 AM – 2:30 PM

- Note: Design team to be available, as needed, to address BOSC questions

VIII. REVIEW COMMENTS 2:30 PM – 4:30 PM

- Overview of Comments
- Comment Clarification & Discussion
- Summary of Actions for Comment Resolution

IX. CONCLUSIONS & ACTIONS 4:30 PM – 5:00 PM

Attachment 2

**WEST SACRAMENTO LEVEE IMPROVEMENT PROGRAM
BOARD OF SENIOR CONSULTANTS**

CHARGE TO THE BOARD

The West Sacramento Area Flood Control Agency (WSAFCA) has assembled this Board of Senior Consultants (Board) to conduct an independent and external expert review of the levee improvements under design by the WSAFCA and its consultants for construction. The Board is charged with confirming that the design investigation and analysis and associated recommendations for levee improvements at each site are acceptable for providing 200-year level of flood protection in an urban environment. The Board shall consider current and relevant regulations, policy, standards, and guidance for the design and construction of flood protection measures in rendering its opinion. The Board shall document its findings that will include, but is not limited to, responding to the instructions provided by WSAFCA. WSAFCA shall be responsible for providing the Board with instructions, the historic data and records, programmatic or planning studies, and design phase data and documentation necessary to understand the technical context and natural setting within which the levee improvement recommendation has been proposed.

BOSC remarks: See comments provided in Attachment 5

Attachment 3

**WEST SACRAMENTO LEVEE IMPROVEMENT PROGRAM
BOARD OF SENIOR CONSULTANTS**

INSTRUCTIONS TO THE BOARD

WSAFCA requests that the Board specifically consider the following concerns:

1. Are there any concerns related to the general design approach presented to the BOSC?

BOSC remarks: See comments and suggestions included in Attachment 5.

In providing commentary on these and other matters related to the documents reviewed for these projects, please provide the following where possible:

- A clear statement of the degree of concern;
- The basis of the concern;
- The significance of the concern; and
- The actions needed to resolve the concern

BOSC remarks: See comments and suggestions included in Attachment 5.

Attachment 4

**WEST SACRAMENTO AREA FLOOD CONTROL AGENCY
MEETING NOTES**

***SOUTHPORT EIP Project Design and Rivers and CHP Academy EIP
Construction***

**WEST SACRAMENTO LEVEE IMPROVEMENT PROGRAM
BOARD OF SENIOR CONSULTANTS
MEETING NO. 5**

Date:	August 30, 2011	August 31, 2011 Site Visit
Time:	8:00 am to 5:00 pm	8:30 am to 11:30 am
Location:	Boathouse at Bridgeway Lakes 3560 Southport Parkway West Sacramento, CA 95691	West Sacramento City Hall 1110 W Capitol Ave West Sacramento, CA 95691

Meeting introduction was followed by presentations of the studies preceding the Southport EIP effort, and the three task orders to date that either have been completed (nos. 1 and 2) or were underway (no.3) at the time of the meeting.

Presentations:

- 1) Draft Problem Identification Report;
- 2) Draft Alternatives Analysis Report;
- 3) Southport EIP Task Order No.1 Interim Preliminary Design Report;
- 4) Southport EIP Task Order No. 2 Final Preliminary Design Report;
- 5) Southport EIP Task Order No.3, Project Design
 - a) Civil Design
 - b) Hydraulics
 - c) Geomorphic Studies
 - d) Geotechnical Studies

Each presentation was followed by question/answer/discussion sessions. The following notes summarize comments and recommendations made during and after these presentations.

Hydraulics

- 1) A request was made for the design team to obtain a letter of concurrence from the USACE regarding the configuration of the HEC-RAS model applied for the project to date.

- 2) A request was made to document similarities and differences between the Corps's base model, from which the project model was built, and the project model itself.

Geotechnical Studies

- 1) A request was made for installation of piezometers, including some on the waterside of the levee.
- 2) A request was made to distinguish between CPTs and boring logs on exhibits showing the locations of geotechnical explorations.
- 3) A request was made for the design team to obtain and review DWR's EM data for the site.
- 4) A request was made for the geotechnical modeling result tables to have added to them the relevant limiting criteria.
- 5) A comment was made that seepage gradients associated with both the 200-yr plus 3 ft water surface elevation and the 500-yr water surface elevation should be evaluated and that the lower of the two should govern.
- 6) An observation was made that a 76 ft wide seepage berm might not fit throughout Segment G.
- 7) The design team noted that the adjacent levee offset was under review and had not been set at this time.
- 8) A request was made to include in the geotechnical basis of design for the Southport EIP project the horizontal hydraulic conductivities and the anisotropic ratios used for the NLIP.
- 9) The design team noted that it was currently reviewing seepage berm geometry design criteria to confirm that current configurations in their terrain models met those requirements.
- 10) A recommendation was made to take care when assigning hydraulic conductivity values as they can significantly affect berm width requirements.
- 11) It was noted that according to an a 1956 USACE manual, a pervious seepage berm was to have a vertical hydraulic conductivity of at least two orders of magnitude greater than the subgrade material.
- 12) The design team noted that mass balance evaluations, accounting for re-use of degraded material and the most recent seepage berm width requirements, was underway.
- 13) There was discussion of assumptions typically made regarding the waterside blanket when conducting a blanket theory seepage analysis. The importance of identifying the assumed entry point was noted.
- 14) The design noted that an 'end of construction' stability evaluation should be included in the design effort.
- 15) It was noted that the materials under consideration for use in seepage berms and zoned levees should be carefully evaluated.
- 16) It was noted that the design team's interpretation of the Corps's Vegetation ETL should be provided in conjunction with the ongoing design effort.
- 17) It was suggested that it might be worth varying material type to reduce the widths of the berms and that this idea needed to be included as part of a value engineering evaluation.

Attachment 5

September 19, 2011

**West Sacramento Levee Improvement Program
West Sacramento, California**

Southport Sacramento River Early Implementation Project

**Board of Senior Consultants Report on
Final Preliminary Design Report**

Prepared by David Williams, Ray Martin and George Sills, BOSC

This report was prepared by the Board of Senior Consultants (BOSC) for the purpose of providing review comments on the HDR Southport Sacramento River Levee (SSR Levee) Final Preliminary Design Report (FPD Report), dated June 30, 2011, to the design team.

Prior to the BOSC Meeting held on August 30th and 31st, Ray Martin provided review comments (Martin Comments) on the geotechnical engineering and selected aspects of civil engineering portions of the HDR FPD Report to the design team. During the meeting, it was stated that many of the questions raised in the Martin Comments would be addressed in a Geotechnical Engineering Report which will be prepared during the next phase of the project. The BOSC understands that this report will also include:

- 1) new subsurface information and laboratory and in situ testing data and results,
- 2) detailed plan and profile sheets for each segment (draft plan and profile sheets were provided during the meeting), and
- 3) updated and additional cross sections for areas with differing subsurface conditions.

This report includes Comments by the SAR Panel. The geotechnical comments contained herein can be considered in more detail during the planned October 25th and 26th BOSC Geotechnical Engineering Workshop to be held at the Blackburn Engineering office in West Sacramento, CA.

The following pages discuss the content of the report and specific comments that the design team should consider are shown as underlined. The format follows the HDR FPD Report format and section numbering system. The report is well written and organized.

Section 1.0 Introduction, Page 1 of 24

This section outlines the key recommendations from the Interim Preliminary Design Report (IPD Report). It notes that this FPD Report will address these and other topics. The report lists six items that summarize some of the 19 recommendations contained in the IPD Report. It be helpful to state that the 19 items (actually 18 items as Item 3 was deleted from the original listing) are include under Section 4, Prior Studies and Key Findings, on Page 9 of 24.

Section 2.0 Background, Page 2 of 24

On Page 3 of 24, the report discusses the Draft Problem Identification Report (Draft PI Report), Levee Improvement Program, West Sacramento Area Flood Control Agency, Yolo County, California, dated April 28, 2008. This report, as was discussed in the IPD Report, provided a feasibility-level overview of levee deficiencies including: 1) freeboard; 2) steady seepage stability 3) rapid drawdown stability; 4) underseepage; 5) seismic vulnerability; 6) geometry, and 7) erosion. Exhibit C-27 included with the HDR Civil Design Considerations Technical Memorandum dated June 21, 2011 (HDR TM June 21, 2011) in Appendix 4 summarizes these features along the SSR Levee. This Exhibit should be referenced on Page 3 of 24.

The report also discusses the Draft Alternatives Analysis Report (Draft AA Report), Levee Improvement Program, West Sacramento Area Flood Control Agency, Yolo County, California, dated November 13, 2009. This report, as was discussed in the IPD Report, provides a feasibility-level comparison of several levee improvement alternatives. Exhibit C-28 included with the HDR TM June 21, 2011 provides a summary of the recommended alternative which included the following component features: 1) relief wells; 2) rip rap erosion protection; 3) levee raises; 4) adjacent levee sections; 5) setback levee sections; and 6) slope flattening levee sections. This Exhibit should be referenced on Page 3 of 24.

These documents, along with the IPD Report, provided the technical background for this FPD Report study.

Section 3.0 Purpose and Scope, Page 4 of 24

This section states that the purpose of the FPD Report *“is to evaluate two setback levee alternatives with respect to project costs and key design questions, and, through comparison to repair-in-place and adjacent levee alternatives, to identify three alternatives for evaluation in the Project Design project phase.”*

Table 3-1 Study Questions and Data Sources on Page 5 of 24 provides a listing of questions to be answered in this FPD Report. The hydraulics, geomorphology, and environmental questions were not considered in this review.

Two of the three geotechnical engineering questions listed are the same as listed in the IPD Report in Table 3-1 and relate to: 1) availability of adequate quantities of suitable borrow fill material; and 2) whether excessive foundation settlements will occur under the setback levee alignments. The third and only new geotechnical question relates to whether the seepage and stability deficiencies identified in the Draft AA Report are supported by the results of this FPD Report. These questions seem appropriate given the geologic setting. These three questions are considered in the Blackburn Geotechnical Design Considerations Technical Memorandum – Final Preliminary Design (Blackburn TM – FPD) included in Appendix 2, which is reviewed below. One deficiency not discussed is seismic stability. Why was this deficiency not considered in this FPD Report? The reason it is not discussed should at least be presented.

Two of six civil engineering questions were also considered in this review. These questions relate to: 2) what local borrow sources would likely be used for each CMA, and 5) what are the opinions of probable cost for implementing each design alternative. These questions seem appropriate given the geologic setting. The term CMA, or Combined Measure Alternatives, should be defined in the text. These questions are discussed in the HDR TM June 21, 2011 included in Appendix 4 which is discussed below from a geotechnical perspective.

Section 4.0 Prior Studies and Key Findings, Page 6 of 24

This section, as in the same section of the IPD Report, again discusses the Draft AA Report and Draft PI Report and their conclusions with respect to improving the SSR Levee and mitigating the deficiencies noted above.

1. Repair the existing SSR Levee in-place between Stations 0+00 to 44+00 (South) and Stations 274+00 to 312+00 (North).
2. Construct a new setback levee with relief wells between Stations 44+00 and 274+00 (4.3 miles long).
3. Completely degrade the exiting levee.

Table 4-1 SSR Levee Improvement Alternatives Evaluated Draft AA Report on Page 8 of 24 provides a summary of the three alternatives considered in the Draft AA Report. Alternative 2 was recommended. Note that the text of the HDR FPD Report appears to suggest that Station 0+00 is at the north end of the SSR Levee, whereas it is located at the south end of the levee. This should be reworded.

The IPD Report modified some of the assumptions in the Draft AA Report: 1) this SSR Levee study concludes at about Station 293+00; 2) the length of the four setback levees evaluated vary from about 2.0 to 4.5 miles long; 3) a partial degrade alternative of the existing levee is reconsidered; and 4) environmental design changes are considered. These modifications seem reasonable.

The FPD Report then lists the recommendations from the IPD Report and provides a summary of progress towards completing these recommendations. It is unusual in that only two of the 18 items listed have been completed for this FPD Report which it is assumed to be a final report and not a draft. The report indicates that eleven of the items are in progress and four items have not been started. Action has been completed on only two items while one item has been deleted from the scope.

Section 5.0 Study Approach, Page 10 of 24

Section 5.2 Team Charge states that *“TO 2 was to compare two setback levee alternatives to repair-in-place and adjacent levee alternatives,”* but the IPD Report did not recommend two alternatives from the four considered. The reason is apparently because a different approach to selecting alternatives was developed, as presented in the discussion of Section 6 below. This should be clarified.

Section 5.3 lists the team organization. This seems reasonable.

Section 5.4 Team Deliverables and Workflow notes that each team member prepared draft technical memoranda. A minor detail is that the cbec, inc. work product was a report, not a technical memorandum.

Section 6.0 Study Findings, Page 11 of 24

Section 6.1 Levee Alternatives Selected for Evaluation, Page 11 of 24

This section indicates a change in the approach to the selection process. The approach used was to “*divide the project reach into segments and to rank alternatives for improving each [segment] from least to most favorable.*” The word segment is in brackets because it appears that the text should include this word rather than the word “reach”. Exhibit C-2A of the HDR TM June 21, 2011 illustrates the locations Segments A through G, which were defined based on the type of alternatives that might be considered to correct deficiencies. The five-step process of how the segments were defined is described on page 12 of 24. This process seems appropriate but after review, it appears it may have been better to define the segment limits based on geotechnical considerations. The term introduced above, CMA, was used to describe the combinations of alternatives that were evaluated. The alternatives are defined as CMA-1 through CMA-4 and they are shown in Exhibits C-3 through C-6 of the HDR TM June 21, 2011. Should erosion deficiencies/rip-rap protection be included for CMA 2 and 4 for Segment G?

Section 6.2.1 Hydraulic Design Considerations, Page 12 of 24

The BOSC evaluation of the HEC-RAS model was performed but comments were tabled because the Corps of Engineers’ Version 3 of the HEC-RAS model will soon come out and may answer most of the questions. Other HEC-RAS technical questions in this section were answered during the presentations at the BOSC meeting of August 30 – 31, 2011. Also, request for additional information was documented in the meeting notes of MBK and HDR, Attachment 4.

The hydraulic top of levee (HTOL) is currently the 200 year flood elevations plus 3 feet of freeboard. Consideration should be given to using the 500 year flood elevations as the HTOL if it is lower than the 200 year elevations plus 3 feet per the Interim Design Criteria document by CA DWR.

Section 6.2.2 Geotechnical Design Considerations, Page 15 of 24

The last sentence of the first paragraph states that, “*[t]he boundaries of suitable borrow material were revisited in light of new data collection as [part] of the final preliminary design effort and, where justified, modified.*” This comment is repeated on the bottom of page 16 of 24. Review of the latest version of the Blackburn TM – FPD dated July 29, 2011 does not indicate any work related to the borrow areas has been completed or is in progress or planned according to Table 9 of the TM.

In the second paragraph it states that borings and CPTs “*recently completed --- (completed in May 2011) --- will be incorporated into the TO 3 evaluation and documentation during the design phase of the project.*” It would have been helpful to the review process if the most recent version of the Blackburn TM – FPD, issued on July 29, 2011, had contained this information.

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The third paragraph states that “*seepage and stability models were developed for a single cross-section in project segments B, C, D, E, F, and G---*.” The Blackburn TM – FPD, issued on July 29, 2011 does not contain a model for segment E.

The berm widths for each levee segment are discussed in the first paragraph below Table 6-2 Summary of Model Locations and Corrective Measures, on Page 16 of 24. Some of these berm widths do not correspond to the berm widths listed in the Blackburn TM – FPD as show below.

Segment	Recommended Berm Widths, feet	
	HDR FPD Report	Blackburn TM – FPD
B	400	250
C	76	115
F	76	100

Section 6.2.3 Geomorphology, Page 17 of 24 – not reviewed

Section 6.2.4 Civil Design Considerations, Page 18 of 24

On page 15 of 24 of the text under Section 6.2.2 Geotechnical Design Considerations it was stated that “*[t]he boundaries of suitable borrow material were revisited in light of new data collection as [part] of the final preliminary design effort and, where justified, modified.*” On the bottom of page 18, the text refers to Exhibits C-13 through C-16, Borrow Analysis for CMA 1 through CMA 4, and states “*[c]olor codes are used to correlate built levee segment[s] with borrow sources.*” These statements suggest that revised borrow areas boundaries are shown on these Exhibits. The areas appear to be unchanged from the areas defined in the IPD Report in the Blackburn TM of Appendix 2. The present delineation of these areas is of concern for the reasons noted in the Review Comments on HDR IPD Report.

Section 6.2.4 Environmental Design Considerations, Page 20 of 24 – no comments

Section 7.0 Opinion of Probable Cost, Page 21 of 24

Table 7-1 – Opinions of Probable Cost, on Page 22 of 24 includes a column heading “Alternative”. It would be helpful to list the alternatives as CMA 1 through CMA 4. Since the costs have increased from about 1.5 to 16 times over the IPD Report values, it would be helpful to list the reasons this occurred. It would it be better to title these Comparative Costs since they are still very preliminary.

Section 8.0 Recommendations, Page 22 of 24

Seventeen recommendations are listed. These seem appropriate.

Appendix 1 Hydraulic TM

See comments in Section 6.2.1, Hydraulic Design Considerations.

Appendix 2 Blackburn TM – FPD

1. Information included in the Blackburn TM dated January 25, 2011 that was not repeated in this Blackburn TM – FPD included:

- 1) Section 2.0 Geologic Setting,
- 2) Section 3.0 Groundwater,
- 3) Section 4.0 Borrow Site Evaluation, and
- 4) the initial Section 5.0 Levee Settlement Evaluation.

See Review Comments on HDR IPD Report for comments on these sections of the Blackburn TM.

2. During this review, a revised Blackburn TM – FPD was issued on July 29, 2011. Review of this revised Blackburn TM – FPD indicated that there were no significant changes to the Blackburn TM – FPD dated June 28, 2011. The minor changes are shown below:

- a. Section 4.1 Introduction, Page 4 – Revised wording in paragraph 2.
- b. Section 4.2.1 Through Seepage, Page 5 – added this section
- c. Appendix F-1 Segment B, Station 79+00 – added figure numbers
- d. Appendix F-2 Segment C, Station 122+00 - added figure numbers
- e. Appendix F-3 Segment D, Station 167+00 - added figure numbers
- f. Appendix F-4 Segment F, Station 241+00 - added figure numbers
- g. Appendix F-5 Segment G, Station 283+00 - added figure numbers

These changes were included in this review. If this interpretation of the changes is incorrect, please provide feedback.

The following comments relate to review of the Blackburn TM – FPD dated July 29, 2011.

3. Section 1.0 Introduction, Page 1 – This section defines the scope of what is presented in the TM. The TM notes the following:

- a. *“This TM focuses on advancement of geotechnical knowledge related to design of an adjacent levee in Segments B and G and a setback levee in Segments C, D, E and F.”*
- b. It indicates that preliminary underseepage, slope stability and settlement analyses were performed.
- c. It indicates that interim preliminary findings and conclusions related to borrow sites and setback levee settlements were presented in the Blackburn TM included with the HDR IPD Report as noted above. It does not mention an updated review of the borrow areas.

4. Section 2.0 Subsurface Exploration and Testing, Page 2 – Exhibits G-1 through G-4 illustrate the locations of the 11 CPT and 5 borings drilled for this TM along with all previous field investigations.

- a. Section 2.1 Cone Penetration Tests (CPTs) and Section 2.2 Exploratory Borings on page 2 indicate ten CPT's were advanced through an upper gravel zone to depths of 80 to 137 feet. One CPT refused at 44 feet. The CPTs were located in all levee segments except Segment A. The five borings were drilled next to CPTs 1, 4, 9, 10, 11. 3-inch tube samples and Standard Penetration Test (SPT) N-values were obtained at selected locations.
 - i. A continuous subsurface profile should be constructed along the centerline of each segment and variations along the segment should be discussed in the text.
 - ii. The subsurface conditions at the cross sections included as Exhibits G-5, G-13, G-21, G-30 and G38 should be discussed in the text.
 - iii. The depths of the borings should be listed in the text similar to the CPTs.
- b. The data found in the Blackburn TM – FPD Appendix A Exploration Logs were reviewed and the following comments are provided.
 - i. It would be helpful for review if the all of the field investigation data were included in the Appendix A, rather than referencing the sources.
 - ii. The number and distribution of CPTs performed appears reasonable given previous CPT data was also available.
 - iv. If additional CPTs were advanced why were they not included?
 - v. The number and distribution of borings performed appears reasonable given previous borings were also available.
 - vi. If additional borings were drilled why were they not included?
 - vii. It would be helpful to provide a label for the Kleinfelder and Blackburn field investigation data points on each Exhibit similar to those for the HDR, Wallace/Kuhl, etc. groupings as is shown on the Plan and Profile Drawings provided at the meeting.
 - viii. The symbols are also missing from the Kleinfelder borings and CPTs in the legend on each Exhibit.
- c. Section 2.3 Laboratory Tests – This section only lists the tests performed. There is no discussion of the results. It would be helpful if there was discussion in this section about how the parameters for Underseepage, Slope Stability and Settlement, shown in Table C-1, D-1 and E-1 included in Appendices C, D and E, were selected.
- d. The data found in the Blackburn TM – FPD Appendix B Laboratory Tests were reviewed and the following comments are provided.
 - i. It would be helpful for the review if all of the laboratory data were included in the Appendix B, rather than referencing the sources.
 - ii. Moisture content, unit weight tests, sieve and hydrometer analysis, and Atterberg limits tests – the number and distribution of tests performed appears reasonable given previous data were also available.
 - iii. Hydraulic conductivity tests – 14 tests – nine tests in upper 10 feet, four tests from 10 to 20 feet, one test from 20 to 30 feet - the number and distribution of tests performed appears reasonable given previous data were also available – the following comments relate to individual tests:

1. B1-1a – soil description does not match the classification data
 2. B1-2c – no classification data
 3. B1-4b – silty sand not “near sandy silt” – based on grain size data
 4. B2-1b – soil description does not match the classification data
 5. B2-2b – soil description does not match the classification data, k not average of all data points as in previous test
 6. B2-3c – soil description does not match grain size data – $k = 5.6E-5$ seems reasonable
 7. B3-1c – soil description does not match the classification data – $k = 5.2E-6$ seems reasonable
 8. B3-3c – no classification data
 9. B3-5a – soil description does not match the classification data
 10. B4-1b – soil description does not match the classification data
 11. B4-2a – no comment
 12. B4-3a – soil description does not match the classification data
 13. B5-1c – soil description does not match the classification data
 14. B5-2c – no classification data
- iv. Triaxial compression tests – 5 tests – the number and distribution of tests performed appears reasonable given previous data were also available – the following comments relate to individual tests:
1. B1-2 – no comment
 2. B2-2
 - a. Soil description does not match the classification data (CL) for sample B2-2b - no classification data was available for other two samples, the third sample is listed on the triaxial data sheet as silty sand (SM), neither the boring log classification (CL) or the visual classification on the lab summary sheet (ML) describe this material as silty sand (SM)
 - b. Effective stress cohesion should equal 0 psf for a normally consolidated lean clay and thus it would seem more reasonable to use the 1st and 3rd sample circles to draw the failure envelop – $\phi = 27^\circ$ and $c = 0$ psf appears more reasonable for this test
 - c. Total stress parameters, using the 1st and 3rd circles are about $\phi = 19^\circ$ and $c = 300$ psf
 3. B3-3 – no comment
 4. B4-3
 - a. Soil description does not match the classification data (ML) for sample B2-3a – no classification data was available for other two samples, the samples are listed on the triaxial data sheet as silty sand (SM), neither the boring log classification (ML) or the visual classification on the lab summary sheet (ML) describe this material as silty sand (SM)
 - b. Again suggest that failure envelop be selected to yield $c = 0$ psf by using 2nd and 3rd circles – effective stress parameters: $\phi = 33^\circ$ and $c = 0$ psf – total stress parameters: $\phi = 12^\circ$ and $c = 500$ psf – neither set of parameters are listed on the data sheet
 5. B5-2
 - a. Use same circles to draw both failure envelopes - effective stress parameters: $\phi = 30^\circ$ and $c = 0$ psf – total stress parameters: $\phi = 15^\circ$ and $c = 200$ psf
- v. Consolidation tests - 6 tests - the number and distribution of tests performed appears reasonable given previous data were also available – the following comments relate to individual tests:

1. B1-2b
 - a. The test suggests that the sample is slightly preconsolidated ($p_o = 800$ psf and $p_c = 1,100$ psf)
 - b. The compression index, C_c , is not listed on the data sheet but is shown in Appendix E under Segment B as $C_c = 0.38$ - the curve suggests it might be slightly less at $C_c = 0.34$
 - c. The recompression index, C_r , was estimated by the slope of the unload curve at $C_r = 0.04$
 2. B3-3b
 - a. The test suggests that the sample is very slightly preconsolidated ($p_o = 950$ psf and $p_c = 1,050$ psf) and should be assumed to be normally consolidated
 - b. The compression index, C_c , is not listed on the data sheet but is shown in Appendix E under Segment D as $C_c = 0.39$ - the curve suggests it might be slightly more at $C_c = 0.43$
 3. B3-4b
 - a. The test suggests that the sample is preconsolidated ($p_o = 1,200$ psf and $p_c = 2,500$ psf)
 - b. The compression index, C_c , is not listed on the data sheet but is shown in Appendix E under Segment D as $C_c = 0.31$ which appears reasonable
 - c. The recompression index, C_r , was estimated by the slope of the unload curve at $C_r = 0.06$
 4. B3-5a
 - a. The test suggests that the sample is preconsolidated ($p_o = 1,700$ psf and $p_c = 3,200$ psf)
 - b. The compression index, C_c , is not listed on the data sheet but is shown in Appendix E under Segment D as $C_c = 0.30$ which appears reasonable
 - c. The recompression index, C_r , was estimated by the slope of the unload curve at $C_r = 0.06$
 5. B4-3b – the test was not used as it classified silty sand
 6. B5-2b
 - a. The test suggests that the sample is preconsolidated ($p_o = 560$ psf and $p_c = 1,050$ psf) but the curve looks a little suspect - assume normally consolidated?
 - b. The compression index, C_c , is not listed on the data sheet but is shown in Appendix E under Segment B as $C_c = 0.36$ which appears reasonable
 - c. The recompression index, C_r , was estimated by the slope of the unload curve at $C_r = 0.04$ if sample is assumed to be preconsolidated
5. Section 3.0 Subsurface Conditions, Page 3 – Table 1 Subsurface Materials and Conditions, provides very brief soil description data, groundwater data, and other notes for each levee segment. As noted above, it would be helpful to expand this into a more detailed narrative about the subsurface conditions within the text of the TM.
6. Section 4.0 Geotechnical Analyses, Page 3
- a. Section 4.1 Introduction on Page 3 describes the findings of the Draft PI Report and the Draft AA Report and introduces the analyses assumptions. Cross sections used in the analyses are

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summarized in Table 2 and locations are shown on Exhibits G-1 through G-4. Some explanation as to why Segment A was not considered in the analyses and the extent to which Segment E was considered should be included.

- i. The TM states that analyses were completed for each of the following segments:

Segment	Alternatives Considered	Cross Sections Evaluated	<u>Analyses Cases Considered for Underseepage Mitigation</u>		
			Without		With
			200-yr DWSE	200-yr DWSE	200-yr DWSE + 3 ft
B	Adjacent levee	79+00	1) Underseepage	1) Underseepage, 2)	1) Steady-
C	Setback levee	122+00	for Segments B,	steady-state-seepage	state-seepage
D	Setback levee	167+00	C, D, F, G	slope stability, 3)	slope stability
F	Setback levee	241+00		rapid-drawdown slope	for Segments
G	Adjacent levee	283+00		stability, and 4) end-	B, C, D, F, G
				of-construction slope	
				stability for Segments	
				B, C, D, F, G	

- i. The TM also states that both immediate (elastic) and long-term (consolidation) settlements were estimated for each cross section.
 - ii. The assumption was made that the SSR Levee qualified as an *“intermediately loaded levee”* which was defined as a levee that *“does not experience a water surface elevation of one foot or higher above the elevation of the levee toe [for] at least once a day for more than 36 days per year on average.”* The TM notes that this assumption must be confirmed by the design team. This may be a significant issue and it seems it should have been confirmed by the design team with whom ever has the responsibility to make the decision.
- b. Section 4.2 Preliminary Underseepage Analyses Results, Page 4
- i. The text notes that the hydraulic conductivity values used in the analyses are preliminary and are shown on Table C-1. As noted above, it would be helpful if there was discussion about the process used to develop the recommended values in Table C-1.
 - 1. The kh values for the following two Soil Types appear to be incorrect in Table C-1.
 - a. Clay, Sandy Clay, PI < 20, $\gamma_d > 85$ pcf, k_h should be 2.0×10^{-5} cm/sec not 2.0×10^{-4} cm/sec
 - b. Silt, Clayey Silt, Silty Sand, PI > 4, $\gamma_d > 85$ pcf, k_h should be 2.0×10^{-5} cm/sec not 2.0×10^{-4} cm/sec
 - c. Under the Clay, Sandy Clay Soil Type what data was used to support the inclusion of $k_h = 6 \times 10^{-7}$ cm/sec for SC soil?
 - ii. The text states that two cases were analyzed for the without mitigation condition: 1) no landside borrow excavation or filled in excavation, and 2) landside borrow excavation remained open. The text states that Case 1 – no land side excavation was critical. This seems counter-intuitively.
 - iii. The TM cross sections of Exhibits C-7 and C-8 with sand (SP) berms and homogeneous (non-zoned) clayey soil levee embankments were used in the analyses. The Blackburn TM included in the HDR IPD Report noted that levee zoning and soil mixing are very important

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design subjects and that they would be considered in more detail in the Blackburn TM – FPD. It appears that no consideration was given to using a zoned cross section. As noted in the Review Comments on HDR IPD Report, this issues should be reevaluated given the greater quantity of Type 2 fill (including ML and CH soils) available for use from the adjacent borrow pits.

- iv. The analyses results are not discussed but are summarized in Tables 3 through 5. A discussion of the results would be helpful.
- v. Section 4.2.1 Through Seepage on page 5 – the analyses indicate that through seepage is not an issue post-mitigation.

c. Section 4.3 Preliminary Slope Stability Analyses Results, Page 5

- i. The text notes that the shear strength and unit weight values used in the analyses are preliminary and are shown on Table D-1. As noted above, it would be helpful if there was discussion about the process used to develop the recommended values in Table D-1.
 - 1. A suggested revised Table D-1 is shown below given the suggested changes recommended above in the discussion of Laboratory Testing

Table D – 1 Preliminary Soil Strength Parameters for Slope Stability Analysis

<u>Soil Type</u>	<u>Effective Strength Parameters</u>	<u>Total Strength Parameters</u>
New Embankment Fill (CL, CL-ML, SC, ML, SM)	$\phi = 30^\circ, c = 0 \text{ psf}$	$\phi = 16^\circ, c = 100 \text{ psf}$
Qa (ML and CL) above ▼	$\phi = 31^\circ, c = 0 \text{ psf}$	$\phi = 19^\circ, c = 300 \text{ psf}$
Qa (CL and CH) above ▼	$\phi = 33^\circ, c = 0 \text{ psf}$	$\phi = 16^\circ, c = 100 \text{ psf}$
Qa (Non-plastic ML and SM below ▼)	$\phi = 33^\circ, c = 0 \text{ psf}$	$\phi = 12^\circ, c = 400 \text{ psf}$
SM below Qa (SC, SP-SC, SW-SC, SW, SP, GP-GC, GW-GC, GW, GP)	$\phi = \text{formula}$	NA

2. It is very hard to understand how the data from other sources was used to set the shear strength parameters. This should be discussed in Appendix D.

- ii. The results are not discussed but are summarized in Tables 6 and 7. A discussion of the results would be helpful.

d. Preliminary Settlement Analyses Results, Page 6

- i. The results are not discussed but are summarized in Table 8. A discussion of the results would be helpful.

7. Section 5.0 Review of SAGE Report for Setback Levee in Segment E, Page 6
 - a. SAGE recommended:
 - i. Southern portion of Segment – 65-foot deep cut-off wall
 - ii. Northern portion of Segment – 145-foot wide seepage berm
 - b. Blackburn reviewed the SAGE report and concluded
 - i. Southern portion of Segment – potentially reduce the proposed cutoff wall to “around 25 ft”
 - ii. Northern portion of Segment – a 65-foot to 75-foot deep cutoff wall may be “a viable solution”
 - vi. The text states that “[a]dditional subsurface exploration and analyses are necessary to refine the subsurface profile and support our conclusions---.” Why was this segment excluded from present TM, a similar amount of subsurface data appears to be available as for the other segments?
8. Section 6.0 Preliminary Conclusions, Page 7
 - a. The data provided in Appendix F Preliminary Geotechnical Analysis, were reviewed in detail to provide an indication of the review comments that would be typical for the remainder of the segments. Time did not allow a complete review of each segment. Only general comments and comments on settlement estimates are provided for the remaining segments.
 - b. Section 6.1 Segment A, Page 7 – Preliminary conclusions are drawn but this segment is not considered anywhere previously in the TM. Why not discuss this in an added Section 4.2.2?
 - d. Section 6.2 Segment B, Page 7 – The text indicates that an adjacent levee with a 250-foot wide seepage berm is a viable option. It notes that additional subsurface exploration and analyses are being performed and that an adjacent levee with a deep cutoff wall or combination of an adjacent levee with a shallow cutoff wall and relief wells is being evaluated. The following comments relate to the review of this segment:
 - i. In the past the Corps has not look favorably on the use of relief wells – has this been discussed with the Corps?
 - ii. If this is the FPD TM why was this supplemental analysis not included for review based on the available data?
 - iii. Only Blackburn boring logs were provided for review. The cross section at this station shown on Exhibit G-5 defines the stratigraphy used in the seepage and stability analyses.
 1. There are insufficient data included to evaluate if the selected cross section is the most representative within the segment. This is where a profile along the segment would be helpful.
 2. There are insufficient data included to evaluate whether sub-segments may be needed to define differing subsurface conditions.
 3. The cross section and labeling of the strata appears reasonable based on the subsurface data shown.

- iv. Appendix C Preliminary Underseepage Parameter Selection indicates that the hydraulic conductivity values for Qa soils to depths of 15 to 40 feet were selected from Table C-1 for the seepage analysis. Table C-1 also indicates that the hydraulic conductive values for soils below the Qa soils and all soils with < 13% fines were obtained from *Table 4 Permeability Values Recommended by the BOSC for the Natomas Levees*. The following comments relate to the selection of permeability values for Segment B.
1. Exhibits G-6 through G-8 suggest that the above described approach was not followed to establish k_v and k_h values for all strata.
 - a. The surficial lean clay (CL) blanket that extends from the ground surface at about El 18 to about El 11, designated Material (5), was assumed to have a $k_h = 2.0 \times 10^{-5}$ cm/sec and $k_v = 5.0 \times 10^{-6}$ cm/sec. Table C-1 suggests that the values for lean clay with a $PI < 20$ and for $\gamma_d < 85$ pcf are $k_h = 4.0 \times 10^{-4}$ cm/sec and $k_v = 1.0 \times 10^{-4}$ cm/sec. The former values of k appear to be more appropriate then the latter conservative k values required by Table C-1. The BOSC recommended values of $k_h = 1.0 \times 10^{-5}$ cm/sec and $k_v = 2.5 \times 10^{-6}$ cm/sec would even be a better choice based on the laboratory testing.
 - b. The silt (ML) and silty sand (SM) layer from about El -50 to about El -61, designated Material (19), was assumed to have a $k_h = 1.2 \times 10^{-4}$ cm/sec and $k_v = 3.0 \times 10^{-5}$ cm/sec and was obtained from Table C-1. Using the criteria established on Table C-1, the BOSC table should have been used and the values selected should have been $k_h = 3.0 \times 10^{-5}$ cm/sec and $k_v = 7.5 \times 10^{-6}$ cm/sec.
 2. These changes would not have impacted the results of first seepage case, an adjacent levee without seepage mitigation, shown on Exhibit G-6. But, they may alter the results for the adjacent levee with a 250-foot wide seepage berm for the 200-yr WSE and the 200-yr WSE + 3 feet (HTOL) shown on Exhibits G-7 and G-8.
- v. Appendix D Preliminary Slope Stability Parameter Selection indicates the shear strength parameters included in Table D-1 were used to perform stability analyses. The analyses are shown on Exhibits G-9 through G-12. The following comments relate to the selection of shear strength parameters for Segment B.
1. The suggested revised shear strength parameters shown in revised Table D-1 above should considered for the analyses. Comments are therefore limited related to selection of shear strength parameters.
 2. It would be helpful to show the critical slip circles associated with the lowest factor of safety shown on Exhibits G-9 similar to the other Exhibits - or is it just an extremely shallow circle?
 3. The center of the critical slip circles do not appear to be plotted correctly.
 4. Two points to consider about the steady state seepage analysis shown on Exhibits G-9 and G-10:
 - a. The use of an effective stress cohesion value, $c' > 0$ psf for the embankment fill should be reconsidered. It is likely, that over time this apparent cohesion will be reduced to zero with repeated desiccation and wetting which will result in softening for shallow slope failure.
 - b. Although the factors of safety for steady seepage analyses shown on Exhibits G-9 and G-10 for the 200-yr WSE and the 200-yr WSE + 3 feet (HTOL) are quite high, the cohesion has a major impact on factor of safety.

5. On Exhibit G-11, for the rapid drawdown case:
 - a. The bottom figure appears to have a circular slip surface and the top figure a compound non-circular slip surface - is this a drafting error or was a compound surface used in the analysis?
 - b. Total strength parameters are lists for Material (24), Silt, Silty Sand, but there are no parameters listed in Table D-1.
6. Total strength parameters should be used for the end of construction case.
- vi. Appendix E Preliminary Settlement Parameter Selection indicates the consolidation characteristics of fine grained soils were developed from laboratory tests and that modulus data for granular soils were obtained from correlations with SPT N-values. The text notes that up to 1.0 to 1.5 feet of immediate settlement should be anticipated. The following comments relate to the selection of these parameters for Segment B.
 1. Review of the analysis suggests that the layer thicknesses selected for evaluation of settlement, shown on page 3 of 6, are not the same as shown in Exhibit G-5. If different stratigraphy was used it should be identified in the analysis.
 2. The total settlement includes settlement of the levee under its own weight plus settlement of underlying soils and includes both immediate (0.72 ft) and consolidation settlement (0.45 ft) for a total settlement estimate of 1.17 ft. This total settlement amount appears reasonable.
- e. Section 6.3 Segment C, Page 7 -_The text indicates that a setback levee with a 115-foot wide seepage berm is a viable option. It notes that additional subsurface exploration and analyses are being performed and that a setback levee with a deep cutoff wall is being evaluated.
 - i. If this is the FPD TM why was this supplemental analysis not included for review based on the available data?
 - ii. Only Blackburn boring logs were provided for review. The cross section at this station shown on Exhibit G-13 defines the stratigraphy used in the seepage and stability analyses.
 1. There are insufficient data included to evaluate if the selected cross section is the most representative within the segment. This is where a profile along the segment would be helpful.
 2. There are insufficient data included to evaluate whether sub-segments may be needed to define differing subsurface conditions – the settlement analysis, discussed below, suggests that a second cross section should have been evaluated.
 3. The cross section and labeling of the strata appears reasonable based on the subsurface data shown.
 - iii. Appendix C Preliminary Underseepage Parameter Selection indicates that the hydraulic conductivity values for Qa soils to depths of 15 to 40 feet were selected from Table C-1 for the seepage analysis. Table C-1 also indicates that the hydraulic conductive values for soils below the Qa soils and all soils with < 13% fines were obtained from *Table 4 Permeability Values Recommended by the BOSC for the Natomas Levees*. The following comments relate to the selection of permeability values for Segment C.
 1. Exhibits G-14 through G-16 suggest that the above described approach was not followed to establish k_v and k_h values for all strata.
 - a. The surfical plastic silt and lean clay (ML/CL) blanket that extends from the ground surface at about El 21 to about El 16, designated Material (9), was assumed to have a

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$k_h = 2.0 \times 10^{-5}$ cm/sec and $k_v = 5.0 \times 10^{-6}$ cm/sec. Table C-1 suggests that the values for plastic silt with a $PI < 20$ and for $\gamma_d < 85$ pcf are $k_h = 4.0 \times 10^{-4}$ cm/sec and $k_v = 1.0 \times 10^{-4}$ cm/sec. Based on the laboratory testing the later values of k appear to be more appropriate.

- b. The sand and gravel designated Material (17) is classified as GP on Boring B-4, SP on the Kleinfelder Boring KA-06-12, and sand or gravel and sand on CPT -10. There is are no data that suggest the material is classified GM or GC. The $k_h = 4.0 \times 10^{-4}$ cm/sec seems to low for this material and is the same value used for Material (6) which is classified ML/S/M). The BOSC Table 4 suggests that a value of $k_h = 1.0 \times 10^{-2}$ or 1.0×10^{-3} cm/sec would be reasonable.
2. These changes would not have impacted the results of first seepage case, an adjacent levee without seepage mitigation, shown on Exhibit G-14. But, they may alter the results for the setback levee with a 115-foot wide seepage berm for the 200-yr WSE and the 200-yr WSE + 3 feet (HTOL) shown on Exhibits G-15 and G-16.
- iv. Appendix D Preliminary Slope Stability Parameter Selection indicates the shear strength parameters included in Table D-1 were used to perform stability analyses. The analyses are shown on Exhibits G-17 through G-20. The following comments relate to the selection of shear strength parameters for Segment C.
1. The suggested revised shear strength parameters shown in revised Table D-1 above should considered for the analyses. Comments are therefore limited related to selection of shear strength parameters.
 2. The center of the critical slip circles do not appear to be plotted correctly.
 3. Two points to consider about the steady state seepage analysis shown on Exhibits G-17 and G-18:
 - a. The use of an effective stress cohesion value, $c' > 0$ psf for the embankment fill should be reconsidered. It is likely, that over time this apparent cohesion will be reduced to zero with repeated desiccation and wetting which will result in softening for shallow slope failures.
 - b. Although the factors of safety for steady seepage analyses shown on Exhibits G-17 and G-18 for the 200-yr WSE and the 200-yr WSE + 3 feet (HTOL) are quite high, the cohesion has a major impact on factor of safety.
 4. On Exhibit G-19, for the rapid drawdown case, the total strength parameters are lists for Material (6), Silt, Silty Sand, but there are no parameters listed in Table D-1.
 5. Total strength parameters should be used for the end of construction case.
- v. Appendix E Preliminary Settlement Parameter Selection indicates the consolidation characteristics of fine grained soils were developed from laboratory tests and that modulus data for granular soils were obtained from correlations with SPT N-values. The text notes that up to 1.0 to 1.5 feet of immediate settlement should be anticipated. The following comments relate to the selection of these parameters for Segment C.
1. This settlement amount appears reasonable.
 2. The next paragraph states, almost as an after though, that from Station 140+00 to 165+00 the magnitude of settlement could approach 2.5 top 3.0 feet with up to 2.0 feet settlement occurring over a period of 1.5 years after construction is completed. There is no way to evaluate the subsurface conditions in this area since neither a profile or a cross section is provided.

3. Three consolidation tests were performed from samples obtained from Boring B-3 at the northern end of this segment. The upper most sample was normally consolidated, but the other two samples appear to be preconsolidated by 1,200 to 1,500 psf, as discussed above. The estimated settlement from Appendix F-3 is 2.75ft with 1.63 ft being consolidation settlement, but the entire layer was assumed to be normally consolidated. These analyses should be reviewed.
- f. Section 6.4 Segment D, Page 8 - The text indicates that a setback levee with a shallow cutoff wall is a viable option. It notes that additional subsurface exploration and analyses are being performed to refine the design.
- i. This is a reasonable approach.
 - ii. Only Blackburn boring logs were provided for review. The cross section at this station shown on Exhibit G-21 defines the stratigraphy used in the seepage and stability analyses.
 1. There are insufficient data included to evaluate if the selected cross section is the most representative within the segment. This is where a profile along the segment would be helpful.
 2. There are insufficient data included to evaluate whether sub-segments may be needed to define differing subsurface conditions.
 3. The cross section and labeling of the strata appears reasonable based on the subsurface data shown.
 - iii. Appendix C Preliminary Underseepage Parameter Selection indicates that the hydraulic conductivity values for Qa soils to depths of 15 to 40 feet were selected from Table C-1 for the seepage analysis. Table C-1 also indicates that the hydraulic conductive values for soils below the Qa soils and all soils with < 13% fines were obtained from *Table 4 Permeability Values Recommended by the BOSC for the Natomas Levees*. The following comments relate to the selection of permeability values for Segment D.
 1. Exhibits G-22 through G-23 illustrate the non-mitigation analysis for both the 200-yr WSE and the 200-yr WSE + 3 feet (HTOL) and Exhibits G-24 and G-25 illustrate the analysis with a 25-foot deep soil-bentonite cutoff wall. These analysis suggest the cutoff wall is required to meet exit gradient criteria and to keep the phreatic surface from breaking out on the face of the levee.
 - a. This approach appears reasonable given the presence of cravase splay deposits shown on the Geomorphology Map of Exhibit G-1 in the Blackburn TM dated January 25, 2011.
 - iv. Appendix D Preliminary Slope Stability Parameter Selection indicates the shear strength parameters included in Table D-1 were used to perform stability analyses. The analyses are shown on Exhibits G-26 through G-29. The following comments relate to the selection of shear strength parameters for Segment D.
 1. The suggested revised shear strength parameters shown in revised Table D-1 above should considered for the analyses. Comments are therefore limited related to selection of shear strength parameters.
 2. The center of the critical slip circles do not appear to be plotted correctly.
 3. Two points to consider about the steady state seepage analysis shown on Exhibits G-26 and G-27:

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- a. The use of an effective stress cohesion value, $c' > 0$ psf for the shallow portion of the embankment fill should be considered. It is likely, that over time this apparent cohesion will be reduced to zero with repeated desiccation and wetting which will result in softening.
 - b. Effective strength parameters should be shown for the slurry wall although it does not appear to enter the computation based on the location of the critical slip circle.
- 4. On Exhibit G-28, for the rapid drawdown case, the total strength parameters are lists for Material (12), Silt, Silty Sand, but there are no parameters listed in Table D-1.
- 5. Total strength parameters should be used for the end of construction case on Exhibit G-29.
- v. Appendix E Preliminary Settlement Parameter Selection indicates the consolidation characteristics of fine grained soils were developed from laboratory tests and that modulus data for granular soils were obtained from correlations with SPT N-values. The text notes that the magnitude of settlement could approach 2.5 to 3.0 feet with up to 2.0 feet settlement occurring over a period of 1.5 years after construction is completed. This is the settlement estimate referred to in Segment C. See comment for Segment C. The recommended test section appears appropriate if the settlement estimate is reasonable.
- g. Section 6.5 Segment E, Page 8 – This segment was evaluated by SAGE and was discussed under Section 5.0.
 - i. Blackburn commented on the SAGE evaluation and suggested the following:
 - 1. Southern portion of Segment – reduce cutoff wall to about 25 ft.
 - 2. Northern portion of Segment – use a 65 to 75-foot deep cutoff.
 - 3. The text notes that additional subsurface exploration and analyses are being performed to refine the recommendations. This is a reasonable approach.
 - ii. Why was this segment excluded from present TM, a similar amount of subsurface data appears to be available as for the other segments?
 - iii. The text states that settlement was not evaluated but goes on to state that in the southern portion of the segment the settlement may approach 2.5 to 3 feet and in the north half of the segment the settlement is expected to be up to about 1-foot and be immediate. These settlement estimates appear to relate to the estimates for Segments D and F on either side of Segment D. Why was the settlement not evaluated based on the data available?
- h. Section 6.6 Segment F, Page 8 - The text indicates that a setback levee with a 100-foot wide seepage berm is a viable option. It also notes that a 65-foot to 75-foot deep cutoff wall may be a viable option compared to a seepage berm in the extreme southern end of the segment (see Item g above in Section 6.5). It notes that additional subsurface exploration and analyses are being performed to evaluate whether a deep cutoff wall is feasible rather than a berm. An adjacent levee with a seepage berm is also being evaluated.
 - i. If this is the FPD TM why were these supplemental analysis not included for review based on the available data?
 - ii. Only Blackburn boring logs were provided for review. The cross section at this station shown on Exhibit G-30 defines the stratigraphy used in the seepage and stability analyses.

1. There are insufficient data included to evaluate if the selected cross section is the most representative within the segment. This is where a profile along the segment would be helpful.
 2. There are insufficient data included to evaluate whether sub-segments may be needed to define differing subsurface conditions.
 3. The cross section and labeling of the strata appears reasonable based on the subsurface data shown.
- iii. Appendix C Preliminary Underseepage Parameter Selection indicates that the hydraulic conductivity values for Qa soils to depths of 15 to 40 feet were selected from Table C-1 for the seepage analysis. Table C-1 also indicates that the hydraulic conductive values for soils below the Qa soils and all soils with < 13% fines were obtained from *Table 4 Permeability Values Recommended by the BOSC for the Natomas Levees*. The following comments relate to the selection of permeability values for Segment F.
1. Exhibits G-31 through G-33 suggest that the above described approach was followed to establish k_v and k_h values for all strata.
- iv. Appendix D Preliminary Slope Stability Parameter Selection indicates the shear strength parameters included in Table D-1 were used to perform stability analyses. The analyses are shown on Exhibits G-34 through G-37. The following comments relate to the selection of shear strength parameters for Segment F.
1. The suggested revised shear strength parameters shown in revised Table D-1 above should considered for the analyses. Comments are therefore limited related to selection of shear strength parameters.
 2. The center of the critical slip circles do not appear to be plotted correctly.
 3. The use of an effective stress cohesion value, $c' > 0$ psf for the shallow portion of the embankment fill should be considered. It is likely, that over time this apparent cohesion will be reduced to zero with repeated desiccation and wetting which will result in softening.
 4. On Exhibit G-36, for the rapid drawdown case, the total strength parameters are lists for Material (5), Silt, Silty Sand, but there are no parameters listed in Table D-1.
 5. Total strength parameters should be used for the end of construction case on Exhibit 37.
- v. Appendix E Preliminary Settlement Parameter Selection indicates the consolidation characteristics of fine grained soils were developed from laboratory tests and that modulus data for granular soils were obtained from correlations with SPT N-values. The text notes that up to 1-foot of immediate settlement is anticipated, but no analysis was completed. Was there sufficient existing data to perform a qualified settlement estimate?
- i. Section 6.7 Segment G, Page 9 - The text indicates that an adjacent levee with a 76-foot minimum width seepage berm is a viable option. It notes that additional subsurface exploration and analyses are being performed to evaluate whether a cutoff wall is feasible rather than a berm.
- i. If this is the FPD TM why were these supplemental analysis not included for review based on the available data?
 - ii. Only Blackburn boring logs were provided for review. The cross section at this station shown on Exhibit G-38 defines the stratigraphy used in the seepage and stability analyses.
 1. There is only one boring log shown on the cross section. The second stratum is labeled ML/CL but the log describes the material as ML.

2. How was the boundary between the GP and SP strata established since the boring terminates in the GP material?
 3. There are insufficient data included to evaluate if the selected cross section is the most representative within the segment. This is where a profile along the segment would be helpful.
 4. There are insufficient data included to evaluate whether sub-segments may be needed to define differing subsurface conditions.
 5. The cross section and labeling of the strata appears reasonable based on the subsurface data shown.
- iii. Appendix C Preliminary Underseepage Parameter Selection indicates that the hydraulic conductivity values for Qa soils to depths of 15 to 40 feet were selected from Table C-1 for the seepage analysis. Table C-1 also indicates that the hydraulic conductive values for soils below the Qa soils and all soils with < 13% fines were obtained from *Table 4 Permeability Values Recommended by the BOSC for the Natomas Levees*. The following comments relate to the selection of permeability values for Segment G
1. The following changes are suggested for Exhibits G-39 through G-41.
 - a. The upper lean clay layer (CL) has a recorded laboratory vertical permeability $k_v = 1.2 \times 10^{-4}$. This value appears too high and is considered very suspect – perhaps it was disturbed. Other similar sample are about an order of magnitude lower. It is suggested that the same permeability values used for the second strata be used for both strata.
 - b. There doesn't appear to be any data to suggest that the GP and SP strata should have a permeability value as high as $k_h = 1.0 \times 10^{-2}$ cm/sec. These types of soils on other sections were assigned $k_h = 3.0 \times 10^{-3}$ cm/sec.
- iv. Appendix D Preliminary Slope Stability Parameter Selection indicates the shear strength parameters included in Table D-1 were used to perform stability analyses. The analyses are shown on Exhibits G-42 through G-45. The following comments relate to the selection of shear strength parameters for Segment G.
1. The suggested revised shear strength parameters shown in revised Table D-1 above should considered for the analyses. Comments are therefore limited related to selection of shear strength parameters.
 2. The center of the critical slip circles do not appear to be plotted correctly.
 3. Two points to consider about the steady state seepage analysis shown on Exhibits G-42 and G-43:
 - a. The use of an effective stress cohesion value, $c' > 0$ psf for the shallow portion of the embankment fill should be considered. It is likely, that over time this apparent cohesion will be reduced to zero with repeated desiccation and wetting which will result in softening.
 - b. Although the factors of safety for steady seepage analyses shown on Exhibits G-42 and G-43 for the 200-yr WSE and the 200-yr WSE + 3 feet (HTOL) are quite high, the cohesion has a major impact on factor of safety.
 4. Total strength parameters should be used for the end of construction case on Exhibit G-45.
- v. Appendix E Preliminary Settlement Parameter Selection indicates the consolidation characteristics of fine grained soils were developed from laboratory tests and that modulus data for granular soils were obtained from correlations with SPT N-values. The text notes

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that up to 1 to 1.5 feet of immediate settlement is anticipated. This settlement amount appears reasonable.

9. Section 7.0 Additional Exploration and Analysis, Page 9 – The text states that “*additional exploration, laboratory testing and underseepage analysis within Segments B, F, and G---are being planned for---Preliminary Design*” as noted in Table 9. If this is the FPD TM why were these supplemental analysis not included for review based on the available data? Section 6.0 Preliminary Conclusions and Table 9 noted that subsurface exploration and analyses were under way also for Segments A, C, D, and E. Is there a reason why these segments were not included?

Appendix 3 Geomorphology Report– not reviewed

Appendix 4 Civil Design Considerations TM – comments included in the text

Appendix 5 Environmental TM – not reviewed

Appendix 6 Cost Opinions – comments included in the text