



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

Technical Memorandum

Recommendations for Transition in Cutoff Wall Depth in Reach 13 Feather River West Levee Project

To Chris Krivanec, HDR
Les Harder, HDR

Project Feather River West Levee

Date June 18, 2014

Subject Review of Transition in Cutoff Wall Depth in Reach 13 and the Need for Ditch Infill to Address Potential End Around Effects

Prepared By Robert Green, PE, GE

Reviewed By Michael Hughes, PE
Khaled Chowdhury, PE, GE

INTRODUCTION

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

This Technical Memorandum addresses recommendations for the transition in SB cutoff wall depth in Reach 13 between Station 915+50 and 916+10. In this location, the SB cutoff wall acts as a stitching wall tying together the upper, interbedded fine-grained layers to form a thickened blanket. The original design tip elevation for the SB cutoff wall was +25 feet, which is about 35 feet into the foundation soils. At around Station 915+50, logging of the cuttings coming out of the trench excavation showed a thinning and shallowing of the fine-grained layers, such that the 'stitched' blanket layer was not thick enough to meet underseepage criteria. As a result, the base of the wall was lowered to elevation -5 feet between Station 916+10 and 922+36 to tie into a deeper aquiclude layer.

At the location where the tip of the SB cutoff wall transitions from elevation +25 feet to - 5 feet, there is an area about 100 to 150 feet long at around Station 916+00 where the thinner blanket could have issues due to end around effects. Therefore, additional analysis was performed to calculate exit gradients and assess whether end around effects were a problem.

To assist in the evaluation of end around effects, two additional explorations were performed on the landside of the levee at around Station 916+00 to provide information on the depth of the blanket layer.

This Technical Memorandum presents the results of the assessment and provides recommendations to address end around effects.



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

Technical Memorandum Recommendations for Transition in Cutoff Wall Depth in Reach 13 Feather River West Levee Project

SEEPAGE ANALYSES

Two-Dimensional Analyses

URS performed two-dimensional seepage analyses using SEEP/W to estimate the seepage gradients on the landside of the levee. The analyses were performed for a cross section with the shallow blanket condition and SB cutoff wall tip at elevation +25 feet. The cross section is shown in Figure 1 and the analyses results are presented in Figure 2.

The analyses show the exit gradient at the existing relief well ditch 15 feet from the levee toe is 0.52 for the 200-year plus one foot water surface elevation (WSE) and 0.49 at a swale 93 feet from the levee toe. The corresponding exit gradient criteria at these offset distances is 0.53 and 0.69 respectively. Analyses were also run for the 200-year plus 4 feet WSE as shown in Figure 3. The exit gradient at the relief well ditch was 0.59 and 0.55 at the swale. The corresponding exit gradient criteria are 0.63 and 0.79 respectively. Therefore, the calculated exit gradients meet criteria.

The existing relief wells were not modeled as part of the analyses, because it is proposed to convert the existing relief wells to observation wells once it has been confirmed that the cutoff wall in Reach 13 is performing as intended¹.

Three-Dimensional Analyses

The two-dimensional seepage analyses are conservative because the effects of lateral dissipation of pressure head around the end of the cutoff wall are ignored. HDR performed three-dimensional seepage analyses at the 200-year plus 1 foot WSE using the plan view option in SEEP/W to estimate the pressure head within the aquifer layer. The same waterside and landside boundary conditions as the two-dimensional analyses were used, i.e., 200-year plus 1 foot WSE at the waterside boundary and ground surface elevation at the landside boundary 2000 feet from the levee. The analyses were run for conditions with and without the cutoff wall to see the differences in pressure head between the two models. The results show that the pressure head at the location of the swale is about 3 feet less for the model with the cutoff wall. The analyses results are presented in Figures 4 and 5.

¹ To eliminate the need for continued maintenance of the relief wells in Reach 13, it is proposed remove/block the subsurface discharge pipe and convert the relief wells to observation wells. However, due to the past performance issues and complex subsurface conditions in Reach 13, it is intended to leave the existing relief wells in place until the newly constructed cutoff wall has been tested during a high water event and shown to perform as intended.



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

Technical Memorandum Recommendations for Transition in Cutoff Wall Depth in Reach 13 Feather River West Levee Project

CONCLUSIONS AND RECOMMENDATIONS

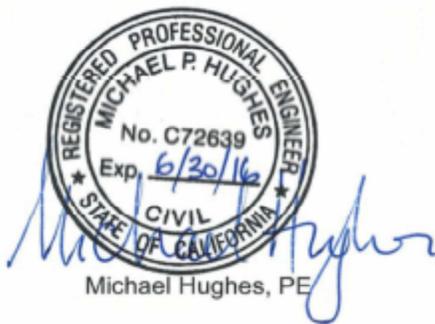
Based on the 2D analyses results, the exit gradients at locations in the vicinity of the cutoff wall transition where the blanket is thinnest and could be most vulnerable to end around effects meet criteria and remediation is not required.

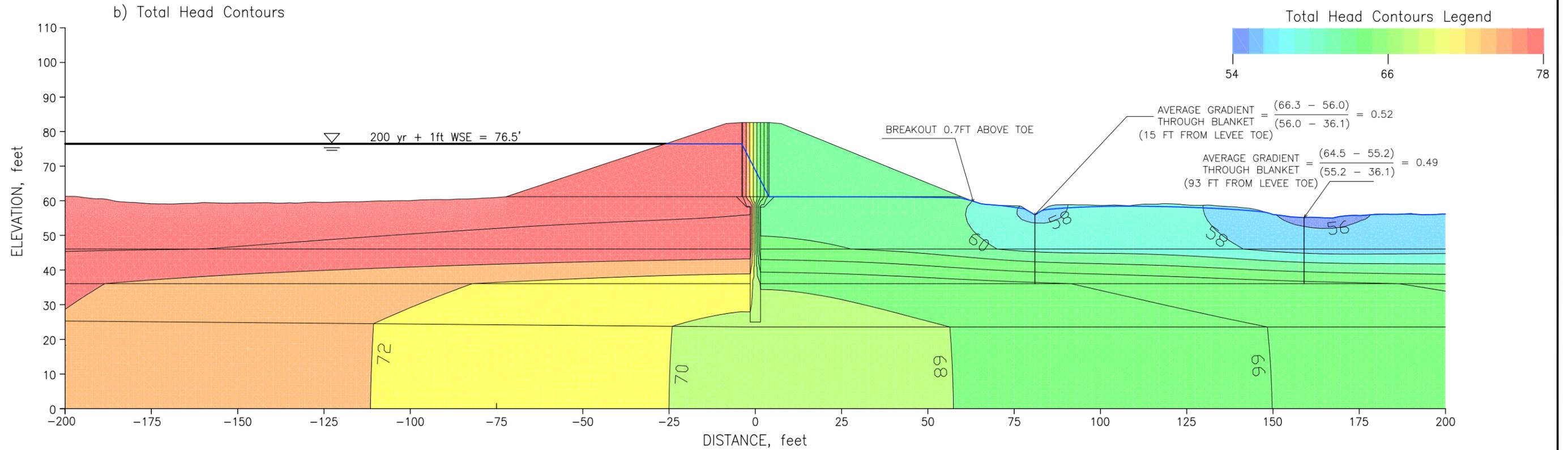
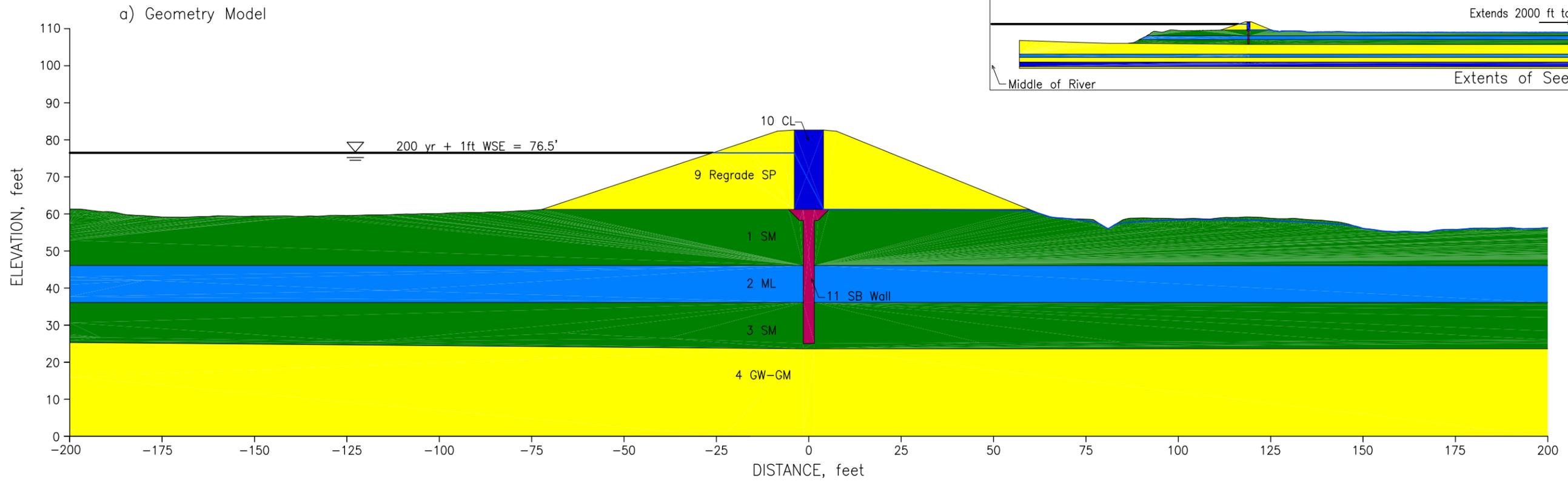
Furthermore, at the transition between the shallower and deeper sections of cutoff wall, 3D analyses show that there is a reduction in pressure head in the aquifer layer due to the shielding effects of the deeper wall and radial dissipation of pore pressures around the wall. As a result of this, the vertical exit gradients in the field are likely lower than those calculated from the results of 2D analyses.

LIMITATIONS

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

The limitations section of the GDRR for Segments 1 through 6, dated October 2012 also applies in full to this memorandum.





PLOT BY: C:\CNC\JACK_HONG - Jun 12, 2014 - 9:21:56am
 DRAWING: C:\SECO\PRJ\Analysis\14-TOA\4-3_Drf_Coo_Rec_Report\Appendix\Appendix C - Seepage, Stability, BOD Results\Steady State and 915+00_SS_Midstream_Seep_200r+1.dwg



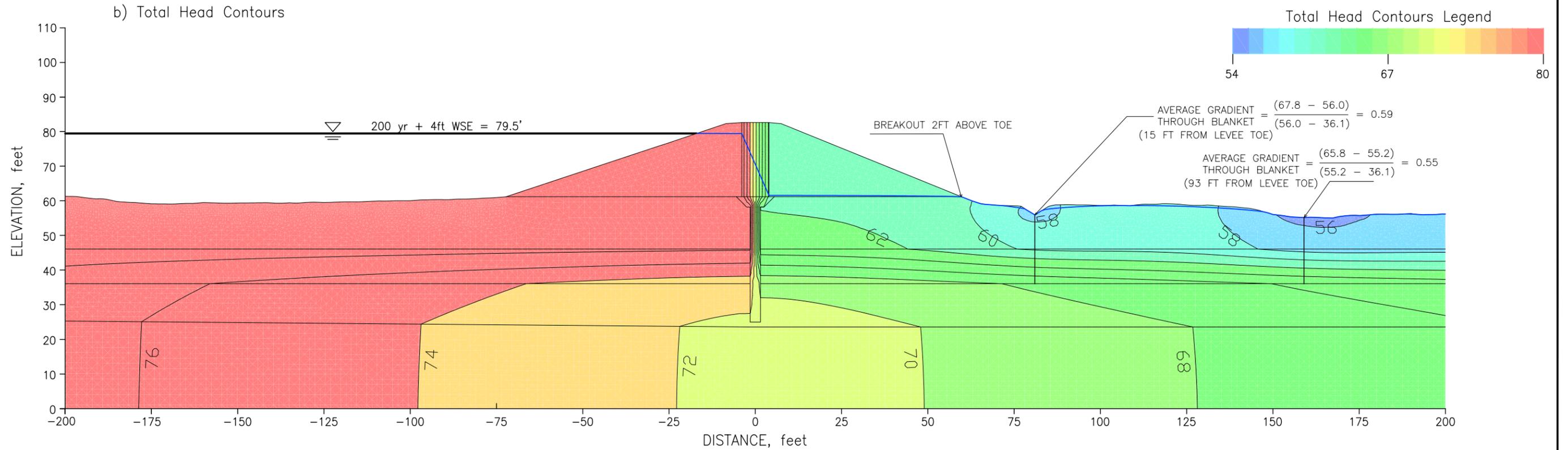
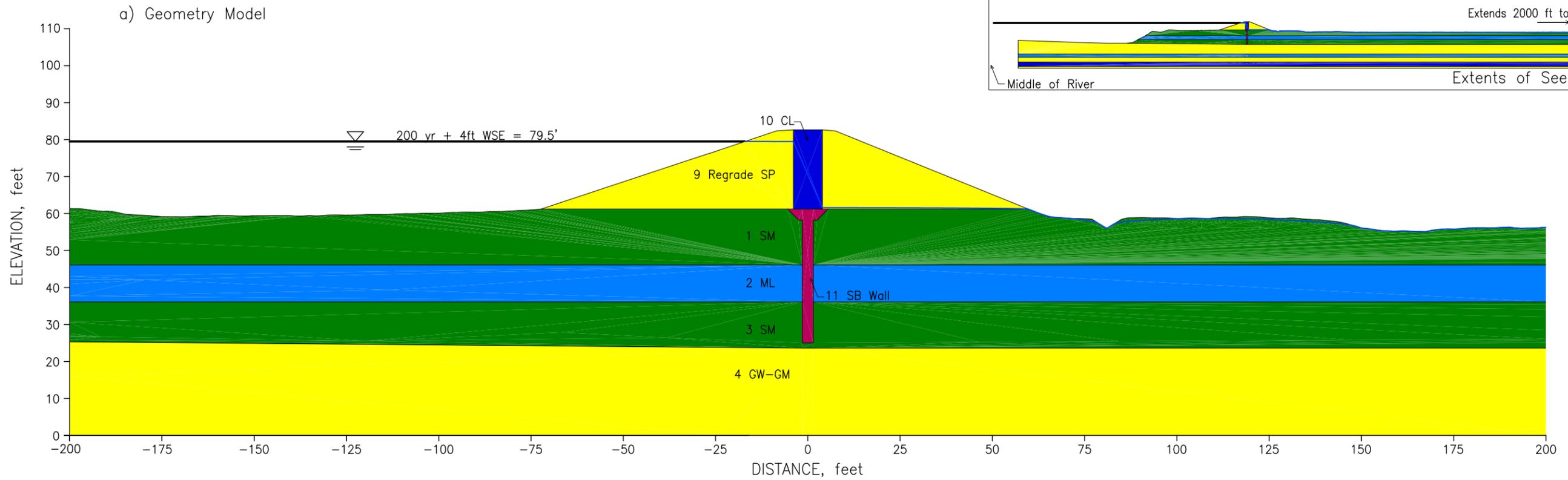
PROJECT NUMBER
17326712
TASK ORDER
TO4
DATE
October 2012

PREPARED BY
GT Hong
CHECKED BY

FEATHER RIVER WEST LEVEE PROJECT
GEOTECHNICAL DESIGN
RECOMMENDATIONS REPORT

Seepage Analysis Results
with Mitigation
200yr+1' Flood Event Steady State Seepage Condition
915+00
Reach 13

FIGURE
2



PLOT BY: C:\CNC\JACK\WORK - Jun 18, 2014 - 14:27:08pm
 DRAWING: C:\SECO\PRK\Analysis\14-TOA\14-3_Drf_Coo_Rec_Report\Appendix\Appendix C - Seepage, Stability, BOD Results\Steady State and 915+00_SS_Midstream Seep_2014.dwg



Sutter Butte
Flood Control Agency



PROJECT NUMBER
17326712
TASK ORDER
TO4
DATE
October 2012

PREPARED BY
GT Hong
CHECKED BY

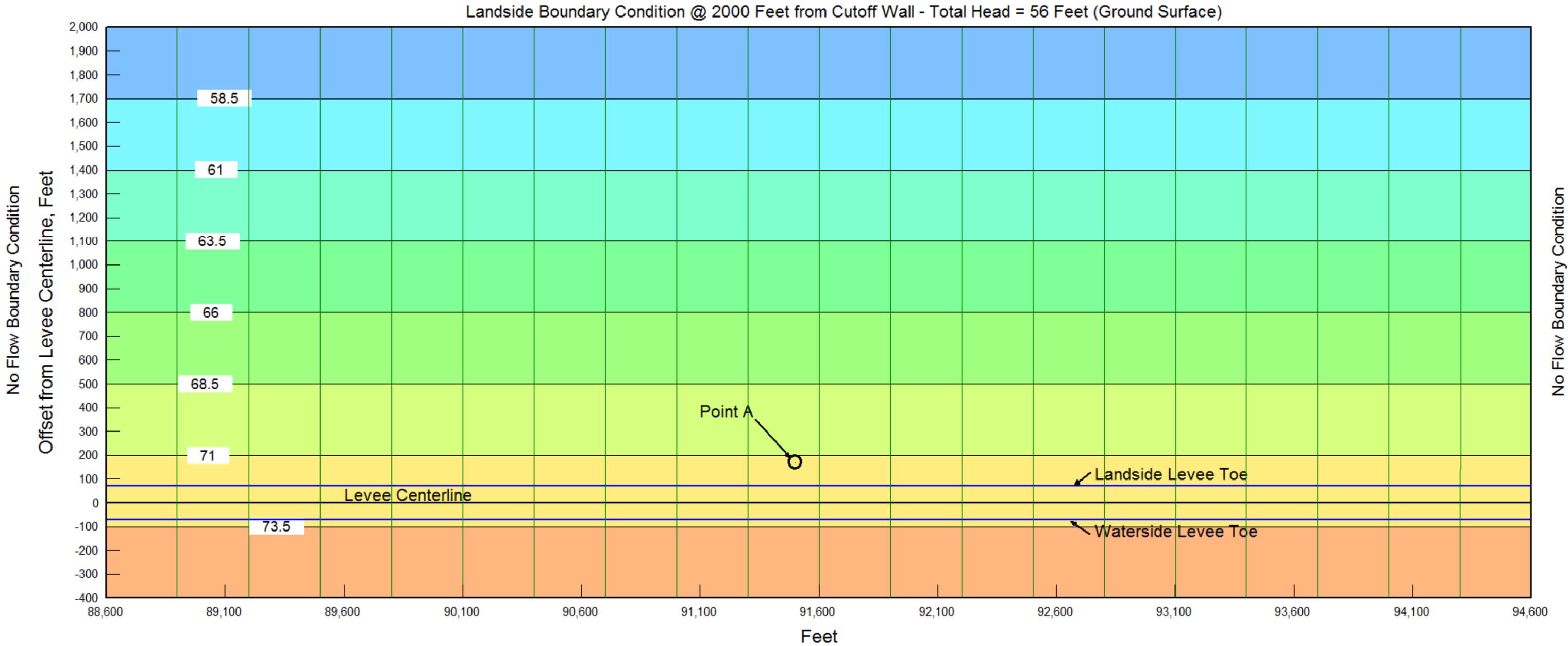
FEATHER RIVER WEST LEVEE PROJECT
GEOTECHNICAL DESIGN
RECOMMENDATIONS REPORT

Seepage Analysis Results
with Mitigation
200yr+4' Flood Event Steady State Seepage Condition
915+00
Reach 13

FIGURE
3

Title: Reach 13 Station 915+00 - Horizontal Flow Net with Cutoff
 Name: 1 - Plan Flow (without Cutoff)
 Created By: Crosariol, Victor
 Date: 1/7/2014
 File Name: Station 915+00_Plan_without Cutoff.gsz

Name: Aquifer - GW-GM (K-Sat = 5×10^{-3} cm/s) Model: Saturated Only Ky'/Kx' Ratio: 1



Landside Boundary Condition @ 2000 Feet from Cutoff Wall - Total Head = 56 Feet (Ground Surface)

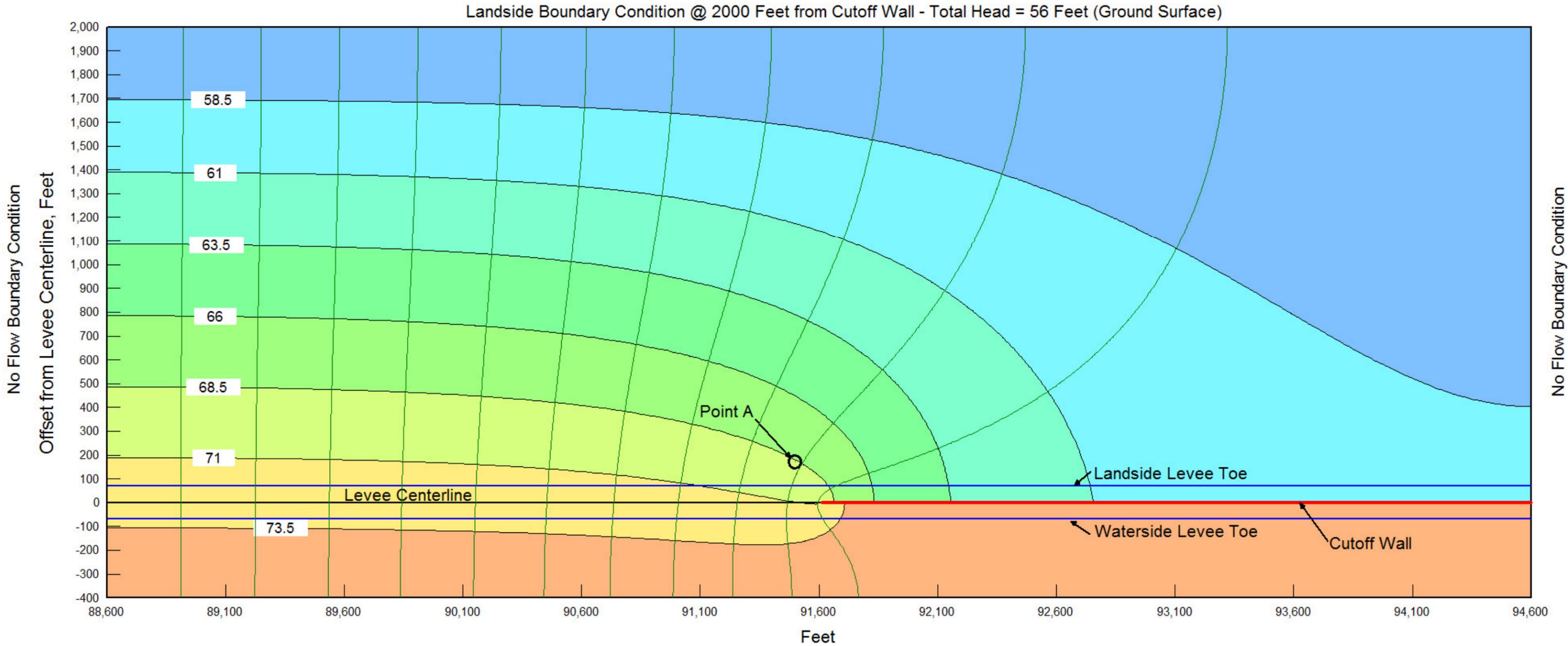
River Stage - Elevation 76 Feet (Total Head Boundary Condition)

Point A
 Station 915+00, 170 Feet Landward of Levee Centerline
 Total Head without Cutoff Wall = 71.3 Feet
 Total Head with Cutoff Wall = 68.6 Feet

Figure
4

Title: Reach 13 Station 915+00 - Horizontal Flow Net with Cutoff
 Name: 2 - Plan Flow (with cutoff)
 Created By: Crosariol, Victor
 Date: 1/7/2014
 File Name: Station 915+00_Plan_with Cutoff.gsz

Name: Aquifer - GW-GM (K-Sat = 5×10^{-3} cm/s) Model: Saturated Only K_y'/K_x' Ratio: 1
 Name: 3-Foot Wide Cutoff Wall (K-Sat = 5×10^{-7} cm/s) Model: Saturated Only K_y'/K_x' Ratio: 1



Point A
 Station 915+00, 170 Feet Landward of Levee Centerline
 Total Head without Cutoff Wall = 71.3 Feet
 Total Head with Cutoff Wall = 68.6 Feet

River Stage - Elevation 76 Feet (Total Head Boundary Condition)

Figure
5