STATE OF COLORADO

Ebert -, Jared <jared.ebert@state.co.us>

Henderson Response to DRMS TR-32 Geotech Review Report

Hilshorst, Aaron <ahilshor@fmi.com> Fri, Jul 17, 2020 at 10:57 AM
To: "Hays - DNR, Peter (peter.hays@state.co.us)" <peter.hays@state.co.us>, "Ebert -, Jared" <jared.ebert@state.co.us>
Cc: "Hamarat, Miguel" <mhamarat@fmi.com>, "Parmet, Amber L." <aparmet@fmi.com>

Peter, Jared,

Please find attached Henderson's response to the July 14, 2020 DRMS Geotechnical Stability Analysis Report. A hard copy will be sent via UPS later today.

If you have any questions, please reply all to this email, as I will be on vacation all next week.

Thanks,

Aaron

Aaron Hilshorst

Chief Environmental Engineer

Climax Molybdenum
A Freeport-McMoRan Company

Henderson Operations

(720) - 942 - 3420 – Office

(719) - 209 - 8249 – Mobile

20200717-Mill-Out-DRMS-TR-32 Geotech Review Response.pdf
1329K

Climax Molybdenum
A Freeport-McMoRan Company

COLORADO OPERATIONS
Henderson Mine and Mill
P.O. Box 68
Empire, CO 80438
Phone (303) 569-3221
Fax (303) 569-2830

July 17, 2020

Sent by UPS#: 1Z 804 641 NT 9169 7636

Mr. Peter Hays
Division of Reclamation Mining and Safety
1313 Sherman St., Rm. 215
Denver, CO 80203

RE: Climax Molybdenum Company, Henderson Mill, Permit No. M-1977-342, Technical Revision 32, Response to DRMS Geotechnical Stability Analysis Report

Dear Mr. Hays:

Climax Molybdenum Company – Henderson Mill (Henderson) received an emailed copy of the DRMS Geotechnical Stability Analysis Report on July 14, 2020. On July 16, 2020, Henderson submitted a request for an extension to the TR-32 review period to July 23, 2020 to allow time to respond to requests for further information detailed in the Report. This extension request was approved on July 17, 2020.

Please find attached a memo from AECOM Technical Services which includes responses to each DRMS comment along with the requested supporting documentation.

Please let me know if you have any questions or need any additional information at this time.

Regards,

Aaron Hilshorst
Chief Environmental Engineer
Henderson Operations
Climax Molybdenum Company

Enc. AECOM Memo

Cc: M. Hamarat, Climax
A. Parmet, Climax
File

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July 16, 2020

Mr. Ron Hickman
Climax Molybdenum Company
Henderson Mill
19302 County Road 3
Parshall, CO 80468

Subject: Response to DRMS comments for 3 Dam Buttress Stage II Design, Henderson Mill Tailings Dam, near Parshall, Colorado

Dear Ron:

AECOM Technical Services (AECOM) was contracted by Climax Molybdenum Company-Henderson Mill (Henderson) to analyze and design stabilization measures (buttress) for Phase II of the Henderson Mill No. 3 Tailings Impoundment (3 Dam) to meet Freeport's internal seismic design criteria. The buttress design is based on current state of the practice and was reviewed by an independent technical review board (TRB) of recognized experts within the tailings dam industry.

A technical revision No. 32 (TR-32), which presents the design and construction drawing for the second stage of the 3 Dam buttress, was submitted to the Division of Reclamation, Mining and Safety (Division/DRMS) for approval in June 2020. On July 15, 2020, DRMS provided an internal review letter dated July 14, 2020 addressed to Mr. Peter Hays from Mr. Zach Trujillo, both with DRMS, outlining his review of TR-32 and his request for additional information. Presented below are the additional information requests identified by the DRMS shown in *italics* followed by AECOM response.

DRMS REVIEW REQUEST FOR ADDITIONAL INFORMATION AND AECOM RESPONSES

DRMS Comment 1

Please have Henderson provide the additional stability analysis for the 1 Dam to ensure to the Division that long-term stability will remain if material is borrowed from the 1 Dam benches.

AECOM Response 1

There was a similar question posed during the review of the Phase I Buttress. The response provided below is excerpted from the 2018 TR-29 adequacy review response since it still applies. The original stability design of 1 Dam was based on an overall design slope of

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Greenwood Village, CO 80111
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4:1(horizontal to vertical). Steeper benches are constructed as part of normal operations as the impoundment steps upstream. These benches serve as access routes during operation until the following upstream step is constructed. A schematic showing the design slope and benches is provided in Figure 1. These benches are regularly graded as part of erosion and storm water control measures and are considered standard maintenance of the impoundment. The overall slope of 4:1 provides embankment stability and this slope is maintained during any bench regrading activities.

DRMS Comment 2

Please provide additional discussion and stability results for the 3 Dam Phase II buttress design under static conditions to ensure a minimum factor of safety of 1.5 is met as stated under Section 30.

AECOM Response 2

Steady-state drained loading conditions represents the long-term stability of the dam. Stability analyses were performed on the design section, Sections 2 and 4A, with the designed Phase II buttress and crest elevation of 8,887 ft under steady-state (static) loading conditions using the drained shear strengths shown on Figures 2 and 3. The limit equilibrium computer program UTEXAS4 (Wright, 2008) and Spencer's method of slices were used for the stability analyses. Spencer's method satisfies all conditions of static equilibrium, including horizontal and vertical force imbalance and moment imbalance. Search routines available within UTEXAS4 were used for circular and noncircular trial shear surfaces to locate critical shear surfaces. The results of the two-dimensional (2D) limit equilibrium steady state drained factor of safety for Section 2 is 2.5 and for Section 4A is 2.1. Figures 2 and 3 show resulting failure surfaces for Section 2 and 4A, respectively.

DRMS Comment 3

It is stated under the cover page for the proposed TR-32 application that a geotechnical investigation was scheduled for June 2020 which could potentially result in minor modifications to the geometry of the buttress. Please provide additional details of the June 2020 investigation (if occurred) and whether this investigation will have an impact on the currently proposed Phase II 3 Dam buttress design.

AECOM Response 3

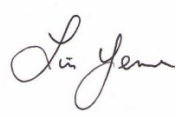
A Cone Penetration Test (CPT) field investigation consisting of 14 CPTs with pore pressure dissipation tests was completed in the original 3 Dam buttress area June 2 to 5, 2020. The CPTS ranged in depth from 10 to 20 ft to the natural ground. Results from the CPT program

were used to refine the fine tailings extent and to confirm pore pressure conditions. The CPT investigation showed that the fine tailings material located on the northern side of the original 3 Dam buttress are isolated and confirmed pore pressure conditions. An updated 2D post-earthquake loading stability analysis was completed on design section 4A with the updated fine extents. This analysis was completed using the same procedures described in the 3 Dam, Phase II Buttress Design letter report dated June 1, 2020. Figure 4 presents the updated slope stability analysis results for post-earthquake loading condition which meets the stability criteria. As a result, the proposed regrade or slope flattening of the northern original 3 Dam buttress is no longer required. Remainder of the design remains consistent with the 3 Dam Phase II submission.

CLOSING REMARKS

We hope this document helps clarifies any concerns the DRMS has with the Phase II 3 Dam buttress design. In addition, the DRMS should continue to take comfort that Freeport has taken the initiative to have a Technical Review Board of tailings dam experts review the design.

Sincerely,

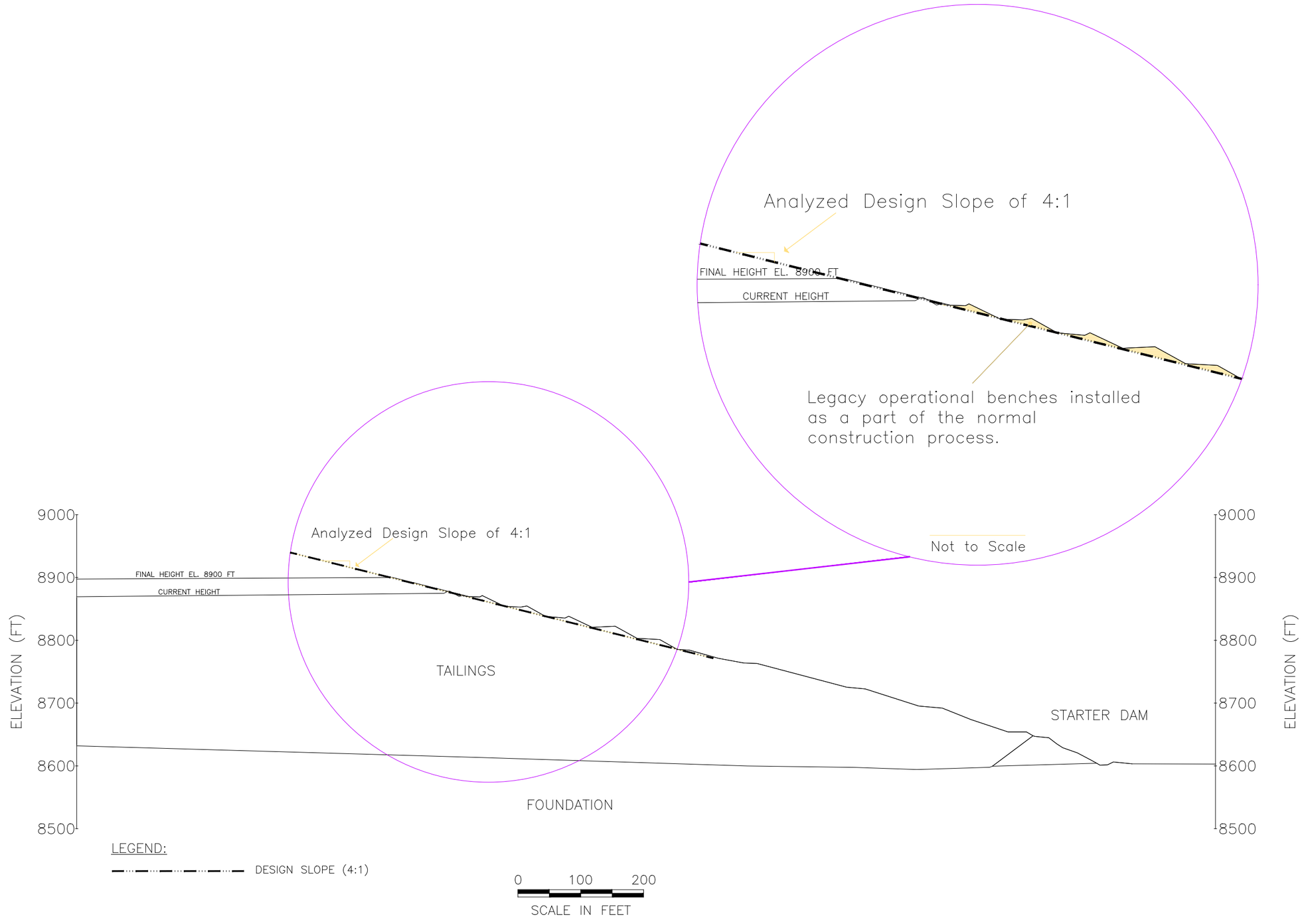


Lisa Yenne, P.E.
Project Manager

Richard R. Davidson, P.E.
Vice President and Principal Engineer

cc: File

Attachments:
Figure 1
Figure 2
Figure 3
Figure 4



NOTE:
this figure was also provided as part of the 3 Dam Buttress Phase I response to comments.

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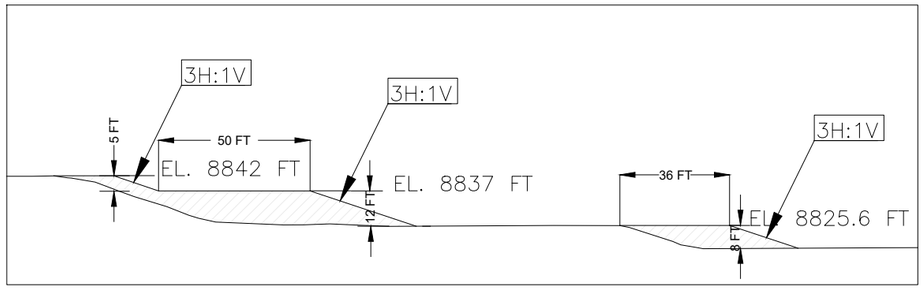
Figure 1

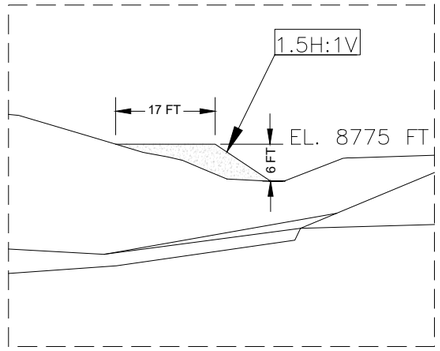
1 DAM TYPICAL STUDY CROSS SECTION
OPERATIONAL BENCHES
CREST EL. 8900 FT

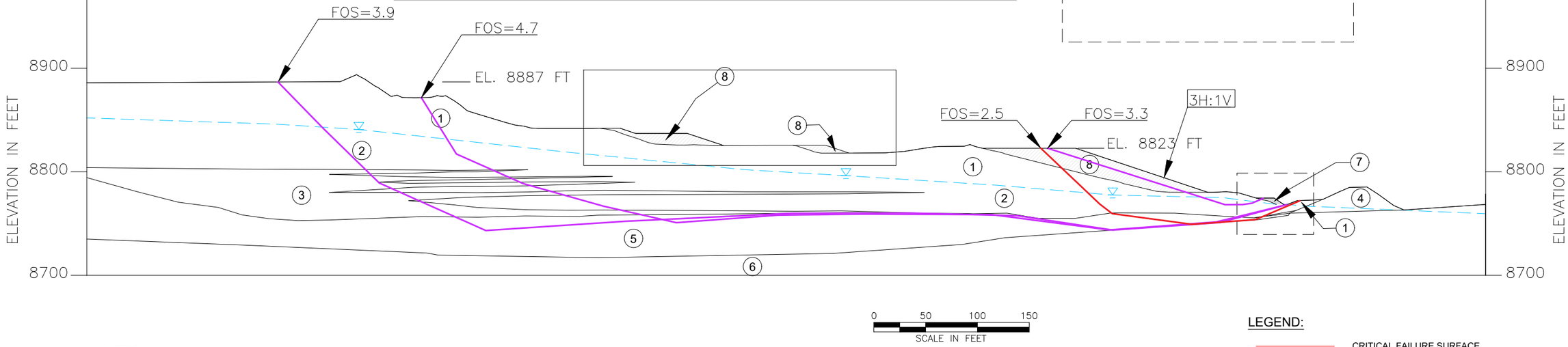
HENDERSON

Project No.: 60618654

MATERIALS			
NO.	DESCRIPTION	UNIT WEIGHT (PCF)	DRAINED SHEAR STRENGTH
1	UNSATURATED COARSE TAILINGS	117	C' = 0 PSF, ϕ' = 38° (Drained Strength)
2	SATURATED COARSE TAILINGS (80-100% HYDROSTATIC)	119	C' = 0 PSF, ϕ' = 38° (Drained Strength)
3	SATURATED FINE TAILINGS (80-100% HYDROSTATIC)	119	C' = 0 PSF, ϕ' = 37° (Drained Strength)
4	STARTER DAM	135	C' = 500 PSF, ϕ' = 35° (Drained Strength)
5	UPPER FOUNDATION (80% HYDROSTATIC)	135	C' = 0 PSF, ϕ' = 28° (Drained Strength)
6	LOWER FOUNDATION (80% HYDROSTATIC)	135	C' =500 PSF, ϕ' = 35° (Drained Strength)
7	UNSATURATED GRAVEL/SAND FILL	130	C' = 0 PSF, ϕ' = 35° (Drained Strength)
8	TAILINGS BUTTRESS	113	C' = 0 PSF, ϕ' = 38° (Drained Strength)







0 50 100 150
SCALE IN FEET

LEGEND:
- CRITICAL FAILURE SURFACE
- FAILURE SURFACE
- PHREATIC SURFACE

NOTES:
1. STABILITY ANALYSES PERFORMED USING UTEXAS4 SOFTWARE.

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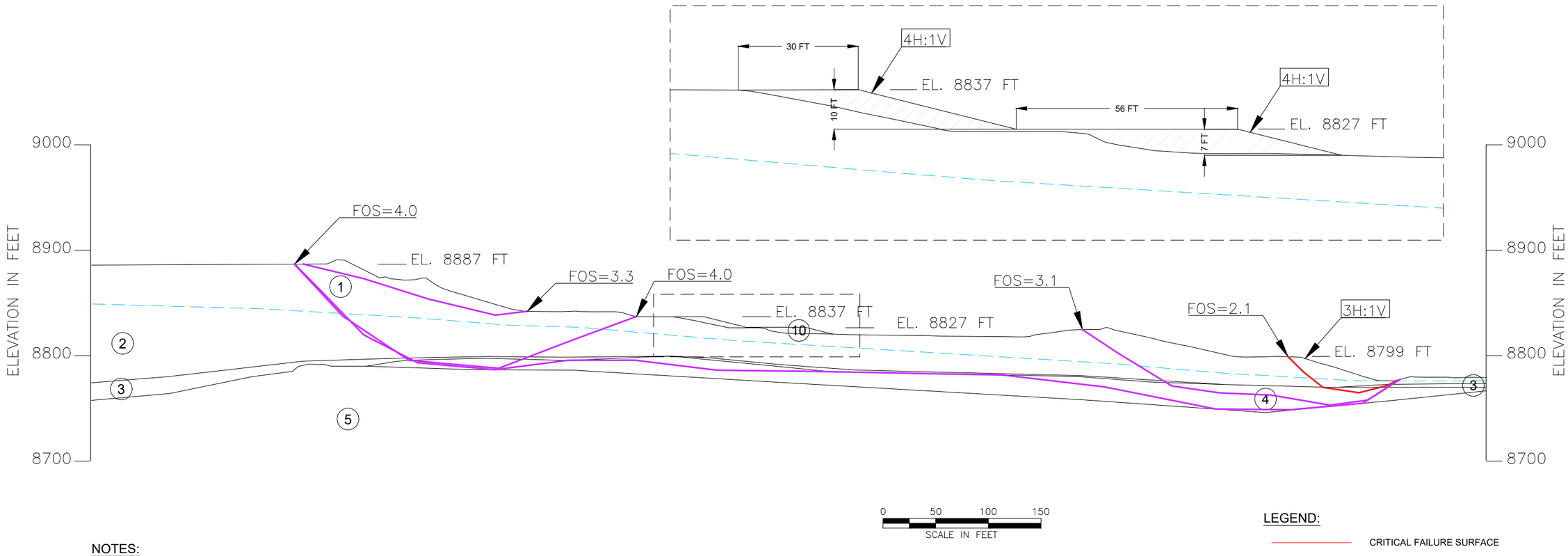
SECTION 2 - STAGE 2 BUTTRESS
DRAINED
STABILITY ANALYSES RESULTS
CREST EL. 8887 FT

AECOM
Figure 2

Project No.: 60618654

MATERIALS			
NO.	DESCRIPTION	UNIT WEIGHT (PCF)	DRAINED SHEAR STRENGTH
1	UNSATURATED COARSE TAILINGS	117	C' = 0 PSF, ϕ' = 38° (Drained Strength)
2	SATURATED COARSE TAILINGS	119	C' = 0 PSF, ϕ' = 38° (Drained Strength)
3	SATURATED FINE TAILINGS	119	C' = 0 PSF, ϕ' = 37° (Drained Strength)
4	UPPER FOUNDATION	135	C' = 0 PSF, ϕ' = 28° (Drained Strength)
5	LOWER FOUNDATION	135	C' = 500 PSF, ϕ' = 35° (Drained Strength)
10	BUTTRESS TAILINGS	113	C' =0 PSF, ϕ' = 38° (Drained Strength)



NOTES:

1. STABILITY ANALYSES PERFORMED USING UTEXAS4 SOFTWARE.

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Figure 3

SECTION 4A - STAGE 2 BUTTRESS
DRAINED
STABILITY ANALYSES RESULTS
CREST EL. 8887 FT

HENDERSON

Project No.: 60618654

Project Management Initials: Designer: ZK Checked:____ Approved:____ ANSI D 22" x 34"

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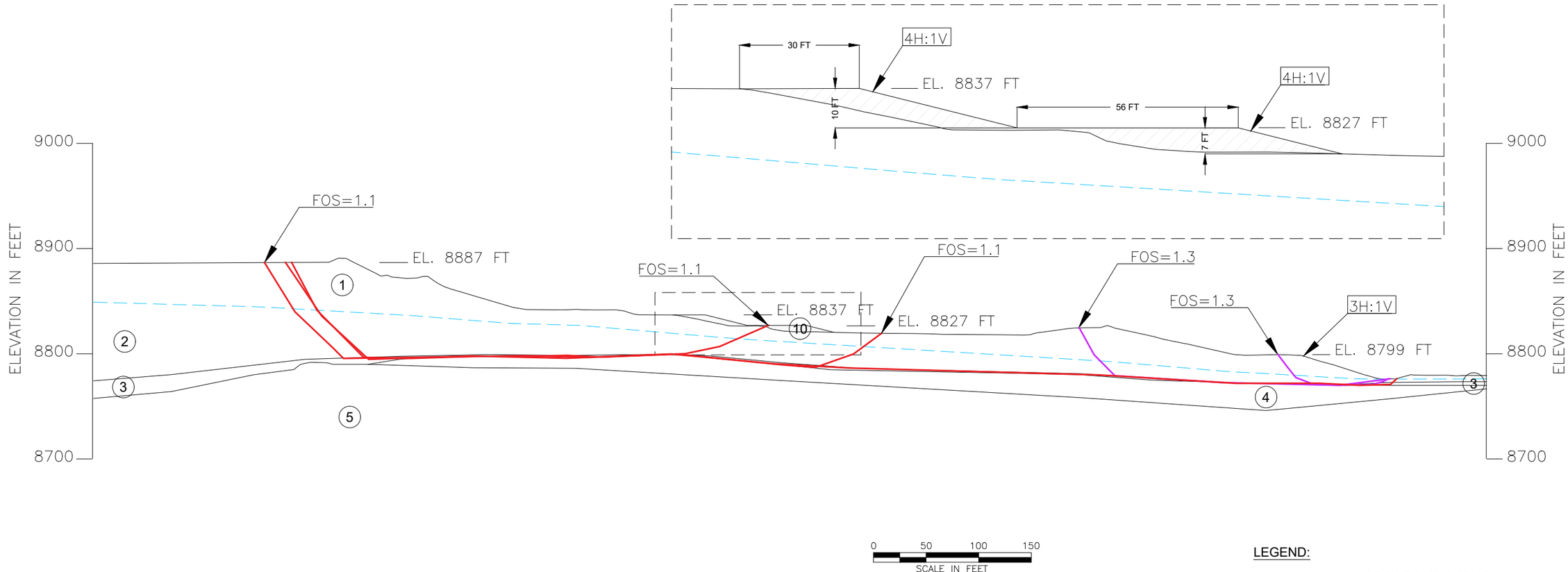
MATERIALS			
NO.	DESCRIPTION	UNIT WEIGHT (PCF)	POST-EARTHQUAKE SHEAR STRENGTH
(1)	UNSATURATED COARSE TAILINGS	117	C' = 0 PSF, ϕ' = 38° (Drained Strength)
(2)	LIQUEFIABLE COARSE TAILINGS	119	Su/p' = 0.24
(3)	LIQUEFIABLE FINE TAILINGS	119	Su/p' = 0.10
(4)	UPPER FOUNDATION	135	Su/p' = 0.27
(5)	LOWER FOUNDATION	135	C' = 500 PSF, ϕ' = 35° (Drained Strength)
(10)	BUTTRESS TAILINGS	113	C' =0 PSF, ϕ' = 38° (Drained Strength)



NOTE:

1. STABILITY ANALYSES PERFORMED USING UTEXAS4 SOFTWARE.

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Figure 4

SECTION 4A - STAGE 2 BUTTRESS
MDE POST EARTHQUAKE (UPDATED)
STABILITY ANALYSES RESULTS
CREST EL. 8887 FT

HENDERSON

Project No.: 60618654

Project Management Initials: Designer:ZK Checked:____ Approved:____ ANSI D 22" x 34"

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