HDR ONE COMPANY *Many Solutions*℠

Memo

To:	Henri Mulder, PE USACE Sacramento District		
From:	Christopher Krivanec, PE, GE	Project:	TRLIA - Phase 2
CC:	Ray Costa, PE, GE		
Date:	22 February 2007	Job No:	201064-36522

RE: Evaluation of As-Built Conditions, Yuba River Seepage Berms

BACKGROUND

In your review dated 7 February 2007 of construction records for the Three Rivers Levee Improvement Authority (TRLIA) Phase 2 Levee Repair Project, one issue that required follow up by the design team was for the Yuba River levee seepage berms constructed between Highway 70 and the UP Railroad. In your review, you noted that numerous test samples had fines contents greater than the specified maximum of 5% passing the No. 200 sieve. Per your request, we have evaluated the effectiveness of the seepage berm with these higher percentages of fines and have verified that the as-constructed seepage berm meets the intent of the design. This memorandum summarizes that evaluation.

Note that as a follow up to our discussion on 20 February 2007 we have focused our evaluation on the 90-foot wide seepage berm. As we discussed, the 300-foot wide berm is already at the maximum dimension recommended by USACE guidance documents for seepage berms. Further modifications would generally not be required unless a serious deficiency is identified during subsequent high river stage events.

SEEPAGE BERM ANALYSIS AND DESIGN

To address through and underseepage conditions at the Yuba River levee between Highway 70 and the location of the 1986 levee breach, a combination of a 50-foot deep cutoff wall and a 90-foot wide seepage berm was designed and constructed. These levee repairs were designed to provide protection against both 100- and 200-year flood conditions. The seepage berm constructed based on the seepage analysis to meet USACE criteria was a minimum berm (width equal to 4 times the levee height) and was 5 feet thick at the levee toe and 3 feet thick at a point 90 feet from the levee toe.

As noted in the attached memorandum from Ray Costa (Geotechnical Consultant for Kleinfelder), the berm was originally designed considering a permeability on the order of $1.2\text{x}10^{-4}$ cm/s. However, it was anticipated that sand from a local source (the Goldfields) may be the most economical borrow location, and as such was specified as the required berm material. In accordance with USACE criteria, to construct a pervious (sand) berm the berm should have a minimum permeability greater than $1\text{x}10^{-2}$ cm/s. The specifications required material with no more than 5% passing the No. 200 sieve to achieve a permeability greater than $1\text{x}10^{-2}$ cm/s. The specifications required an in-place relative density of 70% for the sand berm, but also required a minimum of three passes with a static roller.

CONSTRUCTION ISSUES

During construction of the sand seepage berm, the Contractor elected to not use material from the Goldfields borrow (the Contractor was not directed to use a specific borrow source), but instead chose another local source for sand. This source was of volcanic origin and did not contain as durable particles as conventionally encountered from alluvium derived from Sierra Nevada derived stream courses. During placement of this sand, Quality Control gradation tests indicated the fines content of the sand in some cases was exceeding the specified maximum of 5% passing the No. 200 sieve. It was speculated that under the compaction effort specified (i.e., a minimum of three passes with a static roller), the volcanic origin sands were breaking down. Following discussions with Kleinfelder and USACE, the Contractor was directed to deposit the sand from the transport equipment and spread it into place using graders. It was determined the relative compaction of the sand berm was not as critical as the permeability and overburden weight of the berm. As a result, the need to achieve a minimum specified relative density greater than what would be achieved by the rubber tired equipment used for transport and shaping was not considered important and was deleted. The majority of the initial on site berm materials not meeting specification were placed within the toe drain trench removal excavation and as such should not negatively impact the function of the seepage berm.

After the placement method was adjusted, the majority of the gradation tests confirmed the sand material met the specification. However, some tests indicate that materials from areas throughout the 90-foot wide berm still exceeded the fines limit of 5%. These test results are summarized in the attached table. As shown, most failing tests indicated the sand had fines contents of between 5 and 7%. A few tests were measured up to 11% passing the No. 200 sieve.

ASSESSMENT OF AS-BUILT CONDITIONS

As requested, Kleinfelder has revisited their seepage analyses for the 90-foot berm considering the as-built conditions. The results are summarized in the attached e-mail, summary of permeabilities versus fines content and seepage model results.

As indicated, the permeability of the seepage berm was assumed to have dropped as low as $6x10^{-5}$ cm/s, which corresponds to a sand with a fines content over 21%. Even with this low permeability and high fines content, the seepage berm had a hydraulic exit gradient of 0.57 at the berm toe which meets USACE criteria. It is our opinion this evaluation of as-built conditions confirms the 90-foot seepage berm meets the original intent of the seepage berm design.