

## Technical Memorandum

**TO:** Ron Morosky – CE Ranch  
**FROM:** Dan Forlastro  
**DATE:** March 29, 2022  
**RE:** Summary of Copano Geotechnical Investigations

This memorandum provides a summary and brief description of geotechnical investigations that have been performed at the Copano Site regarding the stability of the levees for Beds 1 through 4. It is reported that Beds 1 and 2 were constructed from 1968 to 1972 and Beds 3 and 4 were constructed from 1976 to 1980. Various investigations and stability analyses in response to proposed site improvements were conducted following bed construction. The information Tetra Tech has in its possession and has reviewed is summarized in chronological order:

- In 1973, Dames & Moore conducted a stability analysis of the Beds 1 and 2 levees in response to a proposed increase in the levee height from approximately elevation 20 to elevation 28 (the current top of levee elevation). Stability factors of safety were above referenced standards and the levee heights were increased over time.
- In 1996, Fugro Environmental, Inc. conducted analyses for the Beds 1 and 2 levees and the underlying soil in response to a potential need to increase residue storage capacity. In addition, the underlying soil in Bed 4 was evaluated to determine if Bed 4 was suitable for residue containment. The conclusions were that Beds 1 and 2 levee heights could be increased to elevation 45 without exceeding recommended stability factors of safety and that the permeability of the underlying Bed 4 soil layer was sufficient to serve as a liner.
- In 2001, PSI, Inc. conducted a short-term and long-term stability evaluation of the Beds 1 through 4 levees to model the current conditions in 2001. The Bed 4 levees were evaluated with the bed empty and assumed filled with water. Only the long-term factor of safety for Bed 4 assuming that the bed was filled with water and undergoing rapid drawdown was less than referenced standards. All other scenarios were deemed stable.
- In 2002, geotechnical engineer Richard Van Tassell conducted an evaluation of Beds 1 and 2 for the ability to construct “step in” interior levees to increase residue

storage capacity. Various residue stack heights were evaluated and recommendations made on residue stack height for selected “step in” levee construction scenarios.

- In 2002, representatives of Texas A&M University conducted an investigation of the Bed 1 residue stack to evaluate residue stability. The evaluation determined that the residue stack could be increased to elevation 70 (current elevation 56) and meet referenced factor of safety standards.
- In 2011, Tetra Tech, Inc. conducted a focused stability analysis of the Beds 1 and 2 levees where previous investigations had identified potential granular soil lenses beneath the levees. The analysis concluded that the underlying granular soil was not adversely affecting levee stability and was not acting as a potential conduit for seepage from the beds.
- In 2012, HDR Engineering, Inc. conducted a Risk Assessment of Beds 1 through 4 following a US Army Corps of Engineers standard for evaluating civil infrastructure, including earthen impoundments. Stability analyses for various loading scenarios (e.g., increased stack heights, large storm events, surcharge placement on the residue stack) resulted in factors of safety less than referenced standards for only the “step in” interior levees at Bed 1, which are constructed of residue.
- In 2020, Tetra Tech, Inc. conducted a seismic stability analysis of Bed 1. Analysis results indicated that factors of safety for the Bed 1 levees under static, pseudo-static (earthquake), and post-earthquake conditions for the site location were greater than referenced standards.