1.0 Introduction

This technical memorandum summarizes the results of a slope stability analysis performed for the Waste Rock Storage Area associated with the proposed Rosemont Copper Project (Project) located in Pima County, Arizona. The Waste Rock Storage Area is located southeast of the Open Pit and south of the Dry Stack Tailings. A Heap Leach Facility (pad and ponds) is located in the northwest corner of the Waste Rock Storage Area. The pad and ponds will be closed and covered with waste rock by about Operational Year 10 of the 20 to 25 year mine life. Figure 01 shows a plan view of the Waste Rock Storage Area based on a reclaimed version of the Rosemont Ridge Landform termed the Base Concept Landform.

Two (2) cross sections were selected for stability modeling which considered a full height global (rotational) failure. Section A, shown on Figure 01, evaluated the stability of the waste rock with an overall slope ratio of 5H:1V and a height of about 518 feet. The overall slope was divided into six (6) smaller slopes to accommodate a series of wide benches incorporated into the final reclaimed surface of the Waste Rock Storage Area. Detention pools are also planned on the benches to detain stormwater runoff from up to a 500-year, 24-hour event. The slopes along Section A range from 3H:1V to 4.2H:1V and in height from 48 feet to 108 feet.

Section B was modeled with an overall waste rock slope of 2.4H:1V and height of 314 feet. The overall slope is divided into three (3) smaller slopes with a ratio of 2H:1V with heights ranging between 90 feet and 114 feet. Static and pseudostatic conditions were evaluated for Section A and Section B. Attachment 1 contains the results of the stability analysis.

2.0 Construction of Model Cross Section

As shown on Figure 01, the majority of the Waste Rock Storage Area is underlain by Gila Conglomerate. A small portion of the Waste Rock Storage Area adjacent to the eastern boundary is underlain by the younger alluvium. Evaluation and potential removal of the alluvial material shall take place along the critical outer slopes prior to the placement of Run of Mine...
(ROM) Waste Rock material. A layer of compacted fill material, assumed to be composed of the native Gila Conglomerate, was used as the material below the waste rock to model the cross sections. Although the young alluvium material is shown to occur in sparse locations of this facility, the material properties and impacts shall be evaluated prior to waste rock placement in areas other than the outer critical slopes.

The smaller slopes represented in the cross section models for the detention pools located on the benches are not expected to impact the overall slope stability of the Waste Rock Storage Area. In the event of a localized failure along one of these slopes, rehabilitation of the area shall occur, which may require maintenance and additional monitoring, and would not significantly impact the factor of safety or the overall stability of the Waste Rock Storage Area.

3.0 Design Criteria

Design of the Waste Rock Storage Area is governed by requirements of Arizona Department of Environmental Quality (ADEQ) as detailed in the Arizona Mining BADCT Guidance Manual (ADEQ, 2004). Based on these requirements, the minimum stability criteria adopted for the Waste Rock are presented in Table 1.0. These factors assume material testing has been performed.

<table>
<thead>
<tr>
<th>Analysis Condition</th>
<th>Required Minimum Factor of Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static</td>
<td>1.30</td>
</tr>
<tr>
<td>Pseudostatic</td>
<td>1.00</td>
</tr>
</tbody>
</table>

As documented in the Geologic Hazards Assessment (Tetra Tech, 2007a), the site seismicity was analyzed for two (2) levels of ground motion: the Maximum Probable Earthquake (MPE) and the Maximum Credible Earthquake (MCE). These values are 0.045g for the MPE and 0.326g for the MCE.

In accordance with BADCT design criteria, the MPE was selected as the design earthquake for pseudostatic analysis. To allow for damping and attenuation of the bedrock acceleration within a slope or embankment, and to account for the rigid body pseudostatic model, the pseudo-static coefficient used in the model was a conservative estimate of horizontal ground motion equivalent to 2/3 of the MPE, or 0.03g.

4.0 Modeling Method

The slope stability analysis was conducted using the Slope/W component of the GeoStudio 2007 software package produced by Geo-Slope International, Ltd. Slope/W was used to conduct limiting equilibrium analysis using the general limit equilibrium (GLE) method, which satisfies both force and moment equilibrium. The Slope/W program incorporates a search routine to locate those failure surfaces with the least factor of safety within user defined search limits. Trial failure surfaces were defined with “entry and exit” slip surfaces, resulting in a range
of possible locations to search for the most critical (lowest factor of safety) potential failure surface.

The slope stability modeling completed considered global (rotational) stability of the ROM waste rock and considered a full height failure to avoid the shallow slopes. To evaluate the performance of the Waste Rock Storage Area under seismic loading, a pseudostatic analysis was performed. The pseudostatic analyses subjects the two-dimensional sliding mass to a horizontal acceleration equal to an earthquake coefficient multiplied by the acceleration of gravity. To allow for damping and attenuation of the bedrock acceleration within a slope or embankment, and to account for the rigid body pseudostatic model, the pseudostatic coefficient used in the model was a conservative estimate of horizontal ground motion of 2/3 of the peak ground acceleration of the design earthquake (MPE), or 0.03g.

5.0 Material Properties

The material properties presented in Table 2.0 for the embankment and foundation materials were determined from field and laboratory testing (Tetra Tech, 2009), experience with similar materials, and professional judgment. For the ROM waste rock material, the Shear/Normal strength function in Slope/W was utilized. To obtain this function, the shear strength was calculated according to the following equation:

\[ S = c + \sigma \tan \phi \]

Where:

- \( S \) = shear strength
- \( \sigma \) = normal pressure
- \( c \) = cohesion
- \( \phi \) = friction angle

The normal pressures were calculated based on the unit weight obtained from field tests on the ROM waste rock. The friction angles were calculated using the graph presented by Leps (1970). The values were obtained through the intersection of the normal pressure values and the weak rock line on the Leps graph shown on Illustration 1.0 (more conservative approach).
Both the static and pseudostatic factors of safety against a full-height failure of Waste Rock Storage Area were found to be above the BADCT minimum stability requirements (Table 1.0) for a block failure sliding and for global stability. Table 2.0 shows the factor of safety results for both sections analyzed.

The stability modeling results for Sections A and B are shown in Attachment 1 and presented in Table 3.0.
Table 3.0  Results of Slope Stability Analysis

<table>
<thead>
<tr>
<th>Ore Slope</th>
<th>Factor of Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Static</td>
</tr>
<tr>
<td>Section A</td>
<td>5.25</td>
</tr>
<tr>
<td>Section B</td>
<td>3.28</td>
</tr>
</tbody>
</table>

REFERENCES


ROSEMONT COPPER PROJECT
WASTE ROCK STORAGE AREA STABILITY MODELING
Cross Section A

Method: GLE
Slip Surface Option: Entry and Exit

Horiz. Siesmic Load: Value: 0
Kind: SLOPE/W
Analysis: 1: static E&E

Name: ROM Waste Rock
Model: Shear/Normal Fn.
Unit Weight: 145 pcf
Strength Function: Leps Weak Rock
Phi-B: 0 °

Name: Gila Conglomerate
Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 0 psf
Phi: 39 °
Phi-B: 0 °
ROSEMONT COPPER PROJECT
WASTE ROCK STORAGE AREA STABILITY MODELING
Cross Section A

Method: GLE
Slip Surface Option: Entry and Exit

Horiz. Siesmic Load: Value: 0.03
Kind: SLOPE/W
Analysis: 2: Psuedostatic E&E

Name: ROM Waste Rock
Model: Shear/Normal Fn.
Unit Weight: 145 pcf
Strength Function: Leps Weak Rock
Phi-B: 0 °

Name: Gila Conglomerate
Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 0 psf
Phi: 39 °
Phi-B: 0 °
ROSEMOND COPPER PROJECT
WASTE ROCK STORAGE AREA STABILITY MODELING
Cross Section B

Horiz. Siesmic Load: Value: 0
Kind: SLOPE/W
Analysis: 1: static E&E full height
Method: GLE
Slip Surface Option: Entry and Exit

Name: ROM Waste Rock
Model: Shear/Normal Fr.
Unit Weight: 145 pcf
Strength Function: Leps Weak Rock
Phi-B: 0°

Name: Gila Conglomerate
Model: Mohr-Coulomb
Unit Weight: 127 pcf
Cohesion: 0 psf
Phi: 39°
Phi-B: 0°