

# Memorandum



**Date:** February 26, 2020  
**To:** Resolution Copper Company  
**From:** Tryana Garza-Cruz, Itasca Consulting Group  
Matthew Pierce, Pierce Engineering  
**Re:** Response to GS-5 Comments on Resolution Copper  
DEIS from Dr. Emerman (Subsidence and  
Uncertainty)  
**Ref:** 2-4208-07:20M03

## **Response to Action Item GS-5. Provide input on specific assumptions made by Emerman related to uncertainty of subsidence modeling**

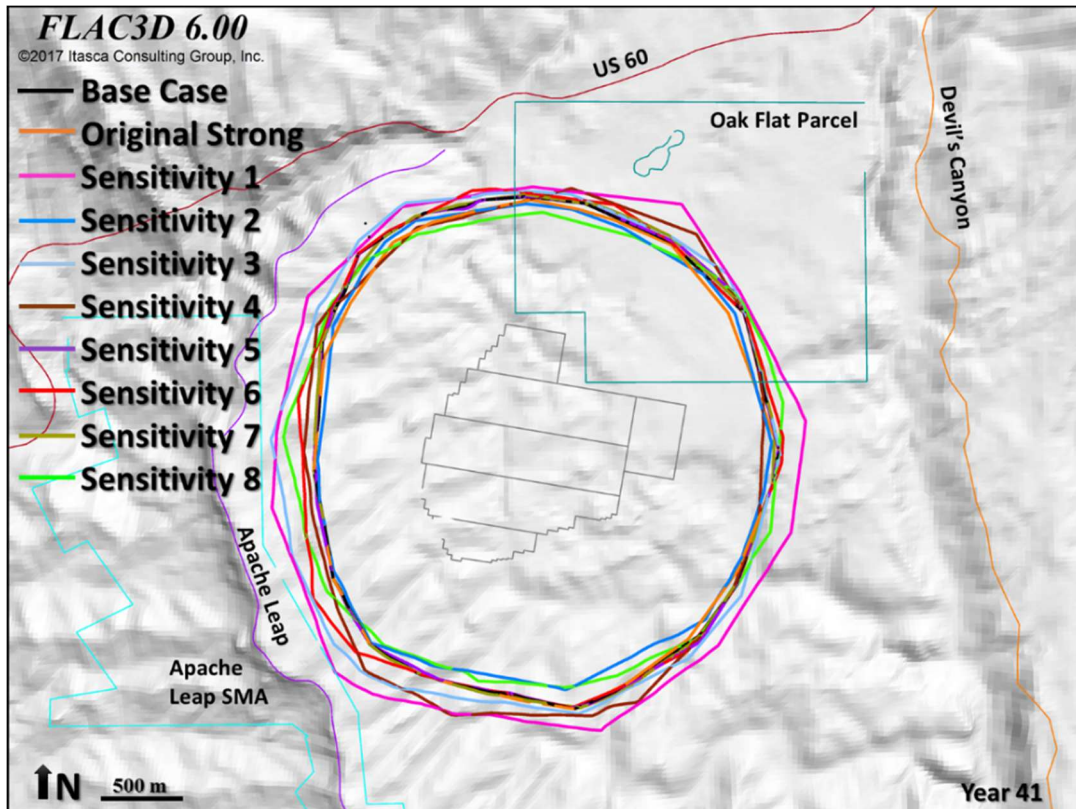
*“If the uncertainty (164 feet) is assumed to be the standard deviation (although that is not clear from the text), then the coefficient of variation (ratio of standard deviation to mean) of the predicted maximum depth is 20%. In the absence of other information, the same coefficient of variation could be assumed to apply to other aspects of the subsidence predictions.”*

It is completely erroneous to extrapolate from an incorrectly calculated coefficient of variation of the predicted maximum crater depth for calculation of the probability of the extent of surface subsidence.

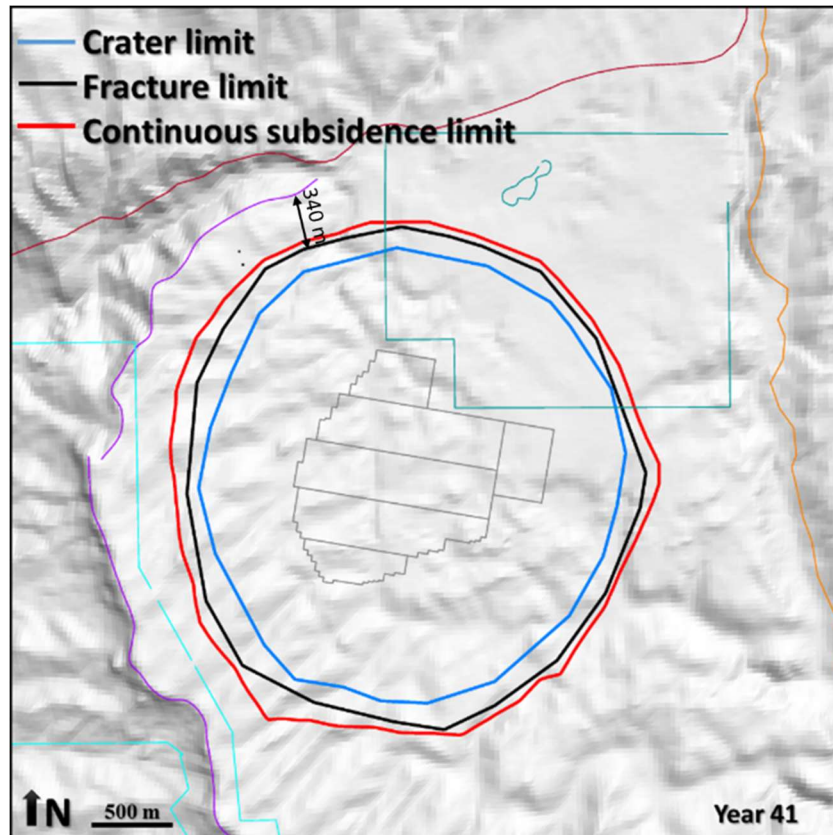
The Geology and Subsidence Workgroup requested a number of sensitivity model runs to evaluate how the variation of different input parameters in the model would affect the predicted fracture limit. The fractured limit is defined by a region with the total measure of strain exceeding 0.5%, and it represents the expected limits of visible fracturing on the ground surface. The evaluated cases examined rock mass strength, fault strength, caved rock porosity, as well as magnitude and direction of the in-situ stresses. In all cases, the fracture zone limits at the end of mine life were obtained to illustrate the model sensitivity to the input key parameters; these results are shown in Figure 1. Even when highly conservative assumptions on rock mass strength were evaluated (Garza-Cruz and Pierce, 2018), the fracture limit was not predicted to reach the Apache Leap.

Using the results from the sensitivity analysis, the appropriate standard deviation of the base-case fracture limit can be calculated (assuming a normal distribution) by measuring the distance between the fracture limits resulting from the sensitivity study and that of the base case along a series of rays that would intersect the Apache Leap. This resulted in a fracture-limit standard deviation of 110 m. Using the same logic as that employed by Dr. Emerman but applying the correct standard deviation associated to the fracture limit, the probability of the fracture limit reaching the eastern edge of the Apache Leap can be calculated.

The minimum distance between the fracture limit and the Apache Leap in the base case evaluated is 340 m as shown in Figure 2 (Figure 3.2.4-1 at Year 41 in DEIS, 2019). Comparison of the minimum 340 m distance between the fracture limit and the Apache Leap to the resulting standard deviation of 110 m means that the Apache Leap is more than 3 standard deviations away from the base case fracture limit; therefore, the probability of the fracture limit reaching the eastern edge of the Apache Leap is <0.1%.



*Figure 1 Comparison of predicted fracture limits for base case and all sensitivities (Garza-Cruz and Pierce, 2018).*



**Figure 2** *Crater, fracture and continuous subsidence limits predicted to exist at the end of life of mine (modified from Garza-Cruz and Pierce, 2017).*

The continuous subsidence limit is an area outside the fractured zone that is characterized by small, continuous subsidence deformations that can only be detected using high resolution monitoring instrumentation. This area is also commonly referred to as the elastic zone, because the deformations are usually below the threshold where rock fractures; therefore, it should not be used to evaluate impacts on the Apache Leap.

26 February 2020

Via email to: mary.rasmussen@usda.gov

Mary Rasmussen  
US Forest Service  
Supervisor's Office  
2324E McDowell Road  
Phoenix, AZ 85006-2496

**Subject: Resolution Copper Mining, LLC – Mine Plan of Operations and Land Exchange – Response to Action Item GS-5 (Geology, Subsidence, Seismicity)**

Dear Ms. Rasmussen,

Enclosed for your review and consideration, please find the following response to GS-5 from Itasca Consulting Group and Pierce Engineering:

*Provide input on specific assumptions made by Emerman related to uncertainty of subsidence modeling*

Should you have any questions or require further information please do not hesitate to contact me.

Sincerely,



Vicky Peacey  
Senior Manager, Permitting and Approvals; Resolution Copper Company, as Manager of Resolution Copper Mining LLC

Attachment: Itasca Consulting Group and Pierce Engineering: Response to GS-5 Comments on Resolution Copper DEIS from Dr. Emerman (Subsidence and Uncertainty)