Tailings and Mine Waste 2013
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Development of a Mine Site-Wide Water Balance

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Introduction

- **Mine Water Management**

  Effective water management strategy includes minimizing water usage and the impact to the water supply of the surrounding communities.

- **Water balance model**

  Water balance models are useful tools for mines to meet site water management objectives and assist with critical decisions through the mine life cycle.

- **Case Studies**

  Included to illustrate uses and benefits of a mine site water balance

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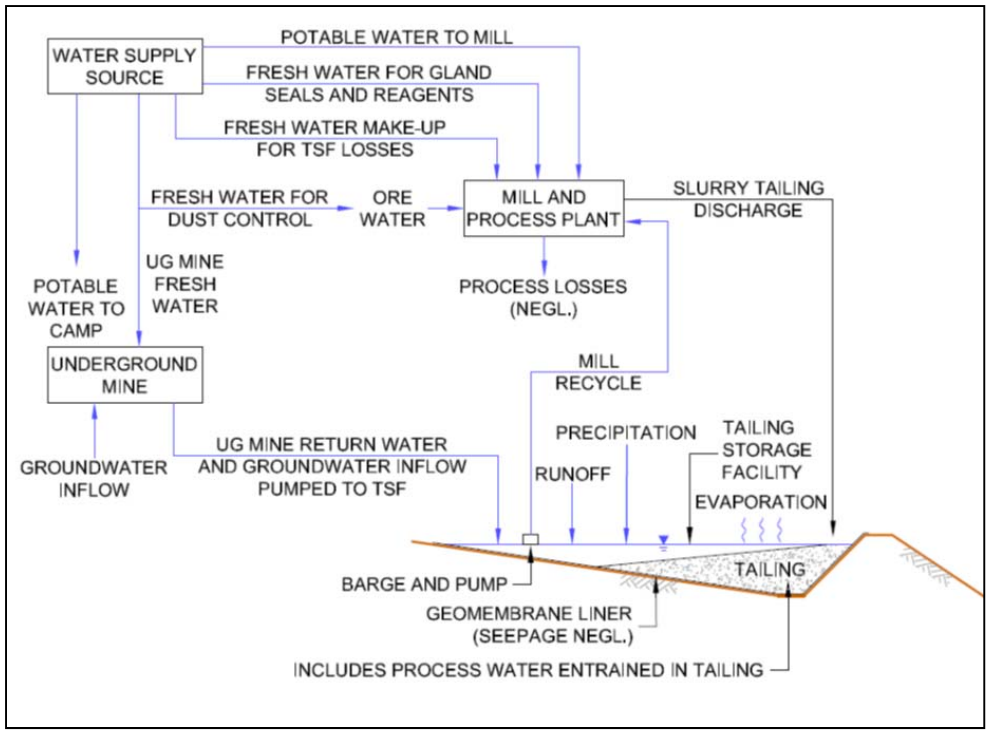
Water Balance Model

- Critical planning and management tool
  - Needs to reflect the most important moving parts
  - Variability and uncertainty need to be incorporated to understand operational sensitivities/ weaknesses
  - Should be updated as needed to reflect changes in the mine plan
  - Development should involve staff from each operational area



Developing a Water Balance

1. Define Model Objectives
2. Determine the Methodology
3. Develop Conceptual Model
4. Collect and Evaluate Data
5. Develop and Calibrate Model

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Defining the Water Balance Objectives

- Questions to Consider:
  - What is the key objective/ goal of the end user?
  - What information is the end user looking to obtain or situation are they wanting to evaluate?
  - Site-wide water balance or water balance specific to a certain area of the facility (i.e. tailings storage facility, water supply)?
  - Stage of operation (pre-feasibility, feasibility, operations, expansion, closure)
  - Why these objectives?

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Determine the Methodology

- Objectives determine your methodology
  - Important to have well-defined objectives
- Methodology – how will the water balance be developed?
  - Phase of mine life being modeled?
  - Mass balance?
  - Steady-state (single solution) or dynamic (solution changes in time)?
  - Deterministic (repeatable solutions) or Stochastic (random solutions)?
  - Sensitivity analyses
  - What software should be used? Spreadsheet, real-time management software, dynamic software

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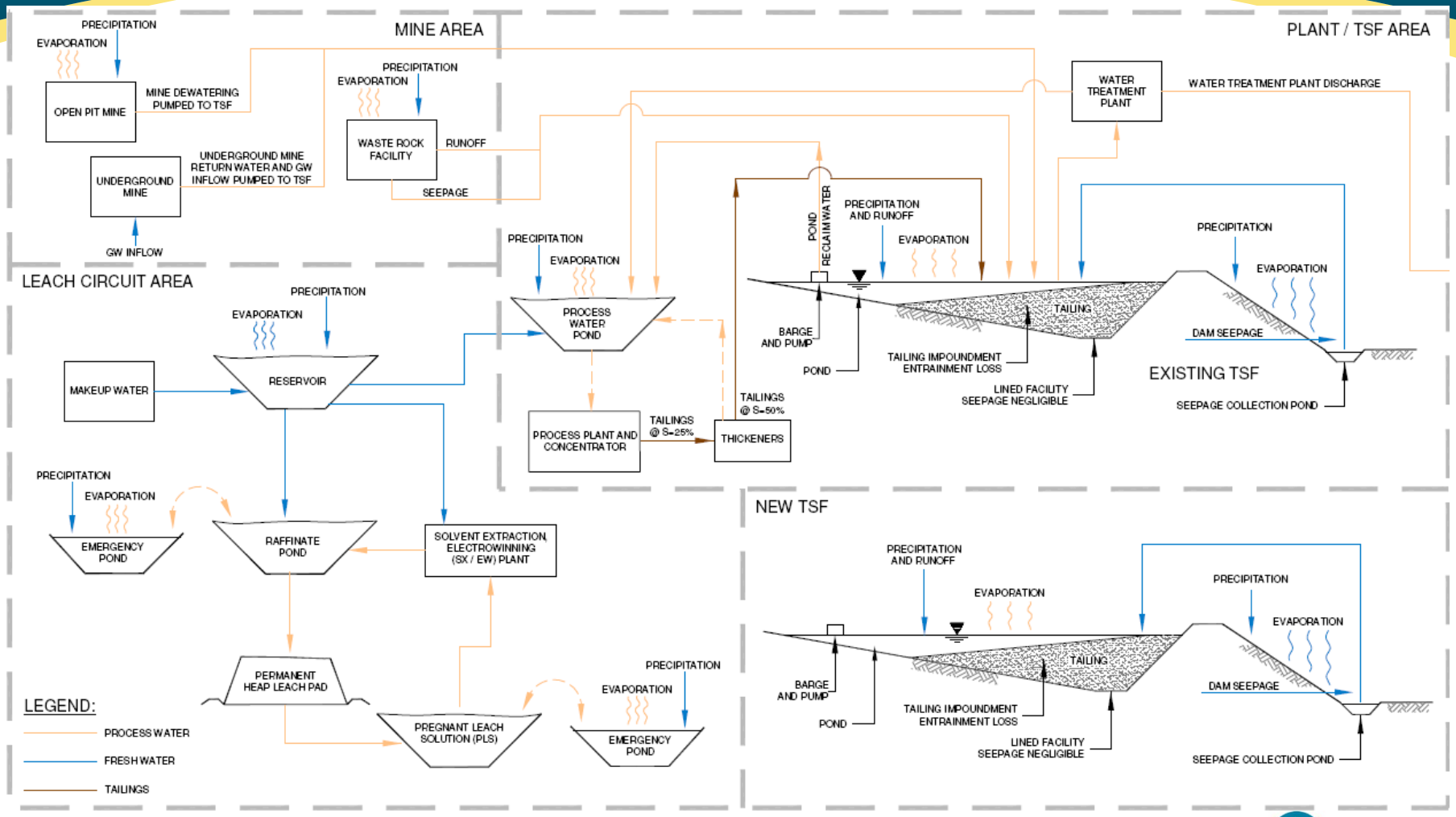
Conceptual Model



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Water Balance Input Data

- Examples of data:
  - Site specific climate data
  - Information from site visit
  - Aerial photographs and topographic maps
  - Process diagrams
  - Flow rates/Flow meter Data
  - Historical and future production rates
  - Tailing properties
  - Water quality data
  - Geochemistry data
  - Historical hydrologic and hydrogeologic reports
  - Historical geotechnical and design reports

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Model Development

1. Model Main Mine Areas
   - Calculate water demands at major facilities (i.e. plant, TSF, heap leach pad)
   - Determine other demands such as dust control, etc.
   - Model components within the main areas
   - Connect facilities to develop entire model
2. Connect Facilities to Develop Site-Wide Model
3. Calibrate the Model

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Importance of Water Balance – New Mines

- New Mines
  - How much water is required for the operations?
  - What is the source of water?
  - What is the cost for water supply?
  - What is the risk in securing the water?
  - What is the quality of the output streams?
  - What is the impact of the project on water use for surrounding communities?
  - What is the environmental impact of the water streams?
  - What is the energy required to extract, move and treat the water?
  - What components should be included in the design for water management?
  - What is the closure water balance?

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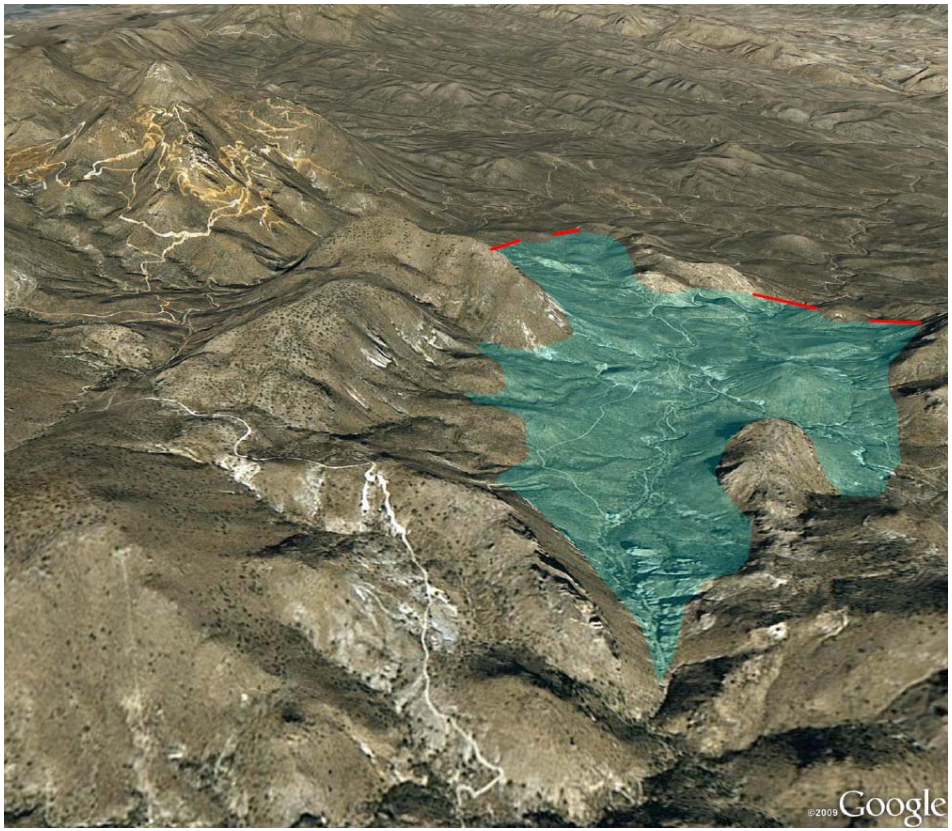
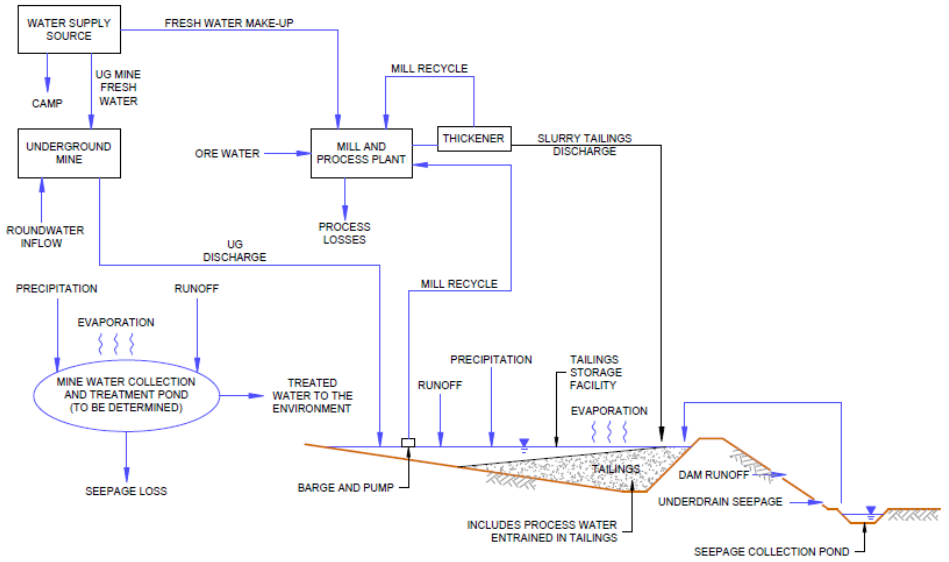
New Mine in Central America – water supply permit

How much water would be required?
Obtain permit for water supply wells.





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Importance of Water Balance – Operating Mines

- Operating Mines
  - Provide information for reporting requirements
  - Reduce risk of insufficient water
  - Reduce risk of stopping production
  - Reduce operational cost
  - Reduce liability
  - Reduce risk of tailing dam overtopping
  - Reduce risk for discharge of contaminated water
  - Estimate quantity of water required for an expansion
  - Estimate excess water for operational change

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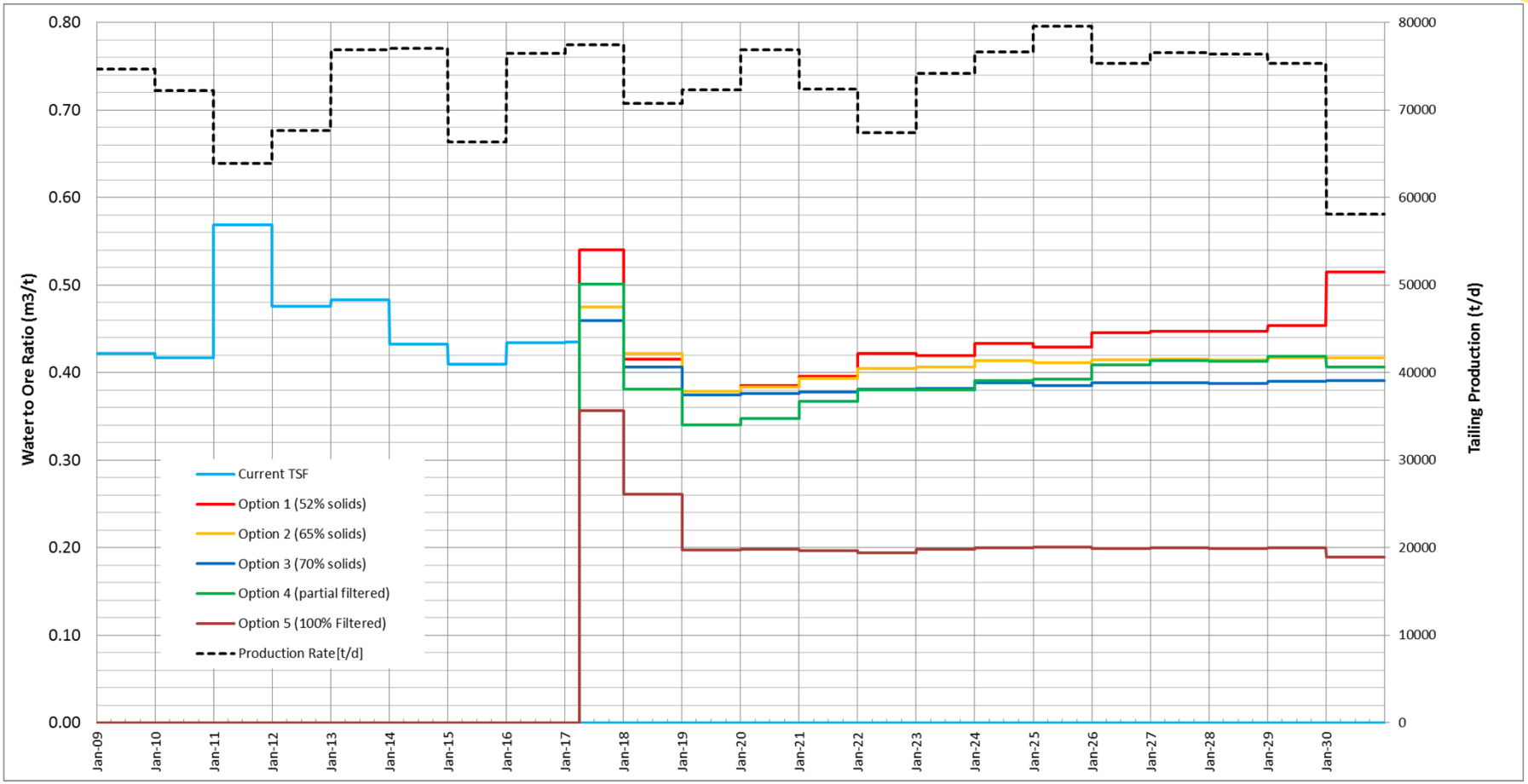
Operating Mine – Commissioning a New TSF
Evaluation of Alternative Tailing Disposal Options



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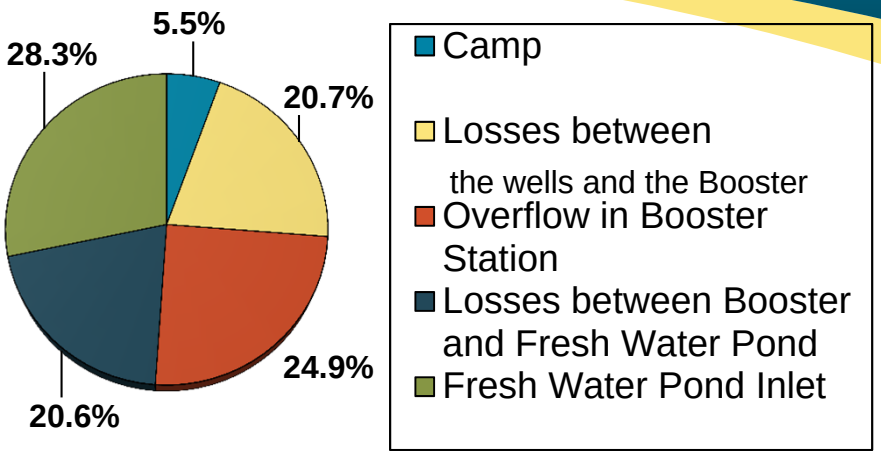
Saving water by finding hidden losses

- 15,000 ft altitude, arid climate
- Water system 15 to 20 years old
- Supply from wells 25 km from site
- Pipeline and booster station
- Heap leach operation
- Cold weather challenges
- 60+ % losses between supply and mine



Importance of Water Balance – Closed Mines and Closure Planning

- Mine Closure
  - Wet or dry closure?
  - Impact of climate change
  - Can water treatment be avoided?
  - Water quality and quantity
  - Planning for closure during design
  - Cost reduction
  - Liability and risk reduction

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Mine Closure

- Evaluate water treatment requirements for closure

Mine Closure

- Make better decisions for closure planning

Closing

- Mine Water Balance is a useful tool for:
  - Decision-making
  - Trouble-shooting
  - Operations planning
  - Closure planning
  - Risk management
  - Permitting
  - Negotiating
  - Reporting

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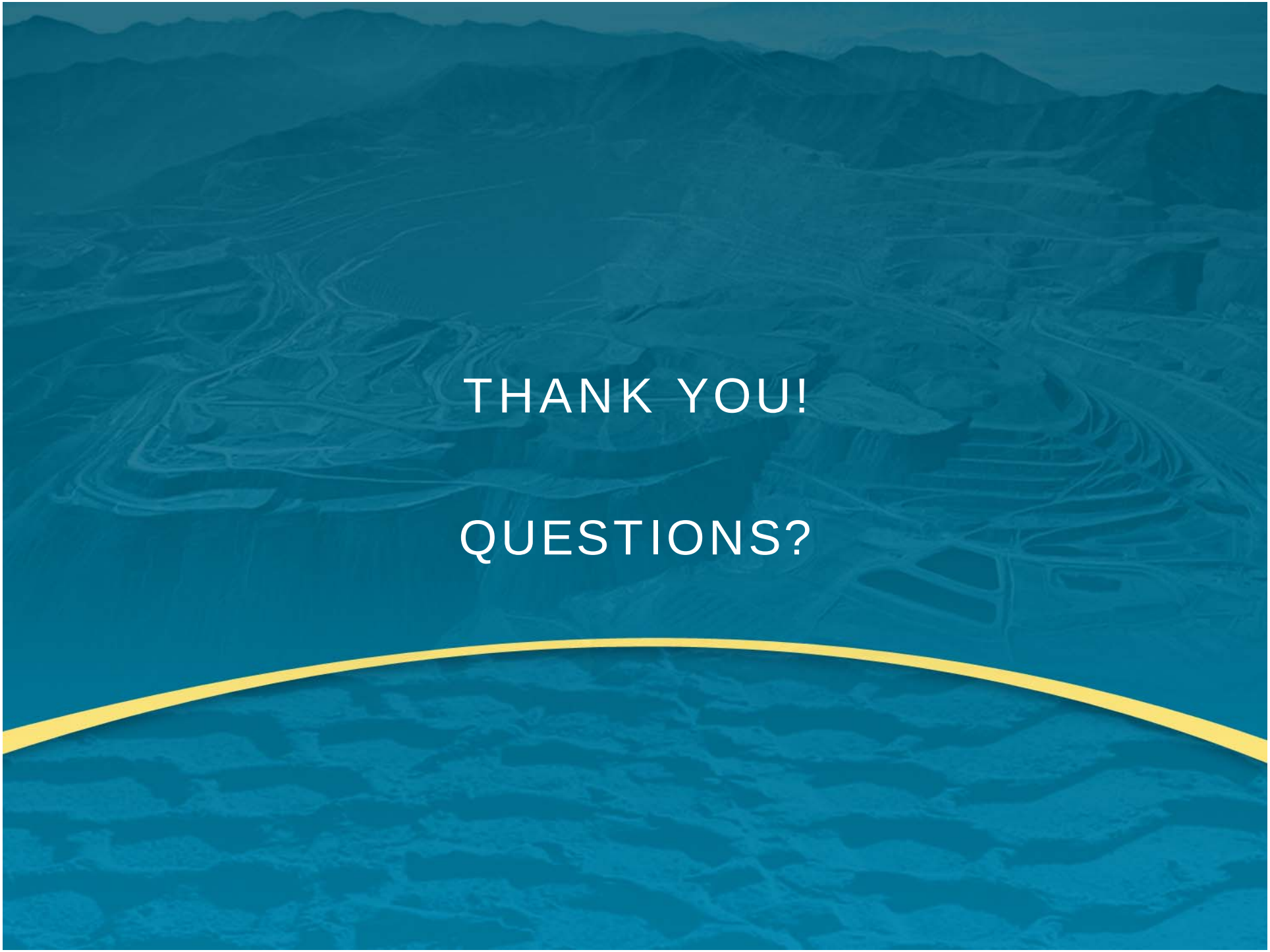
THANK YOU!
QUESTIONS?