A systems modelling approach to manage mine discharge risk to rivers

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Mine River Discharge

- Strategic Risk
  - Environmental Impact
  - Social license to operate
- Operational Risk
  - Breach of licence, fines
  - Loss of community support
  - Errors in holding required volumes
- Critical to manage discharge risk

Outline

- Current Practice
  - Issues
- Systems Modelling Approach
  - Mine Water Systems
  - Model Development
  - Scenarios
- Results and Discussion
Current Practice

- Stores and Ponds considered in isolation from remainder of mine water systems
  - Dam safety
- Hydrological Analysis
  - Catchment model, IDF data for design events, analyse scenarios for specific ARIs

Issues

- Water stores are connected to the water systems
- Any change to the water system has the potential to impact on the discharge risk
- With many practices being implemented, it is critical to try and assess their impact on discharge risk

Features of Mine Water Systems (1)

- Multiple Inputs
  - Climate (rainfall and runoff, lakes and rivers)
  - External regulating bodies (water suppliers, third parties)
  - Physical characteristics (aquifers)
  - Site conditions (water entrained in the materials brought on site)
- Causal relationships between water tasks, water treatment and stores
  - Depend on the water management strategies implemented
Features of Mine Water Systems (2)

- Various sources of water
  - Surface water, groundwater, sea water, third-party water
  - Varying quality

- Various “states” of water
  - Raw Water: Water that is supplied or captured and has not been used for any purpose
  - Worked Water: Water that has been used for a purpose and is returned for future use
  - Treated Water: Raw and/or worked water that is treated on-site to provide water of a more appropriate quality.

- Water flows represented as combination of sub-sets

Features of Mine Water Systems (3)

- Feedback mechanisms
  - Quality – eg. Rules on water quality tolerance at the input of certain tasks.

- Non-linearity of input/output relationships
  - Climate control
  - Feedback mechanisms

- Non-linear system of connected elements not controlled by a central entity, that includes causal relationships between objects embedded in other objects Complex System

Traditional Engineering Models
Systems Model

Scenarios

- Two mines
  - One small gold/silver operation, high level of treatment
  - One large coal operation
  - Applicability of model to range of commodities and operation types.

- Analysis of impact of management strategies
  - Loss reduction
  - Change in proportion of raw water at task’s input (task = processing)
  - Adoption of production ratio

Reduction in Task Loss
Reduction in Evaporation Loss

Changes in Production Ratio

Concluding Remarks

- Mine water stores are part of complex systems
- Changes to the system can impact on discharge risk
- Impact of water management strategies cannot be deduced, modelling is required
- System modelling approach is appropriate to assess the impact of water management strategies on discharge risk
- Use of the model can provide a risk profile for management options