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 license, 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, IFD 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

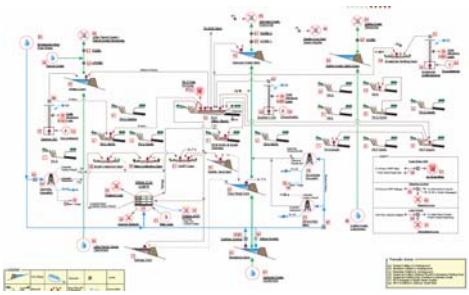
Features of Mine Water Systems (2)

- **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**

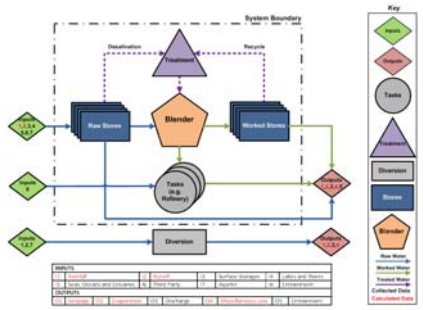
Features of Mine Water Systems (3)

- **Feedback mechanisms**
  - Quantity – eg. Rules on water level in stores.
  - 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



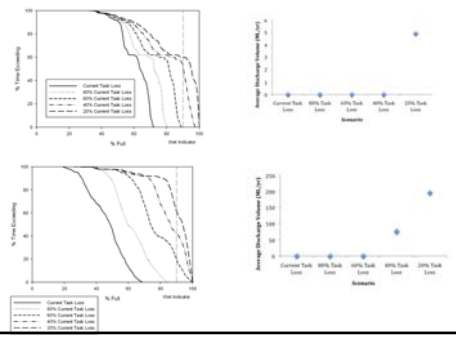
Systems Model



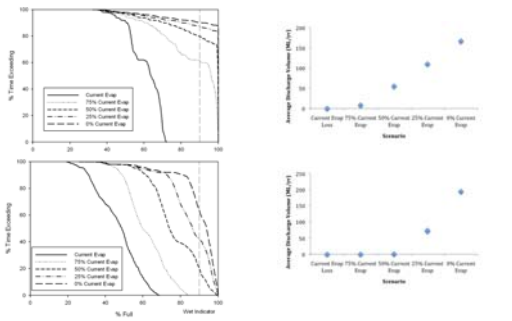
Scenarios

- **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

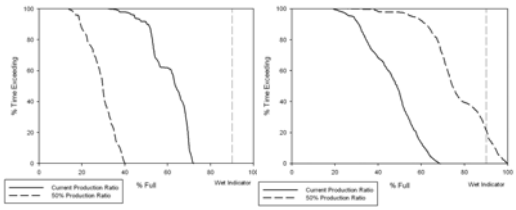
Reduction in Task Loss



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 deducted, modelling is required**
- **System modelling approach is appropriate to assess the impact of water mangement strategies on discharge risk**
- **Use of the model can provide a risk profile for management options**