How Much Modelling is Too Much Modelling Red Chris Mine: A Case Study

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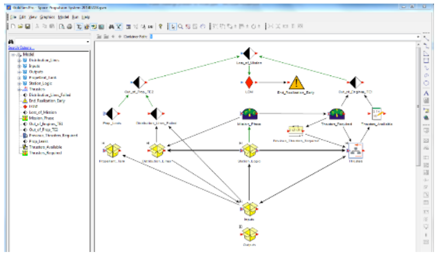
Water and Load Balance Modelling

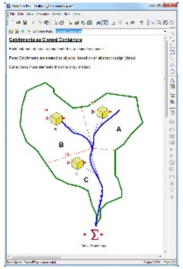
- Focus here is on water and load balance models used to evaluate water management at mine sites.
- Water and load balance models are the best tools we have for evaluating and managing environmental risks.
- Water and load balance models are used to answer questions such as:
  - Will discharge from site be required?
  - If so, how much water and when?
  - What is the likely quality of the discharge and is treatment required?

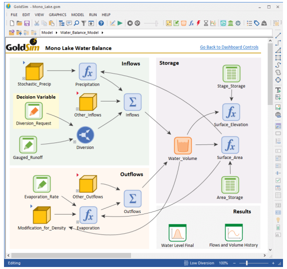
Water and Load Balance Modelling

- Current state of practice:
  - Models usually developed in the Software Goldsim®.
  - Comprehensive characterization of inputs, including site-specific geochemical source terms, meteorology, hydrology, hydrogeology, waste rock and tailings deposition, location and performance of water management infrastructure, etc.
  - Often, stochastic variables are used to represent variability in climatic, hydrologic and chemical source terms.

Figure 2: Top-level view of the mission model.







Topic of Discussion

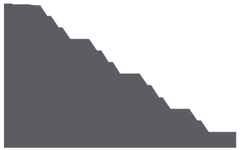
- Does increased model complexity actually improve model accuracy?

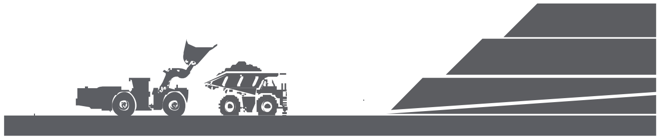
Higher Complexity = Greater Accuracy ?

- Or is it possible that model complexity masks model uncertainty by portraying a false sense of accuracy?

Why it Matters

- A decision of some importance must be made:
  - For example, expansion of an open pit, closure of a heap leach or waste rock area, change in mining rate.
- Investments could be significant – and so could be the risks.



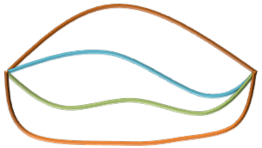


Why it Matters

- Water and load balance models are used for forecasting and understanding consequences of the decision.
- Because of high stakes (cost and risks) decision makers want “defensible” (*i.e.* reliable, accurate) model results.
- As modellers, we (too) often comply:
  - Rely on model complexity to demonstrate “defensibility” and (may unintentionally) mask uncertainty.

Why it Matters

- A simpler approach to modelling can improve understanding of *real* model uncertainty and lead to better (or at least better informed) decision making.



Case Study: Red Chris Mine Site-Wide Water Balance and Water Quality Model

Red Chris Case Study Overview

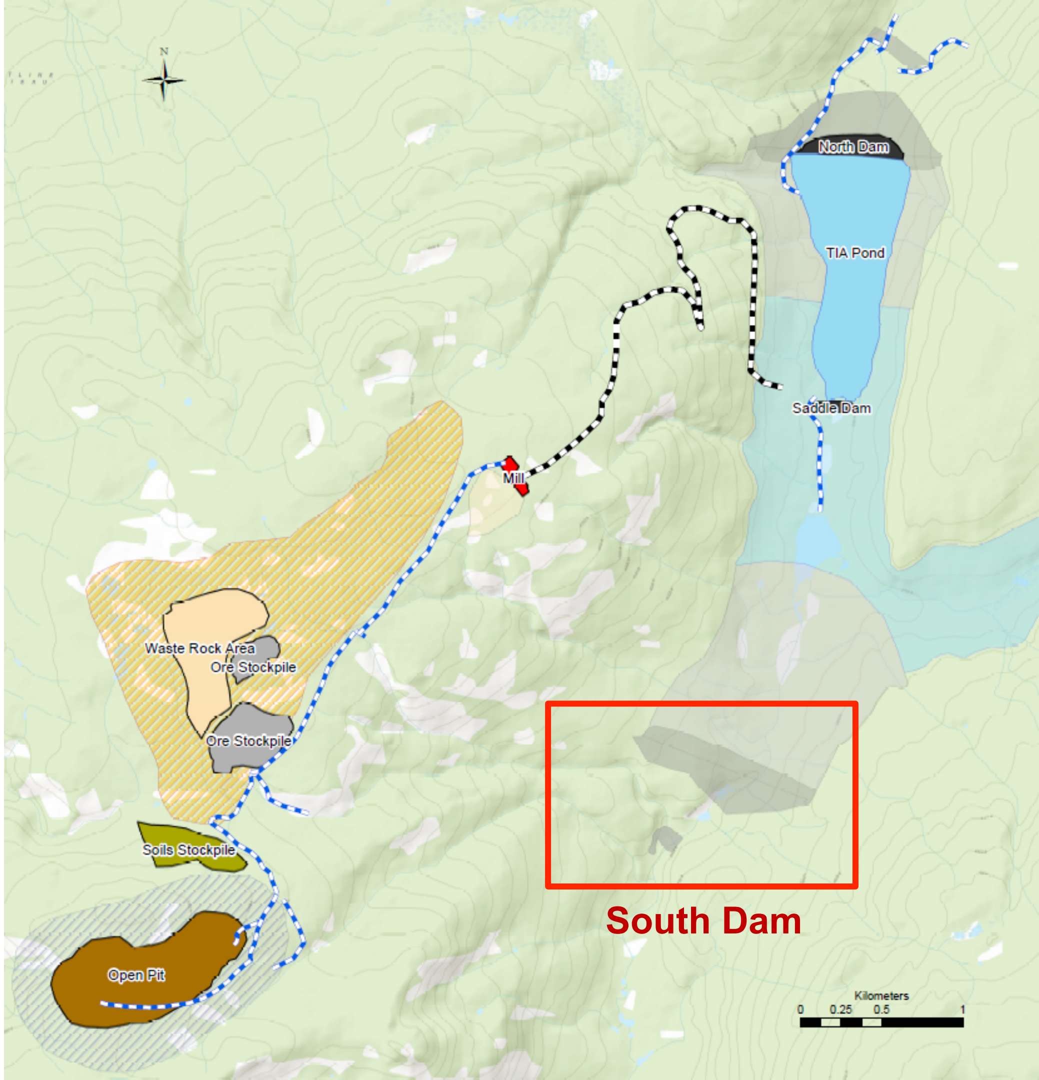
- This case study illustrates the potential utility of a simpler model for understanding *real* model uncertainty.

Background – Red Chris SWWBWQ Model

- In 2016: Application to amend the *Mines Act* Permit and *Environmental Management Act* Permit to advance construction of the South Dam.
- A Site-Wide Water Balance and Water Quality Model (SWWBWQ model) was needed to:
  - Estimate future water quality of tailings pond water.
  - Requirements for discharge.
  - Evaluation of potential effects on downstream water quality.
  - Assessment of water quality mitigation measures.
  - etc.

Red Chris Mine

2016 and Future

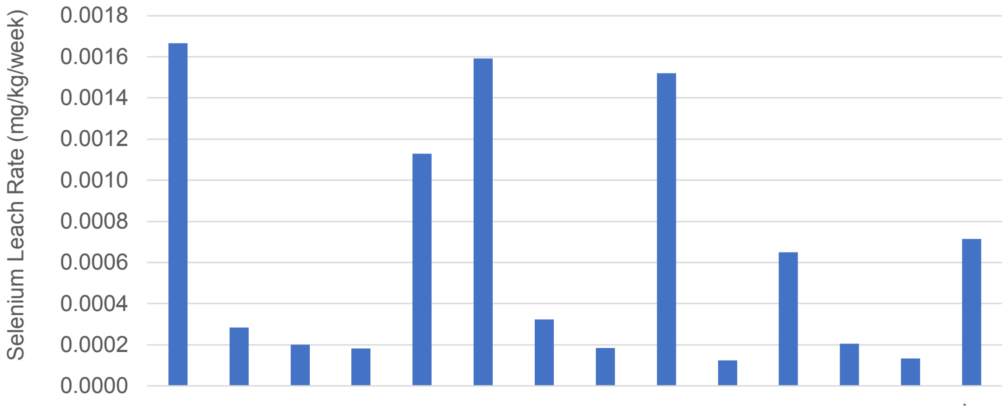


Red Chris SWWBWQ Model

- Model inputs:
  - Meteorology and surface hydrology
  - Hydrogeology (with 3D Groundwater Modelling)
  - Geochemical source terms
  - Mine plan (tailings and waste rock production and deposition)
- Main sources of uncertainty:
  - Geochemical source terms and attenuation of constituents in the TIA.
  - Groundwater/surface water interactions.
- However, all inputs have uncertainties.

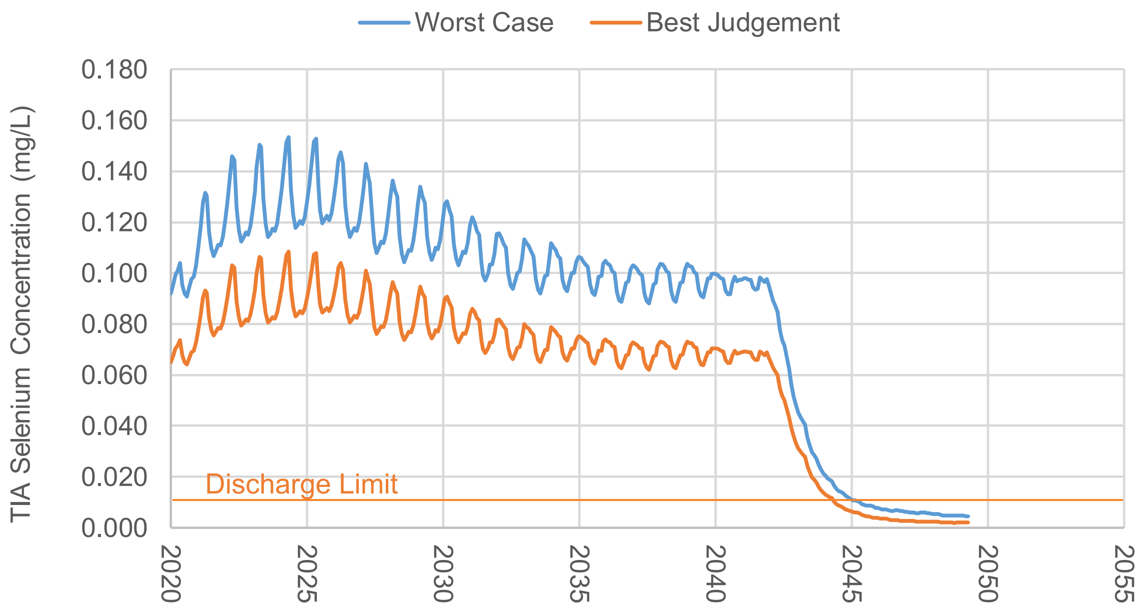
Example: Waste Rock Source Terms (Selenium)

- Based on geochemical testwork.
- Natural variability in weathering rates → uncertainty in predicted rates.
- Variability addressed through 50th and 95th percentiles.

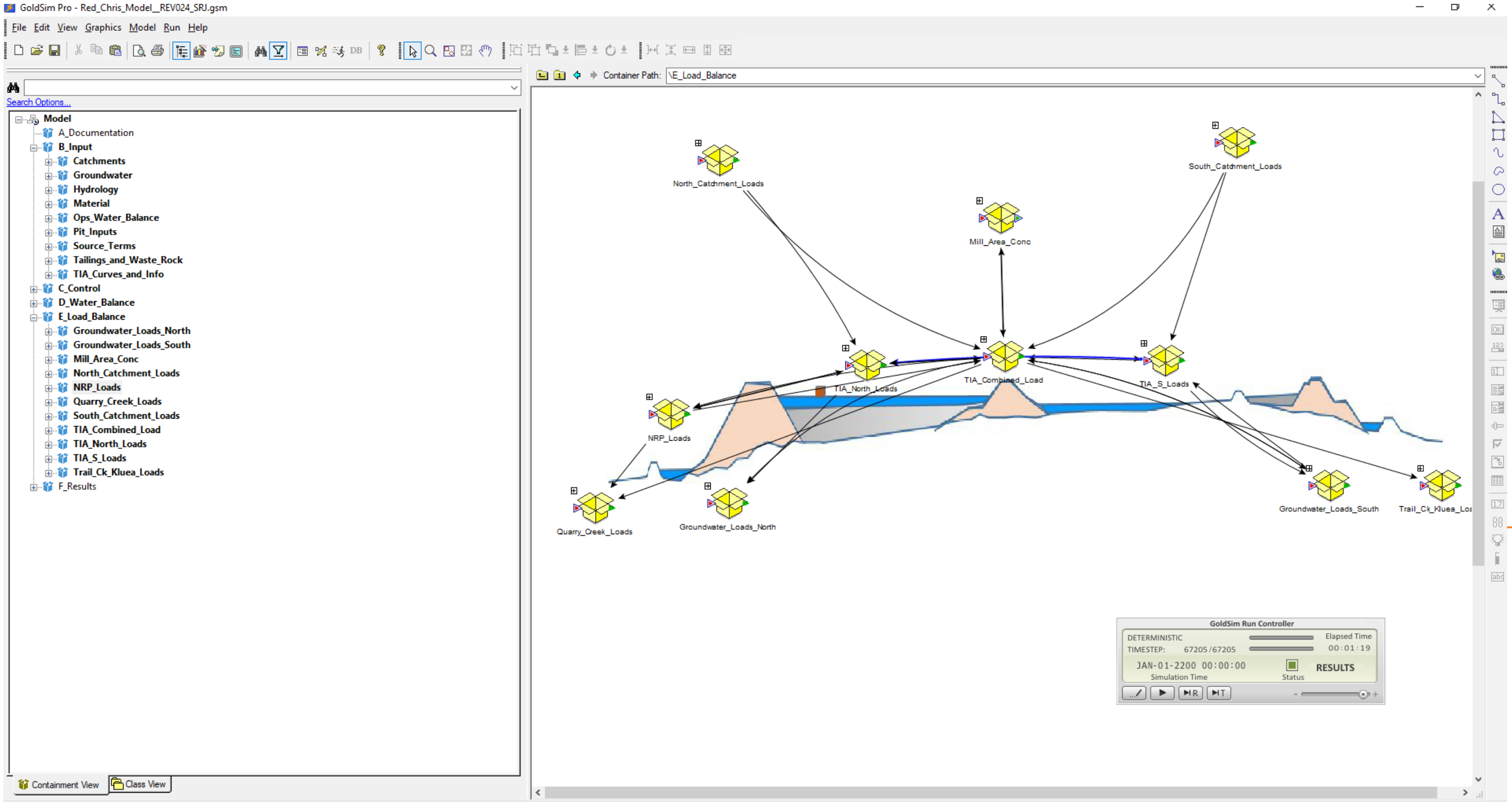


The Typical Approach

- Goldsim® Model.
- Can be months of model development.
- Includes all quantifiable inputs.
- Can be difficult to review and challenge.
- Infer certain precision of results.



The Typical Approach



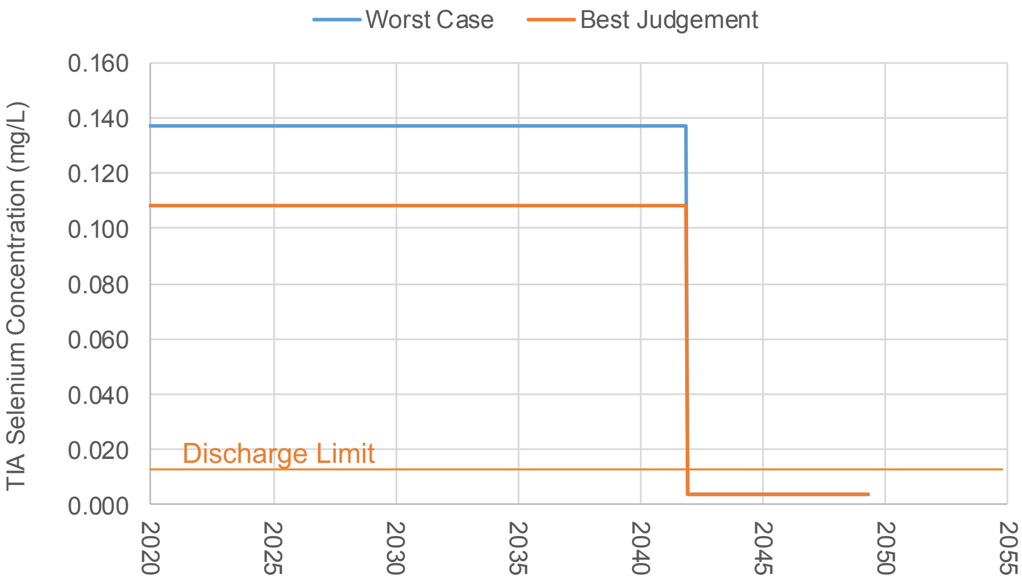
Alternative Approach: Simple Excel® model (<20 Rows)

DON'T TRY TO READ THIS!

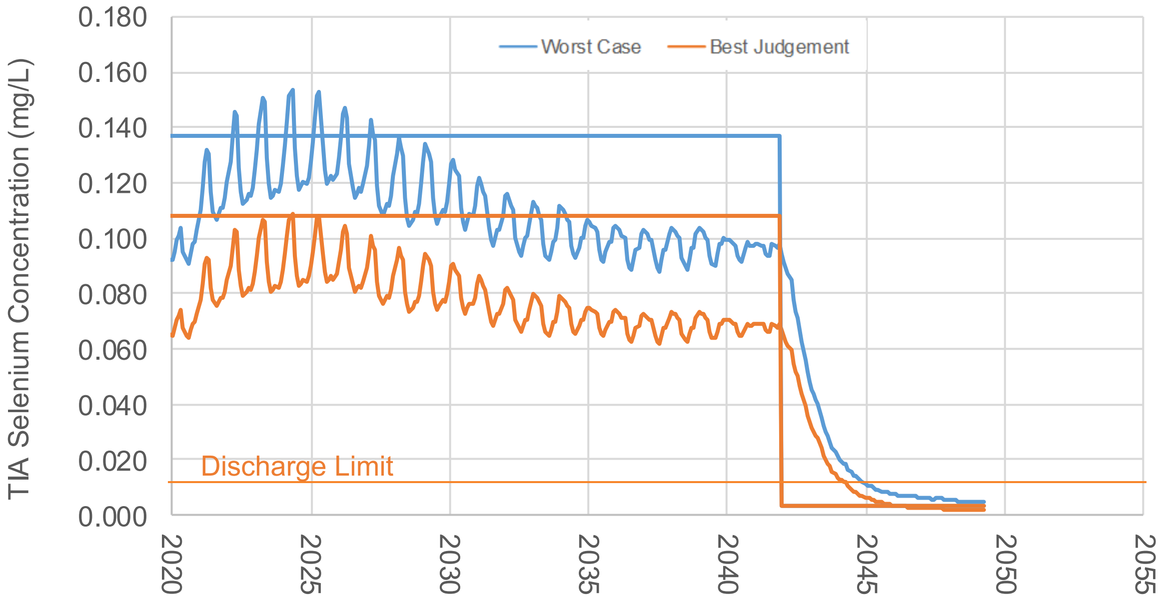
Site Runoff		
Total Project Catchment	3200	ha
Average Annual Precipitation	578	mm
Total Annual Inflow to TIA (incl. groundwater) Estimated	8.3	Mm^3/year
Tailings		
Daily Production	30,000	tonnes/day
Annual Production	11	Mtonnes/year
Best Estimate Source Term, Selenium	55	mg/tonne
Total Selenium Load Dissolved	602	kg/year
Waste Rock		
Ultimate Waste Rock Area	284	ha
Runoff Coefficient, Developed Area	0.6	
Waste Rock Area Flow	1	Mm^3/year
Waste Rock Source Term	0.3	mg/L
Selenium Loadings from Waste Rock	295	kg/year
Result		
Selenium Concentration, TIA, Steady State	0.1	mg/L
Selenium Concentration, TIA, Post Closure, Steady State	0.004	mg/L

Alternate Approach

- Simple Excel (or Goldsim) model.
- Few hours of model development.
- Same fundamental inputs.
- Easy to review, revise, discuss and challenge.
- No “precision illusion”.



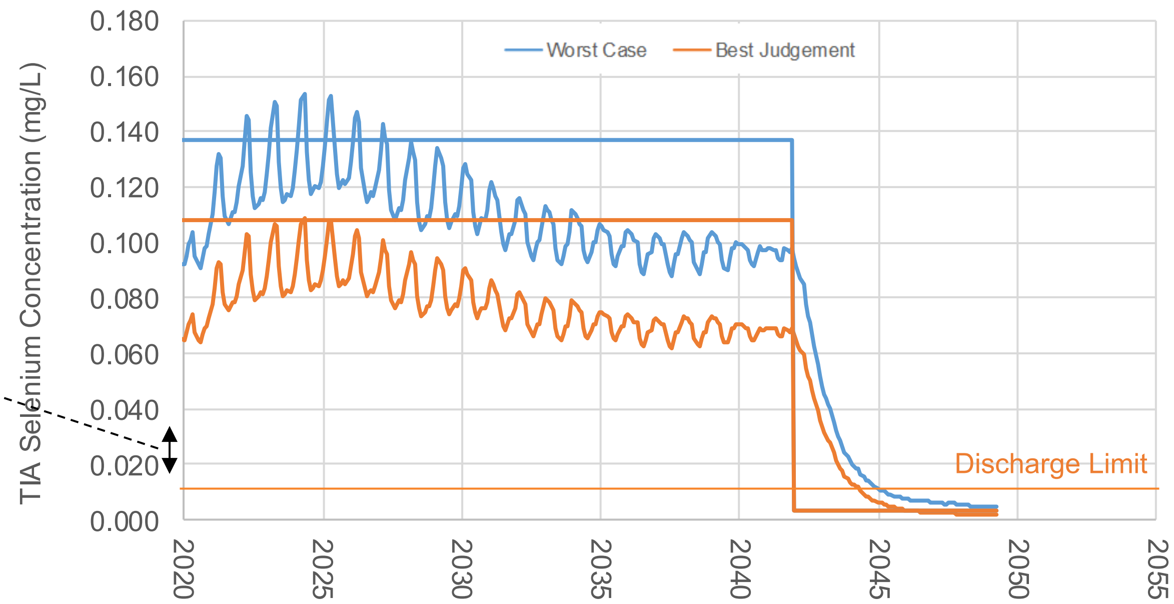
Typical vs. Simple Model



In Reality:

Observed range of concentrations in 2018: 0.025 ± 0.007 mg/L

(pay attention to field monitoring data!)



Conclusions

- Identical conclusions:
  - Both models show elevated selenium concentrations in the TIA during operational years followed by a sharp drop when milling of ore ceases.
  - Selenium treatment unlikely to be required post-closure.
- Seasonal variability unlikely to be important for TIA water quality.

Closing Remarks

So, how much modelling is too much modelling?

- Answer is project-specific.
- Consider working with simpler models when identifying, conceptualizing and reporting model uncertainty because:
  - Resolution of a simple model matches level of certainty (i.e. order-of-magnitude).
  - Easy to review, revise, discuss, verify, challenge and report result.
  - Addition of complexity often does not change the outcome.
- Pay attention to field monitoring!