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Determining the effect of Grade Engineering® on the water account of a copper mine

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GECAMIN Conferences for Mining

Introduction

- Mining uses significant water (2% to 3%)
- Mines are intense local users and impact is often keenly felt by adjacent communities
- Generally: mines don't have enough water unless they have too much, in which case they have too much.
- Mines increasingly vulnerable to a commodity which has historically had very low purchase cost

Introduction

- It is reasonable and justified for operations to assess their impact on resources, especially in light of variation of climate, increased competition etc.
- Concurrent decrease in productivity, which leads to increased intensity of use (L water/ unit metal produced)
- Jevon's Paradox (rebound effect)
- Grade Engineering and Water Accounting

Grade Engineering

- Developed by CRC ORE, based at the SMI, UQ.
- Philosophy of optimization at all stages of process to upgrade ore
- Goal is to see improved mineral grades entering the processing plant
- A primary tool is the Integrated Extraction Simulator (IES) – software package which covers the whole extraction sequence

Water Accounting

- WAF also developed by CWiMI at the SMI, UQ
- Framework provides a method for consistent water reporting at a site
- Water Miner is the software tool developed to conduct the water account
- Includes:
  - Imports; stores, tasks, exports, treatment plants and diversions

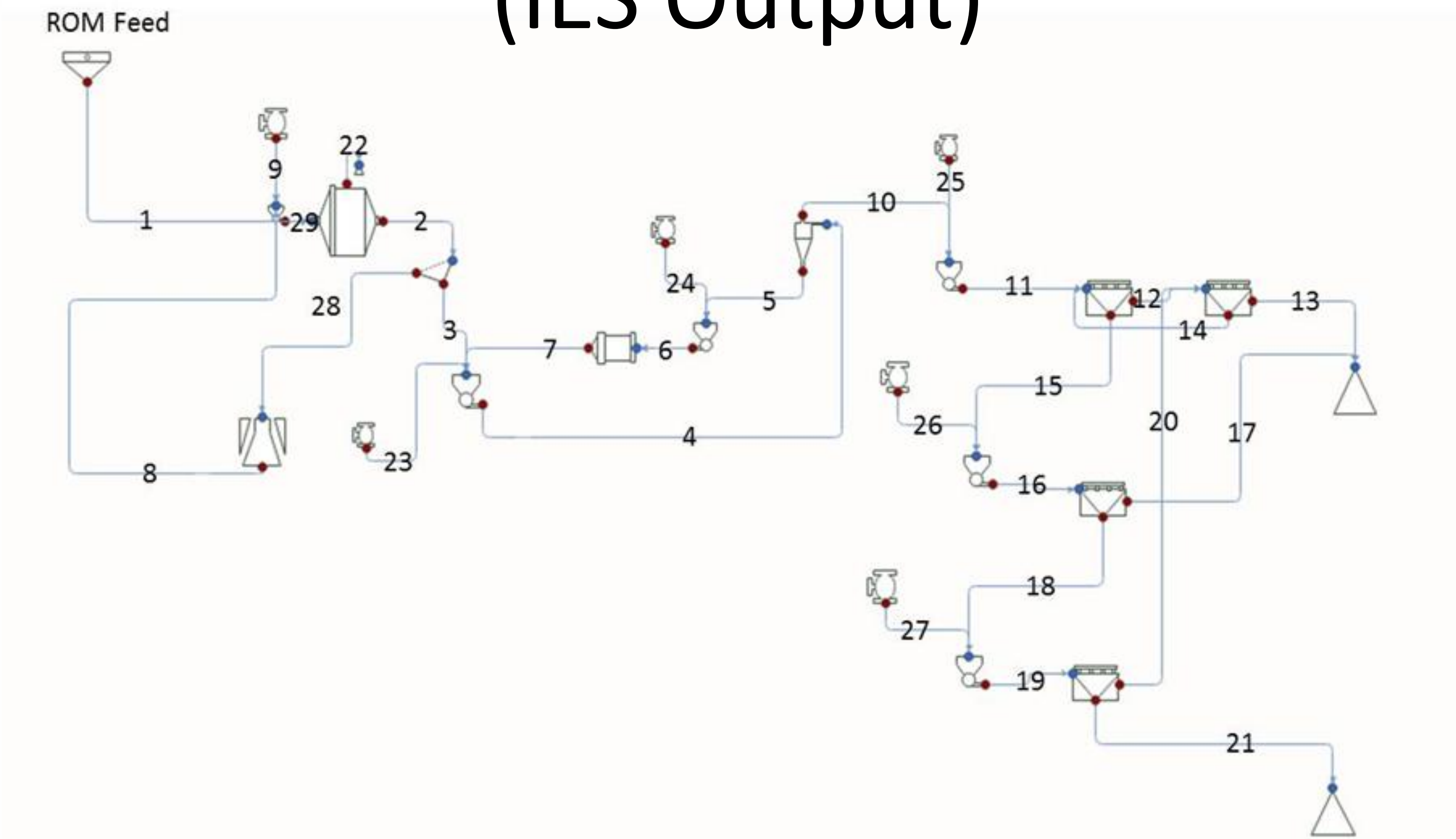
Research Objective

- Purpose of grade engineering to upgrade mineral at every step of the process.
- Double grade, halve tonnage – halve water usage?
- Double grade, same tonnage – same water usage?
- Try to understand how the upgrading would impact the water account of a simulated operation.

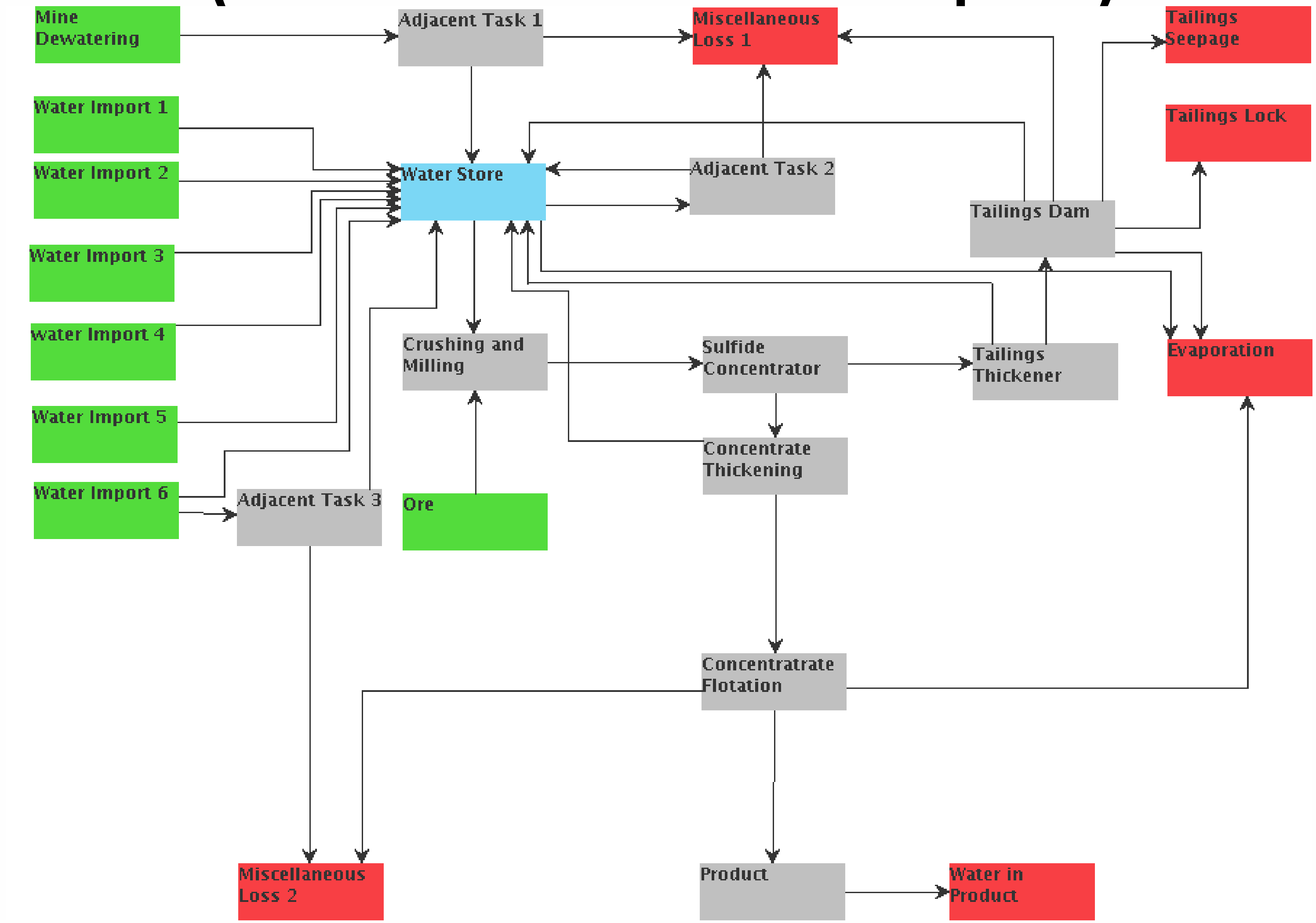
Methodology/ Basis

- Use of both WaterMiner and IES
- Large porphyry copper deposit (Arid Environment):
  - 1% Chalcopyrite, 0.2% Chalcocite, 0.2% bornite
  - 135 000 tons per day

Methodology/Process Description (IES Output)



Methodology/ Water Flow Description (Water Miner Output)



Results

- Base case: 135 000 tons/day
- Scenario 1: Doubling head grade, processing same tonnage (doubling copper)
- Scenario 2: Doubling head grade, halving tonnage (copper throughput constant)

Results: Base Case

Storage Volumes		Imports and Exports	
Storage at End of Period (ML)	11 200	Imports (ML)	38 649
Storage at Start of Period (ML)	11 888	Exports (ML)	38 661
Change in Storage (ML)	12	Difference (Imports - Exports)	**-12**

Global Reporting Indicators (GRIs)

EN8 – Total water withdrawal by source (ML/yr)				
Quality:	1	2	3	Total
Ground	20 246	5 893	12 615	38 754
Total	20 246	5 893	12 615	38 754

EN21: Total water discharge by destination (ML/yr)				
Quality:	1	2	3	Total
Ground	1 608	0	0	1 608
Evaporation	6 144	0	0	6 144
Entrainment	0	15 360	0	15 360
Other	0	15 654	0	15 654
Total	7 752	31 015	0	38 767

EN10: Water reused and recycled	
ML/yr	490 273
Percent of Volume Imported	1 269

Results: Scenario 1

Storage Volumes		Imports and Exports	
Storage at End of Period (ML)	7 720	Imports (ML)	38 649
Storage at Start of Period (ML)	11 200	Exports (ML)	42 128
Change in Storage (ML)	-3 480	Difference (Imports - Exports)	**-3 480**

Global Reporting Indicators (GRIs)

EN8 – Total water withdrawal by source (ML/yr)

Quality:	1	2	3	Total
Ground	20 246	5 893	12 615	38 754
Total	20 246	5 893	12 615	38 754

EN21: Total water discharge by destination (ML/yr)

Quality:	1	2	3	Total
Ground	1 608	0	0	1 608
Evaporation	6 144	0	0	6 144
Entrainment	0	18 837	0	18 837
Other	0	15 654	0	15 654
Total	7 752	34 492	0	42 244

EN10: Water reused and recycled

ML/yr	504 840
Percent of Volume Imported	1 306

Results: Scenario 2

Storage Volumes		Imports and Exports	
Storage at End of Period (ML)	12 549	Imports (ML)	29 116
Storage at Start of Period (ML)	11 200	Exports (ML)	7 766
Change in Storage (ML)	1 349	Difference (Imports - Exports)	**1 349**

Global Reporting Indicators (GRIs)				
EN8 – Total water withdrawal by source (ML/yr)				
Quality:	1	2	3	Total
Ground	15 160	1 421	12 615	29 196
Total	15 160	1 421	12 615	29 196
EN21: Total water discharge by destination (ML/yr)				
Quality:	1	2	3	Total
Ground	1 058	0	0	1 058
Evaporation	4 306	0	0	4 306
Entrainment	0	10 670	0	10 670
Other	0	11 808	0	11 808
Total	5 364	22 479	0	27 842
EN10: Water reused and recycled				
ML/yr	321 115			
Percent of Volume Imported	1 103			

Results/ Water Intensity

- Base Case
  - 0.402 ML/ton copper
  - 12 ML/year deficit
- Scenario 1 (double grade normal tonnage)
  - 0.200 ML/ton copper
  - 3 480 ML/year deficit
- Scenario 2 (double grade half tonnage)
  - 0.191 ML/year
  - 1 349 ML/year surplus

Conclusion

- Grade Engineering® will have a significant effect on the water account and the water intensity of the mine
- Rebound Effect/Jevon's paradox applies
- More meaningful to ask: What would be the optimum grade and tonnage processed within the set of given constraints at a site?
  - Switching off parts of circuit
  - Energy, capital, O&M implications
- Much work to be done linking to understanding energy usage
- NPV could be a constraint/boundary of the optimisation

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