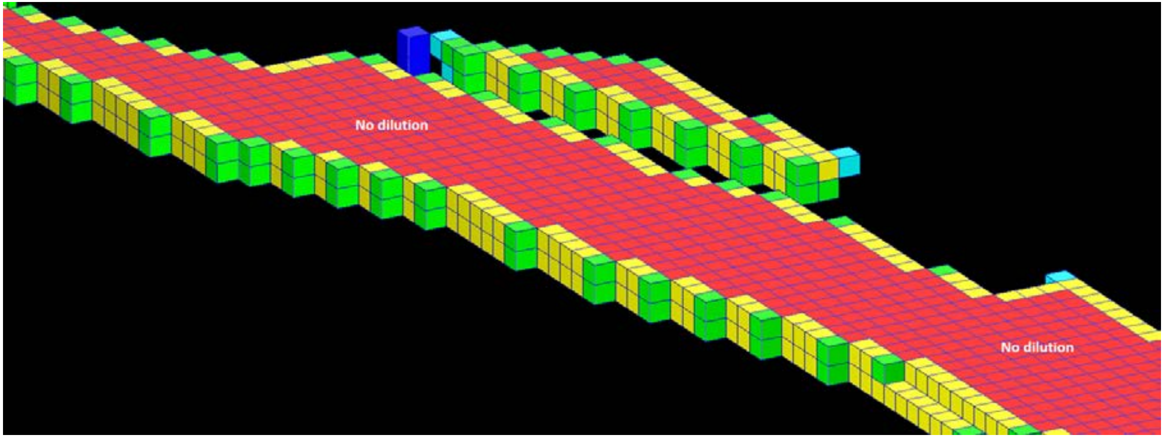

MINING DILUTION: VARIABLE VERSUS FIXED FACTOR

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SME
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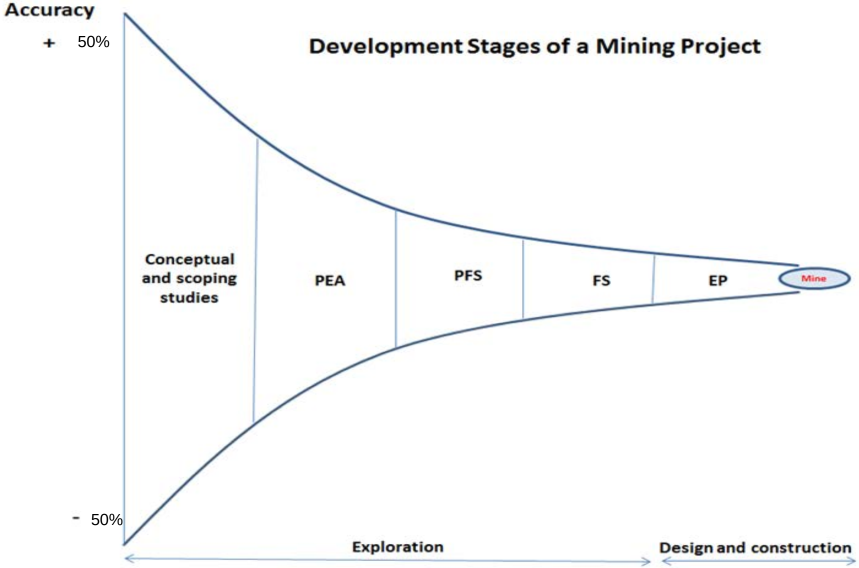
Input Parameters for Mine Design and Evaluation

- Resource model (grades, impurities, densities, topography, ….)
- Geotechnical information (slope stability, water, ….)
- Processing recoveries (recoveries, quality of salable products, ….)
- Scale of operation (processing and mining)
- Operating costs (mining, metallurgy, general and administration)
- Water supply (quality, quantity)
- Power supply
- Environmental protection and waste management (ARD, …)
- Permitting and legal issues
- Prices
- Shipping, off-site costs, ….
- Capital costs (initial and sustaining)
- ……
- Dilution

One step at a time

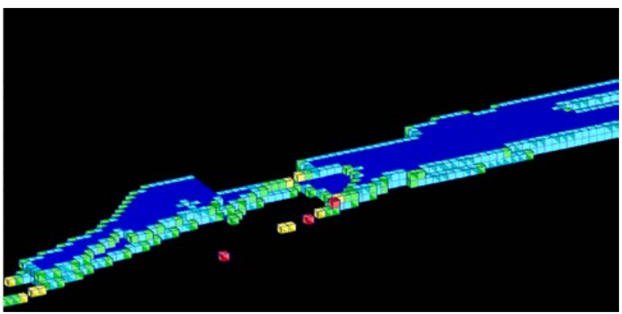
- A common approach to manage costs and risks of developing a mine is to do the work sequentially.



And work through details as much as possible, …

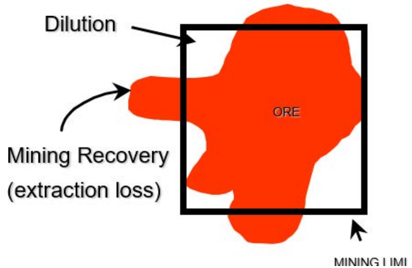
Mining Dilution: Examples of mining Projects

Study Level	Dilution	Notes
PFS	0%	As blocks are 25x25x15 dilution is assumed to be 0% as as SMU is smaller
FS	1%	
PEA	5%	20x20x10 model used
PFS	5%	Model is 5x5x5
FS	7.1%	SMU is 12x12x6, dilution determined using Barrick internal model
Tech Rep	8%	
Tech Rep	10%	
Tech Rep	15.5%	11.7% From Block Size, 3.8% from mining
Tech Rep	15%-24%	
FS	32%-40%	SMU is 5x2x2.5



Mining dilution – definition

- Dilution refers to the waste (and/or low grade) material that is not separated from ore during mining operation. The unwanted material that is mixed with ore and sent to processing plant.



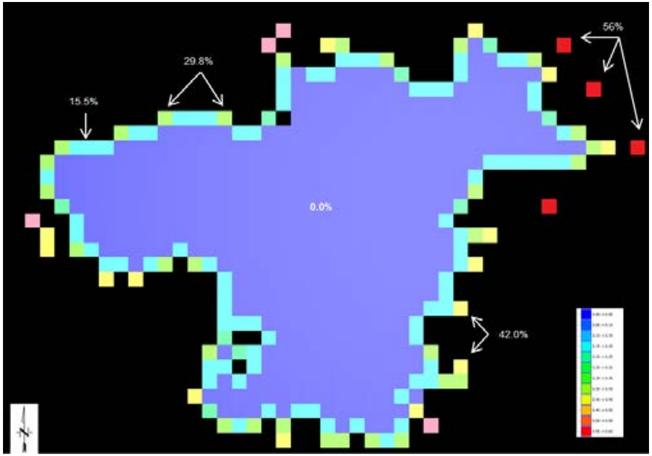
- Two perspectives:

$$Dilution(insitu) = \frac{Waste\ Tonnes}{Ore\ Tonnes} \text{ x } 100$$

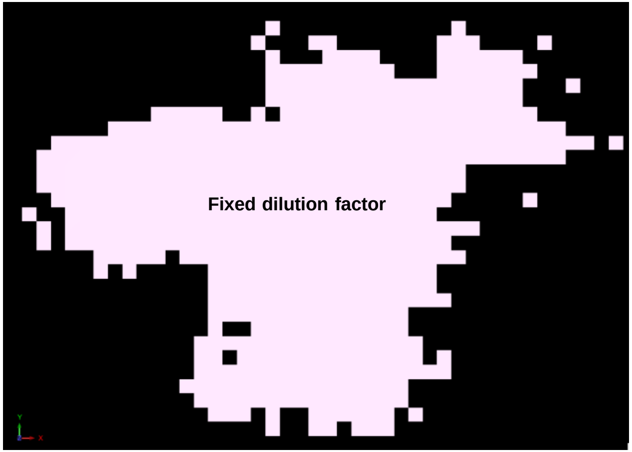
$$Dilution(mill\ feed) = \frac{Waste\ Tonnes}{(Ore\ Tonnes + Waste\ Tonnes)} \text{ x } 100$$

Neither is a standard. It is common to use insitu dilution in mine planning.

Variable Factor Versus Fixed Factor

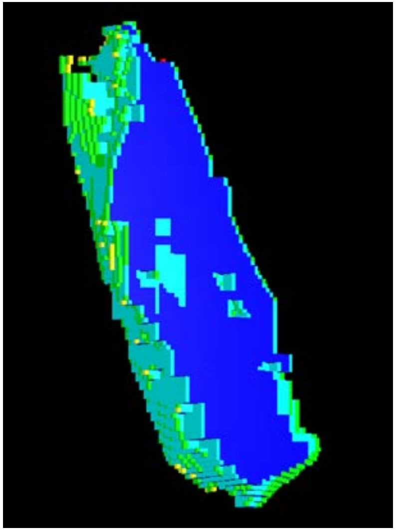


Blocks above cut-off grade are shown in the picture.



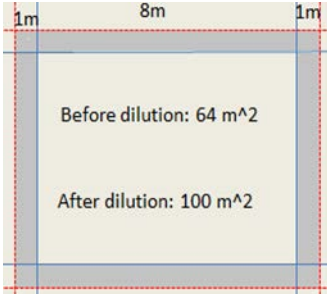
Variable Dilution Factor: Methodology

1. Develop a value model such as NSR
2. Calculate the cut-off grade
3. Identify corner/side waste blocks for each ore block
4. Using engineering and operational judgment to define a thickness for dilution skin
5. Calculate dilution factor for each ore block
6. Estimate diluting grades
7. Calculate grades after dilution for ore blocks
8. Update the value model using diluted grades

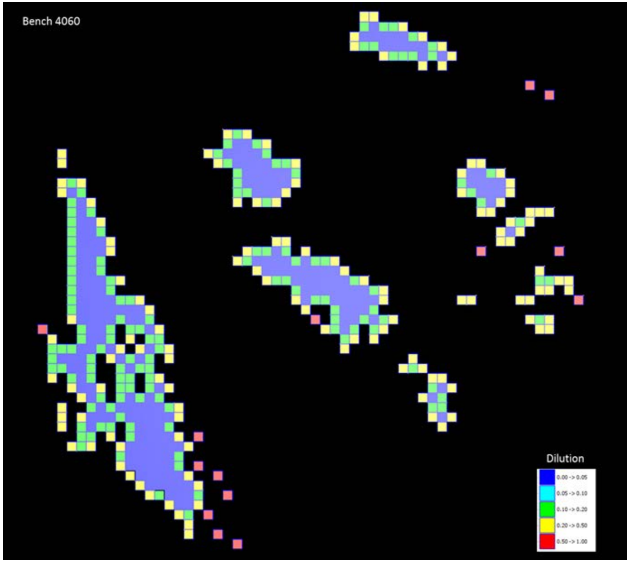


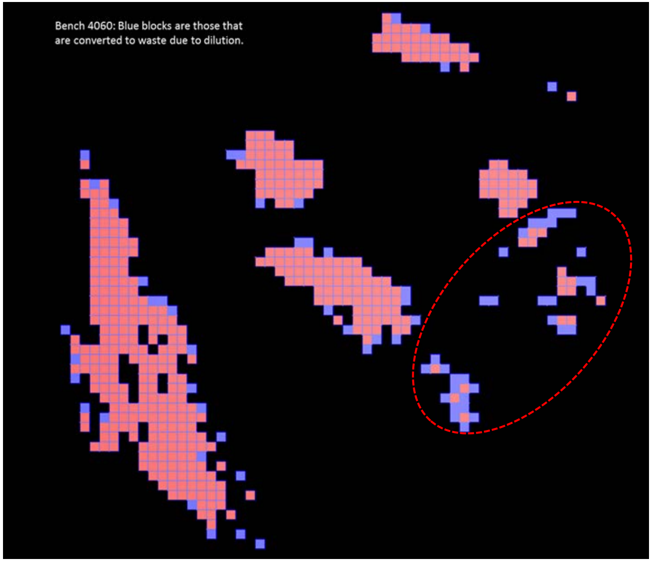
Variable Dilution Factor, Example

- Dilution is calculated based on the location of each individual block. For example for a 8m by 8m block and 1m skin dilution is calculated as:
  - 1.6% for each corner dilution (max 4 corners)
  - 12.5% for each side dilution (max 4 sides)
  - Maximum of 56% dilution for an isolated ore block that are surrounded by waste blocks

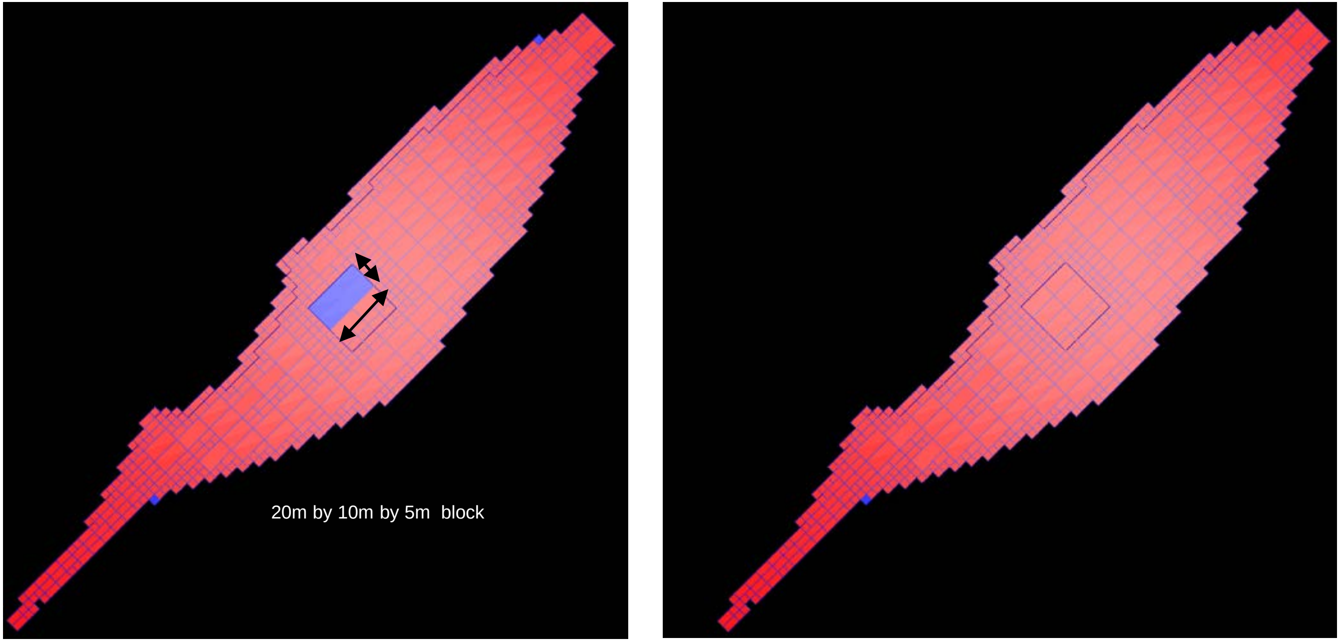


Variable Factor: Example of Ore Selection





Fixed Factor: Example of Ore Selection



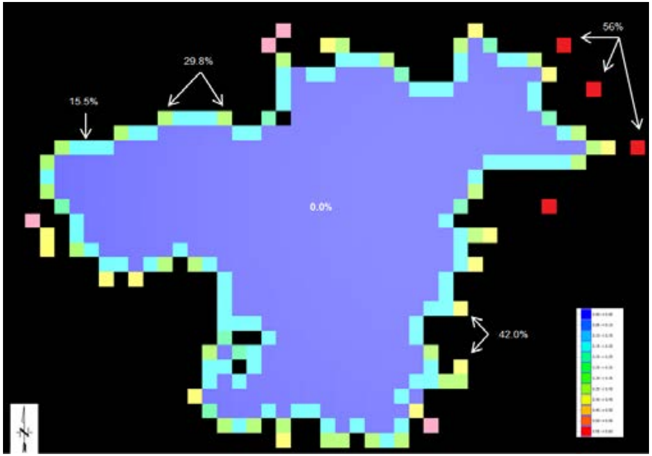
4300 tonne of ore counted as waste in fixed dilution.

Case Study A: Silver Project

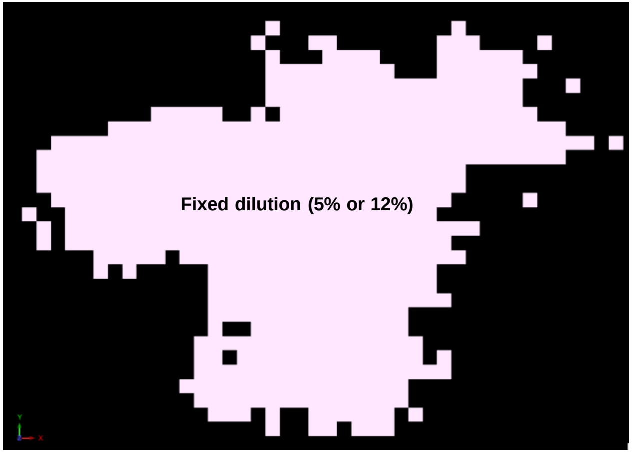
- 3 scenarios for dilution
  - A: 5% global dilution
  - B: 12% global dilution
  - C: Variable dilution

Studies	A	B	C
Silver price	$ 18.50 /oz	$ 18.50 /oz	$ 18.50 /oz
Mining operating cost	$ 2.54 /t	$ 2.54 /t	$ 2.54 /t
Processing operating and G&A costs	$ 31.10 /t	$ 31.10 /t	$ 31.10 /t
Royalty	3%	3%	3%
Discount rate	10%	10%	10%
Initial capital M$	80.00	80.00	80.00
Sustsaining capital $M	82.00	82.00	73.00
Pre stripping M$	8.00	8.00	8.00
Project life (year)	11.00	11.00	10.00
Production rate (t/day)	4,000	4,000	4,000
Ore Mt	12,379,999	12,738,972	11,579,748
Ag g/t	156	151	157
Pb %	1.19	1.15	1.20
Zn %	0.43	0.41	0.42
Waste Mt	47,280,165	46,889,347	46,572,097
Total mined	59,660,164	59,628,319	58,151,845

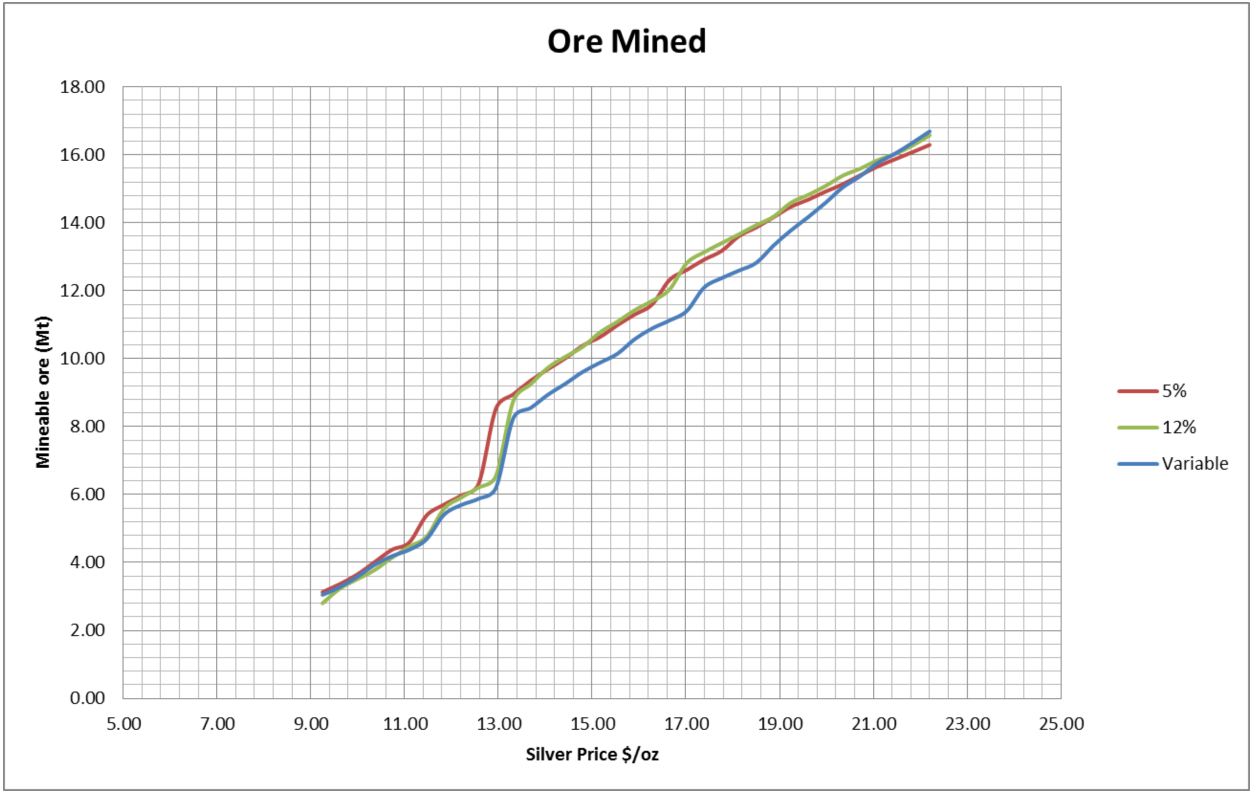
Case Study A



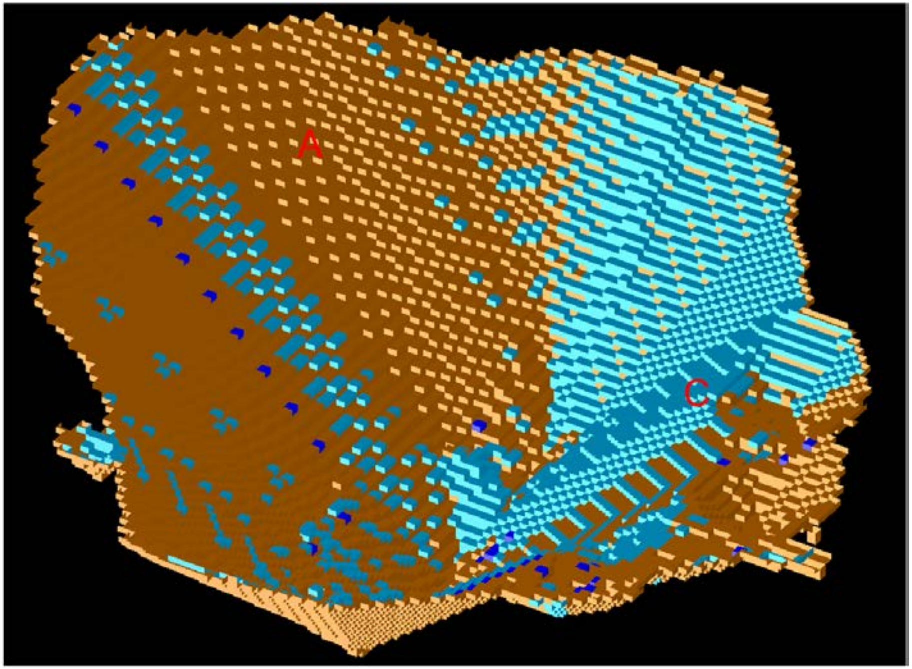
Blocks above cut-off grade are shown in the picture.



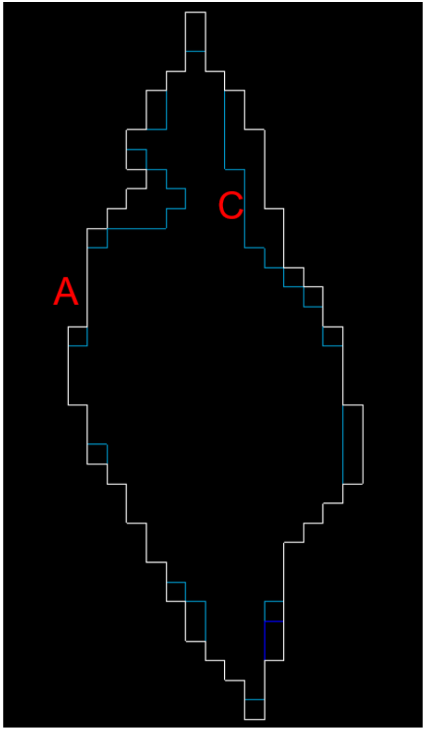
Case Study A: Optimum Pits

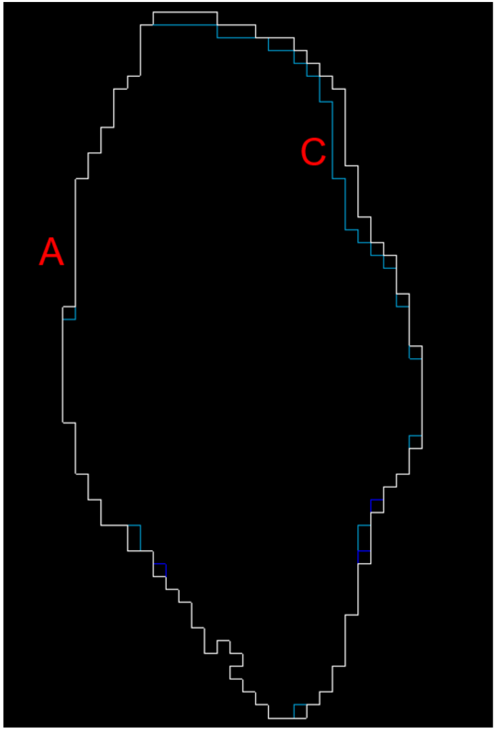


Case Study A: Optimum Pit Shells (A, B, C)

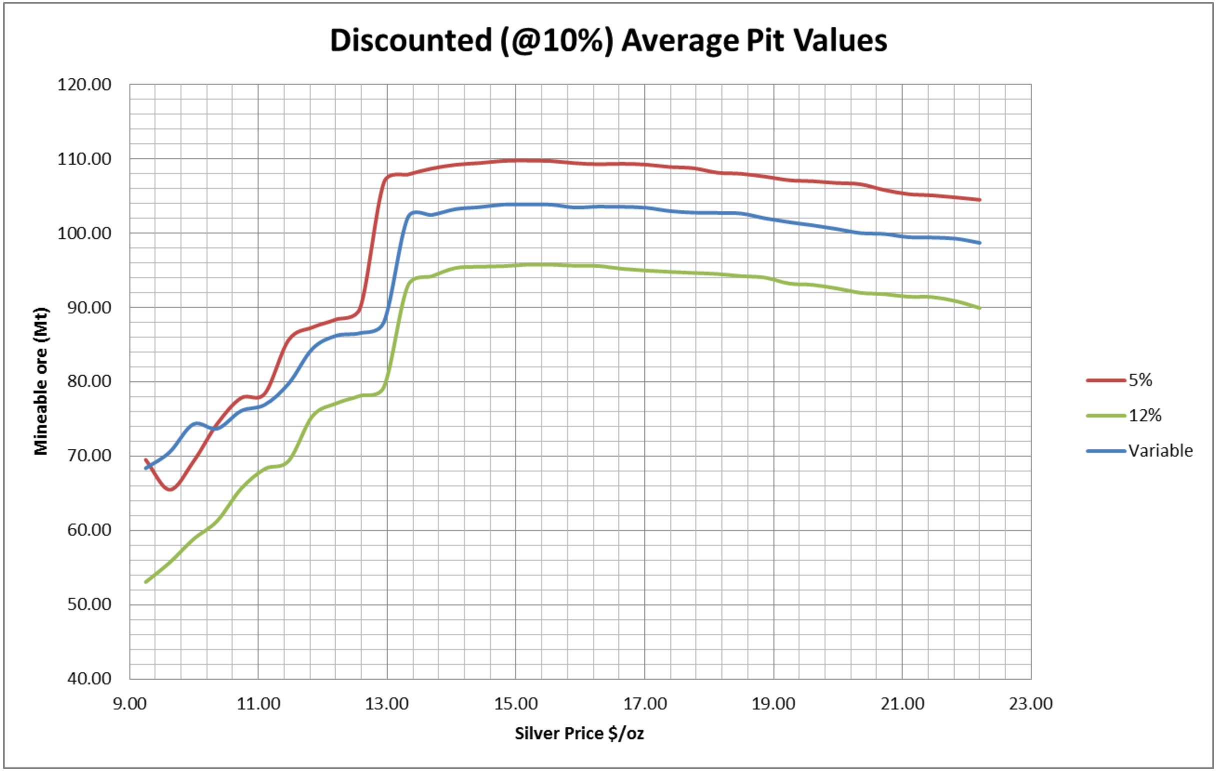


Case Study A: plan views

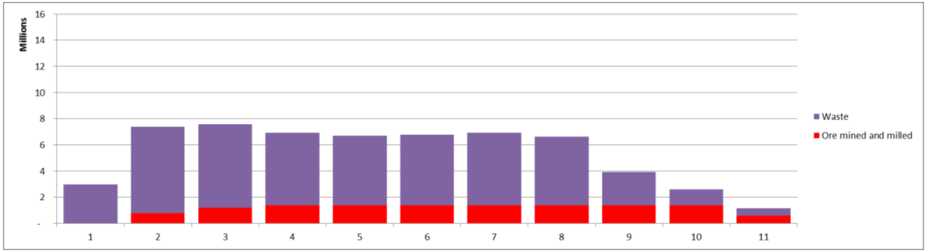




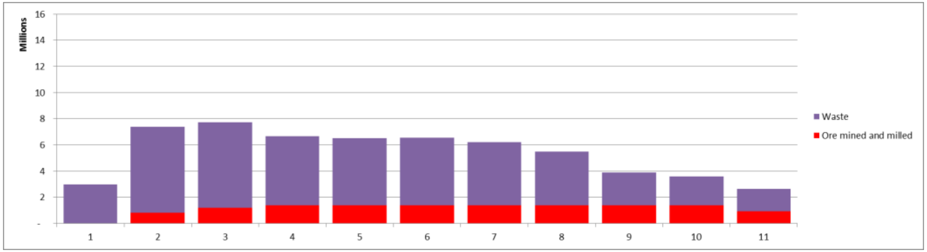
Case Study A: Discounted Pit Values



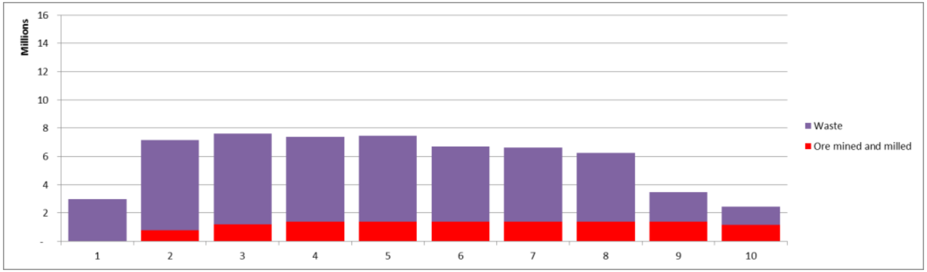
Case Study A: Production Schedules



A

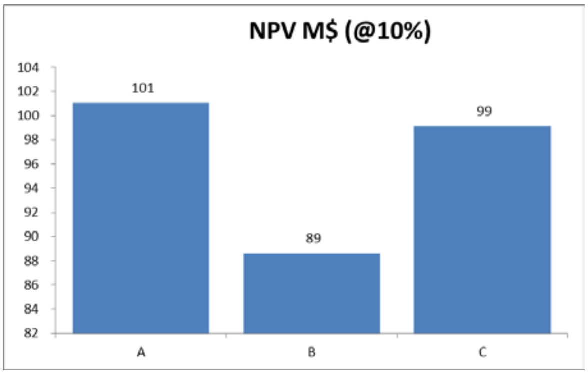


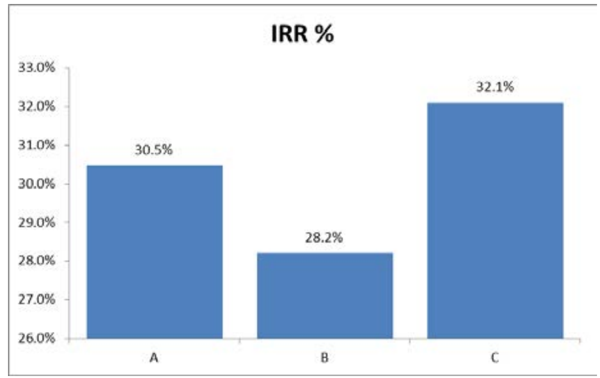
B



C

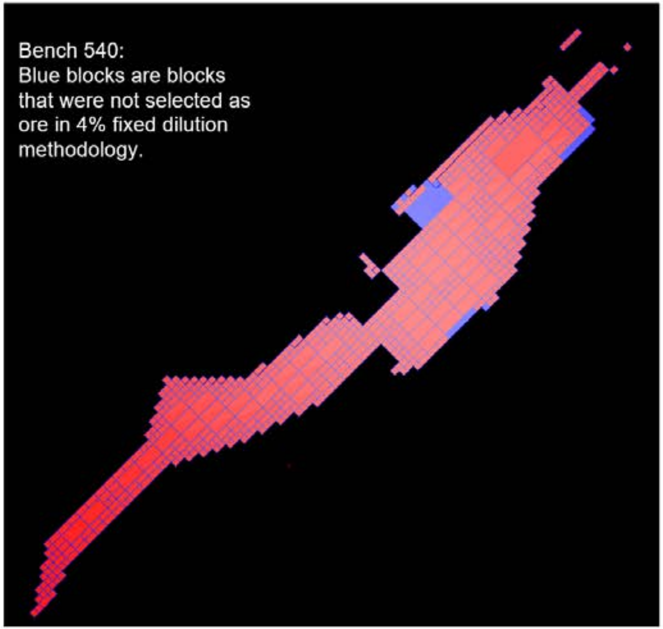
Case Study A: NPV & IRR

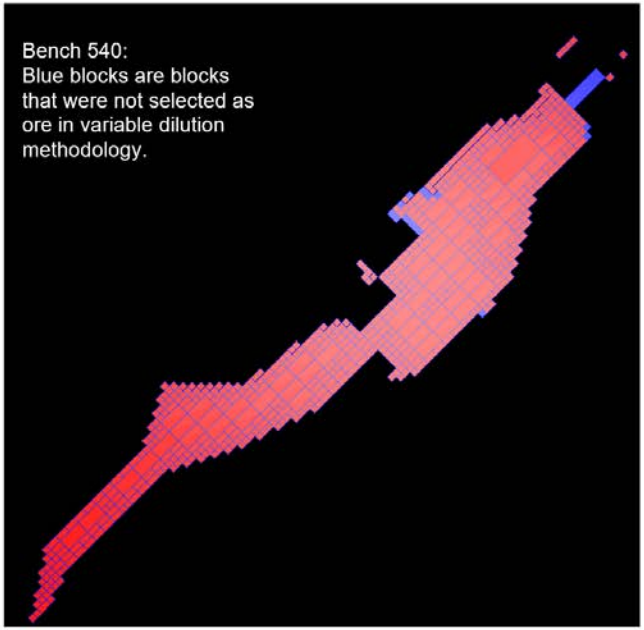




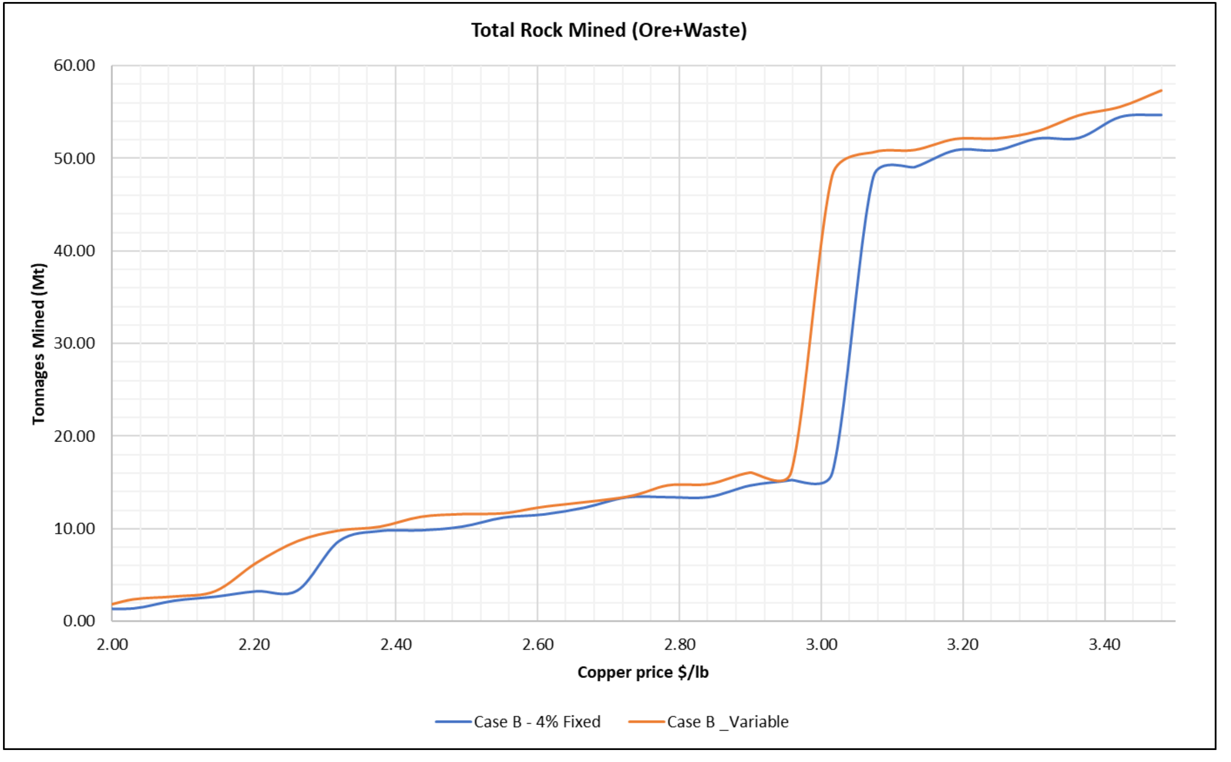
The point is that the economic evaluations are different. The question is which one is more reliable?

Case Study B: Small Copper Mine

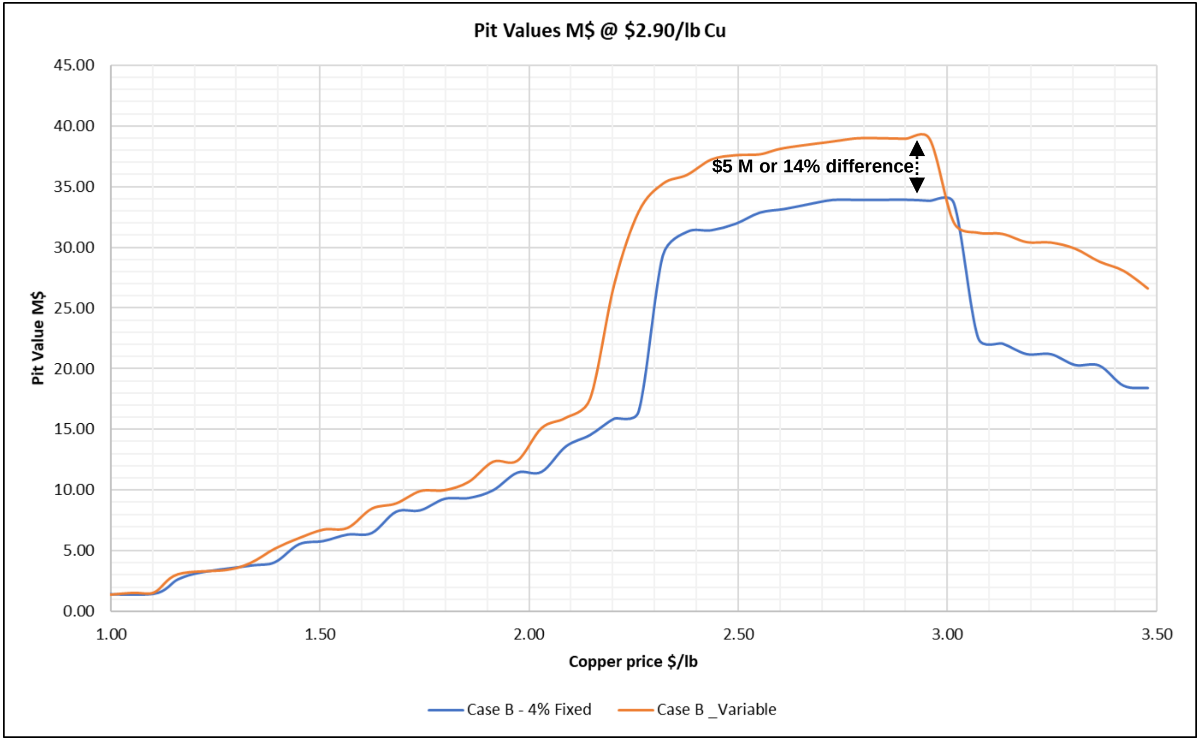




Case Study B, a satellite copper deposit



Case Study B, a satellite copper deposit



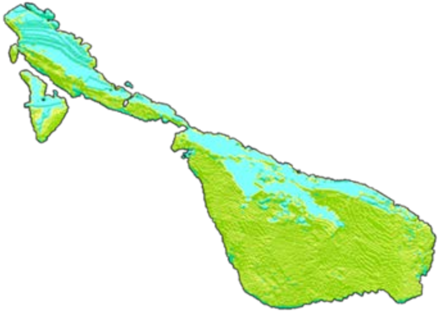
Conclusion

- There is significant differences in results when different methodologies are used for applying dilution in open pit projects and evaluations.

- In mining industry it is common to use fixed dilution factors for mine designs and evaluations. The results of such designs are not optimum, therefore the economic outputs are also less reliable.

- Applying variable dilution will considerably increase the accuracy of mining studies by providing more realistic production schedule (tonnage and grade). This approach will reduce reconciliation issue that is common in many mines.

Questions?



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