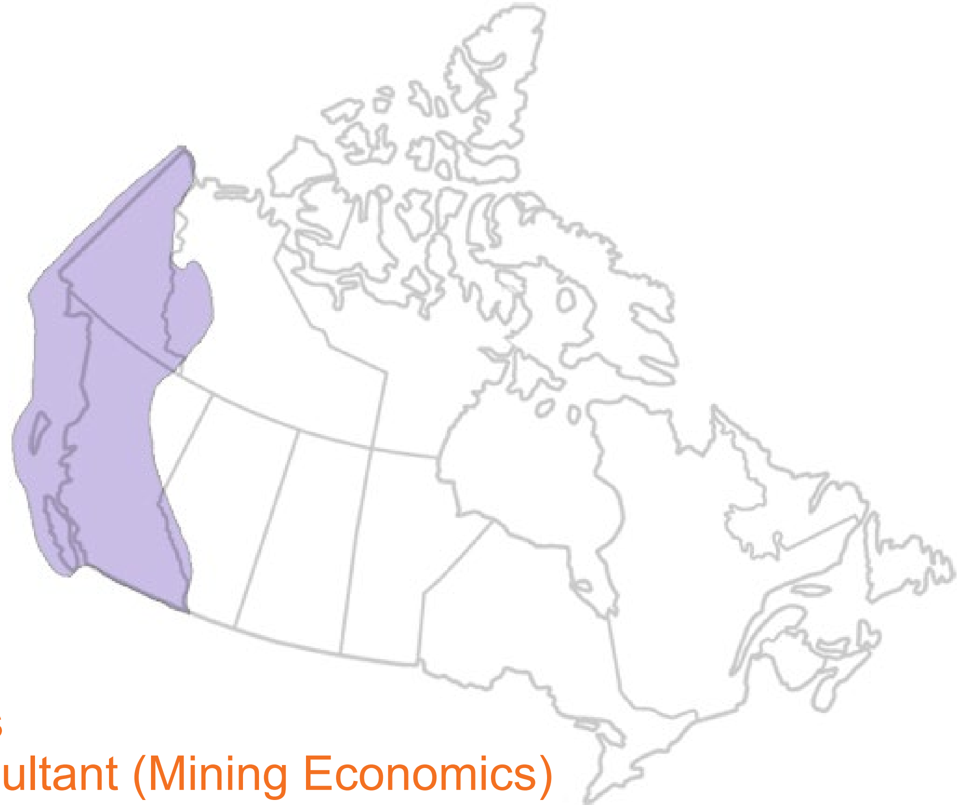
Economic Considerations and Project Evaluation for Porphyry Copper Deposits in the Northern Cordillera



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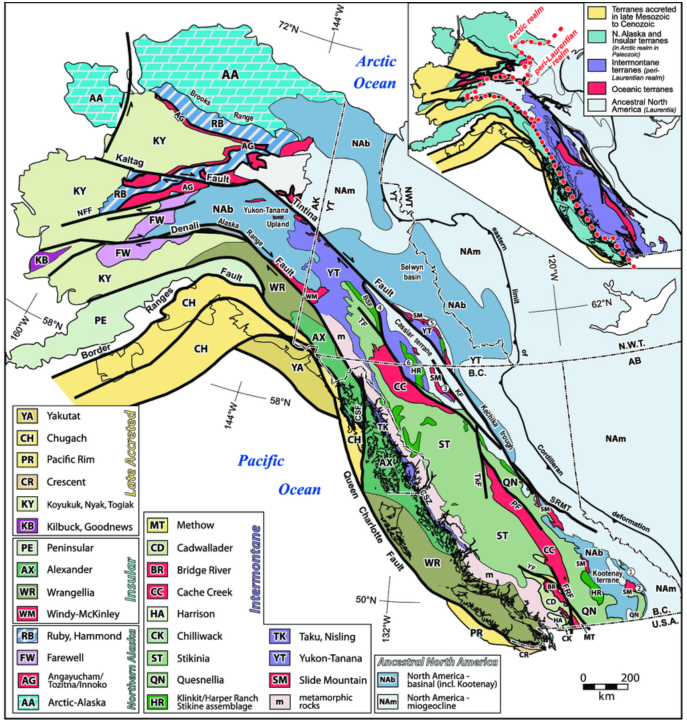
Economic Considerations and Project Evaluation for Porphyry Copper Deposits in the Northern Cordillera

- Setting
- Technical
- Geography
- Environment / permitting
- Social / community
- Economics
- Project evaluation
- Conclusions
- Questions

Setting

- North American Cordillera
- Remote location
- Topographic extremes
- Weather extremes
- Permitting is a rigorous and technical process

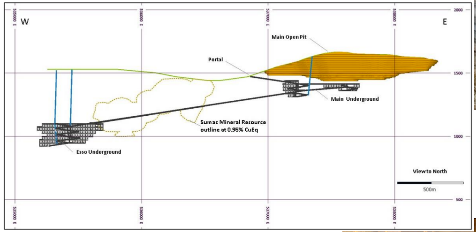


(Source: Colpron et al 2007)

Technical Considerations

- Geology
- Mining method
- Mining recovery
- Metallurgical recovery
  - Processing method selection
  - Small change in absolute recovery can have large impact on revenue and therefore project NPV

(from teck.com 2022)



(Source: CSA Global 2021)

(credit – V. Somma 2007)

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Technical Considerations

- Area is tectonically and seismically active
  - Safety impacts
  - Production impacts
- Geotechnical and hydrogeological context
  - Waste dump / TSF stability
  - Pit wall stability
  - Ground support / stope stability
- Subsidence
  - UG mining only (obviously)
  - Surface impacts and associated costs (especially if infrastructure is involved)
  - Dilution effects and associated revenue and cost impacts

(from mining.com 2013)

(credit – J. Heath 2016)

(from Van As et al 2003)

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Geography

- Access
  - Road
  - Air (fly-in/fly-out)

- Infrastructure
  - Power
  - Water

- Logistics / Transportation
  - Air, road, river (e.g., barging on Taku River for Tulsequah Chief)

(from Capital News 2022)

Environment/Permitting

- Metal leaching/acid rock drainage
  - Heavy metals (Cu, Zn, Pb, Cd, etc.)
  - Selenium (more often associated with coal)
  - Impact on receiving water quality/biota

- Water quality/treatment
  - Pit walls, underground workings
  - Waste rock / tailings storage facilities
  - Often need to assume treatment is required in perpetuity

(credit – C. Miller 2013)

Environment/Permitting

- Cumulative effects
  - Need to be aware of total impacts from ALL projects in the region, not just yours
- Permitting delays
  - Projects have an expected start date, based on expectations of when certain activities can commence, but that does not always come to pass
  - Carrying costs continue, but revenue generation delayed (large NPV impact)
- Closure
  - Has a relatively small impact on NPV, but can still be a significant expenditure in the year(s) of closure activities
  - This does not take into consideration bonding costs, which depending on the jurisdiction, can require upfront accrual (guarantee) of a large portion of expected closure costs

Social / Community

- First Nations
  - Can have very different perspective on project compared to proponent
  - Need ongoing, active and early consultation
- Workforce
  - Sourced from where (local vs regional)
  - Camp or no camp
  - Rotation schedules
- Increased traffic (concentrate trucking)
  - Impact on local communities (noise, dust, accidents)
  - Impact on wildlife (vehicle-animal collisions, potent to bisect migration routes)
- Increased wages/disposable income
  - Positive and negative impacts

Economics

- Discount rate
  - Often use 5% for gold-dominated revenue, 8% for other commodities
  - Can be adjusted to reflect political risk
    - Not usually applied to North American projects

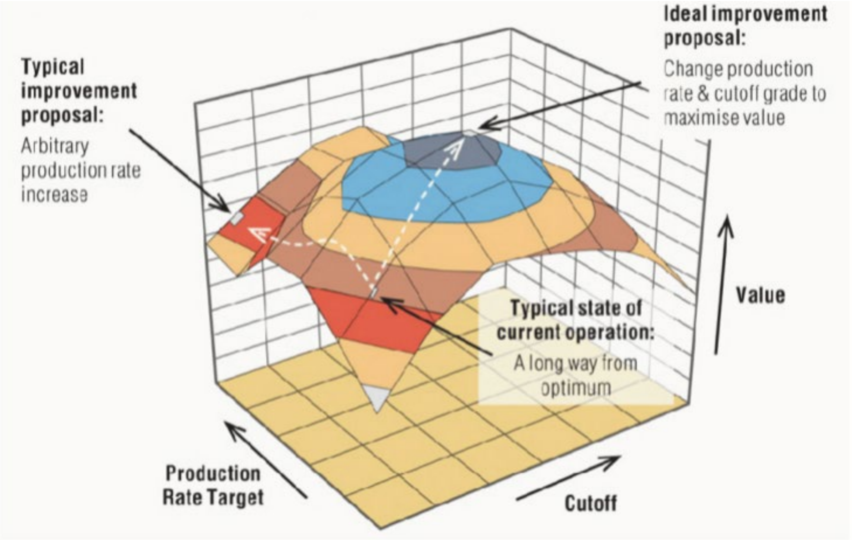
- Commodity price
  - Spot price driven by market
  - Selling price driven by market and contract
  - Study prices
    - Price used for optimization and mine planning (e.g., cut-off grade, revenue factor, etc.)
    - Price used for financial analysis

Economics

- By-products
  - Gold, silver, molybdenum, zinc, lead
- TCRCs (for copper concentrates)
  - Determined by smelters and associated contracts
  - At the study stage, terms are assumed to be fairly standard
    - In reality, the terms can be very complex and involve considerable negotiation
  - Terms seem to favour smelters to some degree
- Taxes / royalties
  - Local, provincial/state and federal taxes (vary by jurisdiction)
  - Both government and private royalties

Project Evaluation

- How do we optimize a project to generate the highest economic return?
  - Get to the summit of the “hill of value”
  - The most valuable project is the one where the resource is still in the ground
  - Once we start designing it, we start losing project value
  - Our goal is to minimize value erosion

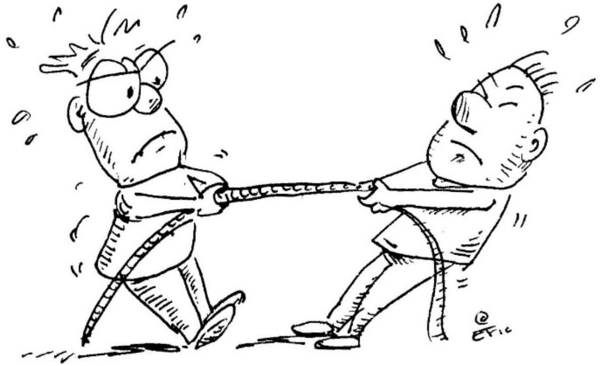


(after Hall & Hall 2015)

- Project goes through a series of studies, increasing in detail and accuracy
  - Scoping study, PEA, PFS, FS

Context

- Mining projects
  - Capital intensive investments (particularly greenfield projects)
  - Require robust economics to justify the expenditure
  - High risks, high rewards
- Objective of project development
  - Minimize the risks; maximize the rewards
  - Want to optimize the trade-off between the two



Risk Reward

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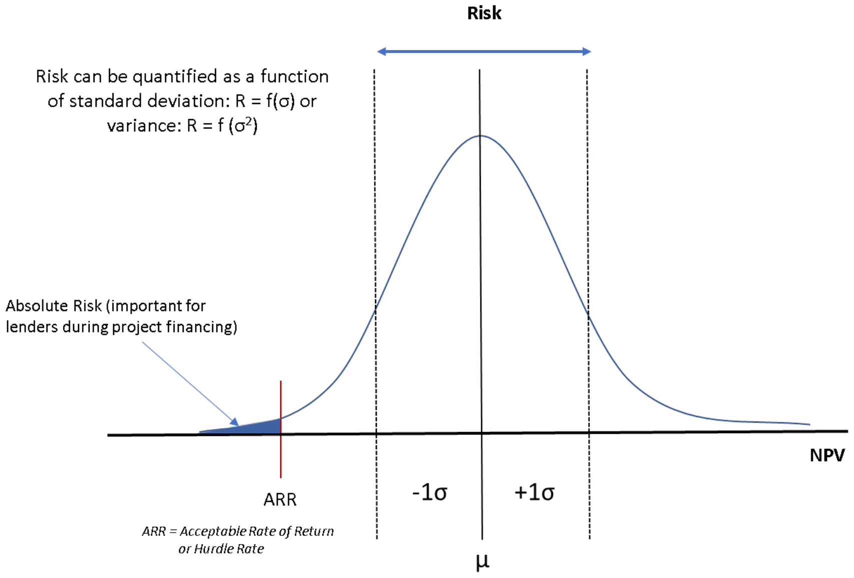
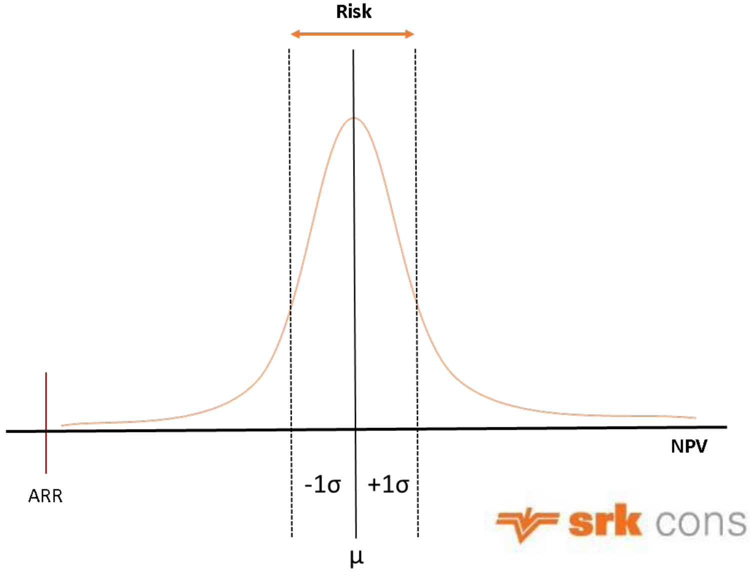
Risk

- Only thing we know for certain is that we are wrong
  - Our plans are based on assumptions that inevitably turn out to be incorrect
- Trick is to understand which of our immediate and future project development decisions carry the greatest risk
- Understanding risk associated with uncertainty is not simple
  - Some areas of uncertainty are impervious to analysis
  - Some areas of uncertainty are prohibitively expensive to resolve (compared to the benefits)
  - Some areas of uncertainty simply may not be significant with respect to project development decisions

Minimizing Risk

- Spend the money to reduce uncertainty (i.e., complete technical characterization and associated studies)
  - But spend money where the risk of incorrect assumptions has the greatest impact
  - Despite our recognition of risk and our desire to understand and minimize it, we subconsciously tend to operate using a "presumed success model"





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Regret

- The real risk at the heart of the issue is not that the world does not turn out how we predicted (we know it won't), but rather that we discover we should have built a different project

- As defined by Oxford Dictionary
  - **regret**: "*A feeling of sadness, repentance or disappointment over an occurrence or something that one has done or failed to do*"

- Regret can occur whether the future world is better than we expected **OR** worse

- How much regret might we have?

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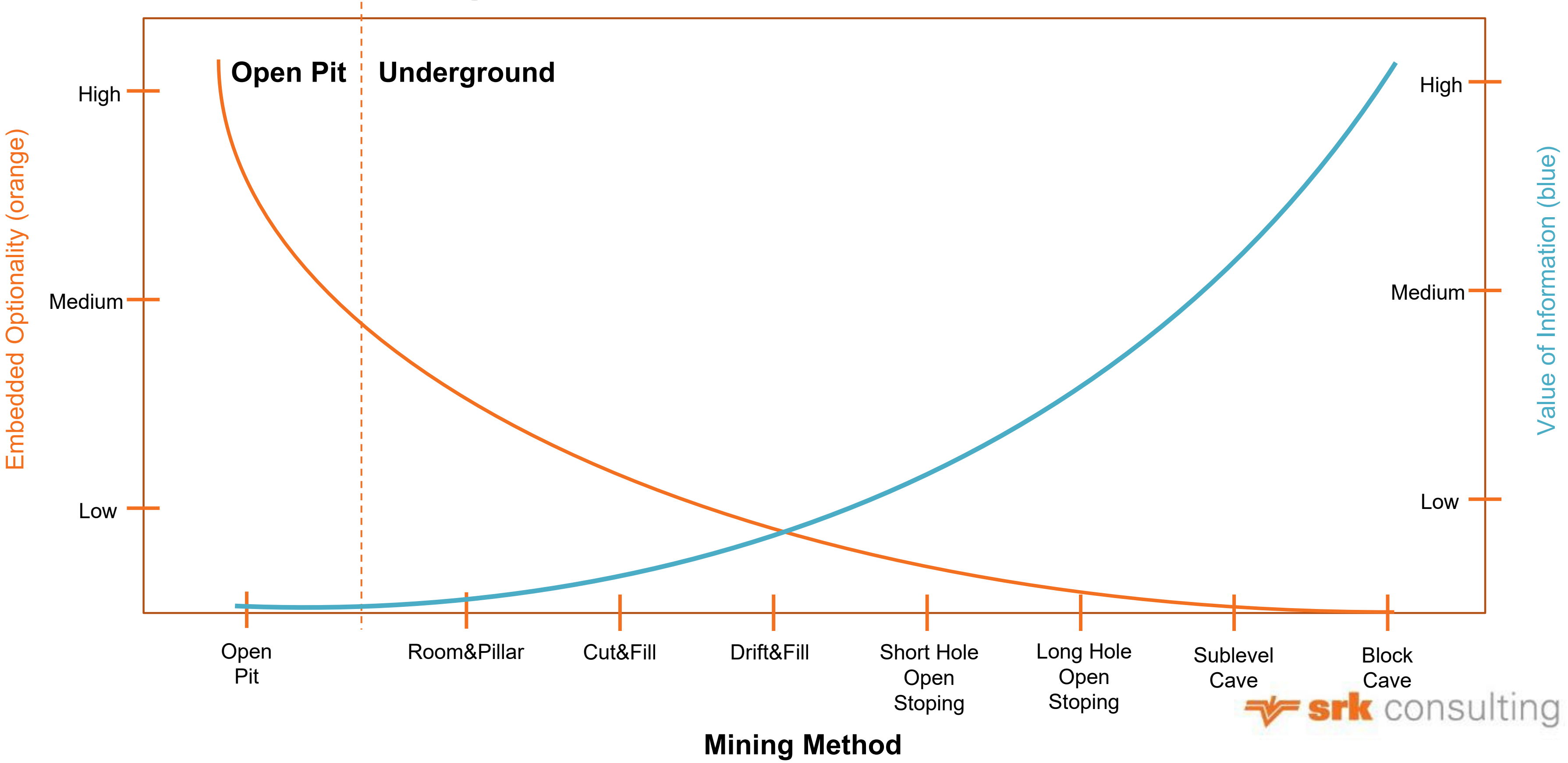
Cost of Regret: Low - - - - - - - - - - - High

- Large, long-life open pit mine
  - Opportunity for expansion of both processing facility and equipment fleet to execute a dynamic cut-off and strategic stockpiling policy to adapt to changing metal prices and different than forecasted costs and technical factors
  - Operation has embedded flexibility and optionality
- Initial set of assumptions drives project design and construction
  - When the future proves those assumptions incorrect, the project can adapt
- **Value created by expenditure** to fully understand the orebody and the best way to develop it before going into operation **diminishes**, because of inherent adaptability and embedded optionality within the mine itself when operating

Cost of Regret: Low - - - - - - - - - - - High

- Deep underground mine
- Limited flexibility; difficult (impossible) to adapt to changing technical or economic conditions
- Consider cut-off grade in a block cave
- **Value created by expenditure** to fully understand the orebody and the best way to develop it before going into operation **can be significant**, due to potential for major losses (or at least lost value) if wrong project is designed

Cost of Regret



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Quantifying Regret

- To make the best project development decisions, we need to quantify this regret

- SRK has developed a standard process - **Strategic Mine Planning**
  - Rapid evaluation of a large number of possible project strategies
  - Involves elements of mine design/optimization, mine scheduling, mine costing and economic analysis
  - Work is undertaken at a high level
  - Minimizes effort expended on sub-optimal plans
  - Arrive at an optimized development plan for the project

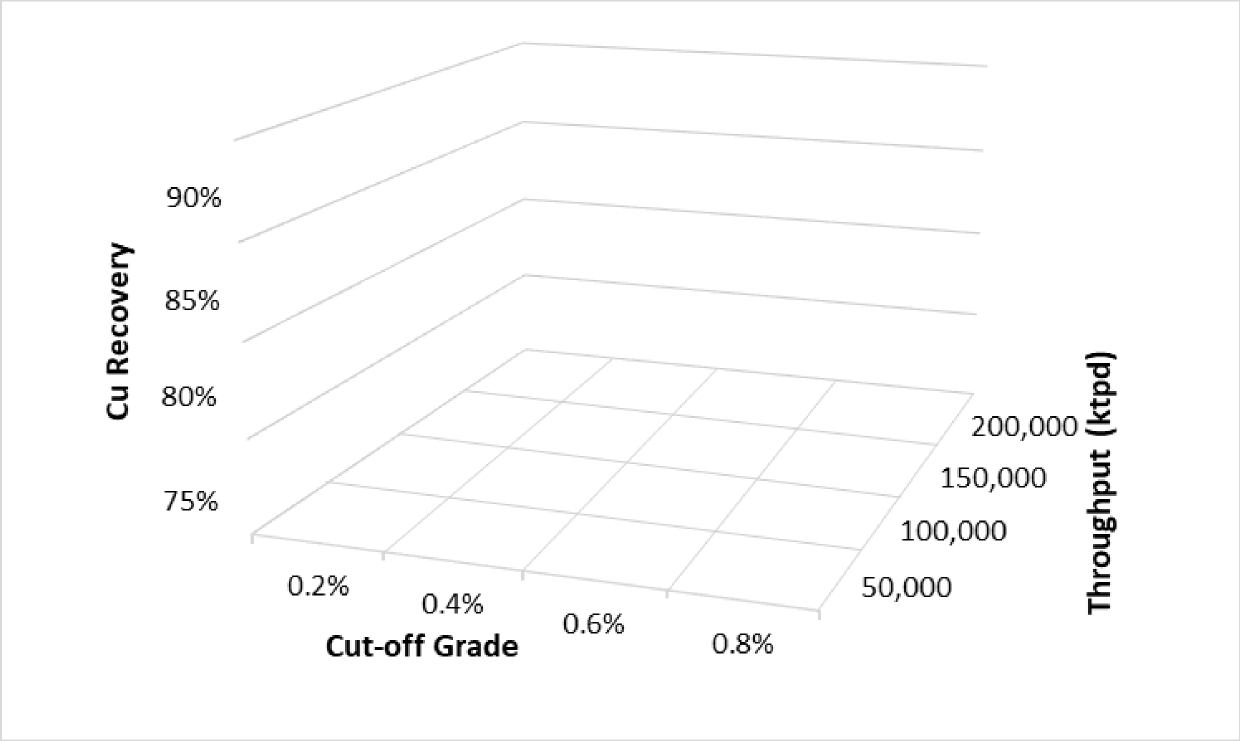
Strategic Mine Planning

- Generation of options/strategies for the case matrix occurs at the design stage
- Strategies are evaluated across a range of parameters within the economic model
- Strategic Mine Planning helps answer the question of how we might mitigate downside and capitalize on upside when the future turns out differently than our base case assumptions

Strategic Mine Planning

- Economic analysis of multiple scenarios
  - Develop a case matrix with different project-specific assumptions
  - Project analogs, benchmarks and/or first principle estimates are used for costing purposes
  - Sensitivity analysis is performed on exogenous/macro-economic assumptions (metal prices, exchange rates, etc.) to assess economic robustness of each scenario
  - Results are consolidated and compared to each other
  - Allows scenarios to be ranked

Simple Case Matrix



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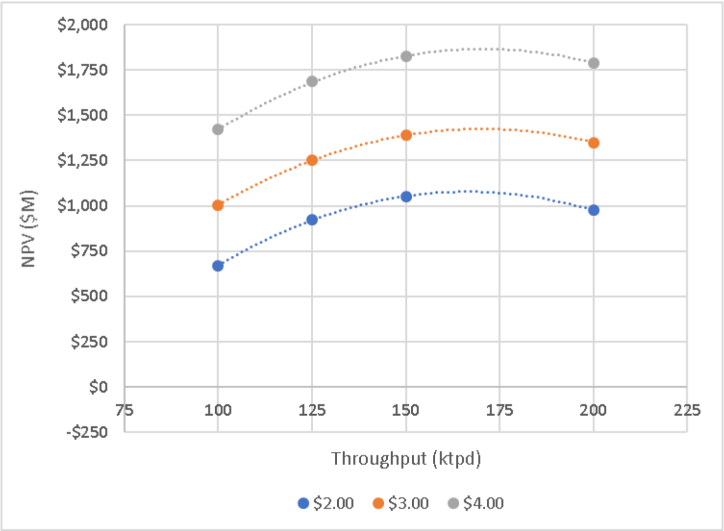
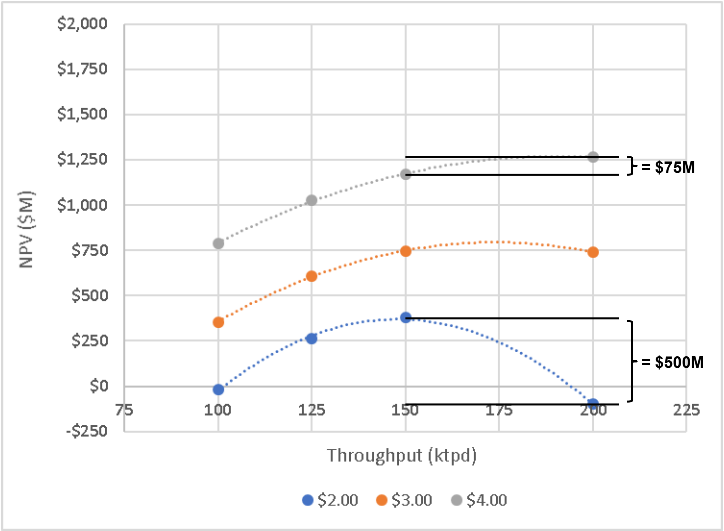
Scenario Analysis





Strategic Mine Planning

- The outcome of the SMP process is an optimized development plan
- The SMP process helps us minimize the “cost of regret”
  - The lost value (excess cost) that comes by not developing the project in a way that unlocks the full value of the resource under different operating conditions
- **Executing strategies that minimize the expected magnitude of these potential losses should be paramount in strategic mine planning**

Conclusions

- Economic considerations encompass ALL aspects of the project
  - Technical, geographical, environmental, legislative, social AND economic
- Mining projects are capital intensive investments
  - Potential for big reward (comes with potential of big risks)
- Need to understand the risks
  - Specifically the consequences of the risks
  - Spend money to better understand the assumptions that are value-drivers

Conclusion

- Evaluate a full spectrum of possible outcomes
  – Develop a case matrix; run scenario analysis; complete sensitivity analysis for each scenario; rank the results; focus on the highest value AND achievable cases

- We WILL be wrong about the future
  – Hindsight is 20:20
  – Want to minimize the consequence of the error (Cost of Regret)