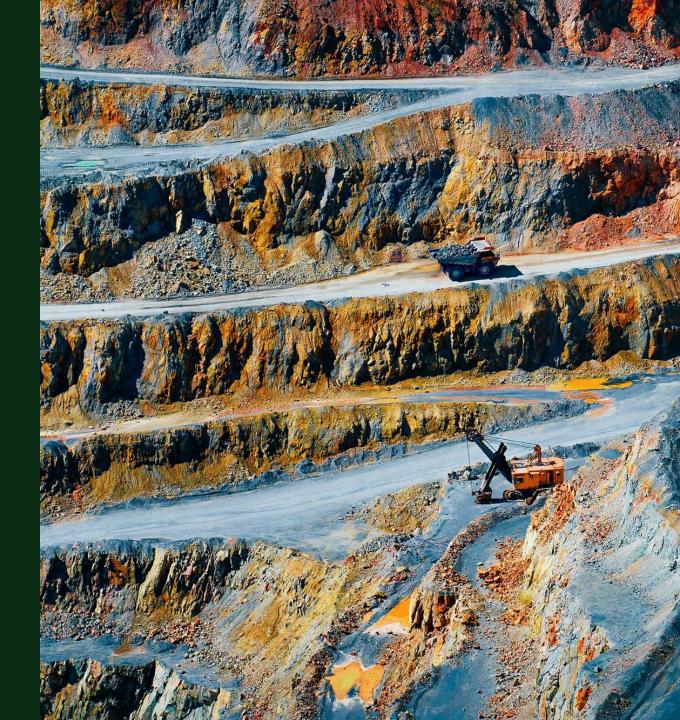


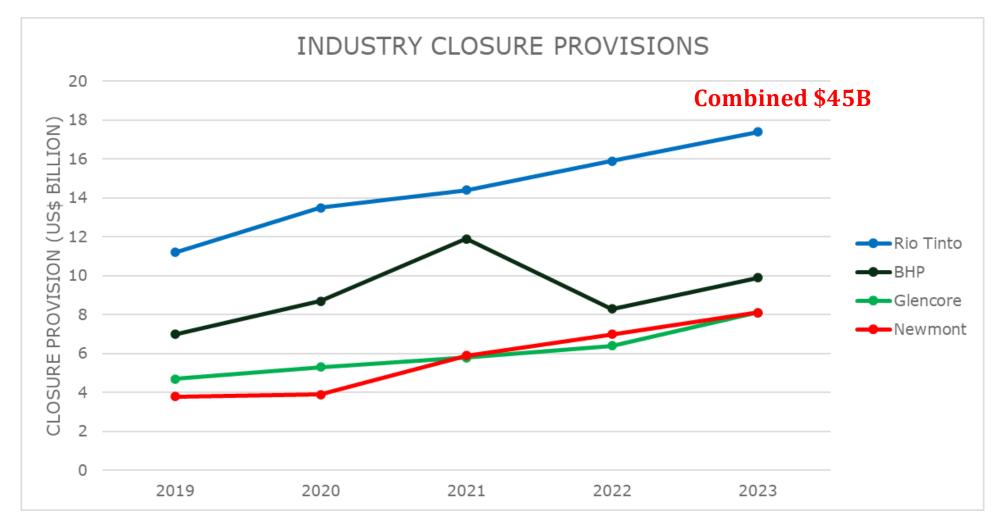
Mine closure liabilities – Understanding the true exposure

18th JUNE 2025



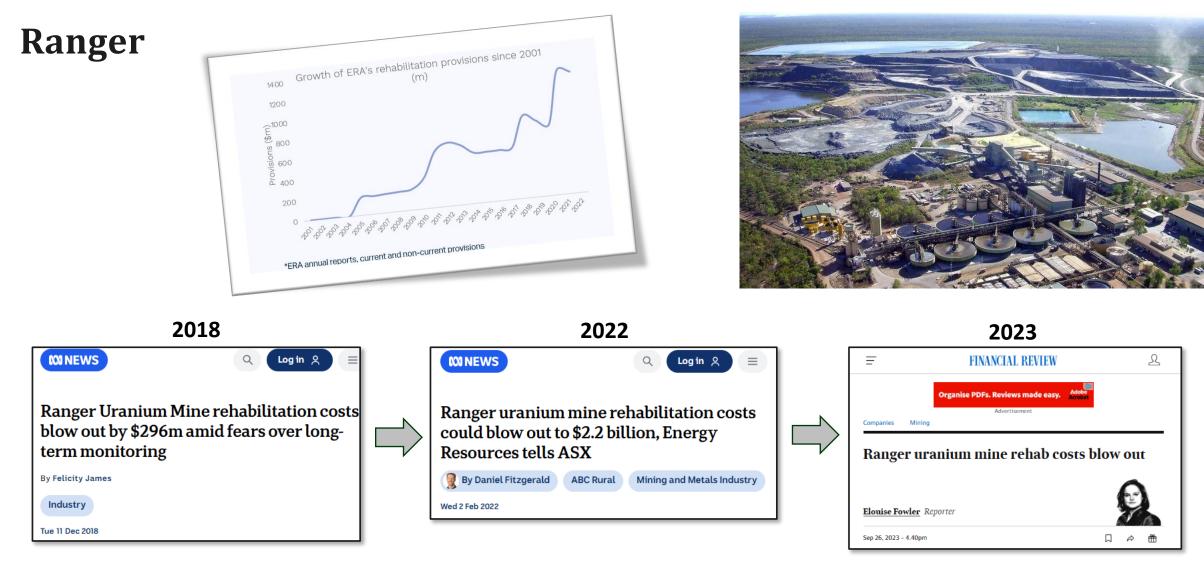
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Up \$17B (+63%) over 4 years





"...\$808 million — \$296 million more than ERA's initial \$512-million estimate"

Mine closure liabilities - Understanding the true exposure

"...could cost up to \$1.2 billion more than expected and take two years longer than initially planned" "...rehabilitation would "materially exceed" \$2.2 billion"

Victor Diamond Mine Ontario Canada





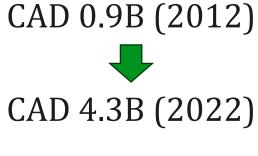
Equity Silver Mine BC Canada

> CAD 32M (1990) CAD 87.2M (2018)

> > 1 272%



Giant Mine NWT Canada

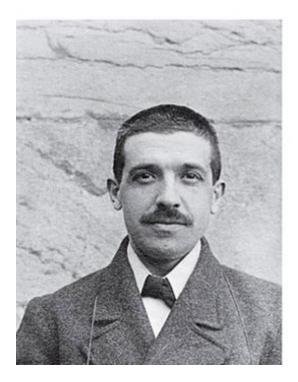


1478%

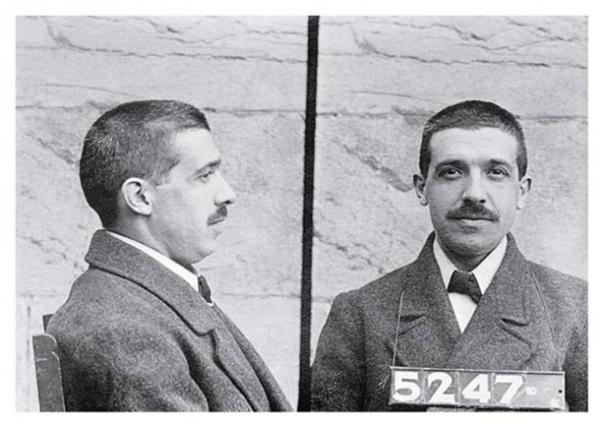


Source: Sanders, J. et al (2024) - ACG Mine Closure Conference





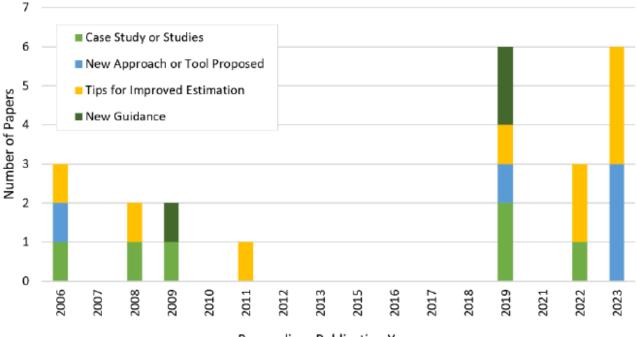




Charles Ponzi

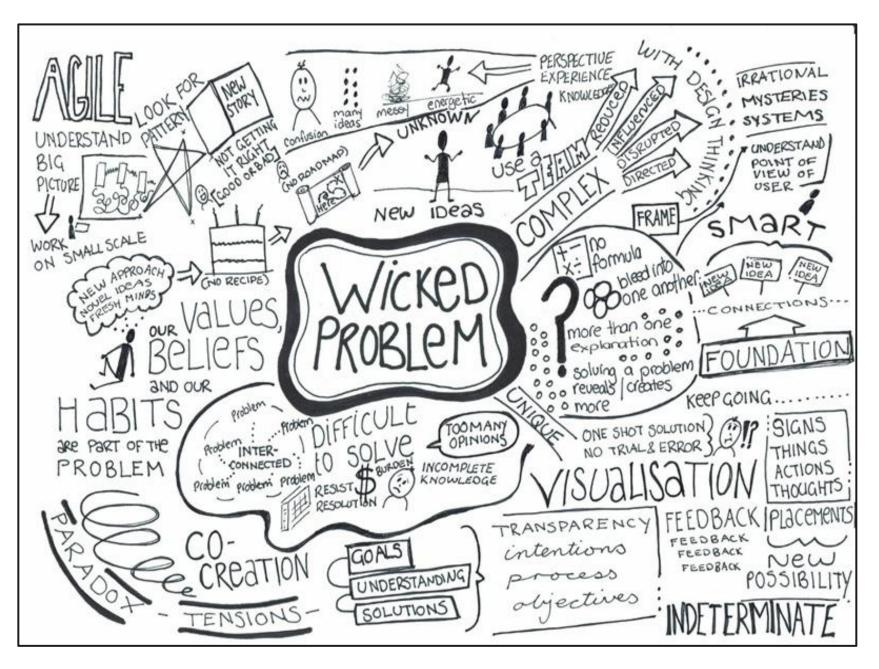


Mine closure costing gaining increasing focus



Proceedings Publication Year



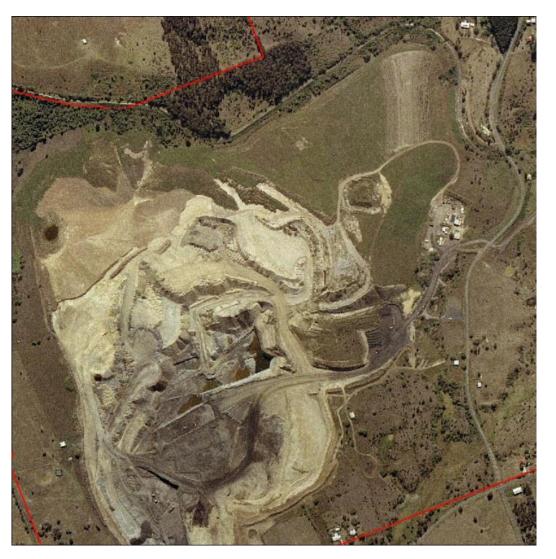






1990 **Pre-mining**





2005 Active mining





2010 Active mining





2012 End of mining



Relevant factors:

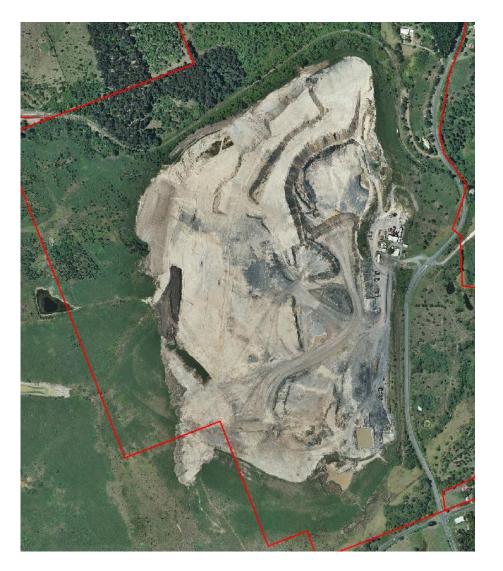
- Proximity to Rosewood township and other neighbours active community interest
- Company trying to get another mine approved social licence
- Steep catchments (~100m fall from top of catchment to bottom, steep grades)
- Significant topsoil deficit (~30 ha of residual areas for which topsoil was not available)
- Dispersive topsoil/subsoil materials
- Underground workings in/near ML potential issues with groundwater
- Water harvesting licence
- Final landuse grazing



Decision:

- Void backfilled to form free-draining landform
- Approximately 4 million m^3 was moved to backfill the ~80m deep void to the designed levels, taking ~2 years
- Site re-contoured to the final landform
- Topsoil imported
- Seed and gypsum applied
- Biosolids used good results





2013 **Commence backfilling**





2014 **Bulk earthworks complete**





2015

Final grading, topsoiling and seeding











2017

2 years post rehabilitation





2025 **10 years post rehabilitation**



- Stakeholder landscape changed (political, social licence)
- **Closure scope** substantially changed
- **Closure cost** substantially increased





It's a Burning Platform for Industry....

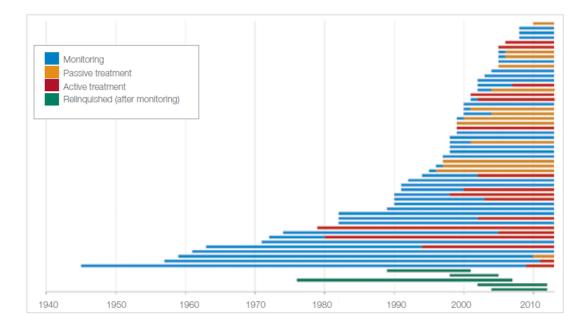
Closure is a **material risk** to mining companies.

The mining sector is beginning to better understand the potential total cost of closure:

- Often **multiple times higher** than originally estimated and/or carried on the books.
- Total cost of closure is **often unrealistic and optimistic** based on overly optimistic estimates and timelines, design and operating decisions, and amplified by ambitious commitments for land rehabilitation made in pursuit of permits.
- Costs of execution commonly come in at levels that are can have a material impact on the bottom line.

There is tremendous **uncertainty** in the likelihood and timing that closed sites will be **able to be relinquished**. Relinquishment successes across the globe are rare.

There is little incentive for government to return financial securities and certify closure completion. This results in long term care and maintenance costs



There is need for a new approach....

ERM's approach is centred on recognising that the problem is a "wicked problem" and we work to reimagine Closure, embracing the concepts of unconstrained thinking to solving complex problems.



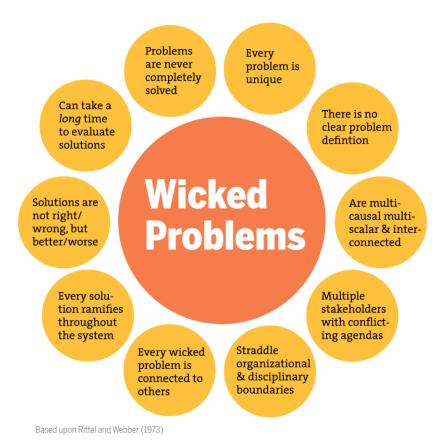
It really is a "Wicked" Problem...

Mine closure is a classic example of a "wicked problem"

..... A wicked problem is at heart a social or cultural problem that is difficult to solve due to incomplete or contradictory knowledge, the number of people and opinions involved, the large economic burden, and the interconnected nature of these problems with other problems.

...it is an established fact that wicked problems cannot be engineered away...

....but great outcomes can be achieved by the right blend of expertise, an unconstrained approach to thinking, and an acknowledgment that **external stakeholders will ultimately judge the success of any solution and must play an intimate role in the establishment of a shared solution**.



This is perhaps the main reason that so many closures achieve a poor outcome - while few achieve a brilliant outcome. Its all about acknowledging the problem fundamentals.



Costing challenges



Getting projects going

Many mining projects/expansions start that should never (costs exceed income)

Desire to get projects off the ground

Optimism bias



Major Projects That Went Catastrophically Over-Budget

Selected over-budget construction projects worldwide (billion U.S. dollars)*

Planned Current/Final	\$ Over Budget
International Space Station	\$68.25bn
Sochi Olympics 🚃 🔤 🔤 👘	\$39.00bn
The Channel Tunnel 🎢 🛛 🔤 🔤	\$21.10bn
Three Gorges Dam 📴 🔤 🔤 👘	\$16.18bn
Boston's Big Dig 🔜	\$13.45bn
London Olympics 💥	\$11.91bn
Athens Olympics 🔚	\$6.99bn
Jubilee Line Extension 💥 🔢	\$4.11bn
Hubble Space Telescope 🔜 📕	\$3.80bn
Denver International Airport 🔜 📗	\$3.10bn
Montreal Olympic Stadium 🚺	\$2.96bn
Brazil World Cup 💽 📗	\$2.50bn
0 20bn 40bn 60bn 80bn 100br ©	n 120bn bes statista 🗹



Layered assumptions



Knowledge Base





Propagating assumptions



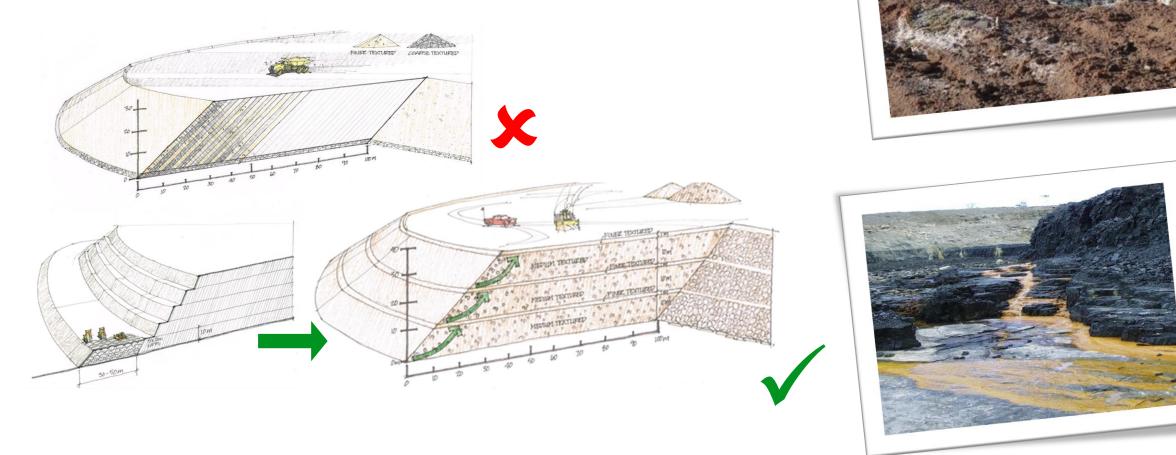




Tunnel vision

Short term thinking

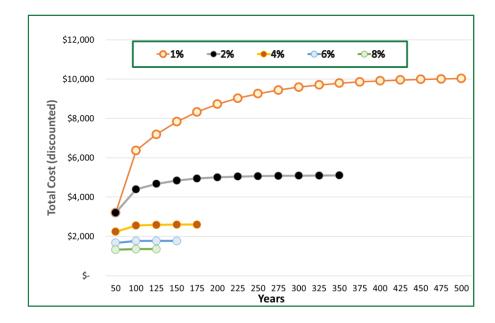
Short haul versus long haul (LOM planning) - rehandle Poor decisions can lead to long term implications (e.g. AMD)

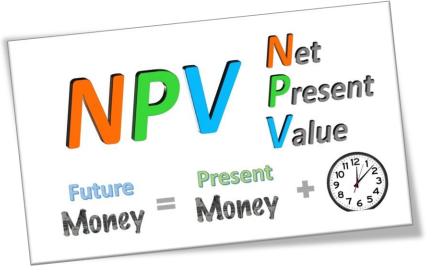




Financial analysis

Net Present Value (NPV) - has been used to delay of rehabilitation





ICMM (2019b) states that:

"...An NPV (or present value) analysis of costs is likely to suggest that progressive closure is more expensive, as the present value of any expenditure will be lower the further in the future it is placed (assuming no change in scope). However, if progressive closure is looked upon as an investment, a more balanced analysis emerges..."



Boundaries

Post closure overheads





Power

Property tax



Site Safety & Security



Water Management



Severence - Rehab workers



Ongoing monitoring

Off lease obligations



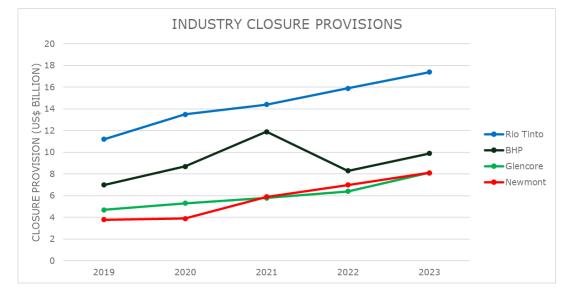


Include assets not on the Mining Tenement where obligations may exist (e.g. working camps, dams, rail loops or contractual obligations for joint venture properties to remove / rehabilitate on closure. Contractual and license commitments need to be reviewed to determine rehabilitation responsibility.



Delivering bad news









Improved practice



Improved practice

Better closure planning leads to better outcomes and certainty – and therefore <u>better cost estimates</u>

- 1. Regulatory reform
- 2. Value creation
- 3. Effective stakeholder involvement
- 4. Tools/approaches





Improving regulatory frameworks

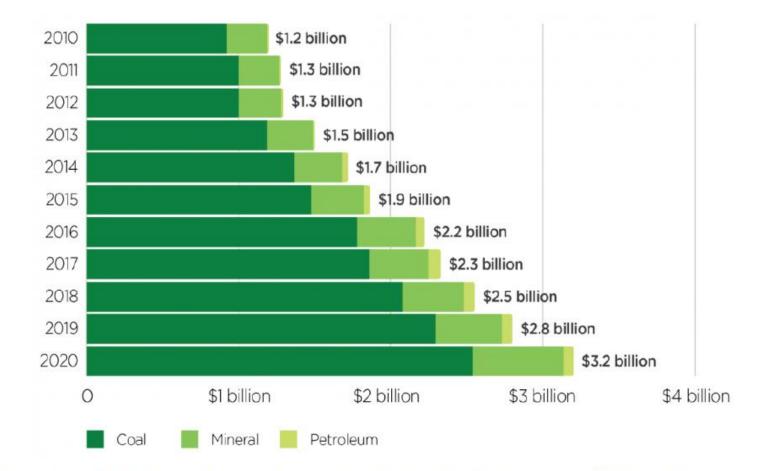
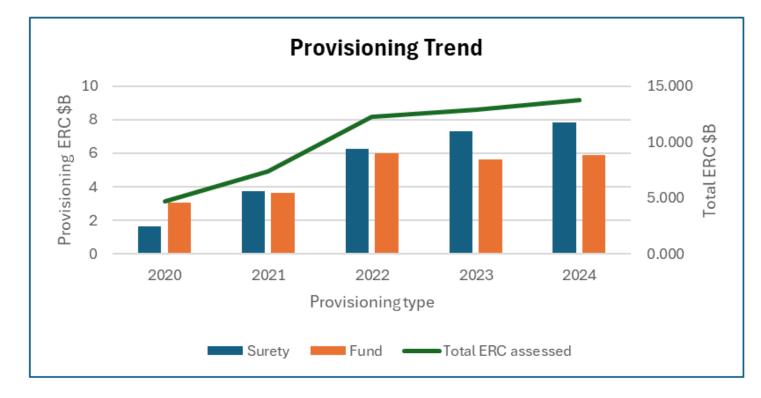


Figure 1 Rehabilitation and mine closure security deposits held by year by the NSW government



Improving regulatory frameworks







Value creation: Evolution of mine closure

LIABILITY MANAGEMENT Compliance Understand and mitigate risks Manage costs Stakeholder management Relinquishment Localised Conservative

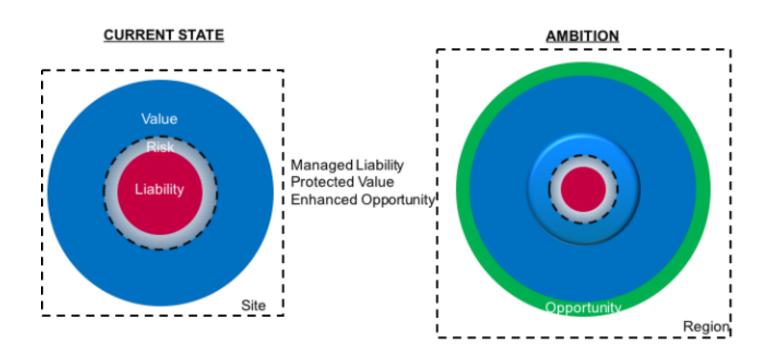


VALUE CREATION
Hitting ESG goals
Positive legacy
Social licence
Business resiliency
Regional and global scale
Innovative
Retaining assets



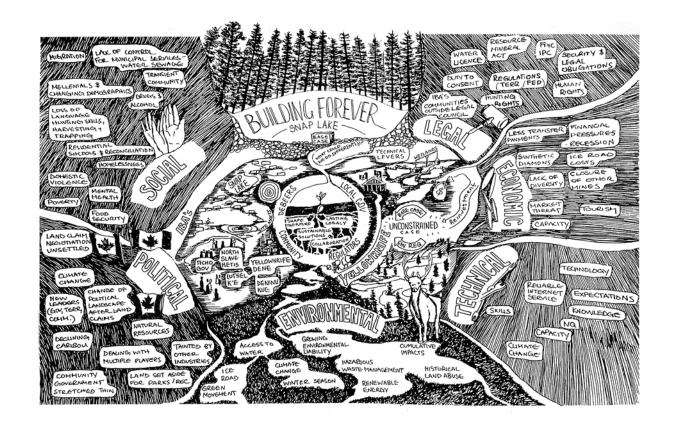
Enabling a Different Kind of Conversation: The Shared Value Approach to Repurposing & Regeneration

- To enable exploring a new closure paradigm, stakeholders need to be able to see this as an **Opportunity** as opposed to a scale back on environmental and social commitments.
- Need to move from a conversation about Mine Closure
- To a discussion on Regional
 Opportunities that can arise from different closure outcomes
- Mining Companies become an actor in the system instead of the single proponent, creating a *shared value approach*



Shared Value Approach: Collaborative Approach

- Adoption of a new paradigm and strategic model to closure across the asset portfolio. ERM is working with De Beers at three (3) sites as active reimagining Case Studies.
- There are three concurrent elements:
 - Redefining the scope of closure activities to be undertaken on the mine site by <u>removing the</u> <u>constraints of past commitments:</u>
 - Working with local stakeholders and other interested parties to seek Collaborate Regional Development (reinvestment) options for the <u>region</u> in which the mine is located.
 - Working with local stakeholders and other interested parties to identify alternative post-mining uses for <u>site assets and the lands</u> themselves.



A Collaborative Design Approach to Multi-Stakeholder Engagement for Reimagining Asset Retirement



Effective stakeholder engagement

Linked to clear end goals

Changing expectation

Multi-stakeholder approaches





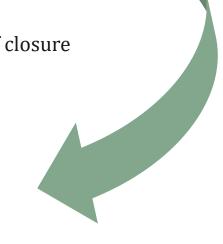
Linear...To Dynamic and Iterative

Traditional Stage Gate Approach

- Programmatic delivery
- Stage Gate approach at fixed time intervals
- Internally focused
- Engineering driven solutions
- Not proactive to emerging opportunities
- Internally Focussed and perhaps doesn't understand sufficiently the wider implications of closure
- Leads to higher costs/provisions

Embedded Closure and Regeneration Approach

- Dynamic and iterative process not a single end point
- Allows interrogation of any opportunities
- Embeds external stakeholders in the co-creation of solutions
- Focuses on positive outcomes, including both corporate and community
- Designs and operates assets with future economy of the area in mind
- Manages liability exposures and creates successful exit strategies
- Leads to optimised costs Driving down provisions



Evolution not Revolution



Better closure planning

Operate with a view to closure

Manage operations so that they don't hinder closure process
Circular Economy for Materials
Tips & tailings operated for safety
Progressive restoration & habitat creation
Remediation where necessary

Envision an end to operations

- •Preparation towards an end to mining
- Divestment or repurposing?
 Local needs and post-closure readiness – are the right skills available?
- •How does closure affect local communities and the environment?
- Understand value of place
 Use Sustainable Development Goals to frame this ______

Engage with stakeholders and identify opportunities

- Who influences and shapes?
 What do communities want in place of a mine / refinery? How
- does this affect SDG FrameworkData Gathering
- •Regulatory Impact of closure obligations
- •What opportunities exist and who can carry these through to fruition?
- •Review process / widen stakeholder base
- •Develop Regeneration Options
- Appraisal

Have a post closure vision & determine success factors

- Assist in master planning / defining a post-closure vision for the site
- •Define what a sustainable outcome is for company, the site and community
- •Consider metrics for success / develop targets

Evolve Preferred Option - Exit framework / Asset Transfer

- •Who to? Can they deliver the vision in the required timeframe? •Guarantees
- •Surety / long term nature of any transfer
- •Need for dowry arrangements for release / capping of payments
- •Legal agreements
- •Up-side agreements



Summarising the Principles Underpinning the "Reimagination" of Closure

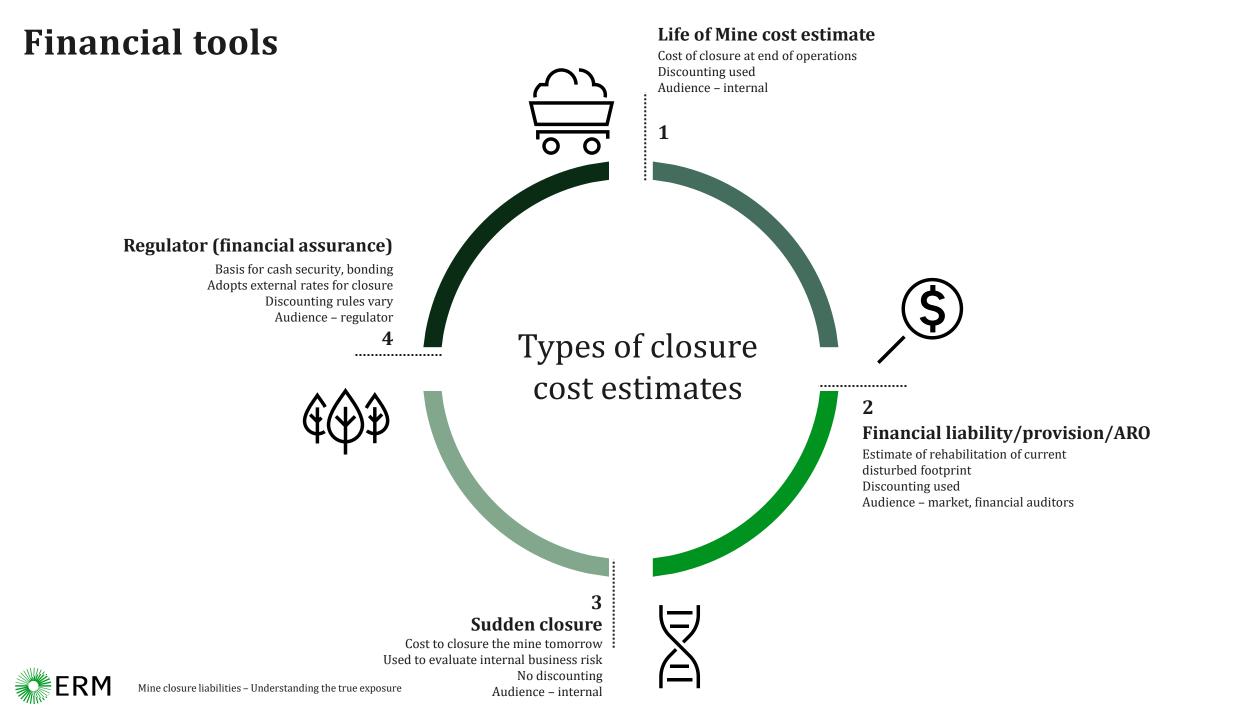
- The mining phase is a **temporary land-use** activity within a broader regional socio-economic context;
- The boundaries of **mine closure extends beyond the "fence line"** to include the region in which the mine is located;
- Environmental **end points must be set** in balance with broad social and financial considerations;
- There is a need to **challenge base assumptions (constraints)**
- Lands and infrastructure used for mining may provide future value for the Company or other land users / investors;
- Need to consider regional and national governmental and/or private investment as **enablers of future shared value**;
- Residual site liabilities are managed through a combination of physical/management/legal conditions;
- **Relinquishment** of asset lands is not a prerequisite;
- Regulatory mechanisms exist externally to **make changes to the existing closure plans**;
- There **needs to be community perception of a Shared Value approach** to defining closure.

This unconstrained thinking is used for Legacy sites, Sites near Closure and helping to achieve Closure by Design – Wicked Problem solving provides a framework for success.



Tools and approaches



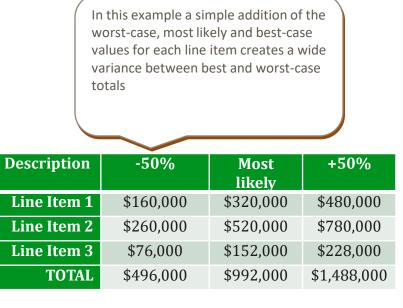


Traditional (Deterministic) Costing Approach

- Quantitative risk analysis is performed
- Uses single-point estimate
- Components of a project: Assigned values + discrete scenarios = outcome might be for each
- Values are based on existing information, commercial experience and/or guestimates
- No attempt to assess the likelihood of each outcome
- Treatment of contingency often arbitrary based on little understanding of risk

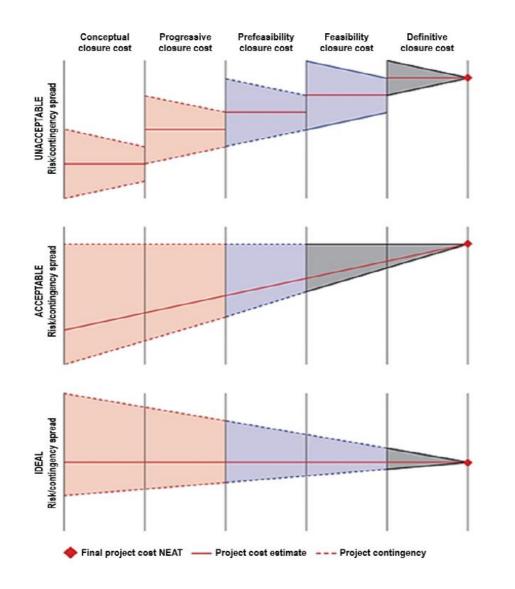


- Approach excludes potential interactions between scenarios
- Complex finance implications for companies and investors approaching closure
- Lack of reliable information to support project and investment and cashflow
- Lack of understanding where the focus of should be





Closure cost maturity



Project phase (design accuracy)	Phase name	Example target date (years prior to end of mining)	Typical mine closure planning inputs (studies/ assessments)
Detailed design (+/–10%)	Class 1/ execution	< 2	Refine the closure engineering with inputs from FS forward works programs As-built designs
Feasibility study (–10 to +15%)	Class 2/front- end loading (FEL) 3	2 to 8	Refine the closure engineering with inputs from pre-feasibility study forward works programs Construction trials
Pre-feasibility study	Class 3/FEL 2	8 to 15	Refined closure engineering with inputs from PFS forward works programs
(–15 to +25%)			Agreed post-mining land and infrastructure use(s) Social transition engagement and integration, including infrastructure repurposing
			Agreed closure objectives and success criteria
			Clear closure obligations and legal requirements
			Consolidated knowledge base and spatial data management
			Closure design basis including climate change considerations
			Closure risk and opportunities assessment
			Closure scenario options assessment for each closure domain (guided by post-mining land use/s and closure objectives)
			Life of mine plan opportunities (mine rock handling, growth medium stockpiling, tailings deposition, water management, etc.)
Concept (-35 to +100 %)	Class 4 or 5/FEL 1	> 15+ years	Identified post-mining land use, depending on time to the end of operations
			Infrastructure decommissioning plan
			Closure social programs
			Closure vision, objectives and success criteria
			Closure risk and opportunities assessment
			Closure scenario options assessment for each closure domain (guided by post-mining land use/s and closure objectives)



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Revisiting the Costing Approach

Traditional Method

Deterministic Approach

Limits or excludes uncertainties

There is not 100% confidence in each line item that supports a cost estimate

The cost estimate increasingly suffers from compound error

Towards

Revised Method

Probabilistic Approach

Embraces the uncertainties related

Combines the variables and analyze multiple scenarios

Generates outcomes based on probability

Supports prioritization

Supports robust business decisions



Example: Embracing uncertainty



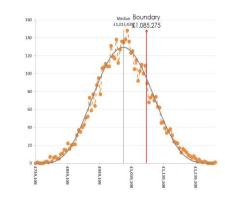
Figure 1 Illustration of options relating to soil & groundwater contamination

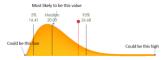


Cost Risk Analysis (CRA)

- Uses Monte Carlo simulation
- Analysis of the site aspects, closure criteria, objectives
- Uncertain inputs in a model are represented using ranges of possible values known as probability distributions
- More realistic way of describing uncertainty in variables of a risk analysis
- In cost modelling, probability distributions often fall towards the higher end of the curve being more likely

For each iteration, the simulation produces an estimate for an individual line item based on a predetermined probability distribution with values around the median/most likely value produced more often than those on the 'tails' of the distribution. In this case with 5000 iterations being run for each line item the distribution of results (right) shows the most likely (median) result as £1,013,439 with an 80% confidence it will be at or below £1,085,275.





Description	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration n
Line Item 1	398,103.62	302,603.33	307,837.19	341,125.21	281,464.38
Line Item 2	311,585.12	264,997.67	300,591.44	246,425.79	303,546.31
Line Item 3	422,601.17	423,653.22	295,313.21	341,064.03	271,523.80
TOTAL	1,132,289.91	991,254.22	903,741.84	928,615.03	856,534.49

Example of interactions



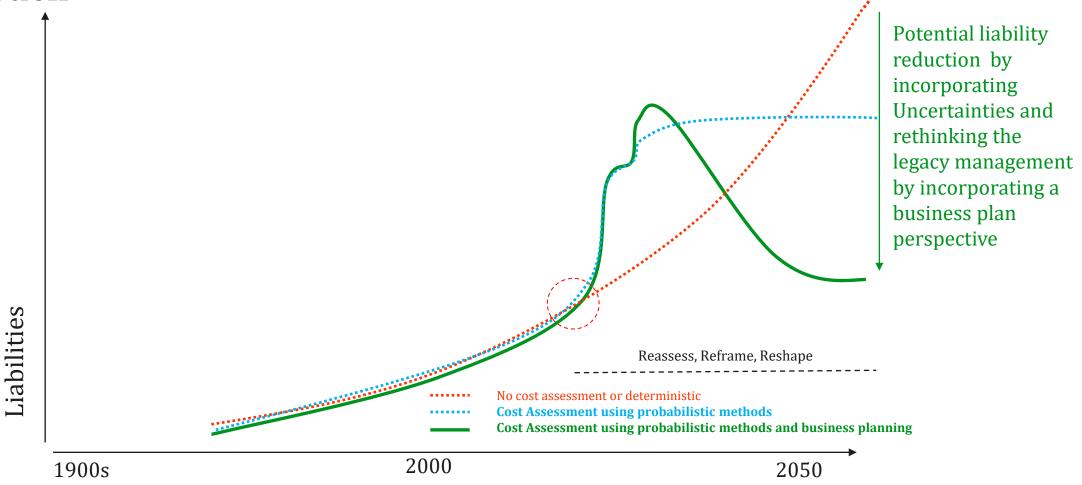
Cost Risk Analysis

Example of cost Risk Analysis Dashboard

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Experience throughout the Mine Closure: Transition to a process that incorporates uncertainty and rethinks the legacy management approach





Other improvement strategies

Integrating best practice closure planning into governance and operating models:

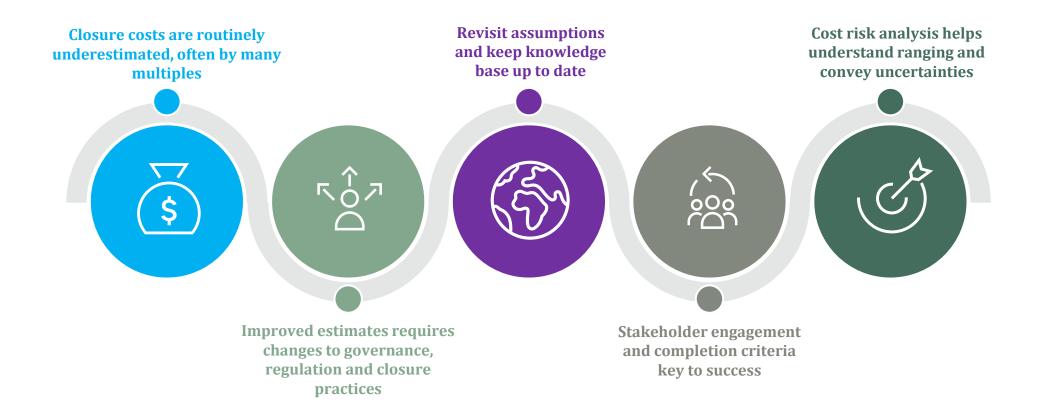
Basis of estimate	Front end load closure studies	Corporate governance	Risk & opportunity in LOA planning	Closure vision endorsed by management	Integrate closure designs into LOM
Progressively improve knowledge base	Track obligations (incl social)	Right expertise	ر أ ر o o o o o o o o	Effective stakeholder engagement	Feedback loop from progressive rehabilitation



Conclusions



Conclusions





Thank you



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Shaping a sustainable future with the world's leading organizations

