



GTK

**DIGITAL MANAGEMENT CAN
ENHANCE CONTINUOUS MINE
CLOSURE**

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WHAT IS MINE CLOSURE?

24.9.2019

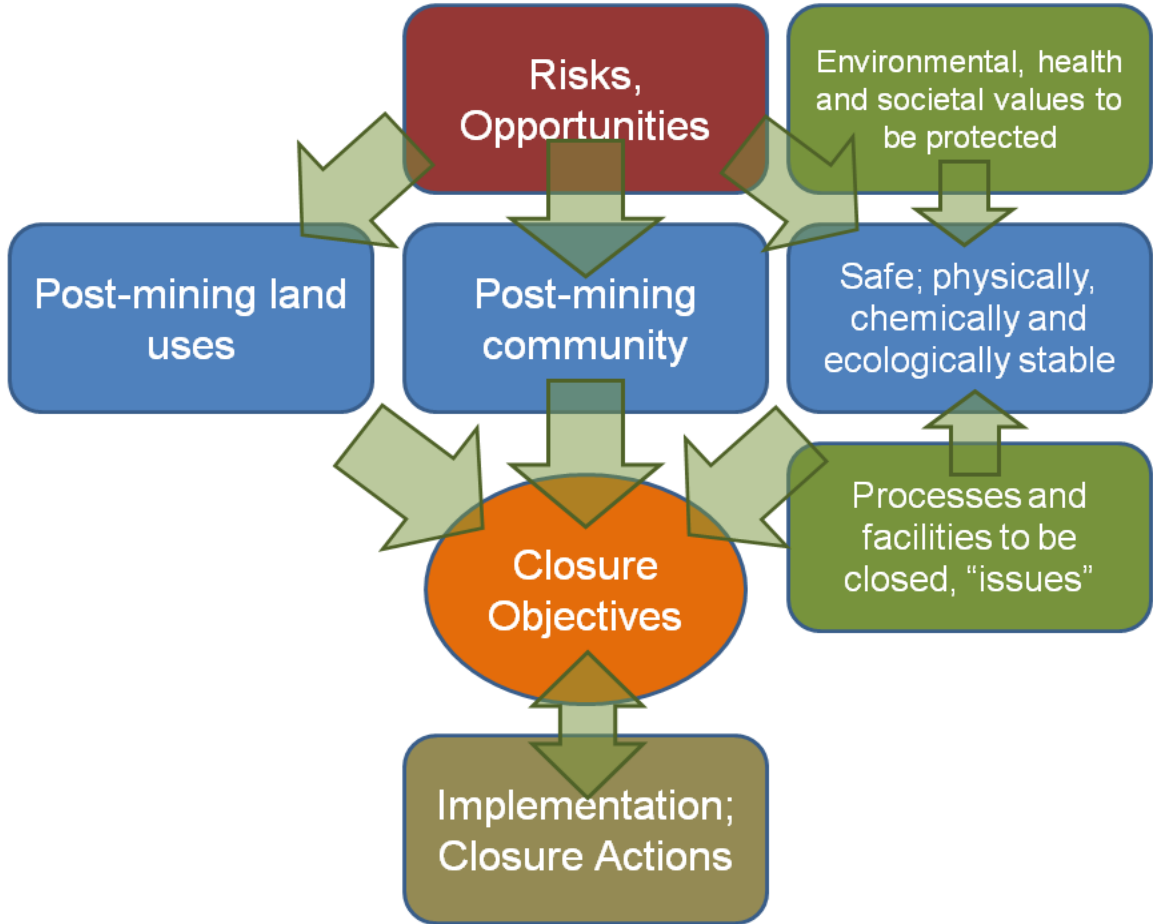
WHAT IS MINE CLOSURE

- Mine closure aims at bringing all parts of the mine site to a safe and physically, chemically and biologically stable state that facilitates the planned post mining uses of the site.
- Mine closure consists of two main activities:
 - **Decommissioning** = *permanently ending the mining and mineral processing operations and removing all the equipment and facilities that are not destined to remain in place for future use*
 - **Reclamation** = *reclaiming the mine site for the planned sustainable post mining land uses*

MINE CLOSURE IS IMPORTANT

- For the environment
 - *The post closure environmental legacy may be the most significant impact of the operation*
- For the operator
 - *Mine closure always involves considerable costs – often partly covered by sureties*
 - *Post mining expenses can be substantial in the long term (relinquishment)*
- For the region
 - *Mine closure affects the regional economy, employment, demography, services*
 - *Mine sites provide a wealth of opportunities for the post mining period due to the infrastructure and skilled work force in place*

CLOSURE OBJECTIVES: MINIMIZE RISKS, MAXIMIZE OPPORTUNITIES



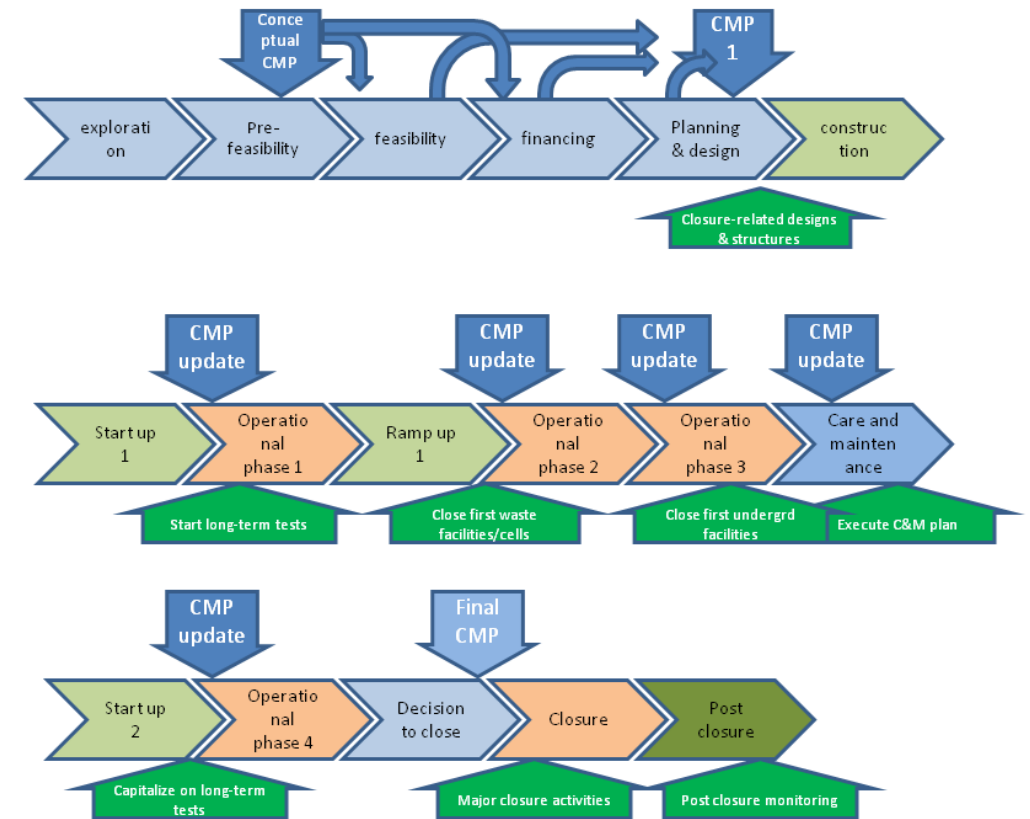
WHAT IS MINE CLOSURE

- Mine closure aims at managing the life-of-project impacts, bringing all parts of the mine site to a safe and physically, chemically and biologically stable state, and maximizing positive legacy of the project
- Mine closure consists of three main activities:
 - **Impacts and opportunities management** = working with stakeholders to ensure that lifetime negative impacts of the mining project are minimized and sustainable benefits for the community are maximized
 - **Decommissioning** = permanently ending the mining and mineral processing operations and preparing the facilities for future use
 - **Reclamation** = reclaiming the mine site for the planned sustainable post mining land uses

A MANAGEMENT CHALLENGE

MINE CLOSURE IS A LONG, COMPLEX PROCESS

- Starts early in the project
- Internal and external stakeholders
- Changes in ownership and management
- Involves considerable costs, liabilities
- Public administrative process
- Continuous reduction of unknowns
- Progressive closure
- Operating for closure
- Integration with LOM planning
- Accumulation of data, documentation
- A long post-closure phase



CLOSURE MANAGEMENT PLANS

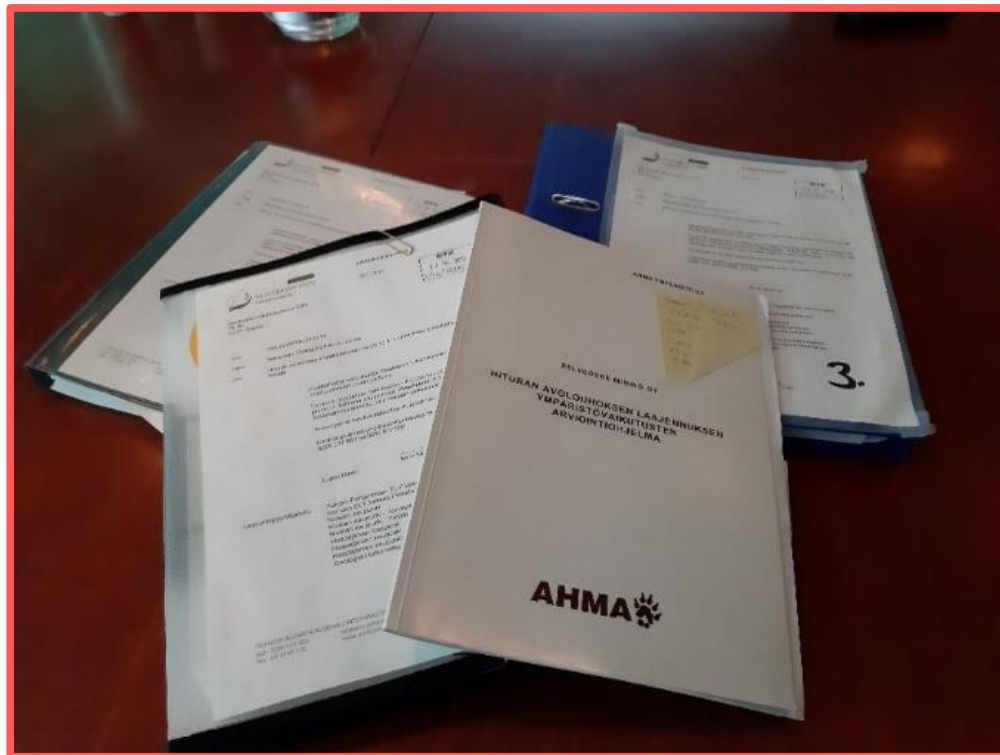
- The closure process is typically managed with a CMP
 - *Public participation, long term vision, predictability, continuity*
 - *Continuous closure, continuous reduction of risks, and foresight*
 - *Demonstration of closability and financial issues*
- Evolve from early conceptual plans to final detailed plans
- Authorities also require public CMPs to be submitted or included in other documents
- CMPs are usually paper documents stored in folders
- Contain several appendices from various sources
- Difficult to update, easy to put on the shelf



WHAT WE NEED IS 'CMP 2.0'

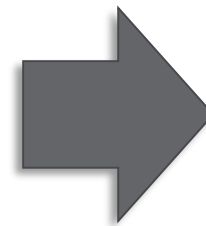
A real-life CMP from 2019...

- Prepared mainly for authorities
- Static, rarely used for management



A dedicated tool for closure planning and management

- Easy updates
- Planning and management features
- Data management



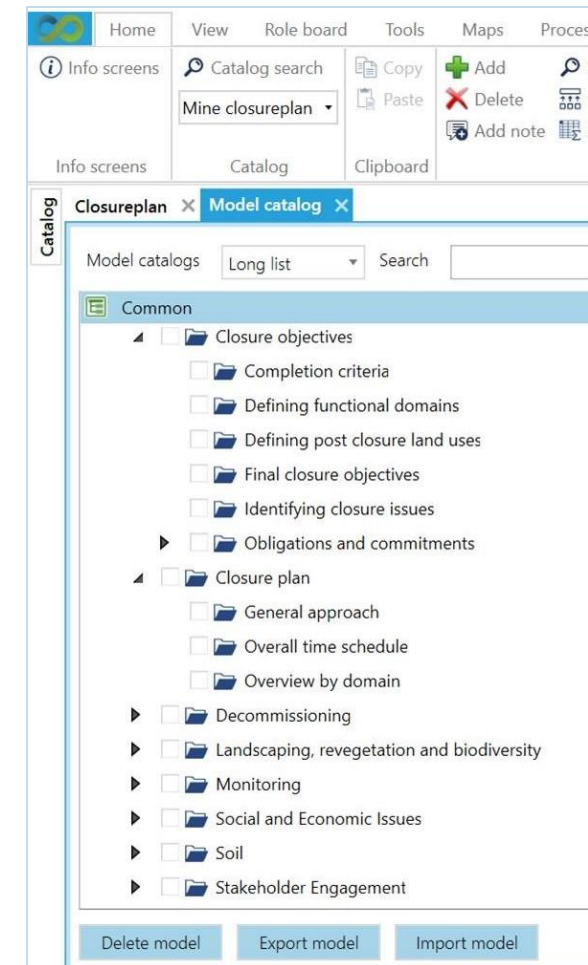
A close-up photograph of a rock surface covered with numerous green, prismatic mineral crystals. The crystals vary in size and orientation, some showing clear cleavage planes. The background is a lighter, more crystalline matrix.

FEATURES OF THE CLOSURE MANAGEMENT PROCESS

Benefits from a dedicated digital tool

NEED FOR UNIFORM HIGH QUALITY PLANS

- CMPs are of variable quality depending on the experience of the company and consultant
- Templates for typical items in a CMP
- On-line help for all features of the templates
- One size doesn't fit all
 - *General enough, but useful; systematic approach*
 - *A large selection of templates – no one will need them all*
 - *Make your own templates or edit existing ones*
- Re-use sections from all your other CMPs
- Context sensitive technical guidance (how to)
 - *Lots of information available out there*



AN UP-TO-DATE MASTER PLAN

- Every mine should have an up-to-date in-house CMP right from the start of the project
 - *We don't do this for authorities alone...*
 - *Progress beyond compliance*
- The CMP evolves over the years from an early conceptual plan to a very detailed final plan
- Updating the plan should be easy
- Version control, change logs, approvals...

Narrative

Master Plan

1. Introduction
2. Project description
3. Site description
4. Closure objectives
5. Closure planning and alternatives
6. Decommissioning infrastructure
7. Open pits
8. Underground mine
9. Tailings management facilities
10. Waste rock facilities
11. Water management
12. Water treatments
13. Monitoring
14. Etc...

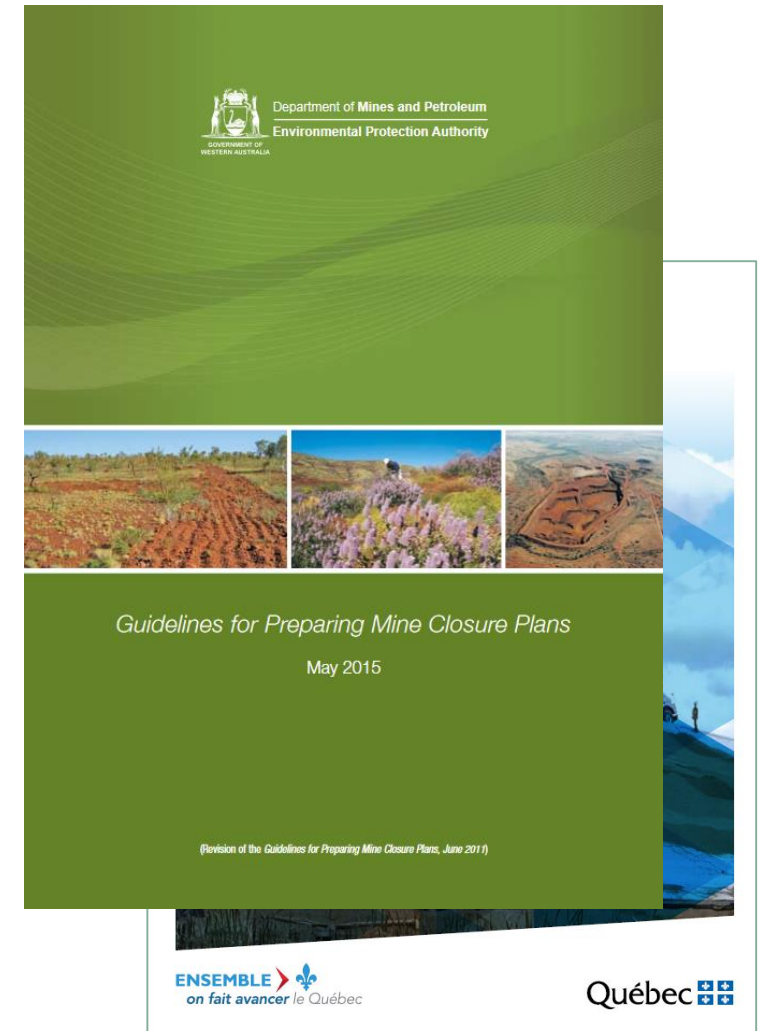
Detailed

Action plan

Acti on n o	Do m a i n	pon s i b i l i t y	Res our ces	Veri fica tion	Doc ume nts
2. Project description					
2.1.1.					
2.2.1.					
3. Site Description					
3.1.3.					
4. Closure Objectives					
4.1.4.					
4.2.3.					
5. Closure planning and Alternatives					
5.1.1.					
5.2.4.					
6. Decommissioning and Site Safety					
6.1.2.					
6.2.2.					
7. Open Pit					
7.1.1.					
7.2.2.					
7.3.1.					
8. Underground Mine					
8.1.3.					
8.2.3.					
8.3.3.					
9. Tailings Management Facility A					
9.1.2.					
9.2.2.					
9.3.2.					
9.4.2.					
10. Waste Rock Facility					
10.1.1.					
10.2.1.					
10.3.1.					
11. Site Water Management					
11.1.1.					
11.2.4.					
12. Water Treatment					
12.1.6.					
12.2.6.					
12.3.5.					
12.4.5.					
13. Monitoring					
13.1.5.					
13.2.5.					
13.3.5.					

ADMINISTRATIVE DOCUMENTS

- Authorities also want to see CMPs of good quality
- Several jurisdictions have published guidelines for preparing official mine closure plans
 - *Prescribed TOCs*
- Templates for these public CMPs should be included in the digital tool
- The public CMPs should be easy to produce from the detailed, in-house master plan
- Authorities are going digital – e-government initiatives



IT IS A COLLECTIVE EFFORT

- Drafting a CMP is never a single person undertaking
- Contributions from several persons in the company
- User management, users with different profiles
- CMPs assigned to selected users
- Third party contributions – how do you manage that?
- Access by authorities might be desirable but difficult in practice



PROGRESSIVE CLOSURE ACCUMULATES DATA

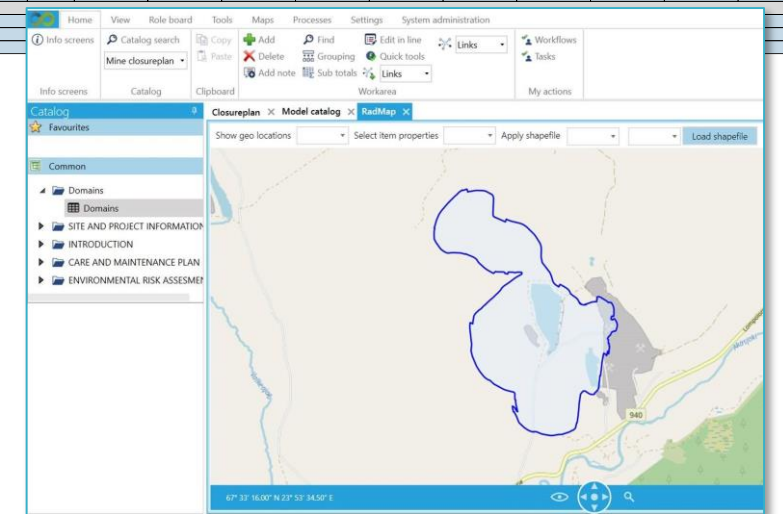
- Modern CMPs include actions to constantly reduce uncertainties and close individual facilities when they come to the end of their service life
- CMPs include actions that generate data and documents related to specific closure topics
 - *Plans, designs, procurement, construction, inspections...*
 - *Long term tests, trials, studies, monitoring reports...*
- Copies of these need to be stored and made accessible at correct places within the plan
 - *Master plan, action plan*



A LOT OF ACTIONS TO PLAN AND MANAGE

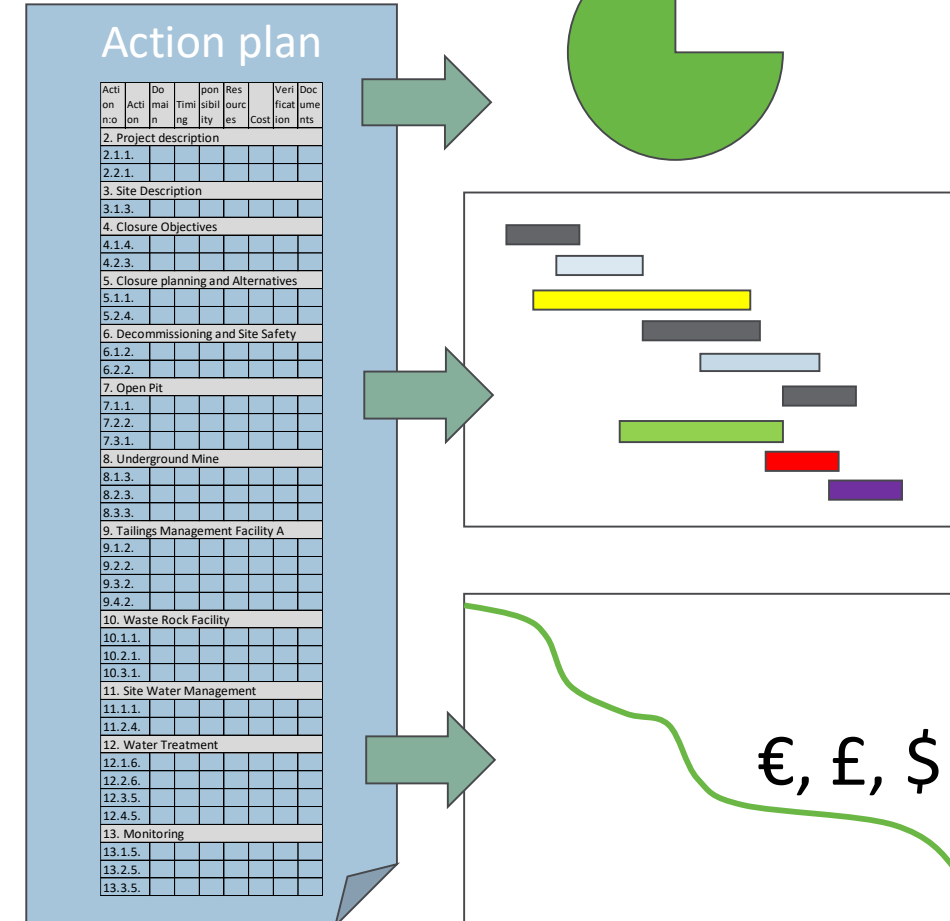
- Any mine closure process consists of a multitude of individual actions and tasks
- These should be planned and monitored
 - *Action plan*
 - *Start-end, responsibilities, costs, approval, documentation...*
- Actions are linked to closure topic and spatio-functional domains – map tool
- Viewing and tracking by domain, topic, time period...

Domain	Topic	Action	Description	Is based on	Is based for	Start (planned)	Started	End (planned)	End	Responsibility (names/positions)	Resources	Cost estimate	Cost	Verification	Documents
2. Project description															
2	1	1	Process design writeup	3.1.1.	5.1.1.	01-June-2021	18-June-2021	31-August-2021	31-August-2021	Mill engineer	Consultant	0		chapter approved	Process design
2	1	2													
3. Site Description															
3	1	1													
4. Closure Objectives															
4	1	1													
4	1	2													
5. Closure planning and Alternatives															
5	1	1													
5	1	2													
6. Decommissioning and Site Safety															
6	1	1													
6	2	1													
6	2	2													
7. Open Pit															
7	4	1													
7	4	2													
7	4	3													



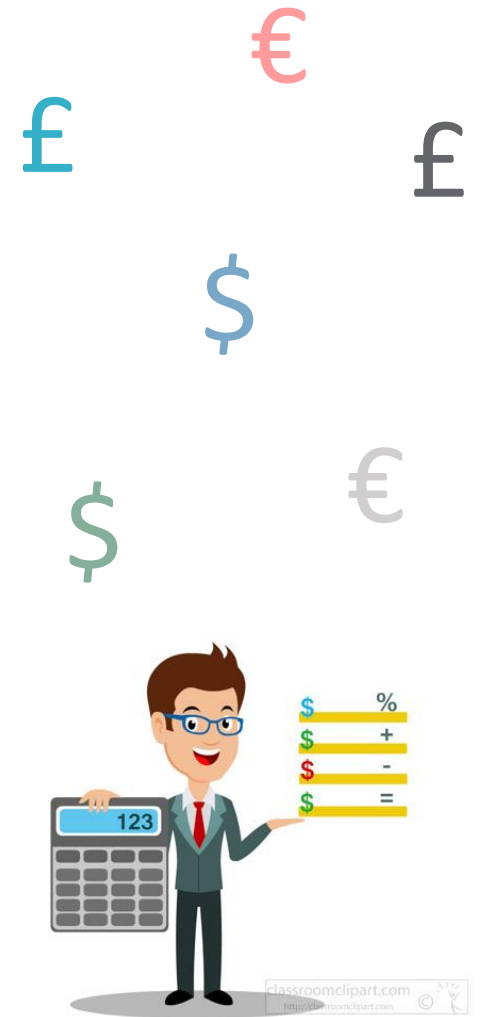
TRACKING THE PROGRESS

- Planned actions can be tracked for several properties
 - Start and end dates*
 - Degree of completion*
 - Expenditures...*
- Actions can be grouped by any attribute for tracking
 - Domain, responsible person, next quarter...*
- Closure objectives should be tracked, too
 - More subjective, less mechanical, even with well defined measurable objectives*



IT COSTS A LOT TO CLOSE A MINE

- The financial department is often the key motivator for updating CMPs
 - *They want to know how much resources are needed this year and next quarter*
 - *Outstanding liabilities*
- A detailed, up-to-date action plan with cost estimates is the most accurate source of this information
 - *Tools for cost estimation – earth construction activities are key*
- A digital closure management tool can generate these figures and reports automatically if Action Plan is up to date
- In fact, the bean counters can check it themselves if we give them permissions



CONTINUITY

- Continuity is the key in closure management
 - *the post closure land uses and objectives agreed early on in the project should guide all actions*
- These goals should survive changes in management and ownership
- A complete, standalone closure management system should be transferred to new owners
 - *Copies of all documents stored within the system*
 - *A complete history of actions and changes*
 - *The original objectives and post-closure land use plans*

MERGERS & ACQUISITIONS MINING NEWS

September 17, 2019

Core Gold Comments on Titan Minerals' Announcement of Its Intention to Commence a Take-Over Offer for All of Core Gold's Common Shares and Provides Update on Vertex Debt

September
Recomm

Lundin Mining completes acquisition of Chapada copper mine in Brazil

By msagar 08 Jul 2019

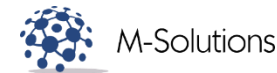
MINING OTHER COMMODITIES OTHERS

Production at Chapada mine started in 2007, and produced approximately 58.6kt of copper and 121koz of gold in 2018



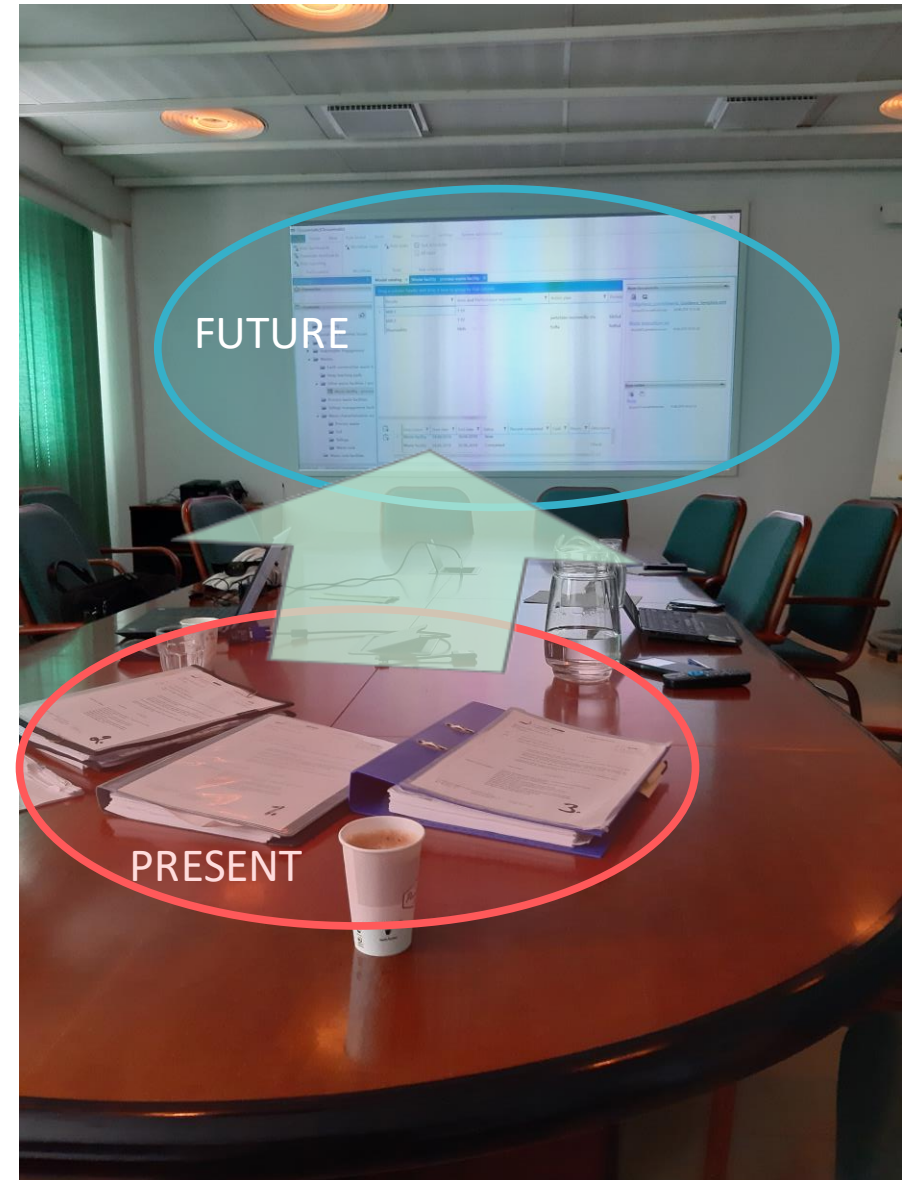
THE CLOSUREMATIC PROJECT

- EIT RM funded project 17032
 - *1.1.2018-1.4.2021*
- Partners:
 - *Geological Survey of Finland, GTK*
 - *DMT GmbH*
 - *French Geological Survey, BRGM*
 - *M-Solutions Oy*
 - *Hannukainen Mining Oy*
- Digital tool for closure management
- www.closurematic.com



CONCLUSIONS

- 🌐 Mine closure is crucial if we are to produce positive legacies from mining projects
- 🌐 Continuous, integrated closure is the industry standard for best outcomes
- 🌐 This is a complex management challenge that benefits from dedicated digital tools





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THANK YOU

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