

The end is nigh

Experienced consultants often lead the way when it comes to mine closures, Paul Moore reports

Mine closure is as much a part of planning for modern mine operations as the feasibility study prior to start-up. In fact, it is usually an integral part of the feasibility study itself, and in most cases, is most effective when incorporated at the earliest possible stage.

This is the time when the project has the greatest degrees of freedom to place facilities in locations where they will be easiest to decommission and rehabilitate.

Careful consideration of closure approaches and objectives, regardless of how conceptual they might be during early design phases, could significantly affect design criteria in ways that the design team would not otherwise consider.

A plan that incorporates winding down a very large industrial process such as a mine can be very complex, involving aspects of environmental planning for waste/tailings areas, major earthworks/landscaping, dismantling of fixed structures and liaising with key customers, governments and local communities over phased cutbacks of production and the resultant loss of permanent jobs.

The process is also complex as mines often operate well beyond their initially defined life due to discovery of more reserves; or sale of assets to a junior company that may be able/willing to operate the mine on a scaled back basis.

In many cases, the most difficult aspect may be updating the closure cost estimate. Closure plans need to be flexible as, not only can a mine life be extended, but as in the recent economic downturn, many mines were forced to close ahead of the schedules that had been developed only a few years earlier.

In either case, the scenarios developed in the closure plans must be updated to reflect reality before any closure plan is approved by regulatory agencies, and then implemented by the project owner.

One of the other big issues is the ever changing regulatory environment. If regulations change mid-way through a decommissioning project, there may be significant impacts on the closure requirements. Also many jurisdictions do not have well defined policies for returning the land to the government.

It is important to note that the responsibility of closure extends long beyond the day that the plant stops producing concentrate or the last blast occurs in the open pit. Fergus Anckorn,

technical director for AMEC's UK environmental business states: "The concept of walk-away closure planning is dead. Today, the mining company must set up a closure plan that manages the site 'in perpetuity'. Clearly this raises technical and economic challenges, the most demanding of which are likely to be concerned with water resources and water quality."

SPECIALIST CONSULTANTS

In terms of the companies involved, while some mining groups choose to develop their own closure plans using in-house resources, most don't employ the range of professionals/specialists that are required to prepare a comprehensive plan, so need to retain consultants for those areas that they don't have the resources. At the same time, both the miner and the specialist offer their own expertise.

Jeff Parshley, a principal at SRK Consulting (US) Inc states: "Most international mining companies have experienced closure specialists in-house who oversee closure planning. Some companies have sufficient resources to develop closure plans themselves. Others retain mine closure consultants to assist them in the process."

Mr Botham echoes this: "Most closure plans require input from a multi-disciplinary team in order to develop a defensible closure plan. The team could include geotechnical engineers and tailings management specialists, geochemists, biologists, socio-economists, structural engineers, mining engineers, demolition specialists, costing engineers, accountants and lawyers depending on the nature of the site. It would be difficult for a specialist consultant with only one area of specialisation to prepare a defensible closure plan."

The group of major consultants with expertise in this area includes Golder Associates, URS, SRK, Wardell Armstrong, AMEC, Snowden, Knight Piesold Consulting and others, but is still a relatively select club. Most of these consultants are specialists in several areas, such as tailings management, geochemistry, rock mechanics etc, but take advantage of their combined skills to conduct effective mine closure planning.

The independence of consultants is an important part of their role. Leon Botham, principal and senior geotechnical



engineer at Golder Associates, says: "In many jurisdictions, the mine closure regulations require that the closure plan be 'certified' by an independent third party. Depending on the complexity of the project, this certification may require significant rework and verification, so ultimately, it may be more economic to retain that 'independent third party' to prepare the plan."

Fergus Anckorn says: "The trend is to increasingly use consultants with specialist knowledge at all stages from project inception through to final closure planning although this can vary according to the mining jurisdiction and the type of company, such as whether the mining company is state-owned or a private international mining house.

"This issue is particularly driven by the fact that the audit of closure plans and closure planning outcomes is becoming much more exacting, if not via national regulations, then via equator principles."

EARLY PLANNING

A common thread that emerges in the says from the specialist consultants that help mining groups to plan for closure, is the importance of factoring in the closure plan as early as possible.

Jeff Parshley says: "The industry standard practice in recent years is to consider mine decommissioning early in the project development cycle, usually during pre-feasibility. As documented by the World Bank Group (2002) and ICMM (2008), planning mine closure early in the project development process is essential to ensuring the mine that is designed is one that can be closed properly. For that reason closure specialists are typically an integral part of the initial project design team."

"The most difficult aspect may be updating the closure cost estimate"



Han Ilhan, vice-president and global mining business director at URS tells *Mining Magazine*: "More and more mine closure/decommissioning is being planned during the very early stages of project development in order to appropriately capture impacts on financial evaluations and particularly on ROI. URS provides strategic planning and design for mine closure from the early phases of projects into operations, as well as construction execution after the mine operations cease. Additionally, URS' speciality in demolition provides mining companies positive cash flow as part of the mine closure/decommissioning activities."

Mr Anckorn says: "AMEC recommends that planning for mine closure begins as early as the preliminary economic assessment (PEA) and scoping stages and that a costed 'closure strategy' is formulated at least by the time that feasibility and environmental and social impact assessment studies are completed. This should be based on meeting all the technical, economic, environmental and social criteria established through stakeholder consultation." Stakeholders should include the project proponent, government agencies and local communities as well as relevant NGOs.

The closure strategy established prior to project construction will then be upgraded into a draft closure plan' as operational experience is gained and results of issues such as planting trials and water treatment become available.

Mr Anckorn adds: "Stakeholder consultation on closure objectives must continue through the life of the mine. Before final closure works commence, normally well before the mining operation ceases and in line with permitting requirements, a final closure plan will

be agreed with authorities. Again, this must follow the agreed procedures for public consultation and information disclosure, which is also the subject of an agreed consultation and information disclosure plan."

STICKING IT OUT

It is also true that closure planning is not viewed as a very positive or team-building topic for mine staff. Some in the industry would prefer the process to be referred to as "mine completion" rather than the commonly used "mine closure".

Yet it has to be remembered that every mine that opens is certain to close at some point so it must be adequately planned for. But the negative perception of "closure" can create staffing issues.

Hugh Jones, senior consultant at Golder Associates says: "There are serious issues with closure because it is seen as a negative by companies. There are no promotions for closing an operation, only opening one. The mine operating staff see 'the end' and get off the ship as soon as practicable, taking their considerable corporate experience with them. This can make the actual closure more difficult to implement. But as every mine must close, companies need to recognise that effective closure, which is accepted by the community, is part of their licence to operate a future mine and should therefore encourage their staff to hang in there until 'the end' happens."

ALLOWING FOR CHANGE

As stated, the closure plan has to be adaptable to change – change in the mine life, the available reserves (related as much to economics as ore grade), local circumstances, wider mining group strategy and many other factors.

The closure plan can therefore be seen as a "live" document that is kept under active review and is subject to ongoing consultation throughout the project. This regular review process will also help to highlight upcoming issues related to, for example, changing production levels.

The timing of decommissioning is a commercial decision and usually happens when either the ore is exhausted or the operation becomes uneconomic. In the first case, the timing is relatively easy to predict, but in the second most operations extend beyond the optimal economic closure time because every operations team is optimistic that economics will improve.

Because factors relating to closure change all the time, closure plans have to be fluid and adaptable. Jeff Parshley at SRK states: "Development of a mine closure plan is a fluid process that continues throughout of the mine life cycle and is influenced not only by changes in ore reserves, but changing regulations, new site information, evolving industry practices and stakeholder input.

"Most regulatory jurisdictions require periodic reviews and updates, financial reporting requirements require a review of the estimated closure costs each year and most companies have programs to monitor the progress of their contemporaneous closure efforts to allow continuous improvement in their closure methods.

"Ongoing stakeholder consultation may identify additional closure objectives. And the addition of reserves during the mine life is both expected and desired. While the objectives of mine closure may not change significantly with changing project conditions, the timing and sequence of closure activities may."

Mr Parshley adds: "Adjusting for these changes involves working closely with the mine design team to incorporate aspects, such as phasing of mine waste facilities so that portions of them can be closed as the phases are completed. Since the standard approach to mine closure is to optimise opportunities for concurrent or contemporaneous closure, alterations to the closure plan later in the mine life may also benefit from lessons learned from closure work already completed."

THE THIRD-PARTY OPTION

Some mines wind down then subsequently stay in production on a smaller scale under a new owner, such as a junior mining company. As a smaller company, they may be able to operate the site at an acceptable profit level relative to the global mining group. Equally, the global miner may have decided that the mine is no longer ►

Scrapped equipment in Katanga mining region, DRC

"Closure planning is not viewed as a very positive or team-building topic for mine staff"

- ▶ producing on a scale or at a profit margin that fits with its overall strategy.

Some companies actively seek junior companies to take over their operations, in the hope the company can pass on the closure costs to the junior company. Other companies like to retain control over the site of their operations as long as practicable. But it is not always a simple solution as far as closure is concerned.

Leon Botham at Golder says: "In these cases, the closure plan would have to allocate responsibility for closure prior to transfer of the property. In most cases, a small operator would not have the financial resources to complete closure of a large mine if they acquired the property with the intent of scaling back production at the end of the mine life. And it is unlikely that the regulators would allow the transfer of the property, unless the original proponent was to provide the financial guarantee for closure of the property."

Jeff Parshley at SRK says: "As a general rule mine closure plans recognise that future economic conditions may allow the mine to be reopened to extract additional resources and therefore typically avoid sterilising potential future ore reserves.

"However, mine closure plans are developed and modified based the mine plan and financial objectives of the operating company that exist at the time. Furthermore the financial benchmarks for closing a mine will vary by company. Therefore, a mine scheduled for closure by a large company may still represent an opportunity for a smaller company with different financial objectives."

When a mine is transferred to another company a modified closure plan consistent with a new mine plan is required. Regulatory and stakeholder obligations are generally transferred to the new owner but may be modified through additional stakeholder involvement.

"Because factors relating to closure change all the time, closure plans have to be fluid and adaptable"

The road to Codelco's El Teniente mine shows the scars of many years of mine activity



If contemporaneous closure formed a significant portion of the initial closure plan, some mine components may already have been closed by the original owner. If these facilities have been completely decommissioned, then new facilities may be required. Other closed facilities, such as waste rock dumps may be reopened for expansion with minimal effort.

ENVIRONMENTAL ASPECTS

The environment always forms an important part of closure plans. Closed mine sites need to be left in a safe condition so that inadvertent access will not jeopardise the safety or local residents of wildlife. Decommissioning must also address social aspects such as maintenance of infrastructure left behind after closure of the mine.

Environmental considerations apply to all mines irrespective of location. The 'green' aspects of the environment dominate many mine closure requirements set by governments, as these have a relatively short time scale to determine if the site is suitable for a post operational use. The 'brown' aspects, particularly erosion have a much longer time scale (several orders of magnitude longer than the biological aspects) and are considered less important.

The social aspects of closure require very different responses depending on location. The fly-in-fly-out operations require considerably less social aspects input to the plan than those operations where the workforce live at the site of the operation.

While mine closure plans consider social and financial requirements of the company, the primary objective of a mine closure plan is to leave an environmentally safe and sustainable site that meets the designated post-closure land use objectives.

Therefore, although the financial impacts of closure may define the specific methods and technologies selected for a closure plan the long term environmental aspects of closure tend to define the closure approach.

EQUIPMENT AND ASSETS

The approach to dealing with remaining equipment and other assets during the closure process will depend on the operator. In many cases the saleable assets are offloaded through auction, but much of the material if it has exceeded its usable life may also simply be salvaged for scrap or placed in an off-site or on-site disposal facility. Additionally, some equipment and facilities could be retained on site if this suits the agreed after-use, such as ongoing use as an aggregates quarry to service local building and roads construction.

History of closure

Prior to the early 1990s there were no requirements, in most jurisdictions, for mining companies to develop closure plans for their operating mines.

Leon Botham, principal and senior geotechnical engineer at Golder Associates, says: "The exception to this rule, in Canada in particular, was for uranium mines, which operated in the 1970s and 1980s. At the time, the Atomic Energy Control Board (AECB), now the Canadian Nuclear Safety Commission (CNSC) required the mines to have closure plans developed.

"In most jurisdictions in Canada, with the exception of uranium mining, regulation falls mainly to the provincial government. Most provincial governments in Canada required mining operations to have an approved closure plan developed by about 1996."

In the US, since 1974, all mining projects on National Forest lands had a regulatory requirement to have a closure plan and cost estimate in place.

Following introduction of new laws and regulations on mine closure, all projects are now required to have closure plans developed as part of the permitting process. Conceptual closure plans must be included within the project EIA, so that long term impacts, if any, can be predicted.

Typically, concepts for closure are now developed as part of each level of economic assessment and permitting for a project. Once a project goes into production, the closure plans must be updated, and financial assurance packages posted, on a regular basis throughout the mine life, including any extensions to the mine life as a result of discovery of additional reserves.

Hugh Jones at Golder comments: "The use of equipment in other operations depends on many factors including the minerals mined. For example, uranium contaminated equipment requires costly decontamination before it can be used elsewhere."

The winding down of production and its costs must be factored in. As an operation reaches the end of the mining cycle, the rate of expansion of facilities such as waste-rock dumps will decrease, thereby increasing opportunities to close facilities or parts of facilities contemporaneously.

However, annual revenues also decrease and if closure activities are funded through operational cash flow, this may reduce the amount of work that can be performed without other funding mechanisms. ▼