Paste 2023 – GW Wilson, NA Beier, DC Sego, AB Fourie & D Reid (eds)

doi:10.36487/ACG_repo/2355_64

Critical timelines and pathways: addressing environmental, social, governance and permitting

JR Kellner *Nevada Gold Mines, USA*

A Hall *Responsible Mining Solutions, Canada*

FM Tanentzap *Responsible Mining Solutions, Canada*

Abstract

The need for projects to focus on permitting and environmental, social and governance (ESG) considerations is increasingly prioritised over the technical and economic aspects of backfill and tailings solutions. This includes not only environmental permitting, but also takes into account public perception and responses to a project, as well as local community engagement and support. To optimise the success of a project, it is essential to incorporate and understand both the mining companies' ESG frameworks and the local and governmental permitting requirements from the beginning.

There is a need to pull these more advanced backfill and tailings designs earlier into the process to satisfy permitting requirements rather than the usual execution schedule.

Permitting timelines may also lead to temporary backfill solutions such as cemented rockfill until paste backfill can be permitted and implemented.

Comparing surface versus underground permitting requirements can lead to a more strategic approach by evaluating alternative solutions for infrastructure placement. For example, some facilities can be located underground if surface is perceived to be contentious. This can also lead to an approach where facility placement that might be better suited underground, but a more conservative approach is to start on surface and move underground as the project progresses.

Given the focus on ESG and permitting and the timelines involved, it is more important than ever to provide a narrative which conveys a responsible integrated tailings solution for mining projects, both for permitting and to ensure public support.

Keywords: *permitting, ESG, underground, responsible, backfill, community engagement*

1 Introduction

Mine backfill is a process in which waste materials are used to fill the void created by mining operations, having both technical and economic benefits (Tenbergen 2000). From a technical perspective, mine backfill can help to improve the stability of the mine, reducing the risk of collapse and other safety hazards (Tenbergen 2000). From an economic perspective, mine backfill can be a cost-effective way to dispose of waste materials, as it eliminates the need for additional disposal sites and can even generate revenue if the waste materials have value. Additionally, by improving the stability of the mine, mine backfill can help to extend the life of the mine, increasing its overall profitability (Bahera et al. 2021).

Environmental, social and corporate governance (ESG) are important factors that influence mining decisions. Mining companies must consider the potential impacts of their operations on the environment, local communities, and stakeholders when making decisions about where and how to mine. This is because ESG factors can have significant financial, social, and reputational implications. One of the key environmental considerations in mining is the need for environmental permitting. In many areas, mining companies are required to obtain permits from government agencies before they can begin operations. These permits typically require the company to demonstrate that their proposed activities will not have undesirable environmental impacts to the air, water, or significant loss of biodiversity or land degradation. Permitting timelines vary depending on project's size, scope, location, and several other factors, such as if an environmental impact study (EIS) or environmental assessment needs to be conducted. The timeline for this process can range from one to several years depending on the complexity of the project and the extent of public engagement and consultation required.

The critical path timelines for environmental permitting can be affected by changes in the regulatory bodies that oversee the permitting process. This can happen for a variety of reasons, such as changes in leadership, shifts in policy, or changes in the legal framework governing environmental permitting. It is important for organisations and individuals seeking permits to be aware of these changes and to factor in time for unexpected changes in the planning and decision-making processes.

To optimise the success of a project it is essential to incorporate and understand both the mining companies' ESG frameworks and the local and governmental permitting requirements from the beginning. This paper is a literature review of the critical path and project management pathways that will address the need to pull more advanced backfill and tailings designs earlier into the permitting process to satisfy regulatory requirements rather than the usual execution schedule.

2 Critical path overview: historical project execution

2.1 Critical path and project management history

The critical path method (CPM) is a project planning, scheduling and execution strategy formalised by engineers James Kelley and Morgan Walker in the 1950s (Kelley & Walker 1959). The current CPM utilises software to better understand the schedule impacts of a set of tasks. The CPM relies on a separation of planning and scheduling aspects of project management. Understanding the tasks to be completed and laying them out in order must occur before assigning realistic timelines to the tasks. In this way, preceding and subsequent tasks can be laid out in a diagram. Today, this is commonly represented through the Gantt chart.

2.2 Traditional critical paths in mining

Construction or mine development projects have traditionally identified procurement or construction time schedules as the primary critical path in project execution. Hickson & Owen (2015) outline methodology for project execution plan set up. Their work "presents the project philosophy with respect to engineering, procurement, and construction" (Hickson & Owen 2015). Although considerations for permitting are made throughout the guidance, Hickson & Owen (2015) take the stance that environmental permitting and social risks be handled primarily by parties outside the project team long-term. However, they acknowledge that the project manager assumes responsibility for obtaining these permits and the need to consult with these groups throughout the process.

The role of construction and procurement schedules as the critical paths in project execution continues to diminish as these aspects are further explored and refined. Significant work has been put forth in proposing and testing procurement strategies in an organisation, and the impacts these procurement strategies have on project execution (Milanzi & Bond-Bernard 2017). Exploration of concepts such as centralised procurement governance models versus decentralised procurement governance models shows the significant work that has been done in exploring procurement's role in project delivery.

Comparatively less work has been done in the permitting realm. Research into centralised versus decentralised permitting governance models have not been as robustly explored, and this area of research could provide better frameworks and insights into permitting processes' impacts and development of strategies for project schedule estimation.

3 Project execution drivers and timelines/critical path today

As ESG becomes more prominent in project management and execution, project managers need to understand the importance of project location, jurisdiction, and permitting obligations that are present in the area that will need permitting. Varying magnitudes of obligations among different jurisdictions have direct impacts on project execution timelines.

3.1 Regulatory landscape for permitting of tailings and mine backfills

The permitting process for mine tailings and mine backfills projects can differ in key ways. Mine tailings have been traditionally stored in impoundment ponds, and the permitting process for transitioning an operation from conventional to highly dewatered tailings can be complex and time-consuming due the potential environmental impacts, such as slope, water contamination and air pollution (Reid et al. 2009). However, mine backfill projects uses waste materials from the mining process to fill mined-out areas, reducing the overall tailings storage area with the benefit of improving underground stability (Reid et al. 2009). Therefore, mine backfill permitting might be less of a permitting risk, though it requires careful consideration and testing on the location, materials of waste used, and design to ensure safe and effective practices (Tenbergen 2000).

3.1.1 Variation of permitting timelines

The environmental permitting process varies widely depending on the country, region and even can be dealt with on a project specific basis (Table 1). Hence, having a firm understanding of the local permitting landscape can have a massive effect on a project's timeline.

Table 1 Examples of the timeline ranges for environmental permitting projects and the different regulatory agencies involved in the process.

Country	Average permitting timeline (can be longer)	Involved permitting agencies (can be more)
Australia	1–3 years	Federal, state, and local, Department of Industry, Department of Environmental and Heritage Protection (SNL Metals & Mining 2015).
Brazil	1–3 years	Multiple regulatory agencies such as Brazilian Institute of Environmental (IBAMA), National Council of the Environment, State and Local Agencies (Cescon et al. 2021).
Canada	2–5 years	Federal, provincial, Fisheries and Oceans (SNL Metals & Mining 2015).
United States	2–10 years	Federal, state and local regulatory agencies, EPA, BLM, NEPA (GAO 2020; CEQ 2020).

3.2 Impacts of litigation

Litigation can drastically impact timelines and is currently omitted from traditional project schedule estimates. Increasing impacts and budgets of NGOs opposed to mining and development projects has recently brought this issue to the forefront.

3.3 Project management takeaways

The impacts of permitting timelines and ESG considerations on project budgets and schedules has not been considered traditionally in project execution. New legislation, increasing scrutiny, and corporate ESG principles and considerations have shifted the paradigm in managing large-scale projects. Traditional critical path drivers, such as procurement and construction, have seen significant improvement in timelines while permitting and ESG aspects boast larger roles in the scheduling and budgeting estimation process. Moving forward, mining project managers need to consider environmental permitting as a potential critical path.

4 Cautionary tales and what comes next

Understanding the future of mining projects, including the design, permitting, operation and closure of tailings facilities, is incumbent on an understanding of the history and failings of this industry. This history includes technical failures of tailings facilities, containment, and waste heaps, as well as projects that have failed in terms of permitting and social engagement and support.

4.1 Tailings and the global industry standard

Since the year 2000, there have been over 60 incidents involving the failure of tailings dams globally. This number grows to more than 70 if we include waste heap failures, major pipeline leaks, and failures of environmental containment (Dieh 2022).

While the majority of these incidents will not be familiar to most people, there is no denying that significant events such as Mount Polley (Canada) in 2014 or the Brumadinho dam disaster (Brazil) in 2019 received considerable global media coverage. It can only be expected that events such as these result in closer and more critical engagement with both NGOs and regulatory bodies for the permitting of future tailings and/or waste disposal facilities.

Additionally, public perception is understandably altered when viewing coverage of catastrophic failures on the news. Depending on the location of any new projects looking to be permitted, the permitting process including public consultation will be just as critical as technical and economic considerations in terms of avoiding major delays as the project progresses towards operation. Some of methods that are employed to ensure a smooth permitting process include following recognised standards or guidelines, employment of best technologies (real or perceived), careful and cautious engagement with regulators and others throughout the design process, and testing campaigns to support concepts.

The Global Industry Standard (the “Standard”) on Tailings Management was developed as a response to the catastrophic dam collapse at Vale’s Corrego de Feijao mine in Brumadinho (Oberle 2020). It was developed via panel, with requirements organised into six topic areas. There were also 15 principles and 77 auditable requirements detailed within the Standard. The Standard is directed at operators with the intent to be applied to both existing and future tailings facilities. This Standard will be addressed within this paper, but it should be noted that there are many other guidelines available, such as the Guide to the Management of Tailings Facilities published by the Mining Association of Canada, Guidelines for Responsible Mine Tailings Management published by Earthworks and others, the Global Acid Rock Drainage Guide, and the Canadian Dam Association’s Dam Safety Guidelines.

Topic Area I of the Standard focuses on project-affected people, while Topic Area II requires operators to develop knowledge about the social, environmental, and local economic context of a proposed or existing tailings facility. Topic Area III focuses on designing, constructing, operating, maintaining, monitoring, and closing tailings facilities, while IV addresses the ongoing management and governance of a tailings facility. Topic Area V covers emergency preparedness and response in the event of a failure, while VI provides guidelines on public reporting and accountability surrounding tailings facilities.

The Standard also includes definition of relevant terminology, roles and functions, key documents, levels of review, and provides a consequence classification matrix. Implicit within even the structure of the document is the notion that the guideline and the design cover so much around the design, construction, operation and maintenance of and closure of tailings facilities, that there is almost certainly to be principles or requirements which would support alternative designs or locations. There is then the need to evaluate tailings facility options with regards not only to capital, operating and closure costs, water balance, environmental impact, etc., but also with regards to the objectives and intent of the Global Industry Standard.

As with any sort of weighted matrix analysis implemented for determining a preferred solution, the output of the exercise is inherently dependent on the individuals participating in the exercise. While having those people involved in the exercise familiar with the content and objectives of the Standard will certainly improve the exercise and the solution it produces as preferred, weighting and ranking of options is a matter of those populating the matrix, their biases, experiences, and preferences.

While this is true of any systematic approach to evaluate alternative designs, it is of critical importance to have the right people involved to give the process the best chance of selecting the optimal solution. This means having stakeholders across disciplines engaged in the process, a strong technical presence with understanding of the options and the process which was followed to develop them, an appreciation for how the processes engage with the broader project (permitting, construction, sequencing and integration with mining, all the way through to closure). As well, a selection process must be tailored to the specifics of the site, including the physical site, but also political, regulatory, and social considerations.

4.1.1 Competing drivers and integrated solutions

Requirement 3.2 of the Standard states that "For new tailings facilities, the Operator shall use the knowledge base and undertake a multi-criteria alternatives analysis of all feasible sites, technologies and strategies for tailings management. The goal of this analysis shall be to: (i) select an alternative that minimises risks to people and the environment throughout the tailings facility lifecycle; and (ii) minimise the volume of tailings and water placed in external tailings facilities."

Incumbent to any multi-criteria analysis is that certain considerations will drive towards one solution while other solutions will be preferred based on other criteria. Even within the narrow scope of a single requirement (3.2), there are competing drivers which might pull the solution in different directions. For example, testing on high-sulphide tailings by Verburg and Oliveira (2016) showed that unsaturated filtered tailings present a higher environmental risk than saturated tailings in terms of leachate. Minimising risk to the environment in this case (and in most cases) may not directly align with minimising the volume of water placed in the tailings facility.

It should be noted that one of the challenges with weighing the advantages and disadvantages of different options, when there are so many ways in which competing designs impact the environment, is through an integrated approach to design. Minimising the volume of tailings and water in line with Requirement 3.2 cannot be optimised if the tailings facility is designed in a silo. The mine plan, mine waste management including possible classification and creative solutions, and mine backfill are all intrinsically connected to this objective. For a mining company then to hire several consultants to work independently on tailings, mining, mineral processing, geotechnical aspects etc., is a recipe for sub-optimal tailings solutions. Does the onus fall on the tailings engineer to understand all the connected aspects of the project to optimise their design? Or is the responsibility of the project to set up means of communication to have full alignment of all the experts involved? Even if battery limits for a company includes backfill, tailings management and tailings dewatering to allow for a more robust design, the issue of how to marry the design with those designs on the other side of battery limits persists.

There may be no best means of how to drive towards an integrated tailings solution, but it is clear that the path there involves many parties and disciplines, and that communication and collaboration is a critical part of that path.

4.2 Permitting and social considerations

Permitting in the mining industry involves a complex process of evaluating the potential impacts of the project on the environment and local communities and implementing measures to minimise those impacts. Sometimes mining projects have not been successfully permitted resulting in projects being caught in permitting purgatory or having the permit being revoked completely. A few examples of projects left in permitting purgatory are Resolution Copper in Arizona and Polymet in Minnesota. These permits faced significant opposition from local communities and environmental groups due to the potential impacts on local water quality and surrounding wildlife. Sometimes after a long period of time permits end up being completely revoked, such as in the case of Rosemont Copper Mine in Montana, where the mine faced significant opposition from local communities on the concerns about the impacts to the environment, water, air and wildlife. After several delays in the permitting process the project was rejected effectively ending the project. Another example of a project having their operating permit revoked is the Twin Metals in Minnesota, USA – which, after a delayed permitting process, the minerals lease failed to be renewed effectively ending the project. However, in 2020 the US Department of the Interior reversed this decision, and the project is now revived. A high-profile example of a project that is currently impacted by social issues includes the Los Bambas copper mine in Peru. The mine is one of the largest copper mines in the world but has generated controversy due to its environmental impact and the impact on the local communities resulting in protests and blockades. Therefore, the Critical Pathways that must not be underestimated in project management scheduling are both the environmental and social drivers within the project timeline.

It is often permitting and social drivers that lead engineers and owners down the path of "pay more, feel better." It is understandable that use of pressure filters and tailings dry stack disposal, for instance, is a very simple narrative in terms of communicating the strategy to regulators and the public. We are buying the most expensive filters we can and removing the most water from the tailings possible!

Jumping straight to pressure filtration of tailings may mean the easiest/fastest permits and community buy-in, but does this align with good practices that balance all the considerations and implications around a tailings solution? In some cases, such as sites with severe water constraints, maximising water recovery may be so critical that pressure filters are the obvious solution. However, in many cases, it seems as though projects commit to dry stack disposal early in the process without economic, social, or environmental drivers to support the approach. Therefore, it certainly seems as though there is a disconnect between the tailings disposal technology that is often selected early in the study process and the strategy that makes sense from a broader perspective. It is likely a combination of perceived risk, engineering in silos without proper integration, considerations around community and permitting, and in many cases unchecked conservatism that steers a project down a path that is hard to step back from, even if pressure filtration at some point becomes obviously not the best solution for the project.

The best solution is not necessarily the most expensive one, even if it makes for the easiest narrative to obtain stakeholder buy-in. It is hard to put the cat back in the bag – meaning operators need a thoughtful solution tailored to the project that considers permitting, construction, operation, closure, and environmental risks. If multi-criteria analysis (even with the support and context provided by the Global Industry Standard) is too often leading to designs that do not best fit the project, then we as an industry need to endeavour to pull stakeholders into the process sooner rather than later, and to challenge the inputs and outputs of the analysis to ensure projects are not saddled with unnecessary cost and complexity.

4.3 Trends and observations

Some recent industry trends encountered across a number of projects from concept phase through to permitting and implementation are captured below. While by no means an exhaustive list, these examples are largely the result of the drivers described above.

4.3.1 Dry stack tailings

Increasingly there seems to be a push early in projects (as early as PEA/scoping) to lock in dry stack tailings disposal. It is sometimes unclear exactly how clients are sold on this disposal strategy, but once any sort of document mentioning dry stack has been made public, there is great reluctance to re-open any discussion on thickened tailings or paste disposal. In many of these cases, there doesn't appear to be strong drivers that would support a higher cost solution versus the alternatives (such as footprint, water management, etc.). This trend applies to existing operations as well that are looking to move from conventional tailings disposal to an alternative which allows for increased storage capacity on an existing facility and/or eliminating costly dam raises.

Even when presented with examples of successful operations, such as Kidd Creek (thickened tailings) or tailings disposal that has switched to paste disposal (Bulyanhulu, Tanzania), the notion that such systems do not work seems to be prevalent (Theriault et al. 2001). Early and engaged participation by the industry is required to ensure that options such as thickened tailings disposal, paste disposal and co-disposal with waste rock are considered and reasonably evaluated.

4.3.2 Permitting and permitted backfill materials

Cemented rockfill (CRF) is often used in mines due to low initial investment but compared to paste backfill it is inefficient and costly to operate.

Increasingly the use of rock for backfill has become necessary in projects looking to permit and implement paste backfill. This is driven largely by permitting and the associated timelines. If permitting will take too long and paste will not be available to support scaling mining up to production, then the trend of installing additional CRF capacity is an obvious solution, especially if the mine is already permitted for the use of CRF. Replacing mine waste back underground, or even leaving the waste underground with underground CRF plants seems intuitively easier to permit than tailings.

A number of projects even considered generation of a paste aggregate fill from permitted waste rock, however the crushing and grinding to reliably produce the backfill is relatively prohibitive.

4.3.3 Underground paste backfill plants

While there are several operating underground paste backfill plants globally, they are massively outnumbered by plants located on surface. The reason for this is obvious – backfill plants located at higher elevation can take better advantage of gravity and are less dependent on pumping. Also obvious is the inherently higher cost of underground plants, which are also harder to maintain than plants located on surface. Add the complication of operating the plant through shift change and/or blasting, and the drivers for surface plants are obvious. Due to these considerations, underground paste backfill plants are generally not considered in earnest if a surface plant is a viable option.

While capital and operational considerations continue to be strong drivers for surface plants, there are very clearly scenarios where underground plants may be viable despite the challenges and limitations of underground installation. The majority of these are driven by site geometry – ore bodies in mountains with long distances to enter and often stopes above the access, ore bodies which are accessed by long declines due to local geometry, and surface considerations. With the shift in project critical path to be more integrated with ESG considerations, there is an increasing opportunity for underground plants to be further driven by permitting, particularly as this approach can reduce operating risk, stages of pumping, overall project power requirements, and binder consumption (to what extent depending obviously on project specifics.)

For example, unwillingness to place infrastructure on surface where local inhabitants will see / hear the operation of the paste plant, or other issues which would prohibit permitting of the plant on surface may inherently lead to an underground backfill plant regardless of logistical challenges and cost implications that favour surface plants.

It should be noted that despite several successful underground installations that have been operating for years (Garson mine sand/silt paste backfill plant (1994), Greens Creek pressure filter cake fed paste backfill plant (2001), San Rafael paste plant w/ filters (2003), Freeport Indonesia UG paste backfill plant with filters (2007), Gwalia Mine, Australia, UG paste aggregate fill with waste rock crushing (2018), Kensington Mine UG paste backfill plant (2010)), there is quite often pushback from even experienced people in the industry that paste or even hydraulic fill cannot work underground. This pushback is important to understand and to address as the project develops. Buy-in is critical from both client stakeholders and regulators, but the mindset that cemented rockfill or cemented aggregate fill plants are fine underground, but paste is not, is fundamentally flawed. CRF plants can greatly exceed the size of paste plants, particularly in scenarios where no filters are required within the underground paste plant. Concerns of geotechnical stability and maintenance apply equally, while concerns around ventilation actually favour paste by an order of magnitude, as the equipment required for the transport and placement of CRF carry increased ventilation requirements, while paste is limited to whatever mobile equipment is used for installation of the distribution system and barricade construction, which will relate to a greatly reduced ventilation requirement versus CRF.

Mine dewatering and binder delivery/logistics with paste are also inherently better with paste than CRF or hydraulic fill, yet perceptions exist for some that these considerations should deter from underground paste backfill plants. The takeaway being that, due to a lack of experience within the industry for underground plants, in those scenarios where an underground paste plant is the preferred solution for the project, it is critically important to understand the challenges of designing, constructing, maintaining, and operating such a system. These considerations, along with how the design de-risks these aspects of backfill, must be communicated clearly, along with addressing concerns (regardless of whether concerns are valid or perceived) of key stakeholders to drive towards the best backfill design for the project.

4.4 Communication and testing

In all cases, a solution is only as good as the narrative that is used to describe it to stakeholders. This is not just a matter of a viable technical solution with sound engineering supporting it. Rather, the evaluation of alternatives, demonstrating and understanding of the project risks and measures to minimise those risks to the extent possible, and limiting environmental impacts both during operation and following closure are key for stakeholder engagement and buy-in.

As the design progresses prior to the submission of a permitting application, mining companies will often engage with regulators and community groups to minimise the risk of any major issues/revisions in the design. The need for these discussions throughout the development of the design will depend on the local requirements for the site, but in some areas these conversations and gauging opinions and likely responses from these stakeholders must be done carefully and tactfully.

Additionally, a great way to support a solution in terms of this narrative is with testing. Concepts and flow sheets and calculations are core to the engineering process, but testing of notions to prove a solution can be a compelling and hard to refute means of supporting a design that is being submitted for permitting. Khalili et al. (2010) are a great example of how methodical testing of a notion (co-disposal of waste rock and tailings) can be used to support the concept for industry adoption.

Even more convincing is previous successful implementation of a technology in the industry. For example, thickened tailings disposal at Kidd Creek in Timmins, Ontario. However, claims from clients or even tailings engineers that thickened tailings do not work can be heard today, or perhaps it works there but won’t work for us. Testing on these proven systems to understand them further can help address concerns of applicability for other operations and can hopefully lead to thickened and paste tailings disposal for sites where these strategies are preferable to filtered tailings (Barbour et al. 1993).

5 Conclusion

The impacts of permitting timelines and ESG considerations on project budgets and schedules has not been traditionally considered in project execution. New legislation, increasing scrutiny, and corporate ESG principles and considerations have shifted the paradigm in managing large-scale projects. Traditional critical path drivers, such as procurement and construction have seen significant improvement, while permitting and ESG aspects boast larger roles in the scheduling and budgeting estimation process. Moving forward, mining project managers need to consider environmental permitting as a potential critical path. This paradigm shift has manifested itself in the implementation of paste backfill solutions through the Global Industry Standard and is observed in several projects through stalled timelines or litigation. Addressing this shift technically and through project management techniques throughout the design and construction process is critical to project success.

The best solution is not necessarily the most expensive one, even if it makes for the easiest narrative to obtain stakeholder buy-in. Operators need a thoughtful integrated solution tailored to the project that considers permitting, construction, operation, closure, and environmental risks. Benchmarking of existing operational successes in addition to project specific testing can further support the proposed solution.

Acknowledgement

The authors of the paper would like to acknowledge Frank Palkovits and Rudy Tenbergen for their many years of advancing the fields of paste and paste backfill. Both not only find the time to explain, challenge and mentor young colleagues and clients alike but do so with passion and enthusiasm.

References

Bahera, SK, Mishra, DP, Singh, P, Mishra, K, Mandal, SK, Ghosh, CN, … & Mandal, PK 2021, 'Utilization of mill tailings, fly ash and slag as mine paste backfill material: Review and future perspective', *Construction and Building Materials,* vol. 309.

Barbour, SL, Wilson, GW & St-Arnaud, LC 1993, 'Evaluation of the saturated-unsaturated groundwater conditions of a thickened tailings deposit', *Canadian Geotechnical Journal,* vol. 30, no. 6, pp. 905–919.

CEQ 2020, *EIS Timelines*, National Environmental Policy Act, viewed 27 December 2022, https://ceq.doe.gov/nepa-practice/eis-timelines.html

Cescon, Barrieu, Flesch & Barreto Advofados 2021, *Brazil: 2021 Mining Guide- Brazilian Law Overview, Trends, Perspectives and Opportunities*, https://www.cesconbarrieu.com.br/Documents/Brazil%202021%20Mining%20Guide(2).pdf

Dieh, P 2022, *List of Tailings Dam and Mine Waste Failures*, https://www.wise-uranium.org/mdaf.html

GAO 2020, *Mining on Federal Lands: More Than 800 Operations Authorized to Mine and Total Mineral Production Is Unknown*, viewed 2 January 2023, https://www.gao.gov/assets/gao-20-461r.pdf

Hickson, RJ & Owen, TL 2015*, Project Management for Mining: Handbook for Delivering Project Success*, Society for Mining Metallurgy and Exploration, Engelwood.

Kelley Jr, JE & Walker, WR 1959*, '*Critical-path planning and scheduling*'*, *Proceedings of the Eastern Joint Computer Conference*, pp. 160–173.

Khalil, A, Wijewickreme, D & Wilson GW 2010, 'Mechanical response of highly gap-graded mixtures of waste rock and tailings. Part 1: Monotonic shear response', *Canadian Geotechnical Journal*, vol. 47, no. 5. pp. 497–515.

Milanzi, M & Bond-Barnard, T 2017, 'Exploring the effects of centralized procurement on projects in South African Matrix Mining Organizations', *PMI Australia Conference,* Sydney, https://doi.org/10.5130/pmrp.pmiac2017.5835

Oberle, B 2002, *Global Industry Standard on Tailings Management*, Global Tailings Review, https://globaltailingsreview.org/global-industry-standard

Reid, C, Becaert, V, Audertin, M, Rosenbaum, RK, & Deschenes, L 2009, Life cycle assessment of mine tailings management in Canada. *Journal of Cleaner Production,* vol. 17, no. 4, pp 471-479.

SNL Metals & Mining 2015, *Permitting, Economic Value, and Mining in the United States*, prepared for The National Mining Association, https://nma.org/wp-content/uploads/2016/09/SNL_Permitting_Delay_Report-Online.pdf

Theriault, JA, Frostiak, J & Welch, D 2001, 'Surface Disposal of Paste Tailings at the Bulyanhulu Gold Mine, Tanzania', *Revista Escola de Minas*, vol. 81, no. 1, pp. 1–8.

Tenbergen, RA 2000, 'Paste dewatering techniques and past plant circuit designs', *Tailings and Mine Waste 2000*, pp 1-10.

Verburg, R & Oliveira, M 2016, 'Surface waste disposal of high-sulfide tailings at neves-corvo-evaluation of environmental stability and operational experience', *Proceedings of the International Mine Water Association Conference,* IMWA, Leipzig, pp. 361–367.