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Innovative Approaches to Building Technical Capability for a Modern Mining and Metals Organisation

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ABSTRACT

Rio Tinto has a large globally distributed technical workforce and needs to ensure these employees have the requisite skills to not only manage technical risk and enable safe efficient production, but also ensure they are keeping pace with a fast-changing technological landscape. Traditional approaches to learning struggle for scale and an inability to respond to the extreme diversity of capability development needs. In response, Rio Tinto has successfully introduced innovative approaches to learning and employee engagement via leveraging the power of globally distributed networks for peer-to-peer knowledge transfer and providing mechanisms to recognise, reward and retain the individual technical contributors.

INTRODUCTION

Like other mining and metals organisations, Rio Tinto is dependent on high quality technical expertise to find, study, build, operate and close the mines and processing facilities that provide the metals and minerals that underpin our modern society. Arguably, the calibre of the technical workforce together with the quality of the mineral resources represent the core sources of competitive advantage for any minerals company. As one of the largest minerals producers in the world, Rio Tinto employs a large global technical workforce, currently around 10,000 professionals, which comprises many engineers and scientists and makes up approximately 20% of the total Rio Tinto workforce.

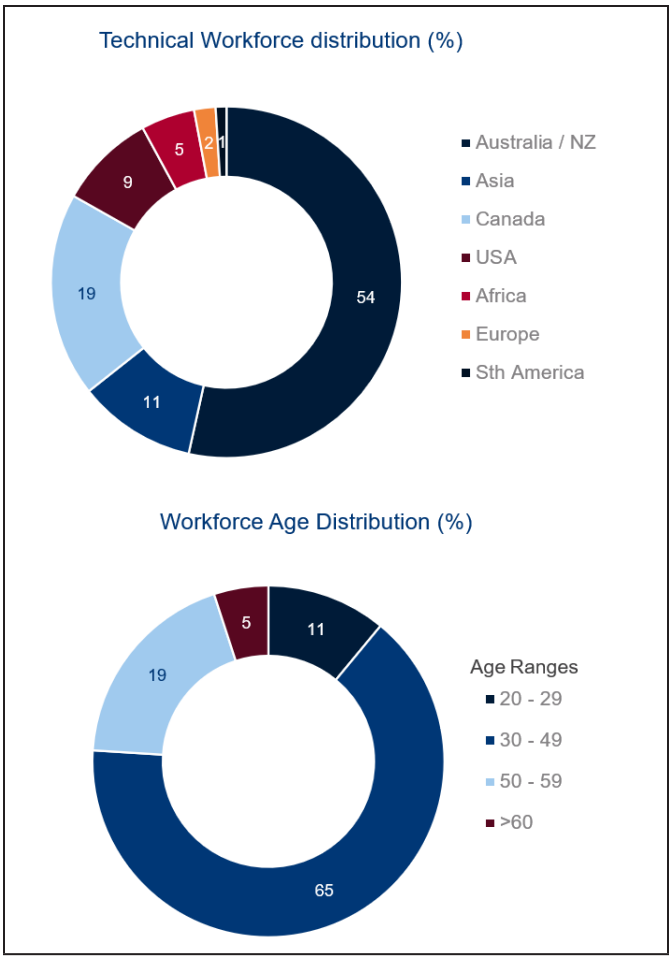
The following table and figures present some of the basic demographics of the technical professional workforce.

In addition to the traditional mining and metals professions of geologist, mining engineer and metallurgist, Rio Tinto today employs a vast array of scientific and

Table 1. Distribution of technical professionals by category

Category	% of Total Technical Workforce	Selected Professional Backgrounds
Asset Management	37	Assorted engineers especially Mechanical
Geoscience	6	Geologists, Hydrogeologists
Processing	19	Metallurgists, Chemical Engineers, Process Engineers
Mining (Surface & underground)	18	Mining, Software, Geotechnical, Civil, Environmental, Tailings engineers, Surveyors
Integrated Operations	9	Assorted engineers and data scientists
Capital, Closure and R&D Projects	11	Assorted engineers, scientists and researchers

Source: Rio Tinto



Source: Rio Tinto

Figure 1 & 2. Geographic and age distribution of Rio Tinto technical workforce

engineering professionals. In the past decade there has been a substantial increase in the 'digital' professionals including software engineers, data engineers and data scientists. Similarly, there has been a sizeable increase in the number of environmental and social scientists in response to increasing mine closure, community and other ESG obligations.

More than 80% of the technical workforce is in Australia and North America, but Rio Tinto also has a substantial and growing footprint in Africa and Asia, with large development projects in Guinea and Mongolia (Figure 1). The age demographics in Figure 2 are included to highlight the fact that approximately one quarter of the workforce will be at or approaching retirement age in the next decade.

DRIVERS TO INVEST IN TECHNICAL CAPABILITY DEVELOPMENT

Learning underpins the Rio Tinto purpose of "finding better ways to provide the materials the world needs," and connects strongly with the company values of care, courage and curiosity (Figure 3). The company objectives of best operator, impeccable ESG and excel in development all require a substantial focus on capability development to be successfully delivered.

The drivers to invest in technical capability development span a broad range of business outcomes from ensuring that the organisation remains legally compliant, to safe operating practices, through to innovating and redesigning business processes and technologies to transform operational and safety performance.

The learning needs associated with the different business outcomes cover a broad range from very prescriptive (eg employees need to understand their specific obligations to be compliant with antitrust regulations) to highly complex and difficult to define (eg we need the skills to design a zero waste, decarbonised and fully automated mine). In Figure 4 these business outcomes are shown in order of increasing complexity from left to right. While training on the left side leans toward executing tasks, the right shifts more toward being able to solve increasingly complex problems in an ever changing environment. Technical knowledge alone won't solve for this, and programs aim to enhance or amplify technical capability by building skills in creative thought, future vision and collaborative intelligence through community.

The accompanying learning delivery methods range from traditional classroom or discrete e-learning modules to a more agile, creative and adaptive approach. Agility is the ability to solve all kinds of challenges as they present, which isn't something typically associated with task-based training. This paper is focused primarily on the right-hand side of Figure 4.

In addition to the business outcomes described above, an investment in learning and capability development is widely recognised as a driver of improved employee engagement and retention.

MEETING THE LEARNING NEEDS OF THE RIO TINTO TECHNICAL WORKFORCE

There are several inherent challenges when defining an approach to satisfy the learning requirements of the global Rio Tinto technical workforce, starting with the diversity of learning needs given the breadth of technical disciplines represented and wide ranges of experience. An early career professional, fresh from university will have a very different learning needs profile to a 30-year industry veteran, possibly with multiple postgraduate qualifications.

Source: Rio Tinto

Figure 3. The Rio Tinto Purpose, Values and Objectives

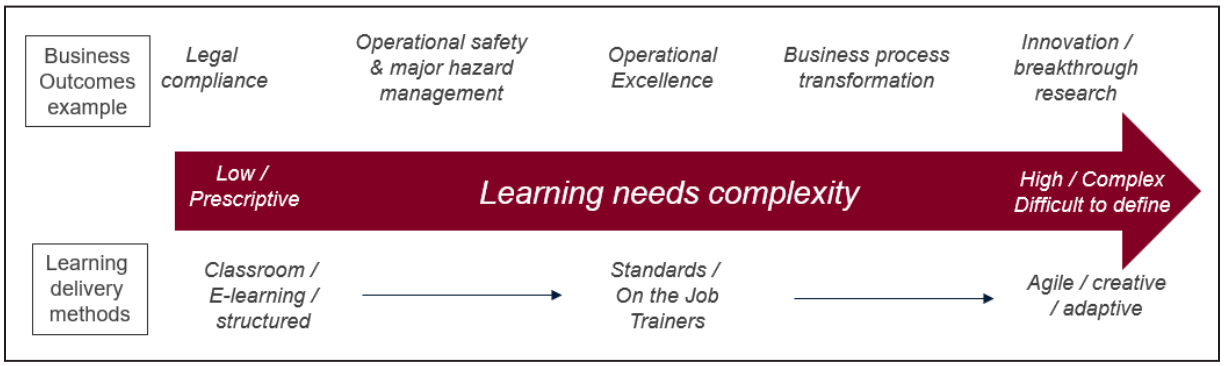


Figure 4. Learning needs complexity and associated learning delivery method

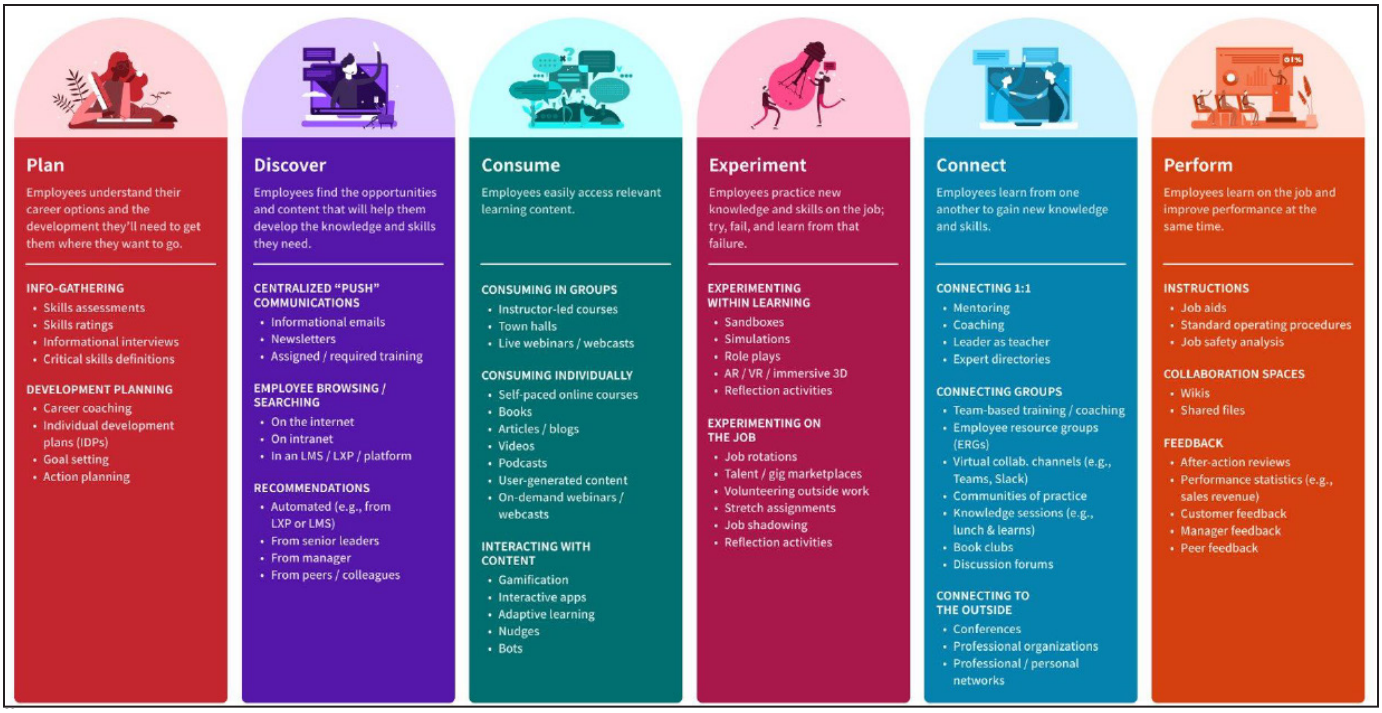
This is further complicated by:

- Geographic and language diversity and an audience distributed across numerous time zones making it harder to deploy learning solutions contemporaneously at scale.
- Accelerated rate of operational technology change meaning rapid obsolescence for learning content.
- Ongoing production demands competing for time allocated to learning therefore requiring flexibility around when, how and where employees learn.

Working with the constraints described above, it is important that we adopt an expansive definition for what constitutes learning, that leverages the inherent strengths of a global organisation with access to extensive knowledge and experience across the workforce. Recent research by consultancy Red Thread offers a picture of the diversity of learning opportunities available to organisations and their employees today (Figure 5).

Versions of many of the learning mechanisms described in Figure 5 are in application across Rio Tinto today. However, this paper focuses specifically on three programs that respond to the inherent learning challenges and leverage organisational strengths. The design of these programs needed to be:

- Adaptive to a vast diversity of learning needs
- Available to a global audience with different cultural and language needs
- Accessible across different work environments and able to fit within assorted demanding work schedules
- Able to draw upon the vast expertise contained within the large global workforce of technical professionals.



Source Red Thread Research 2021

Figure 5. Diversity of mechanisms that organisations apply to support learning in the workplace

INNOVATIVE APPROACHES TO BUILDING TECHNICAL CAPABILITY

In addition to responding to the inherent learning challenges, the following three initiatives – technical communities of practice, agile Technical Network and RioExcel™/ RioExperts™ – are designed to be mutually reinforcing, and to build and protect unique sources of technical capability that provide competitive advantage for Rio Tinto.

1. The Networked Technical organisation – Technical Communities of Practice

Rio Tinto is organised primarily around four product groups (Iron Ore, Aluminium, Copper and Minerals) and employees typically identify strongly with their product group and receive management direction 'through the line'. While this approach offers many benefits, it risks forming product group siloes, and therefore doesn't capture the potential value available from employees performing similar roles in different product groups collaborating and sharing knowledge.

Rio Tinto has established several technical Communities of Practice, each with differing levels of maturity, across numerous technical domains including geoscience, surface mining, processing, geotechnical engineering, tailings

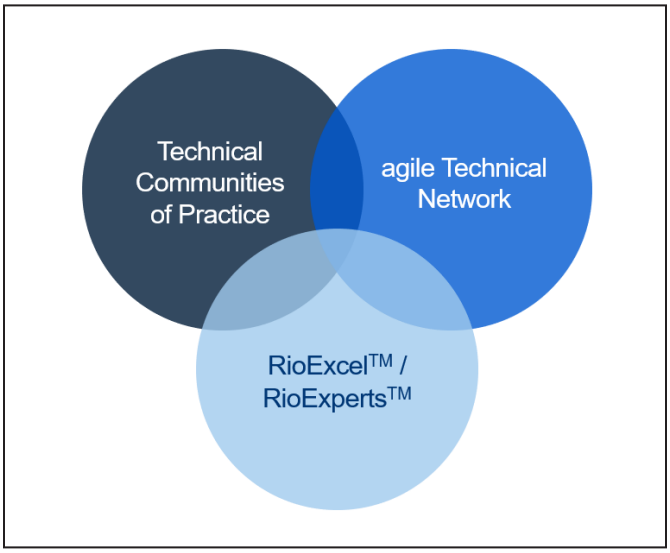


Figure 6. Three mutually reinforcing initiatives for building and protecting technical capability

management, asset management and several others. These forums have become powerful platforms for:

- Knowledge transfer and leading practice replication
- Facilitating employee learning through an annual program of internal webinars, conferences and

knowledge exchange via internal social media platforms
- Navigating career pathways, talent management for succession planning and identifying mentors for those seeking development
- Driving consistent global technical standards

While the concept of technical communities of practice is not new, the level of maturity, vibrancy and organisational impact achieved has been significant. The more mature communities have become self-sustaining and are maintained by groups of 'volunteer' employees passionate about the benefits of thriving technical communities. Participation in these communities has become a source of pride and employee engagement and is a unique part of the Rio Tinto employee value proposition.

Although communities of practice are mostly low cost to maintain, they require a persistent investment of time, effort and leader sponsorship. One of the challenges in preserving leader support is being able to articulate the business value, which is mostly intangible.

2. The Agile Technical Network

Across the large population of engineers and scientists employed by Rio Tinto there is an enormous depth of experience, and very likely the expertise to solve almost any technical challenge. However, the ability to find that expertise when it is needed and release it to solve the challenge, has historically been limited to an employee's personal network and organisational reach. Confronted with the difficulty of finding the right expertise, many employees would seek an external solution with accompanying additional costs.

Adult education design principles emphasise the most powerful form of learning is experience based, giving employees the opportunity to be stretched and solving new challenges. However, the lack of visibility about these development projects, and the difficulty in connecting with willing learners at the right moment, has meant these opportunities were hard to find.

In response, Rio Tinto has established the agile Technical Network (aTN), an internal platform that allows employees to share their skills profile (current and for development) and allows employees to post short-term ad-hoc projects that call for expertise applying a consistent skills taxonomy. The aTN is effectively an internal version of the 'gig' economy that applies matching algorithms to connect the supply of expertise with demand. This enables Rio Tinto to improve the level of collaboration, solve more challenges with the existing workforce, and provide greater visibility around internal personal development opportunities (Figure 7).

Employees have embraced the concept and are attracted by the visibility around development opportunities and interesting work outside their substantive role responsibilities. Since launching in 2021 there have been more than 1400 employee skill profiles posted and 132 short term projects submitted with 327 employees offering to support. Notwithstanding the obvious benefits, substantial change management and communication effort has been required

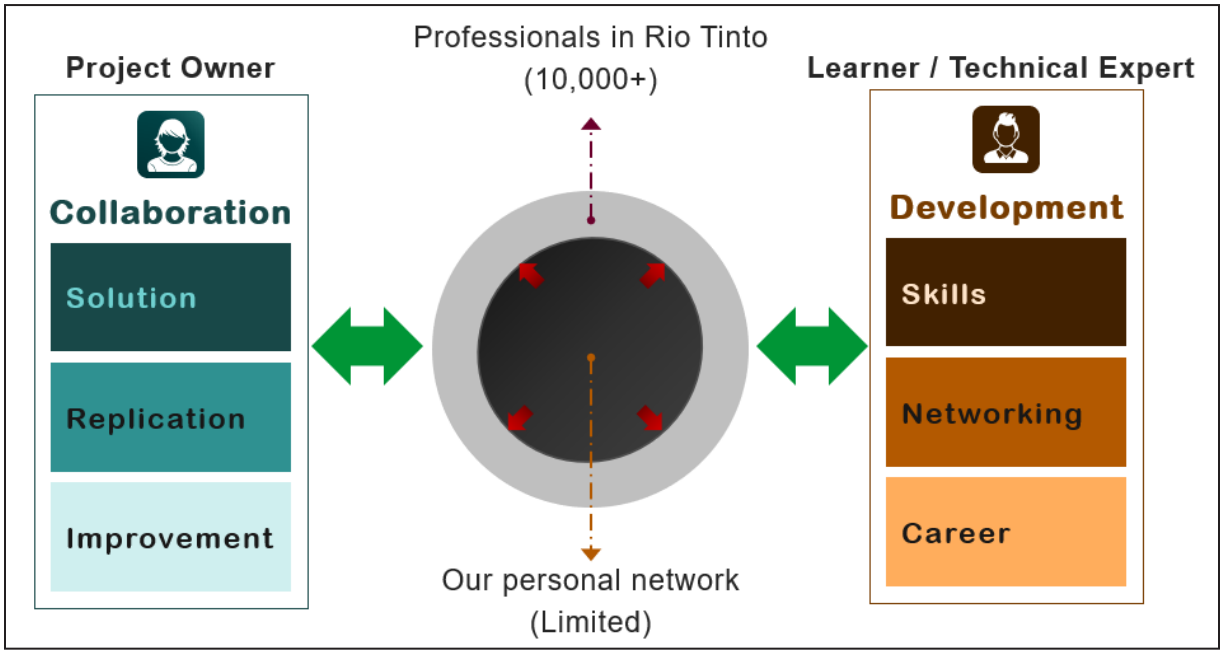


Figure 7. Concept of the agile Technical Network (aTN)

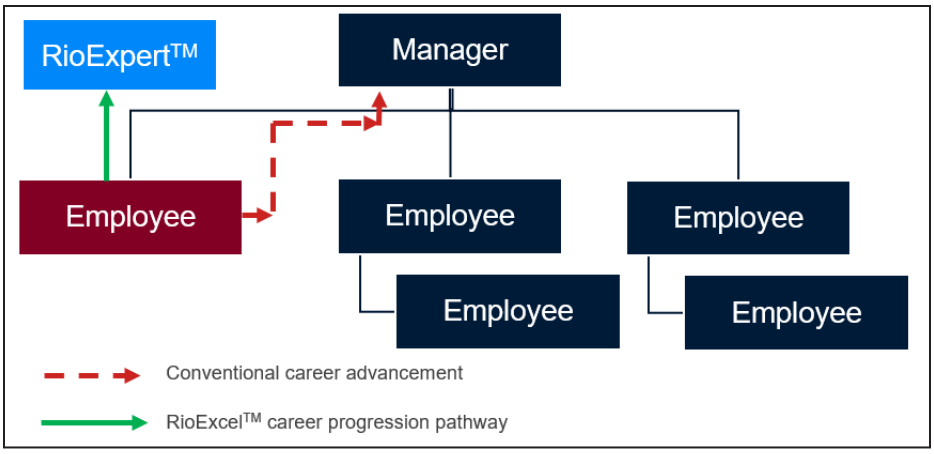


Figure 8 The RioExcel pathway for recognition and career progression

to reassure the business that employees will not neglect their substantive duties in favour of more 'interesting' work accessed via the aTN.

3. RioExcel™

Like most organisations with a large population of technical experts, Rio Tinto has a subset of the technical workforce that seeks career progression but is not motivated to become a 'people' leader, instead preferring to focus on technical work. The RioExcel™ program provides a structured mechanism to assess and provide recognition and career advancement for deep technical experts while remaining an individual contributor. Candidates for this recognition need to demonstrate not only the quality of their work and contribution to business outcomes, but to demonstrate their effectiveness at sharing their technical expertise through the communities of practice or as a mentor to the next generation of experts.

Individuals that have been successfully recognised via RioExcel™ are referred to as RioExperts™, and these individuals are considered the custodians of the culture of technical excellence at Rio Tinto. There are currently ~150 RioExperts distributed globally and representing the full spectrum of technical activity and a significant human capital asset for Rio Tinto. RioExperts™ are expected to become a source of internal expertise that can be accessed via an internal expertise directory, helping to ensure that Rio Tinto is fully leveraging these unique skills for maximum advantage.

Additionally, the RioExcel program has provided improved attraction and retention of technical experts with attrition rates typically less than half the rate of the broader technical population.

CONCLUSIONS

While traditional forms of learning and development such as classroom and e-learning will continue to play a role, increasingly modern mining and metals organisations need to consider learning methods that are agile, scalable and adaptive to a fast changing social, technological and regulatory landscape. In response, Rio Tinto has invested heavily in creating a networked technical organisation both through the establishment of vibrant technical communities of practice and the creation of an internal expertise marketplace through the agile Technical Network. The strength of the networked technical organisation has been enhanced by linking the RioExcel™ technical expert program as an incentive for candidates to provide leadership for the technical communities.

In addition to being relatively cost effective, this approach offers the benefit of being:

- Adaptive to a vast diversity of learning needs – something for everyone
- Available to a global audience with different cultural and language needs
- Accessible across different work environments and accommodates assorted demanding work schedules
- Able to draw upon the vast expertise contained with the large global workforce of technical professionals.

Measuring return on learning investment is tricky; the ultimate measure is the quality of technical advice informing better decision making and business outcomes. Rio Tinto undertakes employee engagement surveys every 6 months and collects data across a number of parameters including personal growth, which has steadily improved by approximately 15% in the past 5 years. This improvement is at least in part attributable to the three initiatives described in this paper.

Future plans for maturing the technical learning ecosystem at Rio Tinto include strengthening the linkages to technical knowledge management systems, using technology to curate customised learning pathways for employees and the establishment of a broad-based capability maturity index as a measure of technical capability trends over time.

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Investing in Sustainable Tailings Management: Reduce Risk by Considering Environmental and Utility Costs During Pre-Feasibility

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ABSTRACT

The use of conventional tailings deposition methods has been the standard for decades. With the need to reduce the impact of mining, alternative methods are considered when expanding or upgrading tailings handling systems. Converting an existing tailings management system to a more sustainable deposition method during the operation of a mine may incur considerable operational and financial risk, and when assessed more traditionally, does not provide significant advantages. As a result, most mines choose to continue their current technology and add an additional pumping stage or pumpstation to their tailings line in case of a pipeline extension or Tailings Storage Facility (TSF) expansion. This also often involves raising embankments.

Changing pumping technology is traditionally assessed by comparing the energy efficiency of current and prospective pumping technology. Despite a reduction in absorbed power, this traditional assessment does not include possible savings in water and the carbon footprint. With the consideration of all these three aspects, alternative pump technologies, such as Positive Displacement (PD) technology, become more economically feasible, providing increased sustainability and enable a site to future-proof their operations.

Project feasibility may be affected by the high capital investment required for PD pumps. The benefit of applying PD pumping technology could be enhanced by reducing the volumetric throughput of the pipeline by dewatering the tailings to 65% solids concentration by weight. It was found that despite increasing capital expenditure, the improved reclamation of water will have a positive effect on the direct and indirect cost of fresh water intake to mine operations.

This paper seeks to illustrate that in many applications the long-term benefits of investing in sustainable tailings management are optimized when more efficient PD pumping technology is combined with tailings dewatering when upgrading or expanding the tailings handling system.

INTRODUCTION

The Iron Range in the United States (US) has a long tradition of iron ore mining. Many of the mines in the area have been operational for decades and have significant Life Of Mine (LOM) remaining.

Increasing pressure to reduce emissions, as well as the demand to improve environmental and social stewardship, makes mining companies look at alternative technologies for ore processing and tailings management. Significant investments in the development and implementation of sustainable technology are required to secure profitability of current and future operations. Investing in sustainable