THESIS

CHARACTERIZING TAILINGS PROFESSIONAL LABOR DEMAND

Submitted by

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ABSTRACT

CHARACTERIZING TAILINGS PROFESSIONAL LABOR DEMAND

A low-carbon future necessitates increased extraction of critical minerals via mining. The act of mining includes not only extraction of commodities, but also management of tremendous volumes of waste. Despite the need for mining to support green technologies, mining is experiencing a credibility crisis due to historic legacies of environmental damage and recent catastrophic failures of tailings (mine waste) facilities. To regain social trust and environmental credibility, the mining industry must do better at managing tailings. The recently issued Global Industry Standard on Tailings Management (GISTM) places significant demand on tailings professionals worldwide. Given these pressures, this study addresses the question: is the current tailings professional labor pool sufficient to provide the specialized labor needed to meet new guidance designed to make tailings facilities safer, and if not, how can this shortage be rectified?

To address this question, a coupled qualitative-quantitative approach was undertaken. Research was conducted to characterize the current (Spring 2021) industry practitioner perspectives on the state of tailings labor resources. Then, future tailings labor demand under the GISTM was calculated quantitatively by estimating professional labor demand based on guidelines presented in the GSITM and applied to the estimated number of tailings facilities worldwide. Finally, opportunities to address current and future tailings labor demand were identified through tailing practitioner perspectives.

According to current practitioners, there is shortage of qualified tailings professionals, related to increased labor needs, difficulties of recruitment into and retention within the industry, as well as senior-level professionals retiring. Managing the minimum estimated 16,000 tailings facilities worldwide was estimated to require as many as 17,800 full-time equivalent, qualified and trained personnel. Finally, current actions to train future tailings professionals are provided, as well as recommendations for actions via collaboration

between academia, industry, consultants, regulators, and non-governmental organizations (NGOs) to fortify tailings recruitment activities, training programs, and educational opportunities.

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1.0 INTRODUCTION

Tailings facility failures continue to occur around the world, which create profound impacts on human life, the environment, the mining industry, and public perception. Recent tailings dam failures at Mount Polley (Morgenstern et al. 2015), Fundão (Morgenstern et al. 2016), and Feijão (Robertson et al. 2019) have resulted in the promulgation of new tailings management guidance, including recent and forthcoming updates to management and regulatory requirements of tailings dams by the Canadian Dam Association, Mining Association of Canada, Australian National Committee on Large Dams, and the International Council on Mining and Metals (ICMM). The Global Tailings Review (GTR) convened in March 2019 create the Global Industry Standard on Tailings Management (GISTM; GTR 2020) for tailings facility design, construction, management, and closure throughout the lifetime of a tailings facility. The GISTM was finalized in August 2020. These efforts have been welcomed throughout the mining industry.

There are a large and increasing number of tailings facilities globally. Commonly cited estimates on the number of tailings facilities worldwide vary substantially, ranging from 3,500 (Davies et al. 2000), to 18,400 (Herza et al. 2019), to 35,000 (World Mine Tailings Failures 2020). Previous research described by Hatton et al. (2020)[1] and Spencer et al. (2021)[1] was used for the estimate of the total number of tailings facilities worldwide to aid in calculating current and future tailings labor demand. Spencer et al. (2021) suggest the existence of between 12,880 to 14,820 active and inactive tailings facilities within the following countries: Australia, Brazil, Bulgaria, Canada, Chile, China, Peru, United States, South Africa, and Zimbabwe. Outside of the countries listed above, the Spencer et al. (2021) estimate included an additional 550 tailings facilities scattered in other countries, that were initially disclosed and categorized with the March 2021 release of the Global Tailings Portal Database Version 4.0 (GTD 2021). Spencer et al. (2021) concluded that there are at least 13,430 to 15,370 active and inactive tailings facilities within the countries

[1] Two conference papers written by the author and detailing the previous research assessing tailings labor demand were published in the 2020 Tailings and Mine Waste Conference and 2021 Mine Waste and Tailings Conference. The Hatton et al. (2020) paper is included in **Appendix A** and the Spencer et al. (2021) paper is included in **Appendix B**.

shown in **Figure 1-1**. Given the large number of countries with partial disclosure of information to the Global Tailings Portal and countries lacking any information on tailings facility quantities, the minimum estimated quantity of tailings facilities worldwide was assumed to be 16,000 by Spencer et al. (2021).

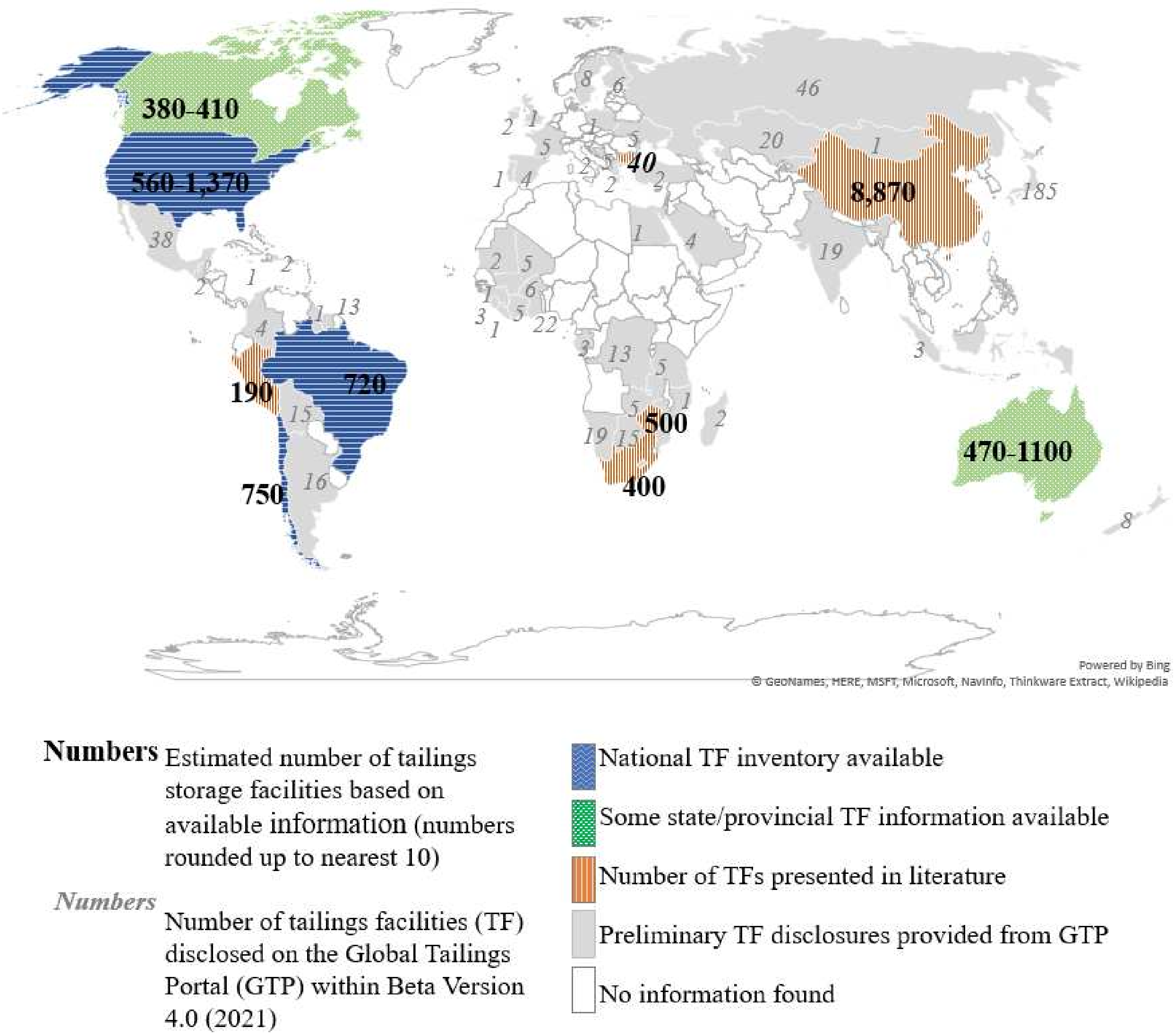

Figure 1-1. Numbers of tailings facilities around the world.

Thus, given new guidance to improve the environmental stewardship of tailings, and the large number of tailings facilities globally, an important question can be raised:

Is the current tailings professional labor pool sufficient to provide the specialized labor needed to meet new guidance designed to make tailings facilities safer, and what opportunities exist to improve the state of recruitment, education, and training of tailings professionals to provide future labor need?

The GISTM is an ICMM member company commitment that stipulates additional requirements for oversight and management of all existing tailings facilities, in addition to new guidelines for tailings facility design, construction, and closure. For many mines, the GISTM significantly increases the oversight personnel required to manage existing and future facilities. Thus, our hypothesis is that additional qualified and trained tailings professionals are needed now, more than ever. Academic departments such as geological, and mining engineering, that traditionally fed the pipeline for tailings professions, are shrinking at many universities (Saucier 2020, Sichinava and Goetsch 2019). In addition, a negative public perception of mining with continued challenges to the credibility of mining to operate in an environmentally friendly manner are yielding a declining interest in careers in mining. Consequently, the pipeline that the industry has relied upon for qualified professionals is shrinking. This supply shortage is occurring amidst the ongoing and imminent retirements of many of the world's leading experts in tailings management as they age out of the workforce.

To address the aforementioned question, two research objectives were defined. The first research objective was to characterize if there is an existing or perceived labor shortage among tailings professionals, and if so, quantify the need. The existing tailings professional labor situation was qualitatively assessed by soliciting perspectives from industry professionals. To assess future tailings labor demand, the required number of tailings professionals was quantified by estimating a range of expected labor need for a tailings facility based on requirements under the GISTM. Then, that range of expected labor was applied to the total estimated quantity of tailings facilities worldwide. The second objective of this research was to identify opportunities to address the current and future tailings labor demand.

My research aims to raise awareness of the current demand for tailings labor resources and the need for collaboration within academia and industry training to recruit and retain future tailings professionals. With promulgated guidance of the GISTM and the ICMM guidelines for standard of care, the industry must rapidly evolve to bring more professionals into the industry. The logical approach to address this is to educate and train tailings professionals to enhance the current labor supply, while promoting tailings as an interesting and successful career path to reduce labor shortages in the future.

2.0 METHODS

Research methods implemented in this project are outlined in **Figure 2-1**. To characterize tailings labor demand and identify opportunities to marry labor supply to labor demand, a two-prong approach was used to qualitatively and quantitatively assess tailings labor demand. Tailings labor demand was qualified using tailings practitioner feedback via an online survey and then current labor demand was quantified under consideration of the requirements stipulated in the GISTM.

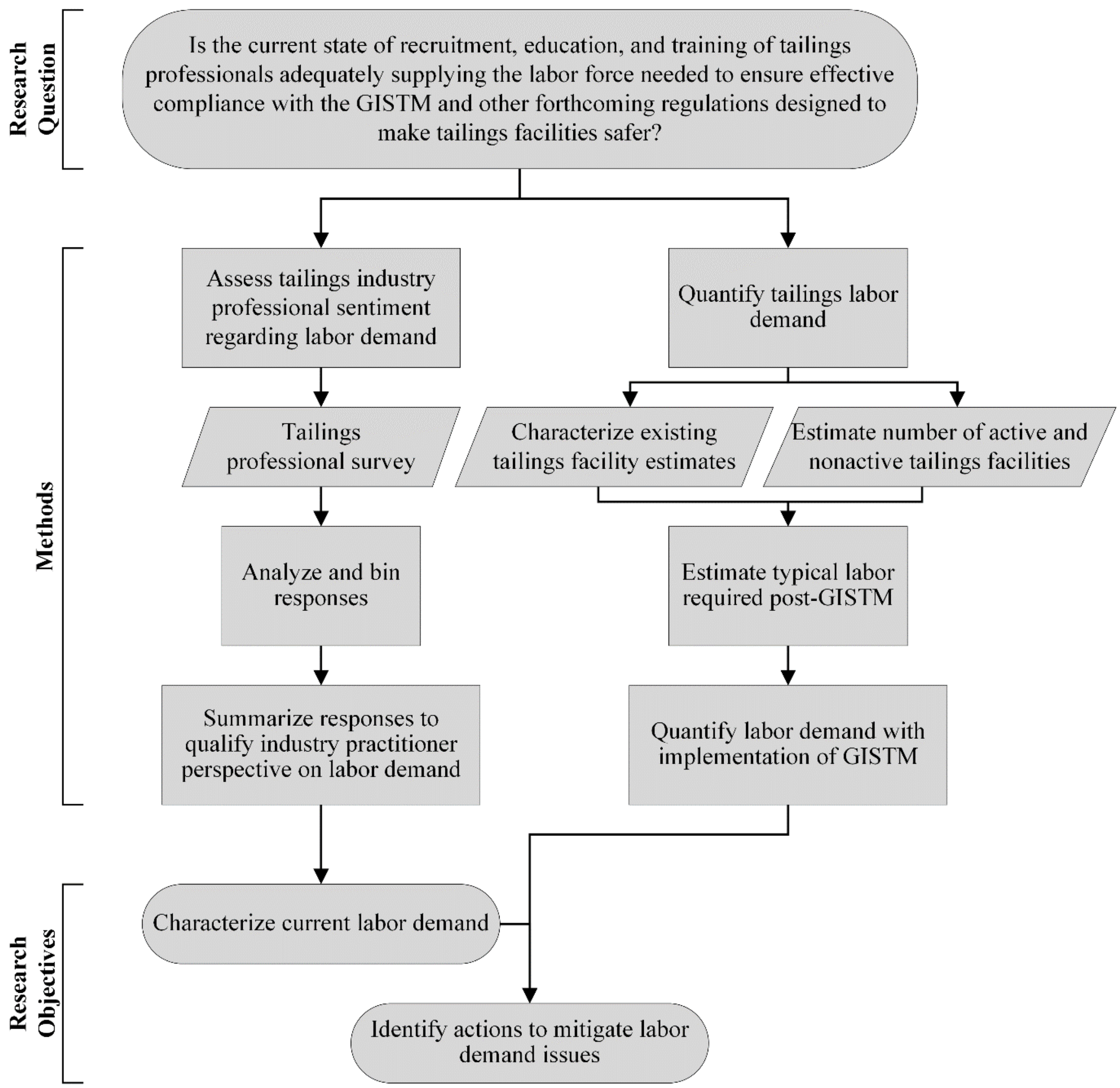

Figure 2-1. Flowchart of the research methods implemented in this project.

2.1 Tailings Professional Perspectives

The first technique used to characterize the current labor demand was to qualitatively assess the perspective of existing tailings industry professionals on challenges and opportunities within the tailings and mine waste industry. Industry perspectives also were used to identify opportunities to address future labor demand.

An online survey was developed to assess the perceived tailings professional resource labor shortage, as well as to identify opportunities to promote tailings education and professional training. The survey also included questions on background, tailings career, short-answer perspective, and logistics. The full survey questionnaire is included in **Appendix C1**.

Numerous survey questions were open-ended and allowed respondents to write their perspective. Text from these questions was assessed via "bins", which were developed for specific questions and subsequently individual responses were sorted into one or more categorical bins. Bins for a given question were developed after initially reviewing responses and then identifying bins that represented the range of responses. After initial bins were created for each question, response "binning" was reviewed independently by three researchers with tailings expertise to minimize bias and provide consistency in the binning interpretation for each response.

2.2 Tailings Labor Demand

To further characterize the current and future labor demand, the labor required to implement the GISTM was quantified. The GISTM outlines requirements for a tailings facility to adhere to good governance and good engineering practice through the lifecycle of a facility, which includes everything from the feasibility, design, and construction phases to life-of-facility management and closure. Personnel duties required for a tailings facility under the GISTM were quantified and then applied to the global estimate of tailings facilities. The ICMM members' commitment is to ensure that all tailings facilities that have 'extreme' or 'very high' potential consequences conform to the GISTM within 2 years (2023) from the standard issuance date of 5 August 2021. All other tailings facilities operated by ICMM members that are not adequately closed are committed to complying with the GISTM guidelines within 4 years (5 August 2025).

2.2.1 Characterizing Tailings Facilities Worldwide

The estimated total number of tailings facilities worldwide was further characterized to assist in quantifying the tailings labor demand. The estimate of 16,000 tailings facilities from Spencer et al. (2021; **Appendix B**) was refined by categorizing the available tailings facility inventories by crest height, hazard classification, and status (active or not active). Tailings facility characterization was developed to proportionally estimate labor resource needs with an inherent understanding that the level of effort required to service a smaller, lower production tailings facility (for example) is less compared to a larger, high-tonnage facility. A similar proportional distribution of labor resource time was applied when tailings facilities are viewed in terms of hazard classification or status, with high-hazard tailings facilities, for example, requiring more labor to effectively design, manage, and close relative to low-hazard facilities. As part of our previous research (Hatton et al. 2020; **Appendix A**), acquired tailings facility inventories were screened for available information pertaining to crest height and consequence, hazard, or risk rating, and subsequently divided into classification types (Type A, Type B, and Type C). The range of percentages for each type was then applied to the total number of tailings facilities to estimate the number of each facility type worldwide.

In recognition that every tailings facility is unique, (i) dam height and (ii) consequence, hazard, or risk rating categories were used to assign three tailings facility classifications: Type A, Type B, and Type C. Tailings facilities were grouped into the following three classification types based on crest height (thresholds arbitrarily selected):

- Type A – small structures with crest height <40 ft (12m);
- Type B – intermediate structures with crest height >40 ft (12 m) but <100 ft (30 m); and
- Type C – large structures with crest height >100 ft (30 m).

A separate assessment was conducted whereby tailings facilities were categorized into the following classification types based on hazard potential (United States) or potential associated damage rating (Brazil):

- Type A – low hazard potential or low potential associated damage;
- Type B – significant hazard potential or medium potential associated damage; and
- Type C – high hazard potential or high potential associated damage.

At present, there is no global classification system for ranking hazard, risk, or consequence ratings. For example, within the Global Tailings Portal disclosures, there were over 100 hazard classification systems used to assign hazard classifications (GTD 2021). The GISTM presents a standardized "potential consequence" matrix to classify tailings facilities into consequence categories. The hazard classifications presented herein (for Type A, B, and C facilities) do not correspond directly to a consequence category within the GISTM and we do not have enough information to categorize them according to the GISTM matrix. Our type classifications by hazard were not meant to represent an established consequence classification, but only to serve as a constructive grouping for comparison and to support labor demand calculations.

The total estimated number of global tailings facilities was then partitioned into active and inactive facilities. Although information for some closed tailings facilities is available, there is an unknown number of historic/legacy facilities that are not documented (or completely unknown). Thus, existing data sources collected as part of the Hatton et al. (2020) and Spencer et al. (2021) research were queried to summarize the percent of total facilities categorized as active. The average percentage of active tailings facilities was then applied to the total number of facilities to approximate the number of active and non-active (inactive or closed) tailings facilities. On average, the resources required to service a non-active facility were assumed less than an active facility, which was assumed to create a justifiable estimate of labor needed to service existing tailings facilities worldwide.

2.2.2 Tailings Labor Demand Post-GISTM

Estimations for labor resources required to service global tailings facilities were developed under consideration of requirements for tailings facility design and management under the GISTM (GTR 2020).

Labor needs include the following personnel roles: Senior Technical Reviewer or Independent Tailings Review Board (ITRB), Accountable Executive, Engineer of Record (EOR), Responsible Tailings Facility Engineer (RTFE), Project Engineer, and Staff Engineer.

A summary of experience level, specific GISTM requirements, and estimated labor for Type A, B, and C tailings facilities is presented in **Table 2-1**. Experience levels and estimates for labor were developed based on GISTM requirements. The calculation of a full-time equivalent (FTE) was based on a 40-hr work week. Initial drafts of **Table 2-1** were circulated to leading tailings industry professionals to provide feedback and guide the estimated values presented herein.

Labor Intensity Levels by Tailings Facility Classification

The amount of labor required to design and manage a given tailings facility varies greatly based on a combination of factors, such as site geology, topography, climate, failure hazards, dam height, impoundment volume, construction method, etc. Labor estimates for each personnel role were divided into three levels of anticipated labor intensity based on three tailings facility classifications: Type A, Type B, and Type C (Hatton et al. 2020). For example, a Type C tailings facility classifies as high hazard (or high crest height) and corresponds to the highest estimated level of labor intensity for the purposes of this study. Labor intensity levels were chosen to represent the range of potential labor resources needed for facilities with varying characteristics and by distinctions in requirements within the GISTM. For example, under the GISTM, dams with potential consequence ratings of high, very high, and extreme have more requirements for independent reviews than dams with potential consequence ratings of low or significant. The service needs from a given role for a given type of dam (Type A, Type B, and Type C) are assumed to be generally consistent based on anticipated needs and represent activities that can be estimated and roughly quantified.

Personnel Roles

Assumptions used to quantify personnel duties as described herein were associated with tailings facility design, construction, and management based on the GISTM and include the required interaction with operations and continuous engineering support. The resource demand calculations in Table 2-1 include support for day-to-day tailings facility operation and intentionally exclude items such as the design of capital expenditure projects (CAPEX), sustaining capital projects, and specific aspects of operational expenditures (OPEX). In addition, the calculations do not include associated overhead costs, supporting labor such as word processing, or other administrative support services such as drafting and communications.

Senior Technical Reviewer / Independent Tailings Review Board (ITRB)

The GISTM stipulates independent (third-party) review of tailings facilities, conducted by either a Senior Technical Reviewer or Independent Tailings Review Board (ITRB), as dictated based on potential consequence rating under the GISTM. Facilities with a potential consequence rating of "low" or "significant" may have their independent review conducted by a senior technical reviewer, while facilities with consequence ratings of "high, very high, or extreme" must have a full ITRB conduct the review tasks. Typical experience levels of independent reviewers are generally agreed upon to be around 25 years or more.

The independent review duties (**Table 2-1**) are assumed to consist of one to three people for an average total of approximately 2-15 days per year, or 0.01-0.06 FTEs per tailings facility. Estimating ranges of labor effort for independent reviews are particularly difficult because the level of effort depends on how well stewardship is executed prior to initiating an independent review and/or how long a particular tailings facility has been under independent review. The estimated effort for independent review duties presented herein is intended to be a wide range to capture a broad variety of needs.

Accountable Executive

The Accountable Executive is intended to be an in-house executive directly answerable to the CEO and who also communicates with the Board of Directors. General experience levels for the Accountable Executive are assumed to be around 10-20 plus years' experience. The Accountable Executive's duties

(**Table 2-1**) are assumed to be performed within a range of approximately 1 – 6 hours per month, or 0.01-0.04 FTEs per tailings facility.

Responsible Tailings Facility Engineer (RTFE)

The RTFE is intended to be an in-house, onsite engineer who directly oversees day-to-day tailings facility management and monitoring. Typical experience levels of an RTFE range from 10 years to higher. The RTFE duties (**Table 2-1**) are assumed to be performed within a range of approximately 8-32 hours per week, or 0.2-0.8 FTEs per tailings facility.

Engineer of Record

Under the GISTM, the operator may nominate an external senior engineer to serve as EOR or appoint an in-house engineer as the EOR. In the latter case, the EOR may delegate design to an external firm to serve as the Designer of Record (DOR). For this exercise, we assume that an external senior engineer is used for the EOR role or that the EOR and DOR labor load is captured under EOR efforts (i.e., EOR and DOR are grouped as one labor effort).

The typical experience level of an EOR is at least 10 years. For high consequence or complex facilities, experience levels for the EOR will likely be closer to 15 to 20 years of experience. However, 10 years of experience may be sufficient for lower consequence tailings facilities to serve as a necessary progression in EOR experience. The EOR duties (**Table 2-1**) are assumed to be performed within a range of approximately 4-24 hours per week, or 0.1-0.6 FTEs per tailings facility.

Table 2-1. Personnel and Labor Resource Demands under Global Industry Standard on Tailings Management

Personnel Role	Typical Experience Range	GISTM Applicable Requirements	Estimated Average Labor Quantity and Frequency for Life of Project [1]			Resource Demand as FTEs (Assuming FT = 40 hours per week)		
			Type A TF [2]	Type B TF [2]	Type C TF [2]	Type A TF [2]	Type B TF [2]	Type C TF [2]
Senior Technical Reviewer or ITRB [3]	25 years +	3.2, 4.2, 4.7, 4.8, 5.7,10.1, 10.5, 10.6	2 days / year	10 days / year	15 days / year	0.01	0.04	0.06
Accountable Executive	10 - 20 years +	4.3, 4.7, 5.7, 7.1, 8.2, 8.3, 8.4,8.5, 8.6, 8.7, 9, 12.1	1 hour / month	4 hours / month	6 hours / month	0.01	0.03	0.04
RTFE	10 years +	6.3, 6.4, 6.5, 7.2, 7.3, 7.5, 8.5	8 hours / week	16 hours / week	32 hours / week	0.2	0.4	0.8
EOR	10 years +	4.8, 6.3, 6.4, 6.5, 7.4, 7.5, 9, 10.4	4 hours / week	12 hours / week	24 hours / week	0.1	0.3	0.6
Project Engineer	5 - 15 years	None - Assist EOR and RTFE	4 hours / week	12 hours / week	24 hours / week	0.1	0.3	0.6
Staff Engineer	0 - 5 years	None - Assist EOR and RTFE	16 hours / week	24 hours / week	32 hours / week	0.4	0.6	0.8

The information presented in this table does not establish requirements or recommendations for experience or labor quantity for any specific tailings storage facility. This table is solely intended to approximate non-project-specific averages to estimate global tailings professional resource demands.

Abbreviations

- EOR - Engineer of Record
- FT - Full Time
- FTE - Full Time Equivalents
- GISTM - Global Industry Standard on Tailings Management
- ITRB - Independent Tailings Review Board
- RTFE - Responsible Tailings Facility Engineer
- TF - Tailings Facility

Notes

[1] Estimated labor quantity and frequency are presented as an **average** over the life of the project for active, regular operations. Estimated labor would be expected to be higher during design and expansion phases and lower in closed/inactive phases.

[2] Dam type classifications are not intended to implicate that specific TFs require the specific criteria shown in the table. Three dam type levels were chosen to represent the range of potential labor resources needed for facilities with varying characteristics. For example, the level of effort required to service a smaller, lower production TF would be less compared to a sizeable, world-class facility.

[3] Senior Technical Reviewer or ITRB, as required under the GISTM. ITRB assumed to consist of 2-3 people for a total of the days listed.

Project Engineer and Staff Engineer

The Project and Staff Engineer roles are not mandated under the GISTM. However, the level of detail in the tasks required for both the EOR and RTFE necessitate the assistance from an engineering team, consisting primarily of project-level and staff engineers reporting to the EOR. For example, the EOR and RTFE are responsible for the Construction Records Report, but most likely, are using data compiled by a project engineer field manager and collected/entered by staff engineers/technicians. Similar to the EOR role, Project and Staff Engineers may be external or in-house employees. Experience levels for staff and project engineers are generally agreed upon to be around 0-5 years and 5-15 years, respectively.

The Project Engineer duties (**Table 2-1**) are assumed to be performed within a range of approximately 4-24 hours per week, or 0.1-0.6 FTEs per tailings facility. Staff Engineer duties are approximated to be within a range of 16-32 hours per week, or 0.4-0.8 FTEs per facility.

Labor Quantity Discussion

Estimated labor quantity and frequency are presented as an average over the life of the project for active, regular operations. Estimated labor would be expected to be higher during permitting, design, and expansion phases and lower in closed/inactive phases. For a conservative estimate of required resources for this study, a labor reduction factor of 75% was applied to the labor estimate of inactive/closed facilities to remain in line with the GISTM (i.e., non-active facilities require 25% of the total labor for active facilities). We also acknowledge that the labor required to service specific tailings facilities vary based on site-specific conditions and may fall outside the presented labor quantities in **Table 2-1**. This project includes assumptions using broad generalizations with the intent to estimate the number of tailings professional required to service tailings facilities worldwide. The estimate, in this context, illustrates the significant labor demand for qualified tailings professional resources within the industry.

Total Labor Demand Calculation

To quantify the total labor demand, the FTE estimations for each type (**Table 2-1**) were applied to the estimated number of tailings facilities worldwide. The estimated FTEs per tailings facility type (**Table 2-1**) was multiplied by the estimated number of active facilities of that type. A 75% reduction of FTEs was multiplied by the estimated number of non-active facilities of each type. To reflect the current demand resulting from ICMM member commitment to bring all of their tailings facilities up to the standard within 5 years, the FTE estimations were first applied to the tailings facilities disclosed in the GTD (2021). To capture future tailings labor demand, the FTE estimations were then applied to the total global estimate of tailings facilities, with the recognition that in order to increase mining's social license to operate, all global tailings facilities must be brought up to the standard.

2.3 Characterization of Labor Demand

Quantitative results from the labor demand calculations described in **Section 2.1** together with qualitative response from tailings professional survey described in **Section 2.2** were used to describe a snapshot of the tailings industry labor pool at this time.

2.4 Identification of Opportunities

Relevant themes from the tailings professional survey were summarized to identify opportunities for improving current and future labor pools. To frame the current state of education and training for entry and retention within the tailings industry, relevant academic collaborations, trainings, and certifications targeting tailings dam professionals were inventoried. The 2021 SME MinExchange conference included a tailings module entitled "Building the Tailings Operators and Engineers of Tomorrow", which included short presentations by representatives for the industry's leading tailings training programs. The existing training programs presented within the module were summarized to give examples of how the academia and industry are collaborating to recruit and retain tailings professionals to address tailings labor demand.

3.0 RESULTS

3.1 Tailings Professional Perspectives

An online survey was administered to current tailings practitioners to capture their perspectives on current and future challenges within the tailings and mine waste industry. A total of 363 unique responses from tailings practitioners were recorded and subsequently evaluated. The full survey questionnaire is included in **Appendix C1**. Categorization of short answer responses is included in **Appendix C2** and the complete set of raw data for the survey responses is included in **Appendix C3**.

3.1.1 Background Responses

The distributions of years of experience, current employment, and highest level of formal education of the 363 respondents are shown in **Figure 3-1**. The distribution of experience was fairly even among the respondents, with 29.8% of the professionals having 20+ years of experience, 31.4% having 10-20 years of experience, 14.6% having 5-10 years of experience, and 24.2% having 0-5 years of experience. The majority of the respondents reported that they worked in consulting (50.6%) and/or in the mining industry (34.9%) (**Figure 3-1**); smaller percentages of the respondents represented academia (5.3%), regulators (4.8%), and other areas (4.3%). In addition, the majority of the tailings professional respondents (65.5%) had a graduate degree (Masters or PhD), whereas 32.2% reported a bachelor's degree as their highest formal education (**Figure 3-1**).

The range of academic background for the tailings practitioners is shown in **Figure 3-2**. The percentages reported in **Figure 3-2** for a given discipline were calculated based on total number of respondents reporting that discipline as an area of technical background divided by 363. All disciplines were normalized to the total number of respondents because each respondent was provided the liberty to select all relevant disciplines that capture their academic background. Civil engineering (68.8%) was by far the most predominant academic background, following by geological engineering (28.2%), mining engineering (19.3%), and geosciences (13.3%).

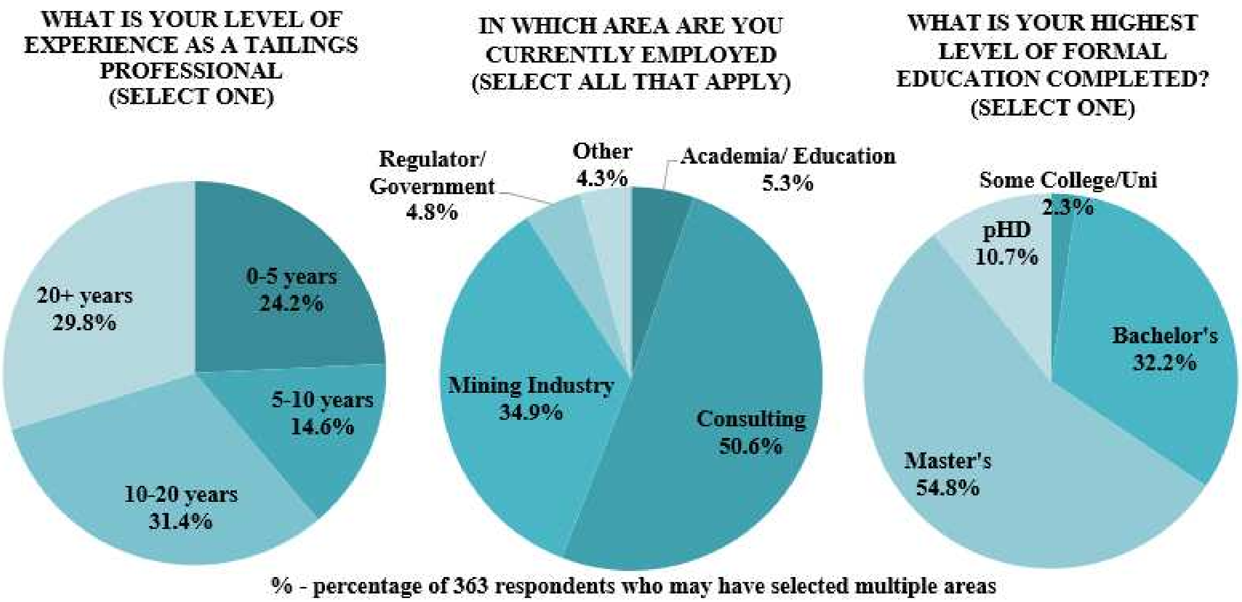

Figure 3-1. Tailings professional background survey responses

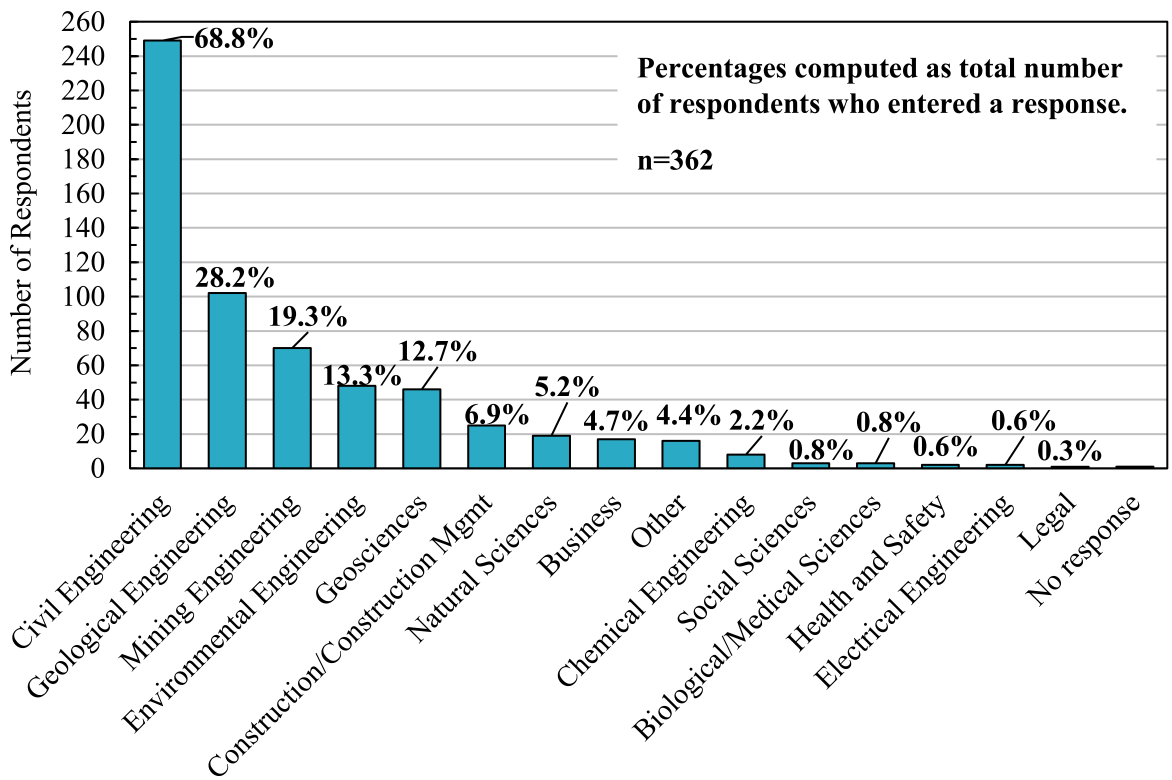

Figure 3-2. Tailings survey respondents' academic backgrounds (select all that apply)

3.1.2 Responses on Tailings Industry Challenges

A variety of quantitative and qualitative questions were asked of the tailings practitioners to gather insight on their perspective of current challenges facing the mining industry. The distribution of responses to a question regarding the perceived shortage of tailings professionals is shown in **Figure 3-3**. More than 75% of respondents viewed the tailings industry professional resource shortage as critical (ranked 4 or 5 on a scale of 1- not critical to 5- very critical), whereas only a single respondent answered that the perceived resource shortage was not critical.

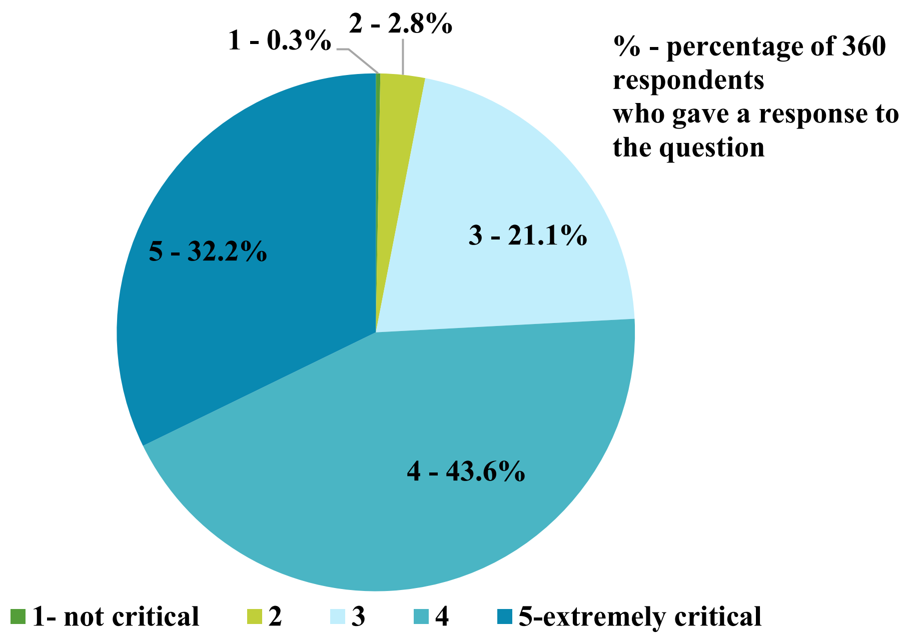

Figure 3-3. Percentage of respondents answering the questions: On a scale of 1 to 5, where 1 is not critical and 5 is extremely critical, how critical do you perceive the tailings industry professional resource shortage (select one)

The percentages of yes and no answers to questions pertaining to (i) if tailings was part of their formal education and (ii) if tailings was a chosen career path when entering the workforce are shown in **Figure 3-4**. Despite 65.8% of respondents indicating they had exposure to tailings in their formal education, the majority (77.6%) of respondents did not enter the tailings industry intentionally.

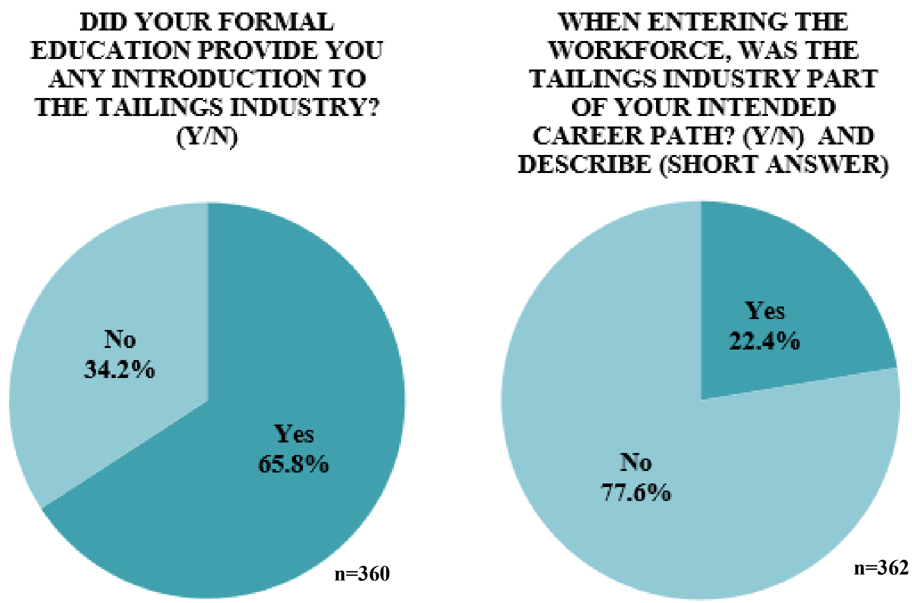

Figure 3-4. Survey responses on introduction to and entry into tailings industry

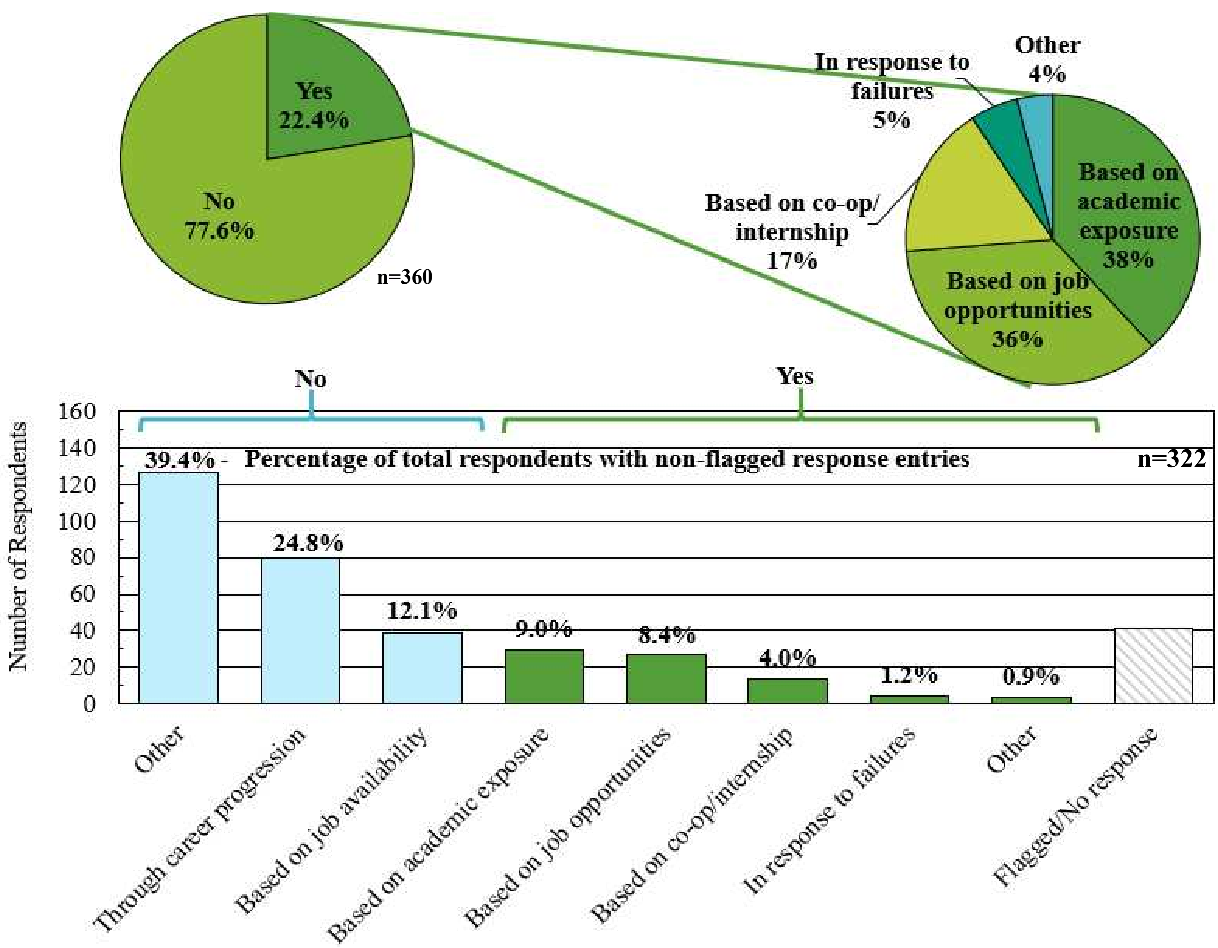

Figure 3-5. Percentage of respondents answering the questions: When entering the workforce, was the tailings industry part of your intended career path (yes/no) and describe how or why (short answer).

A subsequent breakdown of how the 363 tailings practitioners ultimately found their way to a career in tailings is shown in **Figure 3-5**. Most practitioners that entered the workforce intending to pursue a career in tailings received exposure to tailings academia / research projects, recruitment / job opportunities, or co-ops / internships. For those practitioners who entered the tailings industry by chance, there was a wide variety of pathways, including natural career progression and job availability. These responses suggest there is opportunity to increase recruitment into the tailings industry through exposure and presentation of job opportunities at the academic level and through co-ops and internships.

The next set of questions in the survey focused on trainings that would benefit the practitioners in their current positions. The distribution of major categories of desired training is shown in **Figure 3-6** and a subsequent breakdown of specific subject matter within a given discipline of desired training is summarized in **Table 3-1.** The majority of respondents (70.6%) indicated that geotechnics, or geotechnical engineering training would benefit them, while hydrotechnics and operations were the next most listed disciplines at 43.9% and 38.3% of respondents, respectively. New technology (20.8%), geosciences (17.5%), soft skills (16.7%), risk/safety (10.0%), and case studies (3.0%) were also mentioned within the responses. Response sub-categories that were mentioned by 10 or more respondents are included in **Appendix C2**.

The responses shown in **Figure 3-6** span a wide range of disciplines, which reinforces the need for interdisciplinary training for all tailings professionals. The general perspective of the respondent suggests that a strong geotechnical background is important for comprehensive tailings management, but a diverse background also is required. The diversity of topics within a given discipline that respondents desire training (**Table 3-1**) also is broad and suggests that there is considerable opportunity to develop professional training that can benefit tailings practitioners. For example, independent professional short course could be developed on each of the sub-categories listed geotechnics, which include liquefaction and critical state soil mechanics, soil dynamics, dam design, slope stability, and material characterization.

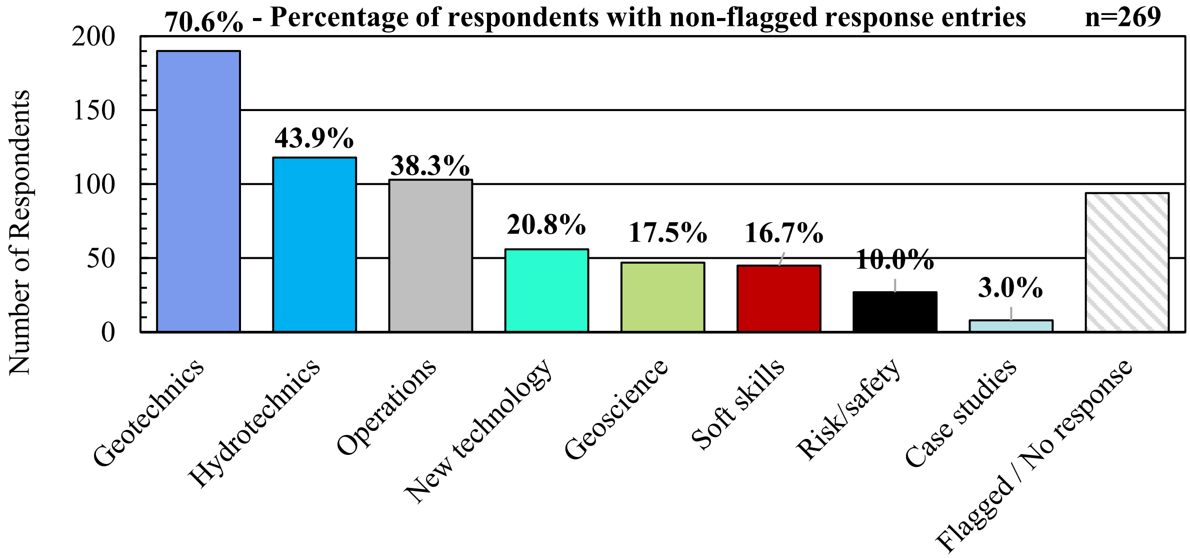

Figure 3-6. Percentage of respondents within each major category response to the question: What professional training disciplines would help you execute your work on a day-to-day basis? (short answer)

Table 3-1. Professional Training Disciplines: Survey Response Major Categories and Subcategories

Major Response Categories	Response Subcategories
Geotechnics	• Soil mechanics/liquefaction/critical state • Slope/dam stability • Soil dynamics • Dam design • Material characterization
Hydrotechnics	• Hydrogeology • Water treatment • Hydrology • Hydraulic engineering • Modeling/dam breach analysis • Tailings rheology
Operations	• Mining engineering • Process/metallurgical engineering • Mining transport • Regulations/permitting • Closure • Construction • Tailings/water management & water balance
New technology	• New laboratory techniques (simple shear, large-strain, etc.) • Observation (drones, images, satellites, etc.) • Instrumentation (sensors) • Digital transformation/big data/AI • GIS • New tailings technology
Geoscience	• Geochemistry • Soil sciences • Seismicity • Geophysics • Rock mechanics
Soft skills	• Social & communication • Writing • Project management • Legal • Business • Community engagement
Risk/safety	• Risk • Safety
Case studies	• Case studies
---	• Flagged • No response • Didn't understand question

Responses to a question pertaining to current and future challenges related to professional labor resources were first categorized into the following major categories: (i) current labor pool, (ii) attracting new talent, (iii) training, (iv) none, and (v) flagged/no response, as shown in **Figure 3-7**. A broad range of subcategories to the main categories shown in **Figure 3-7** were used to categorized all responses, and these are listed in **Appendix C2**.

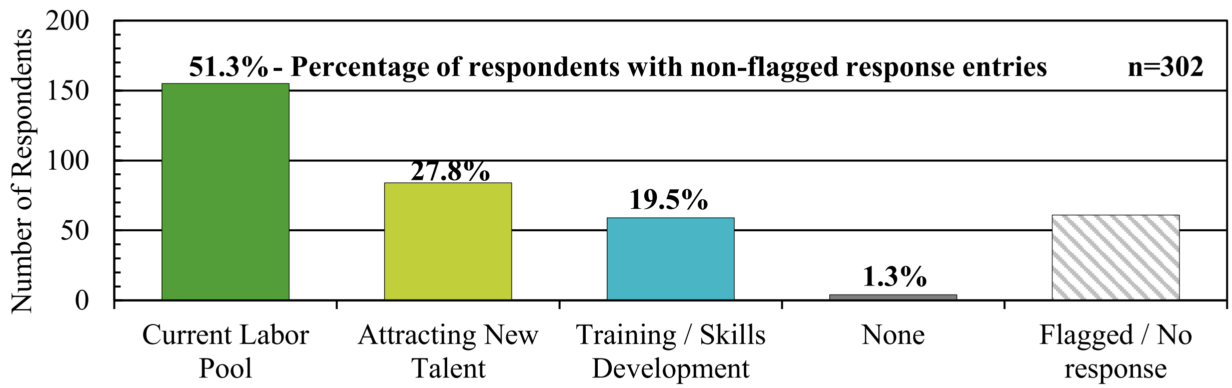

Figure 3-7. Percentage of respondents who entered a response within each major category in response to the question: what challenges do you see with respect to available professional labor resources, both currently and in the future (short answer).

The majority of respondents (51.3% of those who entered a response) indicated that issues related to the current labor pool were a significant challenge. Current labor pool challenges predominantly were associated with the shortage of qualified professionals and the gap between junior level staff and senior-level professionals retiring. The abundance of senior-level professionals approaching retirement results in a shortage of senior professionals available to mentor and train the upcoming tailings practitioners. Other common themes included in responses associated with current labor pool include challenges related to succession planning, EOR risk/liability aversion, and current regulations increasing labor requirements.

The 27.8% of respondents who indicated that attracting new talent was a challenge, highlights a lack of exposure to tailings as a career path at the academic level, a general negative perception of mining and view that tailings are not interesting or exciting, and challenges related to attracting entry-level professionals to work in remote locations and/or in the field getting "boots on the ground". Finally, 19.5% of respondents indicated that training/skills development was a challenge. Common themes included lack of a broad background with no practical problem solving skills, lack of available training programs, too few senior professionals to mentor, and lack of field experience.

Survey respondents were then asked their opinion on the greatest challenge faced by the tailings and mine waste industry. Responses to this question were first categorized by the following major categories: (i) labor, (ii) tailings management, (iv) social license, (v) design/safety, (vi) mining industry/practice, (vii) governance, (viii)research/data, and (ix) flagged/no response. The number and percentage of total respondents identifying each each major category are visually represented in **Figure 3-8**. Responses were also classified into numerous subcategories that are listed in **Appendix C2**

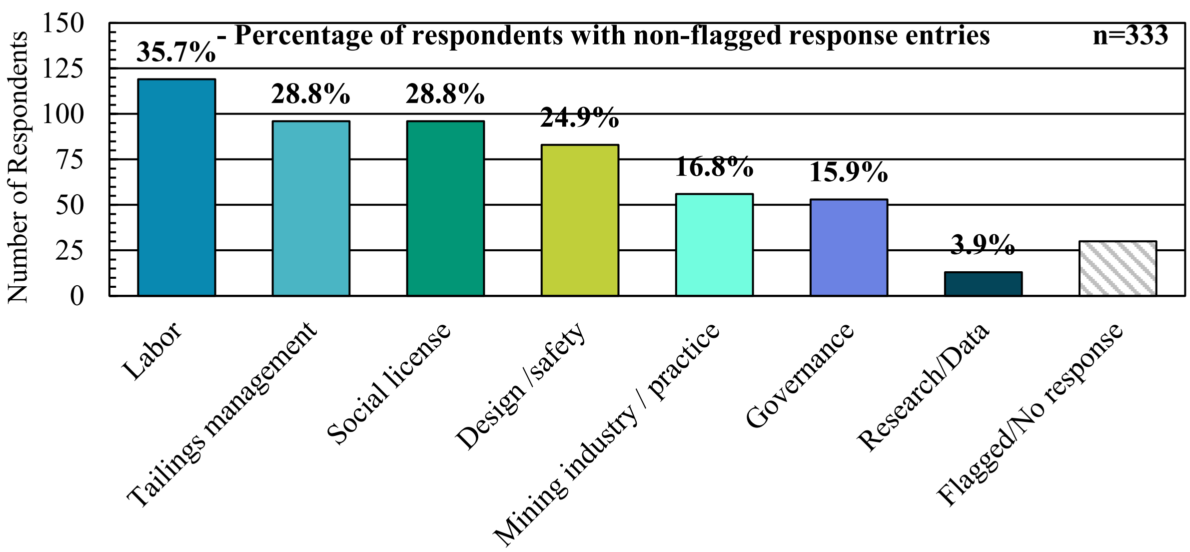

Figure 3-8. Percentage of respondents who entered a response within each major category in response to the question: What is the greatest challenge facing the tailings and mine waste industry, in your opinion (short answer).

In total, 35.7% of respondents (who entered a response to the question) included labor as one of the greatest challenges within the tailings industry. Commonly mentioned themes associated with labor challenges included lack of qualified professionals, aging professional labor force, attraction of entry-level professionals, retention of existing professionals, and skills development. Tailings management was included as part of the responses from 28.8% of respondents. Main themes related to tailings management included challenges associated with increased tailings volumes, the need for effective tailings management in response to climate change and environmental impacts, and the need to adapt to new tailings technologies and improve the state of practice. Challenges related to social license was mentioned in responses from 28.8% of respondents and included the negative public perception, lack of confidence and trust from the public, poor decisions and past failures decreasing social license, and risk management issues. Additional main categories that were noted as challenges by the respondents included design and safety challenges (24.9%), mining industry/business practices (16.8%), governance (15.9%), and research (3.9%).

The final question included in the survey asked respondents to identify potential areas of change within the tailings industry. Responses were first categorized as shown in **Figure 3-9**, with major categories including (i) industry culture/business practices, (ii) labor pool/career pathways, (iii) public perception, (iv) tailings management, (v) governance, (vi) liability, (vii) nothing, and (viii) no response. Responses were also classified into the subcategories listed in **Appendix C2**.

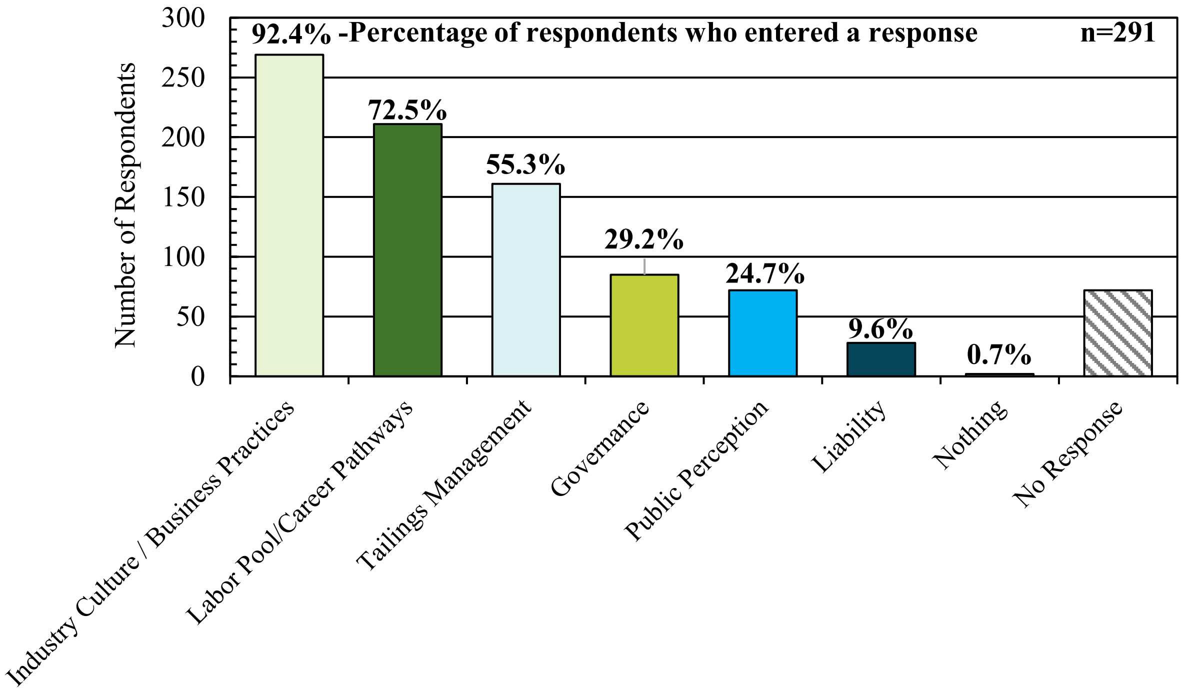

Figure 3-9. Percentage of respondents who entered a response within each major category in response to the question: If you could change three things within the tailings and mine waste industry, what would they be (short answer)

Most respondents (92.4%) indicated that they would change the current industry culture and business practices. Common themes under this major category included changing industry culture around tailings, increase accountability, increase transparency and collaboration, decrease institutional resistance and going about business as usual, decrease commodification of work (stop low bidding/undercutting), and to consider alternatives to present-value accounting.

Labor pool and career pathways was the second most mentioned item, at 72.5% of respondents. Common responses included increase research, increase training and mentoring opportunities, increase academic exposure to tailings and industry-academic engagement, provide clear definition of roles in the tailings industry and recognize accomplishments of professionals, recruit, retain, and motivate professionals, and to increase overall labor force.

More than half of the respondents (55.3%) indicated they would make changes to tailings management, including a focus on adapting new technologies and improving the state-of-practice, enhancing existing tailings management, improving closure & reclamation, and improving water management.

Changes to governance was included by 29.2% of respondents. These responses included suggestions for more stringent regulations, less variability in regulations, more consolidation of guidance documents, and less permitting uncertainty. Finally, changing public perception of mining in general and tailings was included in 24.7% of respondents' responses and 9.6% of respondents included liability in their list of things to change in the tailings and mine waste industry.

3.2 Tailings Labor Demand

The tailings professional survey provides insight on the perceived labor challenges within the tailings and mine waste industry, which includes an emphasis on the shortage of qualified personnel (i.e., labor demand exceeds current labor supply). The following sections include quantification of the current and future labor demand to service tailings facilities in accordance with the GISTM. First, the estimate of tailings facilities worldwide was binned into three classifications, and then labor demand under the GISTM was calculated via the estimate of total tailings facilities globally.

3.2.1 Characterizing Tailings Facilities Worldwide

Classification by Type

The distribution of tailings facilities in the U.S. and Brazil that classify into Types A, B, and C based on height and hazard is shown in **Figure 3-10** (Hatton et al. 2020). Data available for the U.S. and Brazil were used herein to yield estimates of the Type A, B, and C tailings facilities due to the high quality of information available for these two countries on tailings facility quantities and characteristics. Classification by crest height is biased towards smaller dams (Type A) for both the U.S. and Brazil, whereas classification by hazard rating is bias towards high hazard (Type C) for both countries. This difference in bias is likely attributed to not accounting for other factors (e.g., volume of tailings impounded, distance from towns/cities, etc.) that can influence the hazard rating for a tailings facility with a low dam height. Average distributions of Type A, B, and C tailings facilities based on height were used to generate a lower-bound estimate for labor demand and average distributions based on hazard rating were used to generate an upper-bound estimate.

Classification by Status (Active or Not Active)

A summary of relevant literature sources that identify active and non-active (inactive or closed) tailings facilities within a given database is in **Table 3-2**. The most recent release (Version 4.0) from the Global Tailings Database (2021) catalogues 1,947 tailings facilities, of which 827 (42%) are identified as "Active". The other literature sources and inventories report percentages of active tailings facilities between 14% and 56%. The arithmetic average of all sources in **Table 3-2** is 40%, which is comparable to that reported by the Global Tailings Database. Thus, 40% of all tailings facilities being active was applied our estimate of 16,000 tailings facilities worldwide to yield 6,400 estimated active facilities and 9,600 non-active facilities (inactive or closed).

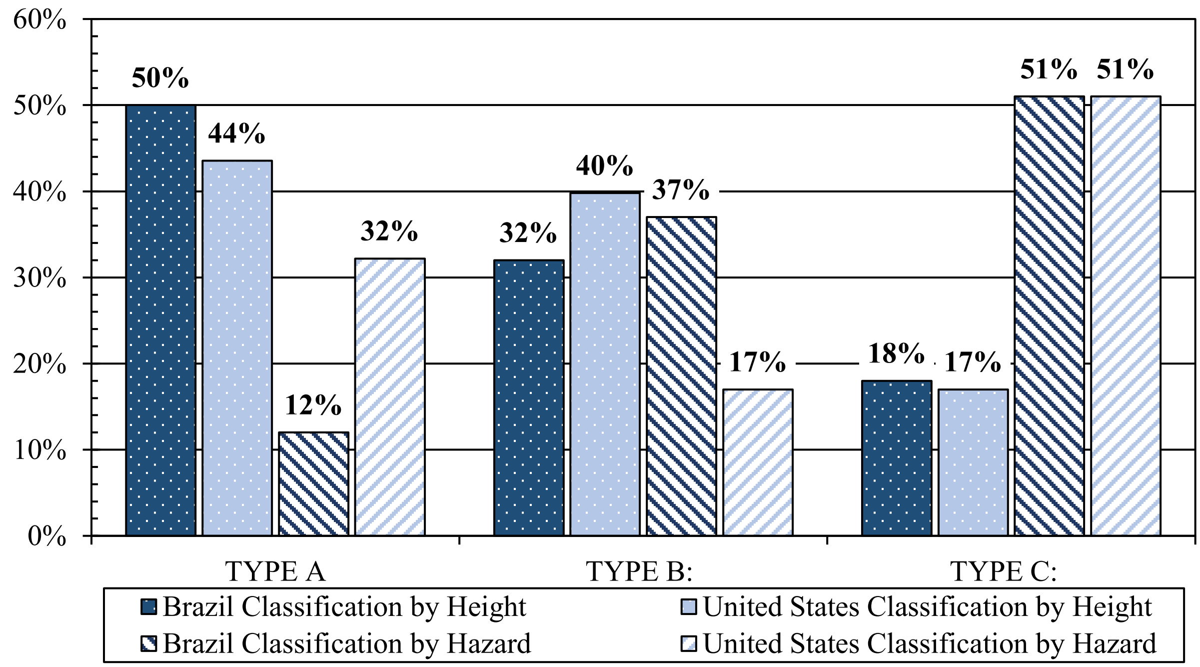

Figure 3-10. Percentage of tailings facility inventory for each type based on Brazilian and United States height or hazard classifications.

Table 3-2. Percentages of Active Tailings Facilities (TF) from Various Sources

Region	Total TF Records	Active TF Records	% Active TF	Data Source
Worldwide	1942	827	42%	GTD 2021
Chile	742	104	14%	Servicio Nacional de Geología y Minería (Sernageomin) 2019
Chile	449	175	39%	Villavicencio et al. 2013
Chile	660	257	39%	Ghorbani & Kuan 2016
Peru	183	90	49%	H.R. Wallingford 2019
Western Australia	492	277	56%	Personal Communication (2020), Mine Safety Directorate of Department of Mines, Industry, Regulation and Safety
United States	1363	560	41%	MSHA 2019, NID 2018
		Average	**40%**	

3.2.2 Labor Estimates Post-GISTM

Companies that have disclosed tailings facilities to the Global Tailings Database (2021) already are underway in bringing their facilities up to the guidelines outlined in the GISTM. This transition is happening now, and demand for the associated personnel roles in the GISTM is increasing rapidly to meet the expectations. An initial estimate of labor demand is in **Table 3-3**, which includes personnel required to service the 1,947 disclosed tailings facilities in the Global Tailings Database (2021). The numbers in **Table 3-3** reflect the 42% active facilities reported in the database, and labor required for nonactive facilities reduced by 75% from the labor required for an active facility.

Labor estimated in **Table 3-3** reflects the immediate need for the mining industry. The lower-bound estimate based on tailings dam crest height suggests that more than 1,500 full-time equivalents (FTEs) are required to serve the 1,957 tailings facilities, whereas the upper-bound estimate based on hazard rating suggests that more than 2,200 FTEs are required. The total number of FTEs includes all personnel outlined in **Table 3-3**: ITRB, Accountable Executive, RTFE, EOR, Project Engineer, and Staff Engineer. However, to increase the mining industry's social license to operate and prevent future failures damaging human health and the environment, the GISTM sets forth guidelines for design, construction, and management of all tailings facilities worldwide, in perpetuity. Additionally, securing investors and insurance policies now and in the future will require adherence to the GISTM. Thus, our interpretation is that if all mine owners adhere to GISTM, all of the estimated 16,000 tailings facilities should be managed under the labor requirements estimated herein.

The labor demand required to service the estimated 16,000 tailings facilities in accordance with the GISTM is in **Table 3-4**, which includes 6,400 active facilities and 9,600 non-active facilities. The labor demand to service 16,000 tailings facilities worldwide is considerably higher relative to the 1,947 tailings facilities in the Global Tailings Database (2021) and represents a forward-looking projection to capture the needs of the mining industry. Thus, if the mining industry desires to manage all facilities worldwide, in a safe and sustainable manner, we will need approximately 12,100 – 17,800 FTEs. Labor resources required to achieve this will take time to recruit, develop, retain, and replenish. Another major effort will be to find and catalog the extent of historic and legacy tailings facilities worldwide to more appropriately refine the calculation for active and non-active tailings facilities (calculations used herein are in **Appendix D**).

Labor quantification in this study was performed to yield a total number of FTEs. However, fulfilling one FTE role likely will require multiple people. For example, most upper-level technical experts who serve as Senior Technical Reviewers or are on ITRBs do so in addition to other professional duties. In other words, most ITRB member do not serve as ITRB members full-time. Therefore, to meet the required 30-45 ITRB FTEs to service the 1,947 tailings facilities disclosed on the GTD (**Table 3-3**), the actual number of expert individuals will exceed the stated FTE requirement.

A preliminary attempt at quantifying the labor demand prior to the GISTM was performed and is included in **Appendix E**. However, the GISTM is the first initiative to outline the anticipated level of effort required to design, construct, manage, and close tailings facilities worldwide. Many world-class tailings facilities already exist, that have been managed under guidelines and recommendations that align with the GISTM guidelines. However, there are also many facilities that may be under little to no management beyond day-to-day maintenance. Acknowledging this wide variability, we were unable to accurately quantify labor estimates prior to implementation of the GISTM.

Labor demand under the GISTM has definitively increased per tailings facility as a result of the addition of personnel roles such as Accountable Executive and RTFE, which were created explicitly in the standard. Labor demand for all personnel roles also is increasing, as the number of facilities managed in accordance with the GISTM increases. For example, an increasing reliance on low-carbon renewable energy will increase demand for raw materials, such as graphite and lithium, that must be mined (Herrington 2021). According to the World Bank (2020), graphite and lithium demand production would need to increase almost 500% in the next 30 years to meet demand for a low-carbon future (2^{o}C change scenario), as outlined by the Paris Agreement. To meet the increasing mineral demands, more material must be extracted and processed, resulting in increasing volumes of tailings to manage.

Table 3-3. Estimates of tailings labor demand for the 1,947 facilities disclosed on the Global Tailings Database (2021)

Percent Contribution of Tailings Facilities (TF)				Full-Time-Equivalents (FTEs) Needed to Service 1,947 TFs with 75% Labor Reduction for non-active facilities[1]						
TF Screening Criteria	Type A [2]	Type B [2]	Type C [2]	Senior Technical Reviewer or ITRB	Accountable Executive	RTFE	EOR	Project Engineer	Staff Engineer	**Total FTEs**
Crest Height – Hazard	51% --- 12%	40% --- 17%	17% --- 51%	30 --- 45	23 --- 32	387 --- 598	267 --- 431	267 --- 431	554 --- 706	**1,528** **---** **2,242**

[1] Tables for active and non-active calculations are found in **Appendix D**
[2] Classification by dam height: Type A < 40 ft, Type B > 40 ft and < 100 ft, Type C > 100 ft.
Classification by hazard: Type A = low, Type B = significant or medium, Type C = high (Hatton et al. 2020)

Table 3-4. Estimates of tailings labor demand for the minimum estimated 16,000 tailings facilities worldwide

Percent Contribution of Tailings Facilities (TF)				Full-Time-Equivalents Needed to Service 16,000 TFs with 75% Labor Reduction for non-active facilities[1]						
TF Screening Criteria	Type A [2]	Type B [2]	Type C [2]	Senior Technical Reviewer or ITRB	Accountable Executive	RTFE	EOR	Project Engineer	Staff Engineer	**Total FTEs**
Crest Height --- Hazard	51% --- 12%	40% --- 17%	17% --- 51%	240 --- 357	182 --- 253	3,080 --- 4,752	2,121 --- 3,423	2,121 --- 3,423	4,400 --- 5,614	**12,140** **---** **17,823**

[1] Tables for active and non-active calculations are found in **Appendix D**
[2] Classification by dam height: Type A < 40 ft, Type B > 40 ft and < 100 ft, Type C > 100 ft.
Classification by hazard: Type A = low, Type B = significant or medium, Type C = high (Hatton et al. 2020)

Labor demand changes under the GISTM have happened rapidly, with the expectation that once the GISTM was issued, companies expecting funding from the 100 investors (with over $13 trillion USD in assets under management) supporting the Investor Mining and Safety Initiative, will need to bring their facilities up to compliance with the standard. The ICMM member commitment pledges to bring all member-owned tailings facilities up to the Standard between August 2023 and August 2025. This includes retrogressively assessing existing facilities for data gaps to align with the guidelines, along with modifying existing design and construction projects to comply with the GISTM. Altering the supply chain to incorporate the tailings professionals needed to satisfy the guidelines in the GISTM does not happen instantaneously. New and existing professionals must be drawn into the industry, trained, and spend years gaining practical experience to be qualified to satisfy the personnel roles and the duties listed in the GISTM.

3.3 Characterization of Labor Demand

Changes in the demand for tailings professionals resulting from implementation of the GISTM are taking effect within a short time. This change is happening concurrently, according to the perception of current industry professionals, with a shortage of qualified professionals, both entering the industry and at the mid- to upper levels of experience.

A major challenge highlighted within the survey is a perceived lack of tailings professionals in the 10-20 years of experience range, both in replacing independent reviewers (ITRB members) and having enough experience to take on EOR for complex tailings facilities that require higher levels of experience to safely design, construct, and manage. Other common themes recognized in the survey are challenges related to recruiting and retaining new talent into the tailings industry.

3.4 Identification of Opportunities

Our profession must identify how to marry supply and demand for tailings professionals by regenerating resources more effectively. Tailings professionals are specialized and require breadth and depth of a variety of topics. The survey results indicate that the majority of professionals do not enter the industry intentionally (**Figure 3-4** and **Figure 3-5**). Thus, industry and academia need to promote tailings as a sustainable and viable career path, and industry needs to collaborate with academic to properly train existing professionals and retain them within the tailings career path to fulfill requirements set forth to safely manage these facilities.

Promotion of mining and tailings as a successful, dynamic career path can be approached during many stages of young professionals' lives. Opportunities identified through our research are summarized below in **Table 3-5**. For the K-12 level, industry and academia need to collaborate to increase visibility and exposure to mining and tailings, along with promoting STEM topics to diverse groups of students. At the undergraduate and graduate level, industry and academia should collaborate to expose students in STEM fields to mining and tailings, fund internships and research projects. Once professionals enter the workforce, career advancement opportunities in tailings should be promoted, maintaining a diverse workspace should be a priority, and specialized tailings professional training should be provided. Opportunities also exist to recruit professionals who are later in their career but looking for a lateral move into the tailings industry.

The development of a focused tailings professional training program has many challenges. This is, in part, due to the broad skill set necessary to be an effective tailings professional, which requires understanding of professional workspaces in both engineering and science. A common thread to any training program is the practical application of theoretical principles. The idea that one can take an engineer that has been in the office for 10 years, place them on an active tailings facility and expect them to be an effective tailings engineer is unreasonable. Therefore, the development of resources, especially entry- and mid-level personnel, requires a commitment to operational exposure and the practical application of theoretical principles in a tailings environment.

The industry is working collaboratively to develop programs focused on training tailings professionals and operators to address the increases in labor demand. The programs presented during the SME MinExchange "Building the Tailings Operators and Engineers of Tomorrow" module and summarized below demonstrate the beginning of that process.

Table 3-5. Opportunities to recruit and retain tailings professionals

Life/Career Stage	Opportunities
K – 8	Increase exposure to mining/tailings • promote interest in STEM topics to diverse group of students
9 – 12 (High School)	Increase exposure to mining/tailings • promote interest in STEM topics to diverse group of students • offer internships • fund/support tailings-focused projects
University (Undergraduate)	Increase exposure to mining/tailings as a sustainable career and critical to green energy movement • promote interest in STEM topics to a diverse group of students • offer internships • fund/support tailings-focused projects
University (Graduate)	Provide research funding • tailings-specific graduate courses • offer internships
Entry-level Professional	Highlight career advancement opportunities in tailings • structure and support a career path in tailings • provide professional development and tailings-specific training • increase diversity in the workplace • provide incentives for growth • adapt new sustainable technologies • promote and support innovation.
Existing Professional	Recruit from parallel career paths • structure and support a career path in tailings • provide professional development and tailings-specific training • give recognition for accomplishments • provide incentives for growth • reduce individual liability • increase diversity in the workplace • adapt new sustainable technologies • promote and support innovation.

3.4.1 TAILENG

The Tailings and Industrial Waste Engineering (TAILENG) Center is a collaboration between Georgia Tech, Colorado State University, University of Illinois, and University of California, Berkeley dedicated to advancing the state of knowledge and practice in the design of tailings and industrial waste storage facilities. A key focus of TAILENG is to offer experiential learning to graduate students through research opportunities and technical training for tailings engineers via short courses. Training offered by TAILENG started in March 2021 with a course entitled *Fundamentals of Tailings Engineering*, which was offered in collaboration with the Tailings Center.

3.4.2 *Tailings Center*

The Tailings Center is envisioned as an industry-academic cooperative research and education center that includes Colorado School of Mines, Colorado State University, and the University of Arizona. These universities, together, provide a full spectrum of multi-disciplinary skills needed for effective tailings management. Center Director Mike Henderson stated, "[Tailings], as most people know, isn't specifically geotechnical issues or water management issues or geochemistry issues or mineral processing issues. It's all of the above and more" (Henderson, 2021).

The Tailings Center is partnering with industry to provide professional development courses, a supply of trained tailings professionals to the industry, multi-disciplinary research to meet the technical challenges associated with tailings management, and qualified faculty to lead university and educational programs on tailings. The Tailings Center initiated their first six-course, Certificate in Tailings Management, short course series in March 2021.

3.4.3 *AusIMM Tailings Management Course*

Dr. David Williams of the University of Queensland, Australia offered his vision for the ideal tailings professional as one who (i) understands past failings in tailing management, (ii) is trained in the fundamentals of tailings management, (iii) questions and "interrogates" available data and analyses while seeking to reduce uncertainty and add value, and (iv) communicates effectively with the wider community. To facilitate developing these abilities in tailings professionals, Dr. Williams initiated and largely delivers the Australasian Institute of Mining and Metallurgy (AusIMM) Professional Certificate in Tailings Management, an online, interactive course first offered in Fall 2020. The AusIMM course contains six modules: (1) introduction to tailings management; (2) geotechnical considerations; (3) geochemical and water considerations; (4) governance and surveillance; (5) closure considerations; and (6) socioeconomic considerations.

3.4.4 GHD and Australian Vocational Education & Training

GHD is a multi-disciplined, global professional services company. Their specialized tailings team has a dual approach to tailings training. First, their internal GHD School of Tailings is available to staff in related disciplines, junior staff, and select clients. The GHD School of Tailings includes 25 topics offered online that are presented by internal and external specialists. Second, tailings training is offered as an external, commercial training business for mine site operators. GHD and Water Training Australia (WTA) developed a training course for managers and operators of tailings facilities. The course includes recognition from the Australian Vocational Education and Training (VET) system, which aims to provide skills for work and issue a nationally recognized qualification in a Certificate ranging from level I to IV. The certificates can also lead to diplomas and degrees.

3.4.5 Future Tails

Future Tails is a partnership between the University of Western Australia, Rio Tinto, and BHP to provide training and professional development, further research for innovation, and compile and update industry technical references. Future Tails developed over a period of many months and overlapped with the development of the GISTM. Trainings offered by Future Tails are "tailored very much to meeting the range of expectations regarding personnel in the GISTM" (Fourie 2021).

Future Tails has developed four topic areas for training geared towards various tailings professionals: Tailings Management for Senior Leaders; Tailings Design and Technology; Tailings Management and Technology; and Tailings Operations. Micro-credentials can be earned via completion of qualifications in each topic area, which can be aggregated or "stacked" towards higher qualifications (e.g., certificate or degree). To expand the research base on tailings and encourage innovation in the industry, Future Tails also offers full-time research scholarships.

The research focus of Future Tails seeks to improve industry practice as well as the training opportunities. Future Tails is creating a technical reference manual containing up-to-date information on the body of knowledge related to tailings management. The technical reference is intended to become a reference for industry and will be updated continuously as research and innovation expand.

4.0 SUMMARY AND CONCLUSIONS

The Global Industry Standard on Tailings Management (GISTM) sets a new standard for the level-of-care associated with the feasibility, design, construction, management, and closure of tailings facilities worldwide. The resources required to bring individual tailings facilities, from their current status, up to compliance with the GISTM guidelines varies widely. For example, some facilities are already operating under the requirements set forth in the GISTM and are prepared to provide any necessary labor resources to satisfy additional/forthcoming guidelines. Other facilities, however, may be operating significantly below the GISTM guidelines and may have limited to no financial and/or personnel resources available to upgrade and adhere to the guidelines presented therein. Still other facilities may have been fully abandoned, without consideration for proper closure and management.

As suggested by the responses to the tailings professional survey, supplying adequate labor resources is a major challenge. Current tailings professionals are concerned that the tailings industry does not have sufficient qualified professionals to service the existing tailings facilities. Recruitment into and retention within the industry are some of the main challenges associated with meeting the labor resource demand. Collaboration between academia and industry is key, both to increase exposure to tailings within academic pathways as well as to fortify exiting tailings professional training opportunities to transition professionals with other backgrounds to qualified tailings professionals. Tailings careers need to be promoted as successful and fulfilling pathways to promote sustainable energy and an environmentally responsible industry. Tailings professionals are critical for sustainability because safe tailings management enables responsible extraction of critical minerals to develop green energy technologies, providing the foundation for our continued transition from fossil fuels to alternative energies. With the transition to renewable energy sources, we need mining now, more than ever, to provide the raw materials needed to expand green energy across the globe. The future of society does not exist without mining, and safer tailings facilities do not exist without the recruitment and retention of qualified professionals to manage them worldwide.

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APPENDIX A – TAILINGS AND MINE WASTE 2020 CONFERENCE PAPER SUBMISSION

All Hands on Deck! - A Semi-Quantitative Attempt to Characterize the Impending Qualified Tailings Professional Resource Shortage

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ABSTRACT

The mining industry is experiencing a radical change in the governance of tailings storage facilities. Guidance and regulations crossing many jurisdictions continue to contribute to this amorphous change. The Canadian Dam Association, Mining Association of Canada, Australian National Committee on Large Dams, and the Global Tailings Standard being produced by the International Council on Mining and Metals, among others, are establishing guidelines for more rigorous industry governance. This new and evolving guidance regarding tailings storage facilities (TSFs) is developing concurrently with a historic shortage of experienced tailings engineers, which adversely affects the resource base available to deploy and support the new governance. An inventory was made to quantify the number and size of TSFs worldwide, and to estimate labour required by qualified professionals and associated costs to meet ongoing tailings stewardship initiatives. The evaluation was initiated using available data documenting active and inactive jurisdictional TSFs. Several jurisdictions queried produced searchable inventories synthesized based on dam height and hazard classification. The research presented herein represents a discrete moment in time as contributions to the available information and inventories accessed continues and, today, is incomplete; however, the data used provides essential insight into the resource deficiencies that currently exist within our profession.

INTRODUCTION

The recent Mount Polley (Morgenstern, Vick, & Van Zyl 2015), Fundão (Morgenstern et al. 2016), and Feijão (Robertson et al. 2019) TSF failures have had profound and pivotal impacts on the mining industry and tailings stewardship. The Mount Polley failure in British Columbia, Canada, raised awareness of the distribution of responsibility, the importance of governance, and the role of the Engineer of Record (EoR). The immediate outcome from Mount Polley was a renewed focus on tailings governance documents such as those developed by the Canadian Dam Association (CDA), the Mining Association of Canada (MAC), and others, with anticipated contributions from jurisdictions in Australia via Australian National Committee on Large Dams (ANCOLD). Further, EoR guidance was established by the Geoprofessional Business Association (GBA) post-Mount Polley.

The Fundão failure in Mariana, Brazil, reinforced the importance of governance, highlighted the importance of monitoring systems, and provided further understanding of collapse mechanisms that occur in extrusive TSF failures. The failure also put the industry on notice that further attention to TSFs was required beyond that which is partially implemented by major mining companies.

The Feijão Dam failure in Brumadinho, Brazil, sparked a shift to action. The International Council on Mining and Metals (ICMM) convened tailings professionals from mining companies worldwide to provide input for a new guidance document, recently released for industry-wide comment and known as the Global Tailings Standard (GTS). The Church of England, supported by 100 investors with over $13 trillion USD in assets under management, made a call to action to request dam-by-dam disclosure of TSFs. This initiative is named the Investor Mining and Tailings Safety Initiative and is co-chaired by the Church of England Pensions Board and Swedish National Pension Funds' Council on Ethics, with additional support from the UN Environment Programme.

These recent tailings dam failures have reaffirmed the need for enhanced tailings governance, which is evident in the anticipated updates to monitoring and regulatory requirements of TSFs from the CDA, MAC, ANCOLD, and ICMM. The promulgated guidance establishes requirements for EoR experience, development requirements for conducting dam safety reviews, and inspections for the ever-changing state-of-practice and associated standard of care. We are beginning to see developments of prescriptive requirements for engaging the EoR and established frameworks for owner-defined responsibilities and expectations thereof. Continued concerns of TSF failures, demands for tailings governance, and new monitoring and regulatory requirements justify the question: do we have enough professional labour resources to serve the mining industry? The lack of labour resources was first brought to the industry's attention by Hatton and Morrison (2016). Our profession needs justifiable estimates of the number and characteristics of TSFs worldwide to make relevant predictions for the labour force needed to serve the mining industry in our collective mission to make tailings management safer for human health and the environment.

Our preliminary literature review revealed that most studies that compile TSF data focus on the 356 documented tailings dam failures that have occurred since 1915 (Bowker and Chambers 2019). Limited studies have been conducted to compile active and inactive TSFs throughout the world. Thus, commonly referenced estimates of the number of worldwide TSFs vary between 3500 (Davies et al. 2000) and 18 400 (Herza et al. 2019).

The Investor Mining and Tailings Safety Initiative sent disclosure request letters regarding TSF data disclosures in April 2019 to 727 publicly listed companies. Disclosed data is currently being compiled by GRID-Arendal in collaboration with the Investor Mining and Tailings Safety Initiative to create the Global Tailings Portal (2020). The most recent release of information from the Global Tailings Portal identified **1939** TSFs and suggests, based on the research presented in this paper, there remains a large information gap with regards to the number of TSFs worldwide (Global Tailings Portal 2020).

This paper presents an initial estimate of the number of TSFs that is then used to estimate the labour resources necessary to service these structures in our global economy. The information available is generally sparse with limited documentation concerning the existence of TSFs, let alone the additional information related to physical geometry, downstream consequences, and risks of failure. The initial presentation of these data was in a keynote lecture at the 2019 Tailings and Mine Waste Conference in Vancouver, Canada (Hatton 2019). Since that time, the team has refined the database and will continue to pursue opportunities to improve the efficacy of these data further.

METHODS

Worldwide TSF Inventory

Compilation of Publicly Available Information

An initial literature review was performed to compile data on TSFs for select regions, including North America, South America, and Australia. Focus regions were selected based on anticipated publicly available information. The search was performed using online platforms, including Google Scholar, Colorado State University Library, and OneMine. Literature was queried for the regions as mentioned above with terms such as "tailings," "tailing," and "tails."

Preliminary search efforts for a global inventory of TSFs yielded two potential sources. The International Committee on Large Dams (ICOLD) maintains a World Register of Dams (WRD) with data furnished by the ICOLD National Committees. However, the Secretary-General of ICOLD indicated that 'only very recently' the WRD has included TSFs (LeDelliou 2019, personal communication). On 5 April 2019, the Investor Mining and Safety Initiative issued a request for disclosure of TSFs from 727 publicly listed extractive companies, which includes companies in mining, oil, and gas industries. As of 20 December 2019, 46% of the companies contacted responded with disclosures of TSFs.

Direct Contact with Regulatory Agencies

Screening for a global TSF inventory was supplemented with efforts to locate publicly available TSF inventories at the national level with a continued focus on North America, South America, and Australia. Direct contact was initiated with regulators via email at the state and/or province-level within Australia, Canada, and the United States (Table 1) to identify the quantity and characteristics of TSFs within each regulatory jurisdiction. The specific agencies contacted for each jurisdictional region are summarized in Table 1. Agencies that responded with TSF information are bolded in the table below.

Table 1. Summary of Regulatory Agencies Contacted

Country	**Regulator** (Jurisdictional Region Contacted)
United States	**Mine Safety and Health Administration** (United States), Bureau of Land Management (Alaska, Arizona, California, Colorado, Idaho, Nevada, Oregon/Washington, **Utah**, Wyoming), **Department of Natural Resources** (Colorado), **Department of Water Resources** (Idaho), **Division of Environmental Protection** (Nevada).
Canada	Enterprise and Trade Resource Development Division (Manitoba), **Department of Natural Resources and Energy Development** (New Brunswick), Dam Safety Program (Newfoundland and Labrador) **Mackenzie Valley Land and Water Board** (Northwest Territories**), Environment, Inspection Compliance and Enforcement** (Nova Scotia**), Ministry of Energy, Northern Development and Mines** (Ontario), Ministry of Natural Resources and Forestry (Ontario), **Ministry of Environment, Environmental Protection Division** (Saskatchewan), Minerals Resources Branch (Yukon Territory), Yukon Water Board (Yukon Territory), **Energy, Mines and Resources, Mineral Resources** (Yukon)
Australia	Department of National Resources, Mines and Energy (Queensland), Department of Environment and Science (Queensland), **Department for Energy and Mining** (South Australia), Environment Protection Authority, Licensing and Community Responses (South Australia), **Department of Primary Industries, Parks, Water and Environment** (Tasmania), Department of Environment, Land, Water, and Planning (Victoria), **Department of Jobs, Precincts and Regions** (Victoria), **Department of Mines, Industry Regulation and Safety, Resource and Environmental Compliance Division** (Western Australia)

Note: Regulatory Agencies that responded with TSF information are noted in **bold** font

TSF Classification Types

Acquired TSF inventories were screened for available information pertaining to dam geometry and/or risk criteria and subsequently divided into classification types. Criteria used to separate TSFs into classification types were selected for convenience in our work with the recognition that there are multiple permutations and screening levels that could be applied. These screening criteria were tailored to the available resource databases.

The TSF classification types were developed to proportionally estimate labour resources with an inherent understanding that the level of effort required to service a smaller, lower production TSF (for example) is less compared to a sizeable, world-class facility. In this example, the smaller facility would require a much smaller amount of time to provide appropriate EoR support (eg eight hours of senior engineer time per month), whereas a large, world-class facility would require a dedicated team of professionals working daily throughout the structure's operational life. A similar proportional distribution of labour resource time could be applied when TSFs are viewed in terms of risk classification as assigned by their given jurisdictions, with high-risk TSFs requiring more time.

In recognition that every TSF is unique, (i) dam height and (ii) hazard or risk rating categories were used to assign three TSF classifications for each: Type A, Type B, and Type C (described subsequently). The TSF classification types helped address variability across the inventoried TSFs and served to simplify the albeit rough estimate of labour resource needs.

An initial comparison was made between the number and percentages of TSFs falling within the Types A, B, and C classifications for jurisdictions with available information. The proportion range for Types A, B, and C defined from this exercise were subsequently extrapolated to our estimate of TSFs worldwide to assign classification types for labour force calculations.

Screening Criteria by Height

Dam geometry was initially selected as a screening criterion with the intent to use available TSF characteristics, such as embankment height, surface area, storage volume, or other attributes in the compiled information. Embankment (crest) height was the most ubiquitous TSF characteristic within the inventories available, while other data was often limited. Therefore, height was selected as the preferred screening criterion.

TSFs were grouped into the following three classification types based on crest height (thresholds arbitrarily selected) provided in the available inventories:

- Type A – small structures with crest height < 12 m (40 ft);
- Type B – intermediate structures with crest height > 12 m (40 ft) but < 30 m (100 ft); and
- Type C – large structures with crest height > 30 m (100 ft).

Within a given classification type, other TSF characteristics, such as retained tailings or pond surface area, vary due to different elevation and topography characteristics between structures. For example, in mountainous regions, TSFs with high crest heights built across narrow valleys may contain small volumes of tailings compared to TSFs built on flatter topography where low crest heights can retain large volumes of tailings. Thus, using only crest height as a screening tool does not capture the substantial differences between any two TSFs and is not a reliable indicator of risk when compared to other geometric characteristics.

Screening Criteria by Hazard

Hazard or risk rating was the second criterion used for assigning TSF classification type. Different guidelines were used to assign risk/hazard ratings in TSF inventories for the U.S., Canada, and Brazil. For example, the United States hazard potential is defined by the Mine Safety Health Administration (MSHA) as “low,” “significant”, or “high” following the Federal Emergency Management Act (FEMA 1998). In Canada, consequence potentials are defined as “low,” “significant,” “high,” “very high,” or “extreme,” as outlined by the Canadian Dam Association (CDA 2013). Finally, in Brazil, the Agência Nacional de Mineração (2019) assigns each TSF a potential associated damage rating of “low,” “medium,” or “high.”

TSFs from the U.S., Canada, and Brazil were separated into the following classification types:

- Type A – low hazard potential (United States), low consequence potential (Canada), and low potential associated damage (Brazil);
- Type B – significant hazard potential (United States), significant consequence potential (Canada), high consequence potential (Canada), and medium potential associated damage (Brazil); and

- Type C – high hazard potential (United States), very high consequence potential (Canada), extreme consequence potential (Canada), and high potential associated damage (Brazil).

The selected hazard potential classification types were not meant to represent an established risk or hazard classification, but only to serve as a constructive grouping for comparison and to support labour force calculations presented below.

Personnel and Labour Resource Calculations

The exercise for calculating labour resources needs was conservatively approached with simplified assumptions using broad generalisations with the intent of obtaining an order of magnitude estimate. This estimate, in this context, has been made to illustrate the more significant point regarding available tailings professional resources within the industry.

Calculations for personnel and labour resources were estimated with consideration of requirements for TSF governance and informed by our experience in the execution of EoR duties. Limits for resource demands were further refined and focused on a tangible, measurable task such as the requirements for servicing the facility as the EoR. The service needs of an EoR for a given type of TSF (eg Type A, B, C) were assumed to be generally consistent based on anticipated needs and represent activities that can be estimated and roughly quantified. Assumptions used for quantification of EoR duties as described within this paper was associated with day-to-day TSF operations based on established or forthcoming governance. These responsibilities cover the interaction with operations and the continuous engineering support required.

The resource demand calculations included operational support for day-to-day safe dam operation and intentionally excluded the engineering demand outside of EoR, such as the design of capital expenditure projects (CAPEX), sustaining capital projects, and specific aspects of operational expenditures (OPEX). The exercise also focused on the use of external resources with an outside party serving as the EoR, which is a common approach in the industry. Associated overhead costs, supporting labour such as word processing, and other administrative support services such as drafting and communications were not included.

A summary of the personnel, billing rates, and resource demands used for the labour resource calculations is presented in Table 2 below. The EoR is assumed to be a Senior Engineer that fulfills the following expectations:

- Subject matter expert in tailings dam design, construction, and operation,
- 10 years (minimum) of qualifying experience,
- Liaise with responsible tailings facility engineer(s),
- Regular and proactive engagement with operations,
- Conduct regular dam safety inspections (eg monthly, quarterly, annually),
- Develop and/or update operational documents (eg Emergency Action Plans, Operation, and Maintenance Manuals, Tracking Action Response Plans [TARPs], Emergency Preparedness Response Plan [EPRP]),
- Oversee environmental and regulatory compliance,
- Prepare for third-party reviews, and,
- Support tailings stewardship boards.

Table 2. Personnel, Rates, and Resource Demands Used for Labour Resource Calculations.

Personnel	Experience	Billing	Resource Demand as Billable Hours per Month		
			Type A TSF	Type B TSF	Type C TSF
EoR	10-25 years	$200 USD/hour	8	48	64
Junior Eng.	5-10 years	$140 USD/hour	16	48	120

RESULTS

Worldwide TSF Inventory

Literature Review

A summary of country-specific TSF quantities based on numbers reported in the literature is in Table 3. The literature review revealed two sources widely referenced regarding the estimated number of global TSFs. Davies et al. (2000) provide an estimate of "more than 3500 tailings storage facilities worldwide," which included TSFs quantified in Western Australia, Quebec, British Columbia, South Africa, and Zimbabwe. Azam and Li (2010) directly reference "a world inventory of 18,401 mine sites". Other papers found in the literature (eg Herza et al. 2019) reference Azam and Li (2010) as approximately **18 400** tailings storage facilities, which appears to assume that each mine site, on average, has one TSF.

Table 3. Tailings Storage Facility Quantities Reported in Literature

Region	TSFs Reported	Literature Source
Peru	183	H.R. Wallingford 2019
China	8869	Li, Agioutantis, & Zou 2017
South Africa	400	Davies, Martin, & Lighthall 2000
Zimbabwe	500	Davies, Martin, & Lighthall 2000
Alberta	48	Alberta Energy Regulator 2018
British Columbia	98	Chernoloz 2017; Government of British Columbia 2015
British Columbia	118	Casino Mining Corp
British Columbia	130	Davies, Martin, & Lighthall 2000
Quebec	65	Davies, Martin, & Lighthall 2000
Western Australia	350	Davies, Martin, & Lighthall 2000
Western Australia	800	ASMJ 2019
Brazil	633	Oliveira & Kerbauy 2016
Chile	449	Villavicencio 2013
Chile	740	Honrubia 2019
Chile	660	Ghorbani & Kuan 2016

Internet Resources

Global

The current version of ICOLD's WRD, updated in September 2019, includes 74 dams with a listed purpose of "tailings." After manual inspection of the inventory, an additional 65 TSFs were identified by the words “tails” or “tailings” contained in the name. These additional 65 TSFs were classified with the purpose of “Other” and not “Tailings.” Including these facilities identified by name, the current WRD contains 139 TSFs.

As of 30 January 2020, the total number of individual TSFs submitted to and compiled by the Investor Mining and Safety Initiative was 1939, which pertain to 305 mining operators at 764 mine sites within 60 countries (Figure 1). The currently disclosed volume of tailings in storage totals 45 billion m^3 (Global Tailings Portal 2020). Information disclosed through the Investor Mining and Tailings Safety Initiative is publicly available on both the Church of England website and the Global Tailings Portal website hosted by GRID-Arsenal.

National Inventories

Publicly available national inventories were found for the U.S., Chile, and Brazil. Three TSF inventories were obtained for the U.S.: (i) MSHA, (ii) National Performance of Dams Program (NPDP), and (iii) National Inventory of Dams (NID), facilitated by the United States Army Corps of Engineers (USACE). The Mine Safety and Health Impoundment inventory (MSHA 2019) contains active dams associated with MSHA regulated sites that are classified by purpose. In the MSHA database, there currently are 470 dams that classify as “tailings” or contain “tails” or “tailings” within the name of the impoundment.

The NPDP (NPDP 2015) is an inventory compiled by Stanford University that includes active and inactive dams, of which 848 dams identify with the purpose “tailings.” Finally, the NID (NID 2018) is an inventory maintained by the USACE that also contains active and inactive dams classified by purpose. As of 2018, the NID reports 1363 dams in the U.S. with purpose listed as “tailings.” The NID is believed to be the most complete database as MSHA provides its list of active dams to the NID each year.

A national compilation for Chile is published by the Servicio Nacional de Geología y Minería of Chile (2019). The published inventory in 2019 includes 742 tailings storage facilities, which are classified as “depositos relaves” in the Chilean compilation. Similarly, the Agência Nacional de Mineração of Brazil (2019) published an inventory of “barragens de mineração” on 31 January 2019, through which 717 tailings storage facilities were identified.

Direct Contact with Regulatory Agencies

Direct contact with regulatory agencies in the U.S., Canada, and Australia provided additional TSF data. The number of TSFs reported from regulatory jurisdictions are summarized in Table 4. The coverage of any single country was not complete. However, reported TSFs by regional jurisdiction provided valuable data to compare with the national inventories.

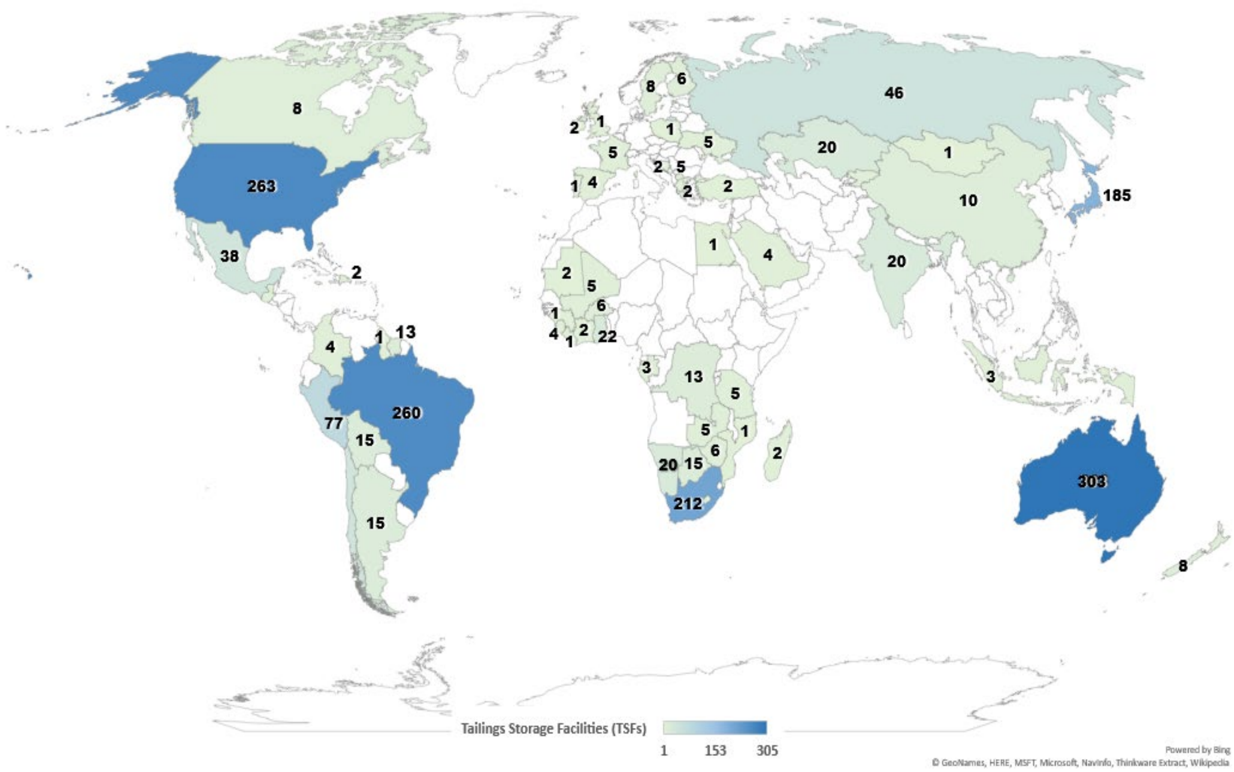

Figure 1. TSFs disclosed as of 30/1/2020 from the Investor Mining & Tailings Safety Initiative request for disclosure.

Table 4. Tailings Storage Facilities Reported From Direct Contact with Regulators

Country	Jurisdictional Region	Regulator Reported Tailings Storage Facilities
United States	Idaho	39
	Nevada	150
Canada	New Brunswick	19
	Newfoundland and Labrador	60
	Northwest Territories	10
	Nova Scotia	15
	Ontario	30
	Saskatchewan	18
	Yukon Territory	10
Australia	New South Wales	59
	South Australia	33
	Tasmania	16
	Victoria	10

National TSF Compilation and Global Estimate

National estimates of the number of TSFs throughout the world are shown in Figure 2. Publicly available information on TSF quantities was combined with state/provincial regulatory data to create national estimates. Each national TSF estimate was rounded to the nearest ten to reflect data uncertainty for each country as well as variability in the number of TSFs for a given country when referencing different databases. Also included in Figure 2 are reported TSFs in the Church of England database for countries not yet compiled in this study.

United States

Comparisons between the number of TSFs reported in three available inventories for the U.S. and reported directly from the regulator are in Table 5. The MSHA database provided the lowest quantity of reported TSFs. The regulator provided the highest number of TSFs for the two states evaluated (Nevada and Idaho). The MSHA impoundment inventory only reported active TSFs, of which they report 560 active TSFs in the U.S. Data from the MSHA inventory are provided to the NID data, who report a total of 1370 active and inactive TSFs. In this study, the NID estimate was used for labour resource calculations under the presumption that inactive dams still require engineering oversight. The NID also maintains the most substantial, current, and comprehensive data set on tailings storage facilities within each state.

Table 5. Comparison of Tailings Storage Facilities Reported by Public Inventories and Regulators

	Idaho	Nevada	Arizona	Texas
MSHA 2019 Inventory	6	18	24	1
NPDP 2015 Stanford Inventory	36	74	12	46
NID 2018 Inventory	22	74	11	50
Regulator Reported	39	150	---	---

Canada

Publicly available data in literature were combined with regulator-provided estimates to generate an estimate of 370-410 TSFs in Canada. The range, for example, represents varying estimates in literature for the number of TSFs in British Columbia. No references or responses from regulators were obtained for Manitoba, Prince Edward Island, or the Nunavut Territory.

Australia

Publicly available data in literature were combined with regulator-provided estimates to generate an estimate of 610 - 1090 TSFs in Australia. The large range in TSFs reflects discrepancies between several literature sources, and the regulator provided information for Western Australia. For example, Davies and Martin (2000) refer to 350 tailings dams within the state, while the Australian Safety and Mine Journal (2019) reports more than 800 TSFs. The mine infrastructure database available through the Department of Mines, Industry, Regulation and Safety (2019) indicates there are 976 entries classified as TSFs. However, multiple entries could be associated with a single TSF (for example, one TSF can have several cells, with each cell having an entry in the infrastructure database). No references or responses from regulators were obtained for Queensland or the Northern Territory.

South America

National estimates of TSF in South America were used directly from the reporting organization. The Agência Nacional de Mineração in Brazil reports 720 TSFs and the Servicio Nacional de

Geología y Minería in Chile reports 750 TSFs. An estimate of 190 TSFs in Peru was taken from the Wallingford (2019), which references the Organismo Supervisor de la Inversión en Energía y Minería website inventory on TSFs. The remaining countries in South America are still being researched to obtain estimates of the number of TSFs.

Other

National estimates of TSFs for the remaining countries throughout the world are also in progress. Estimates in Figure 2 developed in this study include 8870 TSFs in China (Agioutantis and Zou 2017), as well as 400 TSFs in South Africa and 500 TSFs in Zimbabwe obtained from Davies et al. (2000). All remaining estimates in Figure 2 shown as grey text with grey-highlighted countries were derived from the Global Tailings Portal's current disclosure.

Global Estimate

Our study found 12 970 - 14 300 active and inactive tailings storage facilities in the following countries: Canada, United States, Brazil, Peru, Chile, China, Zimbabwe, South Africa, and Australia. Including the addition, 550 TSFs disclosed on the Global Tailings Portal in countries outside of the ones listed above suggests more than 13 520 - 14 850 active and inactive TSFs worldwide. The lowest estimated quantity of TSFs worldwide, for this paper, totals 15 000 incorporating the number of countries with partial disclosure of information from the Investor Mining and Tailings Safety Initiative and countries lacking any information on TSF quantities.

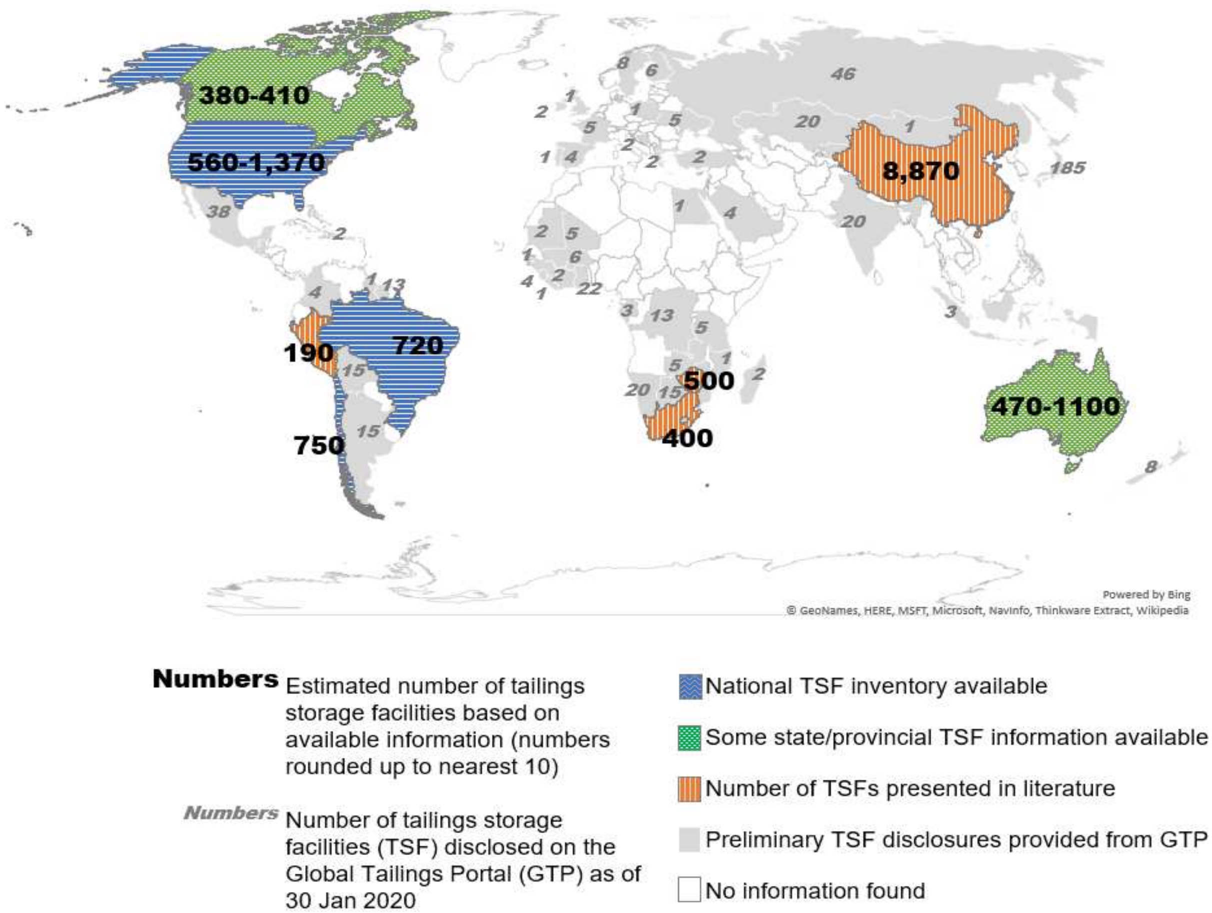

Figure 2. Available Information on Tailings Storage Facilities by Country

TSF Classifications

Inventories acquired that included information on TSF geometry and/or hazard/risk classification included the following: United States, Brazil, New South Wales (Australia), Tasmania (Australia), New Brunswick (Canada), and Alberta (Canada). Estimates of the number of TSFs and proportion of Type A, B, or C TSF classification are summarized below in Table 6 for embankment crest height and in Table 7 for hazard potential.

TSF classification by crest height (Table 5) yielded a wide range of type distributions by country. Type A classifications ranged from 8% - 63%, Type B from 17% - 50%, and Type C from 13% - 75%. Data from Australia and Canada are only available for two jurisdictional regions representing less than 100 TSFs in each country. These data are therefore judged to be not representative of the distribution of dam geometry country-wide. Data from the U.S. and Brazil appear to reasonably cover active and inactive TSFs within the country and have detailed information on geometry.

	United States		**Brazil**		**Australia**				**Canada**			
					New South Wales		Tasmania		New Brunswick		Alberta	
Tailings Storage Facilities	**1362**		**717**		**58**		**16**		**19**		**48**	
Type A Height < 40ft	593	43%	361	50%	12	21%	10	63%	4	21%	4	8%
Type B 40ft ≤ Height ≤100ft	542	40%	231	32%	29	50%	4	25%	12	63%	8	17%
Type C Height > 100ft	227	17%	125	17%	17	29%	2	13%	3	16%	36	75%

TSF classification by hazard (Table 7) resulted in a heavier classification of Type C dams. Type A classifications ranged from 0% - 32%, Type B from 17% - 37%, and Type C from 30% - 63%. The dam inventory available for Alberta, Canada, contains only “high consequence” dams and therefore does not include any Type A TSFs, skewing the classification distribution towards the Type C category. TSF data for New Brunswick only includes hazard classifications for 10 of the 19 TSFs within the inventory. Data from the U.S. and Brazil appear to comprehensively cover active and inactive TSFs within the country and have detailed information on geometry.

The highest country-wide coverage and level of detail in disclosed information is available for the inventories of active TSFs within the United States (MSHA 2019) and within Brazil (Agência Nacional de Mineração 2019). Note: of the 717 TSFs listed in Brazil, 292 do not have an associated potential damage rating. Percentages calculated for this study are percentages of the categorized 425 TSFs. A comparison was made between the U.S. and Brazil to assess similarities and differences in the percent distribution of TSFs in the three classification types. Figure 3 shows the distribution of Type A, Type B, and Type C TSFs within Brazil and the U.S. based on height and hazard classification.

Classification by crest height is biased towards small dams, as shown in Figure 3. This is likely attributed to not accounting for other factors (eg the volume of tailings impounded, distance from towns/cities, etc.) that can influence the hazard rating. In contrast, the hazard rating is biased toward high hazard facilities. Thus, using both estimates for labour resources led to what is believed a lower-bound estimate based on crest height and upper bound estimate based on hazard potential.

Table 7. Tailings Storage Facility Screening by Hazard Classification

	United States		Brazil		Canada			
					New Brunswick		Alberta	
Tailings Storage Facilities	**559**		**425**		**10**		**48**	
Type A "Low" Hazard	180	32%	50	12%	4	40%	0	0%
Type B "Medium" Hazard	94	17%	157	37%	3	30%	18	38%
Type C "High" Hazard	285	51%	218	51%	3	30%	30	63%
Not classified	0	---	292	---	9	---	0	---

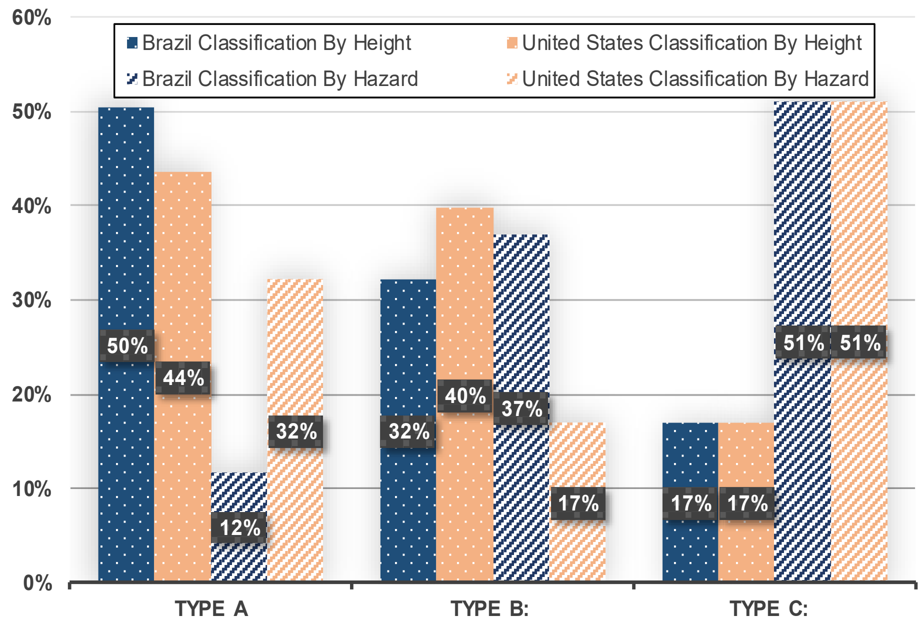

Figure 3. TSF Classifications by Type

Personnel and Labour Resource Calculations

Estimates of annual personnel and labour resources required to service the current estimate of 15 000 global TSFs are shown in Table 7. The ranges of percent contribution of TSFs for each type classification were chosen from the data available for the United States and Brazil due to the high quality of information available on tailings dam quantities and characteristics for these two countries. For each range of type distribution, the monthly hours for junior engineers and EoRs were calculated using the labour distribution by type described above in Table 2. The number of monthly hours was then multiplied by the billing rate shown in Table 2 to calculate a total annual cost in USD. Finally, using a 52-week average year and an average of 40 hours per week, the number of full-time equivalents (FTEs) were calculated by dividing the total number of hours for each engineer type by the 2080 average work hours per FTE per year.

The calculations from this study indicate that the annual cost for EoR duties totals between $2.2 – $3.9 billion USD. The estimate shows, based on our assumptions and inputs, that roughly **6500 to 11 500 FTEs will be required to provide EoR services annually**.

Table 7. Estimates of TSF Type Classification and Labour Resource Demands.

TSF Screening Criteria	Percent Contribution of TSFs			Annual Cost (USD)	Full Time Equivalents (FTEs) - Junior Engineer	FTEs - Engineer of Record (EoR)
	Type A	Type B	Type C			
Crest Height	44 – 51	32 – 40	17	$2.2 - 2.4 billion	3800 - 4030	2630 - 2900
Hazard Potential	12 – 32	17 – 37	51	$3.4 - 3.9 billion	6450 - 7000	3760 - 4450

CALL TO ACTION

The shrinking numbers of talent within the industry – through retirement and lack of “fresh” tailings personnel entering in the past 20 years – is significant, and the time required to develop sustainable personnel resources that comply with the existing and known forthcoming guidance must be thoroughly developed within the next decade. This is a call to action directed at the Owners and Operators, Tailings Consultants, and Universities and Colleges. This triumvirate of resources must provide the training ground for individuals that would eventually serve the role of the Engineer of Record (EoR).

These groups are interlinked regarding mutual financial and resource support needs, and each should serve as an asset to TSF stewardship. Competition between these groups and a lack of collaboration will continue to dilute the resource base negatively. We need to change the way we do business.

This is a call to action for mining industry Owners and Operators. The greater community is asking Owners and Operators to:

- Commit to TSF planning and operation with a “no failures” mindset,
- Raise awareness of the necessity of mining in the global supply chain and that waste management including TSFs are a fundamental necessity to almost every operation,
- Develop comprehensive and well-structured stewardship programs that include comprehensive training programs,
- Deliberate and evaluate the long-term effects of every decision made or not made, and temper quarterly reporting that lacks alignment with long-term vision and stewardship needs. In other words, quit kicking the can down the road,
- Engage and share resources through training, secondment, and apprenticeships,
- Establish favorable contract conditions that allow consultants and universities to function as partners and extensions of the operations. These resources should be used to provide a knowledge transfer, not a liability transfer,
- Commit to extending the State of the Practice through research and embracing innovations;
- Allow and encourage service providers to share project experiences to advance the State of the Practice. The amount of experience and information that has been prevented from dissemination by intervention from corporate attorneys and other company

representatives over the last 20 years is immense and to the detriment of the industry, and
- Share lessons learned and best practices with peers, even externally.

This is a call to action for Tailings Consultants. The greater community is asking Tailings Consultants to:

- Pledge to protect communities and the environment through safe and robust TSF design,
- Commit to developing and sustaining the EoR role through comprehensive training programs, focused mentorship from senior practitioners, and practicable attrition programs,
- Cultivate a "dirty boots" mindset through site visits and engaging with site operations personnel. Sitting behind a desk for 10 years will not create a high-caliber, proactive EoR,
- Engage with local universities or alma matters to help attract new talent,
- Provide and support continued education opportunities, industry initiatives, and thereby advance the State of the Practice. This initiative should include shared resources through training, secondment and apprenticeships,
- Commit to developing soft skills and raising the emotional IQ of engineers and scientists, and
- Encourage and even demand practitioners publish journal articles, conference papers, and white papers.

This is a call to action for Universities and Colleges worldwide. The greater community is asking Universities and Colleges worldwide to:

- Bridge the gap between mining and civil engineering programs to develop tailings-centric curriculum and elevate tailings engineering as a viable area of focus,
- Invest in research and laboratory support to evaluate tailings with an understanding of the industry values practicality and applicability,
- Develop certification programs related to tailings engineering and tailings/deposition management techniques, and
- Engage undergraduate leadership in the training of individuals at the university level.

These groups provide the resources available in the tailings labour pool, but there are, however, two additional groups that have a profound effect on the industry. It is now time to demand a call to action from the nongovernmental organisations (NGOs) and regulatory agencies. These groups provide a significant backdrop to the enforcement of established guidelines as well as represent a link beyond our industry to the greater public at large. The greater community is asking NGOs and regulatory agencies worldwide to:

- Invest in universities and colleges for training,
- Develop core practitioners with a comprehensive technical and practical understanding of TSF <u>design and operation including</u> engineering principles and operating constraints from both a professional and a nontechnical standpoint,
- Acknowledge the contribution to consumer goods and technological/digital innovation mining provides – remember, "if it can't be grown, it must be mined,"
- Acknowledge the government's role and responsibility in sustainable mining and enforcing their designated legal frameworks,
- Learn to interact with a high emotional IQ and establish these expectations within peer groups,

- Understand and respect the difference between transparency and entitlement
- Avoid the development, support, and deployment of pseudoscience,
- Communicate with the general public in a way that is educational and fair, and
- Avoid public shaming when the standard of care is met, and negligence is unproven (see BC regulatory agencies).

Finally, there is a call to each of us as individuals. The greater community is asking each of us for our contributions beyond the work environment including:

- Mentoring and actively cultivating young professionals and "who's next",
- Exercising personal accountability for professional growth, from both technical and emotional IQ/"soft skill" perspectives,
- Engaging in and supporting Science Technology Engineering and Math (STEM) -based educational initiatives beginning at the elementary school level, drawing attention to the earth sciences and not just technology, and
- Advocating for OUR mining industry.

We need to change the philosophy and alignment of the industry. As an industry, we need to raise our emotional IQ. We need to understand the spirit of transparency and the need to share information. Together we will get farther faster. We need to share lessons learned from best practices and negative experiences and focus on making positive contributions. We also need to understand that openness contributes to the State of the Practice; it does not provide access to business strategies and other proprietary information, so there is nothing to "protect."

We need to maintain a vigilant awareness that our professional decisions create wider repercussions to surrounding communities, the environment, and even investors; as such, we must strive for excellence. But when bad things happen – and they will – we need to thoughtfully evaluate the causes, present solutions and implement improvements moving forward, thus capitalizing on a learning opportunity in a mature fashion. Collectively and collaboratively, we can improve the industry "black eye" tailings disasters have created. The future does not exist without mining, and safer TSFs do not exist without all of us working together.

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APPENDIX B – MINE WASTE AND TAILINGS 2021 CONFERENCE PAPER SUBMISSION

Deck Hands Needed! Experience Necessary – Addressing the Impending Qualified Tailings Professional Resource Shortage

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ABSTRACT

The mining industry is experiencing change in the governance of tailings facilities (TFs). Guidance and regulations across many jurisdictions contribute to this amorphous change. The Canadian Dam Association, Mining Association of Canada, Australian National Committee on Large Dams, and the Global Industry Standard on Tailings Management, produced by the International Council on Mining and Metals, are establishing guidelines for more rigorous industry governance. Evolving guidance regarding TFs is developing concurrently with a shortage of experienced tailings engineers, which adversely affects the resource base available to support new governance. This paper presents an updated semi-quantitative estimate of the impending resource shortage of qualified tailings professionals. Updates are provided herein for the estimated number of TFs worldwide, which included available data on active and inactive TFs, as well as the estimated labor resources required to service these facilities. The tailings labor shortage is discussed in the context of academic and professional training currently available to increase the quantity of trained personnel. This paper represents a discrete moment in time as contributions to the available information and inventories accessed continue to improve, but as of today are incomplete. However, the data and information included provide insight into the resource deficiencies currently within our profession, training and education opportunities to address those resource deficiencies, and a snapshot of a recent professional training course offered on mine tailings.

INTRODUCTION

Tailings facility (TF) failures during the last decade have forced the industry to re-evaluate and establish enhanced tailings governance, as evident in the updates to monitoring and management guidance for TFs from the Canadian Dam Association (CDA), Mining Association of Canada (MAC), Australian National Committee on Large Dams (ANCOLD), and International Council on Mining and Metals (ICMM). At the core of these promulgated guidance documents is the pivotal role of the Engineer of Record (EoR). Each guidance establishes responsibilities and requirements for EoR, proposes experience criteria, provides requirements for continued engagement in TF design, construction, and safety inspection, and reviews for the ever-changing state-of-practice and associated standard of care.

The role of engineering engagement during a TF operation varies depending on location. The Global Industry Standard for Tailings Management (GISTM) has placed a fine point on the need for proper engineering support to execute guidance. The EoR, a new concept to many and an established standard for others, is now a prized commodity. The continued focus on TF failures, demands for tailings governance, and new monitoring and regulatory requirements, raise the question: do we have sufficient qualified professionals to serve the mining industry now and into the future?

The lack of labor resources was qualitatively brought to the industry's attention by Hatton and Morrison (2016). Hatton and Spencer (2019) attempted to quantify the number of TFs and relative lack of resources in the industry as presented in a keynote lecture at Tailings and Mine Waste 2019. Further efforts were made and expanded upon in Hatton et al. (2020) based on the rapidly evolving state of tailings engineering. The mining industry and our profession in particular need justifiable estimates of the number and characteristics of TFs worldwide to make relevant predictions for the labor force needed to serve the mining industry in our collective mission to make extraction of critical minerals safe for human health and the environment.

Key to understanding the labor shortage is to identify the quantity of TFs worldwide, as attempted and expanded in earlier papers (Hatton and Spencer 2019, Hatton et al 2020). In the review stages of those papers, the authors found that most studies that compile TF data focus on the documented failures that have occurred since 1915. Limited studies have been conducted to compile active and inactive TFs worldwide. Thus, commonly referenced estimates of the numbers vary between 3 500 (Davies et al. 2000) and 18 400 (Herza et al. 2019). With this in mind, Hatton et al. (2020) converged on a reasonable estimate of global TFs of approximately 15 000 within the jurisdictions queried (Canada, United States, Brazil, Peru, Chile, China, Zimbabwe, South Africa, and Australia). Methods employed to catalog inactive and active TFs worldwide included searching technical literature (peer-reviewed journal and conference papers) on TF quantities, existing global and national dam or TF inventories, information published by regulatory agencies, and information received from direct contact with regulators. Initial regions of focus included North America, South America, and Australia due to readily available information. The efforts also included the 1939 TFs initially disclosed and categorized associated with the Global Tailings Portal as of 30 January 2020 (Global Tailings Portal, 2020). The initial estimate from the Global Tailings Portal included an unresolved population of TFs yet to be defined and included.

Hatton et al. (2020) found between 12 970 – 14 300 well documented active and inactive TFs in Canada, United States, Brazil, Peru, Chile, China, Zimbabwe, South Africa, and Australia combined. Including the additional 550 TFs disclosed on the Global Tailings Portal in countries outside those listed suggests there are at least 13 520 to 14 850 active and inactive TFs worldwide. A total of 15 000 was selected as a conservative estimate of TFs worldwide. However, the authors speculated (subjective projection) the number is likely closer to 30 000 based on the number of countries lacking confirmation, partial disclosure of information from the Global Tailings Portal, and countries lacking any information on TF quantities.

As a next step, Hatton et al. (2020) recognize that every TF is unique and that the governance and operational needs and demands, including labor, vary among TFs. Given that the goal was to estimate labor demands, TFs were grouped into common bins. Acquired TF inventories were screened for available information pertaining to dam geometry and/or risk criteria and subsequently divided into classification types. The proportion of TFs within each classification type defined from the exercise were subsequently extrapolated to the estimate of TFs worldwide to calculate labor force requirements for TF management. The idea behind the exercise was to proportionally distribute labor based on size or consequence classification. For example, the labor demand for a large world-class facility is much higher than a smaller lower-production facility.

Average estimates for labor were then proportionally distributed over the global TF quantities to estimate the number of tailings dam professionals needed given current guidance and regulations (including the GISTM). The calculations from Hatton et al. (2020) indicated that the estimated annual cost demand for EoR duties totalled between $2.2 – $3.9 billion USD. Based on simple assumptions and inputs, the estimate shows that conservatively 2 600 to 4 450 EOR full-time equivalents (FTE) would be required to provide EoR services worldwide today.

This paper presents an update to the inventoried TFs, the resulting minimum estimate of TFs worldwide, and the estimated EoR labor resources required to service these facilities. Qualified engineers with the requisite skills necessary for supporting tailings operations are few. A significant gap exists in qualified labor resources necessary to properly serve TFs worldwide, and the existing pathways providing trained professionals to the industry are shrinking. The authors are presently working with industry leaders to raise awareness of the current lack of resources and the need for education and future generations. We must widen the pathways and expand existing training programs to entice more talented entry-, mid-and senior-level professionals.

UPDATE WORLDWIDE TF INVENTORY

A literature review was performed to compile updated data on TFs from publications issued since Hatton et al. (2020). We anticipated that additional disclosures and inventories had been published in response to the recently issued GISTM. The review was performed using online platforms, including Google Scholar, Colorado State University Library, and OneMine. Literature was queried for the regions as mentioned above with terms such as "tailings," "tailing," and "tails." Global databases were re-queried to inventory additions and/or changes. These inventories included the International Committee on Large Dams (ICOLD) World Register of Dams (WRD 2020) with data furnished by ICOLD National Committees and the Global Tailings Portal (2021).

The literature review yielded an updated estimate of 270 TFs within the Witwatersrand Basin in South Africa (Kamunda 2016) and 33 TFs in Bulgaria, of which 12 are active, and 21 are inactive (Chopoy 2016). The current version of ICOLD's WRD, updated in April 2020, includes 115 dams with a listed purpose of "tailings." After manual inspection of the inventory, an additional 67 TFs were identified by the words "tails" or "tailings" contained in the name. These additional 67 TFs were classified with the purpose "other" and not "tailings." Including these facilities identified by name, the current WRD contains 182 TFs, increasing 43 TFs since the initial publication.

As of 15 March 2021, the number of individual TFs compiled on the Global Tailings Portal (2021) totalled 1 862, which pertained to 310 mining operators at 761 mine sites under 106 mining companies. The currently disclosed volume of tailings in storage totals 56 billion m^3, with an anticipated storage volume in 2025 of 69 billion m^3 (Global Tailings Portal, 2021). Information disclosed through the Investor Mining and Tailings Safety Initiative is publicly available on both the Church of England website and the Global Tailings Portal website hosted by GRID-Arendal.

A map with updated TF quantities is shown in Figure 1. The current study identified between 12 880 – 14 820 active and inactive TFs in the following countries: Australia, Brazil, Bulgaria, Canada, Chile, China, Peru, United States, South Africa, and Zimbabwe. Including the additional 550 TFs disclosed on the Global Tailings Portal in countries outside of the counties listed above suggests there are more than 13 430 – 15 370 active and inactive TFs worldwide. Therefore, the estimated quantity of TFs is suggested to be at least 16 000, but still likely closer to a subjective projection of 30 000 given the lack of globally comprehensive inventories. This approximation incorporates the number of countries with partial disclosure of information from the GTP.

Updated estimates of annual personnel and labor resources required for a minimum of 16 000 global TFs are in Table 1. The ranges of percent contribution of TFs for each classification were chosen from data available for the United States and Brazil (Hatton et al. 2020). For each TF type, monthly hours for junior engineers and EoRs were calculated using the labor distribution by type described in Hatton et al. (2020). Monthly hours were then multiplied by billing rate (i.e., EoR = $200 USD/hr and Junior Engineer = $140 USD/hr) to calculate a total annual cost in USD. A 52-week average year and 40-hour average week were used to compute the number of full-time equivalents (FTEs) by dividing the total number of hours for each engineer by the 2080 average work hours per FTE per year.

Calculations from this study indicate that the annual cost for EoR duties totals between $2.3 – $4.1 billion USD. Based on our assumptions and inputs, the estimate shows that roughly 6 900 to 12 200 FTEs will be required to provide EoR services annually. The industry is facing a severe lack of resources. There are many reasons for this, as identified by (Hatton and Spencer 2019), including:

- naturally occurring senior attrition (exacerbated by the size of the baby boomer generation);
- historic commodity price pressure and fluctuation resulting in resource attrition;
- resource scalping by competing industries (e.g., the dot-coms in the mid-1990s); and
- unnecessary and ill-advised public shaming of engineers (e.g., post-Mount Polley).

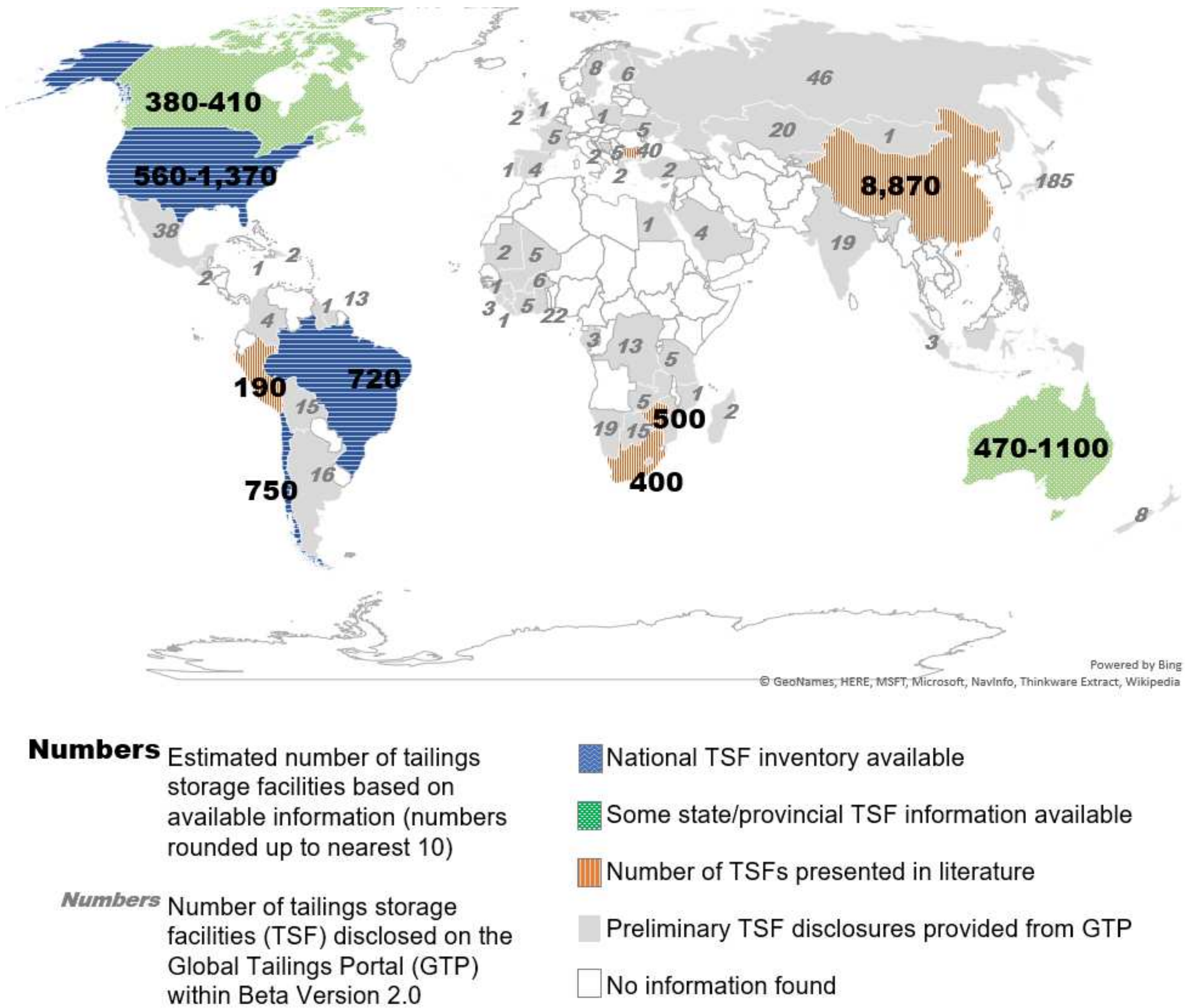

Figure 1. Quantities of Tailings Storage Facilities by Country, which included updated numbers relative to Hatton et al. (2020)

Table 1. Estimates of TF type classification and labor resource demands.

TF Screening Criteria	Percent Contribution of TFs [a]			Annual Cost (USD)	Full-Time Equivalents (FTEs) - Junior Engineer	FTEs - Engineer of Record (EoR)
	Type A	Type B	Type C			
Crest Height	43 – 51	32 – 40	17	\$2.3 – 2.5 billion	4 050 – 4 290	2 800 – 3 090
Hazard Potential	12 – 32	17 – 37	51	\$3.7 – 4.1 billion	6 880 – 7 470	4 000 – 4 740

[a] Classification by dam height: Type A < 12 m, Type B > 12 m and < 30 m, Type C > 30 m. Classification by hazard: Type A = low, Type B = medium, Type C = high (Hatton et al. 2020)

The next question is how we can regenerate these missing resources most effectively. There is a thought that we can fast-track resource development; however, the hard reality is nothing but 10 years of experience can replace 10 years of experience. The logical approach is to educate and train engineers to enhance the current supply of engineers while investing in our future to reduce labor shortages in future years. The remainder of this paper initiates the process of marrying demand with supply. A summary of existing academic and professional training networks that currently serve incoming and existing industry professionals to manage TFs worldwide is provided. With promulgated guidance of the GISTM and forthcoming ICMM guidelines for standard of care, the industry must rapidly evolve to bring more professionals into the industry.

SME MINEXCHANGE – BUILDING THE TAILINGS ENGINEERS AND OPERATORS OF TOMORROW

The MinExchange 2021 Conference, hosted by the Society of Mining, Metallurgy, & Exploration (SME), included a tailings module with presentations by representatives from the industry's leading tailings education and training programs. The module concluded with a tailings panel discussion between eight industry experts presenting the state of practice in tailings education and training, and future training needs to usher in a new age of tailings management. A summary of the existing training programs is presented herein, with select insights from the panel discussion.

Tailings & Mine Waste Conference / Colorado State University

Colorado State University (CSU) has a longstanding relationship with the tailings and mine waste industry. CSU initiated the annual Tailings and Mine Waste (T&MW) Conference as the Uranium Mill Tailings Symposium in 1978. The current T&MW Conference is shared between CSU, the University of British Colombia, and the University of Alberta to broaden the reach and impact of the conference. Proceeds from the T&MW conference support graduate education and research in tailings and mine waste geotechnics.

At CSU, over the past decade, Drs. Christopher Bareither and Joseph Scalia have worked to enrich the undergraduate and graduate focus area of geotechnical and geoenvironmental engineering with mine waste-specific courses, as well as including tailings content in all geo-related courses within the program (e.g., Advance Soil Mechanics; Slope Stability, Seepage, & Earth Dams; Barrier Systems for Waste Containment; etc.). Beginning in 2019, senior design projects centered on tailings dams have been offered to undergraduates. According to Dr.

Bareither, CSU has "developed this culture of graduating and cultivating engineers and inspiring them to move on and become active in a career in pursuit of tailings" (Bareither, 2021).

TAILENG

The Tailings and Industrial Waste Engineering (TAILENG) Center, is a collaboration between Georgia Tech, CSU, University of Illinois, and University of California, Berkeley dedicated to advancing the state of knowledge and practice in the design of tailings and industrial waste storage facilities. A key focus of TAILENG is to offer experiential learning to graduate students through research opportunities and technical training for tailings engineers via short courses. Training offered by TAILENG started in March 2021 with a course entitled *Fundamentals of Tailings Engineering*, which was offered in collaboration with the Tailings Center.

Tailings Center

The Tailings Center is envisioned as an industry-academic cooperative research and education center that includes Colorado School of Mines, Colorado State University, and the University of Arizona. These universities, together, provide a full spectrum of multi-disciplinary skills needed for effective tailings management. Center Director Mike Henderson stated, "[Tailings], as most people know, isn't specifically geotechnical issues or water management issues or geochemistry issues or mineral processing issues. It's all of the above and more" (Henderson, 2021).

The Tailings Center is partnering with industry to provide professional development courses, a supply of trained tailings professionals to the industry, multi-disciplinary research to meet the technical challenges associated with tailings management, and qualified faculty to lead university and educational programs on tailings. The Tailings Center initiated their first six-course, Certificate in Tailings Management, short course series in March 2021.

AusIMM Tailings Management Course

Dr. David Williams of the University of Queensland offered his vision for the ideal tailings professional as one who (i) understands past failings in tailing management, (ii) is trained in the fundamentals of tailings management, (iii) questions and "interrogates" available data and analyses while seeking to reduce uncertainty and add value, and (iv) communicates effectively with the wider community. To facilitate developing these abilities in tailings professionals, Dr. Williams initiated and largely delivers the AusIMM Professional Certificate in Tailings Management, an online, interactive course first offered in Fall 2020. The AusIMM course contains six modules: (1) introduction to tailings management; (2) geotechnical considerations; (3) geochemical and water considerations; (4) governance and surveillance; (5) closure considerations; and (6) socioeconomic considerations.

GHD and Australian Vocational Education & Training

GHD is a multi-disciplined, global professional services company. Their specialized tailings team has a dual approach to tailings training. First, their internal GHD School of Tailings is available to staff in related disciplines, junior staff, and select clients. The GHD School of Tailings includes 25 topics offered online that are presented by internal and external specialists. Second, tailings training is offered as an external, commercial training business for mine site operators. GHD and Water Training Australia (WTA) developed a training course for managers and operators of tailings facilities. The course includes recognition from the Australian Vocational Education and Training (VET) system, which aims to provide skills for work and issue a nationally recognized qualification in a Certificate ranging from level I to IV. The certificates can also lead to diplomas and degrees.

Future Tails

Future Tails is a partnership between the University of Western Australia, Rio Tinto, and BHP to provide training and professional development, further research for innovation, and compile and update industry technical references. Future Tails developed over a period of many months and overlapped with the development of the GISTM. Trainings offered by Future Tails are "tailored very much to meeting the range of expectations regarding personnel in the GISTM" (Fourie, 2021).

Future Tails has developed four topic areas for training geared towards various tailings professionals: Tailings Management for Senior Leaders; Tailings Design and Technology; Tailings Management and Technology; and Tailings Operations. Micro-credentials can be earned via completion of qualifications in each topic area, which can be aggregated or "stacked" towards higher qualifications (e.g., certificate or degree). To expand the research base on tailings and encourage innovation in the industry, Future Tails also offers full-time research scholarships.

The research focus of Future Tails seeks to improve industry practice as well as the training opportunities. Future Tails is creating a technical reference manual containing up-to-date information on the body of knowledge related to tailings management. The technical reference is intended to become a reference for industry and will be updated continuously as research and innovation expand.

Panel Discussion

During the panel discussion, a major theme emphasized was the need for collaboration within academia and between academia and industry. Dr. Dirk Van Zyl asserted that "With the GISTM, it is very clear that tailings engineers in the future will have to be conversant with a broad range of topics. Aside from geotechnical training … we are also going to have to deal with issues around environmental, social, and governance issues." With this multi-disciplinary mindset, training the next generation of tailings engineers will require that universities work together because tailings engineering is multi-disciplinary, and the ability for a single university or single group of individuals to address the multitude of various topics encountered in tailings is challenging. As emphasized by Dr. David Williams, "tailings are easy to transport and difficult to manage … it's a lifelong journey … you need lifelong training, and you'll get it from a diversity of opinions."

Generally, students are not trained specifically in mine tailings but graduate with a license to learn. Opportunities such as Co-Op programs and internships are effective for exposing young engineers to the world of mine tailings. The license to learn obtained by young engineers provides a foundation from which to flourish, and any young engineer's development is substantially enhanced through effective mentorship. No single engineer can be trained for every situation encountered during a career in tailings, but they can be well prepared. The development of skills and expertise is a continual process that must be emphasized throughout one's career. As Mike Henderson noted, "tailings management is changing all the time... every few years there's a fairly significant step up in oversight and regulations and the approach and engineering that goes into it... we are learning and trying to be smarter." Ultimately, tailings are eternal and will require human labor to solve relevant challenges each and every day.

SME Session Reflection

The industry is working feverishly and collaboratively to develop programs focused on training engineers and operators. Some of the most innovative changes are in the training of operators. However, the core of the effort presently is addressing the lack of qualified engineering resources. The programs presented and discussed during the SME session show the beginning of that process, and with time, each will establish their uniqueness. Through cooperation and collaboration these programs provide a kernel for the future training of tailings engineers

The development of a focused program has many challenges. This is, in part, due to the broad skill set necessary to be an effective tailings engineer, which requires knowledge beyond civil engineering and extends into other professional workspaces in both engineering and science. A common thread to any training program is the practical application of theoretical principles. The idea that one can take an engineer that has been in the office for 10 years, place them on an active TF and expect them to be an effective tailings engineer is unreasonable. Therefore, the development of resources, especially entry- and mid-level personnel, requires a commitment to operational exposure and the practical application of engineering principles in a tailings environment.

The GISTM also brings into the discussion elements of social awareness, environmental advocacy, and sustainability. At the foundation of the GISTM is the tenant of transparency and full disclosure. However, the distribution of highly technical information generated by skilled engineering professionals trained in the design operation and closure of TFs requires an equivalent skill in reviewing this information. Thus, a significant amount of pressure is placed upon non-governmental organizations (NGOs), and there is an expectation that these groups will make an equivalent investment in raising their collective skill sets to understand current and future projects and objectively review and query these materials from a place of experience and knowledge.

TRAINING TAILINGS PROFESSIONALS – AN INITIAL PERSPECTIVE

The development of a tailings training program is a significant undertaking and requires considerable skill and expertise in communicating and connecting with recipient engineers. The TAILENG Center and Tailings Center recently collaborated on a 15-hr short course entitled *Fundamentals of Tailings Engineers* that targeted practicing engineers. The objective of the course was to develop a comprehension of mine tailings fundamentals to build the capacity to engage in conversations, projects, research, and subsequent short courses focused on mine tailings. A survey was launched at the start of the course that inquired about the following:

- Generalized field of formal education, highest level of education received, and whether or not mine tailings was part of that formal education;
- Area of current employment, years of experience, and practice as a tailings engineer; and
- Relevant topics in mine tailings where training will benefit one's current career.

A summary of the formal educational training, area of current employment, and years of experience of the 54 course attendees are in Figure 2. A total of 54 responses were received from the 80 short course attendees. As might be expected for a course focusing on 'fundamentals,' 45 of the 54 registrants (83%), indicated that they did not receive formal education in mine tailings. The predominant background of the attendees was engineering, primarily civil engineering. Among the 54 attendees, all were university / college-educated, with 37% at the BS level, 54% at the MS level, and 9% at the Ph.D. level.

The majority of attendees work in consulting and the mining industry, with no more than three responses identifying work for NGOs, regulators, or education. Finally, nearly 65% of the short course attendees had less than 10 years of experience, and more than 45% reported less than 5 years of experience. The years of experience indicate that most of the course attendees were early in their careers and sought supplemental training related to mine tailings.

A summary of topics covered in the short course specified as areas of relevance for an attendee's current work is shown in Figure 3. All topics covered in the introductory course on mine tailings were identified as areas of interest. Topic areas that received the most votes included tailings characteristics, tailings geotechnics, and tailings facility design However, votes for all topic areas and the 18 respondents (33%) who indicated all topics are equally relevant to suggest that there are training needs for all topics associated with mine tailings.

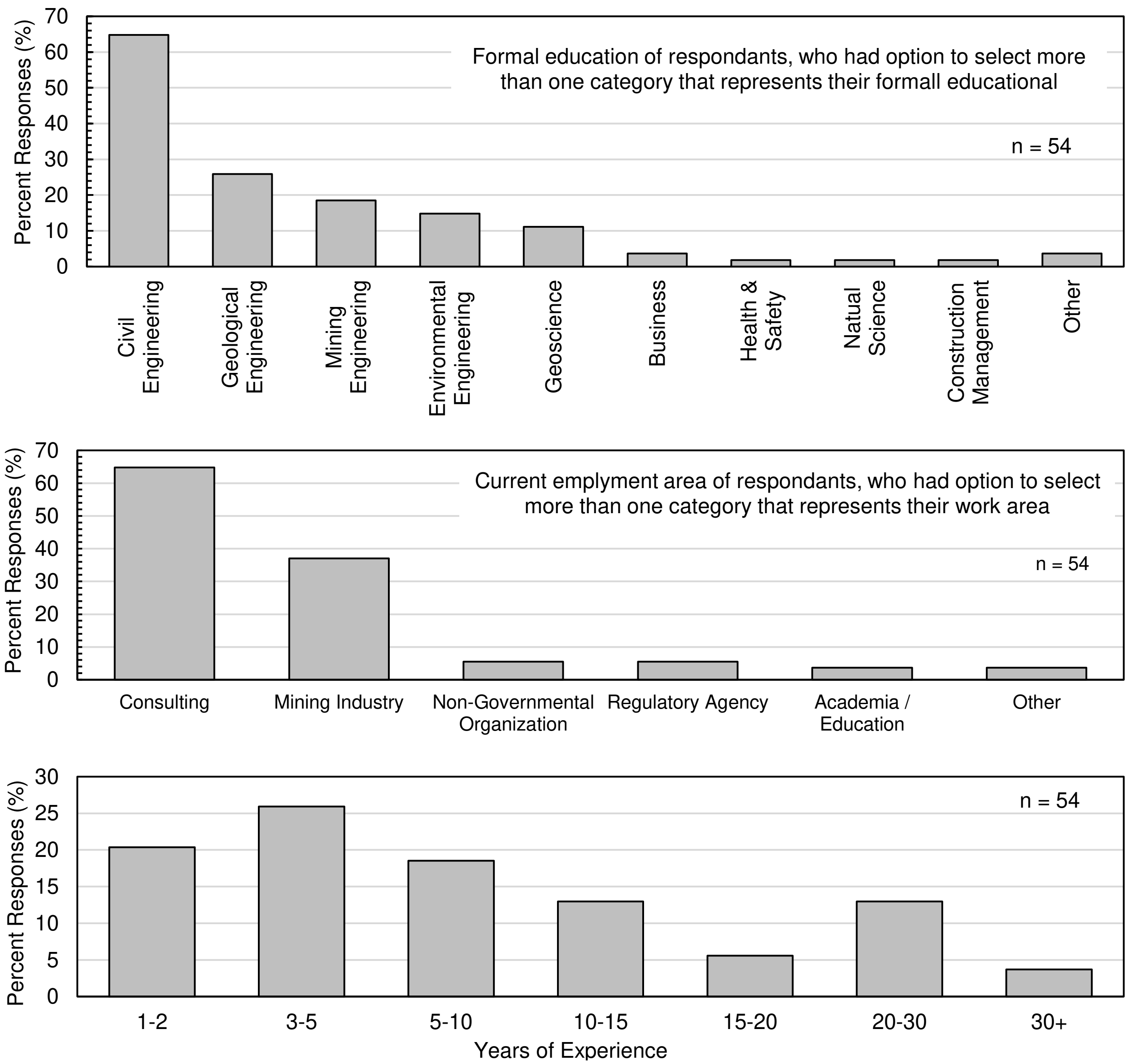

Figure 2. Summary of percent of responses from short course attendees pertaining to (a) formal area of education, (b) current area of employment, and (c) years of experience. Attendees were able to select multiple options for formal education and current employment.

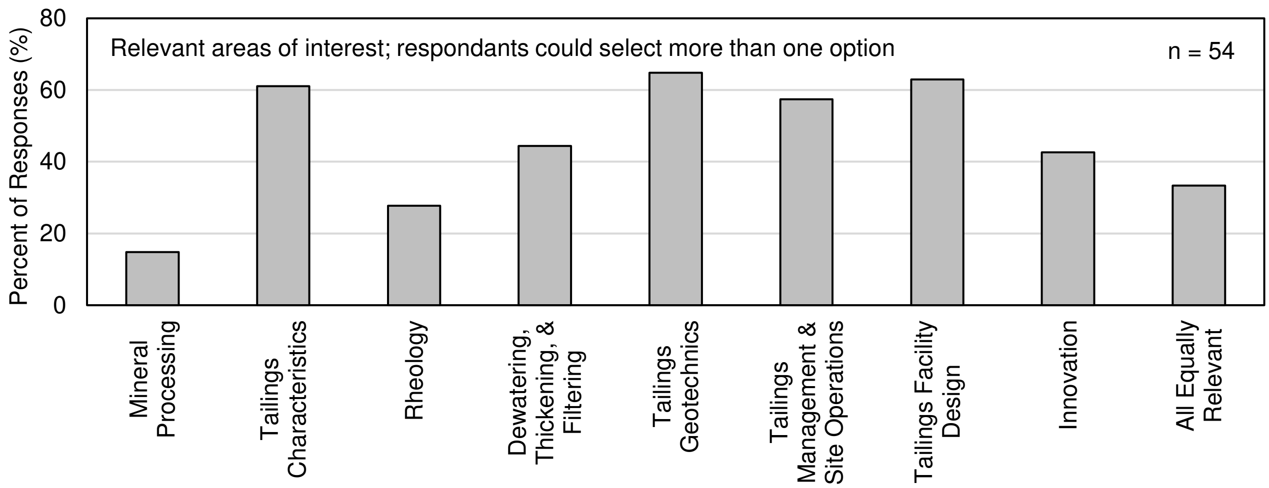

Figure 3. Summary of percent of responses from short course attendees regarding the relevant areas of interest for training pertinent to their current career.

CONCLUSION

The declining numbers of tailings professionals within the mining industry – through retirement and lack of "fresh" tailings personnel entering over the past 20 years – is significant. The effort required to develop sustainable personnel resources that comply with the existing and anticipated forthcoming guidance on tailings management must start today. The tailings industry has acknowledged the lack of personnel resources, which justifies the all-important question, *where do we go from here?*

The education and training programs summarized herein, along with additional programs throughout the world, are a commendable effort to (i) train professionals and (ii) educate students on mine tailings. There has been considerable activity related to mine tailings education, training, service, and research within the last couple of years; this momentum must be continued for the foreseeable future. The recent module at the SME MinExchange conference related to training the engineers and operators of tomorrow emphasized the dedication of universities, companies, and professional groups to tailings training and education. To ensure the vitality of these efforts, engagement is and support from consultants and operators is critical.

These individual groups must look to collaborate and support one another, as opposed to competing with one another. As long as each group develops and administers training and education with the collective goal of serving the mining industry, the groups will be complementary to addressing the lack of personnel resources. Given the tailings engineer labor needs identified, and the continued growth of the mining industry, these groups working collectively may still be insufficient to meet industry needs. However, we appear to be moving in the right direction.

ACKNOWLEDGEMENTS

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APPENDIX C1 – TAILINGS PROFESSIONAL SURVEY QUESTIONNAIRE

Tailings Industry Survey

Survey responses are anonymous and any personal information voluntarily provided will be held confidential

This collaborative research effort seeks to understand and quantify the growing tailings industry professional labor shortage, as well as to support the development of a pipeline to feed qualified and trained professionals into the tailings industry.

The project team for this survey includes:
Dr. Chris Bareither, Associate Professor at Colorado State University
Dr. Joe Scalia, Assistant Professor at Colorado State University
Louise Spencer, M.S. Student at Colorado State University
Christopher N. Hatton, Senior Program Leader at Golder Associates, Inc.
Kelly Ward, Vice President at Marsh Mining, Metals, and Minerals Practice

Note: The opinions and findings associated with this research effort are solely those of the authors, and do not reflect the opinions of Colorado State University, Golder, or Marsh.

1. 1. On a scale of 1 to 5, how critical do you perceive the tailings industry professional resource shortage?

Mark only one oval.

	1	2	3	4	5	
not critical	⬭	⬭	⬭	⬭	⬭	extremely critical

2. 2. What is your level of experience as a tailings professional?

Mark only one oval.

- ⬭ 0-5 years
- ⬭ 5-10 years
- ⬭ 10-20 years
- ⬭ 20+ years

3. 3. In which area are you currently employed? (Select all that apply)

Check all that apply.

- ☐ Academia/Education
- ☐ Consulting
- ☐ Mining Industry
- ☐ Non-Governmental Organization (NGO)
- ☐ Regulator/Government

Other: ☐ ____________________

4. 4. What is your highest level of formal education completed?

Mark only one oval.

- ⬭ Some or All High School
- ⬭ Some College/University
- ⬭ Bachelor's Degree
- ⬭ Master's Degree
- ⬭ PhD Degree
- ⬭ Post-Doc Study

5. 5. In which field would you generalize your formal educational training? (select all that apply)

Check all that apply.

- ☐ Accounting
- ☐ Biological/Medical Sciences
- ☐ Business
- ☐ Civil Engineering
- ☐ Construction/Construction Management
- ☐ Electrical Engineering
- ☐ Environmental Engineering
- ☐ Geological Engineering
- ☐ Geosciences (Geology)
- ☐ Global Supply Chain/Purchasing
- ☐ Health and Safety
- ☐ Legal
- ☐ Mechanical Engineering
- ☐ Media/Journalism
- ☐ Mining Engineering
- ☐ Natural Sciences
- ☐ Social Sciences

Other: ☐ ______________________

6. 6. Did your formal education provide you any introduction to the tailings industry?

Mark only one oval.

- ◯ Yes
- ◯ No

7. 7. When entering the workforce, was the tailings industry part of your intended career path?

Mark only one oval.

- ◯ Yes
- ◯ No

8. Explain your response to Question 7:

____

____

____

____

____

9. 8. Are you, or have you been, involved with formal professional training (short courses, certifications, etc.) associated with tailings? (Select all that apply)

Check all that apply.

- ☐ I have participated in internal formal trainings
- ☐ I have participated in external formal trainings
- ☐ I had training on tailings during my educational experience
- ☐ I lead internal formal trainings
- ☐ I lead external formal trainings
- ☐ I have not participated in any formal professional training on tailings

Other: ☐ ______________________

10. 9. Are you a member of a Global Mineral Professionals Alliance (GMPA) Society? (Select all that apply)

Check all that apply.

- ☐ AusIMM – Australasian Institute of Mining and Metallurgy
- ☐ CIM – Canadian Institute of Mining, Metallurgy and Petroleum
- ☐ IIMCh – Instituto de Ingenieros de Minas de Chile
- ☐ IIMP – Instituto de Ingenieros de Minas del Perú
- ☐ IOM3 – The Institute of Materials, Minerals & Mining
- ☐ SAIMM – Southern African Institute of Mining and Metallurgy
- ☐ SME – Society for Mining, Metallurgy & Exploration
- ☐ Not a member of a GMPA Society

11. 10. Have you heard about the GMPA Global Action on Tailings Initiative?

Mark only one oval.

- ◯ Yes
- ◯ No

12. 11. Do you consider yourself an industry advocate?

Mark only one oval.

- ◯ Yes
- ◯ No

13. Describe why you responded Yes or No to Question 11:

14. 12. What professional training disciplines would help you execute your work on a day-to-day basis?

15. 13. What challenges do you see with respect to available professional labor resources, both currently and in the future?

16. 14. What is the greatest challenge facing the tailings and mine waste industry, in your opinion?

17. 15. If you could change three things within the tailings and mine waste industry, what would they be?

18. 16. How did you receive the link for this survey? (select all that apply)

Check all that apply.

- [ ] Conference/Short Course Posting
- [ ] Direct email from the Project Team
- [ ] LinkedIn post from the Project Team
- [ ] LinkedIn direct message from the Project Team
- [ ] Forwarded email from a colleague/industry contact
- [ ] Shared/forwarded through LinkedIn from a colleague/industry contact

Other: [ ] ____________

19. **OPTIONAL and CONFIDENTIAL** Add your name

20. **OPTIONAL and CONFIDENTIAL** Add your email contact information

21. **OPTIONAL** If you provided contact information above, would you like to be included in further correspondence associated with this project?

APPENDIX C2 – TAILINGS PROFESSIONAL SURVEY SHORT ANSWER CATEGORY BINS AND RESPONSE SUBCATEGORIES WITH >10 RESPONSES

Table C2-1. Survey Response Major Categories and Subcategories for responses to the question: what professional training disciplines would help you execute your work on a day-to-day basis? (short answer)

Question 12 Major Categories	Question 12 Subcategories
Geotechnics	• Soil mechanics • Slope stability • Soil dynamics • Dam design • Material characterization
Hydrotechnics	• Hydrogeology • Water treatment • Hydrology • Hydraulic engineering • Modeling (groundwater, dam breach analysis,etc) •
Operations	• Mining engineering • Process/metallurgical engineering • Mining transport • Regulations/permitting • Closure • Construction • Tailings/water management & water balance
New technology	• New laboratory techniques (simple shear, large-strain, etc) • Observation (drones, images, satellites, etc) • Instrumentation (sensors) • Digital transpormation/big data/AI • GIS • New tailings technology
Geoscience	• Geochemistry • Soil sciences • Seismicity • Geophysics • Rock mechanics
Soft skills	• Social & communciation • Writing • Project management • Legal • Business • Community engagement
Risk/safety	• Risk • Safety
Case studies	• Case studies
---	• Flagged • No response • Didn't understand question

Figure C2-1. Response subcategories with 10 or more responses categorized from the following question: What professional training disciplines would help you execute your work on a day-to-day basis? (short answer)

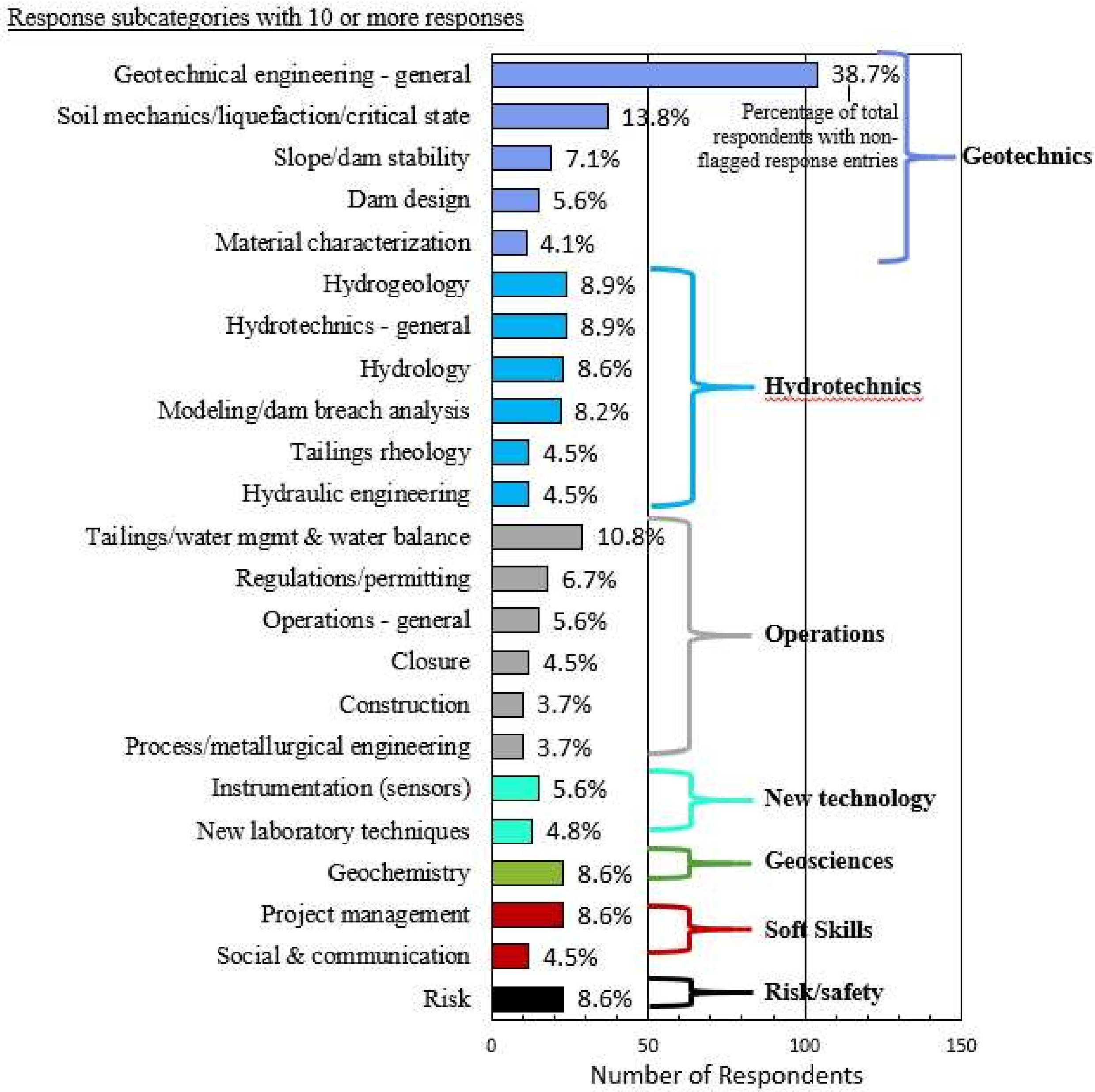


Table C2-2. Survey Response Major Categories and Subcategories for responses to the question: What challenges do you see with respect to available professional labor resources, both currently and in the future? (short answer)

Question 13 Major Categories	Question 13 Sub Categories
Current Labor Pool	Need higher billing rates to retain designers • Existing shortage of qualified professionals • Need developed tailings industry career path • Existing gap between entering professionals and folks retiring • Succession planning • Challenges related to EORs • Increasing labor requirements from new regulations • Lack of diversity • COI concerns
Attracting New Talent	Getting new professionals to move to rural areas • Entry-levels not interested in field experience • Lack of information • Negative perception of mining • Tailings are not interesting • Lack of attention in university • Need increased support in education
Training / Skills Development	Lack of strong technical background • Lack of field experience • Training too theoretical or narrow (lack broad background, no practical problem solving skills) • Training takes too much time • Too few senior folks to adequately mentor • Little formal training available • Challenges with adapting to new technology
---	Flagged • No response

Figure C2-2. Response subcategories with 10 or more responses categorized from the following question: What challenges do you see with respect to available professional labor resources, both currently and in the future? (short answer)

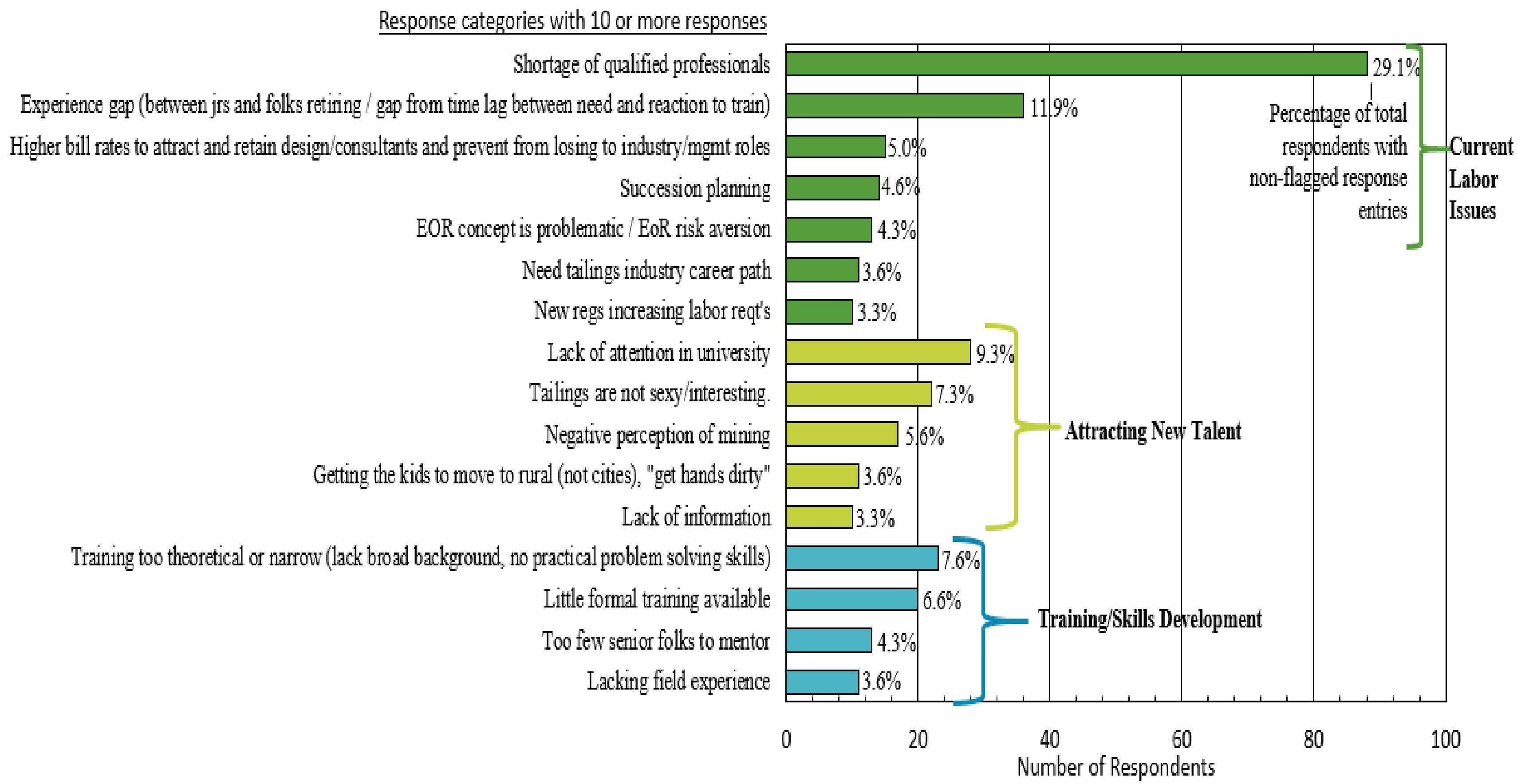


Table C2-3. Survey Response Major Categories and Subcategories for responses to the question: What is the greatest challenge facing the tailings and mine waste industry, in your opinion? (short answer)

Question 14 Major Categories	Question 14 Sub Categories
Labor	Lack of qualified folks • Attracting & retaining talent/promoting career paths in tailings • Training/getting new practitioners up to speed • Role clarity • Collaboration
Tailings management	Increased tonnage / tailings volumes/ decreasing available space • Closure • Climate change/sustainable tailings management • Adapting to new tailings technologies/improving SOP • Water management / water scarcity
Social license	Poor decisions / failures • Past environmental impacts • Anti-mining groups (ties into governance) • Risk management
Design /safety	Uncertainty in design parameters • Maintaining work quality - monitoring, safety, stability, etc • Legacy facilities • Cost
Industry Culture / Business Practices	Reactions to commodity prices • Continuing business as usual • Adopting responsibility • Maintaining momentum & forward thinking
Governance	Following GISTM/other requlatory requirements • Lack of regulations / varying regulations • Regulations based on public opinion and not facts (ties into social license)
Research/Data	Tailings behavior/material characterization • Data management
---	Flagged • No response

Figure C2-3. Response subcategories with 10 or more responses categorized from the following question: What is the greatest challenge facing the tailings and mine waste industry, in your opinion? (short answer).

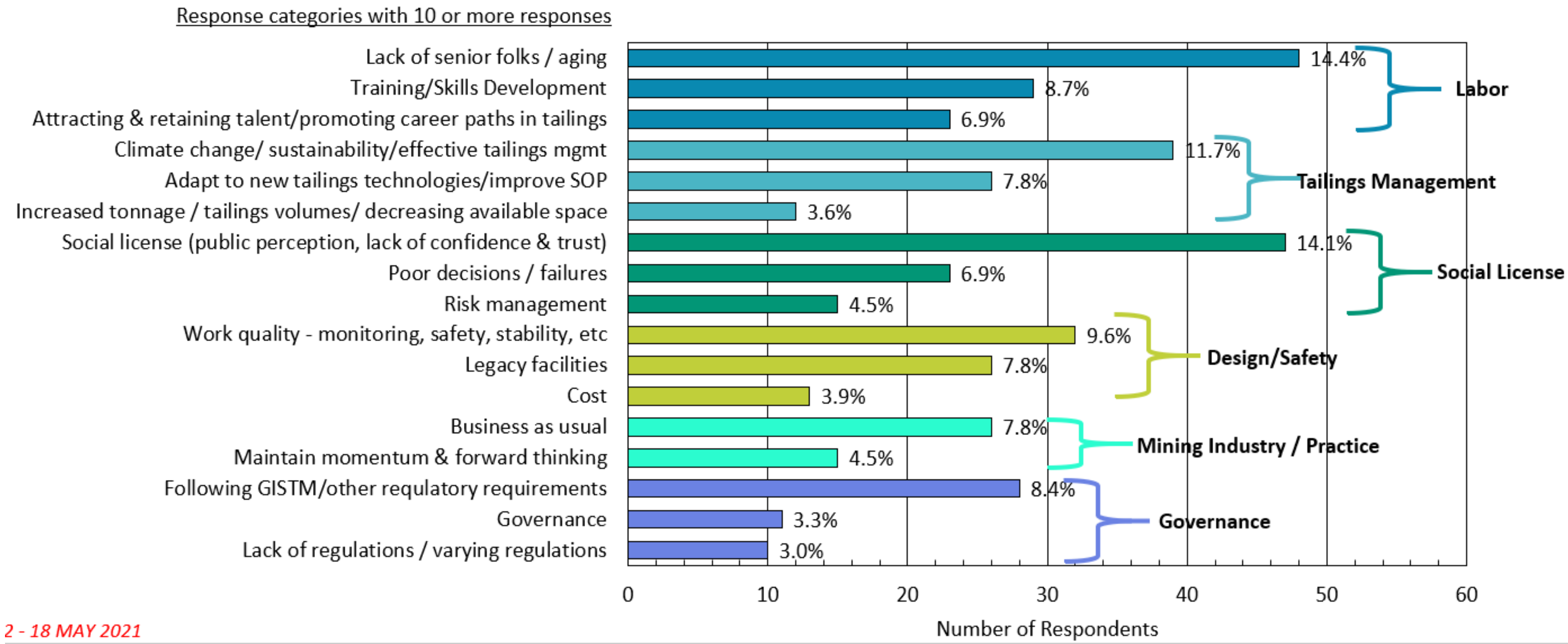
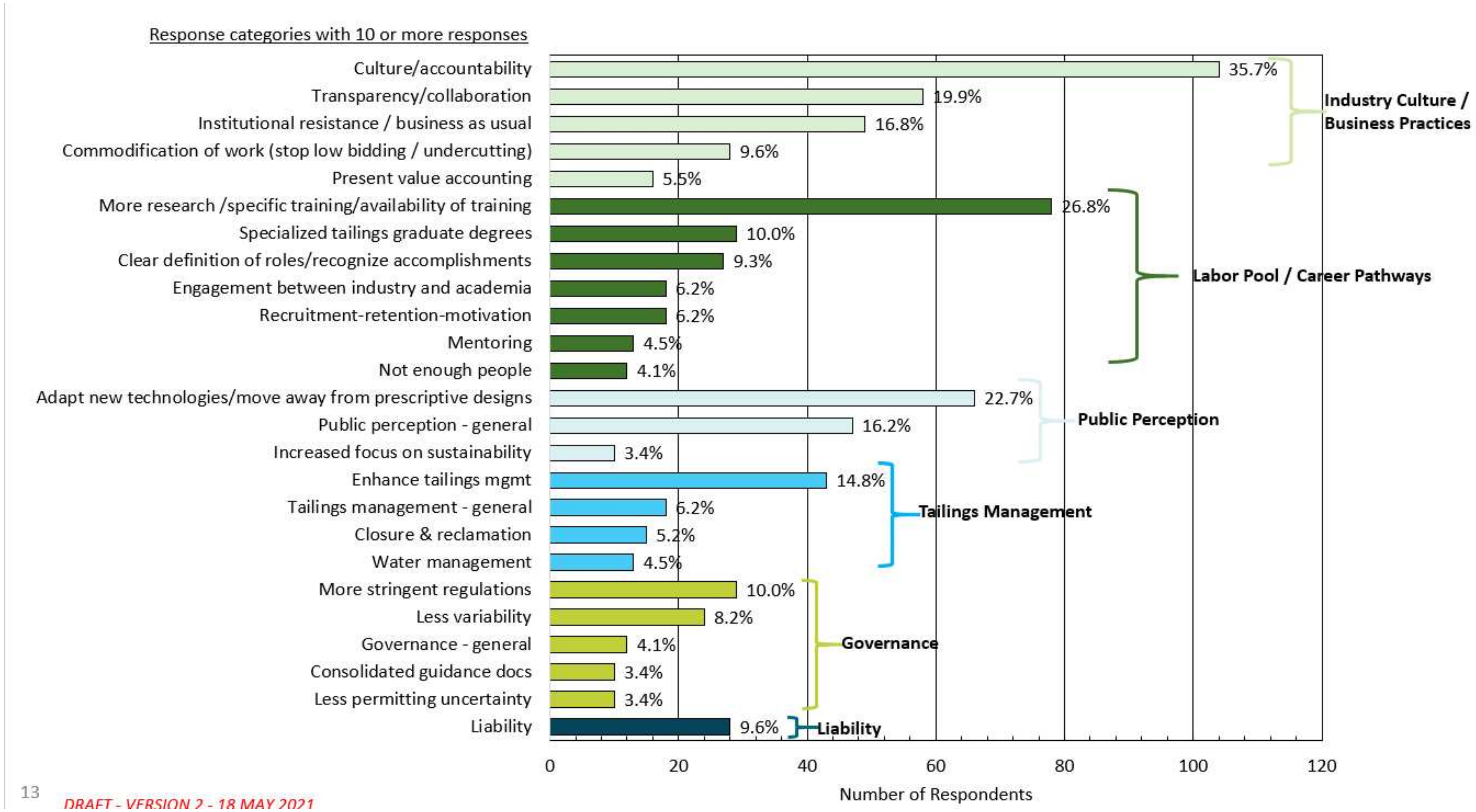


Table C2-4. Survey Response Major Categories and Subcategories for responses to the question: If you could change three things within the tailings and mine waste industry, what would they be (short answer).

Question 15 Major Categories	Question 15 Sub Categories
Industry Culture / Business Practices	Commodification of work (stop low bidding / undercutting and start collaborating) • Transparency/Collaboration • Institutional resistance • Present value accounting • Stop low bidding • Planning for future
Labor Pool/Career Pathways	Not enough people • Lack of diversity • recruitment-retention-motivation • Mentoring • clear definition of roles/recognize accomplishments • more research /specific training/availability of training • Specialized tailings graduate degrees • engagement between industry and academia
Public Perception	Increased focus on interdisciplinary • Increased focus on sustainability • Risk communication
Tailings Management	Enhance tailings management • Closure & reclamation • No more failures • Water management • Adapt new technologies / move away from prescriptive designs
Governance	More stringent regulations • Less permitting uncertainty • Less variability in governance • Create consolidated guidance docs • Change business as usual
Liability	Liability
Nothing	Nothing
---	No response

Figure C2-3. Response subcategories with 10 or more responses categorized from the following question: If you could change three things within the tailings and mine waste industry, what would they be (short answer).



APPENDIX C3 – TAILINGS PROFESSIONAL SURVEY RESPONSES (RAW DATA)

Record #	1. On a scale of 1 to 5, how critical do you perceive the tailings industry professional resource shortage?	2. What is your level of experience as a tailings professional?	3. In which area are you currently employed? (Select all that apply)	4. What is your highest level of formal education completed?	5. In which field would you generalize your formal educational training? (select all that apply)	6. Did your formal education provide you any introduction to the tailings industry?	7. When entering the workforce, was the tailings industry part of your intended career path?	Explain your response to Question 7:	8. Are you, or have you been, involved with formal professional training (short courses, certifications, etc.) associated with tailings? (Select all that apply)	9.Are you a member of a Global Mineral Professionals Alliance (GMPA) Society? (Select all that apply)	10. Have you heard about the GMPA Global Action on Tailings Initiative?	11. Do you consider yourself an industry advocate?	Describe why you responded Yes or No to Question 11:	12.What professional training disciplines would help you execute your work on a day-to-day basis?	13.What challenges do you see with respect to available professional labor resources, both currently and in the future?	14.What is the greatest challenge facing the tailings and mine waste industry, in your opinion?	15.If you could change three things within the tailings and mine waste industry, what would they be?	16. How did you receive the link for this survey? (select all that apply)
1001	5	20+ years	Consulting	Master's Degree	Civil Engineering	Yes	No	John Nelson asked me to do my research on uranium tailings stored in a column in a back room. I took one look at it and said no. I told him I wanted to work on collapsing soils. He was pissed, I was happy.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	AusIMM â€“ Australasian Institute of Mining and Metallurgy;SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	I believe it's our responsibility to objectively train and otherwise develop younger engineers. Mining is a necessity if we are to grow as a society. Ergo the need and responsibility to advocate for the industry in development of key resources	engiineering disciplines including heavy civil, structural, hydrotechnical, geotechnical, geologic, mechanical, electrical and software. project and systems management (i.e. Project controls) and cost estimating	I saw this really cool online presentation at tailings and mine waste that outlined how deficient our industry is. :-)	pseudoscience and the lack of resources.	the general public's understanding of the mining benefits, the lack of drive and motivation from younger engineers and the pervasive fear of speaking up or speaking out in young people's.	Direct email from the Project Team
1002	5	0-5 years	Mining Industry	Master's Degree	Geological Engineering	Yes	Yes	I interned with tailings team during my program, this exposure made me join the tailings workforce full time	I have participated in internal formal trainings;I have participated in external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration;Not a member of a GMPA Society	No	Yes						Direct email from the Project Team
1003	4	10-20 years	Consulting	Master's Degree	Civil Engineering;Geological Engineering	No	No	I was not familiar with the tailings industry and initially had no interest in working on mining projects.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	I strongly feel that it is a rewording career path, but better PR is needed.		Lack of attention at the university level, negative perception at all levels limits candidate pool - who would want to be a tailings engineer given the risk?	labor shortage, lack of public and regulatory confidence	improved candidate pool, decreased risk (personal and professional), increased desire to "the right thing" all the time and recognize that "it could happen to me"	Direct email from the Project Team
1004	4	0-5 years	Consulting	Master's Degree	telecommunication engineering	No	No	I came along to TSF monitoring only after the Brumadinho disaster	I have participated in external formal trainings;I lead internal formal trainings	Not a member of a GMPA Society	No	No	I am consuling the industry from a very particular perspective. Don't feel I am "one of the industry" myself		Find skilled people	Find skilled and competent people, have management to endorse new responsabilities		Direct email from the Project Team
1005	3	0-5 years	Mining Industry	Master's Degree	Civil Engineering	No	No	Didn't know about it, was lucky enough to fall into the field	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	Yes	No	I haven't yet participated or contributed to the field outside of my company	high understanding of geotechnical engineering, writing and communication skills, and numerical modeling (I think more so in the future)	Skill level of the entry level field. What we do is complex and graduates tend to lack the skills needed to be helpful right out of school.	We need more mine funded studies to understand tailings behavior	more understanding from the Mine managers about what we do and why its important and not black and white.	Direct email from the Project Team
1006	4	0-5 years	Mining Industry	Master's Degree	Civil Engineering;Water resources	No	No	I am in charge of Water Resources in mi operations, tailings become part of my dues when I enter to see recovery water process	I have not participated in any formal professional training on tailings	IIMP â€“ Instituto de Ingenieros de Minas del PerÃº	No	Yes	my responsabilities are related to manage of water recovery from tailings	managing tailings and measure flows of them	formation of professional with wide vision about TSF management with new global standars	reduce the impact in the environment and reduce water consumption in mining operation	planning criterial, definition of priorities and actual planning for the future	Direct email from the Project Team
1007	3	20+ years	Consulting	Master's Degree	Business;Civil Engineering;Geotechnical Engineering	No	No	My initial career path focused on foundation engineering and on municipal and industrial solid waste landfills.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	No	I am not currently in leadership roles in tailings focused professional and industry organizations.	Further training on paste and filtered tailings, and liquefaction and static liquefaction of tailings.	In part we need industry acceptance of higher consultant billing rates in order to improve compensation and attractiveness of a consulting career in tailings management	An inability to overcome cost constraints associated with use of alternative tailings management approaches.	1) Improve economics of alternative tailings management methods. 2) Improve focus on sustainable mining - reduced risk and environmental impact, and thereby increased social license to mine. 3) Reduced uncertainty in environmental permitting	Forwarded email from a colleague/industry contact
1008	4	10-20 years	Mining Industry	Master's Degree	Geosciences (Geology)	No	No	I was a geophysicist and so there were projects related to tailings but they were lumped in the group of environmental and engineering geophysics.	I have participated in internal formal trainings	Not a member of a GMPA Society	No	Yes	Could go either way, I participated in an industry wide webinar last year and am writing a case study for the SME, but I am a GIS analyst in a support role and not a geotech engineer	Geotech engineering, Hydraulics, Imagery analysis, Gis Development	The problem is the age gap and trying to find qualified young engineers	the consequences of a major failure	Change I don't know maybe to be more aware of new technologies, less failures	Direct email from the Project Team
1009	5	0-5 years	Consulting	Some College/University	Civil Engineering;Construction/Construction Management	No	No		I have participated in external formal trainings;I lead external formal trainings	Not a member of a GMPA Society	No	Yes	Because, I work acording to the international standars.	laboratory in tailings, programming and management	lack of information about tailings	in my country (Peru), the little investment amount of money to study the behaviour of our materials	In my country (PerÃº) the countryÂ´s standars to built, engagements between industry and academy and use of new technologies	Direct email from the Project Team;LinkedIn post from the Project Team
1010	5	5-10 years	Mining Industry	Master's Degree	Civil Engineering	No	No	I wanted to be a structural engineer. Tailings came as part of operations training	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	No	Yes	because iÂ´d like to improve the industry practices leading by example	specific tailings training on behaviour, models and how to tie geotechnical concepts with tailings	shortage leading to bidding war on the professionals / internal-external training getting stronger on tailings	adequate management, understanding and reduction of tailings.	Management standards, training and COI Involvement improvement	Direct email from the Project Team
1011		5-10 years		PhD Degree		No	No	I am a chemist by tranining	I have not participated in any formal professional training on tailings	SME â€“ Society for Mining, Metallurgy & Exploration	No	No						Direct email from the Project Team
1012	4	20+ years	Consulting	Master's Degree	Civil Engineering	No	No	Joined a consulting firm as a junior geotechnical engineer and then transitioned into tailings management following my Masters.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum	No	Yes	I think tailings management is still an afterthought and professionals in the industry are often forgotten. I spend a lot of effort to inform operators that tailings is often the single largest long term risk to a project.	Water Resources, geochemistry, geotechnical, civil design, bio-environmental	Implementation of the new GISTM is going to force mining companies to battle for rare talent to help them manage their assets. Often times, the EOR may only get a call once or twice a year, when in reality they should be much more proactively involved. If operators follow the new standards, it will mean that the existing professionals will ultimately be able support fewer ongoing projects.	Getting new practitioners up to speed.	1. Elevate the importance of tailings management in "technical reports" instead of having the issue covered in a few pages hidden under the project infrastructure sections of these reports. 2. Improve understanding of risks with tailings management across the mining industry. 3. Have greater collaboration amongst companies. For example, eliminate what is often a contentious process when companies are completing Dam Safety Reviews. May times the DSR firm either seems to take pleasure in criticizing the work of the EOR or the EOR takes exception to what may be a very viable critique of the design.	Direct email from the Project Team
1013	3	0-5 years	Consulting	PhD Degree	Civil Engineering	Yes	Yes	My M.S. and Ph.D. research was heavily focused on Tailings.	I have participated in internal formal trainings;I had training on tailings during my educational experience	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes		A training that includes geotechnical, environmental, and water resource topics applicable in tailings industry. In a format of (i) preliminary (i.e., introduction) of different topics, and (ii) advanced. For example, I like to have an understanding of everything that happens in tailings basin (hydro-geo-environmental aspects, introductory course), but I like to be an expert on shear strength and dam design (advance classes)	I am new in consulting. Can not comment on it.	I am new in consulting. Can not comment on it.	(i) more interdisciplinary work, (ii) more specific trainings.	Direct email from the Project Team;Forwarded email from a colleague/industry contact
1014	5	5-10 years	Consulting	Master's Degree	Civil Engineering;Geological Engineering	No	No		I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	Not a member of a GMPA Society	No	Yes		Advanced soil mechanics	Increasing regulation, oversight, and third party review requires additional resources which are already slim to complete ongoing design and monitoring. Lack of graduates with solid soil mechanics background (too little focus in undergraduate level)	Uncertainty both from regulation/guidance, as well as uncertainty in design parameters, operations, etc. that go into assessment of risk levels.	(1) Require more soil mechanics at undergraduate level. (2) Greater understanding of risks and failure mechanisms with understanding of nuances that may not be able to be prescriptively controlled in guidance documents (3) Less undercutting by consultants against each other which can cause operators to become confused and lead to riskier designs	Direct email from the Project Team
1015	4	10-20 years	Consulting	Master's Degree	Civil Engineering	No	No	i studied geotechnical engineering with an intent to continue my practice in foundations for buildings and transportation projects.	I have participated in internal formal trainings;I have participated in external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	i am in a leadership position in a consulting form supporting the mining industry.	risk assessment and decision analysis	Developing well-rounded engineers to lead tailings related projects takes considerable time. We must retain these staff and continue to challenge them with interesting opportunities. The duration of development means that we often won't have staff with sufficient experience ready to meet industry demands.	Eliminating tailings dam failures. TVA Kingston and Mount Polley showed us that facilities owned by reputable companies and engineered by reputable firms fail.	1. A path to offer support to mining companies in emerging economies, where government regulations (including environmental and public safety) might not be as strict, engineering standards might not be sufficient, and funds. 2. Continued improvement in the preparedness of students entering the engineering ranks. To be frank, we recruit terrific engineers. Our challenge is the amount of time that it takes to learn the mining & tailings specific elements of practice. 3. Clarity and transparency around the role of mine owners, regulators, and engineers in the safe design, operation, and closure of tailings facilities, including clear recognition of these roles in RFPs and contract documents.	Direct email from the Project Team
1016	3	0-5 years	Mining Industry	Master's Degree	Civil Engineering;Construction/Construction Management;Environmental Engineering	No	No	Started as a dam safety engineer	I have participated in internal formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	No	No	Still new to the Tailings industry	water resources engineering, dam safety		Managing risk	Higher profile inside and outside of mining industry, the understanding that propoer tailings disposal is just not a cost to be minimized, recognition of new trends in industry	Direct email from the Project Team
1017	4	10-20 years	Consulting	Bachelor's Degree	Geosciences (Geology)	No	No	I was more on the infrastructure side, but business needs opened up more opportunity in Tailings	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	AusIMM â€“ Australasian Institute of Mining and Metallurgy	Yes	Yes	I believe better Tailings management is required.	I attend a lot of training already	Mining fluctuates so much and can negatively impact careers. With so much focus on the bottom line it can leave well trained people out of work	Quality work and lack of expert personnel		Direct email from the Project Team
1018	5	10-20 years	Consulting	Master's Degree	Civil Engineering	No	No	Joined the industry out of coincidence - it happened to be the group with a job opening when I was looking.	I have participated in internal formal trainings;I lead internal formal trainings	Not a member of a GMPA Society	No	Yes	Leadership on professional society committee.	Writing and communication	Cost of labor outpacing what consulting business models can support.	Lack of interest by prospective talent and the significant time investment required before an engineer is even remotely suitable to be an EOR	1. need to consolidate the number of international guidance documents; 2. need to reduce the "commodification" of tailings work; 3. stop accepting a lower degree of engineering compared to water dams	Direct email from the Project Team
1019	3	0-5 years	Regulator/Government	Bachelor's Degree	Geological Engineering	Yes	No	Started out in mineral exploration, moved to government during a downturn	I have participated in external formal trainings	Not a member of a GMPA Society	No	No	Hadn't occurred to me.			Clumsy regulation		Direct email from the Project Team
1020	4	0-5 years	Consulting	PhD Degree	Civil Engineering;Geological Engineering	No	No	My intent was to practice geotechnical engineering irrespective of the business line.	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	Yes	My objective from a professional standpoint is to contribute to the collective effort and ultimately advance the profession positively	Geochemistry and Hydrology	Potential increase in labor resources.	Going green, and water management	Improve on the job mentoring, and proper documentation of experiences	Direct email from the Project Team
1021	3	5-10 years	Consulting	Bachelor's Degree	Geological Engineering	Yes	Yes	through coop and class I identified it as a field of interest.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	No	Yes	I believe communication to the public about steps that have been made are lacking.	Clearer and more consistent tailings regulations across the globe. Less regional exceptions.	Lots of theoretical expertise but little practical (field) experience.	Market fluctuations that cause tailings initiatives to be defunded and cut, delaying crucial R&D.	Consistent Guidelines. Stricter path to reclamation requirements. More efficient regulatory bodies with shorter turnaround time.	Forwarded email from a colleague/industry contact
1022	5	5-10 years	Regulator/Government	Bachelor's Degree	Civil Engineering	No	No	With a degree in civil engineering, I applied to a variety of positions but at the time I would have preferred a water resources/municipal engineering type role. I accepted a role as a Geotechnical Engineer, which led to extensive work experience in the tailings industry	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	Yes	Yes - to the limited ability of my experience/position.	Formal training on mine waste management; design, operation and assessment of tailings dams	Lack of formal training available, limited opportunities for learning through experience/mentors without prior experience	Lack of regulation	More training opportunities for new professionals, more consistent and robust regulation and governance, more collaboration/access to information to allow development of knowledge/technologies	Direct email from the Project Team
1023	5	5-10 years	Consulting	Master's Degree	Civil Engineering;Geotechnical Engineering	No	No	I didn't know what tailings were and how they were part of the geotechnical field	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	No	I work in the industry but I don't go out of my way to bring others into it		There will not be enough senior and principal e (30 plus year) folks to properly mentor the influx of juniors, if we get an influx of juniors	Folks on ITRB's are getting old and there aren't that many people globally who are going to be able to step into those roles.	Better alignment of the standards: Global, provincial and national Clearer life cycle expectations and guidelines from regulators Everyone involved to have a better understanding of risk and how it should be communicated to the public (when the public is uneducated on the subject)	Direct email from the Project Team
1024	5	10-20 years	Consulting	Master's Degree	Civil Engineering;Construction/Construction Management;Geosciences (Geology)	Yes	No	Once I got exposed to Tailings Management, I liked it and I decided to follow that path	I have participated in internal formal trainings;I have participated in external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	Tailings management is the most important environmental issue at every mine - I make sure all parties involved in each mining operation and Corporate Governance understand this issue	Tailings Management 101 for new professionals	Mining is not attractive to Millennials or Gen Z due to environmental perception - mining is seen as "bad", so many don't want to be involved with it	Follow new GISTM - Many juniors, mid-tiers will face economic constraints to comply	1) regulations - there should be a Global governing body. 2) accountability - mine owners and EORs should be accountable to maintain good operation of their TSFs, and 3) recognition - TSFs should be seen as a mayor player in mining operations, not just waste, residue	Direct email from the Project Team
1025	4	10-20 years	Mining Industry	Bachelor's Degree	Civil Engineering;Construction/Construction Management;Environmental Engineering;Mining Engineering	No	No	I developed in the field of civil engineering, open pit mining, oil and gas. However, in the area of â€‹â€‹earthworks, I began to build dams for mining tailings deposits. at that moment my introduction to the world of tailings began	I have participated in external formal trainings	Not a member of a GMPA Society	Yes	Yes	Yes, and quality control in all types of construction	geotechnical, soil mechanics	little experience in the area	knowledge of handling, quality control, dehydration methods	1) do not recommend dams made with hydrocyclone. 2) prefer dehydrated tailings over liquid ones. 3) apply backfilling whenever possible.	Direct email from the Project Team
1026	4	0-5 years	Mining Industry	PhD Degree	Civil Engineering;Legal;geotechnical engineering	No	No	I explored this career path while working as a consultant, it was not on my radar when in school due to lack of exposure to this field	I have participated in internal formal trainings;I have participated in external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	I provide talks to the students during my company recruiting events on the pathways to develop career in tailings area	Civil, Geotechnical, Hydrogeology, Mechanical, Environmental	Lack of exposure via formal school course work for future engineers	Role clarity among teams - owners, consultants, boards in addition to lack of human resource	Formalized training prior to and during the job, Role clarity among teams when working on a project, Understanding around role of EoRs	Direct email from the Project Team
1027	4	5-10 years	Consulting	Master's Degree	Geological Engineering	Yes	No	Preference would have been slope improvement work	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	Yes	No	Not in a position to advocate	better understanding of critical state soil mechanics	difficult in today's "cancel culture" world and how quick to assign blame, will be struggle for folks to take on responsibilities of EoR for dams, both tailings and reservoirs - a lot of responsibility for not a lot of pay	Properly funding EoR programs, including training of deputy EoR, educating smaller companies on risk and importance of EoR program	Funding, client education on risk/importance, higher pay for responsibility	Direct email from the Project Team
1028	5	20+ years	Consulting	Bachelor's Degree	Business;Civil Engineering;Construction/Construction Management;Environmental Engineering;Geological Engineering;Geosciences (Geology)	No	No	Who the hell knows what they're going to be doing with a geology degree in 1980's?	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	It is my livelihood.	practical geotechnical engineering for tailings and mine waste.	Current college curriculums do not provide practical problem solving techniques.			Forwarded email from a colleague/industry contact
1029	3	10-20 years	Mining Industry	Post-Doc Study	Natural Sciences	No	No		I have participated in external formal trainings	Not a member of a GMPA Society	No	Yes		Hydrology, soil science, water chemistry	Experiences in tailings dam design and management are critical in the quality of care. This aspects can not be replaced with short courses and university training	Balancing the efforts of meaningful improvement the design and operation of the tailings dam vs chasing unrealistic goals	Improve tailings consolidation technology, include tailings management in formal education programs, and provide training on tailings dam to all mine site staff	Direct email from the Project Team
1030	4	0-5 years	Mining Industry	Master's Degree	Civil Engineering;Construction/Construction Management;Industrial Engineering	No	No	I started out in Military Engineering and Construction, and construction of Earthen and Concrete Hydro Dams.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	I'd like to be an advocate to promote a more formal introduction to tailings facilities in Civil Engineering Programs.	Civil Engineering with a background in deposition modeling.	Tailings Industry is not promoted in Colleges, New earthen and Concrete Structures tends to be much more interesting in the college lectures	New Regulation and little promotion and understanding of the career path.	Offer more awareness and training.	Shared/forwarded through LinkedIn from a colleague/industry contact
1031	5	20+ years	Consulting	Master's Degree	Civil Engineering	Yes	Yes	Interest in tailings was initiated through the tailings conferences at CSU	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	I have consulted for the mining industry throughout my career	soil-water interaction, hydraulics, geohydrology, geology, geochemistry, geotechnics	shortage of professionals with 20+ years of experience, conflicts of interest	improving public perception of the industry	ensure that there are no dam failures in the future	Direct email from the Project Team
1032	4	10-20 years	Consulting	PhD Degree	Civil Engineering;Mining Engineering	Yes	No		I have participated in internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	No	Yes	I work as a consultant for mining companies.	geological engineering, civil engineering - geotechnical and hydraulic disciplines, mechanical engineering- tailings dewatering and pipeline transport, hydrology,	Currently there is a shortage and lack of interest of in tailings engineering. School has never been enough to generate professionals, and a training period in industry is always required. The current best training arena is consulting, which provides exposure to a greater variety of projects and problems in a shorter time than government or industry positions. It is difficult to attract staff to consulting due to: 1) the consulting industry is competitive where low bid wins (a horse race), that is not appealing to many 2) high liability - errors or oversights can result in failures that result in public censure and shaming by the professional association	There are 18000 to 30000 existing tailings facilities that will continue to fail over time. Failures will result in death and environmental disaster, and will maintain the stigma around tailings work, preventing attraction of staff to take care of the problem. The current frame work of mining company hires a consultant for 1 year or less at a time, requiring bidding every year to secure the lowest bidder, is a terrible way to attract good engineers.	1) limit liability for individuals and firms practicing engineering or else make the rewards balance the risk (if failure can cost hundreds of millions or billions, why make firms or individuals responsible that earn a fraction of this?) 2) improve transparency is a great step that appears to be happening 3) mining companies should act on the recommendations of professional engineers, rather than argue against to reduce effort or cost	Direct email from the Project Team

Record #	1. On a scale of 1 to 5, how critical do you perceive the tailings industry professional resource shortage?	2. What is your level of experience as a tailings professional?	3. In which area are you currently employed? (Select all that apply)	4. What is your highest level of formal education completed?	5. In which field would you generalize your formal educational training? (select all that apply)	6. Did your formal education provide you any introduction to the tailings industry?	7. When entering the workforce, was the tailings industry part of your intended career path?	Explain your response to Question 7:	8. Are you, or have you been, involved with formal professional training (short courses, certifications, etc.) associated with tailings? (Select all that apply)	9.Are you a member of a Global Mineral Professionals Alliance (GMPA) Society? (Select all that apply)	10. Have you heard about the GMPA Global Action on Tailings Initiative?	11. Do you consider yourself an industry advocate?	Describe why you responded Yes or No to Question 11:	12.What professional training disciplines would help you execute your work on a day-to-day basis?	13.What challenges do you see with respect to available professional labor resources, both currently and in the future?	14.What is the greatest challenge facing the tailings and mine waste industry, in your opinion?	15.If you could change three things within the tailings and mine waste industry, what would they be?	16. How did you receive the link for this survey? (Select all that apply)
1033	3	20+ years	Mining Industry	Master's Degree	Business;Civil Engineering;Construction/Construction Management	No	No	I am a civil engineer, with an MS in Civil Geotech, Tailings dams are civil structures	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	IIMP â€" Instituto de Ingenieros de Minas del PerÃº;SME â€" Society for Mining, Metallurgy & Exploration	No	Yes	Its my responsibility to be an industry advocate		I sense that generally, engineering students are decreasing	to map the global risk realistically, dont swing too far either way	Recognize educational value, recognize accomplishments, lower institutional resistance	Forwarded email from a colleague/industry contact
1034	4	20+ years	Consulting	Master's Degree	Civil Engineering;Geological Engineering	Yes	No	I graduated from CSU in 1982 and mining had tanked. I found employment in traditional geotechnical practice (at first)	I have participated in internal formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	Ended up spending half of my career in the mining industry	the basics of geology and soil mechanics still apply. Understanding of mining technology and methods would be useful to those entering a career in tailings	the discrepancy between industry and consulting engineering salaries	Understanding of a career path	1) Reduce the cyclical nature of mining itself (response to failures followed by complacency) 2) Eliminate Present Value accounting to assess new mines (capital projects), this plays havoc with closure 3) For students, offer a combination mine technology / civil degree	Direct email from the Project Team
1035	4	10-20 years	Consulting	Master's Degree	Civil Engineering;Geotechnical	No	No	I was looking for a job in Geotechnical and mining provided a good technical field to work in	I have participated in external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	Active participate in mining associations (CMA, SME, NWMA, T&MW)	Continued short courses.	There are not a lot of young people in the industry.	Public perception		Direct email from the Project Team
1036	4	10-20 years	Consulting	Bachelor's Degree	Geological Engineering	No	No	I studied in geological engineering. At the end of my bachelor degree, I was interested in environmental engineering and geotechnical engineering but I didn't know about tailings engineering. After a year in civil geotechnical consulting, I accepted a job in mine waste engineering without really knowing what it meant. While this profession was not really clear to me at that time, young engineers that are hired these days are more aware than I was at that time. I believe it is better known	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	Yes	Yes	I am passionate about my work and I believe the industry is shifting towards something much safer, with a deeper technical understanding of the risks associated to tailings management.	A training on how to reduce risks associated to existing upstream tailings storage facilities. How to eliminate liquefaction triggers.	With the increase in external reviewers demand, plus the increase in Engineers of Record demand, I don't see how we can fulfill the needs of the industry at short term. I see more and more trained junior engineers out of the university but the engineers above 40 years-old working in tailings management is limited for the needs of the industry.	The climatic changes are underestimated.	More stringent regulations. Better governance. More accessibility to professional trainings (more engineers should be attending trainings).	Direct email from the Project Team
1037	4	10-20 years	Mining Industry	Bachelor's Degree	Civil Engineering	No	No	Tailings by way of Geotechnical Engineering by way of Civil Engineering, all based on available opportunities at the time.	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	Yes	Mining issues are critical to the the surrounding communities, but often misunderstood so it is our responsibility to help the community understand the issues better. My role involves government reporting, and so my particular "advocacy" is through unbias and clear reporting of our tailings management.	-Technical Writing -Course outlining the application of geotechnical testing for soft tailings (and the specialized testing developed for soft soils/tailings); -Considering many of us come from a process, geotechnical OR environmental background, high level courses focusing on those three themes would allow many of us to fill in the context from the two proficiencies that we don't have background in.	I think the stigma around mining, as environmentally problematic, will continue to push a lot of skilled professionals into less controversial branches of engineering. The paycheck helps bring in people, but the people who are competent to solve the problems before us also want to feel like they are contributing to something positive in the world. I think a more deliberate focus on the positive aspects of mining would help balance the historic and future criticism of some of our less responsible peers.	Managing transition of responsibility - Whether it is from one mining company to another, or because a mining company has gone under, and it is from the mining company to the govt. there is so much opportunity for critical gaps to be formed in a tailings management plan as it is handed from one party to another. These gaps lead to so many opportunities for mismanagement, and continued poor management of aging facilities will lead to a social backlash that will burden our entire industry. More scrutiny has to be put onto the documenting of risks associated with a facility and processes designed to manage those risks (ongoing monitoring, OMS's, closure plans, etc.), but also in the transferal of those things to new owners, and critically the acknowledgment from the new owner that they understand these risks, and are capable to manage them	Increase the value of reclamation bonds, more formal requirements for detailed standardized closure plans, and more formal requirements for detailed standardized risk registers. I acknowledge we have these last two things already in the oil sands at least, but there is quite a lot of room for improvement and specifically in communicating the risks within the closure plan. This should all dovetail together better so it is clear to any party interested what risks are being managed today, what the plan is to mitigate these risks and what potential hurdles exist in that plan.	Direct email from the Project Team
1038	2	20+ years	Consulting	Master's Degree	Civil Engineering	No	No	I did not start in mining, my career took me there.	I have participated in internal formal trainings;I have participated in external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	Yes	Geotechnical, Mining, Geologic Engineering	Need to move on from the largest 10 firms (Stantec, AMEC, AECOM, Golder, etc,.) and reach out to additional qualified firms	Operators taking the tailings responsibility seriously.	Take responsibility seriously Owner make adequate funds to design and operate properly Owner manage water. These are not water storage dams	Direct email from the Project Team
1039	3	5-10 years	technology development for tailings toxic content containment, stabilization, and dewatering	Master's Degree	Business;Civil Engineering;Geological Engineering	No	No	Design engineer of green construction materials and earth/soils oriented materials	I have not participated in any formal professional training on tailings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	My company has developed a Nano system to contain RCRA metals less 1, contain toxics in tailings, dewater berms, stabilize tailings, control dust, control mud, control some acid rock issues, etc.	How mining companies are best integrated with from a technology standpoint and how best to introduce them to a new technology.	The industry needs to severely green up. Todays youth want to save the planet not contribute to its damage. It is a Catch 22, prisoners dilemma, the industry is faced with.	Contamination of ground water, contamination of surrounding soils through migration, failure of structure due to water gain, and poor berm building style choice practices, in the race to stay market price competitive.	Very high level concept: Set up a global independent monitoring compliance bureau with teeth to regulate compliance. Any nation not joining and complying is heavily charged or boycotted by industry. Simultaneously structure a fines, duty, tariff, and tax system that would force all manufacturers to comply to safety and green standards. These costs systems would apply to all goods that contain any products or by-products of mining. The high level concept would be those manufactures not using products or by-products from mines that are compliant, pay the fines, duties, tariffs and taxes thus placing them in the market at a high price loosing competitive advantage over those manufactures in compliance. at the counter a minute tax would be applied to purchase of same goods to good in to the collective collected funds pool of fines, duties, tariff's and taxes for redistribution to complying mines to offset compliance costs. Simultaneously set up an independent auditing process to assure appropriate funds distribution	Direct email from the Project Team
1040	5	20+ years	Mining Industry	PhD Degree	Civil Engineering;Mining Engineering	Yes	No	In the 80s it did not have the same profile as today. I started in civil engineering.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings;I have designed training sessions on tailings management	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes	I work with the industry and in the industry, for the industry.	Geotechnical engineering and water resources management.	Shortage of engineers that go into the tailings management space with limited exposure to the topic. Also, a huge wave of retirement (baby boomers) that will not be filled easily - there are clear statistics and actual numbers that show this.	Attracting civil engineers in the mining industry, and then developing career paths for tailings engineers (there is a ceiling in every mining operation or company beyond which you simply have no career advancement opportunity; corporate tailings manager are very few opportunities maybe 20 to 30 professionals in the world and one per major company)?	1. Require every mining operation to have a Water and tailings engineering manager, at the same level with the Mining Manager and Plant Manager, and HSEC Manager (until then, not much will change). 2. Recognize the fact that we need civil/mining/geological engineers in this role, and not processing/metallurgical engineers, nor environmental engineers or scientists. 3. Civil and mining engineering departments in Universities need to work closer as we know most engineers that design such facilities or do risk assessments or write an OMS manual are Civil engineers and at times Geological engineers, occasionally/seldom mining engineers. This fact is not fully recognized and this needs to change	Direct email from the Project Team
1041	5	20+ years	Consulting	Master's Degree	Civil Engineering;Geotechnical engineering	No	Yes	I was offered an opportunity to work on a tailings project midway through my Masters Degree. With the work and connections that I made during that project set my mind to have a career in tailings.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	Not a member of a GMPA Society	No	Yes	As a consultant, my work is to support the development of client projects.	Geotechnical, hydrologic, hydrogeologic, processing, metallurgical, mechanical, and electrical engineering. Environmental and geochemical.	Competence and capacity. To date, most initiatives like this focus on "getting numbers up"--not all tailings engineers (and their teams) can work on every type of facility. And take about 20 years to get 20 years of	Competent resources. Client, regulator, and societal expectations.	Industry committing to the fundamental reality that a mine is ALL about mine waste. Developing--and motivating--engineers in tailings. The entire industry to share real-time information (not JUST data!) for the improvement of all (N.B. get the lawyers out of the way).	Direct email from the Project Team
1042	5	10-20 years	Consulting;Mining Industry	Bachelor's Degree	Geological Engineering	Yes	Yes	The main application of geotechnical engineer is related to ground condition and soil mechanics for engineering application. This naturally extends to tailings dam design as majority of tailings dams are earthen structures and tailings' behavior generally fall within soil mechanics.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	Yes	Yes	It is very important to let the owners and operators that tailings and mine waste generally have long term considerations and requires planning to manage according to standard industry practice. The days when walking out from a mine site in non reclaimed conditions due to poor economics shall not be repeated as the society no longer tolerate such practice. If the mining is to survive and grow in the future, we need to apply the same effort and technology in ore processing and mining methods in waste management	Geotechnical engineering, hydrotechnical engineering, hydrology, hydrogeology, water treatment, mining engineering.	Secession will be problem in mining industry. There is a significant shortage of senior technical reviewers with 30 years experience. The world leading experts in geotechnical engineering are reaching or beyond retirement age. There are not enough senior reviewers to fill the gap in 10 years time.	Large old structures with obsolete engineering design that are still in operation, and old abandoned structures that are under limited care and maintenance. The cost of retrofitting and reclamation is too great for the owner or government to undertake and the facilities risk profiles are increasing over time.	1. Increase profile of tailings waste facility operation and closure in the mine planning and design. 2. Unify and mandate engineering responsibility, design, and documentation globally. 3. Reclamation must be done with perpetual care and maintenance only for the exception.	Direct email from the Project Team
1043	2	0-5 years	Consulting	Master's Degree	Civil Engineering	Yes	No	After my undergrad I just applied anywhere related to geotechnical engineering positions. I believe that because of my exposure to tailings in academia, I was offered a position in which I would work on a tailings project	Just a course that involved tailings liquefaction	Not a member of a GMPA Society	No	No	I do not have enough experience in the field to claim that I am an industry advocate	Updates on tailings management	I do not see any.	Tailings are a temporary project. Hence, once the project is completed, companies would have to re-allocate their employees to other projects, if any	I do not have enough exposure in the industry to comment on this.	Direct email from the Project Team
1044	5	0-5 years	Consulting	Master's Degree	Geological Engineering	Yes	No	Was seen as a specialized field	I have participated in internal formal trainings;I have participated in external formal	Not a member of a GMPA Society	No	No	Nope	Geotechnical	Not enough professionals	Resilient tailings dams	More educated community memebers	Direct email from the Project Team
1045	3	10-20 years	Mining Industry	Master's Degree	Civil Engineering	Yes	No	I planned to practice as a traditional geotechnical engineer and felt that the mining industry would be â€œpigeon holeâ€ and would limit my ability to apply geotechnical concepts. I was completely wrong	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	I am a participating member in SME and hope to broaden access to resources about tailings.	I think that technical writing would help many people in our industry.	Itâ€™s simply awareness. This is an exciting and well-paying industry. I believe future engineers will be excited to join our industry with the proper awareness.	Data management, remote sensing, and interpretation. We are getting more and more data and we are not well equipped to manage and process it all.		Direct email from the Project Team
1046	4	20+ years	Consulting	Master's Degree	Civil Engineering;Geological Engineering	No	No	When graduating with BSc, initial focus was toward environmental remediation, then first job was at a consulting firm specializing in mining. Been hooked ever since...	I have participated in internal formal trainings;I have participated in external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	No	Yes	I have spent almost 30 years working in the industry providing consulting engineering services. I find working in the industry is extremely rewarding and believe the industry seeks to perform to the highest standards. Unfortunately sometimes it does not work out that way but there is a desire for continuous improvement and ultimately protection the environment	Strong civil (embankment/impoundment layout/design), geotechnical (stability, consolidation, etc.) and water-related (seepage, water balance, unsaturated flow, etc.) background	Seems like industry-wide there is a shortage of qualified engineers in the market. Loss of experienced engineers is not being replaced fast enough with young engineers. Younger engineers want to work in cities and are hesitant to work at remote sites or in smaller towns (Elko, Winnemucca, etc.) supporting local mines	Upcoming loss of elder statesmen who are retiring after extensive careers supporting the industry. There does not seems to be a substantial number of qualified replacements to fill their shoes.	1. More collaboration/transparency (between Owners and consultants) with facility performance history (good and bad) 2. Additional training opportunities for younger engineers 3.	Direct email from the Project Team
1047	5	20+ years	Regulator/Government	Master's Degree	Environmental Engineering;Mining Engineering	Yes	Yes	Working as a regular in the Mining Industry Tailings Construction, Operation and Monitoring was part of it.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	Yes	Yes	Due to the way I advocated for the change in Tailings management in my country	Construction, Operations, Monitoring and Closure of Tailings Facilities	No institution is giving formal training to Tailings Professionals	The lack of formally trained personnel	1. The way Tailings Breach is estimated for Zone of Influence 2. Encourage Paste or Thicken Tailings 3. It should be a programme of study instead of it being handled under Mineral Processing	Direct email from the Project Team
1048	4	10-20 years	Mining Industry	Master's Degree	Geosciences (Geology);Hydrogeology	No	No	I filled a gap which led me to work on tailings related issues	I lead internal formal trainings	Not a member of a GMPA Society	No	Yes		Trainings which couple geotech, to deposition, to hydrogeology within tailings	Developing a multidisciplinary skillset but not becoming generalists	Collaborating between disciplines.	Advances filtering and thickening scaleup, publishing of results at facilities, integration of disciplines	LinkedIn post from the Project Team
1049	3	10-20 years	Academia/Education	Post-Doc Study	Environmental Engineering;Mining Engineering	Yes	Yes	I am interested in research on tailings management	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	No	Yes	I consider that the industry is working hard to improve its best practices	field instrumentation	multidisciplinarity	poor management decisions	seismicity, floods, bad decisions	Direct email from the Project Team
1050	4	20+ years	Mining Industry	Master's Degree	Civil Engineering;Geological Engineering	No	No	As a young geotechnical/geological engineer, I was not sure in which industry to follow as a career path. My first job out of university was with a consulting firm who does alot of work in the mining industry, so I was exposed to mining as well as other industries (e.g., solid waste management and landslides), but ultimately found mining to be the most interesting and challenging	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	Advocating for mining is essential for our future.	Don't really understand this question	Loss of experience due to retirement/attrition >> incoming young professionals	Safe closure of tailings facilities	End catastrophic TSF failures; Technology improvements to implement dewatered/filtered tailings on large scale; Improve public perception of the mining industry through environmentally responsible and sustainable mining practices;	Direct email from the Project Team
1051	3	20+ years	Consulting	Master's Degree	Civil Engineering	Yes	No	My main topics were geotechnical engineering not specifically tailings	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	No	Yes	I am convinced that the need for a mining industry is a necessity for the development of humanity, so it must be sustainable with the environment and communities	Geotechnical, seismic, risk analysis	There is a shortage of qualified tailings professionals	Be sustainable over time and accepted by stakeholders	1) Provide additional investment in applied research 2) be open to sharing information with industry, regulators and academia 3) properly schedule projects to avoid pressure on consultants	Direct email from the Project Team
1052	4	0-5 years	Mining Industry	PhD Degree	Geological Engineering	No	No	My main interest has always been rock mechanics and worked most of my career (25 + yrs) in open pit design and rock mechanics related projects. In the last 5 yrs got involved in tailings as result of a career change; although still involved in rock mechanics related projects	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	Yes	Yes	As often as possible I try to promote the importance of the mining industry to the development of our society.	soil mechanics, tailings engineering, tailings management, lab testing, hydrogeology.	Not enough qualified professionals available; particularly in the range 10 to 15 years of experience.	Attracting and retaining the young generation.		Direct email from the Project Team
1053	3	10-20 years	Mining Industry	Master's Degree	Environmental Engineering;Geosciences (Geology)	No	No	Didn't know what tailings were when I entered the workforce.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	No	Yes		Risk assessment		Public opinion		Direct email from the Project Team
1054	3	20+ years	Consulting	Bachelor's Degree	Civil Engineering	No	No	un aware of tailings as an industry during college	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	believe in our industry and we do more good than bad		competitive pay, attracting young professionals from cities to mining communities	legacy facilities, built to lower standards than current	less bad press, commitment from operators for stewardship, more mining in US	Direct email from the Project Team
1055	4	5-10 years	Mining Industry	Bachelor's Degree	Geosciences (Geology);Mining Engineering	No	Yes	Geotechnical Engineer position at a mining site, in which tailings facility was part of the responsibilities	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	No	No	Havenâ€™t been involved that much	Tailings and water management	Shortage of capable EOR in the industry	Increase in the amount of tailings being generated	Water content, consolidation rate, and repurpose	LinkedIn post from the Project Team

Record #	1. On a scale of 1 to 5, how critical do you perceive the tailings industry professional resource shortage?	2. What is your level of experience as a tailings professional?	3. In which area are you currently employed? (Select all that apply)	4. What is your highest level of formal education completed?	5. In which field would you generalize your formal educational training? (select all that apply)	6. Did your formal education provide you any introduction to the tailings industry?	7. When entering the workforce, was the tailings industry part of your intended career path?	Explain your response to Question 7:	8. Are you, or have you been, involved with formal professional training (short courses, certifications, etc.) associated with tailings? (Select all that apply)	9.Are you a member of a Global Mineral Professionals Alliance (GMPA) Society? (Select all that apply)	10. Have you heard about the GMPA Global Action on Tailings Initiative?	11. Do you consider yourself an industry advocate?	Describe why you responded Yes or No to Question 11:	12.What professional training disciplines would help you execute your work on a day-to-day basis?	13.What challenges do you see with respect to available professional labor resources, both currently and in the future?	14.What is the greatest challenge facing the tailings and mine waste industry, in your opinion?	15.If you could change three things within the tailings and mine waste industry, what would they be?	16. How did you receive the link for this survey? (select all that apply)
1056	4	5-10 years	Consulting	Master's Degree	Civil Engineering;Geological Engineering;Mining Engineering;Geotechnical Engineering	Yes	No	My Masters education at University of Colorado Boulder included a dams course in which TSFs were discussed significantly. Our soil mechanics course also introduced large-strain finite difference consolidation, with direct application to tailings.	I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings	Not a member of a GMPA Society	No	Yes	On an annual basis I work to reach out to local universities and introduce the topic of mining and tailings. I also lead an internal group call on a weekly basis to discuss topics relevant to mining and tailings.	Geological engineers, geotechnical engineers (with background in advanced soil mechanics, soil dynamics, continuum mechanics, and earthquake analysis including SHAs). Also, practical experience in construction management is CRITICAL to the work that we do.	It seems to me that two separate challenges have emerged. First, students seem to be less interested in mining and/or dams. Second, students who do have that interest seem to be very academically oriented. However we need people with a broad background who can take on and solve the myriad of problems our clients face. Our work, although reliant on academics, must be based first on practical applications, and second on theory. For this reason we are unable to hire many of the students who apply to our company.	Uncertainty in the regulatory environment tends to be the greatest challenge we see our clients face. A shortage of qualified people is still a significant challenge, but in my opinion is still secondary to regulatory issues.	1) More stringent regulations have the obvious benefit of holding tailings practicioners (owners/operators, engineers, consultants, etc) to a higher standard. However, a less obvious challenge is also introduced where mining costs increase leading miners to cut marginal costs. In most cases, those cost cuts are attempted to be passed along to the consulting engineers who design and certify tailings dams. There has been a significant increase in demand for consultants to not only deliver more work, but also at SIGNIFICANTLY lower cost (this ultimately means consultants are pushed incredibly hard to spend less time designing and reviewing these large TSFs). I can easily see situations arising where some consultants, particularly newer or smaller companies, may lower the standard of quality and care in order to meet client needs. So, although miners themselves are held to a higher standard, it appears that miners are pushing consultants to lower theirs to make up for the cost differential. Consultants need to be empowered if further regulatory updates come forward; the obvious avenue is through the Engineer of Record initiative. The GISTM gives some authority to the EOR, but additional guidance is necessary. Consultants must be firmly rooted in our moral obligation to protect people first, and to serve our clients' budgets second. 2) Shortage of qualified people is of course another significant challenge. Qualified people must not only have technical training, but must also be level headed and morally grounded when clients approach with difficult requests and in highly stressful situations. This is not a glamorous career path given	Direct email from the Project Team
1057	4	10-20 years	Mining Industry	Master's Degree	Civil Engineering;Geological Engineering	Yes	No	I only had a very brief understanding of tailings management and the whole mining industry before I entered the workforce. It was through my first job with a consulting company that focused on mining projects that I became more involved and increased my knowledge.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings		No	Yes	I participate on the MAC tailings working group.	Tailings governance	There will also be available labour if the demand is high but the engineering quality may decrease and vary significantly across jurisdictions. We already see this in the industry but it may increase. More and more engineering consultants are being hired by the mining companies. These individuals are usually very driven and highly skilled. This is a positive and will help ensure a certain level of engineering quality is maintained.	Existing low and future lower grade ore deposits that don't financially justify best available technology choices during financial decisions. If the cost of advanced technology is not competitive to other more conventional options, it will not go ahead in most cases. Skilled engineering labour is not the greatest challenge in my opinion. Good governance frameworks with internal, peer, and independent reviews will provide the required checks and balances to ensure adequate design and construction quality	1. Tailings facility design needs to focus more on water management especially quality (future predictions and treatment requirements). This gets mostly overlooked or simplified during the design phase. 2. Every mining company needs to have a corporate tailings focused lead (Director level) with a geotechnical engineering educational background focused on soil mechanics. 3. Diversity within the tailings industry is an issue that rarely gets discussed during key conferences. Conferences are usually technically focused. They should be expanded to include non-technical themes which will hopefully attract people from other industries and backgrounds.	Direct email from the Project Team
1058	5	20+ years	Consulting	Master's Degree	Geotechnical Engineering	Yes	Yes	I worked with tailings in my MS program. Always fascinated by tailings management.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	Not a member of a GMPA Society	Yes	Yes	Industry advocate for educated tailings storage management, yes. My concern is that some of the environmental organizations may not have educated staff and that we have to advocate for our management practices.	ongoing geotechnical assessment updates, tailings processing (filtered, thickened, etc)	one concern is creation of a tailings focused degree and the students that graduate thinking they are ready to be an EOR without accumulating the required experience. One part of that may recommend further classwork in geotechnical assessment wrt to strength, compressibility, and seepage to help get a jump on working in TSF's. Filter design is another topic. These materials are much different from many natural soils that students learn about	stigma that every facility is teetering on the verge of failure. No common sense from others that there are a lot of facilities that have dams that are not just a "shell"	1.more research into geotechnical properties and behavior of tailings, 2.improved methods for dam breach assessment (MPM? etc.) that broader practitioners can use so that all dams have an assessment. DO you need a PhD to model a dam breach or can we teach others how to do it?, 3. reducing the fear of competition and competitiveness with independent reviews by other consultants. I have heard resistance to having a review and have experienced reviewers marketing the client when performing reviews which puts both the engineer and client on edge.	Direct email from the Project Team
1059	5	20+ years	Consulting	Master's Degree	Civil Engineering;Environmental Engineering;Geotechnical Engineering, Mathematics	No	No	My entry into the work force was as a geotechnical engineer. I only got into tailings because I became part of a geotechnical office in Vancouver BC that had several tailings projects. I found I liked the challenge of mining and tailings so stayed with it as the prime part of my work to the point where now it is all that I consult on.	I have participated in internal formal trainings;I have participated in external formal trainings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum;SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	Mining is a necessary part of human life and safe tailings storage in perpetuity is a critical part of mining. We have the engineering, construction and operating tools, and need to diligently apply them to tailings projects without bias on technology and methodology and with safety and stability as the prime consideration.	Changing the mindset to do what is stable and safe using best available practices and best available technology, without bias of what has been done in the past, and without excessive cost pressure. Good courses in logic, creative thinking, question asking, responsibility, and accountability would help, but the biggest issue is the work discipline and diligence of the individuals participating in the work and their ability to think and resist cost-driven pressures from management individuals.	I believe that the engineer-of-record (EOR) concept is flawed and not sustainable as it presently stands, and needs to be revised with more responsibility placed on mining companies and consulting and construction firms, and less on consulting individuals. I believe that this flawed EOR concept is contributing to driving potential labor resources away form the tailings industry.	Cost emphasis versus safety and stability. Management profits over science. Pay more attention to historically successful operations an new technology. Move from the "this is the way we have always done it" bias to "apply the fundamentals of soil mechanics and geotechnical engineering.	(1) Mining companies hire high quality geotechnical engineers to be responsible for tailings facilities. (2) Elevate lead geotechnical engineers to vice president status with responsibility no less than that of financial and decision making managers. (3) Change the mindset of all mining personnel across the board to respect the geotechnical engineering recommendations and not mock them.	Direct email from the Project Team
1060	5	20+ years	Academia/Education;Mining Industry	PhD Degree	Civil Engineering;Geological Engineering	Yes	Yes	My PhD was on tailings. My jobs prior were focused on mine waste including tailings. This was all 30 plus years ago.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings;I have written numerous papers and contributed to several books, guidelines etc	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes	The industry I care for very much and want to see future generations enjoy it too	Too many to note.	Too few entering the profession with the right combination of technical, interpersonal and critical thinking skills	Competence, complacency and capacity.	Level playing field for all operators across all jurisdictions, removal of false narratives about perfectly safe facilities, remove the ambulance chasers who are impediments to attracting younger people to the profession	Direct email from the Project Team
1061	5	20+ years	Mining Industry	Bachelor's Degree	Civil Engineering	Yes	Yes	Following university I joined a consulting company that worked almost exclusively in mining and a large portion of that portfolio was tailings	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum;SME â€" Society for Mining, Metallurgy & Exploration	No	Yes	have worked in tailings for my entire career, participated in industry initiatives and offered training to other professionals.	Geotechnical, Hydrogeology, Hydrology, Stakeholder engagement professionals, etc.	Tailings is the least sexy discipline of an unsexy industry, attracting young professionals is quite difficult and there is a very high need for highly qualified persons.	It's improving, but there are too many professionals professing to be tailings experts who do not have the necessary fundamentals regarding tailings. My undergraduate degree included a one day class and one lab on slope stability analysis. All learning was through graduate classes and on the job learning	1. Accreditation of post-graduate tailings programs (certification) 2. minimum design objective of no-credible failure modes resulting in flow failure when using extreme design criteria. 3. Recognition within the mining industry of a defined career path in tailings (too many people do a 'tour of duty' in tailings as there are limited career path options for them)	Direct email from the Project Team
1062	4	5-10 years	Consulting;Mining Industry	Bachelor's Degree	Geological Engineering	Yes	Yes		I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	Yes	Have been working in the industry for 8 + years; am a member of the Canadian dam Association, and participate regularly in conference events such as the Tailings and Mine waste Conference and occasionally publish papers.	Dam Breach Analysis; lots of uncertainty and grey areas in this particular field right now, even with the newly minted CDA guidelines.		Public view and historic facilities; we need to make sure that we are doing due diligence when we are looking after or adding to (upstream raises etc.) historic facilities and the recent dam breach disasters that have occurred worldwide negatively impact the public's viewpoint on the mining industry	Nothing. I think we are on the right course and need to continue to push forward and strive for better.	Direct email from the Project Team
1063	5	20+ years	Mining Industry	Bachelor's Degree	Civil Engineering;Construction/Construction Management;Mining Engineering;Natural Sciences	Yes	Yes	Implied with Mine Engineering education, not a focus area	I have participated in internal formal trainings;I lead internal formal trainings;Served on tailings governance development committees	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	No	Yes	I lead in the area of governance and technical regarding tailings facilities and dams	Mining Dam Safety, Tailings Technologies, Managing flowability of tailings	Require many more professionals in this area. Need to mature organizational depth and understanding in this area.	1. Skilled professionals. 2. Recognition of significance of tailings in the final landscape and requirements for safe closure. 3. Immature closure regulations for tailings	1. Specific Masters level education for tailings dam & facilities /mine waste management.	Direct email from the Project Team
1064	4	10-20 years	Consulting	Master's Degree	Business	No	No		I have participated in internal formal trainings;I have participated in external formal trainings;I lead external formal trainings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes						Direct email from the Project Team
1065	4	10-20 years	contractor	Bachelor's Degree	Civil Engineering;Geological Engineering	No	No		I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes		tailings geotechnical	Less so at ConeTec, but we see the demand on our clients and see a shortfall in the senior geotechnical engineer category	Intrinsic safety and resiliency		Direct email from the Project Team
1066	4	0-5 years	Mining Industry	Master's Degree	Civil Engineering;Environmental Engineering	No	No	No, I wanted to work on treatment of mine affected water.	I have participated in internal formal trainings	AusIMM â€" Australasian Institute of Mining and Metallurgy	No	No	I still got some work to do to become an advocate. However, I consider myself passionate about the industry and the field I work on.	Training on how to conduct inspections on tailings (what to look at?) and rehabilitation and closure of tailings dams. New technologies on treatment of tailings.	Not many people with engineering background in the field.	The tailings industry is currently getting a lot of attention due to the incidents in the last 10 years. So I guess the challenge is to maintain the momentum and keep people interested in the topic	Perception, relying on old technologies,	Shared/forwarded through LinkedIn from a colleague/industry contact
1067	4	0-5 years	Academia/Education;Consulting	Master's Degree	Civil Engineering;Geological Engineering	No	No	I was slowly attracted to the tailings arena during my co-op placement and then went back to the consulting company I did my co-op term. The rest is history.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I received majority of training in tailings outside my undergraduate education	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	No	Yes	I actively participate in outreach effort.	Speaking from a geotechnical perspective, additional training in numerical modelling (i.e. critical state soil mechanics, NorSand, PM4Sand constitutive models) and more importantly on advanced lab testing skills (they are hard to come by in a consulting environment due to profitability requirement and highly deficient during formal education unless your research specifically uses advanced lab testing such as triaxial and bender	There is a huge gap between new graduates and people with 10 plus years of experience. Lack of well-balanced experiences. Lack of broad range of experiences. Many people spent their entire career in a single commodity under a single climate and geological setting, very silo'ed view as a result. Some spent too much time in the field but not enough training on the theoretical front, and vice versa.	How to attract and retain geotechnical engineers the majority of whom has the option to leave for another industry during a downturn since most consulting firms strive to diversify their client bases into non-mining related industries (i.e. infrastructure and transportation, hydro-electricity). To many, the field is too narrow, esoteric and too niche, at least on the outset.	1. More integration with the production side of things; 2. More innovation in new technologies and outreach; and 3. More data and knowledge sharing.	Direct email from the Project Team
1068	4	0-5 years	Consulting	Some College/University	Business	No	No	new developed technologies led to efforts in the tailings industry	I have participated in internal formal trainings;I have participated in external formal trainings;I lead external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	Our promotions are tailored to addressing the global issue of toxic tailings	hands on development	creating interest amongst candidates	challenging inherent attitudes	more public awareness of the issue, industry acceptance of the urgency of the issue, consideration of new ways to solve the problem	Direct email from the Project Team
1069	4	10-20 years	Mining Industry	Master's Degree	Geological Engineering	Yes	Yes	Through a summer work term in the oil sands I realized that I could make a difference and that there was a lot to do in the field of tailings management	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal	AusIMM â€" Australasian Institute of Mining and Metallurgy;CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes	I think we will continue mining, but we can do better in managing our waste	water management, geotech, hydrogeology, materials properties (fine tailings)	Lack of qualified professionals. Many people are jumping on the wagon at the moment due to increase in opportunities, but they are not true tailings professionals	Ensuring that all mining companies apply GISTM...regardless of membership to ICMM	Raise public awareness. Most countries have very little awareness. Brumadinho barely made the news in Canada.	Forwarded email from a colleague/industry contact
1070	4	10-20 years	Consulting	Bachelor's Degree	Civil Engineering	No	No	I worked along side a mining group and got to know the folks in that group and was asked to join. I went to CSM, but for a Civil degree and knew very little about mining when I graduated.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	If you can't grow it, you have to mine it.... I believe in mining and work very hard to make sure that we do it the best way possible when it comes to safety and the environment.		Lack of interest from younger professionals. The industry, and tailings in particular, have a black eye from the resent failures of tailings dams. That, along with the push for reducing emissions and keeping our water clean, is seriously affecting who would want to work in mining. Tech is sexier	Labor (EOR's in particular), perception of a dirty industry, and resources becoming harder to get.	Stop the tailings dam failures.	Direct email from the Project Team
1071	4	0-5 years	Consulting	Master's Degree	Civil Engineering;Geological Engineering	Yes	No		I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	No	No	I do not discuss my work outside my working group	Internal Erosion (piping) assessments	There are not enough EORs for all the facilities	deviation from design during construction, incentive for contractors to cut corners during construction, corruption in construction practices	more responsibility placed on owners and contractors	Direct email from the Project Team
1072	5	20+ years	Mining Industry	Master's Degree	Civil Engineering;Geological Engineering	No	No	I was a geotechnical engineer that thought I liked dams and retaining walls. I had not been exposed to mining previously.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	I am actively involved in numerous organizations to support industry (ICMM, SME, GBA, USSD, GMPA's GAT, etc.).	People management and communications are the area of weakness	Too few people at all levels	Not enough experts in the field - resource-constrained	Risk education/management, Technology improvements/implementation (dewatering, monitoring), Education (in general)	Direct email from the Project Team
1073	4	10-20 years	Mining Industry	Bachelor's Degree	Civil Engineering	No	No	I started in large scale Civil Construction - Marine and Earthworks	I have participated in external formal trainings	Not a member of a GMPA Society	No	No	My focus is generally on the operations I work in and the company I work in rather than industry wide	Detailed training on monitoring systems including the how and why eg. VWP calculation and interpretation, including trends to watch out for, hydrogeology from the technical to the practical, training for the field staff that support our team.	Trying to find truly "independent" consultants with the appropriate level of knowledge is getting particularly difficult given the travel constraints around COVID	As the industry changes how we do things and makes things safer the spend required to sustain safe and stable TSFs (especially retrofitting them) is going to become unsustainable from a cost for many mines but the facilities still need to be made safe even if the mine is closed.	Tailings specific training to be increased for both technical and practical applications, a way to engage tailings engineers early and keep them engaged, a cross industry grad program or staff exchange where there is opportunities for rotations into different areas eg. consultant and mine based tailings engineer swap roles for a period to obtain a broader understanding of tailings dams. I did a similar thing as a graduate I worked for a government agency as a Client Rep but got to do a placement as a site engineer with a Contractor	Forwarded email from a colleague/industry contact
1074	4	20+ years	Academia/Education;Consulting	PhD Degree	Civil Engineering;Geotechnical Engineering	No	No	I became concerned that the Geotechnical Engineering industry was not directly involved in the Tailings industry about 5 years after beginning my academic career, after hearing a presentation on the Aberfan failure and the Buffalo Creek disaster. I became a member of the ASCE Committee on Embankment Dams and together with Mike Duncan, Nordie Morgenstern, Dick Volpe, and Tom Shepherd we held the first workshop on Research Needs in Mining. After that Tom and I got started doing research regarding tailings management. When I got out of graduate school I did not even know what tailings were	I lead internal formal trainings;I lead external formal trainings;involvement in conferences like TMW	Not a member of a GMPA Society	No	Yes	I believe that the mining industry is a critical industry for manufacturing, medicine and many others.	Nothing in particular	Don't know	Cooperation from administration to make them understand the importance of safe operation of tailings storage facilities	???	Direct email from the Project Team
1075	4	10-20 years	Mining Industry	Master's Degree	Mining Engineering;Project Management	No	No	Only started working in tailings 3 years into my career when I changed companies to one that had a tailings division.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	Not a member of a GMPA Society	No	Yes	Trying to develop a profile within the industry.	Geotechnical, specifically latest investigation, testing and analysis of results.	Managing personal liabilities.	lack of public confidence, growing anti mining movement	More consistent approaches for identifying and assessing stability; greater recognition of experienced practitioners versus people who have done one tailings project once; clearer guidance/understanding of personal liability for tailings engineers	Forwarded email from a colleague/industry contact

Record #	1. On a scale of 1 to 5, how critical do you perceive the tailings industry professional resource shortage?	2. What is your level of experience as a tailings professional?	3. In which area are you currently employed? (Select all that apply)	4. What is your highest level of formal education completed?	5. In which field would you generalize your formal educational training? (select all that apply)	6. Did your formal education provide you any introduction to the tailings industry?	7. When entering the workforce, was the tailings industry part of your intended career path?	Explain your response to Question 7:	8. Are you, or have you been, involved with formal professional training (short courses, certifications, etc.) associated with tailings? (Select all that apply)	9.Are you a member of a Global Mineral Professionals Alliance (GMPA) Society? (Select all that apply)	10. Have you heard about the GMPA Global Action on Tailings Initiative?	11. Do you consider yourself an industry advocate?	Describe why you responded Yes or No to Question 11:	12.What professional training disciplines would help you execute your work on a day-to-day basis?	13.What challenges do you see with respect to available professional labor resources, both currently and in the future?	14.What is the greatest challenge facing the tailings and mine waste industry, in your opinion?	15.If you could change three things within the tailings and mine waste industry, what would they be?	16. How did you receive the link for this survey? (select all that apply)
1076	5	0-5 years	Heavy Oil Exploration / Oil Sands	Bachelor's Degree	Environmental Engineering;Mining Engineering	No	Yes	As an oil sands EIT, the expected rotation of on the job training included tailings.	I have participated in external formal trainings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum;SME â€“ Society for Mining, Metallurgy & Exploration	Yes	No	I'm not in a position to provide public commentary about tailings.	Regulatory Law training with respect to tailings management.	Corporate culture associated with tailings has been negative in my experience. There were excuses made for "bad behavior" in tailings because it was not the production end of the business. This culture drives people away and results in reduced tailings information and knowledge transfer internally as internal tailings "clicks" keep the tailings industry closed to anyone perceived as "not one of us": meaning women, minorities, people with environmental education, safety-minded individuals, anyone who may speak out.	The very limited number of highly qualified engineers that are authorized to deem a tailings facility as "safe".	1. Begin now with a "BIPOC, Diversity and Tailings - Futures Together!" industry initiative to make it very clear that "bad behavior" is no longer acceptable, and that it is damaging to the science and engineering of tailings management in the long run. 2. Create full transparency of regulatory law and inspections on tailings facilities. There is a risk that the tailings industry could be considered as having established "Regulatory Capture" to avert liability to tax payers and continue the operation of high risk facilities without sufficient enforcement. 3. Discontinue the use of the term "engineering judgement" with respect to the design, inspection, operation and de-licensing of tailings facilities. This term is used frequently and creates the perception of a case by case "black-box" of science and engineering without transparent explanation of quantitative uncertainties and risk factors	Direct email from the Project Team
1077	3	10-20 years	Mining Industry	Bachelor's Degree	Civil Engineering;Environmental Engineering;Geological Engineering;Natural Sciences	No	Yes	Undergraduate experience in tailings consulting and stayed	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings	Not a member of a GMPA Society	No	Yes	Lead a team of non-tailings people, working in tailings and advocating for advances in tailings investment / considerations		Mining industry want / need for internal personnel but limited to no care for keeping technical persons technical	Financial - there isnâ€™t the money available to bring every operation for every miner up to the standards, and what will this mean for smaller miners	1. Balance of internal technical staff in line with the gistm, but keeping them technical and â€˜doingâ€™ 2. external EOR and sufficient â€˜in training EORâ€™ being led by quality EOR 3. bring more people into the industry without diluting skillsets, better documentation around tailings (i.e., a new Vick book)	Direct email from the Project Team
1078	5	10-20 years	Mining Industry	Bachelor's Degree	Civil Engineering;Geological Engineering	No	No	My first job as an engineering consultant lead me to the tailings industry through clients.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	We are working to exceed industry standards at our tailings facilities and have presented Tailings Papers at Regional SME Conferences		Personal risk working in the tailings industry.	Changing Regulations	Industry Standards for Tailings and Improved Regulatory Guidance	Direct email from the Project Team
1079	3	10-20 years	Consulting	Master's Degree	Business;Civil Engineering	No	No		I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	IIMP â€“ Instituto de Ingenieros de Minas del PerÃº;SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes		Risk Analysis, Water Management	Depends on the country and Client standards. Some mines are "complying" with new standards hiring low cost companies that in paper follow the guidelines; but in reality not. We have seen that some mines request to consultants to comply with new standards; but are not willing to do what is necessary (they just want the paper or signature by a third party). So we have seen new consultants willing to sign in order to win a project (this should change too)	That Mines adopt the new Standards based on the benefits (lowering risk, etc.) and not just to get another compliance.	1) Have a Tailings responsible people at the mines that has the knowledge (the standards require for that; but in reality is not happening). 2) Waste Dumps most of the time are neglected (they should be designed, I was surprise that even big mines leave this to the end). 3) Financial awareness about postponing some of the cost (leave that to future generations, there should be a way that current owner does not have that incentive)	Direct email from the Project Team
1080	3	5-10 years	Consulting	Master's Degree	Civil Engineering	Yes	No	I began working in the mining industry following graduation. This was not my intended career path as I was happy to work in whichever industry I could.	I have participated in internal formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	No	No	While I support the industry I work in. I don't openly advocate for the industry.		As a relatively young professional I think it presents an opportunity for career advancement.	Maintaining the drive for continuous improvement in practice. This has been strong over the least few years following high profile failures but I'm unsure whether this will continue	the maturity in which certain clients approach tailings (i.e desire to undersell risks or consequences internally), overreliance on NPV or cost considerations when designing new facilities and implementation of thorough life of facility and closure planning throughout a tsfs lifecycle	Direct email from the Project Team
1081	5	20+ years	Academia/Education;Consulting	PhD Degree	Civil Engineering	No	No	I completed a degree in Civil Engineering, with electives in Geotechnical Engineering, worked first for a road authority, then a consultant that engaged me in mining geotech, then a university where tailings, mine waste and mine closure became my specialty.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	AusIMM â€“ Australasian Institute of Mining and Metallurgy	Yes	Yes	I promote the application of geotechnical engineering in mine waste management and mined landform design to the industry through consulting, through research and through training, including delivering a formal university course for over 15 years, and initiating, providing content to and delivering (six-monthly) the AusIMM online Professional Certificate Course in Tailings Management from 2020	Primarily Geotechnical Engineering, with an understanding of the industry and its drivers, plus related hydrological, hydrogeological, geochemistry and biological processes.	Meeting the expectations and requirements of the GISTM. Developing and replacing Tailings Experts at all levels, among the industry, their consultants and their contractors.	Restoring confidence and trust in the industry and their consultants and contractors providing safe tailings facilities, and regulators providing oversight.	Replace NPV accounting with whole-of-life accounting. Focus on the end game of safe closure from the outset, affecting everything that comes before. Restore the industry's standing in the community.	Direct email from the Project Team
1082	4	5-10 years	Mining Industry	Bachelor's Degree	Electrical Engineering	No	No	I started my work in a control system environment working for Honeywell , followed by Dairy industry, Pharmaceutical , Water waste water then mining where i started gaining experience in tailings dam	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	No	My role is a Project Engineer with experience in multi-discipline projects	Project management and engineering	Quite difficult	Lack of professional training experience engineers	a) Appropriate training , Increase monitoring , duty of care for tailings dam	Forwarded email from a colleague/industry contact
1083	5	5-10 years	Regulator/Government	Bachelor's Degree	Geological Engineering	No	No	I knew nothing of TSFs when I graduated from university. I started my career in the forest industry (as a summer student) carrying out terrain stability assessments and road/cut-block lay-out which led to full-time employment when I graduated in geotechnical consulting (mainly forest industry, building foundation and highways). I quickly changed over to a regulatory context spending the first 12 years carrying out highway and bridge foundation design/ regulatory oversight and spending the last 8 years in mining regulatory oversight (pits slopes, underground workings, waste dumps and TSFs). I knew nothing about TSFs until 8 years ago when I entered the mining industry (even though I had practiced in non-mining geotechnical engineering for well over a decade prior to this)	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings		No		I didn't respond. I am a regulator that deals with both the permitting/authorizations and compliance aspects of mine/TSF regulation.	TSF design and standard of practice (as it evolves) including new technologies TSF operation (including overlap of disciplines) and best practices Better understanding of challenges/successes in other jurisdictions	shortage of experienced engineers and operators with tailings knowledge/experience appropriate compensation for these roles (recruitment and retention) Tailings viewed as a periphery aspect of "mine operations" (i.e. not as important or glamourous, and now after multiple failures - also high liability)	appropriate engineering design/operational oversight social license appropriate company resources being dedicated to tailings addressing closed and abandoned sites (particularly in perpetuity)	improved legislation/regulations worldwide (industry only as strong as the weakest link) improved understanding of the importance, complexity and criticality of TSFs more financial resources being dedicated to TSFs	Direct email from the Project Team
1084	4	20+ years	Mining Industry	Bachelor's Degree	Civil Engineering	No	No	Starting working in a consulting firm and learned about tailings and mine waste management and enjoyed working in the field and the office	I have participated in internal formal trainings;I have participated in external formal trainings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum;SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	I am pro-mining and paint a good picture on the mining industry as a whole to those with less information.	Not sure this applies to me.	Liability with respect to tailings dam and people not wanting to be an EoR.	Perception from the public that dams can be safe.	Professional associations like EGBC went too far wrt Todd Martin and others on the Mt Polly disaster. How is this going to help get more EoRs?	Direct email from the Project Team
1085	4	0-5 years	Consulting	Master's Degree	Civil Engineering	No	Yes	After the recent tragedies in my country, the tailings industry was the one that allowed me to work with geotechnical engineering	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	Yes	No						LinkedIn post from the Project Team
1086	3	0-5 years	Mining Industry	Bachelor's Degree	Mining Engineering;Technical sevices	No	No	I have involved with filtered talings for about 2 yrs	Mine closure	Not a member of a GMPA Society	No	Yes	Mining is an essential industry	Storage tailings facilty instrumentation program	In my opinion, I believe that a change in the Subject is taking place for better image of the industry	Make the change of better talings management all over the World.	I guess the Industry is almost there, filtered talings or dry talings is the Point of beginning.	LinkedIn post from the Project Team
1087	4	10-20 years	Mining Industry	Bachelor's Degree	Civil Engineering	No	No	I was in construction quality control, and over the years I became tailings superintendent.	I have participated in external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	I believe in responsible mining	Geotechnical	Most available professionals are seniors, and there is not enough training and career developing opportunities for emerging professionals that could learn and get experience on tailings	The greatest challenge may be reputation, due to the events in recent years professionals are differing to other careers instead of mining. Also risk management is a key challenge that has to be addressed	More engagement with education institutions Standardize training plans for young engineers that are interested in the field Promote responsible mining as a low risk industry	Direct email from the Project Team
1088	4	20+ years	Industry association, previously a regulator	Master's Degree	Geosciences (Geology)	Yes	Yes	I did graduate work looking at the geochemistry of early 20th century mine tailings. That experience provided a good foundation for work as a regulator, which included reviews of environmental assessment of proposed new tailings facilities. That work in turn provided a good foundation for my current work on development of best practices related to tailings management.	I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes	Yes, because as a society we need mining. But we need to do mining responsibly, in a way that protects the environment and human health and safety. That includes managing tailings responsibly.	In my role and position I am fortunate to have ongoing learning opportunities through interactions with other experts. Conferences also provide excellent learning opportunities. I have considered taking the UBC course to further my knowledge. I think courses of that nature are excellent and it would great to see them expand to be able to accommodate more students.	There are, and will be growing challenges finding adequate numbers of personnel with the necessary competencies, particularly engineering related, at all levels, from entry level to senior designers, EoRs, and independent reviewers. The mining industry is not attracting sufficient numbers of competent professionals, and tailings is perhaps the least "sexy" aspect of mining. The lifestyle is not as attractive to young professionals, particularly with so many mine sites located in remote areas, and increasing amounts of travel for professionals as they climb the ladder. It is a very challenging career path for professionals of all ages who want to maintain a healthy work-life balance.	Tailings facilities look simple, but they are very complex, dynamic structures. They also make no revenue for mining companies, but can cost a considerable about of money to manage responsibly. This can lead layers of challenges, both with respect to the potential for human error, and the potential to cut corners or not adequately resource tailings management. I think these two factors, combined, make managing tailings more challenging than managing other risks (e.g, aviation, power generation, etc).	(1) Have mining companies treat their liabilities (i.e., tailings facilities) the same way that they treat their assets. Consider how much money and effort are expended on diamond drilling and other exploration activities to delineate a mineral deposit, build 3D models to help calculate reserves and resources, plan extraction activities, etc. And even then, sometimes they get it wrong. But, compare that with the money and effort expended to understand the foundation conditions of a new tailings facility. The differences are all too often night and day. (2) Banish complacency. Never, ever say it cannot happen to me. Never, ever say that all of the systems I have in place are so good that it cannot happen to me. Never, ever say that it is ok - there is no problem - because the surveillance results have been like that before and nothing happened. Be vigilant, be proactive, and assume it will happen to you. (3) The Boards of Directors of all mining companies must understand tailings management and the risks involved. Obviously not at a detailed level, but they need to understand enough to ask hard questions and make sure that they get good answers. They are just as accountable for safe tailings management as they are for all other aspects of corporate operations. They MUST pay attention to tailings management	Direct email from the Project Team
1089	3	10-20 years	Consulting	Master's Degree	Civil Engineering;Geological Engineering	Yes	No	Had no education on mining/tailings in undergrad and industry wasn't prevalent in the area.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	No	Yes	Mining and tailing management can be done safely if proper regulations are in place and sufficient engineering occurs	Confusing question. Geotechnical specifically seepage, stability, and settlement	Universal engineering standards and getting less developed countries up to current standards	Industry is too cyclical which does not promote personnel to have career long engineering or operations experience	Irregular standards, clients making decisions on costs,	Direct email from the Project Team
1090	5	0-5 years	Mining Industry	Master's Degree	Mining Engineering	Yes	No		I had training on tailings during my educational experience	IIMP â€“ Instituto de Ingenieros de Minas del PerÃº;SAIMM â€“ Southern African Institute of Mining and Metallurgy	Yes	Yes	The development of adequate sustainable mining generates development in the region that impacts the mining project, in addition to generating infrastructure and support for the university community.	Artificial intelligence, optimized management of mining waste,	There is little detailed professional training on the subject of mining waste	A big problem that mining companies are facing is that due to the extensive areas that the treatment of this waste requires, these same areas due to environmental impact issues in the surrounding communities are no longer negotiable, it would be necessary to rethink the entire management issue of mining waste	The way mining waste is managed, not leaving environmental liabilities	Direct email from the Project Team
1091	4	10-20 years	Consulting	Master's Degree	Civil Engineering;Geological Engineering;Geosciences (Geology)	No	Yes	My thesis was related to tailings sands while I was working in a tailings deposit	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	Yes	Because in my work I try to implement the best practices	Geotechnics for dam stability of tailings deposits, prospecting plan, characterization of granular materials, knowledge of deposition plans, knowledge of water balance, among others	As there is no official training, young professionals do not implement the best practices, but rather those that they inherit from older professionals. These practices are not necessarily the best	Respond to the increase in tonnage of ore processed in a sustainable way	Improve technological development, improve local legislation as appropriate, reinforce the figure of engineer of record as appropriate.	Shared/forwarded through LinkedIn from a colleague/industry contact
1092	4	10-20 years	Consulting;Mining Industry	Master's Degree	Civil Engineering	No	No	My university education never really discussed tailings path as part of civil or geotechincal engineering. But although this was not intended it has been a blessing as the work is challenging and rewarding more so than what I though I would be working on as a Civil/Geotechnical Engineer	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	No	No		Geotechnical, Dam safety and tailings operaitons	Tailigns is not really pushed or discussed as a opportunity in most civil engineering education, or in the mining industry. Don't think it pulls enough interest from university students and young professionals	Aging sernior engineers and ability of profession to fill those roles	Stigma of Mining being bad, lack of clear path of professional development, thinking by some that tailings is not a critical item as it is not a revenue generating	Direct email from the Project Team
1093	3	20+ years	Mining Industry	Master's Degree	Business;Civil Engineering;Environmental Engineering	Yes	Yes	My masters research was in waste rock and tailings	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	No	No	I do not do social media but have written technical papers on tailings.	non applicable	There will be a steep curve for young graduates	Tailings performance and how ti can be closed.	Move more sites into closure and abandonment if its there and also have a trajectory to progress them to closure.	Direct email from the Project Team
1094	3	10-20 years	Consulting	Master's Degree	Civil Engineering	No	No		I have participated in external formal trainings	Not a member of a GMPA Society	No							Direct email from the Project Team
1095	5	10-20 years	Academia/Education;Consulting	Master's Degree	Geological Engineering;Mining Engineering	Yes	No	Got interested in mine waste management while working at mining operations and continued while doing engineering consulting.	I have participated in internal formal trainings;I have participated in external formal trainings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes	Yes. I currently teach in a post-secondary institute and am a board member with a sustainable energy association where I often speak about mining and its benefits to society.	mining / geotechnical	Miners need to invest in the next generation as the enrollment in post secondary institutes is causing many schools to drop their mining programs. Start recruiting students in high school, support them in their studies, and provide co-op placements. More collaboration between mines and academia would help to improve student experience and learning opportunity, so when a school calls for a visit to a mine - they should not be getting a no for an answer. Also, academia does not pay enough to attract and keep experienced individuals	Lack of EoRs and what doesn't help are licensing engineering associations that do not provide support (recall Mt Polley & EGBC)	1. Talk/publish our successes more. 2. Improve collaboration amongst miners - "everyone is first to be second" needs to change and we need miners to step up and be leaders. 3. Look at operating mine departments as one - not a bunch of silos/groups (mine planning, processing, etc) and create KPIs for the entire mine, not departments.	Direct email from the Project Team
1096	5	5-10 years	Consulting	Master's Degree	Civil Engineering	No	No	Specialized in geotechnical engineering. But never intended to specifically work on geotech applied to tsf	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	No	.	Risk management. Liquefaction tailings. Help client understands new requirements and how it translate in day to day operations, eor . Idependent review boards, cda and global standards. There is a gap between what upper management direction and day to day activities in mine sites	Lack of experienced professionals in tailings. Currently there is a shortage that will only increment if the state of care required by the industry will made increase. It Is a stressing situation that discourage progressional to enter and stay in this industry.	Lack of experienced professionals. Not forming new ones at the required rate.	Understanding of operators about tailings risks, impact of operation decision taken on long term safety. Less pressure on money and fast work, more in safety and taking time to assess wells projects/decisions. Accountability regarding change in early stages of projects.	LinkedIn post from the Project Team
1097	5	0-5 years	Consulting	Master's Degree	Geological Engineering	Yes	Yes	He had taken courses in the Postgraduate	I have not participated in any formal professional training on tailings	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	I consider that the physical stability of the deposits is very important for the mining industry	Yes	Greater education and training for the success of future projects	The characterization of thick materials	Better QA / QC in construction, better environmental management, better construction methods	LinkedIn post from the Project Team
1098	5	5-10 years	Mining Industry	Bachelor's Degree	Civil Engineering	No	No	I started working in hydrogeology	I had training on tailings during my educational experience	Not a member of a GMPA Society	No	No	No	geotechnical engineering.	Professionals with geotechnical background but without knowing other disciplines (water management, hydrogeology, processes, civil, construction) and vice versa such as mining engineers without geotechnical knowledge	Applying a real risk management approach and not just trying to follow by the letter one standard just for compliance	Formal education in tailings, requirements on multidisciplinary teams at senior levels, international collaboration between different sites	Direct email from the Project Team

Record #	1. On a scale of 1 to 5, how critical do you perceive the tailings industry professional resource shortage?	2. What is your level of experience as a tailings professional?	3. In which area are you currently employed? (Select all that apply)	4. What is your highest level of formal education completed?	5. In which field would you generalize your formal educational training? (select all that apply)	6. Did your formal education provide you any introduction to the tailings industry?	7. When entering the workforce, was the tailings industry part of your intended career path?	Explain your response to Question 7:	8. Are you, or have you been, involved with formal professional training (short courses, certifications, etc.) associated with tailings? (Select all that apply)	9.Are you a member of a Global Mineral Professionals Alliance (GMPA) Society? (Select all that apply)	10. Have you heard about the GMPA Global Action on Tailings Initiative?	11. Do you consider yourself an industry advocate?	Describe why you responded Yes or No to Question 11:	12.What professional training disciplines would help you execute your work on a day-to-day basis?	13.What challenges do you see with respect to available professional labor resources, both currently and in the future?	14.What is the greatest challenge facing the tailings and mine waste industry, in your opinion?	15.If you could change three things within the tailings and mine waste industry, what would they be?	16. How did you receive the link for this survey? (select all that apply)
1099	5	10-20 years	Mining Industry	Bachelor's Degree	Civil Engineering;Construction/Construction Management;Environmental Engineering	No	No	It was not advertised as a significant career path throughout university. Roads, bridges, active mining, water dams, environmental, landfills, etc, but not Tailings Engineering.	I have not participated in any formal professional training on tailings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum	No	Yes	I believe the mining industry can provide many opportunities as an employee and can also benefit communities and stakeholders if engaged and consulted appropriately.	Currently, I would like to know more about seismic liquefaction and runout analysis for tailings dams.	Advocating at the highschool and undergraduate levels to encourage enrollment in mining and tailings related disciplines. Protection and empowerment of the Engineer of Record and similar roles	Ensuring adequate practice standards are being met in an under resourced industry.	Increasing the professional and public knowledge base. Protecting and empowering key individuals / roles. Ensuring tailings siting and design are getting the appropriate levels of attention and funding throughout the mine lifespan (tailings facilities in my experience are where costs are cut)	Direct email from the Project Team
1100	3	10-20 years	Mining Industry	Bachelor's Degree	Environmental Engineering	No	Yes	My beginnings were in the mining industry in the planning area	I have participated in internal formal trainings;I have participated in external formal		Yes	Yes	Mainly because it is the source of my employment	geotechnics	lack of government support	the bad image that has been won by catastrophic events in the world	training for decision makers; technical preparation for operators; technological development	Direct email from the Project Team
1101	5	10-20 years	Consulting	Master's Degree	Environmental Engineering;Geological Engineering	Yes	No	I first graduated as a geological engineer and I started in the mines as a geologist. I then moved to environmental engineering and tailings management, and finally my masters degree, I formally learned more about tailings management and closure. Basically at the same time the industry became more aware of its criticality...	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum	No	Yes	I responded yes because I spent 20 years in the industry before moving on as a consultant. There was a lot of emphasis put on what can go wrong but I feel that great initiatives need to be publicized	Workshops on the new standards and how to practically go about implementing them.		To bring all facilities, old and new, to the same acceptable standard. This means also having junior players of the industry investing more in their tailings facilities (and realizing the importance of doing so). We also need to help regulators get up to the standards for the good of the whole industry. We can't afford to have poorly designed facilities be approved, or approved for an expansion...	The fact that standards and regulations differ so much. The lack of incentives for some companies to adopt better tailings management practices (although this might change with the Global tailings standard and the investors behind it). Have an accessible and affordable, tailings management training program for all (industry, regulators, students, stakeholders, and consultants)- most likely on-line.	Direct email from the Project Team
1102	5	5-10 years	Mining Industry	Master's Degree	Business;Mining Engineering;Metallurgy	No	No		I had training on tailings during my educational experience	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes		Dewatering, deposition, hydro geology, geotechnical, civil	Increasing shortage	Bad design and bad operation	Require a special trading and licensing for those employed in tailing operation... with different levels for operators and management	LinkedIn post from the Project Team
1103	4	20+ years	Mining Industry	PhD Degree	Environmental Engineering	No	No		I have participated in internal formal trainings;I have participated in external formal		Yes	Yes						LinkedIn post from the Project Team
1104	4	0-5 years	Mining Industry	Bachelor's Degree	Business	No	No	I came to this industry later in my career.	I have not participated in any formal professional training on tailings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	I see the value and need for awareness of this industry.	Trains Tailings water management	Proper risk assessments and onsite management.	Continued growth in knowledge sharing and best practices, especially for new people coming into the industry	More collaboration Better access and evaluation of new technologies	Direct email from the Project Team
1105	5	10-20 years	Consulting	Master's Degree	Civil Engineering	No	No	Had no knowledge of tailings industry when I entered work force	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	No	Yes	I actively engage in workshops, conferences, seminars, etc. to promote tailings related issues	Geotechnical Engineering	There are very limited avenues to attract young professionals to tailings industry	Lack of concerted effort; lot of initiatives and interest but they are not driving towards a common goal	Prefer to discuss separately; Please contact me, if interested.	Direct email from the Project Team
1106	5	5-10 years	Consulting	Bachelor's Degree	Civil Engineering	No	No	I wanted to become a geotechnical engineer and the field of tailings presented ample opportunity to gain experience in this field.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings		Yes	Yes	Creating awareness with clients on how the changing best practice will affect their facilities and what is required to improve overall safety.	Laboratory and in-situ testing methods and interpretation. Improved understandings of limit equilibrium, deformation analyses etc.	There is a significant shortage in South Africa. The biggest challenge will be to develop enough EoR class professionals with 10+ years of experience.	The cost of practically implementing international best practice and improving overall safety of TSF's to the requirements. Many mining houses are not planning or prioritizing this.	More engineering professionals, prioritization from client executives to do the required work, better technologies to avoid surface deposition and allow sustainable in-pit or underground deposition (to better preserve the environment).	Direct email from the Project Team
1107	4	0-5 years	Consulting	Bachelor's Degree	Geological Engineering	Yes	No	I was generally interested in the application of geotechnical engineering to general civil engineering structures, i.e. bridges, basement excavations, etc.	I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	No	No	At the moment I am still too inexperienced and am still learning the ropes and getting gradually familiar with the global tailings fraternity.	Technical details for dealing with tailings materials, specifically from an overall stability and management viewpoint.	In the African environment, I can see outside of South Africa, there are very little experienced tailings professionals. And this is exaggerated by mine personnel that are not aware of the risk of mine residue storage facilities.	Mine owners and personnel that are ignorant (uneducated) of the risks of mine residue storage facilities.	- Education of mine owners to risks of mine residue facilities. - Bring in formal post-graduate university courses on tailings. - Establish cross-company mentorship programmes. (e.g. we are a small company that have been pulled into the design of TSFs. When we approached the senior tailings engineers from the large companies to mentor us, they said that it would be a conflict of interest to train their "competition")	Direct email from the Project Team
1108	5	0-5 years	Instrumentation supplier	Master's Degree	Environmental Engineering;Geophysics	No	No		I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No					Safety assessment and monitoring	more control on the facilities, more safety and less waste creation	Direct email from the Project Team
1109	5	10-20 years	Mining Industry;Supplier of Dewatering Technology	Some College/University	Chemical Engineer	No	No	When I started working for my company the issue of the dry stack tailings just started.	I have participated in internal formal trainings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum	No	Yes	I believe Industry is important and is key. It has just to be responsible.	Geochemistry		Mentality of Conservative people.	Filtered Tailings shall be the "Modern Conventional".	Direct email from the Project Team
1110	4	20+ years	Consulting	PhD Degree	Civil Engineering	No	No	I was working in geotechnical projects, including underground, but not in mining	I lead internal formal trainings;I lead external formal trainings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes	My mission is to better the tailings management practice worldwide	Psychoanalysis of many colleagues and clients	Generational gap, loss of value, loss of good sense	Loss of credibility with the public	Stop redoing the same errors, stop running after alibi of all sorts, stop conflicts of interest	Direct email from the Project Team
1111	5	20+ years	Consulting	Post-Doc Study	Civil Engineering;Geological Engineering	No	No	I did not intend working in tailings specifically, but that is where my employer needed me at the time.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	Yes	Yes	I work in this field every day and make clients aware of global initiatives	Geotechnical engineering	Emigration from South Africa, need for 10 year experience for EoR	Non uniformity	Uniformity internationally of standards and practice. Tailings not being seen as 'part of the mining process', just an overhead reducing profit.	Direct email from the Project Team
1112	5	0-5 years	Equipment supplier	Master's Degree	Biochemical and Chemical Engineering	No	No	The equipment we supply can be used in Tailings industry, so I have had to learn about the industry in more detail.	I have not participated in any formal professional training on tailings	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	I want to challenge the current mindset in working with Mine Tailings, just because something has been done one way for 250 years, does not mean it is still the correct way.	More general overview of the process and industry. Learning the terminology a fresh is very difficult.	People are motivated by how active their chosen profession is, if there is a reduction in permitting and funding, then the industry does not look attractive to work in long term.	The adaption on how the best way to treat mine tailings.	Education on technology that was perceived as incorrect for dewatering 50 years ago, to demonstrate how the technology has advanced and how it could be more suitable in this day in age. Demonstration/teaching of different technologies at university level More open forums with technology vendors where ideas can be challenged	Direct email from the Project Team
1113	3	0-5 years	Mining Industry	Bachelor's Degree	Civil Engineering	No	Yes	I worked for an insitu testing company prior to returning to school and every summer throughout. After graduation I continued my career with the same company.	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	Yes	Engagement in industry. Attending external short courses, conferences and continuing professional development.	N/a	Difficult to hire and keep staff for more than 2 years.	Funding for insitu testing, records and interpretation		Direct email from the Project Team
1114	5	10-20 years	Consulting;Mining Industry	Master's Degree	Geological Engineering;Mining Engineering	Yes	Yes	My summer jobs prior to under-graduation were working on tailings deposits and mining became my preferred path. I also focused graduating and masters-graduate projects on seepage from mine wastes & tailings agglomeration for use in backfill aggregate replacement. In fact, I designed my entire masters course-load on mine waste mgmt. Mine waste, tailings, borrow devt, reclamation and dams all were very interesting challenges I was interested in.	I have participated in external formal trainings;I had training on tailings during my educational experience;I lead external formal trainings;I have produced content for tailings training led by others.	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum;SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	I am part of GAT, SME Tailings WG, and Chair of CIM ESRS and part of their tailings WG, helped design programming in Tailings. My personal business also focuses on mine waste and circularity in mining.	Not sure what this means but possible support for projects might come from risk, processing and water mgmt, geotechnical and environmental, including landform designers and reclamation expertise. Also instrumentation, IoT/IT, land use planners and stakeholder engagement specialists.	Not much interest by next gen in mining, let alone mine waste mgmt. We have to get better at showing them how interesting this work really is, and how critical it is for safety reasons. Right now a lot of expertise is leaving without having the next pool of experts being trained effectively to take over.	Insufficient recognition that we canâ€™t keep doing things the same way as waste volumes increase. With major shifts in how we manage tailings coming, we will all need to be learning new things all the while taking care of the old ways too. No one is preparing for that.	A full shift to looking at mineral value in â€œwastesâ€ to divert more away from storage, drier tailings mgmt, and to look at waste mgmt as a design element in the system - ie not think of how we manage the output of processing last but instead engineer tailings as a product to meet particular requirements.	Direct email from the Project Team
1115	3	20+ years	Consulting	Master's Degree	Geological Engineering	No	No	My focus was geotechnical engineering, not with a specific focus on tailings. I still think that fundamental geotechnical engineering captures the necessary fundamentals with mine waste experience occurring during ones profession.	I have participated in internal formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes		soil mechanics, surface water H&H, const mgt,	there is a gap between those in their late 50's and 60's; and those in their 30's and 40's	Getting those in their 20's and 30's enough experience to function as and EoR	Tough question, only thing that comes to mind is US regulations, it would be tremendous if we had consistency between the states as right now there is major inconsistencies. Also, more acceptance of EoR role by agencies and smaller companies.	Direct email from the Project Team
1116	3	10-20 years	Consulting	Bachelor's Degree	Chemical Engineering	No	No		I have participated in internal formal trainings;I have participated in external formal trainings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum	No	Yes	I see sustainable development of our natural resources as an imperative to our overall quality of life	geotechnical, process, mechanical, environmental		viable solutions for long-term liabilities within above-grade tailings structures		Forwarded email from a colleague/industry contact
1117	4	20+ years	Consulting	Master's Degree	Geotechnical Engineering (imperial College, London)	No	No	I was first dedicated to earth dams and after about 6 years I started to be involved in tailings dams in Chile and later on in Peru, Canada, Brazil	I lead internal formal trainings;Numerous talks and presentations for engineers and professional institutions	IIMCh â€“ Instituto de Ingenieros de Minas de Chile	Yes	Yes	I feel responsible as part of the industry on the practice on tailings design	Hydrogeology and geochemistry of minerals and tailings	Tailings and mine waste issues require a multidisciplinary approach: civil and geotechnical engineering, hydrology, hydrogeology, geochemistry, risk analyses and good sense	The closure and abandonment of hundreds of tailings deposits in different environments	Governance; transparency; accountability	Direct email from the Project Team
1118	4	0-5 years	Academia/Education;Consulting	Bachelor's Degree	Environmental Engineering;Geological Engineering;Geosciences (Geology)	Yes	Yes	During my undergraduate studies (bachelor's degree) in geological engineering, there was little or no introduction to the tailings industry during classes. However, I completed a university internship during which I was strongly introduced to the tailings industry during my undergraduate studies. At the end of my bachelor's degree, I started working as a consultant in the tailings industry and also started a master's degree on the topic of tailings.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;Master's project on the topic of tailings	Not a member of a GMPA Society	No	Yes	The mining industry is a stimulating work environment. I also consider it an essential industry for developing new technologies that will help address current environmental and social issues around the world. I am pleased to use my geoscientific knowledge to contribute to the improvement of environmental management in the mining industry.	Training on mining and environmental regulations; training on software (contaminant transport, water infiltration, water flow); training to find out the mining companies' point of view on tailings management.	The main current challenge I see is related to the lack of experts in tailings stability. Unless you perform graduated studies, I think most geoscientists enter the industry with a lack of knowledge about the science surrounding tailings pond stability. I also think that abandoned mine sites are a significant challenge. These sites often generate acid mine drainage and contaminate aquifers for years. This issue is all the more important considering that climate change could reduce the quantity of drinking water available on a global scale.	Former tailings impoundments that are still active and used by the industry to store tailings. The stability of those impoundments are generally not optimal.	1. Limit the production of pulp residues. Filtered or thickened tailings should be preferred to ensure tailings management at high levels of stability ; 2. Incorporate progressive tailings reclamation during mining operation to prevent reactions leading to acid mine drainage. It is more difficult to reclaim a site where AMD reactions are in place and therefore more difficult to ensure the integrity of the surrounding aquifers. 3. Encourage the co-disposal of tailings and waste rock to reduce the footprint of accumulation zones and improve the stability of tailings impoundments.	Direct email from the Project Team
1119	5	20+ years	Consulting;Mining Industry	Master's Degree	Civil Engineering;Geological Engineering	No	No	Tailings engineering was not considered much of a discipline at the time but rather a subsector of Civil and Geotechnical Engineering. it's only more recently that there has been an focus on tailings engineering as a unique discipline	Have participated in Tailings and Mine Waste	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	I am a mining advocate. However, the industry needs to manage tailings more responsibly.	Technical engineering related to water dams, geomembrane design, and risk analyses would be helpful. I don't think we have a strong understanding as an industry of risk associated with tailings failure. I do see progress on the front through incorporating FMEA and QRA analyses into the design and evaluation of tailings dams.	Lack of skilled and experienced technical professionals. Engineering services are being treated as a commodity rather that a professional service. The pressure to reduce engineering costs at the expense of technical expertise has cheapened the profession and we're losing our best people at all levels.	We are making progress but I don't believe we are close to preventing catastrophic tailings failures. We are approaching the problem with advanced modeling and technology. I firmly believe the focus needs to change to simple and very strong design and responsible water management. These are very expensive solutions and not as glamourous as advanced modeling and cutting edge engineering solutions but cutting edge engineering solutions have proven not to work. The consequences of failure too high and there are inherently too many variables to rely on complex engineering solutions. We are taking on too much risk through arrogance in the tailings engineering community and over-reliance on complex models	Eliminate upstream tailings dam configurations. Increase the use of geomembrane lining systems. Review and adopt design, management, and regulatory practices used for water dams. Yes, all of this will increase the costs of tailings management significantly. The current state of the practice, even with the current EOR practices and post Mt Polley guidelines, carries to much risk. I believe tailings failures will continue until we fundamentally change our approach to tailings management.	Forwarded email from a colleague/industry contact
1120	5	10-20 years	Consulting	Bachelor's Degree	Civil Engineering	No	Yes	During my undergrad I completed several internships (co-ops, as they are called in Canada). I was exposed to tailings and mining during one of those internships. I	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	No	Beyond presenting at conferences, and describing the industry to family and friends, I don't have much of a voice or audience to call it 'advocacy'		It is already at a critical level, and has been for years. I see the strain of the workload and responsibility on collages at every rung of the hierarchy, from the EoR down through the graduate engineer supporting them. I'm concerned that the mining industry will think they've 'solved it' now that they have a Global Tailings Standard - but they need to recognize t Looking forward, unless there are more formal streams for training in university and remuneration packages to match the responsibility involved, the industry will	Shortage of skilled professionals. The Global Tailings Standard will become yet another well intentioned guidance document with unrealized potential if there are the people to implement it.	More formal streams of training for the professionals. Better recognition of the role of EoR by mining clients and the responsibility of the work (e.g. doctor, lawyer).	Direct email from the Project Team
1121	4	0-5 years	Mining Industry	Bachelor's Degree	Civil Engineering;Geological Engineering;Geosciences (Geology)	No	No	Completely unaware that there was a career path in tailings. Was not aware or knowledgeable enough of tailings as a process in mining, as an academic subject or that there was a need for people with my education in this business.	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	Yes	No	I believe we need to create more awareness about our business to new grads coming out of relevant university programs. I really strongly believe subjects specific to tailings management and engineering should be offered at undergraduate / graduate levels.	Geotechnical engineering, Water engineering / hydrology, Civil project managing, tailings deposition planning / modelling, GIS, remote sensing, geotech instrumentation technicians, instrumentation database engineers, Tailings dam construction, deposition and operations personnel, pipeline / slurry engineers, reclamation / environmental professionals.	A general non awareness of our business among new grads in the relevant professional disciplines. Unavailability of relevant courses in tailings management / engineering subjects	Mining industry leadership unawareness of tailings dams as a potential latent and serious long term risk in their asset profile and the necessary efforts and costs required to manage that risk.	Awareness of the risk, cost and management strategies among mining industry leadership, a stronger advocation for tailings management as a subject deserving it's own dedicated courses in engineering universities - since tailings management is so multidisciplinary in nature, colleges / universities could explore potential to combine various subjects and create a tailings specialty in undergrad programs - to streamline more well rounded engineering grads towards this business (see my answer to Question 12 for the various disciplines)	Direct email from the Project Team
1122	3	10-20 years	Consulting	Master's Degree	Civil Engineering;Geosciences (Geology);Natural Sciences	No	No	I was not familiar with tailings, so could not have made it part of my career path when I started. I was looking for interesting geotechnical engineering.	I have participated in internal formal trainings;I participate in conferences, and have written papers, and provided short presentations	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	No	To consider someone an advocate, I believe it means speaking to or writing for people outside of the small select group of people who already know about and work with tailings. I have not done this.	Speaking for the industry in general, I think a more nuanced understanding of shear strength and how to select the most appropriate methods for modelling tailings under different conditions/scenarios. Additionally, a wider understanding on how to design for closure. And, at least an introductory training on mining engineering and mining economics for those who come from different fields and end up in tailings	Good people regularly graduate with BS/MS/PhDs. The challenge is getting those people up to speed on the specific challenges of tailings, and how to design/build/operate facilities in general.	Ongoing struggle to more adopt uniform standards across jurisdictions. Risks and consequences don't change across jurisdictions, but the regulations do. Ongoing training and mentoring of new professionals, who need good depth in their discipline, plus understanding of the broader multidisciplinary nature of large mining projects.		Direct email from the Project Team
1123	2	10-20 years	Consulting	Master's Degree	Civil Engineering	No	No	I actually had to chose between the tailings department and soil mechanics/foundation and went for the latter as I considered tailings "boring" at the time	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	No	Just not a priority	Geochemistry, water quality, tailings governance, alternative analysis, permitting, instrumentation	It is somewhat hard to find trained professionals. Plus the industry (mining companies) are hiring many consultants and developing their departments, which is taking a toll on the other stakeholders pool	Orphan and risky tailings dams in the developing world	Ups and downs of the economic cycle, continue opening the information and decision making to the overall community	Direct email from the Project Team

Record #	1. On a scale of 1 to 5, how critical do you perceive the tailings industry professional resource shortage?	2. What is your level of experience as a tailings professional?	3. In which area are you currently employed? (Select all that apply)	4. What is your highest level of formal education completed?	5. In which field would you generalize your formal educational training? (select all that apply)	6. Did your formal education provide you any introduction to the tailings industry?	7. When entering the workforce, was the tailings industry part of your intended career path?	Explain your response to Question 7:	8. Are you, or have you been, involved with formal professional training (short courses, certifications, etc.) associated with tailings? (Select all that apply)	9.Are you a member of a Global Mineral Professionals Alliance (GMPA) Society? (Select all that apply)	10. Have you heard about the GMPA Global Action on Tailings Initiative?	11. Do you consider yourself an industry advocate?	Describe why you responded Yes or No to Question 11:	12.What professional training disciplines would help you execute your work on a day-to-day basis?	13.What challenges do you see with respect to available professional labor resources, both currently and in the future?	14.What is the greatest challenge facing the tailings and mine waste industry, in your opinion?	15.If you could change three things within the tailings and mine waste industry, what would they be?	16. How did you receive the link for this survey? (select all that apply)
1124	5	10-20 years	Consulting	Bachelor's Degree	Civil Engineering	No	Yes	Tailings management provides an opportunity to make an impact to environmental stewardship and risk management.	I have participated in internal formal trainings;I have participated in external formal trainings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum;IOM3 â€" The Institute of Materials, Minerals & Mining	Yes	Yes	Informally, in terms of internal training and mentorship, and external communication (stakeholder engagement, risk communication)	Technical (geotechnical, hydrotechnical, geochemical); risk definition, communication and stakeholder consultation.	Experience gap in engineering service providers, and upcoming retirements, will leave inexperienced people as EORs for many facilities. Multidisciplinary nature of tailings management does not lend itself to a single individual EOR, system should clearly define requirements for multidisciplinary responsibilities.	Lack of technical resources (experienced EORs), and responsibility-autonomy gap between owners and consultant EORs.	1) Require EORs on all tailings facilities, but limit the number of facilities one EOR can be responsible for (based on classification, e.g. an EOR should not be responsible for more than 1 extreme consequence facility). 2) Clarify roles and responsibilities between owners responsible tailings manager, executive team/board, and EOR, that ensure that EOR has sufficient involvement and knowledge of day-to-day operations, and that recommendations are followed. 3) Require EOR support from multidisciplinary teams, commensurate with the complexity of the project	Forwarded email from a colleague/industry contact
1125	3	0-5 years	Mining Industry	Bachelor's Degree	Civil Engineering	Yes	No	I began working with materials and geotechnical instrumentation, which led to tailings through project work over several years	I have participated in internal formal trainings	Not a member of a GMPA Society	No	No	I am unsure what an Industry Advocate is	Critical state soil mechanics. Modelling in Civil 3D/Mine Sight	Awareness among engineering students of the demand for tailings engineers, lack of specialized courses available for tailings outside of specialist institutions	Establishing standard methods for evaluating tailings structures		Forwarded email from a colleague/industry contact
1126	3	10-20 years	Consulting	Master's Degree	Mining Engineering	Yes	Yes	My studies were focused on mine waste management as well as mine closure and reclamation.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes	Many people in the western society are oblivious of the sources of its wealth and the necessary environmental impacts to sustain the high standard of living. I firmly believe we can and must do better, but we cannot be without mining.			The rapid changes requiring constant adjustments to the management methods and societal expectations. While progress is desirable, changing too quickly does bring a high level of uncertainty that must be dealt with in the operator's risk matrices.	Universal standards of care, financial models used for mine life cycle decisions	Forwarded email from a colleague/industry contact
1127	4	5-10 years	Consulting	PhD Degree	Civil Engineering;Environmental Engineering	Yes	Yes	I completed undergrad in Enviro Eng and PhD in Civil (GeoEnviro Eng). Both programs had exensive exposure to many aspects of mine tailings	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	No	No	I am currently focused on gaining consulting/industry experience	?	My consulting company is having challenges staffing projects.	Long term performance of tailings storage facilities		Forwarded email from a colleague/industry contact
1128	3	10-20 years	Consulting;Mining Industry;Regulator/Government	Bachelor's Degree	Environmental Engineering;Geological Engineering;Health and Safety;Mining Engineering;Natural Sciences	Yes	No	Geographer with a passion for the environment. Worked as an mine surveyor phogrammetrist. That was the introduction into tailing dams planning, mapping and monitoring	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum;SAIMM â€" Southern African Institute of Mining and Metallurgy;SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	Experience leads to exposure and ability to determine risk at the end you find yourself advising and advocating for implementation of your practical knowledge and the general important of the tailings faculty.	Environmental Engineering	The current professional adaptability to AI and Machine learning is pivotally for the future. AI should be incorporated into this industry with the current group of professionals who possess both academic and practical experience		Irregular monitoring, enforcement of rehabilitation of old mines tailingsand mine waste industry. Incorporate the microwave technology in chemical, waste separation.	LinkedIn post from the Project Team;LinkedIn direct message from the Project Team
1129	4	10-20 years	Consulting;Mining Industry	Master's Degree	Civil Engineering;Geological Engineering;Geosciences (Geology);Mining Engineering	Yes	Yes	When looking for a job was looking for a career as a consultant in the civil infrastructure and mining industries. As part of this had waste management (waste rock and tailings on my radar).	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes	Active promoter to clients, peers and others in mining industry about tailings design, management, operations, closure . Promote developing standards and guidance documents and look for ways to work with others in the industry and academic institutes to push forward the state of design. Promote more awareness on risk. Always looking for ways for continued development (often done through collaboration with others in and outside my company).	Water quality and quantity (better water and load balances for tailings facilities and mining sites in general). Geotechnical (strong understanding of soil mechanics), hydrotechincal, water resource (quality and treatment), geochemical, geomorphology (better understanding and mapping), metallurgy / milling, sometimes groundwater and geology. Tailings will always be a multi-disciplinary field. Need to have at least a general awareness of the various areas outside of just geotechnical so you know what questions to ask or who to ask to get help from.	Currently good available professionals (consultants, academic, industry) all seem very busy. More demand than supply for good professionals in tailings, and it seems like demand is continually growing as standards (rightfully so) increase and move forward. Can see people getting overloaded (taking on too many sites). See industry growing but not at a rate that would be able to handle all the historic and operating sites in addition to the new sites. Overall see low current supply and low future supply of available professional labour in tailings industry. Future programs aimed to focus on tailings specifically may somwhat assist with this? Do not have a large pool of people with say 10+ years experience so will be a gap for at least the next 10 years as professional labour resources increase / catch up. See a trend towards more EORs on lower consequence structures with less experience.	Social license to mine.	Better communication between site and office and management staff. More multidisciplinary teams (more focus on water), more reliability based designs (more discussions on risk etc.,).	Forwarded email from a colleague/industry contact
1130	3	5-10 years	Consulting	Master's Degree	Civil Engineering	No	No	My target was mining, all of the sudden i found myself in this very compatible environment to my original degree (Civil)	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	Yes	No	Not yet, I still believe I have to much to learn,	Not really clear on waht you mean with "professional training disciplines" Geotechnical and hydotecnial?	There is already a lot of theoretical expertise and value, but lack of experience.	Addapting to the new policy changes and the constantly changing technologies and challenges in the mining industry	what we did in the past, the provintial/country regulations associated with tailings and the relevance on the environmental point of view of Tailings to the mining companies	Forwarded email from a colleague/industry contact
1131	4	20+ years	Consulting	Master's Degree	Civil Engineering	No	No	I didn't have that level of direction when entering the workforce.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead external formal trainings	Not a member of a GMPA Society	No	Yes		Geotechnical engineering	Limited pool of mid-level and higher geotechnical engineers	Professional labor resources	Increase research aimed at improving best practices; Expand the labor pool and increase retention in the field; Improved efforts in mining sustainability	Direct email from the Project Team
1132	4	10-20 years	Mining Industry	Bachelor's Degree	Natural Sciences	No	No	While not strictly a tailings professional' - i am an environmental scientist and closure professional and called upon often to fill the void for tailings closure professionals. Given we are creating landforms to be in place for perpetuity (for the majority) this is the biggest gap I see in the profession - understanding and designing for closure. This was not part of my educational plan	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	Yes	Yes	I have been in mining for 20+ years and understand that the modern world needs mining - responsible mining - for its continuation.	Tailings Closure - how to design for it, operate to it and implement closure, including post closure monitoring and maintenance and timing of closure (i.e., the risks of leaving TSFs in long term care and maintenance without being properly closed)	Lack of focus and expenditure on closure at all stages of a TSF lifecycle (hence lack of closure specialist in TSF vacancies), increased pressure from externals on TSF closure and regulations and societal expectation changing faster than professionals are available.	External expectations moving faster than the industry can respond, ongoing industry focus on production rather than the full lifecycle of its operations and associated risks	1. Focus on and understanding of closure at all stages of lifecycle of TSF 2. Well rounded tailings professionals that understand that TSF design, operation and closure is a multi-disciplinary activity and they must reach out to subject matter experts beyond water and geotech 3. Understanding of in-perpetuity risk and more effort into innovation and waste reuse for circular economy and maximise resource extraction	Forwarded email from a colleague/industry contact
1133	4	20+ years	Regulator/Government	Bachelor's Degree	Civil Engineering;Environmental Engineering	No	Yes	As part of a co-op work-term I worked at a mine site supervising a tailings dam construction, this was my first real exposure to tailings. Upon graduation from University I chose to stay in the tailings field	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	No	Yes	Work in a regulatory role of mining and also support mining in general and tailings in particular	Civil and/or geotechnical engineering	Lack on students wanting to enter into civil or geotechnical engineering and then a lack of opportunities for employment upon graduation	decline in graduates interested in mine tailings	More outreach from mining companies, tailings groups like CDA/MAC, consultants to schools/universities Increased program options or development in universities with tailings specific criteria	Direct email from the Project Team
1134	3	10-20 years	Specialty Contractor	Bachelor's Degree	Civil Engineering	No	No	I was interested in mining and geotechnical engineering, but had almost no awareness of tailings.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	No	Yes	I am involved in hiring new talent into the field, advancing the state of practice, challenging current ways of doing things, seeking efficiencies...	The University of Alberta's International Curricular on Design and Assessment of Tailings and Mine Waste Structures is an asset in my career. I attend the annual conferences for Tailings & Mine Waste, Oil Sands Tailings, Canadian Dam Association, Canadian Geotechnical Society. I review and write papers. I am involved in University research.	The cyclical nature of commodity prices results in volatility in job opportunities for graduates, constraining the intake of new talent.	Tailings are not a revenue producing asset in the mine, therefore many tailings facilities receive the minimum investment necessary to maintain an acceptable level of risk based on the data known at the time.	A strong outreach program for young professionals and members in training, including free virtual conference attendance for students and young professionals. This will help to keep people engaged, and hopefully draw talent in. Legacy TSF's should be progressively closed, reclaimed, and decommissioned as soon as possible, minimizing the overall risk inventory for the industry. Any design relying on perpetual care and maintenance should be viewed with a great deal of scrutiny. The burden to future generations is too immense, and it the site will need to be remediated in the future and/or it is doomed to fail. To the degree possible, tailings budgets should be insulated from commodity fluctuations. The baseline work associated with ensuring safe dam operations does not fluctuate with copper, oil, or gold pricing.	Direct email from the Project Team;LinkedIn post from the Project Team
1135	4	10-20 years	Consulting;Mining Industry	Some College/University	Computer-Aided Design (CAD)	No	No	In school I thought I would be doing mechanical drafting, first decade was working for land surveyors in the oil & gas industry, then the next 20 years were working for consulting engineers (primarily geotechnical)	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	Yes	I have enjoyed the work that I have done with regards to mining, and feel that the work our company is doing is providing a safer and better mining environment.	It's not the training for CAD people that is the issue, it's the lack of qualified people wanting to go into the field. I wish I could answer the question differently.	There is already a shortage of qualified designers as many end up becoming engineers, and unfortunately I can't see this improving in the future.	Public opinion/perception/optics	Greater accountability when things go wrong, better oversight to make sure things don't go wrong, improving the perception/optics of mining in developed/western countries.	Forwarded email from a colleague/industry contact
1136	4	0-5 years	Mining Industry	Bachelor's Degree	Civil Engineering;Construction/Construction Management	No	No	Started in water team (consulting) > dams team (consulting) > TSF specialist (mining industry)	I have participated in external formal trainings	Not a member of a GMPA Society	No	Yes	Passionate about dams management	Civil / geotechnical engineering / risk management and governance	Global hype on tailings might be a passing phase (until another large, public facility fails). Lots of intent, but not enough money (tailings are a net present cost issue, currently as...	General lack of understanding of tailings behavior.	Provide more incentive (not sure what) for people to join the industry.	Forwarded email from a colleague/industry contact
1137	5	20+ years	Mining Industry	Master's Degree	Civil Engineering	No	No	I had a career in geotechnical engineering in mind but then I was told about mine waste management i.e. tailings.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	AusIMM â€" Australasian Institute of Mining and Metallurgy	No	Yes	Involved with ANCOLD, ICMM, AMIRA and AusIMM initiatives.	Not sure about this question	Impacts on projects, delay in deliverables, increase in risk, having to use people that are not suitability qualified	Shortage in skilled engineers	Increase tailings/civil/mining engineering awareness at school level, make these disciplines more attractive, perhaps sustainably increase salaries/wages.	Direct email from the Project Team
1138	4	0-5 years	Mining Industry	Bachelor's Degree	Civil Engineering;Environmental Engineering	Yes	No	Didn't even necessarily intend to enter mining industry, then started as env eng at mining company and moved into tailings from there	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	Yes	I advocate for tailings being a growing field that needs more trained professionals, and more university education around it. For mining as a whole, I advocate for innovation and moving away from the status quo	hydrology, hydrogeology, geotechnical, regulatory, community engagement (think a breadth is valuable for tailings professionals).	there is a lot of pressure and responsibility put on tailings personnel. It takes a toll, and so resources and compensation need to be adequately thought out to support these individuals and to ensure its a continued desired field to be in	developing what modern/future/sustainable tailings management looks like and implementing that. and also major challenge in managing historical tailings facilities. and challenges/concern in enforcing safe tailings practices in non ICMM companies/operations	history, have new tsf developments vetted by a more broad range of professional personnel, have international governing body be requirement for all companies/all countries	Forwarded email from a colleague/industry contact
1139	5	10-20 years	Consulting;Mining Industry	Master's Degree	Geological Engineering	No	No	Wasn't directly intended, but TSF monitoring & inspections turned out to fall in the realm of open pit geotechnical responsibilities too.	I have not participated in any formal professional training on tailings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	Participate in societies, speak to universities, etc.	Geotechnical aspects for design, monitoring, and analysis.	It is a specialized field, mining industry technical staff are already a small percentage of all engineering technical staff. There are too many sites to cover.	Historical facilities, built under different design standards.	Resources, staffing at mines to actually inspect/monitor.	Forwarded email from a colleague/industry contact
1140	5	0-5 years	Mining Industry	Master's Degree	Geosciences (Geology)	No	No	working as a Hydrogeologist in mining industry this was just never on the radar.	I have participated in external formal trainings	Not a member of a GMPA Society	Yes	Yes	Recent exposure and corporate awareness also responsible for leading the implementation of the GISTM for critical assets	TSF design, controls, monitoring, failure modes	availability of RDE and EoR to service the industry	Legacy sites and integration of multidisciplinary faculties in the management of old, existing and future sites.	The perception that these facilities does not contribute to the production cycle. A prevalent view exists that these are waste disposal sites and subsequently they attract less attention as they are perceived as a cost not a value adding asset	Forwarded email from a colleague/industry contact
1141	5	0-5 years	Mining Industry	Master's Degree	Civil Engineering	No	No	When I entered the workforce was not even aware this was a sub discipline for Civil Engineers.	I have participated in internal formal trainings	Not a member of a GMPA Society	No	Yes	Not sufficient time in the industry	More practical training or post grad studies in Tailings related discipline.	Insufficient pipeline of graduates in Civil interested/attracted to Tailings.	Insufficient pool of resources to achieve GISTM compliance	1. Better industry collaboration shared learnings. 2 Has a very bad reputation after recent tragic incidents, needs more promotion/communication/advertisement on why it could be a niche career choice. 3. Better use of technology and more importantly to showcase to industry peers	Forwarded email from a colleague/industry contact
1142	5	10-20 years	Academia/Education	Post-Doc Study	Civil Engineering	Yes	Yes	I had a bursary with a mining company	I have participated in external formal trainings;I had training on tailings during my educational experience;I lead external formal trainings	Not a member of a GMPA Society	Yes	Yes	I actively pursue research in this area and participate in committee meetings (I am indirectly involved with GMPA via a SAICE)					Shared/forwarded through LinkedIn from a colleague/industry contact
1143	4	5-10 years	Mining Industry	Bachelor's Degree	Mining Engineering	No	No	Not a carrer path because of my lack of knowledge	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	No	Yes	it is a key issue for the industrie and also an important aspect of social acceptability for the mining industry	geotechnical engineer	interesting younger generation in this field	reducing the quantity, the impact and finding ways to value this material	Increase the cost for mining industry to produce this waste, increase support to find ways to add value to this material.	Direct email from the Project Team
1144	4	5-10 years	Consulting	Master's Degree	Natural Sciences	No	No	I did not start in mining consulting	I have not participated in any formal professional training on tailings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	No	Yes	I have been a provincial and national level representative of the Canadian IAH	I should take a course in sio mech and stability analysis		lack of good data from sites on foundation conditions, especially related to groundwater and material characteristics of foundation materials. piezometric data within the tailings to better understand drainage and pressure profiles related to stability ... and not just assuming hydrostatic conditions	more detailed foundation investigations better instrumentation for understanding the system changes better understanding of water balance	Forwarded email from a colleague/industry contact
1145	5	5-10 years	Consulting;Mining Industry	Master's Degree	Civil Engineering;Geological Engineering;Geosciences (Geology)	No	No	I knew nothing about tailings at the time I entered the workforce. I was hired into our mine waste division and worked primarily on heap leach, impoundment, and waste rock designs. It wasn't until later in my career (>3-4 years) that I was introduced to tailings.	I have participated in internal formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	No	Yes	I responded yes because I do continued outreach on mining to universities that have no mining advocates.	I'm unsure what this question is asking	A large gap in professional experience between the outgoing generation and the up-and-coming (10-20 year experience) generation. This gap is noticeable in our industry and is going to have a large impact on the ability to have experienced individuals execute work. This is also a large concern in terms of succession planning and communication of site experience	Lack of experienced professionals to serve as EoRs.	1. Change the mindset in operators that the EoR needs to have 20+ years of experience so that we create a great learning environment for up-and-coming mid-level/junior engineers that can be put into training experiences early on in their career. 2. Have the operators pay closer attention to the importance of tailings and put more $ and design effort in building robust facilities. 3. Educate the public and universities on how great of a career this is so that more students will pursue a career in mining	Direct email from the Project Team
1146	5	10-20 years	Consulting	Master's Degree	Geological Engineering;Geosciences (Geology);Natural Sciences	No	No	.	I have participated in internal formal trainings	Not a member of a GMPA Society	Yes	Yes	.			Engineers that are not qualified to practice.	Qualified professionals. This should not be limited to engineers, example engineering geologists may also have the necessary training. This also opens up the pool of potential resources	Direct email from the Project Team
1147	4	0-5 years	Academia/Education;Consulting	Bachelor's Degree	Geological Engineering	No	No	I did not plan on a career in the tailings industry. Instead, I became involved through project opportunities to work on an instrumentation monitoring program for a specific project. As I gained more experience with working in tailings, I became more keen to continue in this industry.	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	Yes	I feel proud to be a part of this industry, and believe that there is a lack of public knowledge about tailings.	Holistic view of tailings management. As a geotechnical engineer, I would like to have a better understanding of the main concerns of the TSF operator.	Lack of senior engineers to provide mentorship to engineers with less experience in tailings.	Potentially high number of TSFs with inadequate monitoring programs. Lack of public trust.	Improve the regulatory oversight. Improve support to TSF operators to meet regulatory requirements. Improve training for geotechnical engineers on TSF management.	Direct email from the Project Team
1148	3	20+ years	Consulting	Master's Degree	Geological Engineering;Mining Engineering;Geotechnical Engineering	Yes	No	My first degree was in mining engineering. I wanted to work at a mine s a mining engineer.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	SME â€" Society for Mining, Metallurgy & Exploration	No	Yes	I am generally pro-(sensible/responsible) mining	advanced soil mechanics	n/a	Desire to be in the profession and formal training.	Alleviate failures, add tailings education to geotechnical engineering programs and create an on-going discussion forum for tailings practitioners.	LinkedIn post from the Project Team

Record #	1. On a scale of 1 to 5, how critical do you perceive the tailings industry professional resource shortage?	2. What is your level of experience as a tailings professional?	3. In which area are you currently employed? (Select all that apply)	4. What is your highest level of formal education completed?	5. In which field would you generalize your formal educational training? (select all that apply)	6. Did your formal education provide you any introduction to the tailings industry?	7. When entering the workforce, was the tailings industry part of your intended career path?	Explain your response to Question 7:	8. Are you, or have you been, involved with formal professional training (short courses, certifications, etc.) associated with tailings? (Select all that apply)	9.Are you a member of a Global Mineral Professionals Alliance (GMPA) Society? (Select all that apply)	10. Have you heard about the GMPA Global Action on Tailings Initiative?	11. Do you consider yourself an industry advocate?	Describe why you responded Yes or No to Question 11:	12.What professional training disciplines would help you execute your work on a day-to-day basis?	13.What challenges do you see with respect to available professional labor resources, both currently and in the future?	14.What is the greatest challenge facing the tailings and mine waste industry, in your opinion?	15.If you could change three things within the tailings and mine waste industry, what would they be?	16. How did you receive the link for this survey? (select all that apply)
1149	5	10-20 years	Consulting	Master's Degree	Civil Engineering	No	No	I did my undergraduate in Chile and I liked soil mechanics so I knew it would most likely have something to do with mining but when I started to work I had very limited knowledge about tailings or other mining components.	I have participated in internal formal trainings;there was a little bit of training on tailings in my master's (1 course)	Not a member of a GMPA Society	No	No	I enjoy my work and I share my experience with junior/intermediate engineers but I do not actively advocate for the mining industry	civil engineers, geological engineers, environmental engineers, groundwater/surface water/water quality engineers, construction management, mechanical engineers, lab technicians.	there is already too much much demand for tailings engineers and not enough knowledgeable/qualified professionals. Mining and specially tailings have a bad reputation and there seems to be less interest of new graduates on working with tailings. Shortage of professionals is slowly change it but too slowly for the demand that there is. The work carries a lot of responsibility and liability without a significant salary difference. There isn't a significant monetary incentive to attract more people. I would expect the unbalance to only get worse in the near future. Any changes now will take many years to make a difference in the short term - still better now than never	lack of formal training, shortage of professionals, bad reputation (I know I listed 3 but hard to chose a single one; they are all somehow related)	Slowly changing but all mining companies need to responsibly manage their mine waste (some do but there are still too many that don't - it should be a priority in all sites; a failure has an impact in all the industry). More/better/targeted promotion of the industry. Better regulatory oversight and permitting (they also need more qualified staff).	Direct email from the Project Team
1150	4	5-10 years	Mining Industry	Master's Degree	Civil Engineering;Environmental Engineering	No	No	I planned to be a structural engineer	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	No	I dint really understand the question. Do I encourage others to enter tailings management as a career? - No	M Sc level geotechnical engineering courses	finding consultants/staff that have adequate training/experience	?	?	Direct email from the Project Team
1151	4	5-10 years	Mining Industry	Master's Degree	Civil Engineering;Geological Engineering;Mining Engineering	Yes	Yes	I always liked soils and tailings was a good and interesting option that I enjoyed more than Rock mechanics.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	AusIMM â€" Australasian Institute of Mining and Metallurgy	No	Yes	I Train people from different backgrounds on the importance of tailings	Structural Engineers, Chemical Engineers, Metallurgists	less people are studing bachelor degrees and are ready for the workforce.	The different safety standards in different countries.	Ensure enough training is provided (practical and theorical) Mentor new ROEs. Get full support from all companies (from academy to mining industry) to implement practical and effective solutions	Forwarded email from a colleague/industry contact
1152	4	20+ years	Consulting	Bachelor's Degree	Civil Engineering;Geological Engineering;Natural Sciences	No	No	It was an evolution after joining a consultancy that specializes in tailings and water management.	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	Yes	Yes	Tailings, waste and water management is critical to the success and sustainability of the mining industry, and ultimately the economy.	Mine waste and water management, Geotechnical engineering	Tailings management is typically learned "on the job". The number of qualified/specialized companies (and their experts) is therefore small. Without specific educational training, it is therefore difficult for graduate engineers to gain exposure to tailings management. Also, the history and reputation related to tailings may not be attractive for many	Legacy issues	1) More education and awareness 2) Consistent global standards 3) Reliance on true experts/specialists	Forwarded email from a colleague/industry contact
1153	4	20+ years	Mining Industry	Bachelor's Degree	Civil Engineering;Construction/Construction Management;Geotechnical and TMFs issues	No	No	I started as a Geotechnical engineer on land developments and industrial facilities, later moving to mining industry (Geotechnical Studies and TMF design & CQA)	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	Yes	Yes	Because I believe that the promotion of competitive businesses within the mining industry is important for the economical & sustainable development of nations worldwide	Geotechnics and tailings rheology	The lack of specific TMFs design and operation training	Prioritizing Capex and Opex over safety issues	Water and tailings reutilization, increase frecuency of independent reviews and proper local authority supervision and owner governance	Shared/forwarded through LinkedIn from a colleague/industry contact
1154	4	5-10 years	Consulting	Some College/University	Civil Engineering	Yes	No		I have participated in external formal trainings	Not a member of a GMPA Society	Yes	Yes						
1155	5	20+ years	Consulting	Master's Degree	Civil Engineering;Geotechnical Engineering	No	Yes	I happened to do my Master Thesis on - An Inventory of Swedish Tailings Dams - and enjoyed it (did not know what a tailings dam was when starting the thesis...	I have participated in external formal trainings;I had training on tailings during my educational experience;I lead external formal trainings	Not a member of a GMPA Society	No	Yes	I believe the Mining Industry is very important for society and I want to contribute to sound management of tailings including stability & environment as well as during the operational phase and closure, i.e. the long term phase.	I would rather need more competent colleagues than more education.	To educate more geotechnical engineers who want to get into the mining industry/tailings management.	I think finding resources/staff with right education and experience is a huge issue for the industry. And maybe especially in small counties (like Sweden and others) where language may be an issue or at least a threshold to pass (translating information etc.) Another issue, I think, is the management of data (especially from investigations and monitoring) as well as communication in general	I would like to see 1) the Mining companies looking at mining as a way to create something new for society. No other industry is moving so much material... 2) more "thinking outside the box", involving more disciplines as well as a more holistic approach to waste management integrating tailings and waste rock. 3) increased understanding at top management regarding the challenges around waste management.	Direct email from the Project Team
1156	5	20+ years	Consulting	Master's Degree	Civil Engineering	No	Yes	Before graduation, I had work experience in the area of mine waste management. I found it interesting and it was a logical continuation post graduation	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes		Specialized training that starts with the fundamentals in Vick's book Planning, Design, and Analysis of Tailings Dams then advancing to more specialized training in specific technical topics	Young professionals that know about this work and want to pursue it as a career.	Same as above, young professionals that want to do this work as a career.	I think I need more time to think about this one	LinkedIn post from the Project Team
1157	4	20+ years	Consulting	Master's Degree	Civil Engineering	No	No	I wanted a career path related to dams but didn't envision it would be mining dams.	I have participated in internal formal trainings;I have participated in external formal trainings	AusIMM â€" Australasian Institute of Mining and Metallurgy;CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum;SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	I mentor younger staff on tailings basin efforts.		Having adequately trained professionals who understand the complicated nature of geotechnical engineering, water management, and tailings facilities in general	Understanding historic facilities enough to be able to quantify the risk.	1. Get operators to understand they affect the stability of the structures. 2. More consistent standards - Like GISTM. 3. Reduced liability for engineers willing to do this work.	Direct email from the Project Team
1158	3	10-20 years	Consulting	Post-Doc Study	Mining Engineering	Yes	Yes	My research work in grad school was involved tailings work	I have participated in external formal trainings;I had training on tailings during my educational experience;I lead external formal trainings	AusIMM â€" Australasian Institute of Mining and Metallurgy;CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum;SAIMM â€" Southern African Institute of Mining and Metallurgy;SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	I have been involved in tailings industry since 2007 and contributed to advancement of the design for safety	Mining geotechnical related	the biggest challenge is with highly experienced engineers who can't understand the advances and reforms in the field and lack the advance knowledge but just relying on their experience and unfortunately having important roles in some organizations	lack of scientific knowledge, reliance on experience, over conservatism and regulators incapability	educational training, more defined global standards, encouraging deep knowledge	Direct email from the Project Team
1159	4	10-20 years	Academia/Education;Consulting	Post-Doc Study	Civil Engineering	Yes	No	Was barely aware that it existed as a pathway for civil engineers - didn't even really know what a TSF was. Just happened to apply to Golder who needed tailings more than conventional geotech engineers at that time (2005)	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	Yes	Yes	I feel I promote research in the area, risks of TSFs, and do enough educational promotion that the word "advocate" is appropriate to use (I think)	Geotechnical engineering	(a) demographics, i.e. boomer retirement, will make it more acute I fear, (b) other non-tailings civil engineers quickly being repurposed to tailings work without enough experience	Finding consensus on how brittle a material must be such that ensuring stability under residual/minimum strength conditions should be required.	(A) everyone in industry would read more papers about tailings geotech related topics. (B) the current focus on increasing numerical techniques would be tempered by a deeper understanding of the pros and cons that exist for numerical techniques (i.e. numerical techniques such as FLAC being treated as a black box. (C) increased discussion and awareness as to the inherent uncertainty in many of the methods and models that are viewed by many across the industry as best practice in 2020/2021	LinkedIn post from the Project Team
1160	4	10-20 years	Mining Industry;Regulator/Government	Bachelor's Degree	Geological Engineering	Yes	No	Was interested in rock mechanic and underground but ended up doing surface water and tailings management infrastructure	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	Yes	Yes	Passionate about moving the needle on safe tailings management, community engagement, and transparency.	MBA or business/people management	current work pool is limited with a major gap in the near to mid future	Retention of passionate practitioners		Direct email from the Project Team
1161	4	0-5 years	Consulting	Master's Degree	Civil Engineering	No	No	I started as geotechnical engineer in ordinary civil engineering (roads, buildings etc), but then change path when I found out that there exist many exciting geotechnical challenges in the tailings industyry.	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	No	ItÂ's an familiar industry to work in - in most projects at all TSF it is good mood between mining companies, consultants and contractors.	Further education in geotechnical engineering	Right now I think that the mining companies have a lack of professionals and hence the consultants sometimes get to inadequate projectmanagement from their clients. It would benefit the industry if the mining companies would have their own experts and not totaly buy everything from the consultants.	Currently, I think the greatest challenge is that the "hot topics" regarding dam safety has grown rapidly (e.g. for just 3 years ago the static liquefaction discussions were alot quiter than what they are today) and hence the industry might have a hard time to get a consenus in all the hot topics that we have to face in the design today. What if we wake up tomorrow and realize that yesterday's measures in design were unnecessarily conservative? Luckily the new standard is a step in the right direction, but a consensus regarding the scientific approach is also needed	#NAME?	Forwarded email from a colleague/industry contact
1162	4	0-5 years	Consulting	Bachelor's Degree	Geological Engineering	No	No	I intended to work primarily in civil infrastructure and not enter the mining field at all. It wasn't until I got bored with my previous work that I moved regions and got into the mining industry.	I have participated in internal formal trainings	Not a member of a GMPA Society	No	No	I am still new to the industry and getting my bearings at this time	planning to attend U of A short course on TSF design, interested in other formal training/education	Consulting is a roller coaster and firms always push to keep clients happy with the least number of employees as possible in case work dries up. With that, It seems that especially during the pandemic there are a lot of people available to work it is just tough on the firms to hire all of them in case work disappears.	Long term planning and closure, changing climates and conditions are drastically effecting the conditions that everyone "thought" would occur and is starting to lead to problems with historically accepted design. Geotech/like mining is based on previous principles that have not grown very much over the decades	remove the stigma that all engineering firms are just trying to fleece the client for as much money as possible for the most conservative design, have formal training programs available as undergraduate studies or additional courses in the fields of Geotech/civil/mining	Forwarded email from a colleague/industry contact
1163	4	10-20 years	Consulting	Master's Degree	Geological Engineering	Yes	Yes	Did grad school at Montana Tech, an old school of mines, so I started working on tailings basin dams when I graduated.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	I try to explain to people how I've been to mines and know of their general dedication to recycling, reuse, and reducing, since they're generally in the middle of nowhere! If it's not grown, it's mined.	performing FMAs	There simply aren't enough of us. When mining tanked and all the school of mines changed, there was a real loss in people heading to geo-engineering, and we as an industry and society and academia still haven't been able to show the general public that they should care about this and pursue these careers, even though they're in such demand!	Public/government perceptions driving regulations over science	1 - Add PFMA requirements into tailings dam regulations (align more with hydro dams and levees), 2 - Clarify role and limitations of EOR, 3 - Find a way to make operations care more about what happens on the other end of the pipe :)	Forwarded email from a colleague/industry contact
1164	3	0-5 years	Mining Industry	Master's Degree	Mining Engineering	Yes	No		I have not participated in any formal professional training on tailings	SME â€" Society for Mining, Metallurgy & Exploration	No	Yes						
1165	5	10-20 years	Mining Industry	Master's Degree	Civil Engineering;Mining Engineering	Yes	No	On my first job i joined an Engineering House, i was assigned to the Tailings group, i ended up working there for 10 years and focused my masters in mine waste management and geotech	I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	Yes	Yes	I'm passionate about what Tailings Practitioners do and the way we are turning the industry around to make it safer and more professional	Geotechnical Engineers, Civil Engineers, Hydraulic Engineers, Hydrogeologists, Geologists, Geochemists, Metallurgical Engineers	We already see a shortage of Engineers that want to develop their carriers on Tailings and the implementation of the GISTM is putting even more pressure into having competent, capable and experienced Tailings Engineers in the field.	Transition to dryer tailings management solutions will be challenging, especially for high tonnage production operations. Industry will become more stringent making wet tailings a lot more difficult to permit, design and operate making filtered tailings and other dry technologies economically viable	Increase the level of awareness to the level of the Plant at least, i believe we are not there yet. Advance technology to reduce costs for safer dryer tailings management options. And i would focus significant effort and resources on the investigation of other uses for mine tailings.	Forwarded email from a colleague/industry contact
1166	4	0-5 years	Mining Industry	Bachelor's Degree	Environmental Engineering	Yes	Yes	I worked at an intern at a mining facility while in school so as entering the workforce I knew I would be a part of the tailings industry.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	No	Yes		geotechnical	I do not foresee challenges with respect to resources	The stricter regulations that will be posed on tailings facilities and meeting them in a timely manner.		Forwarded email from a colleague/industry contact
1167	4	20+ years	Consulting	Bachelor's Degree	Civil Engineering;Construction/Construction Management	No	No	I started working on tailings after 10-yr experience in civil and hydraulic works	I have participated in internal formal trainings;I lead internal formal trainings	Not a member of a GMPA Society	Yes	Yes	I try to question everything in front of me and team-up to get answers	Some of them are: geotech, tailings dewatering, water management, geochemistry	Generalism (a TSF require an overall picture) and governance	Governance	Governance, for me that includes everthing	LinkedIn post from the Project Team
1168	2	20+ years	Consulting	Bachelor's Degree	Civil Engineering;Construction/Construction Management;Environmental Engineering;Geological Engineering;Geosciences (Geology)	Yes	Yes		I have participated in internal formal trainings;I have participated in external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes						Direct email from the Project Team
1169	3	0-5 years	Mining Industry	Bachelor's Degree	Environmental Engineering	No	No	I ended up in the potash industry somewhat serendipitously, as it is one of the major employers, directly or through consulting of environmental engineers in Saskatchewan, Canada	I have participated in external formal trainings	Not a member of a GMPA Society	Yes	No	I don't have the geotechnical/research background to really push tailings management advancement. I work more in an operational role.	Risk assessment training.	These challenges are not as clear in Canada.	Likely lack of new and innovative solutions to manage tailings waste.	It should be just as important as process engineering, reliability, etc. Large mining companies should be required to have a senior leader responsible for tailings management and research.	Forwarded email from a colleague/industry contact
1170	5	20+ years	Consulting	Master's Degree	Civil Engineering;Geosciences (Geology)	No	Yes	While at U of Alberta, heard about tailings and was interested in the industry.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	No	Yes	The industry is important and can be done safely	Not so much for me, but for my junior colleagues: geotechnical engineering, hydrotechnical engineering, surficial geology, risk assessment, hydrogeology, geochemistry, construction	Shortage of young people finding this career path interesting.	Not enough EORs and RTFEs	Committment to attracting and growing young engineers as tailings engineers	Direct email from the Project Team
1171	3	10-20 years	Mining Industry	Bachelor's Degree	Geological Engineering	Yes	No	intended career path was more general in nature	I have participated in internal formal trainings	Not a member of a GMPA Society	No	Yes	I support the industry I work in.	Civil and Geological Engineering	the bar is always moving, disagreements amongst professionals regarding risk analysis, approach, and mitigations.	Educating ngo's, investors, other external stakeholders on North American tailings facilities, governance, risk. Ensuring stability of facilities as they age	Its negative perception, financial assurance from companies to ensure proper decommissioning, require better long term planning.	Forwarded email from a colleague/industry contact
1172	1	20+ years	Consulting	Master's Degree	Civil Engineering	Yes	No		I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes		??	Companies willing to spend money to get the right individuals on board to lead tailings management.	Going to a cookbook approach or too conservative designs for tailings basins because everyone else is. Taking engineering and risk management out of consideration.		Forwarded email from a colleague/industry contact
1173	4	20+ years	Mining Industry	Bachelor's Degree	Civil Engineering	No	Yes	Hired by mining site technical group explicitly managing tailings construction/Engineering right out of school ...and having "fun" ever since.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	SME â€" Society for Mining, Metallurgy & Exploration;Not a member of a GMPA Society	Yes	Yes	...Been around awhile and also part of USSD, ASDSO, CDA, etc. committees.	Civil & Geotechnical Engineering. (Bio-Sciences are on the horizon to emerge harnessing "bugs" to help us with water & tailings constituent problems)	No specific training as yet; much internal time spent on getting up to speed.	Environmental "radical" third party groups slowing progress with agenda intent of stopping everything over time rather than "fronted" story of making it safe etc.	Better education, better communication to outside of advancements made to industry, and better lobbying to educate and give regulators better things to stand on for them to better advocate for the industry and not participate in the ever continual CYA foot-dragging in the process timelines	Direct email from the Project Team
1174	3	20+ years	Construction	Master's Degree	Business;Civil Engineering	No	Yes	The company I worked for constructed tailings basin dams.	I have participated in external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	I am involved in on going construction of tailings basin dams.	Continuing education with short classes or seminars on an annual basis.	Lack of individuals interested in the field.	Bad press from past failures not taking into consideration modern means and methods.	1. faster turn around for permits. 2. greater concern for dam stability vs less concern for wetlands created by dam seepage. 3. skilled workforce training and requirements for miners working in the basin, not just a union seniority decision	Direct email from the Project Team
1175	4	20+ years	Academia/Education;Consulting	PhD Degree	Mining Engineering;Natural Sciences	Yes	No	It became part of the overall metallurgical processing plan when working on flow sheet development	I have not participated in any formal professional training on tailings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum;SME â€" Society for Mining, Metallurgy & Exploration	No	Yes	I work to find uses for the tailings material and ways to stabilize the tailings containment area	Hydraulic engineering and materials property characterization	Many are not wanting to work in remote locations	Reluctance to change practices that have been used for years	Think upfront on material uses and potential problems associated with tailings and mining by-products as part of the planning process. Determine ways to avoid the need for tailings basins	Direct email from the Project Team
1176	2	5-10 years	Mining Industry	Bachelor's Degree	Chemical Engineering	No	No	I did not enter the workforce in the mining industry	I have participated in external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	No	Yes	Yes, in that I am a mining industry professional, and as such we all need to advocate for our industry as the extractive industries are not always viewed in a positive light in the United States	Short courses and seminar to stay on current on technology, understand issues facing other industry colleagues, and keep skills current	Resources in the technical and skill areas are becoming increasingly difficult to find	Third party non-governmental activism and the pressure they put on elected officials and their ability to spin mining as pollution spewing and a money driven industry. These NGO's have no obligation to tell the truth or present all the facts in the appropriate context in order to sway their arguments.	1. Environmental review and permitting processes with prescribed timelines that allow for development and regulation of mines that meet standards yet do not take tens of years to permit. 2. For the industry as a whole to continue, as I think it is starting to, becoming companies that operate with a 21st century approach. Not only in technology but in people and culture management. 3.For all the industry to continue to grow and be proactive about spreading the need for the metals we mine and educate people on the correct methods of permitting, operating and closing and reclaiming mining facilities	Direct email from the Project Team

Record #	1. On a scale of 1 to 5, how critical do you perceive the tailings industry professional resource shortage?	2. What is your level of experience as a tailings professional?	3. In which area are you currently employed? (Select all that apply)	4. What is your highest level of formal education completed?	5. In which field would you generalize your formal educational training? (select all that apply)	6. Did your formal education provide you any introduction to the tailings industry?	7. When entering the workforce, was the tailings industry part of your intended career path?	Explain your response to Question 7:	8. Are you, or have you been, involved with formal professional training (short courses, certifications, etc.) associated with tailings? (Select all that apply)	9.Are you a member of a Global Mineral Professionals Alliance (GMPA) Society? (Select all that apply)	10. Have you heard about the GMPA Global Action on Tailings Initiative?	11. Do you consider yourself an industry advocate?	Describe why you responded Yes or No to Question 11:	12.What professional training disciplines would help you execute your work on a day-to-day basis?	13.What challenges do you see with respect to available professional labor resources, both currently and in the future?	14.What is the greatest challenge facing the tailings and mine waste industry, in your opinion?	15.If you could change three things within the tailings and mine waste industry, what would they be?	16. How did you receive the link for this survey? (Select all that apply)
1177	4	10-20 years	Consulting	PhD Degree	Civil Engineering	No	No	I intended to work in civil engineering	I have not participated in any formal professional training on tailings	SME â€“ Society for Mining, Metallurgy & Exploration	No	No	not sure what is meant	more soil mechanics	poorly trained professionals	poorly trained professionals	required classes in soil mechanics before being able to work on tailings stability studies more geotechnical engineers with formal training in geotechnical engineering better all-round understanding of mechanics	Forwarded email from a colleague/industry contact
1178	4	20+ years	Consulting	PhD Degree	Civil Engineering	Yes	Yes	I worked on design of a Tailings Dam for my Senior Design project and later took a dam engineering class in graduate school. My first job was with a local firm that specialized in Tailings and Mine Waste.	I had training on tailings during my educational experience	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	Mining is a critical industry in our world and we must do everything we can to continue to operate safely to provide the critical benefits of mining.		The move of the dams industry and tailings industry in particular toward a risk informed approach is appropriate and the labor force needs training in this area.	An understanding of and appreciation of our past failures and what we can do to reduce the number of failures in the future.		Direct email from the Project Team
1179	3	20+ years	Consulting	Master's Degree	Civil Engineering	No	Yes	The company where I joined the workforce for the first time was into geotechnical engineering, so there was a chance for that to be a career development	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	No	It is difficult advocating for an industry that has a track records of bad calls	Geotechnical characterization of geomaterials and numerical modeling	In Chile at least the problem is that geotechnical engineering training is only attained at higher education levels, not in graduate courses	Recovering trust from people	Reduction of waste, better engineering and training of regulators	Forwarded email from a colleague/industry contact
1180	4	10-20 years	Academia/Education	PhD Degree	Environmental Engineering;Geological Engineering;Mining Engineering;Natural Sciences;Formal degree is materials engineering which also includes aspects of chemical engineering as well as others indicated above.	Yes	Yes	I did my PhD on characterization of the minerals in process streams and became obsessed by understanding the impact of clay minerals on tailings behavior. I searched for work that would allow me to further understand tailings.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes	I am an advocate for improved technical discipline in tailings and the impact of clay minerals.	Operational challenges - what are the logistical issues/weeds that constrain tailings operations. This is critical information for academia as these are often the issues that cause design optimization to be overridden. Being able to address these constraints/understand them when developing technology is important.	I see that the focus is on geotechnical engineering without enough appreciation of the fundamentals of the materials in the structure. There is a strong disconnect between process engineering and tailings management in the tailings community - most conferences/research focuses on the containment needs but there is a lot of work being done on improving processes but if the full process variability isn't understood or the implications of these ranges aren't understood catastrophes happen. I see a missing piece in understanding the fundamentals of how clays, water chemistry and particle shape are impacting performance. There is no process engineering focus to educate process engineers about geotech requirements and insufficient understanding of process limitations from geotech engineers	A disconnect between stakeholder desires, "technology" promise and the fundamentals of how tailings work. There is a sense that "Technology" will magically fix problems without the commensurate investment in the fundamentals that enable technology development. Without fundamental understanding the "technology" fails because it addresses only part of a complex problem and often exacerbates other aspects.	1) Increase in collaborative teams approach to tailings WITH the realization that collaboration is expensive and time consuming (1/10th of 10 people does not equal 1 FTE - probably need 1/10th of 10 people +1 FTE to coordinate/be lead). This means hiring more people (due to current shortages this will be junior people or people from other disciplines) 2) Ensure middle level managers are aware of the technical complexities and are competent to make the required resource allocations --> possibly this means separating technical budget function from HR budget function or something. There are too many middle managers who make decisions based on powerpoint or a "twitter" version of information without fully understanding the impacts (D-K effect is a big factor!) 3) Focus R&D in understanding of long-term fundamentals of the newer processes that have been implemented (how does degradation of polymer in the long term impact dam stability? How does desalination due to rainwater infiltration impact the static liquifaction boundary?)	Direct email from the Project Team
1181	3	10-20 years	Mining Industry	Master's Degree	Civil Engineering;Environmental Engineering;Mining Engineering	Yes	No	as mining engineer my intended career path was mine engineering, more focused on ore production.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	I work in tailings and understand that a failure at one site is a failure for all. Preventing tailings failures is an important goal for the entire industry	periodic geotechnical and tailing storage facility design refreshers	the industry (both operators and consultants) is good at training 'tailings' engineers regardless of their initial career choice. The challenge is keeping that pipeline fed	Too much uncontrolled growth. Everyone is an expert nowadays.	Add tailings to civil engineering curricula. expand tailings management in Mine engineering curricula. Increase collaboration between operators and between consultants and operators	Direct email from the Project Team
1182	5	5-10 years	Academia/Education;Consulting;Mining Industry	PhD Degree	Civil Engineering;Geological Engineering;Geosciences (Geology);Natural Sciences	No	No	I started my career as an engineering geologist / rock mechanics engineer before assuming more soil mechanics based geotechnical roles, that eventually led into tailings	I have participated in internal formal trainings;I have participated in external formal trainings	AusIMM â€“ Australasian Institute of Mining and Metallurgy	Yes	Yes	Due to personal interest in tailings and wanting to see change in the status quo, I have started to pursue a research PhD in tailings to add on my BSc. and MEng. knowledge, and experiences that I have accumulated through the 16 years I have been in mining operations before switching into consultancy and academia.	leadership, grit and resilience	Currently there is shortage of skilled labor to undertake and meet the requirements that are being proposed through the GISTM and the good practice guidance. Also, there is a considerable knowledge gap between the skilled experts that we currently have in the industry and the ordinary engineers that we have in operations, which makes it difficult to bridge. That gap will be difficult to close if no systems and protocols are established and implemented sooner than later. Time will see more shortages in the tailings industry due to expertise-drain, as the older experts retire	Skills and knowledge	Current status quo, regulatory frameworks, education	Direct email from the Project Team
1183	3	5-10 years	Mining Industry	Bachelor's Degree	Mining Engineering	No	No	The focus was more on mine and plant technology and operation, much less so on ancillary activities and needs such as tailings, stockpiles, water supply etc	I have not participated in any formal professional training on tailings	AusIMM â€“ Australasian Institute of Mining and Metallurgy;CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum;IIMCh â€“ Instituto de Ingenieros de Minas de Chile;SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	I am active in industry/professional organizations and am also active in public organization/government groups		More tailings-specific geotech and operations training, at both professional and operational levels, would be good. However, there is also a tendency for people to not see the mining industry as a needed industry and for its job possibilities, and we need to overcome those restraints, as well as encourage industry support for education and recognition of the financial and other value of its technical professionals	See previous answer	Improved recognition within the industry of the need for knowledgeable technical professionals, creation of better public perception, and improved interest among students and possible students about the value of a related career	Forwarded email from a colleague/industry contact
1184	4	20+ years	Consulting	Bachelor's Degree	Civil Engineering	No	No	Entered work force looking for a paying job. First job was working on mining projects and then took masters coursework focused on geotechnical engineering to apply to mining project I was involved in.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead external formal trainings	Not a member of a GMPA Society	Yes	Yes		Continuing to update my understanding of tailings issues, i.e. additional static liquefaction learning	Defined career path in tailings	NGO/Public perception that tailings dams are all high risk facilities	In some cases owners still view TSF's exclusively as cost-centers and therefore tend to want to cut corners on management and operation	LinkedIn post from the Project Team
1185	4	5-10 years	Academia/Education	Master's Degree	Civil Engineering;Mining Engineering	No	Yes	36 years ago the tailings facilities were not a concern just laboral issues.	I lead internal formal trainings;I have not participated in any formal professional training on tailings;I read all I can	Not a member of a GMPA Society	No	Yes	I would like all companies and professionals involved in tailings stewarship be aware of a good tailings management and practices	The management of the tailings, the site, the risk, and the closure of the facilities	There is a lack of conciousness of the mining professionals interested in tailings	A shortage of trained professionals	1. Awarness of the damage after a failing. 2. Awarness of the cost of remedy. 3. Research on new Technology. (not in order of importance)	
1186	3	5-10 years	Academia/Education;Consulting	PhD Degree	Civil Engineering;Geological Engineering	No	Yes	I found the mining industry has many challenges as a geotechnical eneineer	I have participated in external formal trainings	Not a member of a GMPA Society	Yes	Yes	I encourage engineers to work on mining industry because of all the challenges.	geotechnical concepts	qualified engineers	operation of tailings and improving design over time (state of the art)	monitoring, instrumentation of tailings, and better site characterization	LinkedIn post from the Project Team
1187	4	20+ years	Consulting	Bachelor's Degree	Environmental Engineering	No	No	In college I was only somewhat aware of tailings management and its importance to mining. Over the past 5 years, I have understood its critical importance. Given recent high-profile tailings dam failures, I think it is important for more professionals to be trained in this area.	I have participated in external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	I support the responsible development of critical minerals	Dam breach analysis		Public perception of mining	Better planning for post-mine use, better management of tailings dams, improved public perception of mining and its critical nature to the global supply chain	Forwarded email from a colleague/industry contact
1188	4	0-5 years	Consulting	Bachelor's Degree	Natural Sciences	No	No	water resources was my focus	I have participated in internal formal trainings;I have participated in external formal	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	I am government, client, and public facing	geotech	limited staff and experience, geotech and water balances	public perception and limited engineers of record	public facing communication, legacy issues, and reclamation	Forwarded email from a colleague/industry contact
1189	4	5-10 years	Mining Industry	Bachelor's Degree	Mining Engineering	No	No	My intent was to focus on the mining/extraction process rather than mineral processing	I have participated in external formal trainings;I lead external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	Passionate about everything I do.	Tailings Management 101: ie. Industry standards, standard challenges and solutions.	Industry tends to focus their talent and recourse towards what makes them money... not the â€œexpenses or waste systemsâ€	Executive Management support on funding â€œindirect non-value addedâ€ processes such as waste management	More focus in General Education, better networking among industry peer to peers.	Shared/forwarded through LinkedIn from a colleague/industry contact
1190	3	0-5 years	Consulting;Mining Industry	Master's Degree	Civil Engineering	Yes	Yes	My masters focused on the tailings industry and my job after graduation was in the tailings industry	I had training on tailings during my educational experience	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	No	Currently along for the ride, though I'm feeling more invested as my career progresses.	Understanding common tailings dam failures and how to avoid them.	Mine consulting is not taught in most colleges, so graduates have no experience in those areas	Cost associated with increasing workforce and experience.		Direct email from the Project Team
1191	4	10-20 years	Mining Industry	Master's Degree	Civil Engineering;Geotechnical Engineering	No	No	I didnÂ't know much about tailings. I entered to work as a geotechnical engineer.	I have not participated in any formal professional training on tailings;IÂ'd like to pursue to a Phd.	Not a member of a GMPA Society	No	Yes	Tailings are necessary, we have to know how to deal with it. We are the people who have to better the industry.	Everything involved with instrumentation and how to link it with dynamic analysis. Also, hydrological topics.	There is no much courses focused on tailings. There are not marketing about this. Universities have to teach this topic and make alliances with the mining industry.	Use of water, sulfate plum, communities, and operational management.	Everybody should be regulated by the same standard. There are many experts in tailings, but there is no much connection between the designers and the operational team, no connection between operation and closure planning people. Everybody is working in their own expertise but we dont have much people who can manage everything	Shared/forwarded through LinkedIn from a colleague/industry contact
1192	3	0-5 years	Consulting;Mining Industry;Regulator/Government	Bachelor's Degree	Civil Engineering;Construction/Construction Management;Geological Engineering;Mining Engineering	Yes	Yes	Â' always trying improve myself regarding with tailings design and construction works supporting with trainings.	I have participated in external formal trainings	Not a member of a GMPA Society	Yes	Yes		Tailings storage facility design and construction works	Â' believe to improve local labors will increase quality of production and effectiveness	working with local people who has not have growth mindset	to improve local people mindset , construction methodology and local regulations	Direct email from the Project Team
1193	4	10-20 years	Consulting	Master's Degree	Geological Engineering	No	No	Career path was mining geotechnical (slope design) focused but roles have developed to include responsibility for tailings functions due to demand and synergies.	I have participated in external formal trainings	AusIMM â€“ Australasian Institute of Mining and Metallurgy	No	Yes	Promote and endorse development of geotechnical engineers and rewards of working within the industry	none	Increasing demand and limited pool. Increasing less professionals with onsite practical experience and an understanding of the organization structure of mining companies.	Increased education and accountability of TSF owners, availability of engineers with the competence level to implement and manage industry expectations in terms of global standards and public disclosure	Increased support and recognition of professionals in the industry. Increased collaboration and education.	Forwarded email from a colleague/industry contact
1194	4	10-20 years	Consulting	Master's Degree	Civil Engineering;Geological Engineering	No	No	I started working with contaminated sites and landfills. Transfered within my company to a different office and became engaged with a tailings group. Stuck with the type of work!	I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	Yes	Yes	I advocate tailings governance and stewardship to our clients, in accordance with CDA, MAC, and the GISTM.	Hard to say. With the recent focus on tailings management we end up with so much data the trying to go through it and ensure we are able to ensure data quality is good can be difficult.	There are way too many projects that are behind industry standards, and require tremendous efforts to get to industry standards. This places a major emphasis on technical analysis, and overall project management.	Retrofitting historical designs.	Can't change the past. So moving forward: 1. a clear framework to prioritize projects within the INDUSTRY based on public safety 2. a clear framework to prioritize projects within the INDUSTRY based on environmental risk 3. a way to communicate the above items based on Engineering risks and getting support from existing clients that some important items for them are lower priority based on the state of the industry	Direct email from the Project Team
1195	5	0-5 years	Mining Industry	Master's Degree	Environmental Engineering;Mining Engineering	Yes	Yes	Research was on tailings consolidation. Interesting in tailings world. Good advisors at Colorado State University and it has good tailings program.	I have participated in internal formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	No	Yes	I have two and half years research experience on tailings and two years working experience with tailings. As a site tailings engineer (STE), I have to deal with tailings on a daily basis.	Filter design, inclinometer training and material balance on tailings deposition.	Tailings engineers are consider as a special type of engineer at Freeport McMoran, Inc. I see a great demand for tailings related professionals both currently and in the future.	Water management: how to save water and provide enough water to the mill. Short term tailings deposition plan: this will help Ops make a better plan on where to deposit tailings during upset conditions or planned deposition.	Have a better material balance plan to help Ops save water.	LinkedIn post from the Project Team
1196	4	0-5 years	Mining Industry	Bachelor's Degree	Chemical Engineering	No	No	I started in separations and later moved into tailings	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	No		Geotechnical/Geochemical seminars Regulatory seminars for different regions	Experience gap, there are many older professionals but there are fewer younger professionals. A great deal of knowledge will be lost as these experienced professionals retire	High aversion to any risk/innovation/changes	Create more open dialogue on what are the real costs associated with tailings	Direct email from the Project Team
1197	4	0-5 years	Consulting	Bachelor's Degree	Geological Engineering	No		I knew I was interested in Tailings Dams and management because of the impacts it has on the environment. Mt. Polly played a big role in my motivation to become a tailings engineer.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum;SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	I advocate for bringing new talent into the industry because I am not far out of school and can connect with geotech grad students	Soft skills, geotechnical engineer disciplines	Mid-Level professionals are few and far between. Makes it hard for Junior engineers to get the mentorship they need and even harder to keep them because they do not always feel valued	Personal risk for EORs.	Perception among mining companies, more structured career development plans in mining companies (Tailings pathway), better pay to motivate engineers to come into tailings	LinkedIn post from the Project Team
1198	5	20+ years	Consulting	Master's Degree	Business;Environmental Engineering;Minerals Process Engineering. Please add us to the list!	Yes	No	I thought I was going to be a smelter guy. I always had an interest in sustainability, water and tailings issues from the time in high school when I saw videos of iron ore tailings being dumped into Lake Superior and the failure of the Ok Tedi tailings facility. I was exposed to tailings issues in my first year of my work graduate program and tailings issues have weaved through my career ever since.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings;I am currently involved the SME and GMPA tailings committees and initiatives and am eager to collaborate.	AusIMM â€“ Australasian Institute of Mining and Metallurgy;CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum;SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	I fundamentally believe in the importance of a responsible mining industry to produce the metals and minerals needed for a sustainable society. I am sometimes critical of the many deficiencies of our industry, especially in making up for past environmental damage and denying to uphold rights of Indigenous groups affected by mining operations.	More discipline experience in aspects of civil and geotechnical engineering	Many. Demographic profile of professionals both in mining industry generally and specifically in tailings related areas presents risk of a major loss of knowledge in coming years. Gordon Ritcey for example just recently passed away. Dirk van Zyl is retiring. It doesn't feel like the people coming into the sector can easily replace the experience that is retiring. Young people generally hate the mining industry. To be honest, I don't really blame them. The industry has been too slow to move on inclusive values, respecting the environment, respecting communities and Indigenous rights. Some of the "captains of industry" from the time of my career have had massive blind spots that have allowed latent failures to fester. There is much to do to restore confidence and attract best and brightest to help solve problems in our industry. We are also facing a broader decline in the quality of STEM education through many parts of the world. This is weakening the pipeline of traditional engineering disciplines. Some engineering programs are also becoming more generic. For example, most minerals processing/metallurgy programs have been swallowed into chemical or materials engineering. This has consequences for	Lack of complete understanding of tailings risks	More diversity of experienced mining and tailings professionals. Too many are older men. It is changing, but I still see it as a barrier to entry for new professionals. The industry needs to keep working hard on this, even through it is a "soft skills" issue. It will help build trust with society at large. A more functional global collaboration portal/resource centre for tailings related content. Currently information is too disparate and it is hard to differentiate reputable content from advertorial or poorly researched opinion pieces. There is a strong reluctance by industry, laboratories and consultants to make some tailings related data and information publicly available. This is a huge barrier to fundamental understanding of tailings issues and trust with society. Sustainable funding mechanisms for training and oversight in tailings management to better allocate expertise to the problems and lift the underlying knowledge of tailings by all people working in the mining industry. It feels like there is too much reliance on volunteer efforts (e.g. SME tailings handbook). We do it because it is important and because it is a professional obligation. But it is a struggle as we need to keep the lights on by doing our day jobs.	Conference/Short Course Posting
1199	5	10-20 years	Academia/Education;Consulting;Mining Industry	Master's Degree	Geological Engineering;Mining Engineering	No	No	Hired as mining consultant, first project was tailings reclamation.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	We need mining	tailings and water management, closure and reclamation design, risk assessment, multi-criteria assessment	not enough people, current labor force not adequately prepared	management and retrofit of existing facilities to meet current standards and closure of existing facilities	1. consistent education of tailings practitioners 2. additional research in dewatering strategies 3. better communication of best practices (shared knowledge)	Conference/Short Course Posting;Direct email from the Project Team;LinkedIn post from the Project Team;Forwarded email from a colleague/industry contact
1200	5	20+ years	Consulting	Master's Degree	Civil Engineering	Yes	Yes		I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings;I have not participated in any formal professional training on tailings	AusIMM â€“ Australasian Institute of Mining and Metallurgy;CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum;IIMCh â€“ Instituto de Ingenieros de Minas de Chile;SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes						LinkedIn post from the Project Team;LinkedIn direct message from the Project Team;Shared/forwarded through LinkedIn from a colleague/industry contact

Record #	1. On a scale of 1 to 5, how critical do you perceive the tailings industry professional resource shortage?	2. What is your level of experience as a tailings professional?	3. In which area are you currently employed? (Select all that apply)	4. What is your highest level of formal education completed?	5. In which field would you generalize your formal educational training? (select all that apply)	6. Did your formal education provide you any introduction to the tailings industry?	7. When entering the workforce, was the tailings industry part of your intended career path?	Explain your response to Question 7:	8. Are you, or have you been, involved with formal professional training (short courses, certifications, etc.) associated with tailings? (Select all that apply)	9.Are you a member of a Global Mineral Professionals Alliance (GMPA) Society? (Select all that apply)	10. Have you heard about the GMPA Global Action on Tailings Initiative?	11. Do you consider yourself an industry advocate?	Describe why you responded Yes or No to Question 11:	12.What professional training disciplines would help you execute your work on a day-to-day basis?	13.What challenges do you see with respect to available professional labor resources, both currently and in the future?	14.What is the greatest challenge facing the tailings and mine waste industry, in your opinion?	15.If you could change three things within the tailings and mine waste industry, what would they be?	16. How did you receive the link for this survey? (select all that apply)
1201	4	5-10 years	Retired	Bachelor's Degree	Mineral Processing	No	No	As a mineral processor at the time, tailings were just something that you had to get rid of, they were not considered a product of the process	I have participated in external formal trainings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes	Tailings failures and environmental issues (contaminated water) will have a serious negative impact on the sustainability of the mining industry as we presently know it		Encouraging young professionals to enter a field that is not high tech and sexy	As noted above, failures of TSF and environmental	Make operators and professionals understand that Tailings is a product, not waste. No tailings dams; dry solid disposal only Perception that water is free	Shared/forwarded through LinkedIn from a colleague/industry contact
1202	4	5-10 years	Insurance	Master's Degree	Business;Mining Engineering	Yes	No	As a mining engineer my priority was initially focused on mining operation and finances. I came in contact with tailings more closely when started working in the insurance industry, given that tailings storage facilities (TSF) are a critical part of the risk assessments.	I have participated in internal formal trainings;I have participated in external formal trainings	IIMCh â€“ Instituto de Ingenieros de Minas de Chile;IOM3 â€“ The Institute of Materials, Minerals & Mining	Yes	No	I am part of the industry and understand how critical the mining sector is to humanity's current and future challenges. However, I cannot consider myself an advocate for an entire industry, which brings with it several players that are related to illegal practices, environmental disasters, catastrophes and major accidents. I can be an advocate for specific projects, operations, or companies. In the end, each site and situation must be evaluated on its own merits.	Physical and geochemist stability of TSFs.	I see several professionals from other disciplines coming into the tailings subjects. This is how it has been occurring during the recent mining history. People from civil engineering, geology, hydrogeology, mining, and metallurgy to name a few, have been populating the jobs related with tailings. Most of this professionals and self educated, or by practice, and it is not rare to find gaps in the knowledge about how all these disciplines get together around tailings.	I think that climate change will unveil the real quality of the tailings storage facilities that we all have. All the models considering rain events that occur every 1,000 or 10,000 will be facing stress tests. Another challenge is the extremely high amount of abandoned TSFs around the world. Those deposits are prone to collapse physically or chemically, potentially affecting communities and important surfaces.	1.- I think that tailings planning should be incorporated in the same process of mine planning or plant planning. Simply put, the different waste materials present in a deposit should be treated differently when they are discharged in a TSF. 2.- There are uncountable abandoned tailings around the world. In case of collapse, governments will be facing all the costs related to the collapse. In many cases, governments will not be financially capable of repairing the affected areas and the disaster will be left at that. 3.- There communication level among the tailings industry is overall poor when reaching members of communities located near TSF, and society in general. There is a common sentiment against TSFs. There are several TSF that are very well designed and operated, however the view of the people toward these type of deposits does not seem to change a lot	Forwarded email from a colleague/industry contact;Shared/forwarded through LinkedIn from a colleague/industry contact
1203	4	20+ years	Consulting	Master's Degree	Civil Engineering	No	No	I started working in a region where there were no mines.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	Yes	Yes	I have been involved in vocational activities relating to tailings for most of my working career	Business administration	Shortage of experienced engineers and technicians	Public image	Transparency, governance and commitment to compliance	Forwarded email from a colleague/industry contact
1204	3	0-5 years	Consulting	Bachelor's Degree	Geosciences (Geology)	No	No	I am a sedimentary basin geologist and worked in oil and gas and in-situ uranium and trona mining as a consultant. Now I focus primarily on mine permitting for mining projects through out the western US. I am working on permitting a comingled waste rock and tailings facility in WY and am on the independent tailings review team for Thompson Creek metals in Idaho	I have not participated in any formal professional training on tailings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	I love mining. I dont think most of the general public understands mining and the rigorous environmental regulations the industry meets. I try and advocate for this with the people I meet.	Geotechnical training	Lack of processes and mining engineers.	Old tailings dams, lack of records, fixing problems before they start.	1) Better process for establishing EOR of facilities 2) Emphasis on tailings and waste management on new projects as part of PFS or PEA. This is commonly over looked at these stages. 3) Emphasis on early and continued Geotechnical testing of waste rock and tailings through mine life and re-evaluate stability while the dumps develop.	LinkedIn post from the Project Team
1205	3	20+ years	Consulting	Master's Degree	Geological Engineering;Mining Engineering	No	No	Rock eng focus	I have participated in internal formal trainings;I have participated in external formal trainings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes	Sustainability, responsibility, innovation advocate		Specialty engineering functions are not as common as a career path. Most new grads like the mgmt route.	Licence to operate, increasingly	New mining methods and sorting at the face to reduce waste creation and less tails. Use of tails as special type of construction material, but would need a new class in civil eng standards	Forwarded email from a colleague/industry contact
1206	4	20+ years	Academia/Education;Consulting	PhD Degree	Civil Engineering	No	No	I was a Civil Geotech, but got involved in mine waste management within a few years of graduating	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	AusIMM â€“ Australasian Institute of Mining and Metallurgy	Yes	Yes	I actively mentor and provide training in tailings management.	Learning now from experience, and providing training.	Greater need and loss of expertise through retirement.	Public confidence and trust.	Move from NPV to whole-of-life accounting, and mentality.	Direct email from the Project Team
1207	5	20+ years	Consulting	Post-Doc Study	Geosciences (Geology)	Yes	Yes	Hydrogeology is an integral part of preventing tailings failure	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead external formal	SAIMM â€“ Southern African Institute of Mining and Metallurgy	Yes	Yes	give talks and papers on better tailings management	Geotech	need to Make geosciences more appealing to undergrads	need to Make geosciences more appealing to undergrads	stop wasting money on monitoring movement and monitor causes instead. Make reduction in pore pressures automatic. add visualisations to board room	Direct email from the Project Team
1208	5	0-5 years	Consulting;Mining Industry	Bachelor's Degree	Mining Engineering	Yes	No	Entering the mining industry in the UK in the 1980s was aimed at developing a career in managerial roles, mainly in an underground environment. The senior management were obviously aware of the issues regarding waste material disposal, especially after the Aberfan disaster in South Wales.	I have participated in internal formal trainings	AusIMM â€“ Australasian Institute of Mining and Metallurgy;IOM3 â€“ The Institute of Materials, Minerals & Mining;SAIMM â€“ Southern African Institute of Mining and Metallurgy	Yes	Yes	I have been involved in the mining industry for over 35 years, mostly focussing on mining issues rather than on waste disposal and storage issues. I am on the GMPA GAT initiative, as I am trying to put back something in the industry which has allowed me to develop my career.	Very little at the moment, with the work that I am currently undertaking. I interact with geologists, mining engineers, mechanical and electrical engineers, metallurgists and mineral processing specialists, senior mine management, geotechnical specialists, legal specialists, insurance specialists etc. during the course of my work. This interaction allows me to increase my knowledge of all aspects of the mining industry.	There appears to be a "gap" between the experienced stalwarts of the industry and the next level, who may not have sufficient "life" experience to fill the senior roles. Training of entrants to the industry is less and less "hands on", and less and less people appear to want to work in the harsh environments one finds in many mining operations. Mine planning and design appear to be the favoured occupations, without the need for "getting the hands dirty".	Tailings will be a larger part of a mining operation as grades get lower and lower. The challenge then is to increase production, knowing that a greater volume will end up requiring to be stored for a longer period of time, is an environmentally appropriate manner.	More "hands on" training, more access to issues and the means of determining the solutions to the issues (more sharing of information about mining problems), development of international standards for a range of mining and supply chain issues.	Direct email from the Project Team
1209	4	10-20 years	Consulting	Master's Degree	Geosciences (Geology)	No	No	Plan was environmental hydrogeology	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	Yes						Forwarded email from a colleague/industry contact
1210	4	10-20 years	Consulting	Master's Degree	Natural Sciences;Hydrology	No	No		Hydraulic and hydrologic modelling	Not a member of a GMPA Society	No	Yes		Storm water management		Safety of old tailings dam facility		Direct email from the Project Team
1211	5	10-20 years	Consulting;Mining Industry	Master's Degree	Civil Engineering	No	No	I arrived in Australia as a back packer, worked in the hospital then port industry. I joined a consultancy firm to enter oil and gas but the department was shut down due to the recession. The three waves of economic downturn (2008/2012/2015) has contributed to the lack of resources	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead external formal trainings;I mark the AusIMM tailings course	AusIMM â€“ Australasian Institute of Mining and Metallurgy	No	Yes	I mentor young engineers in the industry from all backgrounds	Communication, project management, excel, accounting, stability	Lack of site work, underpayment of junior engineers, rush to have everyone trained and being trained incorrectly	Training quality, consistency	Offer more training, liaise with students, add a tailings module to existing civil engineering courses than a tailings specific degree.	Forwarded email from a colleague/industry contact
1212	4	10-20 years	Consulting	Bachelor's Degree	Civil Engineering	No	No	Was unaware of it, until an unadvertised position for mine waste consulting was offered to me at a co-op interview (original co-op interview was for geotechnical consulting outside of mining industry)	I have participated in internal formal trainings;I have participated in external formal trainings;significant informal training throughout career	Not a member of a GMPA Society	Yes	No	I'm not overly vocal outside of the industry.	critical state soil mechanics / liquefaction. Large strain consolidation.	Near term (5-10 year) shortage in appropriately experienced engineers to take on Engineer of record role. Much that is required for this role is wisdom gained through experience	Pubic perception	Continued standardization of standards adopted by regulators. Better pay.	Forwarded email from a colleague/industry contact
1213	5	10-20 years	Consulting	Bachelor's Degree	Civil Engineering	No	Yes	i knew someone that worked in the industry and was interested in pursuing a similar career.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes	Having been involved in the industry for nearly 20 years I've seen many opportunities to improve the stewardship of tailings facilities.	Governance and technical design	The demands far out weight the available and the junior mining companies won't be able to keep up with the big players.	Not being able to keep up with the new standards. There will be significant fallout from society when dam failures occur and investigations highlight where the dam wasn't able to keep up with the changing standards	more people, more time, more training	Direct email from the Project Team
1214	5	5-10 years	Consulting	Master's Degree	Civil Engineering;Geotechnical Engineering	No	No	Previously I only worked on civil projects, it was such a twist of life that I entered into the mining industry.	I have participated in internal formal trainings	Not a member of a GMPA Society	No	Yes	I has given me a life opportunity to change my life. Also I have found Tailings and mining industry very much interesting, a lot of experience gained and such challenges i have thrive on. On the economic side, mining has given a lot of communities around their facilities chances to grow their income and life quality	Mining engineering.	It seems that currently and in the future professional labor has shortage. The amount of existing and currently projects developing surpass and will surpass qualified personnel for a correct planning and development.	One of the greatest challenges has become to develop and environmental and sustainable growth on mining facilities.	1.- Environmental legislation. 2.- Sustainable development of mine facilities. 3.- Hiring of real capable people to lead the industry.	Forwarded email from a colleague/industry contact
1215	4	0-5 years	Consulting	Bachelor's Degree	Chemical Engineering	Yes	No	I had new about it but my introduction was limited, and so I did not any company that did that type of work. Also, Working at mine site as a student it seam that it was more a field for like mining engineering. Turns out that the engineering group I am part off is mainly chemical engineers	I have participated in internal formal trainings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum	No	Yes	I do consider my self and industry advocate but I have not yet done much advocating to others.	Chemical engineering, Mining Engineering and Mechanical Engineering.	Aging work force. We have a lot of senior specialist but not much intermediate and junior people	Legacy mine sites (old closed mine)	pouch more and more for backfilling, dry staking, filtering of tailings.	From company Tailing management technical community
1216	3	5-10 years	Consulting	Master's Degree	Civil Engineering	No	No	Didn't know anything about it.	I have participated in internal formal trainings	Not a member of a GMPA Society	No	No	I work on them when I have to and that's where the relationship ends	Design courses	Increase in regulations	Public opinion		Forwarded email from a colleague/industry contact
1217	4	0-5 years	Consulting	Bachelor's Degree	Geological Engineering;Geosciences (Geology)	No	No	I did not have formal intentions of working in Mining or Tailings. After interviewing with a company and learning about the applicability and importance of Geological Engineering within this field, I was attracted to beginning my career in this line of industry focus	I have not participated in any formal professional training on tailings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	Presenting to college students on importance of mining and safe tailings management practices, connecting with peers and colleagues through internal and external networking events.	Analysis and applicability of laboratory/field data to make design decisions	Lack of critical thinking and appeal of industry to younger generations.	Big Picture Outlook	-	Forwarded email from a colleague/industry contact
1218	3	0-5 years	Consulting	Master's Degree	Civil Engineering;Geological Engineering	No	No	I initially thought that my career would be linked to stability. I didn't expect this contact from the tailings industry	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	Yes	It is extremely necessary for the evolution of society	Tailings management, availability courses, more socio-environmental methodologies ..	Quantitative and qualitative challenges	Reconciling environment and industry	Waste volume, tailings content and environmental neglect	Forwarded email from a colleague/industry contact
1219	5	10-20 years	Consulting;Mining Industry	Bachelor's Degree	Civil Engineering	No	No	My focus was general civil engineering.	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	Yes	Yes	Having worked for a mining company, positive public interactions were critical for mine operations	More geotechnical training on stability analysis programs.	The dependence on advanced degrees to advance your career	Public perception and location.	1. Expand the type of technical expertise involved with design. 2. More interaction with operators to get there input. 3. Continue to promote TSF safety to the public	LinkedIn post from the Project Team
1220	4	10-20 years	Consulting	Bachelor's Degree	Geological Engineering	Yes	No	I didn't know much about it and started in the underground mining industry, then transitioned to traditional geotechnical engineering before moving into tailings work	I have participated in internal formal trainings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum	Yes	No	I work mostly on specific client projects and don't get involved in committees or societies other than to learn about changes to the industry	critical state soil mechanics, advanced liquefaction analysis training	there do not seem to be formal training courses in universities focussing on tailings so new engineers require a lot of on the job training, and there aren't enough senior people to provide it	allocating monetary resources to deal with historic sites that require upgrading	focussed courses at the university level, better alignment across global standards, more teamwork between mining company teams and consultants	Direct email from the Project Team
1221	2	0-5 years	Consulting	PhD Degree	Civil Engineering;Geosciences (Geology);Mining Engineering;Geotechnical Engineering	Yes	Yes	Tailings and Geotechnical engineering are somewhat related.	I have participated in internal formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	No	Yes						Direct email from the Project Team
1222	3	10-20 years	Consulting	Master's Degree	Biological/Medical Sciences;Environmental Engineering	Yes	No	I started at the lab with bioleaching of tailings, then jumping to the industrial biox plant treating different tailings and ores to recover gold. I enter to the tailings world for this experience and then in the environmental studies that have to include tailings description at feasibility level and permitting of construction and operation of TSF	I have participated in internal formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	Yes	Yes	Yes, because there are a lot of opportunities to incorporate better practices and communication strategies for tailings and mining industry in general.	Basic training to understand the new best practices in comparison with the old practices. New perspectives as uses of tailings influence area	lack of access for the right information and technical but friendly information for the non engineering people	credibility	Incorporate from the beginning an interdisciplinary analysis of alternatives/include perceptions in the analysis/show new vigilance services of the stability of TSF	Forwarded email from a colleague/industry contact
1223	3	0-5 years	Consulting	Master's Degree	hydrotechnical engineering	No	No	Fell into it	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	No		numerical modelling of flowing tailings	Work appears to be requiring more and more senior engineers and less jr's	Public perception about TSF failure risks	less arrogate, open to change, and open to change (yes, I said it twice)	Direct email from the Project Team
1224	2	0-5 years	Mining Industry	Master's Degree	Environmental Engineering	No	No	I had no intentions of working within the mining industry.	I have participated in internal formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	I often disband uninformed and short-sighted criticisms of the mining industry and mine waste facilities (tailings etc.) to friends and family who have negative impressions of mining. I advocate for a very heavily regulated industry (environmental regulations, safety precautions, closure requirements, etc.) that is necessary to provide the goods and services our current society has come to depend on	Engineering	Traditional reporting styles that use ambiguous and overly conservative language in order to mitigate risk and hide data in appendices	Incorporating sustainability throughout the life of the mine - not just during prefeasibility studies and in closure planning.	Develop interactive public education and community (use artists and educators); Improve life-of-mine sustainability; Innovative environmental and multi-use activities for post-closure facilities.	Forwarded email from a colleague/industry contact
1225	3	0-5 years	Consulting;Mining Industry	Master's Degree	Botany	No	No	When entering the workforce I intended to work as a botanist in a herbarium. However, I am doing environmental consulting and working on mine reclamation, hence the tailings industry	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	Yes	I believe I try to educate people (like myself in the past) that may not have any idea what Tailings industry is, how it works, or what the future could look like.	Soil studies, GIS, hydrology	Not as many people are interested in this industry, leading to a scarcity of proffessionals.	A lack of education for the general populace on the topic.		Direct email from the Project Team
1226	2	0-5 years	Consulting	PhD Degree	Geological Engineering	No	Yes	Knew I wanted to do mining as they provide a clear connection between environmental and geotechnical problems.	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	Yes	No	We do good work, but the industry speaks for itself.	An introduction to the components of a mine and how they all work off the bat would help, but in general, the problems I face are similar to others in geotechnical engineering.	I don't think there is a problem bringing non-tailings engineers into geotechnical problems. The techniques taught at many universities can be applied to a wide range of projects, and it is up to companies to come up with standards to more clearly explain how the slight changes in these techniques can be used	Cost will always be an issue, particularly as opinions start to shift to move to more expensive methods (e.g. dry stacking).	More of a push to interlink the environmental impacts to the geotechnical designs. More of a push to better characterize the in-place conditions. Sharing/publishing results and the techniques of these analyses to increase knowledge of materials with all industries.	Direct email from the Project Team
1227	4	20+ years	Consulting	Master's Degree	Civil Engineering	No	No	My educational studies focused predominantly on water management and risk analysis in general. I subsequently became involved with tailings projects through my employer.	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	No	Through my consulting practice I support a wide variety of industries and applications including tailings management.	Analysis of tailings behavior including liquefaction.	Tailings management is a highly specialized field requiring very specific knowledge and expertise that is impossible to develop through generalized course work. Most undergraduate and graduate level students are unlikely to know that they want to specialize in tailings without some clear exposure to the	Maintaining the safety and integrity of existing facilities and improving public confidence in our ability to manage tailings in a safe, sustainable manner.		Direct email from the Project Team
1228	5	10-20 years	Consulting	Bachelor's Degree	Civil Engineering	Yes	No	Mining was, but tailings wasn't exactly.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience		Yes	Yes	Mining is essential.	Risk management	Students are no longer trained properly for the problems of today. Education is focused on an outdated curriculum.	Responsible development	Focus on responsible development instead of the bottom line, branded resources, education programs.	Direct email from the Project Team

Record #	1. On a scale of 1 to 5, how critical do you perceive the tailings industry professional resource shortage?	2. What is your level of experience as a tailings professional?	3. In which area are you currently employed? (Select all that apply)	4. What is your highest level of formal education completed?	5. In which field would you generalize your formal educational training? (select all that apply)	6. Did your formal education provide you any introduction to the tailings industry?	7. When entering the workforce, was the tailings industry part of your intended career path?	Explain your response to Question 7:	8. Are you, or have you been, involved with formal professional training (short courses, certifications, etc.) associated with tailings? (Select all that apply)	9.Are you a member of a Global Mineral Professionals Alliance (GMPA) Society? (Select all that apply)	10. Have you heard about the GMPA Global Action on Tailings Initiative?	11. Do you consider yourself an industry advocate?	Describe why you responded Yes or No to Question 11:	12.What professional training disciplines would help you execute your work on a day-to-day basis?	13.What challenges do you see with respect to available professional labor resources, both currently and in the future?	14.What is the greatest challenge facing the tailings and mine waste industry, in your opinion?	15.If you could change three things within the tailings and mine waste industry, what would they be?	16. How did you receive the link for this survey? (Select all that apply)
1229	4	10-20 years	Consulting;Mining Industry	Master's Degree	Civil Engineering;Specifically, geotechnical engineering (within Civil Discipline)	No	No	As a civil - geotechnical engineer, I spent the first 6-7 years of my career doing land development, transportation and infrastructure related work. I started working in tailings management consulting in 2006.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	The world needs mining, and we as mining (and tailings) professionals need to lead the charge to develop mines in a safe and sustainable manner.	As a tailings professional and project director the majority of my work is managing multiple disciplines involved with tailings practice (geotech, civil, geology, hydrology, hydrogeology, geochemistry, environment, permitting, social, mining, process, mechanical, electrical, construction, project management, cost estimating, project controls, etc.). I believe that our lack of experienced senior tailings practitioners stems from people falling into one of these many disciplines and not having a solid understanding of how it all relates together. Tailings management is not just geotechnical engineering or dam construction (although these are critically important), it all has to come together. It takes someone with enough knowledge of these various disciplines to make	I generally think the system is working pretty well to generate talent. We need to people with deep understanding of each discipline, who from experience start to learn how to integrate all of the other disciplines.	We need to keep junior people interested and growing and developing in the industry as consultants. When junior staff reach a mid-level position in the consulting stream they are often lured to the "client" side, leaving a gap in the senior most level of consulting stream.		Direct email from the Project Team
1230	5	0-5 years	Academia/Education	PhD Degree	Civil Engineering;Construction/Construction Management;Environmental Engineering;Geological Engineering;Geosciences (Geology);Mining Engineering	No	No	N/A	I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	The mining industry is mandatory for the world	Risk assessment. Innovative technologies. Big data, management and decisions (AI/ML).	Workforce numbers, diversity and both academic and experiential training.	Workforce issues, and the escalating volume of tailings produced.	Geometallurgical materials flow accounting, water extraction and recycling, long-term performance of TSFs.	Direct email from the Project Team
1231	4	5-10 years	Consulting;Mining Industry	Bachelor's Degree	Geological Engineering;Mining Engineering	No	No	I had pit wall geotech and foundations of structures in mind	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	No	I know the importance of professionals working in this field being knowledgeable about it but I am not active in championing anything aside doing my work	not sure I understand very well what you mean by 'professional training disciplines'	For a country like Ghana where I am from and work, there is little investment by employers in training of their Technical staff. Most of what we learn is either acquired on the job or by extra research done on the side. This means we may be getting half baked professionals or it will mean a lot of preventable mistakes being done during the formative years of these professionals who get no training nor guidance from experienced seniors	In some countries the regulators are not firm enough to insist on what must be done so you may have a big international mine conforming to all the right things in an advanced country but will not put in as much effort elsewhere. There are also some mines (the smaller ones) that weigh every decision on the scale of money so are not ready to invest in the right kind of professional to operate/manage the facility etc	not sure yet	Direct email from the Project Team
1232	4	10-20 years	Consulting	Master's Degree	Geological Engineering	Yes	No	I started my career doing civil-geotechnical work (MSE walls, roads, foundations etc...). I moved over to the mining side after my Master's degree (completed ~7 years after my bachelor's) when a former colleague who had also made a similar move suggested trying it out	I have participated in internal formal trainings;I have participated in external formal trainings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes	I am an advocate that mining is a necessity, but the mining industry must continue to improve with respect to safety and good design. There continue to be too many tailings dam failures.	Not sure I understand this question. I work with environmental scientists, civil engineers, geological engineers, geologists, biologists, permitting experts, mining engineers...	Currently there are not enough geotechnical (civil and geological) engineers that work with tailings. Most civil and geological engineers have to find their way to a career in tailings - very few start there. A career in tailings is not considered to be an attractive career path.	Loss of public trust due to tailings dam failures; lack of qualified personnel	Tailings engineering perceived as an attractive career choice; Widespread adoption of the GISTM principles by mining companies, no more tailings dam failures	Forwarded email from a colleague/industry contact
1233	5	5-10 years	Consulting	Master's Degree	Civil Engineering	No	No	It was a new field at the time for me. Initially in mining projects and got interest in TSF construction	I have participated in internal formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	Recent failures have increased demand for engineers that could prevent these failures due to poor construction practices in the past century	tailings material characterization and seismic	Retention for field engineers is a challenge. They get somehow demotivated for the routine component of the tasks in the field	Motivation from engineers based on the field	Some sort of extra motivation for field engineers, education, and more engineering work at sites with support of an engineering firm	Forwarded email from a colleague/industry contact
1234	5	20+ years	TSF monitoring solutions	Post-Doc Study	Electrical Engineering;Geosciences (Geology);Mining Engineering;Natural Sciences	No	No	Electronic monitoring systems	I have participated in internal formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	I invent monitoring systems and solutions for the industry	study of geology mechanics	young starters are in short supply	old unrecorded TSF details	better records of material stored, Better monitoring for internal strains / liquid flow, warning systems	Direct email from the Project Team
1235	5	20+ years	Consulting	Master's Degree	Geosciences (Geology)	No	No	I focus on tailings geochemistry. When I started working in mining, I started learning about the issues associated with tailings management.	I have participated in internal formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	Participated in SME at many levels, including chair of Environmental Division. Participant in UN tailings guidance. On SME tailings committee. Teach geochemistry short courses	Waste rock geochemistry and management, particularly in LATAM	High demand for engineers due to recent tailings dam failures. High demand for Spanish speaking geochemists due to increased focus by investors in SEG risks	Staffing and experience, Spanish language training	1. Better regulations/enforcement in certain mining centers, Mexico in particular. 2) More training in mine waste characterization and management in Spanish, 3) Better corporate structure and budgets for mine waste management at the mine level	Direct email from the Project Team
1236	5	20+ years	Mining Industry	PhD Degree	Business;Civil Engineering;Geological Engineering;Mining Engineering	Yes	Yes	I started entire consulting groups just based upon tailings facility design	I lead internal formal trainings;I lead external formal trainings;I am an adjunct professor of tailings at a few universities in addition to a career long commitment to publishing articles on tailings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes	Society needs mining - if you can't grow it, it is mined.	These days, patience and life balance training.	Huge shortage of people who can think for themselves. Universities are training people using poorly trained professors who seemingly don't understand engineering principles. Vicious cycle that is causing great harm	Lack of qualified people - both in terms of trainers and trainees.	1. Stop all the parallel ambulance chasing initiatives. 2. Stop teaching the physicals of stability incorrectly to students and industry professionals. 3. Create a true life cycle cost for a given commodity based upon the cost of properly managing tailings and mine waste	Direct email from the Project Team
1237	5	0-5 years	Soil Stabilization Technology Mfgr.	Bachelor's Degree	Government	No	No	Intended to work in government justice/legal.	I have participated in internal formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	We need to protect our Earth and the Tailings can be a direct threat to the Earth.	Nation by Nation Guidelines to Tailings per each Nation	short supply from an Educational standpoint and an Industry Experience standpoint	Lack of seriousness with respect to the dangers.	Global Regulation, Soil Stabilization Standards by Soil Type and Geography, Industry education.	Direct email from the Project Team
1238	3	20+ years	Consulting;Mining Industry	Bachelor's Degree	Civil Engineering;Geological Engineering;Geosciences (Geology);Mining Engineering	Yes	No	Specialization and interest is rock mechanics; soils engineering (TSF, HLF) was a side interest and have a lot of experience, but not applied to specific facility design	I have participated in internal formal trainings;I have participated in external formal trainings	CIM â€“ Canadian Institute of Mining, Metallurgy and Petroleum;SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	Mining has been my career for 40 years and I support all aspects of mine development and related waste management, when done correctly	not relevant to my current situation	Continuing education for professionals in an increasingly automated world; interest of the best talent to work/live in remote environments	regulatory requirements and community relations	restrict/prohibit development of upstream raises; sharpen construction QA/QC; minimize/define water use as a permit requirement	Forwarded email from a colleague/industry contact
1239	4	10-20 years	Consulting	Master's Degree	Civil Engineering	Yes	No	I started my career in the infrastructure space and stumbled into tailings a couple of years later.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	Yes	Yes	I try to demystify tailings every chance I get.		Quality of education and succession of knowledge	Willingness of owners to invest in best practices	1) improve publicâ€™s understanding of tailings and mine waste; 2) improve exposure to students at undergraduate level 3) qualification scheme of engineers	Shared/forwarded through LinkedIn from a colleague/industry contact
1240	4	0-5 years	Mining Industry	Bachelor's Degree	Civil Engineering	No	Yes	I grew up in a mining town	I have participated in internal formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	No	No	I have not done anything to actively advocate in the industry. But I am open to being an advocate	Specific tailings dams stability analysis training		Lack of education in college		Forwarded email from a colleague/industry contact
1241	3	20+ years	Regulator/Government	Master's Degree	Civil Engineering;Environmental Engineering;Geosciences (Geology);Mining Engineering	No	Yes	I began reviewing engineering plans for tailings facilities in 1986	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	As a regulator, I advocate for safe and effective tailings facility design and management. I have spent decades promoting safe tailings management throughout the mining industry.		Limited educational curricula. Retaining highly qualified employees through boom-bust cycles. Promotion of Professionals into management roles.	Convincing mid-tier mine operators of the importance of tailings management - Low Probability/High Risk events are low on their priorities.	Focus on Safety, Government Engagement/Coordination, Public Outreach	Forwarded email from a colleague/industry contact
1242	4	0-5 years	Academia/Education;Mining Industry	Post-Doc Study	Mining Engineering	Yes	Yes	I worked as slope stability engineer	I have not participated in any formal professional training on tailings	SME â€“ Society for Mining, Metallurgy & Exploration	No	No			Tendency to stick to traditional methods and not to change and renovate	the gap between theory and practice	Investigating recycling options for tailings, studying the innovative methods to deal with waste, defining new applications for tailing material	Direct email from the Project Team
1243	5	0-5 years	Academia/Education	PhD Degree	Mining Engineering	Yes	No		I had training on tailings during my educational experience	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	As an educator, I am a strong advocate for the industry through various outreach programs.	Not sure, but I am always wanting to learn more about new technology for tailings management	Having professionals who have the skills to evaluate dams. Ethics.	Dealing with and preventing older dams from failing.	reputation, reputation, reputation.	Forwarded email from a colleague/industry contact
1244	3	5-10 years	Consulting	Master's Degree	Civil Engineering;Geological Engineering;Mining Engineering	Yes	Yes	M.Sc. degree was made in partnership with Golder-Mine waste. Topic: Self-weight consolidation of hard rock mine tailings	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal	Not a member of a GMPA Society	No							Forwarded email from a colleague/industry contact
1245	4	10-20 years	Consulting	Bachelor's Degree	Civil Engineering	No	No	Had never even heard of tailings at the time....	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	Not a member of a GMPA Society	Yes	No	I have concerns about the mining industry not respecting human rights and passing on negative externalities to the public	Further training in some technical areas Project management/scheduling	Lack of sufficient mentorship opportunities for the number of EoRs that will be required in the next 5 or 10 years	Lack of personnel with proper experience to avoid dam safety incidents.	#NAME?	Forwarded email from a colleague/industry contact
1246	5	10-20 years	Mining Industry	PhD Degree	Geological Engineering;Geotechnical Engineering	Yes	No	discovered tailings later in my career path!	I have participated in external formal trainings;I lead internal formal trainings	Not a member of a GMPA Society	Yes	No	No time!	Geotechnical Engineering with TSF design/construction/operation experience	attracting the different professionals to the mining industry	identifying adequate resources		Forwarded email from a colleague/industry contact
1247	4	20+ years	Consulting	Master's Degree	Geological Engineering;Mining Engineering;Geotechnical engineering	Yes	No	In the beginning I was a mining engineer, with almost no understanding of tailings	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead external formal	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	I am an advocate of responsible mining	n/a	A general lack of in-coming tailings engineers	Funding and education, especially for people on the mine owners side	Erase the past failures, increase tailings awareness at the mine level and the third thing	Forwarded email from a colleague/industry contact
1248	3	10-20 years	Mining Industry	Master's Degree	Geosciences (Geology)	No	No	Studied Geophysics not Mining or Geotechnical Engineering	I have participated in internal formal trainings	Not a member of a GMPA Society	Yes	Yes	I am part of the Corporate Tailings Group and provide input on issues related to monitoring etc	Basic Geotechnical Engineering Principles,	Remoteness of the sites, Weather Conditions on Site etc	Preventing a failure, its likely we have all the diagnostic tools we need right now but they still keep occuring		Forwarded email from a colleague/industry contact
1249	5	10-20 years	Mining Industry	Master's Degree	Geological Engineering;Geosciences (Geology)	No	No	I wasn't aware that tailings was a career path when I joined the industry. With a geological engineering degree, I was originally focused on pit wall stability or rock fall. It was luck that I ended up in with mentors that were more tailings focused than hard rock focused and got sucked into tailings closure and design.	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	No	Probably not but I'd like to be. I haven't participated in a lot of outreach or presented paper. Now that I am in industry, I've begun talking to my bosses about becoming more involved in university programs or outreach.	Civil engineering for geotechnical and hydrotechnical, mining engineering for the background on ore and mineral processing, environmental sciences for the geochemistry, environmental impacts and containment, and regulatory impacts	Lack of visibility outside the industry except in negative ways i.e. blame once something has gone wrong but no celebration when things are going right, too much responsibilities without commiserate compensation and support from mining company clients	Consistent awareness - it's easy when there's a lot of focus on tailings safety, large companies pushing to reduce risk, but this tends to shift and all of sudden instead of being pushed to spend money to reduce risk, we're asked what's the minimum that's required and what's the smallest amount of money and attention that we can spend to achieve that.	1. More focus on the mining company responsibility for management of the facilities. It can be a perfectly designed and built and monitored facility from the EORs side but if not operated correctly and/ or recommendations are ignored then there's not much an EOR can do. I think this is progressing especially at larger companies but I think this can be hard for junior companies. 2. A lot more flow between mining company roles and consulting than has been in the past. I currently see a lot of professionals moving out of the consulting EOR roles and into the mining companies. I think this is a valuable step to bring some of the technical expertise required into the mining companies that have typically outsourced roles and this may be a bit of backlash on the increased responsibilities in the EOR role. I'd like to see some of these people eventually flow back into consulting and bring some of lessons learned from working "on the other side of the table" back into the consulting firms. This may require some change in the way that consulting firms manage personnel in order to get people to move in the other direction	Direct email from the Project Team
1250	3	0-5 years	Consulting	Master's Degree	Civil Engineering	No	No	Was really interested in infrastructure/traditional geotechnical, slowly developed interest in tailings through mentors and opportunities thru work	informaal internal and external panel discussions/webinars/etc.		No	No		on the job training, more seminars / webinars, short courses	interest from the next generation, need for discussion/topics within civil/geotechnical undergraduate programs/courses	personnel availability		Direct email from the Project Team
1251	4	20+ years	Regulator/Government	Master's Degree	Civil Engineering;Mining Engineering	No	No	I started my career in the mine design field. Only after coming to government did I get involved with tailings disposal.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	If you mean advocate of mining, absolutely. Mining is critical to nearly every other industry because of the materials needed to produce machinery, etc.	We conduct technical review of plans developed for tailings facilities (coal and non-coal). My engineers must be knowledgeable in hydrology, hydraulics, geotechnics, construction, etc. When hiring, we primarily seek strong geotechnical backgrounds because the other disciplines are more easily taught in-house	I see a steady supply of students entering the engineering profession. However, they need to be made better aware of all engineering fields and the opportunities that exist.	How current facilities will need to be modified to comply with future environmental regulations. We all know it is much easier to incorporate controls in the original design than it is to modify an existing site.	US regulations for non-coal tailings facilities.	Forwarded email from a colleague/industry contact
1252	4	10-20 years	Mining Industry	Master's Degree	Civil Engineering	No	No	I joined a mine waste group after completing my master's degree, but I had not originally intended to practice geotechnical engineering in the mining world.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	I participate in working groups and enjoy creating awareness around tailings stewardship and safe tailings management practices	Updates on state of practice, such as CPT analysis methods and constitutive models - Norsand, PM4Silt/Sand, etc.	We are in a mining upswing now. Many folks will join our industry during this time and we may develop good training programs, but we'll need to continue this effort even when the mining cycle undoubtedly turns back down in the future. If we don't maintain the training of staff during downturns, then we could end up with another shortage again in the future	Social license to operate	1. We put too much pressure and too much reliance on our consultants - we need to reduce this or spread the load. 2.) Focus on the big picture/long term result - some times we need to focus less on capital costs, but more on the long term costs and answer. 3.) Change the perception of the mining industry from a "dirty" industry to a necessary and socially/environmentally responsible industry.	Forwarded email from a colleague/industry contact
1253	5	0-5 years	Mining Industry	Bachelor's Degree	Civil Engineering	Yes	Yes	I wanted to work for the mines, so I pursued a degree which would lead me to a career path that I wanted.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal	Not a member of a GMPA Society	No	Yes	I promote responsible mining and tailing management.	Current state of geotechnical practice, theory, and modeling for tailing facilities.	Mines are hard to work for, either very remote, undesirable places, or expensive places.	public perception and social operating license.	Public perception, "secret" information on tailing facilities, specialization in engineering practices limiting available courses/training.	Direct email from the Project Team
1254	3	10-20 years	Mining Industry	Master's Degree	Civil Engineering;Geological Engineering	Yes	No	My intended career path was geotechnical engineering - not specifically tailings	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	No	I do not find myself advocating for the tailings industry	soil mechanics	knowledge gap between experts and developing engineers/scientists	Increasing documentation and compliance requirements		Direct email from the Project Team
1255	2	20+ years	Regulator/Government	Master's Degree	Civil Engineering	No	No	I graduated as a structural engineer but received an offer to do geotechnical work	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	No	I do not advocate for the tailings disposal	Stability analyses of upstream construction and static liquefaction	Geotechnical engineers typically fill the positions that design tailings facilities.	Upstream construction and long term stability.	Eliminate upstream construction; provide additional college coursework in the geotechnical discipline relating to tailings facility stability and liquefaction; and find additional technologies to eliminate downstream pollution from tailings facilities	Forwarded email from a colleague/industry contact
1256	3	0-5 years	Mining Industry	Bachelor's Degree	Civil Engineering;Geotechnical Engineering	Yes	Yes	I had previous internships in tailings so I knew tailings is what I wanted to do.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	I feel my company strives to be front runner for future innovations within our industry, and I am a part of that	Geotechnical Engineering, Project Management, Accounting	TSF's are commonly located in remote locations. This can make hiring professionals difficult	Long term stability and management for perpetuity.	NA	Forwarded email from a colleague/industry contact
1257	5	5-10 years	Consulting	Master's Degree	Geosciences (Geology)	No	No		I have participated in internal formal trainings		No	Yes						Direct email from the Project Team
1258	3	0-5 years	Consulting	Bachelor's Degree	Civil Engineering	No	No	Structural Engineering was the career path plan before I left University	I have participated in internal formal trainings	Not a member of a GMPA Society	No	No	Don't know what an "Industry Advocate" is	?	Don't really have a clear picture of things	The fact that it's not profitable and thus receives less attention, until something goes wrong		Forwarded email from a colleague/industry contact
1259	4	10-20 years	Consulting	Master's Degree	Civil Engineering	No	No	I happened to work on tailings projects when I started full-time work and then continued on that path ever since.	I lead internal formal trainings	Not a member of a GMPA Society	Yes	Yes	Because I am in the tailings industry.	Water resources engineering (hydrogeology and surface water)	There is currently a shortage of tailings professionals in the industry and there will be a shortage of senior tailings professionals/Engineer of Records within the next 5 to 10 years when the current ones retire	1) Shortage of labour now and in the future 2) Mine owners prioritizing short term cost-savings over long term gain (enviro benefits)	1) Emphasis on safety (on site and public) and environmental benefits over financial gains 2) Educate on site personnel with the current tailings standards and safety practices 3) (can't think of a 3rd)	Forwarded email from a colleague/industry contact
1260	4	0-5 years	Mining Industry	Master's Degree	Geological Engineering;Mining Engineering	Yes	Yes	I interned with the tailings and water group, so this made me come back full time into the workforce	I have participated in internal formal trainings;I have participated in external formal trainings		No	Yes		water balance and deposition planning				Direct email from the Project Team

Record #	1. On a scale of 1 to 5, how critical do you perceive the tailings industry professional resource shortage?	2. What is your level of experience as a tailings professional?	3. In which area are you currently employed? (Select all that apply)	4. What is your highest level of formal education completed?	5. In which field would you generalize your formal educational training? (select all that apply)	6. Did your formal education provide you any introduction to the tailings industry?	7. When entering the workforce, was the tailings industry part of your intended career path?	Explain your response to Question 7:	8. Are you, or have you been, involved with formal professional training (short courses, certifications, etc.) associated with tailings? (Select all that apply)	9.Are you a member of a Global Mineral Professionals Alliance (GMPA) Society? (Select all that apply)	10. Have you heard about the GMPA Global Action on Tailings Initiative?	11. Do you consider yourself an industry advocate?	Describe why you responded Yes or No to Question 11:	12.What professional training disciplines would help you execute your work on a day-to-day basis?	13.What challenges do you see with respect to available professional labor resources, both currently and in the future?	14.What is the greatest challenge facing the tailings and mine waste industry, in your opinion?	15.If you could change three things within the tailings and mine waste industry, what would they be?	16. How did you receive the link for this survey? (select all that apply)
1261	4	5-10 years	Consulting	Master's Degree	Civil Engineering;Geotechnical Engineering		No	My B.A.Sc was Civil Engineering (structural+geotechnical), and later got into tailings/geotechnical engineering after being employed	I have participated in internal formal trainings;I have participated in external formal trainings		Yes	No	Not yet but intended to be one. Mostly in the passenger seat at the moment.	Critical state soil mechanics (CSSM) & advanced soils models (NorSand, etc.) + stress-deformation analysis + risk assessment and failure modes	Shortage of 15-20-year experience professionals now and in the future.	Lack of 20+year experience to mentor younger engineers. Lack of understandings in the CSSM.		Direct email from the Project Team
1262	4	0-5 years	Consulting	Master's Degree	Environmental Engineering	Yes	No	Started out in environmental compliance and mine closure, which in the mining industry naturally connects to tailings	I have not participated in any formal professional training on tailings;Internal informal training courses (inhouse lead by SMEs)	Not a member of a GMPA Society	No	No	Not yet enough experience to appropriately lead industry discussions	Integrated tailings design and closure considerations. Comprehensive examples of failures and why specific designs have not worked.	There is a bottle neck in the workforce for senior tailings personnel, so even with new people coming into the sector, limits progression if requiring a principal to advocate for your progression. Tailings is also a hybrid of mechanical, civil and environmental engineering and at the moment there is not the encouragement or drive to involve engineers from the three backgrounds. Incorporation of all three technical understanding is needed and there needs to be incentives to take up the career path from people originating from each background	International regulation and standards. Best practice regulation in international guidance has improved and is well documented, uptake of those uniformly across the state , country and internationally is not consistent. Drive to do so is often from lack of local guidance and not the desire to strive for best practice design and management	Introduction of specific tailings university degree (i.e like mechanical is an option or environmental, there should be a tailings), increase in women in the industry, external formal training course accessibility	Forwarded email from a colleague/industry contact
1263		10-20 years	Regulator/Government	Bachelor's Degree	Geosciences (Geology)	No	No	I CAME INTO WORKING ON TAILINGS LATER IN MY CAREER	I have participated in internal formal trainings;I have participated in external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration;Not a member of a GMPA Society	No	Yes	As a consultant to the mining industry I was an advocate, but now as a regulator I am publicly neutral on promoting the industry, but I am a strong advocate for tailings safety and awareness and improving the regulator role in tailings dam safety and oversight, I do believe mining is necessary to fuel the green power transition and meets vital societal needs and can be done in an balanced, environmentally responsible way	tailings dam oversite for regulators, good practices for improving the regulatory oversight role	I see an increasing lack of tailings professional capacity to handle the increasing global workload	decreasing grades that increase tailings volumes, negative perceptions resulting from tailings dams disasters, reluctance of some large mining companies to join in to ICMM and global tailings standard	More knowledgeable regulators, increased guidelines for governance and permitting best practices, increase in the tailings dams owners transparency and communication with regulators, to promote safety and prevent failures.	LinkedIn post from the Project Team
1264	4	0-5 years	Consulting	Master's Degree	Civil Engineering	No	No	My career path initially intends to go through geotechnical engineering, but not specifically the tailings industry. Due I start my career working in stabilization projects, with time, my path led me to mining industry and then to tailings industry.	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	Yes	People may have a wrong perception of the tailings industry, of course it represents a high hazard to communities and environment, but it is mostly caused by the shortage of professionals more prepared to be part of the tailings industry work force. If the industry would have more resources to develop professionals in tailings, the tailings practice in the world would have an important improved	Applied soil mechanics	Currently, tailings management, at least in Mexico, is seen like a liability more than an asset and to change this thought is one of the biggest problems, and in the future, once the perception of the tailingâ€™s management has changed, the problem could be the shortage of qualified personal to work in tailings management	Currently, tailings management, at least in Mexico, is seen like a liability more than an asset and to change this thought is one of the biggest challenge	Perception of the tailingâ€™s management, regulation in Mexico regarding Tailings Storage Facilities, and including more tailings management topics in universities	Direct email from the Project Team
1265	5	10-20 years	Consulting	Master's Degree	Civil Engineering;Construction/Construction Management;Environmental Engineering;Geological Engineering;Mining Engineering	No	No	Tailings were like a matter only for mining Companies and few design consultants.	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	Yes	I believe mining bring good things for society.	OMS Manual for tailings dans, linked to EoR principles.	Changing their mind because they still think that tailings are â€œthe garbageâ€ and are not strategic for mining Companies, and therefore, donâ€™t need importance. They still buy the cheapest Engineering. FundÃ£o and Brumadinho havenâ€™t already changed behaviours, and consciousness, in mining industry	Mindset.	Planning; Budget; Geotechnical mindset.	LinkedIn post from the Project Team
1266	3	10-20 years	Consulting	PhD Degree	Civil Engineering;Construction/Construction Management;Geotechnical Engineering		No		I have not participated in any formal professional training on tailings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes						Forwarded email from a colleague/industry contact
1267	5	20+ years	Mining Industry	Bachelor's Degree	Civil Engineering	No	Yes	The position I was recruited for had a tailings storage facility in it. though in my eyes it was the same as a water storage at that time and hence the attraction was a Dam and everything to do with managing such a kind of facility. I had a Hydraulics and Geotechnical speciality in Uni and this ticked the box quite readily from geotech, water and environmental perspectives	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I am facilitating training of others as an industry expert promoting the right requirements	AusIMM â€" Australasian Institute of Mining and Metallurgy	No	Yes	been in mining/manufacturing industry since 1993 and feel the best way to improve the industry is from the inside	civil engineering, communication, project management, environmental	not enough or poaching from one lower paying aspect to a higher paying aspect, limited skills and training and increased pressure to meet GISTM commitments without being ready	trust, convincing and demonstrating to people the industry has this under control	1) clarity- clear direction on needs to be done 2) united and common goal rather than multiple vested interest heading in different directions or strong unbudging intolerant personalities 3) high quality personnel who knwo what they need to do	Forwarded email from a colleague/industry contact
1268	4	20+ years	Consulting	Master's Degree	Civil Engineering	No	No	I started working in a region where there were no mines.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	Yes	Yes	I am active in publications and conferences	Better understanding of liquefaction triggers	There are enough graduates but not enough experience to fill all EoR roles	Effective implementation of corporate governance	Improved governance, more experienced Engineers, global alignment	Direct email from the Project Team
1269	4	10-20 years	Consulting	Master's Degree	Civil Engineering;Geological Engineering	Yes	No	MSC Mining Eng, not especificaly tailings eng formation	I have participated in internal formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes						Direct email from the Project Team
1270	4	5-10 years	Mining Industry	Bachelor's Degree	Civil Engineering		No	I had an interest in geotechnical engineering so I was open to any path within geotechnical	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	No	Yes	All participants in the industry are advocates	geoenvironmental engineering	Currently the majority of tailings skilled practitioners are consultants. There is a growing demand for skilled practitioners in mining companies. Consultancy may become just a 'training ground' for tailings engineers before they move on to mining companies, which would then reduce the number of good consultants.	Ensuring that tailings management is seen as a must be well done aspect at all costs, and ensuring profits don't compromise safety and quality	1. Continue to globalise/standardise training and best practice 2. Companies to continue to devote more resources to tailings management 3. Continue to promote the industry to the public eye e.g. through universities	Forwarded email from a colleague/industry contact
1271	5	0-5 years	Mining Industry	Master's Degree	Mechanical Engineering	No	No	Engineering into management , then management of tailings	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	Yes	Yes	Company representative into ICMM	I will do Ausimm and UWA future Tails programs in 2021	Retiring personnel in next couple of years, not enough EoR and ITRB members	Competent trained personnel all areas	Increased resources, more training, more people coming into the industry	LinkedIn post from the Project Team
1272	4	10-20 years	Mining Industry	Master's Degree	Civil Engineering	Yes	Yes	I had already worked on dam safety during my graduation and the opportunity I had to return to my hometown was to work safely on tailings dams.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	Yes	Yes	I understand that the industry is an essential activity for our evolution and needs to be carried out, however, with a constant improvement of its processes to make it more sustainable.	In my master's degree in Geotechnical Engineering with an emphasis on mining, I had several disciplines related to the theme, such as: tailings disposal systems, soil mechanics, hydrogeology and engineering geology.	Give practical experience to recent graduates in the subject, in order to allow them to critically evaluate what the computational models are generating	Implement appropriate governance models, with the necessary technical qualifications and connection with the high administration of the industry, to ensure the safety of tailings disposal processes at all stages of the life cycle: design, implementation, operation and closure.	Lack of cooperation between technicians in the area; drafting legislation for the topic without the total involvement of technicians; and creating international certification to attest to the implementation of good practices in the disposal of tailings.	Forwarded email from a colleague/industry contact
1273	5	10-20 years	Consulting	Master's Degree	Civil Engineering;Geological Engineering	Yes	No	I started as Civil engineer and because of one project, I started working on Tailings Dam operation (water balances, deposition scheme and dam growing design	I have participated in internal formal trainings	Not a member of a GMPA Society	No	Yes	yes I have 13 years of experience working on the tailings management area	all geotechnical / hydrogeological aspects and hidrology		the complience of ICMM standars with current facilities	design, construction and operation under the same consultant (basicaly EoR)	LinkedIn post from the Project Team
1274	5	10-20 years	Technology Supplier	Master's Degree	Chemical Engineering	No	No	When I started initially our company just started approaching the Mining Industry	I lead internal formal trainings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum;SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes				Some existing bias on some professional people	Mentality of Conservative Engineers, Mentality of Conservative Consultants, Mentality of some Mining Companies	Forwarded email from a colleague/industry contact
1275	4	0-5 years	Consulting	Master's Degree	Business;Mining Engineering	No	No	As a Mining Engineer in an underground hardrock operation I entered thinking that was my future. As I advanced I began to have accountabilities for Tailings and was not educated and had to depend on strong leaders and technical staff to provide me confidence. I was not as aware of the risks and consequences as I should have been at thetime	I have not participated in any formal professional training on tailings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum;SME â€" Society for Mining, Metallurgy & Exploration	No	Yes	I am a strong believer that mining is needed to provide the needs of the world and as an industry we must do it in a more sustainable way.	In my role it is mainly on leadership, developing people, and operating successfully in a virtual world.	The risk for the individuals will outweigh the reward and people will not want to go into the area of tailings. This will create a spiral effect of potentially attracting the wrong skill sets.	Technical skills to address current tailings risk and innovative thinking to change "waste" paradigms within the industry and society.	1) Have people understand the cost of waste and reduce it in the mining process 2) Have people invent value for the was so it gets consumed as a product and not discarded and stored 3) Create a passion and a reward for the above 2 to help drive this in the industry.	Shared/forwarded through LinkedIn from a colleague/industry contact
1276	4	20+ years	Regulator/Government	Master's Degree	Civil Engineering	No	No	In school, my primary focus was structural engineering, but my career for the past 26 years has been in geotechnical (primarily coal tailings impoundments) and other general civil fields like structural, hydrology, hydraulics, ground control, etc.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	Not a member of a GMPA Society	No	Yes	i understand the risks associated with tailings facilities and would like to see regulations in the metal/nonmetal industries that are similar to those in coal (from a federal level)	soil mechanics, soil exploration (in-situ and lab testing programs appropriate for TSFs), drained/undrained strength assessments, instrumentation and monitoring	i think engineering expertise associated with TSFs will primarily come from the civil engineering program. I believe additional geotechnical engineering courses pertaining to these facilities in graduate level programs will help to develop engineers, and interest in this specific field	ensuring that existing facilities are stable, and adopting regulations requiring more strict design, construction, and abandonment practices.	better facility design (and government regulation), alternative disposal methods, minimizing environmental impact	Forwarded email from a colleague/industry contact
1277	4	0-5 years	Consulting	PhD Degree	Mining Engineering	No	Yes	I was hired as a junior engineer_mine tailings management	I have participated in internal formal trainings;I had training on tailings during my educational experience	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	No	Yes	The mining industry in the current context of sustainable development must be popularized	Hydrogeology, geotechnic	Lack of professional labor now and in the future	The management and valorization of tailings	strengthen industry and research agency partnership Train more professionals for waste management Also work on the valorization of tailings	Forwarded email from a colleague/industry contact
1278	3	10-20 years	Regulator/Government	Master's Degree	Civil Engineering;Mining Engineering	No	No	Geotechnical (Civil) Engineering + Mining Certification is my master's degree. So tailings dams are a good fit for both subject matters	I have participated in internal formal trainings	Not a member of a GMPA Society	Yes	No	Gov't regulator	Advanced soil mechanics with an emphasis on tailings properties and generation; advanced hydraulics/hydrology	Lack of availability of courses at universities. An undergrad civil degree has many smaller disciplines that need covered in 4 years; I don't recall any classes on dams at all, let alone a verify specific topic like tailings dams.	Lack of awareness of the existence of these facilities (intentional?). As an engineer these facilities are complex structures that cover almost all aspects of the civil engineering profession (geotech, water resources, construction, etc. with environmental engineering added as well) and if presented during undergrad design class would give students another example about how the civil disciplines work together. At least from my experience, there isn't a lot of opportunity for elective classes, so the introduction may need incorporated into a required geotech or hydraulics class. I was able to take an elective on landfill design, which is pretty specific but there was a professor with that design experience; additional classes may need to be taken at the masters level.	1) I think there is the thought that, while necessary, waste disposal is not as cool as a bridge or a building in the civil engineering world; I got the same impression with landfill design. More awareness at the university level would be helpful. 2) I feel like the operators see these structures as eating away at profits and are more reluctant to spend money on the facilities (site geotech exploration/testing, monitoring instrumentation, etc.). These dam should be considered another element of the infrastructure needed to mine, and they should be engineered as such. 3) Better long-term planning as far as reclamation of the tailings dams even after the mine has closed is needed. Example: stockpiling additional material to cap the tailings and reclaim the site once waste stops being generated; not planning ahead leaves sites orphaned or the operator has to spend a lot of money bringing in outside material in some cases.	Forwarded email from a colleague/industry contact
1279	5	20+ years	Consulting	Master's Degree	Civil Engineering	Yes	No	Structural and foundation engineering were initial career paths	I have participated in external formal trainings;I had training on tailings during my educational experience;I lead external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	I consult for mining companies	Hydraulics, GIS, new software	Training and mentoring of new personnel	Public opposition to extractive industries	Processing that requires less water, more informed public knowledge of the industry, cessation of dam failures	Direct email from the Project Team
1280	3	20+ years	Mining Industry	Master's Degree	Geological Engineering	No	No	I became involved in the tailings industry through working on the site investigation and design of a new TSF as part of my junior geotechnical engineering development at an engineering consultancy, then more or less followed the tailings industry path thereafter.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	It's a qualified Yes - advocating for responsible tailings management within my current company is a challenge.	Risk management communications to top-floor executives :)	Within the industry, tailings expertise (in my experience) could improve on facilitating internal mentorship from senior to junior roles AND rotating challenges, career path desires and providing opportunities from junior to senior roles.	The industry must truly demonstrate (actions not just words) to society that we have permanently improved our tailings stewardship, not just responded to the aftermath of some recent tragic tailings dam failures until the attention subsides.	1. Allowing global companies to apply different standards based on jurisdiction (fixing this will require direction from regulators, insurers and investors). 2. Tolerating ill-defined TSF closure plans in project studies and permitting applications. 3. Getting rid of end-of-pipe mentality which still persists at some mine operations.	Direct email from the Project Team
1281	3	0-5 years	Consulting	Master's Degree	Civil Engineering;Environmental Engineering	Yes	No	When I started working, my intention was to work with dam safety and design for hydropower dams only. But when I started working the electricity prices were low and the metal prices OK, meaning there were more dam safety projects available in mining than in hydropower. I quickly got the opportunity to start working with mining dams too, and found it very interesting.	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	Yes	No	I had to google what "industry advocate" means, but as I understand it it's applicable to people more experienced and wellknown than me (being a fairly junior designer and consultant). I'm not interested in politics, I just want to work on finding the best solutions for our clients within whatever frameworks and regulations there are.	Critical state soil mechanics.	We definitely need more people (at least in Sweden where I work). Right now we have a big shortage of people with 7-15 years experience.	The threat of a new big dam failure.	No idea	Direct email from the Project Team
1282	4	20+ years	Regulator/Government	Master's Degree	Civil Engineering	No	No	Worked in the dam related fields, but not specifically tailings/mining.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	Not a member of a GMPA Society	Yes	Yes	I recognize the role of mining/miners in today's society. In my current position I work to protect the health and safety of all miners.	Most of the challenges I face daily are geotechnical related.	Universities typically train civil engineers, geologic engineers, or mining engineers. The tailings dam community is a combination of all three disciplines	Willingness of mine operators to understand the hazards associated with tailings dams.		Forwarded email from a colleague/industry contact
1283	5	10-20 years	Consulting	Bachelor's Degree	Geological Engineering	No	No	I was expecting to pursue a career in exploration geology. I had no exposure to tailings in school or my first several years of working.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	I am involved in multiple tailings committees (SME and USSD). I frequently give guest lectures to students about tailings and my career.	more information about alternative tailing disposal methods	we are doing a better job recruiting directly into our tailings group, and we have several very experienced senior-level resources who dedicate time to mentoring and reviews, but we have a critical shortage of EOR-level resources (enough advanced experience to take on an EOR role, and still working full time, and not already dedicated to 2 or more EOR roles)	legacy sites which have not been properly closed or are not properly monitored	more recognition for tailings as a critical mine function, more collaboration between "water dams" engineers and tailings engineers and more diversity in the field (gender and race)	Direct email from the Project Team
1284	5	10-20 years	Mining Industry	Bachelor's Degree	Civil Engineering;Construction/Construction Management	No	No	I started as quality control supervisor of the construction of a tailings facility. As years went by and got more involved I learned and got into the tailings industry	I have participated in internal formal trainings;I have participated in external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	I support responsible mining.	Geotechnical engineering	There is not enough persons trained and educated on tailings.	Public acceptance and that most of the SMEs are on high demand and there is not enough resource	more discipline specific training, public image, more knowledge sharing within the industry	Direct email from the Project Team
1285	5	5-10 years	Consulting	Master's Degree	Civil Engineering	No	No	Transitioned from urban development to tailings - happened upon tailings-related job due to a family move	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	Yes	Yes						Forwarded email from a colleague/industry contact
1286	5	10-20 years	Mining Industry	PhD Degree	Civil Engineering	Yes	Yes	I like Tailings! waste rock, leaching etc	I lead external formal trainings	IIMP â€" Instituto de Ingenieros de Minas del PerÃº	No	Yes	I work at mining industry	Operations and Survaillance	Operations and Survaillance	Operations and Survaillance	improve culture	Forwarded email from a colleague/industry contact

Record #	1. On a scale of 1 to 5, how critical do you perceive the tailings industry professional resource shortage?	2. What is your level of experience as a tailings professional?	3. In which area are you currently employed? (Select all that apply)	4. What is your highest level of formal education completed?	5. In which field would you generalize your formal educational training? (select all that apply)	6. Did your formal education provide you any introduction to the tailings industry?	7. When entering the workforce, was the tailings industry part of your intended career path?	Explain your response to Question 7:	8. Are you, or have you been, involved with formal professional training (short courses, certifications, etc.) associated with tailings? (Select all that apply)	9.Are you a member of a Global Mineral Professionals Alliance (GMPA) Society? (Select all that apply)	10. Have you heard about the GMPA Global Action on Tailings Initiative?	11. Do you consider yourself an industry advocate?	Describe why you responded Yes or No to Question 11:	12.What professional training disciplines would help you execute your work on a day-to-day basis?	13.What challenges do you see with respect to available professional labor resources, both currently and in the future?	14.What is the greatest challenge facing the tailings and mine waste industry, in your opinion?	15.If you could change three things within the tailings and mine waste industry, what would they be?	16. How did you receive the link for this survey? (select all that apply)
1287	5	0-5 years	Mining Industry	Bachelor's Degree	Mining Engineering	No	Yes	I entered the environmental sector that license all the mining projects	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	Yes	Yes	I know our industry is really important to the world.	Dam inspections, slope stability analysis	We are going to need more professional laber in the geotecnical area, social and environmental.	The challenge is to show the society that the tailings projects are safe when well constructed. Another thing is change the industries to use better tailings projects as dry stack to be constructed, because they safer	Better projects with water reuse in all projects, because make the tailings projects safer.	LinkedIn post from the Project Team
1288	3	20+ years	Consulting	Master's Degree	Civil Engineering;Geological Engineering;Geosciences (Geology)	No	No	In 1970 I don't know that there was a career path in tails management. Most of us who worked with tailing got into it after being hired. We also generally worked on water dams and a large variety of soil and foundation investigations ranging from residential to major industrial structures.	I have not participated in any formal professional training on tailings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	Mining provides the materials essential to our support. Life as we know it would not be what it is with out the raw materials produced by mining.	A broader knowledge of the current state of the practice. Foe example: Closure, Technical Analyses, Regulatory Requirements	Finding qualified people who have an interest in perusing a career in tails.	Getting everyone on board with the idea of designing, constructing, operating and closing facilities with the goal of zero loss of life and zero environmental harm.	1, 2 and 3. Get competent, responsible professionals with the appropriate education and experience involved with each tails facility. In Colorado, the first state I was registered in as a licensed Professional Engineer, the purpose of the registration was the protection of the health and safety of the people. To fulfill that commitment has required making hard decisions to protect the health and safety of the public. But the good news is that in most cases the Clients have fully supported the decisions even though they may have had significant financial impacts on their operations	Forwarded email from a colleague/industry contact
1289	4	20+ years	Consulting;Mining Industry	Bachelor's Degree	Civil Engineering	No	No	My involvement in tailings came with mining experience in Chile	I have participated in internal formal trainings;I have participated in external formal	Not a member of a GMPA Society	No	Yes	I am involved in tailings projects daily.	Geotechnical, Instrumentation, Seismicity, Hydraulics	Not many young professionals are interested in mining, even worse for tailings	Community understanding of mining and how it can be done properly	Better communication, mining companies understanding their roles, proper financing	Forwarded email from a colleague/industry contact
1290	4	20+ years	Regulator/Government	Bachelor's Degree	Civil Engineering;GIS and CADD Technologies	Yes	No	Tailings found me through a job opening at the Federal Government. It is a very interesting career and one that I would highly recommend, particularly to students.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead external formal trainings	Not a member of a GMPA Society	Yes	Yes	I currently work in regulating tailings dams in the United States so I'm an "advocate" of the industry in promoting the safe design and operation of tailings dams. I base my view of tailings dams on engineering designs and proper construction, operation and inspection of the facilities. Everyone in tailings should be focused on their continued safe operation and preventing dam failures	A background in Civil Engineering and nothing beats actually going out to a tailings dam to view in person.	Work in tailings dams has a reputation of being "less glamorous" when compared to other engineering disciplines. That needs to change.	Lack of design plans for some structures and poor operation and inspection of facilities.	Require design plans for all dams, more frequent inspection of high hazard facilities and offer more tailings related curriculum at the university level.	Forwarded email from a colleague/industry contact
1291	4	10-20 years	Consulting	PhD Degree	Civil Engineering;Geological Engineering	No	No	tailings dams had very little engineering back then	I have not participated in any formal professional training on tailings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	tailings management are a critical part of mining industry success	mechanics of saturated fines behavior	tailings staff come from civil background an lack familiarity with mining	water recovery and dam stability given economical construction methods	universal accountability for engineer of record	Direct email from the Project Team
1292	3	0-5 years	Consulting	Some College/University	Civil Engineering	No	No		I have participated in internal formal trainings	Not a member of a GMPA Society	No	No						Forwarded email from a colleague/industry contact
1293	4	0-5 years	Consulting	PhD Degree	Civil Engineering	No	No	I am a geotechnical engineer with a PhD in deep foundation. Therefore I started working on the foundation design of buildings. After a few years I started helping the tailings team with the design of tailings dams	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	Yes		TSF planning and siting; TSF closure and reclamation	-	The biggest challenge from a consultant's point of view is to convince the client to comply with international standards	-	Forwarded email from a colleague/industry contact
1294	4	20+ years	Consulting	Bachelor's Degree	Civil Engineering	No	No	When entering the workforce, I did not have an intended career path. The civil engineering degree provides a path in to many areas and my path in to tailings was via water engineering (dams and water supply)	I have participated in internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	Yes	No	Whilst I supporter mining, I do not actively promote tailings or mining to non-mining people	The question was not very clear? The most helpful professional training is on the job - self learning through research. Following that training in specific software applications. But by disciplines?	The same as for the past 40 years - the time lag between realising the need and industry reacting to support the training needed.	Negative public perception	Nothing comes to mind	Forwarded email from a colleague/industry contact
1295	5	10-20 years	Mining Industry	Bachelor's Degree	Environmental Engineering	Yes	No	Tailings, more waste from mines, was discussed in my western Canada university but I only discovered it as a career option while working in mining	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes	I encourage people I know to explore tailings as a career option. I also love talking tailings to people.	Environmental, geotechnical, mining	Individuals are risk adverse; juniors see tailings management as too much of a risk to manage and avoid entering the area.	Perception and misunderstanding of risk profiles.	Priorities of mines, overall management practices (centralized tailings teams for operators rather than strictly site based) and standardized risk assessments.	Shared/forwarded through LinkedIn from a colleague/industry contact
1296	5	20+ years	Mining Industry	Bachelor's Degree	Civil Engineering;Environmental Engineering	Yes	No	I started my career during a major recession with a consulting firm specializing in foundations and environmental engineering.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	Yes	Yes	I believe in long term sustainability of our industry and the need for it to mitigate tailings risks and build and sustain solid TSF management and engineering capabilities to meet tomorrowâ€™s challenges.		Inability to meet expected standards due to extreme workloads or absence of knowledgeable support personnel. Low entry salaries, as well as the general absence of mentoring and peer support for young professionals tend to dissuade youth from taking the tailings engineering path, if offered.	Current professionals in the field, whether in industry, consulting or even with regulators, have been stretched to the limit for many years, exposing many to increased liability associated with tailings incidents. As these older, more experienced professionals leave the industry, there is little succession to take over and the mining industry will re-enter an age of uninformed tailings management that will multiply the liabilities of both the mining companies, as well as any professional associated with their facilities	Encourage sustainable succession planning of professionals, educate management and workforce on their responsibilities with respect to tailings management, and create opportunities to grow and retain young professionals through partnerships with universities, mining companies, consulting firms and regulators to foster successful peer mentoring and sharing of skills and knowledge.	LinkedIn post from the Project Team
1297	5	10-20 years	Mining Industry	Bachelor's Degree	Civil Engineering	Yes	Yes	Since university, all I wanted to be involved in, is tailings, due to the diverse range of disciplines involved in the design, construction, operation and closure involved.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	No	Yes	I advocate that at the current stage in mining, tailings is a necessary cause of the process, however, it is our responsibility as tailings practisioners/ industry to ensure the solutions are socially, environmentally and technically sound throughout the solution lifecycle.	As an engineer an advance understanding in geotechnical and hydrotechnical disciplines are likely required, however, there is such a diverse number of disciplines involved it really does take time to develop a general understanding to lead the development of such designs and even more time to ensure the design is implemented and operated as required.	The risks for professional engineers associated with the design and operation of TSFs. Motivating young engineers to become tailings engineers as it is just not a very â€˜glamorousâ€™ job like working on skyscrapers or brigdes although the effort and commitment would likely be the same if not more.	Gaining the trust/ confidence of the plublic and the people that may be directly affected by these structures. To demonstrate to them (affected people that are not tailings engineers) that the facilities are designed and operated as safe as possible.	Ensure that each mining client have sufficiently experienced TSF engineer(s) to ensure the facilities designed and operated appropriately (short-tern as this is already being advocated, but as we know competent tailings engineers are in short supply). Consider training engineers but also regulating the competency of engineers involved in tailings (both design and operation) through associations such as ICMM and IMM and their respective regional bodies. As it starts with having competent people involved during the project life cycle (I know this is difficult, if not impossible, and my have unacceptable risk involved for this, but consider the enforcing mining companies to have training courses that is verified by such bodies) Advancing dewatering/ technology so to extend itâ€™s production capability and to make it more competitive to hydaulically placed tailings (remove the bullets, water, from the gun, then the trigger does not matter)	LinkedIn post from the Project Team
1298	4	10-20 years	Consulting;Mining Industry	Bachelor's Degree	Civil Engineering;Construction/Construction Management;Mining Engineering	No	No	I didn't know of tailings industry.	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	No	No	Nowadays i have realized that exist many topics that needs will be improve or aboard with a new focus, but also exist many people that don't understand and following work with a old concept	Hydraulics Engineer, Geothecnical Engineer, Civil Engineer, Mechanical Engineer, Geologyst and Structural Engineer.	We need more Hydraulics Engineer with experience in tailings transport an design	Achieve the integral design in the tailings dams from de concept design until de close of the facilites	Reduce de contamination on the environment, delete de catastrophic fails and achieve sustainable design.	Forwarded email from a colleague/industry contact
1299	4	20+ years	Consulting	Some College/University	Civil Engineering	Yes	Yes	My first job was in the area of Geotechnics but I borrowed to support the area of Relaves for a particular project, but I was left working in a permeent way	I have participated in internal formal trainings;I have participated in external formal trainings;I perfected a curriculum mesh of fluid and tranques transport operators in a large mining company	Not a member of a GMPA Society	No	Yes	I believe that we are walking in the right direction, including the new trends of stakeholders in the talings, there is greater maturity but there is still a lack of development	Geo-chemistry to maximize water recovery and ensure the chemical stability of tailings deposits	Social, solid-liquid separation, aging of tailings deposits, hydraulic barriers	That society sees tailings as a good for the planet, they do not pollute and are safe	Reuse of tailings in another process, minimize the footprint of the surface used and the impact on subsurface waters	Direct email from the Project Team
1300	5	20+ years	Consulting	PhD Degree	Civil Engineering;Geological Engineering;Geosciences (Geology)	No	No	I got into tailings via geotechnical and civil enegineering for my company	I lead internal formal trainings;I lead external formal trainings	SAIMM â€" Southern African Institute of Mining and Metallurgy	Yes	Yes	extensive experience as a geotechnical engineer	Advanced geotechnical engineering	attracting engineers to the tailings industry (it is not 'glamorous')	the ability to attracting engineers and to pay them accordingly	1 change the negative perceptions in the industry ; 2 increase competencies; 3 make it a profession rather than a 'job'	Direct email from the Project Team
1301	4	20+ years	Consulting	Master's Degree	Civil Engineering	No	No	Was offered a role in tailings when the position I applied for had been filled.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	AusIMM â€" Australasian Institute of Mining and Metallurgy	No	Yes	I have been practising as a tailings engineer for over 30 years.	In the past - risk assessment techniques, advanced soil mechanics	Industry has woken up to the need for expert tailings design and advice - there aresimply too few qualified personnel to meet demand.	striking the balance between appropriate levels of risk management and cost.	1) Avoid over-reactions (overly conservative, risk averse protocols and design requirements). 2) Link the three elements of mining (mine planners, processing personnel and enviros) so they communicate and share budgets appropriately. 3) Enforce a minimum level of understanding of tailings design principles on owners/operators	Forwarded email from a colleague/industry contact
1302	4	0-5 years	Consulting	Bachelor's Degree	Civil Engineering	Yes	Yes	Had completed final year project on a tailings topic. Was aware of tailings management and a particular consulting company through a family member in the mining industry.	I have participated in internal formal trainings;I have participated in external formal trainings	AusIMM â€" Australasian Institute of Mining and Metallurgy	Yes	No	I do not consider myself to have enough experience to know the major tailings issues.	Difficult to say as I am still learning (3 years' experience). More understanding when it comes to advanced laboratory testing.	There seems to back a lack of tailings industry professionals due to the mining downturn ~ 6 years ago and the growth in tailings needs after large and public TSF failures.	The current backlog of work, due to increasing standards and more attention due to	*More tailings inclusion/awareness at university level to encourage more tailings practitioners. *Mining companies understanding the importance of planning ahead. It is easier if we take into account the 10 raises that they will eventully do, rather than assuming that they won't and then getting us to add them on later. Think ahead! * Better operations management of TSFs	Forwarded email from a colleague/industry contact
1303	5	0-5 years	Mining Industry	Bachelor's Degree	Civil Engineering	No	No		I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	No						LinkedIn post from the Project Team
1304	3	0-5 years	Risk Management and Data	Master's Degree	Risk Management	No	No	I was military/security and risk	I have not participated in any formal professional training on tailings	SAIMM â€" Southern African Institute of Mining and Metallurgy	Yes	Yes	Because it needs responsible attitudes and broader understanding	Risk based approach and project management	Shortage of hydrologists	Shortage of hydrologists	Narrow approach to Tailings rather than water and risk management. Holistic approach. Results not IT driven.	Forwarded email from a colleague/industry contact
1305	4	10-20 years	Consulting	Master's Degree	Civil Engineering	No	No	The emphasis was more on getting a job first rather than something specifically defined	I have participated in internal formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	The Industry is not well regulated in many african countries when it comes to Tailings	Training on Construction Quality Assurance	Scarcity of professional labor, likely to worsen if no action is undertaken	Adoption of Global Industry Tailings Standards for Tailings Management in every mining country	Make the standards really global	Forwarded email from a colleague/industry contact
1306	4	10-20 years	Consulting	Bachelor's Degree	Civil Engineering	No	No	Iâ€m from a non-mining region, and was not aware of tailings management aspects.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	AusIMM â€" Australasian Institute of Mining and Metallurgy	No	Yes	I leave in a in-development mining region, where anti-mining groups are very active.	Geotechnical, water management, operation	It is almost impossible to get senior tailings professional. It is really hard to get junior staff with addequate technical skills to be developed into the tailings area	Increasing need for follow up, and lack of capable people to do so.	Promote addequate technical eduaction (general science) to allow a smoth progress to the need for capable people our younger generation Increase experiences exchange within jurisdictions, to see good and bad practices / ideas from around the world (I see and increase in bureaucracy based on the experience from limited countries, while good ideas from others are not well known) Provide public capacitation to increase the amount of professionals	Direct email from the Project Team;Forwarded email from a colleague/industry contact
1307	5	5-10 years	Consulting	Bachelor's Degree	Civil Engineering;Environmental Engineering	No	No	I had very little knowledge of the mining industry, and was aiming for more general environmental engineering without forethought on the specific industry	I have participated in internal formal trainings;I have participated in external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	Through SME, CMA, WIM, and within the general industry I have advocated for mining in schooling, the importance and necessity for mining in our lives, and the need for trained professionals in the tailings industry with respect to safety and review boards.		We will be loosing (through retirement) our high-level tailings engineers, those who are able to evaluate the whole system and how all the pieces fit together. Our younger engineers are being asked to focus their expertise (in schooling and careers), and are not being given the knowledge base to see how everything fits together in the bigger picture. Our review boards will need two to three times as many of these "focused" engineers to accomplish the same thing our big picture thinkers are able to now. It is great that our younger generation have skills that allow them to really dig deep into problems and solutions, but if they can't see how it all works together, there are going to be problems.	See above	(1) We need our students to have a semester of mining/tailings management as a whole, that stress all areas of mining and how changes in one area impact others (e.g., how mill operations impact tailings deposition, etc.) - the Butterfly Effect of Mining. This would be similar to the short courses being used by Chris Hatton at our mine sites. (2) These same short courses should be a required seminar taught for all mining operations personnel. (3) we could also include within this class/seminar a lesson learned from the past 5 to 10 years of tailings disasters. This tutorial would need to include a deep dive and not just a gloss over (here's what happened). We should include the process followed by the investigation team to identify initial concerns as well as the deep dive results that come out of the lengthy forensic analysis of why the disaster really happened. There are often initial assumptions made that turn out to be true, but also turn out to be wrong, and we need to know what really happened in these situations in order to educate our people and help prevent these disasters from happening again.	Direct email from the Project Team
1308	3	5-10 years	Consulting;Mining Industry	Bachelor's Degree	Mechanical Engineering	No	No	Didn't have a clear career path at that time	I have participated in internal formal trainings	Not a member of a GMPA Society	No	No	I think is an important activity in the mining industry, but I don't consider myself an advocate of the tailings industry	general notions on geotechnical science	I think the challenges are in the mining industry in general, not particular to the tailings	Sustainability and environmental	awareness, safety and industrial responsibility	Direct email from the Project Team
1309	4	10-20 years	Consulting	Bachelor's Degree	Civil Engineering	No	No	Mining was not on my list.	I have participated in internal formal trainings;I lead internal formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	No		Soil mecanics and hydrology and hydrogeology	Gap in generations, internal training	Education and on-site training	Fasters implementation of new technology, more public engagement, include as part of mine planning	Shared/forwarded through LinkedIn from a colleague/industry contact
1310	5	20+ years	Mining Industry	Master's Degree	Mining Engineering;Geotechnical Engineer	Yes	Yes	There was a concern on physical stability of TSFs	I have participated in internal formal trainings;I have participated in external formal	IMP â€" Instituto de Ingenieros de Minas del PerÃº	Yes	Yes	I am mining engineer I fight against misinformation on my career	Geology, Mine Planning, Blasting, Hydrogeology	Challenges are for old practitioners that havent learnt Python, for example	The size of the TSF is bigger and bigger and demand for metals is increasing	Avoid using water, effective control on heavy metals, less impact view of tailings disposal	LinkedIn share from a friend
1311	5	20+ years	Regulator/Government	Master's Degree	Civil Engineering	No	No	My career evolved and I did not have a specific "career path."	I have given presentations on coal tailings management.	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	Tailings dams have to be designed and operated such that they will not fail.	Geotechnical Engineer	Anti-mining groups discourage students from entering the mining and mining engineering field.	Poor management decisions regarding the long-term stability of TSF's. Top-level mine management should not be part of the decision-making process when it comes to repairs/maintenance to marginally-stable TSF's.	Criminal penalties for management that promote or pursue unsafe TSF practices. Global minimum standards regarding the stability of TSF's. Ensure that the phreatic level does not approach the embankment (more internal drainage).	Forwarded email from a colleague/industry contact
1312	5	20+ years	Consulting;Mining Industry	Master's Degree	Biological/Medical Sciences	No	No	I was a biologist who got into tailings through a water related project when I was first employed in the mining sector.	I have participated in external formal trainings;I lead external formal trainings	SAIMM â€" Southern African Institute of Mining and Metallurgy	Yes	Yes	I believe that even within the mining industry there is a tremendous lack of understanding of tailings in general. One can therefor imagine the lack of understanding of the general public.	Chemistry; geology; mechanical and geotechnical engineering	We currently have a rapidly shrinking base of older people with long-term experience and understanding of tailings. The young engineers currently entering the field, due to the very recent spotlight on tailings management, will have very few mentors. I feel this may lead to many cases of re-inventing the wheel.	The biggest challenge facing the industry is simply removing water from the tailings to achieve a drier product. Sounds simple, but is difficult to achieve due to many reasons both technically and institutionally. Technically, Paste had great promise but failed in large projects due (in my opinion) to an OEM shortcoming in the thickener rake torque calculation. Consequently, institutional stakeholders (mainly the geotechnical fraternity) lost faith in the technology. Currently, filtration is the flavour of the month, but it too has massive technical and cost hurdles to overcome before it will be widely accepted. My opinion is that Paste and thickened tailings should be pushed much harder BUT these systems should be designed with far more rigorous testing - relying on OEM test reports to design dewatering systems will not do	1) Radically revise the metallurgical dewatering syllabus at the undergraduate level to give graduates a proper understanding of the subject (slurry colloidal behaviour, sedimentation theory; dewatering technologies; operation and control). 2) Make it compulsory for tailings geotechnical engineers to have an good understand of metallurgical dewatering processes (at least share the metallurgical graduate program as above). 3) Clarify/define the industry syntax so that clients; regulators; consultants; OEM's and the public in general understand what we mean when words such as Conventional tailings; Paste and thickened tailings; Dry tailings/staking are used.	LinkedIn post from the Project Team

Record #	1. On a scale of 1 to 5, how critical do you perceive the tailings industry professional resource shortage?	2. What is your level of experience as a tailings professional?	3. In which area are you currently employed? (Select all that apply)	4. What is your highest level of formal education completed?	5. In which field would you generalize your formal educational training? (select all that apply)	6. Did your formal education provide you any introduction to the tailings industry?	7. When entering the workforce, was the tailings industry part of your intended career path?	Explain your response to Question 7:	8. Are you, or have you been, involved with formal professional training (short courses, certifications, etc.) associated with tailings? (Select all that apply)	9.Are you a member of a Global Mineral Professionals Alliance (GMPA) Society? (Select all that apply)	10. Have you heard about the GMPA Global Action on Tailings Initiative?	11. Do you consider yourself an industry advocate?	Describe why you responded Yes or No to Question 11:	12.What professional training disciplines would help you execute your work on a day-to-day basis?	13.What challenges do you see with respect to available professional labor resources, both currently and in the future?	14.What is the greatest challenge facing the tailings and mine waste industry, in your opinion?	15.If you could change three things within the tailings and mine waste industry, what would they be?	16. How did you receive the link for this survey? (select all that apply)
1313	4	5-10 years	Mining Industry	Master's Degree	Mining Engineering	No	No	Was planning on being in operations and did not realize the tailings element of the process.	I have participated in internal formal trainings;I have participated in external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	If it canâ€™t be grown it has to be mined.	Roadmap to implementation of a Tailings Management System	New guidelines will require more tailings professional	Impending changes to regulations	More training opportunities for professional More training opportunities for operator Specific set of expectations	Direct email from the Project Team
1314	4	0-5 years	Mining Industry	Bachelor's Degree	Geological Engineering;Mining Engineering	No	No	Slope stability and rock mechanics	I have not participated in any formal professional training on tailings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	No	New to tailings	Tailings short courses	Industry won't keep up with regulations, not enough people,	When tailings risk data are made public, it will affect communities, home values, and insurance rates	Reduce the use of wet depositional facilities, educate mining executives on tsf risk to business continuity, improve community relations	Forwarded email from a colleague/industry contact
1315	4	5-10 years	Regulator/Government	Master's Degree	Biological/Medical Sciences;Natural Sciences	Yes	No	I worked in Superfund remediation and not mining	I had training on tailings during my educational experience	Not a member of a GMPA Society	Yes	No	I respect mining but am concerned about the environmental damage after extraction	Certain computer programs	The shortage of engineers and scientists. The cost of an advanced education	Tailings remediation and management.	The amount of energy, water and land area it takes to extract and refine a metal	Forwarded email from a colleague/industry contact
1316	5	10-20 years	Mining Industry	Bachelor's Degree	Civil Engineering;Mining Engineering	Yes	Yes	Since I finished my civil and mining engineer bachelor I was involved in tailings.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal	AusIMM â€“ Australasian Institute of Mining and Metallurgy;SME â€“ Society for Mining, Metallurgy & Exploration;Not a member of a GMPA Society	No	Yes	I consider mining industry one of the most important source of employment in many countries around the world.	Geotechnical engineering (civil and mining knowledge)	We are just not enough engineers involved in tailings	Not enough expert professionals in tailings to attend the total facilities around the world.	More support from the highest level in the mining companies, more training to professionals, misunderstanding of risk levels of TFS	LinkedIn post from the Project Team
1317	4	10-20 years	Academia/Education;Consulting	PhD Degree	Civil Engineering	No	No	I am a geotechnical engineer who worked with natural soils for +30 years and adventured into tailings some 15 years ago	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	Yes	Yes	I work in SRK Consulting since 12 years, and had the opportunity to learn the vision of the industry regarding tailings management	Geotechnical engineering focused on the behavior of (the many types of) tailings	More efforts in the fundamentals of tailings behavior is needed, not just more regulations and guidelines	We had too many failures. A few more, if in a short period of time, might do immense harm to the industry.	Safety: Promotion, subsidizing of dewatering techniques until they become cost-effective. Social Licence: Promotion, subsidizing of landform design to the extent that tailings storage facilities be perceived as nice places, more like golf courses where possible, we need architects here Knowledge: Requirement of enough materials testing (prior to failure) to understand a particular tailings material as we would understand a similar natural soil. We are far from there	Forwarded email from a colleague/industry contact
1318	5	20+ years	Consulting	Master's Degree	Civil Engineering	Yes	Yes	My Undergraduate thesis was on tailings backfill	I lead external formal trainings	SAIMM â€“ Southern African Institute of Mining and Metallurgy	Yes	Yes	The industry needs to catch-up on stability and technology related advances/requirements.	Interpretation of test data and selection of material properties for stability analyses	Lack of senior/experienced tailings professionals will restrict consultants ability to execute work either fast enough or to the required standards	Lack of capacity at the EoR level	Skills loss from developing countries poached by 1st world. Fewer standards, guidelines as this leads to confusion and peer reviews have preferences (adopt GISTM universally). Junior miners and Chinese clients to stop discounting and pushing for lower standards	Forwarded email from a colleague/industry contact
1319	4	5-10 years	Consulting;Mining Industry	Some College/University	Geosciences (Geology);Mining Engineering	No	No	No, I went to school with the intent to graduate and start working in the exploration industry, but the 2008/2009 financial crisis had other plans, and affected my ability to find steady work in my area of interest. Eventually I found my way into working in the oil sands, and have been involved in executing large-scale geotechnical surveillance programs ever since	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	Yes	I'm passionate about the mining industry, and understand the global need for mining in order for humanity to thrive.	Increased understanding of tailings management related costs/financials, dry-stack tailings technology, and closure and reclamation...	Significant global shortage of 25-35year highly technical tailings focused professionals and the transition to a technology and innovation motivated supporting workforce with a different skillset.	Evolving to meet ESG expectations of investors, public transparency and public education, and compliance with respect to emerging global standards.	Elimination of the risks resulting in loss of life, the development of a consolidated geospatially referenced global database of TSF's with compliance status, increased Owner/Operator accountability.	Forwarded email from a colleague/industry contact
1320	4	5-10 years	Mining Industry	Bachelor's Degree	Civil Engineering	No	No	Had no idea of what career path was going to focus on. Tried tailings since it seemed mysterious.	I have participated in external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	I see the role mining plays in the world and local economies. Its practices should improve for several reasons but it is a necessary industry for extracting raw materials	Instrumentation review, geophysics, project planning, peer to peer communication	Currently, the resources are growing. Future may be difficult to source from within the US since tailings is mentioned primarily in mining schools which have declined in the US	Limited space to build bigger and more complex facilities and the personnel to design, regulate, and operate them. This is in addition to the current legacy facilities	Increase Pay for engineers responsible for them,	Direct email from the Project Team
1321	4	20+ years	Consulting	PhD Degree	Civil Engineering;Geological Engineering	Yes	Yes	PhD doctoral thesis related to tailings	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes		Geotechnical Engineering	Civil Engineering is not attractive as other engineering disciplines. This contribute to shortage.	Tailings is still considered a money drain by the mines, low resources and budget are allocated to design, construct and operate tailings facilities. Dry or filtered tailings is a costly option	Prohibit upstream construction method of TSF. Promote filtered tailings facilities where applicable. Educate miners and investors to change the mindset and allocate more resources to high risk facilities.	LinkedIn post from the Project Team
1322	3	10-20 years	Regulator/Government	Bachelor's Degree	Geological Engineering	No	No	I did not envision working with the mining industry	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	No	As a regulator it is not my place to advocate for industry					Forwarded email from a colleague/industry contact
1323	4	0-5 years	Mining Industry	Bachelor's Degree	Business	No	No	Our company became involved in processes for tailings management	I have participated in internal formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	At our company we have come to understand the impact of tailings on the global community and are working to help find solutions.	Understanding the extent of the issue world wide	Raising up qualified engineers to challenge the status quo	Overcoming company governance reluctant to address issue	1 Create greater general community understanding of the issue 2. Provide regulatory recommendations to influence management 3. Create an investors climate that promotes forward looking applications	Shared/forwarded through LinkedIn from a colleague/industry contact
1324	5	20+ years	Consulting	Master's Degree	Civil Engineering	No	No	went into geotechnical engineering	I have participated in internal formal trainings	Not a member of a GMPA Society	No	Yes	Been in the industry for over 40 years working internationally	no new ones	getting people into civil engineering training	public perception	public perception, public perception, public perception	Forwarded email from a colleague/industry contact
1325	5	20+ years	Consulting	Master's Degree	Geological Engineering	Yes	No	Started in civil geotechnical investigation field, mainly for urban structures, infrastructure.	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	Yes	Yes	Having watched the development into a multidisciplinary industry, a multidisciplinary approach to education and training is required.	engineering geology, soil mechanics, hydrology, hydrogeology, geochemistry, process engineering.	Few specific training courses. High risk industry professionally (so why get involved?), lack of multidisciplinary awareness.	Negative public perception	Develop in house technical expertise and responsibility within Mining companies. Develop appropriate professional training for both consultants and Mining personnel. Encourage investment in paste and filter technology.	Direct email from the Project Team;Forwarded email from a colleague/industry contact
1326	5	20+ years	Consulting	Master's Degree	Civil Engineering;Geotechnical Engineering	Yes	No	I initially intended to focus on water dams.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	Active involvement in CDA, USSD, ICOLD. Published articles on tailings dam design. Advisory group on tailings dam design standards in the US	N/A	Extreme shortage of experienced engineers. Aging baby boomers. Mining companies hiring up qualified designers and EORs to staff their governance and PM programs exacerbates the shortage in design firms. A lot of interest from people wanting to enter the field without experience and specialized knowledge and skills	Self promoting individuals/companies who are more concerned with promoting/marketing/selling themselves and their products/services rather than solving the industry problems.	Reverse the attempts to separate the EOR role from design, eliminate resistance from mining companies and current tailings engineers to integrate qualified engineers from other industries, promote improved collaborative efforts among stakeholders.	Direct email from the Project Team
1327	4	20+ years	Consulting	Master's Degree	Geosciences (Geology)	Yes	No	Went into civil geotechnics then mine geotechnics then tailings	I have participated in internal formal trainings;I lead external formal trainings	IOM3 â€“ The Institute of Materials, Minerals & Mining	No	Yes	Director of a tailings consultancy	Geotechnical, hydrological, geochemical	Lack of suitable courses at undergrad level	Scale and financial cost of tailings dewatering technology	Add engineering to global tailings standard; enforce regulatory compliance with GTS; ensure mining companies pay for good quality engineering	Forwarded email from a colleague/industry contact
1328	5	20+ years	Mining Industry	Bachelor's Degree	Civil Engineering;Construction/Construction Management;Environmental Engineering;Mining Engineering	Yes	Yes	Water Management	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	Yes	Yes	I work in Environmental Management and my role is ensure that include the highest standards during all the process design, construction, operation and closure of Tailings	Environmental Management of Tailings (especially Water Management)	We have the following challenges to the professionals : without experience, risk assessment, social and environmental sensitivity, ethical behavior, monitoring of data and make a decisions during operation, QA/QC during construction, resources for	The most greatest challenge is physical and chemical stability	I think we change: 1) we donâ€™t think physical and chemical stability in long term, 2)ethical behavior of professionals involve during design, construction, operation and closure, and 3) use of tailing as a reservoir of water	LinkedIn post from the Project Team
1329	3	0-5 years	Consulting	Master's Degree	Civil Engineering;Construction/Construction Management;Geological Engineering	Yes	No	Had never considered working in the mining industry	I have participated in external formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	No	No	It's just work	geotechnical	removing the negative connotation from the mining industry	mitigating upstream construction dams worldwide	1) more women, 2) higher pay, 3) more integration with affected communities	Forwarded email from a colleague/industry contact
1330	3	5-10 years	Consulting;Mining Industry	Bachelor's Degree	Civil Engineering	No	No	I really just stumbled upon it but I also really enjoy it.	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	Yes	Yes	I don't really push it I just consider mining a valuable part of the modern world, especially if done correctly.	Geotech and Hydraulics trainings would be valuable.	A lot of students are made to think that mining is evil in some way so I think a lot of them steer away from it coming out of college. That is a critical time to bring new people into the industry	Long term closure technology needs to be developed to the point where companies can walk away without maintenance in perpetuity.	There needs to be a consultant who is intimately familiar with the project who cannot be fired by the client for giving them bad news.	Forwarded email from a colleague/industry contact
1331	4	20+ years	Mining Industry	Master's Degree	Civil Engineering;Construction/Construction Management	No	No	I took the first job I could get, tailings took place because I found a job in Golder	I have participated in external formal trainings;I lead external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	Itâ€™s my career. I have to be engaged	Detailed advanced geotechnical courses, critical state, consolidation, earthquake	Nobody wants to go to tailings	Environmental and	Management, water savings (increase percent solids), value engineering (not doing things the same old way)	LinkedIn post from the Project Team
1332	4	10-20 years	Consulting	Master's Degree	Geosciences (Geology)	No	No	Original career was in environmental science and remediation.	I have participated in internal formal trainings	Not a member of a GMPA Society	Yes	No	I've worked in many industries, including tailings management. Tailings have become a larger part of my career and I support advancement of the industry, but currently can't consider myself an active advocate.	There is a disconnect between engineering of tailings dams and consideration of geological and hydrogeological impacts to the long-term stability and environmental soundness of those structures. Recognizing the importance of variation in foundation conditions isn't solely a problem for the tailings industry, but in general lags behind other similar fields (e.g., water reservoir and dam engineering).	Labor resources are extremely tight for experienced professionals. New graduates aren't equipped with skills to become immediately productive, which requires extensive training. Current industry professionals don't have the bandwidth to perform their job duties plus extend energy into training.	Massive earth engineering structures should be viewed in a holistic approach. Too often structures are designed by the EOR with little consideration of long-term environmental impacts or make assumptions about the homogeneity of a foundation. Other more well-developed fields account for this. Tailings management is improving in this area, but EORs have responsibility to not just consider stability of the dam, but also the implications of constructing such a massive reservoir containing potential-hazardous materials and the systems or communities they may impact	1) Diversify teams to include input from other professions in the geosciences, such as hydrogeologists, engineering geologists, geochemists, and biologists. 2) View massive and potentially hazardous tailings and mine-related infrastructure as a holistic approach. North America is doing well in this regard, but the rest of the Americas requires a significant cultural change to accept this. 3) Water reservoir dams have extensive regulations and transparency not found in the mining world. More regulation is necessary to achieve a goal of zero acceptance for failure.	Forwarded email from a colleague/industry contact
1333	5	20+ years	Consulting;Mining Industry	Master's Degree	Civil Engineering	No	No		I have participated in internal formal trainings;I have participated in external formal	Not a member of a GMPA Society	No	Yes	Want to protect the environment with sound designs		Limited experienced resources	Same as 13	Improve responsibility of mining operations, put priority to these facilities, more investigation/research	Forwarded email from a colleague/industry contact
1334	3	0-5 years	Consulting	Master's Degree	Civil Engineering	Yes	Yes	I went to the Colorado School of Mines where I was introduced to the industry during my graduate work. I first started my career in the solid waste industry and transitioned to the mining side of things after three years working on landfills	I have participated in internal formal trainings;I had training on tailings during my educational experience	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	Disposal of waste is a biproduct of human consumption. To do this cost effectively, safely, and responsibly is important to all parties involved.	geomechanics, hydrology and hydraulics, and seismology	The age gap between young people and senior experts is quite large. There is a lack of folks in between that bridge this gap.	Interest in the profession		Forwarded email from a colleague/industry contact
1335	4	20+ years	Consulting	Master's Degree	Environmental Engineering;Geological Engineering;Geosciences (Geology);Health and Safety	Yes	Yes	I quickly realized as a geochemist that excellence in tailings and water management were critical to the mining industry continuing successfully both technologically and socially	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	Even in moments of doubt about my chosen career I always felt I could do more good on the inside than the outside and have spent my career mentoring others		due to a down turn in the mining industry several years ago there is a dearth of mid level excellence in the labor pool but this is the third time this has happened in my career so not sure it is a fatal flaw	successful closure and control of acid rock drainage		Forwarded email from a colleague/industry contact
1336	3	0-5 years	Consulting;Mining Industry	Master's Degree	Civil Engineering;Geotechnical Engineering	No	No	Wasn't directly trying to get into mining, but in the middle of my masters got an internship at a mining consultancy and enjoyed it a lot.	I have participated in internal formal trainings	Not a member of a GMPA Society	No	No	I am still early in my career and COVID has made it more difficult to engage with the larger industry	In depth understanding of how some of the modeling software works	The mining industry still follows a boom and bust cycle. This makes it more difficult for young employees to stay in the industry during downturns	How to develop reasonable regulations that push for best practices but don't stifle the industry.		Forwarded email from a colleague/industry contact
1337	4	10-20 years	Consulting	Master's Degree	Mining Engineering	Yes	No	I was more focused on extractive metallurgy, Tailings were an after thought in the 1980's	I have participated in external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	No	Yes	If you can't be a positive advocate for the industry that you work in you should get another job	more information on the best practices for tailings design and handling	More young engineers in the pipeline	legacy operations and attitudes	1.Communicate best practices better. 2. Train best operational practices. 3. Inspect for best practices	LinkedIn post from the Project Team
1338	3	0-5 years	Consulting;Mining Industry	Master's Degree	Civil Engineering;Geological Engineering;Geotechnical Engineering	Yes	No	I didn't know how the tailings industry was, I couldn't imagine the opportunities areas	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	Yes	because I have not promoted anything related to the tailings		we need more professionals in tailings who have good knowledge from academic training.	Environmental pollution, safety and stability of tailings dams, improve the design methods around the world	environmental pollution, I would like to use this material for construction and geotechnical project like soil improvement, we need to find another use for tailings and mine waste	Direct email from the Project Team
1339	5	20+ years	Mining Industry	Bachelor's Degree	Civil Engineering;Geological Engineering;Geosciences (Geology)	No	No	I graduated in 1991 and there was no work in my intended area of environmental engineering with a focus on groundwater. Picked up a summer position for a dam project that turned into a career	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	AusIMM â€“ Australasian Institute of Mining and Metallurgy	No	Yes	I have worked with ICMM on developing their documentation	Social and communications	There relatively few 20-30 year experienced professionals with a combined industry/academic or industry/consultant background. External advisory panels are going to struggle to fulfill the intent of GISTM	Understanding and communication	Design in reverse, ie for closure, tails becomes a core asset and not an afterthought, tailings engineers join EXCOs and Boards of companies	Shared/forwarded through LinkedIn from a colleague/industry contact
1340	4	0-5 years	Mining Industry	Master's Degree	Business;Environmental Engineering;Natural Sciences;Social Sciences	No	No	I am a Closure professional, and hence need to understand tailings in order to ensure proposed TSF closure designs are feasible from a geotechnical, seismic, geochemical, erosional, perspective. So have had to educate myself on tailings.	I have participated in external formal trainings;On the job training, through working alongside experienced tailings engineers and engaging tailings consultants.	AusIMM â€“ Australasian Institute of Mining and Metallurgy	No	Yes	I have 15 years experience in mining, see it as an essential industry and should be a key driver of sustainable development.	Tailings engineering training (geotechnical, seismic, geochem, hydrology, Hydrogeology, hydraulic), social performance and governance/assurance/risk.	Shortage of qualified and experienced professionals for probably 10 years at least.	Regaining public trust in the profession.	Educate tailings engineers on social performance, geochem, env and Closure. More widespread desulphurisation of tailings, to prevent acidic drainage and reduce closure costs. Develop innovative technologies to reuse tailings with the aim for elimination or at least relocation back into mine voids, to avoid TSF landforms being present into perpetuity	Shared/forwarded through LinkedIn from a colleague/industry contact
1341	5	20+ years	Equipment supplier	PhD Degree	Environmental Engineering;Mining Engineering	No	No	Mining & Enviroment	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	Yes	Yes	Continue challenge change to ensure safe management of tailings and water inside my organisation and to customers	Solid liquid separation	Adequate recognition as discipline	Cost per ton placed	Use of water in mineral processing Cost effective solid liquid separation technology Operation for closure	LinkedIn direct message from the Project Team
1342	4	5-10 years	Mining Industry	Master's Degree	Environmental Engineering;Geosciences (Geology);Mining Engineering;Natural Sciences	No	No	I started my career in environmental engineering and geotechnical engineering in mining industry. I worked for Golder first and was involved on different projects. One of these projects was the construction and surveillance of a downstream dam. I increased my knowledge and finaly I am currently tailings manager for a mining company. I try to continue to increase my knowledge and I am always looking for mentors and professional trainings, especially because in France tailings management is not a common practise.	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	Yes	Yes	Yes because I always try to implement the Best practices to avoid any incident on site, to share the new vision of tailings management with the directors and employees.	Water management especially water balance tools Global update on tailings management/governance: many researchs/programs are ongoing. Have a frequent training on the conclusions/progress/changes should be helpfull Risk management for tailings dams Not for a work on a Day to Day basis: New lab and in situ testings used to characterize foundation soils (For exemple CDSS/MDSS)	Not enough New professionnal in the discipline. Not enough mentors to train young/intermediate professionnal.	Due to recent failures, change in stability condition due to improvement/Change on the guidelines. This Will lead to transition wet tailings storage facility in dry residue storage.	take into account tailings at the beginning of a mining project and With the same interest as mine part and plant part. Without tailings storage, ore production is not possible --> recognize tailings management and geotechnical discipline. - put in place a gouvernance and a specific and trained team to deal with	Shared/forwarded through LinkedIn from a colleague/industry contact
1343	3	10-20 years	Consulting;Mining Industry	Master's Degree	Civil Engineering	No	No	When I entered the workforce, I started in a regional geotechnical engineering firm and eventually moved my way into water dam & tailing dam design/safety. The tailings industry is discussed much in the eastern half of the United States	I have participated in internal formal trainings;I have participated in external formal trainings	Not a member of a GMPA Society	Yes	No	While I support mining in general, I don't know that would consider myself a "person who publicly supports or recommends a particular cause or policy". I believe that mining is necessary. I believe that tailings dams, like water retention dams, need some amount of regulation as well.		I believe the tailings and mine waste industry will move 1) towards risk informed decision making and 2) will move towards more complex analysis methods (e.g., FLAC deformation versus limit equilibrium) to evaluate geotechnical stability of dams. The majority of the available professional labor force can learn and adapt quickly to Item 1. However, there are limited professionals currently within the labor force that can perform the complex numerical analyses	Public perception - the tailings and mine waste industry needs to convince the general public that we know what we are doing and not a threat to public safety (e.g., loss of life, environmental hazards, etc.)		Forwarded email from a colleague/industry contact
1344	2	20+ years	Consulting	Master's Degree	Civil Engineering;Geological Engineering	Yes	No	Started in solid waste industry and mining working on leach pad design	I have participated in internal formal trainings;I have participated in external formal trainings	SME â€“ Society for Mining, Metallurgy & Exploration	Yes	Yes	I dedicate myself to the tailing design and work with my clients to apply the lates standard	Geotechnical, tailings processing and its correlation.	The education this says neglects the geotechnical education and very little is presented in tailings management	Implementation of new guidelines and the increasing challenges in the terrain available.	Training of operators, training of designers, the requirements for monitoring.	Shared/forwarded through LinkedIn from a colleague/industry contact

Record #	1. On a scale of 1 to 5, how critical do you perceive the tailings industry professional resource shortage?	2. What is your level of experience as a tailings professional?	3. In which area are you currently employed? (Select all that apply)	4. What is your highest level of formal education completed?	5. In which field would you generalize your formal educational training? (select all that apply)	6. Did your formal education provide you any introduction to the tailings industry?	7. When entering the workforce, was the tailings industry part of your intended career path?	Explain your response to Question 7:	8. Are you, or have you been, involved with formal professional training (short courses, certifications, etc.) associated with tailings? (Select all that apply)	9.Are you a member of a Global Mineral Professionals Alliance (GMPA) Society? (Select all that apply)	10. Have you heard about the GMPA Global Action on Tailings Initiative?	11. Do you consider yourself an industry advocate?	Describe why you responded Yes or No to Question 11:	12.What professional training disciplines would help you execute your work on a day-to-day basis?	13.What challenges do you see with respect to available professional labor resources, both currently and in the future?	14.What is the greatest challenge facing the tailings and mine waste industry, in your opinion?	15.If you could change three things within the tailings and mine waste industry, what would they be?	16. How did you receive the link for this survey? (select all that apply)
1345	5	20+ years	Mining Industry	Master's Degree	Civil Engineering	No	Yes		I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	AusIMM â€" Australasian Institute of Mining and Metallurgy	Yes	Yes	Trying to promote and elevate tailings industry profile on a daily basis. Interacting with universities on weekly basis as part of research programs to promote tailings as a career.	Geotechnical and tailings related training	We need to start at school level. Make students aware of mining and tailings at school level. We also need to promote our industry a bit better at unis and schools. If we do not invest in this the shortage will get	Shortage of suitably qualified tailings engineers with adequate experience.	Increase rates for tailings consultants, pay tailings consultants more, see EoRs as partners and technical advisors	LinkedIn post from the Project Team
1346	5	10-20 years	Mining Industry	Bachelor's Degree	Geological Engineering;Mining Engineering	No	Yes	As a geotechnical engineer, that came in the package	I have participated in internal formal trainings;I have participated in external formal	Not a member of a GMPA Society	No	Yes	Try as much as I can participating in tailings webinar, conferences, and general debates	Tailings and water retention facilities governance	Shortage of talented people to assume a reliable position as EOR	Humans and organizational structure	No water	Shared/forwarded through LinkedIn from a colleague/industry contact
1347	4	20+ years	Consulting	PhD Degree	Civil Engineering	No	No	I was a geotechnical engineer. No prior mining ambitions.	I lead internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	Yes	Yes	My research and publication aim to foster societal and corporate well being in mining and other industries	Applied psychology and sociology.	Lack of depth in thinking and reasoning.	Stopping fake news both internally and externally.	Decision making, considering uncertainties, ethics	LinkedIn post from the Project Team
1348	5	10-20 years	Mining Industry	Bachelor's Degree	Civil Engineering	No	No	Stumbled across tailings while trying to find challenging areas I can pursue. Never heard of tailings at university, apart from design and analysis of dams.	I have participated in external formal trainings	Not a member of a GMPA Society	No	Yes	Passionate on eliminating risks related to tailings dam	Further Geotechnical engineering and exposure to other challenges across different countries	Tailings engineers are mostly civil engineers and are highly underpaid. Moving from consulting to mining makes it attractive but at the same time this leads to loss of subject matter experts in the design and consulting firms	Recognition that engineers are paid well, ensure universities introduce these course are and provide internships	Improve Salary, providing exposure and challenges to engineers to allow them to grow and enjoy their career	LinkedIn post from the Project Team
1349	4	10-20 years	Mining Industry	Bachelor's Degree	Civil Engineering;Geological Engineering;Geosciences (Geology);Mining Engineering	Yes	No	At the beginning of my career I worked in the construction of energy generation dams	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience	AusIMM â€" Australasian Institute of Mining and Metallurgy	No	Yes	I work in the operation of geotechnical assets and work in the structuring and standardization of geotechnical processes	Assist in technical strengthening and in the ability to train new professionals		We have a great and long challenge to train current professionals and new entrants so that they are able to operate in the market in a sustainable way.	More technical courses, more access to research and technical work and greater online access to major universities	LinkedIn post from the Project Team
1350	5	20+ years	Consulting;Mining Industry	Master's Degree	Civil Engineering	No	No		I have participated in internal formal trainings;I have participated in external formal	Not a member of a GMPA Society	No	Yes	Want to protect the environment with sound designs		Limited experienced resources	Same as 13	Improve responsibility of mining operations, put priority to these facilities, more investigation/research	Forwarded email from a colleague/industry contact
1351	3	20+ years	specialty contractor	Bachelor's Degree	Civil Engineering	No	No	Our work is in soft soils, of which tailings fits into the subset.	I had training on tailings during my educational experience	Not a member of a GMPA Society	Yes	Yes	Mining gets a bad rap for environmental concerns, but I feel the responsibility to make sure people know how much they rely on mining.	?	The image is, if you become a Mining engineer, you will likely be shipped to some remote corner of the 3rd world for years, for similar pay as someone going into a local consultant industry.	Convincing the public that the mining industry is not a greedy polluter looking to shortcut any oversight, and showing them that it's a well regulated industry with many exceptional measures taken to provide safety and environmental stewardship to the public	A mechanism to ensure a mine that goes out of business has a fund set aside for closure. Mandated instrumentation on any impoundments to track pore pressure levels (public access/information?). A formal 'who is in charge' register of tailings management/transitioning.	LinkedIn post from the Project Team
1352	5	10-20 years	Mining Industry	Master's Degree	Civil Engineering;Construction/Construction Management;Environmental Engineering;Geosciences (Geology);Mining Engineering;Natural Sciences;Social Sciences	No	Yes	Desde que egresÃ© de universidad, identifiquÃ© que el desarrollo de depÃ³sitos de relaves se encontraba en el estado del arte a nivel mundial, por lo que me interesÃ³ ser parte de los desarrollos de la Ã©poca y los desarrollos futuros en la materia	I have participated in external formal trainings;I had training on tailings during my educational experience	IIMCh â€" Instituto de Ingenieros de Minas de Chile	Yes	Yes	Porque hay muchas personas que generan estigmas errÃ³neos o falsos, para perjudicar a esta industria que cada dÃa busca mejorar sus estÃ¡ndares y lo ha logrado, con Ã©xito en el tiempo	Geotecnia, hidrogeologÃa, direcciÃ³n de proyectos, sustentabilidad	Generar impacto positivo en las comunidades aledaÃ±as a los depÃ³sitos de relaves, y hacerlos parte del desarrollo del depÃ³sito en todo su ciclo de vida	Cambiar la percepciÃ³n de las comunidades respecto del impacto que genera la actividad minera, en especial de la gestiÃ³n de sus residuos permanentes cÃ³mo son los relaves	Mejorar la lÃnea base ambiental y social, en minas nuevas, comunicaciÃ³n a la comunidad del monitoreo de los principales indicadores de desempeÃ±o de un depÃ³sito de relaves, influir en los planos reguladores regionales para evitar el poblamiento en zonas de impacto ante el colapso de un depÃ³sito de relaves	Conference/Short Course Posting;Direct email from the Project Team;Shared/forwarded through LinkedIn from a colleague/industry contact
1353	5	20+ years	Academia/Education;Consulting	PhD Degree	Civil Engineering	Yes	No	First job was at a mine, where I ended up dealing with tailings issues.	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes		numerical modeling	The current standards and guidelines were developed in a vacuum - without consideration of capacity.	Qualified staff.	Industry and consultants would do a better job supporting universities; more intern opportunities; and more applied research opportunities.	Direct email from the Project Team
1354	4	20+ years	Consulting	Master's Degree	Civil Engineering	No	No	I graduated over 50 years ago when mine tailings were a non-recognized ssue	I have participated in internal formal trainings;I lead internal formal trainings	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	I have worked in the industry for a long time and have also published on the subject of tailings dam safety	A university Masters level course for geotechnical engineers on dam safety in design, construction and operation	There is a current shortage of experienced tailings engineers. The problem will get worse in the short term	Lack of public/community trust	Get away from the lowest bid mentality, provide more training for tailings operators, provide more graduate education in tailings safety	LinkedIn post from the Project Team
1355	5	0-5 years	Consulting	PhD Degree	Geological Engineering	No	No	It was not. But I realised that is perfect industry that matches my aspirations	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	No		Stability analysis and dam safety				Shared/forwarded through LinkedIn from a colleague/industry contact
1356	3	20+ years	Consulting	Master's Degree	Civil Engineering;Construction/Construction Management;Environmental Engineering;Geological Engineering	Yes	No	Pretty much by default due to demand and supply	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings		No	Yes	Due to experience in design, construct and monitoring areas of the tailings industry.	Legal frameworks	Tailings specialists with sound basic principles are becoming far and few between. As such, tailings management in its current state will only become more complicated / difficult.	Pretty narrow minded in solution findings. Need to look outside the box.	Assess pragmatic ways in the design, construct and operational side.	LinkedIn post from the Project Team
1357	4	20+ years	Consulting	Master's Degree	Geological Engineering	No	No		I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings	CIM â€" Canadian Institute of Mining, Metallurgy and Petroleum	No	Yes			Retiring the male baby boomer generation. I think the industry has relied too long on a very few key personalities and players, and room below them has not been created. In our reliance on hanging onto these experts we have created a gap below them. We now need review boards more than ever and review boards typically lack diversity and any other than a few key people who we have spread too thin. Our challenge is not at the bottom end, but the top.	See above. Lack of really senior people for all the required roles. Also, complacency	See above. More diversity within review boards, including on boarding of the next generation	LinkedIn post from the Project Team
1358	4	20+ years	Regulator/Government	Master's Degree	Civil Engineering	No	No	After college, I pursued a career in geotechnical engineering. Based on my education, I thought I would be designing foundations, walls, and natural slopes - not tailings dams. I thought I was being punished, when I was assigned to drilling jobs on coal waste impoundments. Little did I know, I was being trained for my current position in tailings dams. God is great!	I have participated in internal formal trainings;I have participated in external formal trainings;I lead internal formal trainings;I lead external formal trainings	Not a member of a GMPA Society	Yes	No	I support mining and tailings dams, but I really don't advocate for any industry.	I'm at the point of working on succession planning. More young engineers I see need to take graduate-level classes in geotechnical engineering with emphasis on soil mechanics and seismic engineering. They also need to study professional literature on tailings dams and studies of failures.	Lack of QUALIFIED Civil/Geotechnical Engineers working in tailings dams design, especially for the coal mining industry.	Lack of design plans, operation plans, training, and appreciation for tailings dam safety among smaller mine operators.	Federal regulation requiring all mining dams to be designed by a profession engineer, an industry recognized certification of qualified engineers, and other professional organizations like ASCE take some time from lobbying for transportation money to help support and give more attention to tailings dams.	Forwarded email from a colleague/industry contact
1359	4	5-10 years	Mining Industry	Master's Degree	Geological Engineering;Geosciences (Geology);Mining Engineering	Yes	No	Tailings were only discussed briefly in the two degrees I studied. At the start of my career I was more focused on production. I only found out the actual importance of tailings, or better said tailings management when I started looking at long term cost savings of tailings disposal and opportunities to reduce environmental impact as a "side project". Tailings turned out to be more important then I expected.	I have participated in internal formal trainings;I had training on tailings during my educational experience	SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	I try to explain the importance of mining and tailings management where ever and when ever possible.	For a start I would benefit from a Msc in tailings management with: 1) soil mechanics of tailings products (typically different then most soils). 2) marketing of multi disciplinary solutions to the various stakeholders (focusing on the FS, BFS and permitting). 3) Policy making, to understand how regulations are made and we as an industry can promote sound regulations without them becoming un-workable.	The volume of tailings will keep on increasing for the foreseeable future. As far as I can see there are not enough professionals to address the challenges, small and big, there are waiting to be dealt with.	The biggest challenge faced by the mining industry is regulators introducing strict regulations based on public opinion rather than facts. This trend of over-reacting is driven by the major catastrophic failures we have seen in the recent past. The focus should be on providing a regulatory framework that allows applying the overall most sustainable tailings disposal method. The belief that removing water is the cure to the problem is almost religious. Although water is obviously critical in the failure mechanism, in all the major TSF failures management issues during design, construction and filling of the TSF could have prevented the failures. This will remain the case, no matter which disposal method is applied. Preventing catastrophic TSF failures is in the interest of all stakeholders. The mining industry has to take an integral approach if it comes to tailings management and the regulators have to employ sufficient numbers of competent inspectors to make sure no corners are being cut.		LinkedIn post from the Project Team
1360	4	20+ years	Consulting	Master's Degree	Civil Engineering	No	No		I lead internal formal trainings	Not a member of a GMPA Society	No	Yes						LinkedIn post from the Project Team
1361		20+ years	Consulting	Master's Degree	Civil Engineering;Mining Engineering	No	No	Tailings was almost a non-topic	I have participated in internal formal trainings;I have participated in external formal trainings;I had training on tailings during my educational experience;I lead internal formal trainings;I lead external formal trainings	AusIMM â€" Australasian Institute of Mining and Metallurgy;SME â€" Society for Mining, Metallurgy & Exploration	Yes	Yes	I was one of the members starting the Queensland Tailings Group, I participate in Company Wide training and I am the company Practice Lead		Overall Shortage, lowering Standards	Talent and senior mentorship and guidance		LinkedIn post from the Project Team
1362	5	5-10 years	Mining Industry	Master's Degree	Environmental Engineering;Geosciences (Geology);Mining Engineering;Social Sciences	No	No	Moved to mining after 14yrs in transportation civil eng	I have not participated in any formal professional training on tailings	Not a member of a GMPA Society	No	Yes	I aim at specializing in TSF and am among the first tailings engineer in my country of origin, Madagascar	Digital transformation and applied AI	Shortage of formal and on-the-job education in TSF.	Gain consideration of other engineering peers.	Governance, training opportunities, knowledge transfer from experienced peers	LinkedIn post from the Project Team
1363	3	0-5 years	Consulting	Master's Degree	Civil Engineering;Construction/Construction Management;Geological Engineering;Geosciences (Geology)	No	No	Well, I had heard about tailings industry but it was not my professional goal at begining	I have participated in internal formal trainings;I had training on tailings during my educational experience	Not a member of a GMPA Society	Yes	Yes	Now I work at tailings industry and I consider myself in that way because the information of my job can be explained to a students, for example or to colleagues.	Rock mechanics, geotechnical field test, slope stability.	I think more professionals with a vision of global work, travelling to any place where the tailings are and professionals with rock mechanics, geology and geotechnics formation (all in one can be)	To have major influence in the waste plant processes or in the deposition process before the remediation of stability dams.	The plant processes, the deposition process and enter in consulting before remediation.	Direct email from the Project Team;Forwarded email from a colleague/industry contact;From a email of Paul Ridlen

APPENDIX D – POST-GISTM LABOR CALCULATIONS

Table D1-1. Estimates of post-GISTM labor resource demands for 827 active TFs disclosed on Global Tailings Database (2021)

TSF Screening Criteria	Percent Contribution of TSFs [1]			Full-Time-Equivalents Needed to Service 827 Active TFs Diclosed on GTD						
	Type A	Type B	Type C	Senior Technical Reviewer or ITRB	Accountable Executive	RTFE	EOR	Project Engineer	Staff Engineer	**Total FTEs**
Crest Height	43% - 51%	32% - 40%	17%	23 - 23	17 - 18	289 - 303	199 - 206	199 - 206	414 - 440	**1,141 - 1,196**
Failure Consequence	12% - 32%	17% - 37%	51%	32 - 34	22 - 24	414 - 447	305 - 322	305 - 322	461 - 528	**1,539 - 1,675**

[1] Classification by dam height: Type A < 40 ft, Type B > 40 ft and < 100 ft, Type C > 100 ft.
Classification by hazard: Type A = low, Type B = significant or medium, Type C = high (Hatton et al. 2020)

Table D1-2. Estimates of post GISTM labor resource demands for 1,120 nonactive TFs disclosed on Global Tailings Database (2021)

TSF Screening Criteria	Percent Contribution of TSFs [1]			Full-Time-Equivalents to Service 1,120 Non-Active TFs Diclosed on GTD w/ 25% of the Total Active TF labor (75% Reduction)						
	Type A	Type B	Type C	Senior Technical Reviewer or ITRB	Accountable Executive	RTFE	EOR	Project Engineer	Staff Engineer	**Total FTEs**
Crest Height	43% - 51%	32% - 40%	17%	8 - 8	6 - 6	98 - 102	67 - 70	67 - 70	140 - 149	**386 - 405**
Failure Consequence	12% - 32%	17% - 37%	51%	11 - 11	7 - 8	140 - 151	103 - 109	103 - 109	156 - 179	**521 - 567**

[1] Classification by dam height: Type A < 40 ft, Type B > 40 ft and < 100 ft, Type C > 100 ft.
Classification by hazard: Type A = low, Type B = significant or medium, Type C = high (Hatton et al. 2020)

Table D1-3. Summary of post-GISTM labor resource demands for all TFs disclosed on Global Tailings Database (2021)

Full-Time-Equivalents Needed to Service 1,947 TFs Disclosed on GTD with 75% Labor Reduction for non-active facilities						
Senior Technical Reviewer or ITRB	Accountable Executive	RTFE	EOR	Project Engineer	Staff Engineer	**Total FTEs**
30 - 31	23 - 24	387 - 405	267 - 276	267 - 276	554 - 589	**1,528 - 1,600**
43 - 45	30 - 32	554 - 598	408 - 431	408 - 431	618 - 706	**2,060 - 2,242**

Table D2-1. Estimates of post-GISTM labor resource demands for minimum estimated 6,400 active TFs worldwide

TSF Screening Criteria	Percent Contribution of TSFs [1]			Full-Time-Equivalents Needed to Service Minimum Estimated 6,400 Active TFs Worldwide						
	Type A	Type B	Type C	Senior Technical Reviewer or ITRB	Accountable Executive	RTFE	EOR	Project Engineer	Staff Engineer	**Total FTEs**
Crest Height	43% - 51%	32% - 40%	17%	175 - 180	132 - 138	2,240 - 2,342	1,542 - 1,594	1,542 - 1,594	3,200 - 3,405	**8,832 - 9,252**
Failure Consequence	12% - 32%	17% - 37%	51%	247 - 260	171 - 184	3,200 - 3,456	2,362 - 2,490	2,362 - 2,490	3,571 - 4,083	**11,912 - 12,962**

[1] Classification by dam height: Type A < 40 ft, Type B > 40 ft and < 100 ft, Type C > 100 ft.
Classification by hazard: Type A = low, Type B = significant or medium, Type C = high (Hatton et al. 2020)

Table D2-2. Estimates of post GISTM labor resource demands for minimum estimated 9,600 active TFs worldwide

TSF Screening Criteria	Percent Contribution of TSFs [1]			Full-Time-Equivalents to Service Minimum Estimated 9,600 Active TFs Worldwide w/ 25% of the Total Active TF labor (75% Reduction)						
	Type A	Type B	Type C	Senior Technical Reviewer or ITRB	Accountable Executive	RTFE	EOR	Project Engineer	Staff Engineer	**Total FTEs**
Crest Height	43% - 51%	32% - 40%	17%	66 - 67	50 - 52	840 - 878	578 - 598	578 - 598	1,200 - 1,277	**3,312 - 3,469**
Failure Consequence	12% - 32%	17% - 37%	51%	93 - 97	64 - 69	1,200 - 1,296	886 - 934	886 - 934	1,339 - 1,531	**4,467 - 4,861**

[1] Classification by dam height: Type A < 40 ft, Type B > 40 ft and < 100 ft, Type C > 100 ft.
Classification by hazard: Type A = low, Type B = significant or medium, Type C = high (Hatton et al. 2020)

Table D2-3. Summary of post-GISTM labor resource demands for minimum estimated 16,000 TFs worldwide

Full-Time-Equivalents Needed to Service Minimum Estimated 16,000 TFs Worldwide with 75% Labor Reduction for non-active facilities						
Senior Technical Reviewer or ITRB	Accountable Executive	RTFE	EOR	Project Engineer	Staff Engineer	**Total FTEs**
240 - 247	182 - 189	3,080 - 3,221	2,121 - 2,191	2,121 - 2,191	4,400 - 4,682	**12,144 - 12,721**
340 - 357	235 - 253	4,400 - 4,752	3,247 - 3,423	3,247 - 3,423	4,910 - 5,614	**16,379 - 17,823**

APPENDIX E – ATTEMPT AT PRE-GISTM LABOR CALCULATIONS – DRAFT – WORK IN PROGRESS

Table E1. Personnel and labor resource demands prior to recent (2014) failures and GISTM

Personnel Role	Typical Experience Range	Percentage of Post-GISTM Labor Estimate [1]			Resource Demand as FTEs (Assuming FT = 40 hours per week)		
		Type A TF [2]	Type B TF [2]	Type C TF [2]	Type A TF [2]	Type B TF [2]	Type C TF [2]
Senior Technical Reviewer or Technical Review Board	25 years +	10%	30%	70%	0.001	0.012	0.042
EOR	10 years +				0.01	0.09	0.42
Project Engineer	5 - 15 years				0.01	0.09	0.42
Entry-Level Engineer	0 - 5 years				0.04	0.18	0.56

The information presented in this table is not intended to be applied for any specific tailings storage facility. This table is solely intended to approximate non-project-specific averages to estimate global tailings professional resource demands.

Abbreviations

EOR - Engineer of Record

FT - Full Time

FTE - Full Time Equivalents

GISTM - Global Industry Standard on Tailings Management

ITRB - Independent Tailings Review Board

RTFE - Responsible Tailings Facility Engineer

TF - Tailings Facility

Notes:

[1] Based on discussions with industry professionals, reduction factors were created to estimate labor demand pre-2014 (pre-Mount Polley failure). Low labor intensity TF labor was calculated at 10% of the total labor estimated under the GISTM. Moderate and high labor intensity TF labor was estimated at 30% and 70% of the post-GISTM labor, respectively.

[2] Dam type classifications are not intended to implicate that specific TFs require the specific criteria shown in the table. Three dam type levels were chosen to represent the range of potential labor resources needed for facilities with varying characteristics. For example, the level of effort required to service a smaller, lower production TF would be less compared to a sizeable, world-class facility.

Table E2. Comparison of personnel and labor resource demands pre-2014 and post-GISTM

Personnel Role	Resource Demand as FTEs (Assuming FT = 40 hours per week) Pre-2014 [1]			Resource Demand as FTEs (Assuming FT = 40 hours per week) Post-GISTM [1]		
	Type A TF [2]	Type B TF [2]	Type C TF [2]	Type A TF [2]	Type B TF [2]	Type C TF [2]
Senior Technical Reviewer or ITRB	0.001	0.012	0.042	0.01	0.04	0.06
Accountable Executive	-	-	-	0.01	0.03	0.04
RTFE	-	-	-	0.2	0.4	0.8
EOR	0.01	0.09	0.42	0.1	0.3	0.6
Project Engineer	0.01	0.09	0.42	0.1	0.3	0.6
Entry-Level Engineer	0.04	0.18	0.56	0.4	0.6	0.8

Abbreviations

EOR - Engineer of Record

FT - Full Time

FTE - Full Time Equivalents

GISTM - Global Industry Standard on Tailings Management

ITRB - Independent Tailings Review Board

RTFE - Responsible Tailings Facility Engineer

TF - Tailings Facility

Notes:

[1] Based on discussions with industry professionals, reduction factors were created to estimate labor demand pre-2014 (pre-Mount Polley failure). Low labor intensity TF labor was calculated at 10% of the total labor estimated under the GISTM. Moderate and high labor intensity TF labor was estimated at 30% and 70% of the post-GISTM labor, respectively.

[2] Dam type classifications are not intended to implicate that specific TFs require the specific criteria shown in the table. Three dam type levels were chosen to represent the range of potential labor resources needed for facilities with varying characteristics. For example, the level of effort required to service a smaller, lower production TF would be less compared to a sizeable, world-class facility.

Table E3-1. Estimates of pre-2014 labor resource demands for 827 active TFs disclosed on Global Tailings Database (2021)

TSF Screening Criteria	Percent Contribution of TSFs [1]			Full-Time-Equivalents Needed to Service 827 Active TFs Diclosed on GTD						
	Type A	Type B	Type C	Senior Technical Reviewer or ITRB	Accountable Executive	RTFE	EOR	Project Engineer	Staff Engineer	**Total FTEs**
Crest Height	43% - 51%	32% - 40%	17%	9 - 10	0 - 0	0 - 0	86 - 87	86 - 87	141 - 143	**323 - 327**
Hazard	12% - 32%	17% - 37%	51%	20 - 20	0 - 0	0 - 0	191 - 192	191 - 192	265 - 272	**667 - 677**

[1] Classification by dam height: Type A < 40 ft, Type B > 40 ft and < 100 ft, Type C > 100 ft.
Classification by hazard: Type A = low, Type B = significant or medium, Type C = high (Hatton et al. 2020)

Table E3-2. Estimates of pre-2014 labor resource demands for 1,120 nonactive TFs disclosed on Global Tailings Database (2021)

TSF Screening Criteria	Percent Contribution of TSFs [1]			Full-Time-Equivalents to Service 1,120 Non-Active TFs Diclosed on GTD w/ 25% of the Total Active TF labor (75% Reduction)						
	Type A	Type B	Type C	Senior Technical Reviewer or ITRB	Accountable Executive	RTFE	EOR	Project Engineer	Staff Engineer	**Total FTEs**
Crest Height	43% - 51%	32% - 40%	17%	3 - 3	0 - 0	0 - 0	29 - 29	29 - 29	48 - 48	**109 - 111**
Hazard	12% - 32%	17% - 37%	51%	7 - 7	0 - 0	0 - 0	65 - 65	65 - 65	90 - 92	**226 - 229**

[1] Classification by dam height: Type A < 40 ft, Type B > 40 ft and < 100 ft, Type C > 100 ft.
Classification by hazard: Type A = low, Type B = significant or medium, Type C = high (Hatton et al. 2020)

Table E3-3. Summary of pre-2014 labor resource demands for all TFs disclosed on Global Tailings Database (2021

Full-Time-Equivalents Needed to Service 1,947 TFs Disclosed on GTD with 75% Labor Reduction for non-active facilities						
Senior Technical Reviewer or ITRB	Accountable Executive	RTFE	EOR	Project Engineer	Staff Engineer	**Total FTEs**
13 - 13	0 - 0	0 - 0	116 - 117	116 - 117	188 - 192	**432 - 438**
26 - 26	0 - 0	0 - 0	255 - 258	255 - 258	355 - 364	**892 - 906**