

Constitutive Elements of the Engineer of Record (EoR)-From the Intrinsic to the Esoteric

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SENIOR PROGRAM LEADER -  **GOLDER**
MEMBER OF WSP

Education

Colorado State University, BS, MS  Colorado State University

Highlights

40 years in the business

Key Developer for Major Tailings Stewardship program (2004 through present)

Engineer of Record on multiple world class tailing dams

Trained over 1500 operators and engineers (1996 to present)

SME tailing design book; co-authoring multiple chapters

Review board member for BHP, Rio Tinto, Newmont and Kinross



Abbreviated EoR History

PRIMARY REFERENCE DOCUMENTS

- CANADIAN DAM ASSOCIATION MINING DAMS BULLETIN (REVISED 2019)
- GEOPROFESSIONAL BUSINESS ASSOCIATION (2018)
- MINING ASSOCIATION OF CANADA REVISED GUIDANCE (2017)
- TAILING'S GOVERNANCE FRAMEWORK: POSITION STATEMENT (2016)
- GLOBAL INDUSTRY STANDARD ON TAILINGS MANAGEMENT (2020)
- TAILINGS MANAGEMENT GOOD PRACTICE GUIDE (2021)
- CONFORMANCE PROTOCOLS GLOBAL INDUSTRY STANDARD ON TAILINGS MANAGEMENT (2021)

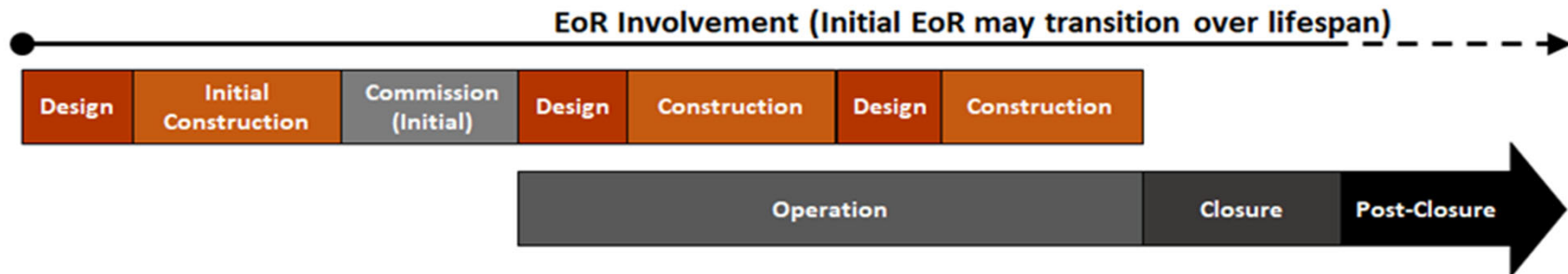


Dam Life Phases and EoR

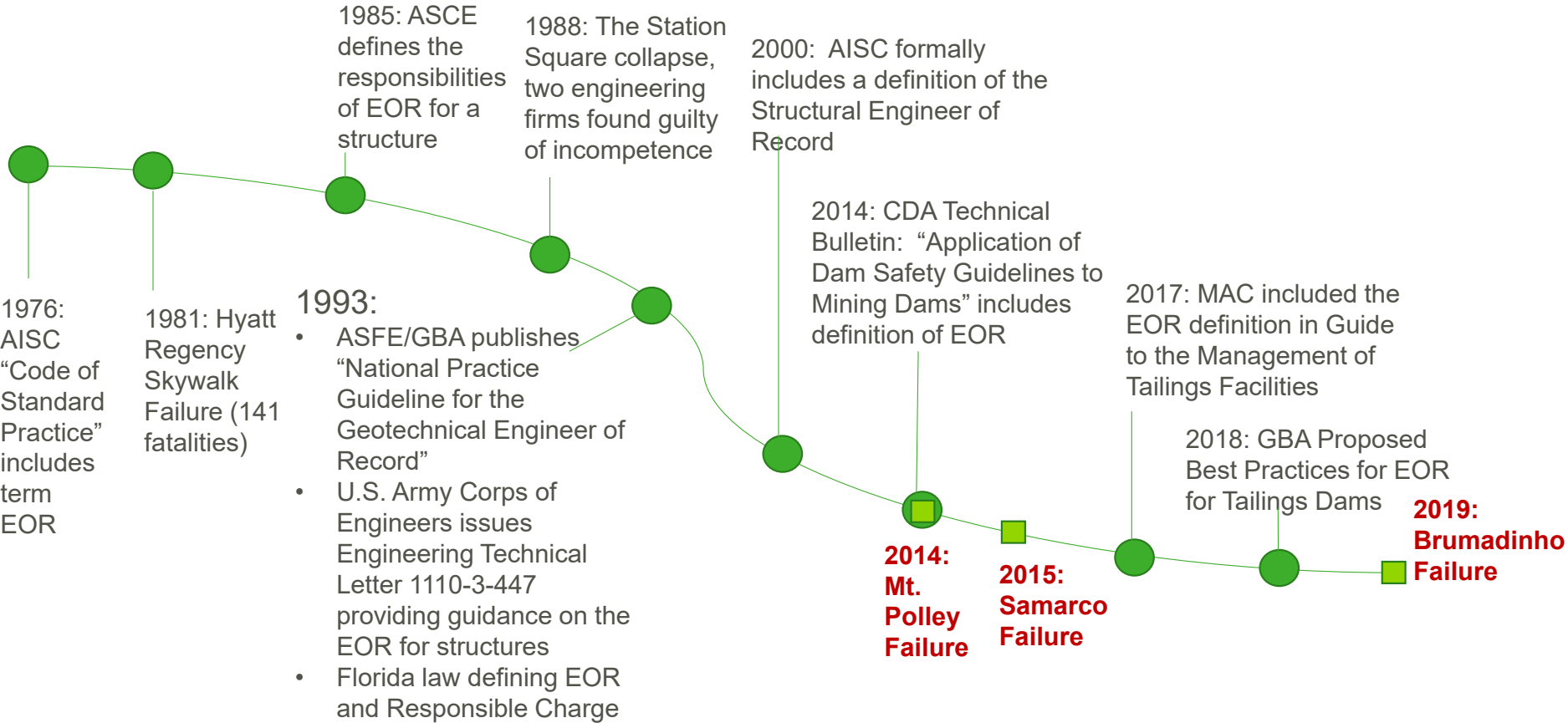
Typical Water Dam Lifecycle



Typical Tailings Facility Lifecycle



EoR Timeline



Constitutive

ADJECTIVE

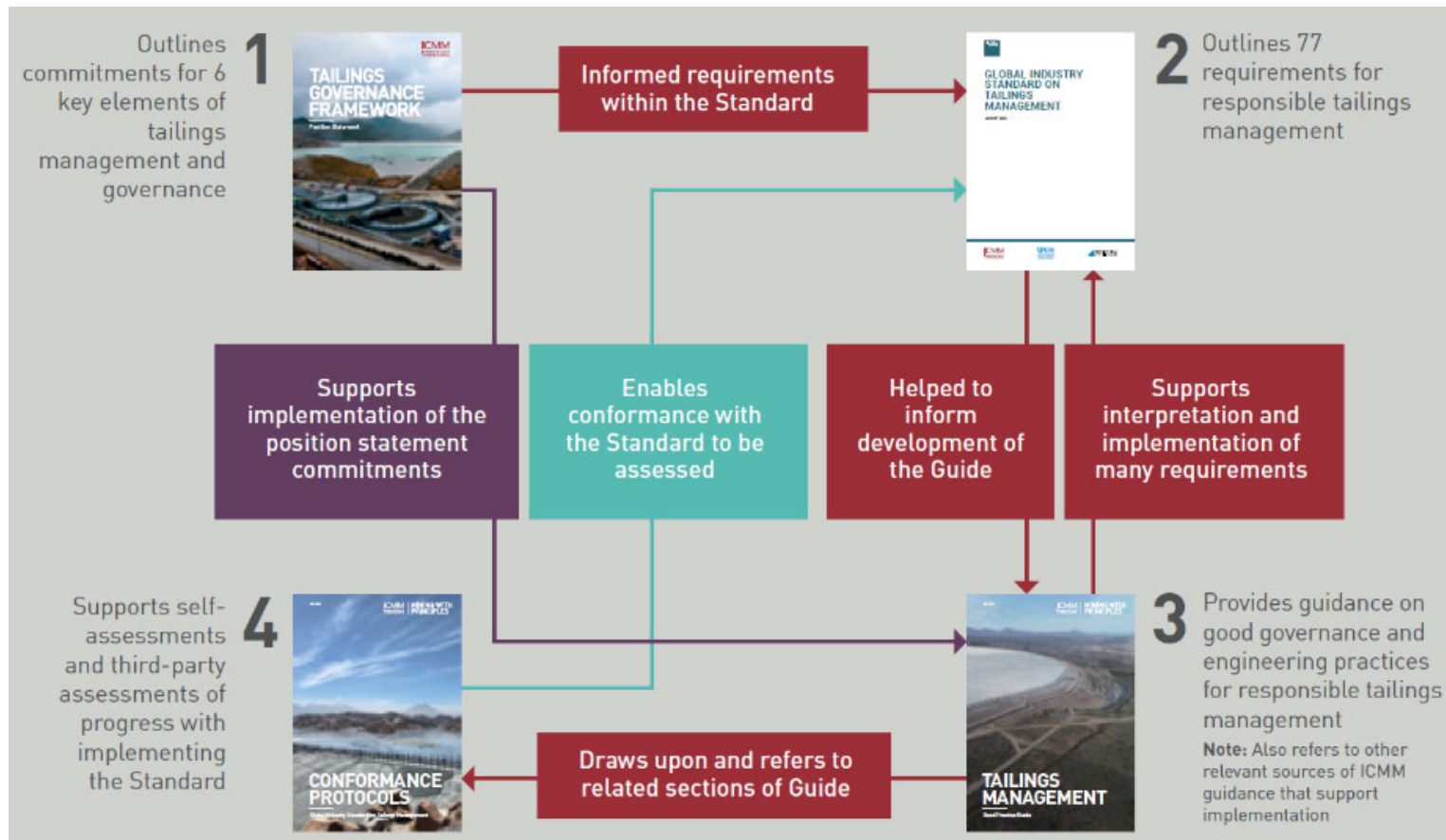
having the power to establish or give organized existence to something.

Oxford English Dictionary



Key Documents

GLOBAL INDUSTRY STANDARD ON TAILINGS MANAGEMENT



Key Documents

Tailings Governance Framework: Position Statement

- Identifies six commitments for tailings management and governance

Global Industry Standard on Tailings Management

- Outlines 77 requirements for responsible tailings management, which are nested under 15 principals that cover the six topic areas from the Tailings Governance Framework

Good Practice Guide

- Supports interpretation and implementation of many requirements in the Standard
- Supports implementation of commitments in Tailings Governance Framework
- Does not replace Requirements or create additional Requirements

Conformance Protocols

- Supports self-assessment and 3rd-Party assessment of progress with implementation

ICMM verse Non ICMM

The Third/Fourth Triumvirate

Accountable Executive



Responsible Tailings Facility Engineer
or
Independent Technical Review Board

Engineer of Record

Engineer of Record (EoR) Definition (GISTM)

EoR (from GISTM glossary)

The qualified engineering firm responsible for confirming that the tailings facility is designed, constructed, and decommissioned with appropriate concern for integrity of the facility, and that it aligns with and meets applicable regulations, statutes, guidelines, codes, and standards.

The Engineer of Record may delegate responsibility *but not accountability*.

Other Considerations

CDA, MAC, GBA and other guidance documents define the EoR as a person supported by a firm

GISTM also indicates a person (but the wording of the definition is confusing)

- Describes an engineering firm that appoints a person to be EoR

Local Jurisdictions may impose additional restrictions

- For example, Montana law
 - Defines EoR as the designer of the facility
 - Precludes an employee of the owner from being the EoR

EOR and Responsible Charge

Responsible Charge – “Shall mean that degree of control an engineer is required to maintain over engineering decisions made personally or by others over which the engineer exercises supervisory direction and control authority...” (Florida 2020)

EoR – The engineer in responsible charge is the Engineer of Record...” (Florida 2020)

What is an Engineer of Record?

OVERVIEW

Execute the Design Vision

- Trusted advisor
- Dam stewards
- Retaining history (design basis)
- An individual, supported by a firm and team that has dam safety specialists
- Oversee proper design and construction
- Vigilant in proactively managing adversity and change
- Continually engaged leader capable of addressing a wide range of issues



Assertive of project requirements with senior personnel and the Owner firm

The EOR is:

- An integral part of the dam safety risk management team
- A trusted advisor
- An individual, supported by a firm and team that has dam safety specialists
- Insistent on working at high technical level
- Assertive of project requirements with senior personnel in the Owner firm
- Capable of addressing a wide range of issues

The EOR is Not:

- ... possibly able to know everything about a TSF
- ... the last person you call
- ... to be kept in the dark
- ... psychic
- ... spokesperson for the site in any capacity
- ... a time traveler
- ... an insurance policy
- ... a rubber stamp
- ... a flash mob (a.k.a. the Seagull) fly in, flap their wings, squawk, poop all over everything and fly away
- ... a quickie...in and out...check the box...off to catch a plane

EOR Qualifications (Technical)

- Education, knowledge, and experience commensurate with complexity and potential failure consequences
- Minimum 10 years of related experience in dams engineering. Field construction and operations experience is critical to education
- Bachelor's degree in a civil engineering discipline
- Relevant advanced degrees encouraged for Extreme Consequence Classification facilities.
- Current knowledge of applicable local regulations and international practice for dam safety and tailings management
- Good standing registration in local jurisdiction

EOR Qualifications (Non-Technical)

- Engage frequently (daily, weekly,?)
- Good written and oral communication skills
- Generate trust from peers, colleagues, and other members of dam safety community
- Ability to lead a team of multidisciplinary professionals
- Willingness to travel to site as needed and on short notice
- Courage and resolve to address dissenting commentary and firmly administer the design intent
- **High emotional intelligence**
- Project confidence and reliability to regulatory officials and other stakeholders
- Demonstrated ability to apply critical thinking.

EoR Models

Common EoR Models

- Outside organization (i.e. consultant)
- Part of Owner's operation (in-house)

Less Common Engineer of Record Models

- EoR is responsible regulatory authorities. Occurs in highly-regulated jurisdictions(i.e. Japan)
- EoR Is third party reviewer(Proposed Chile)

Designer of Record (DOR)

Designer of Record (DOR)

- Design Engineer/team
- Responsible for the design and stamps the construction documents (drawings, specifications and reports) when required
- Follows construction and “certifies” the as-built report, at a minimum

Different models exist for the roles of the DOR and EOR

DoR Models

Common DoR Models

- Current EoR (preferred)
- Outside consultant/ past EoR, or
- Part of Owner's operation (in-house)

Controversy can occur if the EoR differs from DoR

- Contractual relationships
- Ownership/acceptance of work and final construction
- Transfer/acceptance of liability and risk

From the Start – Tailings Dam Basic Principles

Each dam is unique

Behavior is transient – always

Material is non-homogenous and anisotropic

Construction is continuous

Operators are the contractor

Each day is a unique challenge

Operators can profoundly affect behavior

Opportunities for tailings management are regularly lost

Observational Method Benefits

Proactive approach with a cost-benefit

Works well with incremental construction

Works well long-term projects

Demonstrated history of benefit when properly applied

Fits well with the OMS process

Aligns with implementation of TARPs

The observational method, since its inception, has experienced definitional and applicational drift gradually being misused and redefined in a transition from planned change management to "make it up as you go."

This is the paradox. The observational method is intended to leave nothing to uncertainty.

Intrinsic

ADJECTIVE

belonging naturally; essential.

Oxford English Dictionary



Example

Principle and Requirement

The conformance assessment criteria for Meets

Examples of evidence for 'Meets' criteria

Interpretive and Clarification Notes

Equivalent Standards for demonstrating conformance

1	Requirement 1.1	
	<p>Demonstrate respect for human rights in accordance with the United Nations Guiding Principles on Business and Human Rights (UNGP), conduct human rights due diligence to inform management decisions throughout the <i>tailings facility lifecycle</i> and address the human rights risks of <i>tailings facility credible failure scenarios</i>. For existing facilities, the <i>Operator</i> can initially opt to prioritize salient human rights issues in accordance with the UNGP.</p>	
2	Assessment	
	Conformance	Criteria
	Meets	<p>The following are demonstrated:</p> <ul style="list-style-type: none"> a. <i>Operator</i> has a policy commitment to respect human rights in accordance with the UNGPs. b. <i>Operator</i> has conducted a site-specific human rights due diligence process to inform management decisions throughout the <i>tailings lifecycle</i>. c. <i>Operator</i> has addressed the human rights risks of <i>tailings facility credible</i>
		<p>such scenarios exist for a given facility.</p>
	Examples	
	<ul style="list-style-type: none"> a. Documented Human Rights policy in line with UNGPs. <ul style="list-style-type: none"> - Policy may be site specific, or company-wide and implemented at the site. b. Documented human rights due diligence process in line with the UNGPs, as well as evidence that findings are updated regularly and have informed management decision making over time. <ul style="list-style-type: none"> - For existing facilities, <i>Operator</i> can initially prioritize salient human rights issues for management consideration, rather than undertaking a full due diligence process. - Documentation can include a stand-alone due diligence report or a human rights risk and <i>impact assessment</i>, or be incorporated into a Social Impact and Risk Assessment. Can also include annual reports. - Evidence can include minutes of meetings and records of mitigation measures planned and implemented. c. Mitigation strategies or plans connected to specific human rights risks for facilities with <i>credible failure scenarios</i>, as identified in the due diligence process. Related actions should be time-bound, have assigned responsibility and KPIs for monitoring. <ul style="list-style-type: none"> - Implementation may be demonstrated through monitoring and evaluation reports, as well as ongoing revisions to mitigation strategies or plans, based on review. 	
3	Interpretive and Clarification Notes:	
	/	
4	Equivalent Standards for demonstrating conformance	
	<p>ICMM Performance Expectations (Principle 3.1 regarding human rights) is fully equivalent to conformance with this protocol for criteria a and b if the site-specific human rights due diligence process has informed management decisions throughout the <i>tailings facility lifecycle</i>. Specific additional steps need to be taken where criterion c applies.</p>	

Conformance Protocols Example 2

Principal 9: Appoint and **empower** an Engineer of Record.

Requirement 9.2:
Empower the EOR through a written agreement that clearly describes their authority, role and responsibilities
...

Requirement 9.2

1

Empower the *EOR* through a written agreement that clearly describes their authority, role and responsibilities throughout the *tailings facility lifecycle*, and during change of ownership of mining properties. The written agreement must clearly describe the obligations of the *Operator* to the *EOR*, to support the effective performance of the *EOR*.

Assessment

Conformance

Criteria

Examples

2

Meets

The following are demonstrated:

- An *EOR* is appointed and in place at all times throughout the *tailings facility lifecycle*. The appointed *EOR* may change during the *tailings facility lifecycle*.
- The *EOR* is appointed through a written agreement that clearly describes their authority, role and responsibilities throughout the *tailings facility lifecycle*, and during change of ownership of mining properties.
- The written agreement clearly describes the obligations of the *Operator* to the *EOR*, to support the effective performance¹ of the *EOR* during the *tailings facility lifecycle*.

- The *tailings facility Operator* maintains a written agreement with an *EOR* that outlines the *EOR* authority, roles and responsibilities.
- The *EOR* is enabled to effectively perform their roles and responsibilities by clear written direction from the *Operator*.
- /

Interpretive and Clarification Notes:

3

1. Effective performance means that the *EOR* is empowered to fulfil their roles and responsibilities in a manner that is supported by meaningful engagement of the *Operator* through a written agreement, and the results of the *EOR* involvement are used by the *Operator* to manage the *tailings facility* performance risk at all stages of the *tailings facility lifecycle*, including post-closure.



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Conformance Protocols Example 3

Principal 11: Develop an organizational culture that promotes learning, communication and early problem recognition.

Requirement 11.1: Educate personnel who have a role in any phase of the tailings facility lifecycle about how their job procedures and responsibilities relate to the prevention of a failure.

Assessment		
Conformance	Criteria	Examples
2	<p>The following are demonstrated:</p> <ul style="list-style-type: none"> a. The <i>Operator</i> has developed an educational program inclusive of job procedures and responsibilities for prevention of a failure. b. Those with roles for preventing a failure in any phase of the <i>tailings facility lifecycle</i> is included in the education program. 	<ul style="list-style-type: none"> a. Training or education requirements could be identified through a training needs analysis and may be broad and consider those with roles in planning, construction, operational, emergency prevention and response and community engagement that may relate to prevention of a failure. b. Specialized technical training may be required for specific roles. A variety of training methods may be used that are based on the learning objectives and includes classroom-based training, computer based training and hands-on training where appropriate. Examples could include training logs or attendance sheets.
Interpretive and Clarification Notes:		
3	<p>1. The ICMM Tailings Management Good Practice Guide indicates that the Key elements of developing and maintaining competence are qualifications, training, and experience and outlines examples of the types of knowledge requirements for key tailings management roles.</p>	
Equivalent Standards for demonstrating conformance		
4	<ul style="list-style-type: none"> a. ISO 14001:2015 or 45001:2018; Elements 7.2 Competence; 7.3 Awareness; 7.4 Communication is partially equivalent to conformance with this protocol but doesn't explicit refer to <i>tailings</i> management. b. The ICMM Position Statement on Tailings Governance (2016) commitment 1 requires: 'Accountabilities, responsibilities and associated competencies are defined to support appropriate identification and management of TSF risks; Accountability for the overall governance of <i>tailings facilities</i> resides with the owners and operators; Organisational structures and roles are established to support management of TSF risks and governance accountability; Communication processes are maintained to ensure that personnel understand their responsibilities. Training is conducted to maintain currency of knowledge and skills; and Role competency and experience requirements are defined for critical roles within the established organizational structures'. This is fully equivalent to conformance with this protocol. 	

Definition of Personnel

Personnel: includes employees, contractors and consultants (e.g. designer, Engineer-of-Record) and includes those with direct responsibilities for tailings management as well as those with indirect responsibilities whose roles may be related in some manner to tailings management (e.g. heavy equipment operators working on or adjacent to tailings facilities). [ICMMGPG]

You touch it, you own it !

How Much Can a Senior Engineer Handle?

REALITY...



- 1 to 2 large dams *or*
- A combination of 2 to 3 smaller/inactive dams and 1 major dam (maybe)
- 3 to 5 Dam Safety Reviews (DSRs) per year

The Pokémon doctrine - Tailings dam EoR engagements are not to be collected...but respected.

Labor Force – Independent Assessment

Collaborative project: Colorado State University,
Golder, and Marsh Mining

Study focus:

- ***Address the impending qualified tailings professional resource shortage***

Available papers:

- Hatton et al. (2020) – Tailings and Mine Waste Conference, USA
- Spencer et al. (2021) – Mine Waste and Tailings Conference, Australia

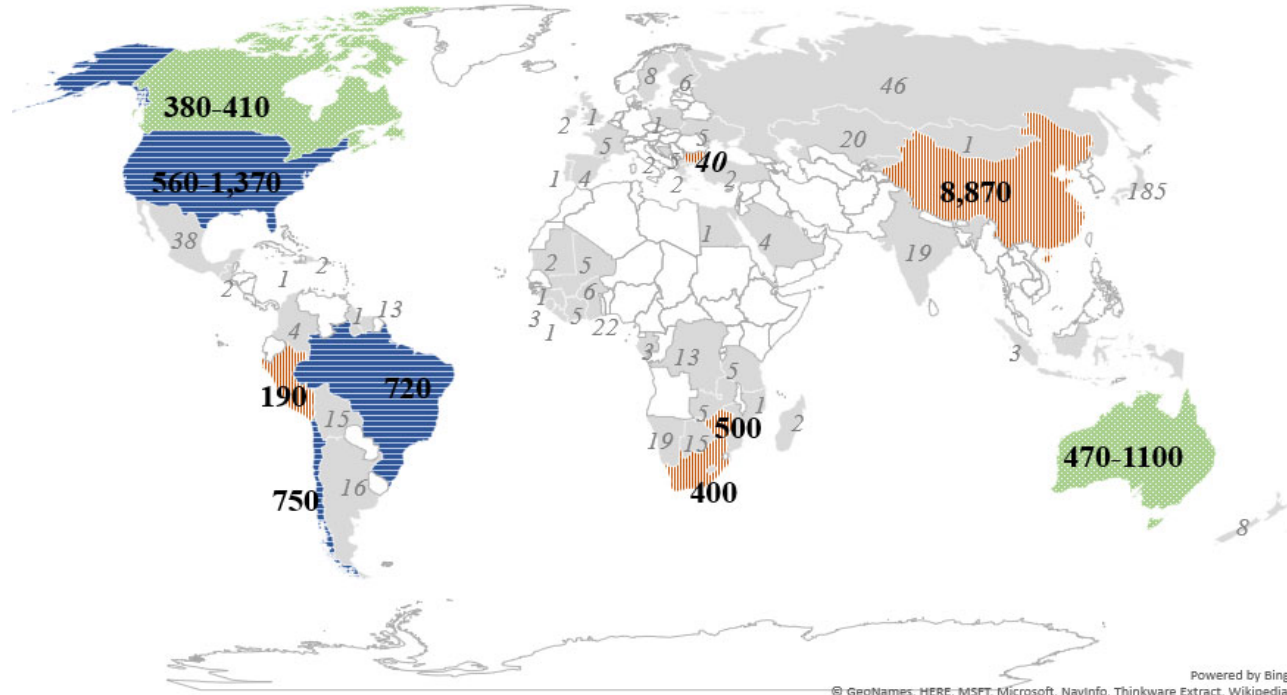
More work to come!



Assessment: Worldwide Tailings Dams

- Common estimates:
 - **3,500** (Davies et al. 2000)
 - **18,400** (Herza et al. 2019)
- Independent assessment of literature, global and national inventories, regulatory agencies, etc.
- Number of facilities found in our study: 13,430 -15,370
- Minimum estimate of tailings facilities for labor calcs:

16,000 +



Numbers Estimated number of tailings storage facilities based on available information (numbers rounded up to nearest 10)

Numbers Number of tailings facilities (TF) disclosed on the Global Tailings Portal (GTP) within Beta Version 4.0 (2021)

- National TF inventory available
- Some state/provincial TF information available
- Number of TFs presented in literature
- Preliminary TF disclosures provided from GTP
- No information found

Labor Demand

Assumptions

- 16,000 TSFs worldwide
- 40 hours per week
- 52 weeks per year
- **Annual Full Time Equivalent (FTEs) Required > 10,000**
- To manage an estimated 16,000 tailings facilities worldwide in accordance with existing guidelines
- Need pathways for recruitment and retention of tailings professionals worldwide

	<u>FTEs</u>	
	Junior Engineer	EoR
TSF Screened by Hazard Potential	6,880 – 7,470	4,000 – 4,740



Services Procurement Impacts

SHIFT FOUNDATION

Consultants no longer competing for work

Competing for People

Industry grabbing qualified resources from consultants

Consultants expected to be an endless supply

Pressure from outside influences

- Attrition (reaching shelf life)
- Fear generated from self indulgent regulatory bodies
- Lack of past industry and peer support



Market Transition

LOOKING TO THE HORIZON



Challenges of complete solicitations in a resource constrained industry

***Example:** Five companies propose (competitively) on a geotechnical scope. [200 hours each]*

- *One company wins (good investment).*
- *Four companies have committed senior, mid-level, junior hours and admin to the preparation of their proposal with no benefit.*
- *800 hours spent/extracted hours from their supporting contractors with no tangible benefit.*

Get ready to say/here no ...

Market Transition – Cont.

INDUSTRY RESOURCE MIGRATION REBOUND

Migration to Industry

Limits to Design, Projects and Technical

Prepare and provide a place to land

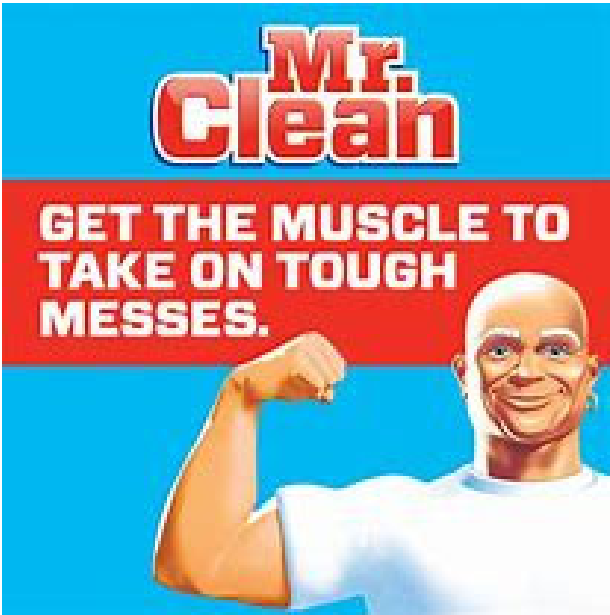
- Rebound in approximately 3 to 5 years
- Peaks at seven years
- Reaches equilibrium thereafter

Industry experience will be expectation?



Desire vs. Reality

INDEPENDENT REVIEW



Desire

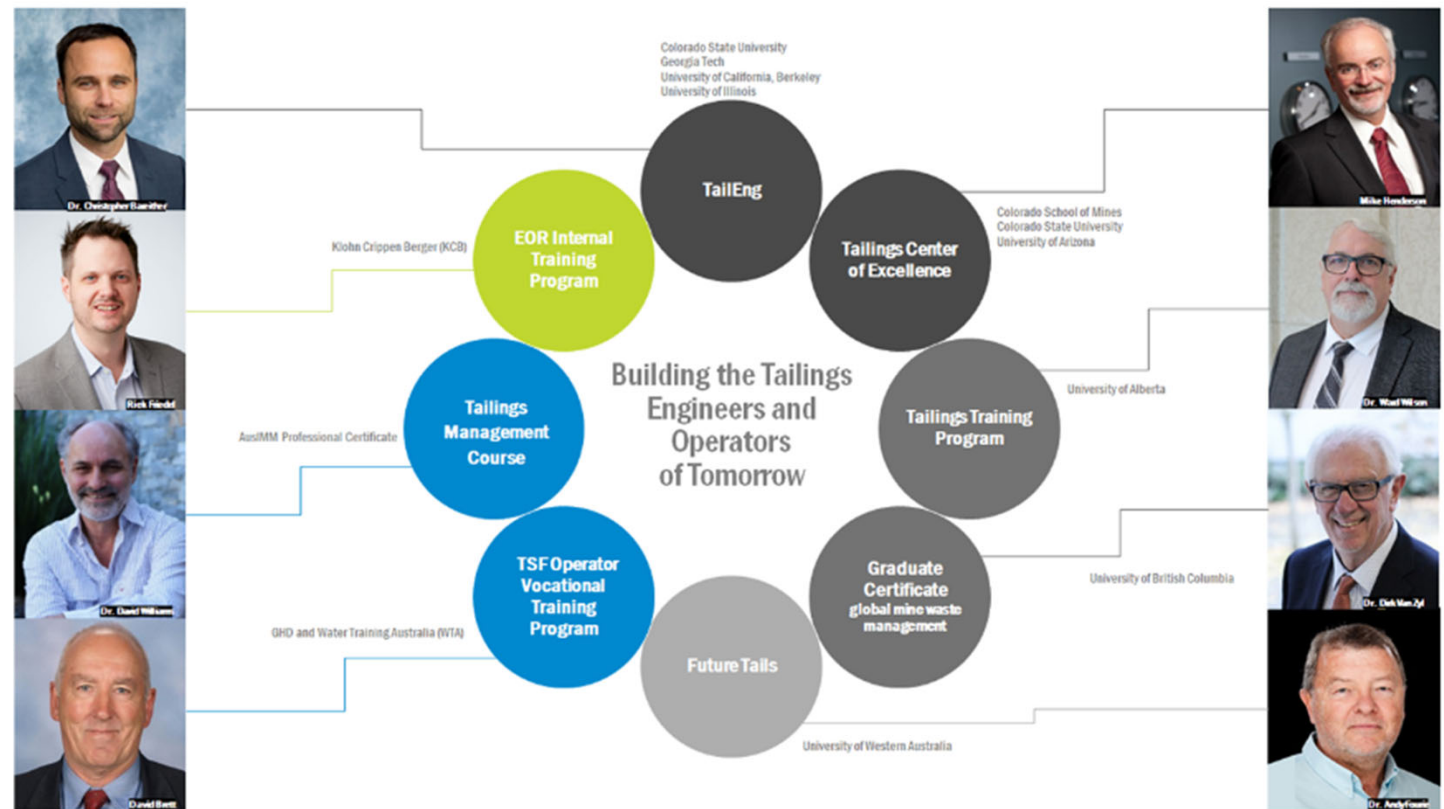


Reality

Educational Initiatives

- All efforts needed to build next generation of mine tailings professionals
- Collaboration needed between academia and industry
- In addition to technical skills, ***soft skills development is critical***

Education and training programs – 2021 MinExchange



Esoteric

ADJECTIVE

intended for or likely to be understood by only a small number of people with a specialized knowledge or interest.

Oxford English Dictionary



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Tailing Engineers – Requisite Skills

Success

**Technical
Skills**



**Operations
Understanding**

Soft Skills = People Skills

Do We See the Big Picture?

A PROVERB

A man is visiting a Cathedral under construction and interviewing workers. At his first stop, he visits with a stonemason and asks what he is doing. The mason replies, "I am chipping away at stones." He proceeds to the next person, another stonemason, and he too is carving away at a stone block. The man asks him what he is doing, and he replies, "I am making gargoyles." So, it goes as he interviews different people, each focused on their task at hand. He then sees an old lady sweeping, and he asks her what she is doing. She looks at him with a smile and great pride and says, "I am glad you ask. I am building a Cathedral."

We see people so focused on a task that they lose sight of the big picture

Communication versus Connection

Know yourself

- Driver
- Analytical
- Amiable
- Expressive

Know your Emotional IQ



Emotional IQ Skills

Maintain self-awareness / monitoring

Reflect on feelings and pause before acting

Provide/receive constructive criticism and praise

Extend empathy without expectation of return



Gather the fortitude to pick one's self up after failure and find opportunities

Demonstrate confidence to own errors and show others grace

Exhibit authenticity and courage

Allow one's self to be vulnerable

Courage to Grow; Courage to Fail

“It is not the critic who counts; not the man who points out how the strong man stumbles, or where the doer of deeds could have done them better. **The credit belongs to the man who is actually in the arena, whose face is marred by dust and sweat and blood; who strives valiantly; who errs, who comes short again and again, because there is no effort without error and shortcoming; but who does actually strive to do the deeds; who knows great enthusiasms, the great devotions; who spends himself in a worthy cause; who at the best knows in the end the triumph of high achievement, and who at the worst, if he fails, at least fails while daring greatly,** so that his place shall never be with those cold and timid souls who neither know victory nor defeat.”

Theodore Roosevelt Citizenship in a Republic, Paris, France 1910



Taking Risk and Vulnerability

"Smooth seas do not make good sailors."

--Christine

Emotional Engagement Levels

Level 1 – Oblivious (reactive)

Level 2 – Aware (reactive)

Level 3 – Engaged (proactive)

Level 4 – Collaborative (proactive)

Level 5 – Entrepreneurial (proactive)



Level 1 – Oblivious

Characteristics:

- Executing prescribed duty without understanding of purpose
- Unaware of, nor concerned of the potential impacts and consequences of deviation

Example for tailings:

- Unfamiliar with most aspects of operations = react in the moment
- Lack practical knowledge of design and construction
- Lack desire to pursue a tailings career with the EoR and engineering leadership
- Operational protocols established in OMS challenging and ambiguous
- Unempowered to act = Highest risk to the operations



Level 2 – Aware

Characteristics:

- Aware of the basics and that information / tools exist
- Limited training; ad hoc / unfocused education

Examples for tailings:

- Not empowered to take action
- Deviations from OMS may have adverse effects, but are not fully aware of consequences
- Share time between roles (e.g., process plant and tailings facility), but primary focus is not tailing management
- Increased awareness that their actions will impact, even perhaps negatively, the performance of the dam.
- Beginning to develop initial concepts and an understanding of how tailing dams are constructed and operated



Level 3 – Engaged

Characteristics:

- Transition to understand they can affect change
- Empowered to take action and trained to do so
- Initiates collaboration and sharing of experience

Examples for tailings:

- Recognition that the tailings facility is a significant liability
- Understand concepts and physics of tailing dam design and construction
- Understand that controlling deposition is a requisite to safe tailings dam operation
- Understand importance of daily interaction and identify potential dam safety issues that should be addressed
- Seeks and values input from Representative Engineer and Engineer of Record (EoR)



Level 4 – Collaborative

Characteristics:

- Engaged in making thoughtful contributions
- Engaged full-time with proper training and understanding
- Supports and advocates for culture of ownership and pride

Examples for tailings:

- Implementing proactive tailing management
- Relatively strong understanding of the basic engineering principles applied to a tailings dam
- Bottom up strategy for support of the tailing storage facility
- Seek collaboration between mill and operations personnel to proactively manage tailings distribution
- Communicate seamlessly with other operations
- Willing to exchange resources



Level 5 – Entrepreneurial

Characteristics:

- Understand criticality of each individual role
- Respectful transparent communications between stakeholders

Examples for tailings:

- Solicit input from EoR and resident engineers on regular basis
- View tailings facility as “my dam” and thoughtful about legacy
- Committed to self-improvement and betterment for the company
- Utilize tailing management plan on a daily basis to verify the tailing placement
- Pre-emptively identify opportunities to improve or change the design process through interactive collaborations
- Understand the current state of the practice



Ignus
Fatuus

COVID 19 Conundrum



Isolation has compromised

- Industry borrowing from an experiential bank account
- Society is dehumanizing the process

Remember:

- Email is not a phone call
- A phone call is not a person-to-person meeting
- Zoom does not replace individual or group human interaction
- Photographs and drone videos do not replace feet on the ground
- Human interaction is critical and irreplaceable

There will be a price to pay!

Final Comment to the Old Guys

TIME TO LET GO AND DELEGATE



Yep, Give the Kids the Key to Ferrari !

Questions and Open Discussion?

"A ship in harbor is safe -- but
that is not what ships are
built for."

John A. Shedd

