What Could Tailings Facility Engineering Look Like in 2030?

Version 5.0

Audience Input QR Code

Andrew Witte, Klohn Crippen Berger, CANADA

Andy Small, Klohn Crippen Berger, CANADA

Annika Bjelkevik, Tailings Consultants Scandinavia, SWEDEN

TAILINGS AND MINE WASTE 2024

What is Tailings Facility Engineering?

Knowledge Areas

- Tailings milling and processing
- Design of tailings storage facilities
- Closure design
- Geotechnical engineering
- Hydrogeological engineering
- Hydrotechnical engineering
- Geology
- Geochemistry
- Environmental protection
- Construction
- Operations
- Surveillance
- Risk Assessment
- Governance

Technical Inputs

- Engineering and scientific studies
- Field work (drilling, construction)
- Lab analyses (testing and interpretation)
- Modelling (simple to advanced)

Organizations Supporting Tailings Facility Engineering

CDA ACB

UN environment programme

USSD U.S. National Committee of ICOLD

CIGB ICOLD
COMMISSION INTERNATIONALE DES GRANDS BARRAGES
INTERNATIONAL COMMISSION ON LARGE DAMS

UNECE

The Mining Association of Canada
ADVOCACY STEWARDSHIP COLLABORATION

LANDFORM DESIGN INSTITUTE

ANCOLD

ICMM

CIM ICM Canadian Institute of Mining, Metallurgy and Petroleum

SIMSG ISSMGE
International Society for Soil Mechanics and Geotechnical Engineering

SME Society for Mining, Metallurgy & Exploration

Swed COLD

World Mine Tailings Failures

CANBREACH

Universities, technical associations, etc.

TAILINGS AND MINE WASTE 2024

Some Mining Trends

- Grades of ore bodies are reducing
- Leads to more tailings (annual growth of mining/tailings about 3%)
- Leads to bigger tailings facilities and repurposing old facilities
- World-wide registry with over 24,000 TSFs (Rana et al, 2024) (ICOLD, TC L)
- There are insufficient human resources to meet this demand

Is the tailings engineering community keeping pace?

Why 2030?

- Why not 2040 or 2050?
- “Next 6 years will go by in the blink of an eye”
- Reflect on some of what has happened in the past 6 years
- Start with guidance documents

Why 2030? - Guides Supporting Tailings Facility Engineering

ICOLD Bulletin 139: Improving Tailings Dam Safety

ICOLD Bulletin 153: Sustainable Design and Post-Closure Performance of Tailings Dams

CDA Mining Dams Bulletin

2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017

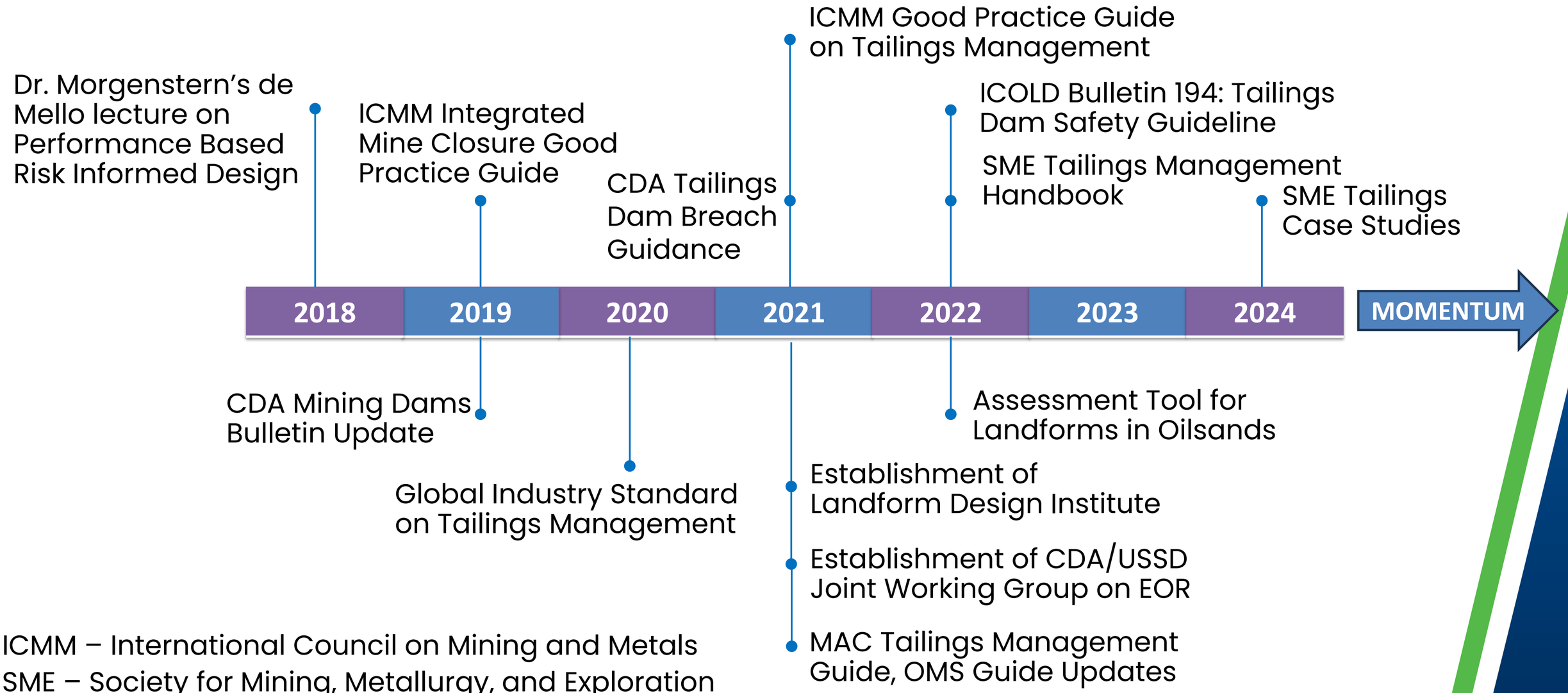
MAC Tailings Management Guide, OMS Guide

ANCOLD Guidelines on Tailings Dams

De-Licensing of Oilsands Tailings Dams

ICOLD – International Commission on Large Dams
ANCOLD – Australia National Commission on Large Dams
CDA – Canadian Dam Association
MAC - Mining Association of Canada

Why 2030? - Guides Supporting Tailings Facility Engineering



ICMM – International Council on Mining and Metals
SME – Society for Mining, Metallurgy, and Exploration
USSD – US Society on Dams

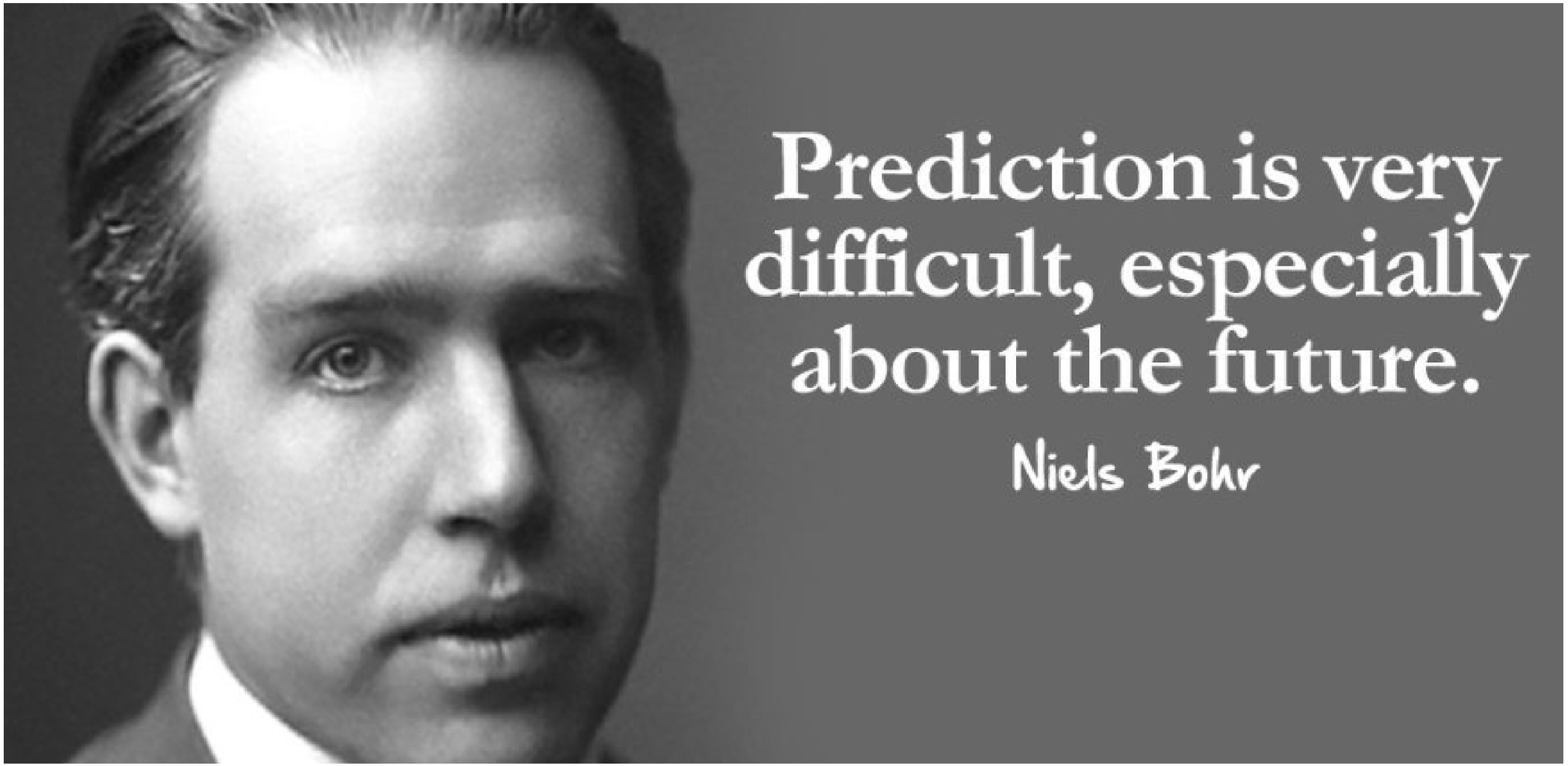
TAILINGS AND MINE WASTE 2024

Why 2030? - Reflection on some examples in the past 6 years

Topic	2018	2024
Engineer of Record	Significant trepidation	Young engineers are viewing this as a viable career path
Surveillance	Some automation	Extensive automation and innovative technologies
Artificial Intelligence	Not prevalent	Playing a bigger role

- We believe:
  - There is opportunity to maintain the momentum that has been built
  - We can do more than just “continuous improvement”
  - We can make significant advances in the next 6 years
- **This aim of this talk (and plenary) is to facilitate near-term discussion and action to continue to advance the state of practice**

Visioning to 2030



What Could Tailings Facility Engineering Look Like in 2030?

1. Technical:
   a) Tailings technology and deposition strategies
   b) Closure strategies
   c) Characterization of tailings and foundation soils
   d) Design
   e) Surveillance
2. Competency and Capacity:
   a) Guidance documents
   b) Training and development of Tailings Facility Engineers
   c) Regulatory competency and capacity

Governance is a key item that is also evolving, but beyond our scope

Papers and Presentations

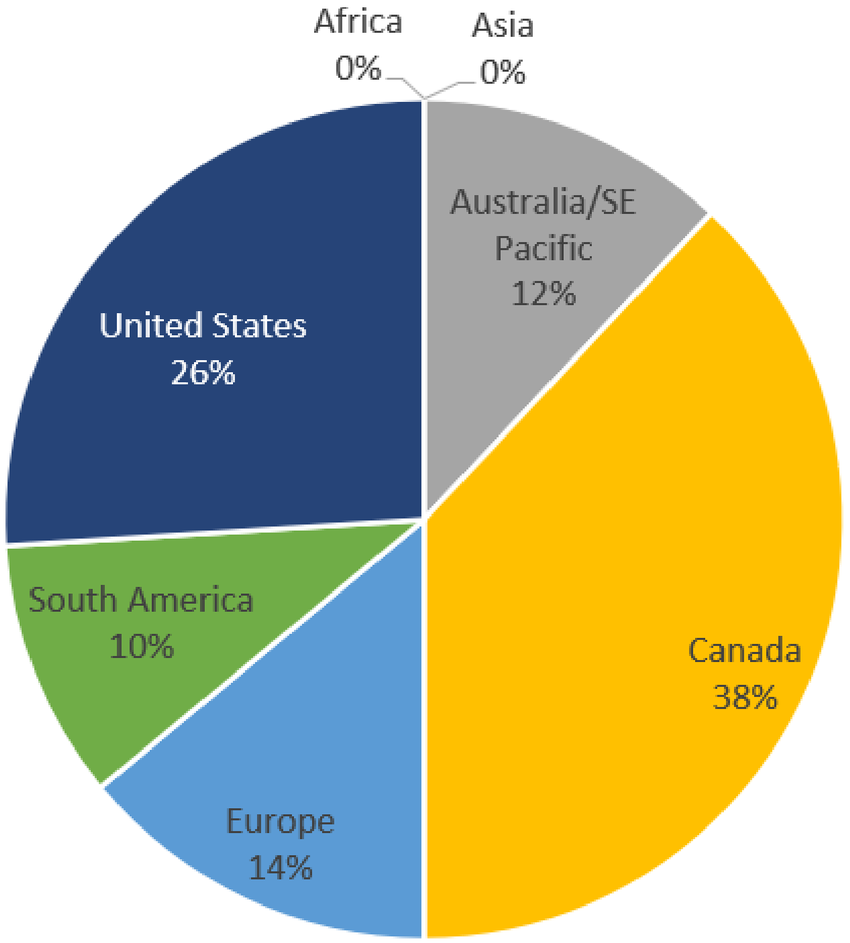
Version	Forum	Location	Deliverable	Date (2024)	Presenter
1.0	Calgary Geotechnical Society	Calgary	Presentation	May 14	Andy
2.0	Edmonton Geotechnical Society	Edmonton	Presentation	May 16	Andy
3.0	Mining Society of Nova Scotia	Nova Scotia	Presentation	July	Andy
4.0	ICOLD	India	Presentation and paper	September	Annika
5.0	Tailings and Mine Waste	Denver	Presentation and paper	November	Andrew
6.0	International Society of Soil Mechanics and Geotechnical Engineering	Chile	Presentation and paper	November	Andy

- Will make presentations and papers available on publicly accessible drive

TAILINGS AND MINE WASTE 2024

Questionnaire to Colleagues/Leaders

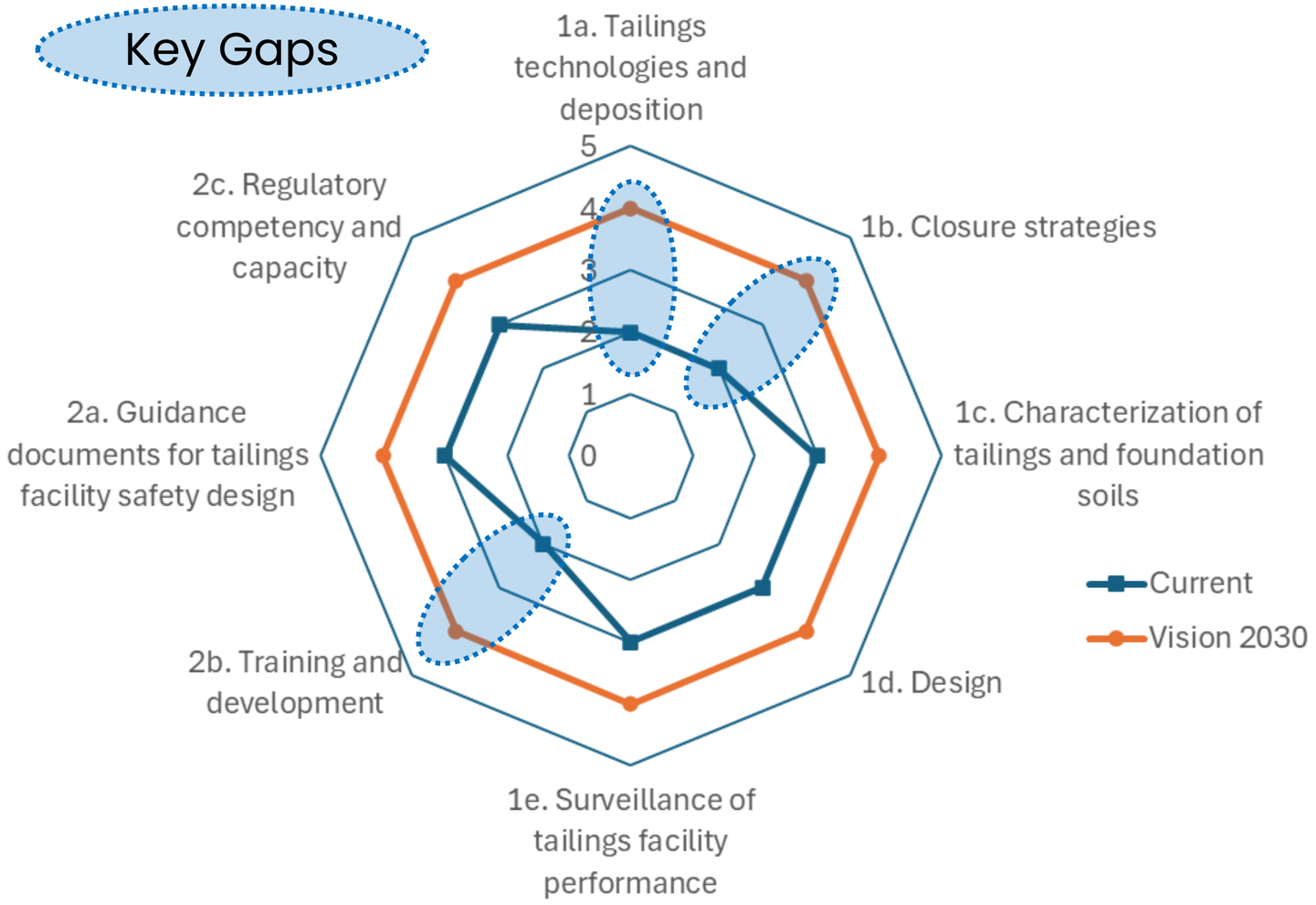
- To support development of the presentations and papers
- Issued to over 240 colleagues around the world
- Over 60 responses
- Lots is happening, this presentation provides some of the highlights



Responses

Estimated Situation For Each Topic Based on Questionaire

Key Gaps



0 = not implemented / used / known

1 = implemented in research / regarded as future (pilot test) / known by few

2 = implemented in a few operations / used in a few places / known by few but regarded as an option

3 = implemented in most operations / used in most places / known by many

4 = implemented in many operations / used in many places / known by most

5 = implemented in “all” operations / best possible use / fully known

KEY GAP FROM QUESTIONAIRE

2b: Training and Development – 2030?

- Establish the discipline of Tailings Management Professional (TMP)
  - distinct career path for young engineers, rather than, as so many do now, "*just fall into tailings engineering*"
  - TMP has general knowledge in areas of tailings facility engineering with a specialty in one or more of those knowledge areas
  - ICOLD forming a working group to develop the scope for the TMP discipline and will work with other organizations (SME, ICMM, CDA, ANCOLD) to define it
- More coordinated training
  - Courses like TailENG
  - Graduate programs
  - SME Tailings Training Portal

Colorado State University

THE UNIVERSITY OF BRITISH COLUMBIA
Norman B. Keevil Institute of Mining Engineering
Faculty of Applied Science

UNIVERSITY OF ALBERTA

KEY GAP FROM QUESTIONAIRE

1a: Tailings Technology – 2030?

- Demonstrated defensible decision making (e.g., prevalent use of MAA, ALARP)
- Conventional/slurried tailings:
  - Still the majority with focus on centerline/downstream methods or upstream methods with engineered structural zones (i.e., no new “classical” upstream dams)
  - Improved Perception: high degree of confidence in slurry tailings facilities
- Filtered tailings will play a larger role
  - Embraced as a companion technology to conventional/slurried tailings
    - *Needs more technical guidance - SME*
- Co-disposal of tailings and waste rock
  - more prevalent
    - *Needs more technical guidance*

KEY GAP FROM QUESTIONAIRE

1b: Closure Strategies – 2030?

- Consensus on an effective definition of Safe closure/ Responsible closure
- Defined and standardized design criteria for closure, incl. transfer of ownership
- Less water in the tailings and impoundments
- Financial models that benefit good practices
- Long-term monitoring with remote methods and AI
- Establish the role of reclamation designer of record (RDR) working in parallel with EOR

1c: Site Characterization - 2030?

- *"tools are already available today, but the toolbox could be better organized, and the tools sharpened"*
- Focus on unsaturated soil mechanics and critical state characterization
  - Wider use of innovative technologies for in-situ water content estimation (e.g., nuclear magnetic resonance)
  - New technologies for estimating in-situ void ratio
  - Improved characterization of liquefaction potential and post liquefaction strength
- Initiatives underway by academia, industry, and suppliers

1d: Design – 2030?

- *"Further recognition of the value of Performance Based Design and significantly greater prominence in its use"*
  - Integration of complementary roles of PBD and classical approaches (e.g., LEM)
  - Fully coupled deformation and seepage models
- Regulatory capacity will still be a limitation to implementation
  - Requires educating industry
- Dam breach analysis that can be relied upon
  - Confidence in models that reflect the reality of tailings dams vs water dams

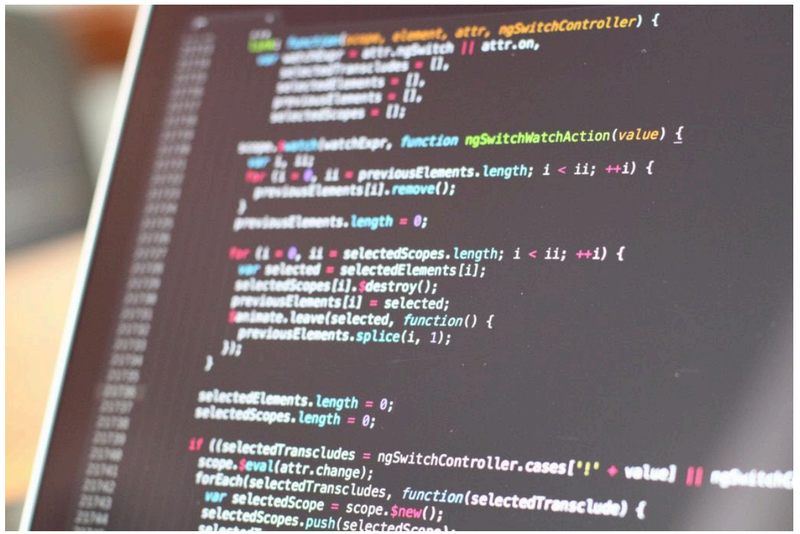
1e: Surveillance – 2030?

- Increased use of “area” measurements (e.g., InSAR, fibre optics, “Smart” geofabrics, ERT cables, drones, etc.)
- Surveillance programs/systems developed based on risk assessment and failure modes
- Widespread automation with improved user interfaces
- Integration of collected data directly into engineering models
- Data scientists employed to manage the reams of data
- Increased use of AI for data review/screening
- Being implemented by owners and providers

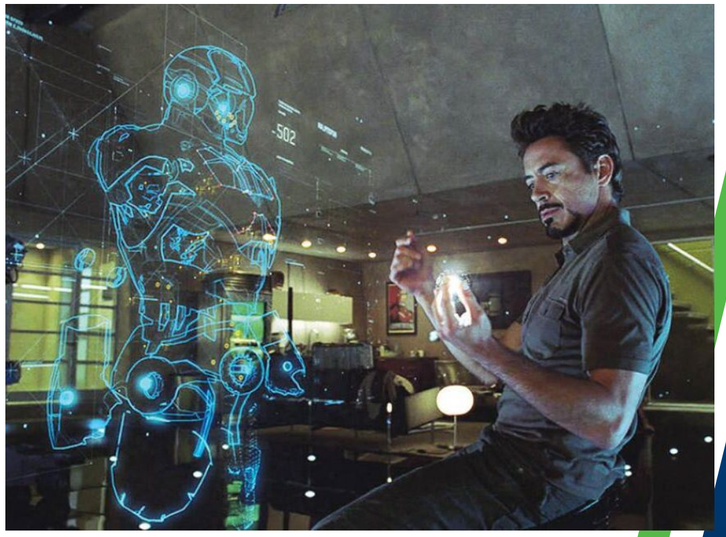
Summary

- This is a fraction of the initiatives that are happening in the world
- Many other good initiatives are underway, pleased to include in our paper
- Let’s maintain the momentum and go beyond just “continuous improvement”

Yesterday



Today



Tomorrow?

Questions & Panel Discussion