Considerations of the Global Industry Standard for Tailings Management

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Introduction

- President Nelson Mandela at the 104th Annual General Meeting of the South African of the Chamber of Mines on the 8th of November 1994 announced that: "*South Africa is blessed with a special geological heritage. As such, the mining industry has been the bedrock of the South African economy for more than a century*".
- Mining also creates residuals (tailings).

- Mine tailings are stored in Tailings Storage Facilities

PROCESSING FLOW CHART

Step 1: Milling
Step 2: Classification and Gravity Concentrating
Step 3: Thickening and Leaching (Cyanide)
Step 4: Adsorption on activated carbon
Step 5: Refining and Smelting

Source: Sibanye-Stillwater

What are Tailings Storage Facilities (Mine Residue Deposits)?

- Tailings Storage Facilities (TSFs) are **engineered structures** that are designed to **contain tailings** (residue following the extraction of valuable material from metal ore processing) and to manage **associated water**.
- TSFs are among the **largest dams and structures in the world, and will stand in perpetuity.**
- A catastrophic release of a large amount of tailings could lead to long term environmental damage with huge cleanup costs.
- To manage mining facilities responsibly, the TSF owner must understand the physical and chemical risks associated with the TSF and implement controls to reduce risks relating to potential health, safety, environmental, societal, business, and economic impacts in line with regulations.
- **If poorly designed, constructed or managed, tailings storage facilities represent a significant risk to local communities and ecosystems, especially in downstream environments.**

Residue stockpiles

The judgement in the De Beers Consolidated Mines Ltd and Ataqua Mining (Pty) Ltd and others matter in the High Court of South Africa (Orange Free State Provincial Division - Case No. : 3215/06) established that:

- "*Mine*", used as a verb in the MPRDA does not include extraction activities in residue stockpiles.
- Extraction of minerals from residue stockpiles constitutes processing that does not require a separate mining permit or mining right.

National Environmental Management Waste Act, 59 of 2008

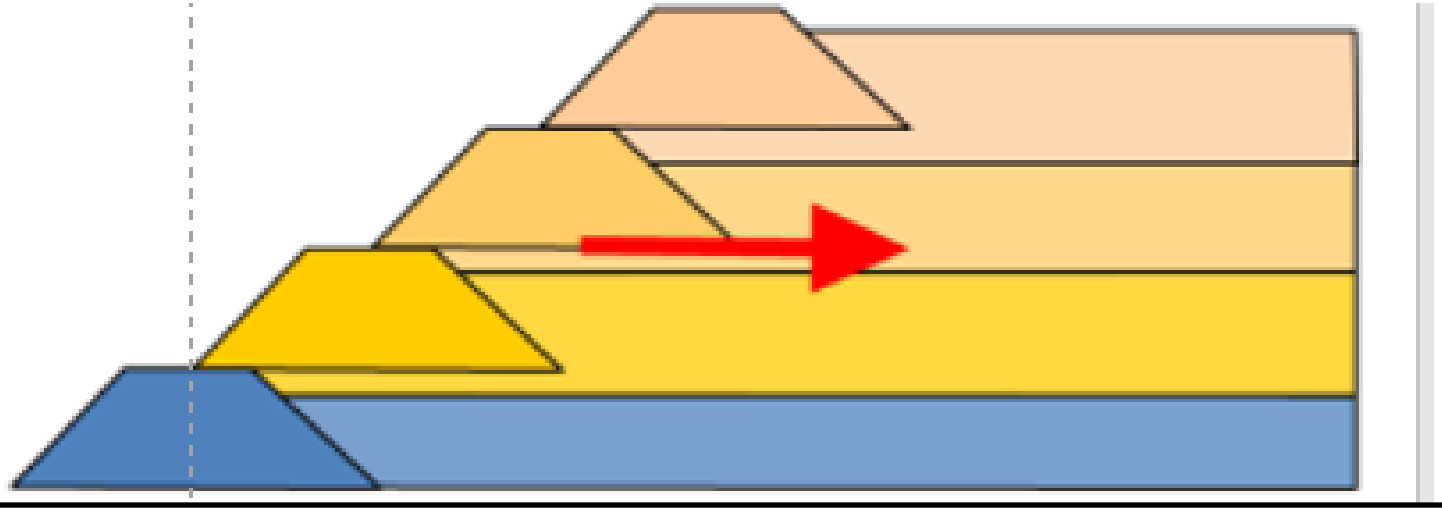
- Residue stockpiles and residue deposits fall within the ambit of NEM:WA and its various regulations.

National Environmental Management Laws Amendment Act, 2022

- The 2018 NEMLA IV Bill to amend NEMWA **to specifically exclude residue stockpiles and residue deposits from the scope of "waste**", providing that it will be regulated instead under NEMA, with the Minister of Mineral Resources and Energy remaining the competent authority.
- NEMLA IV Act was published in June 2022, however, certain provisions, including the revised definition of "waste" and the repeal of section 43A of NEMWA, did not commence owing to the recent decision of the Constitutional Court in South African Iron and Steel Institute and Others v Speaker of the National Assembly and Others [2023] ZACC 18.
- The NEMWA to NEMA transition therefore remains ongoing. The commenting period for the 2023 Notice ends on 4 September 2024.

Tailings Storage Facilities: Construction Designs

- Upstream
- Downstream
- Centreline



Upstream construction begins with a starter dam. The tailings are then discharged into the facility where they form a tailings beach. The deposited tailings adjacent to the dam wall is allowed to drain and then can be compacted to be used to form the foundation for subsequent levels of the wall as the dam is raised. As such, the crest of the dam moves upstream with each raise.

Upstream tailings dams need to be raised slowly, to allow the solid tailings time to dry and consolidate enough to support a new level of the dam. These are suitable for facilities in areas of low rainfall and low seismic activity.

In South Africa, most of our Tailings Storage Facilities are upstream facilities, which is considered low cost but the highest risk.

Methods of Deposition of Tailings

(Source: Ross Cooper, Sibanye Stillwater)

Sibanye Stillwater

Open End (Gold, Daywall)

Spigot (Upstream and Impoundments)

Cyclone (Upstream or Downstream)

Central Discharge (Thickened Tailings and Paste)

Penstock: The penstock is usually situated fairly close to the center of the tailings dam and built up using penstock rings. These control the water level, letting the slimes settle out of the water. This water is then piped under the tailings dam back to the plant via a penstock pipeline.

Source: Ross Cooper, Sibanye Stillwater

Example of poorly designed, constructed or managed tailings storage facilities, which resulted in failures in November 2022 (Mintails Group of Companies)

West Rand: Tailings Storage Facilities (Mintails Group)

Overview (Source: Dr M. Mpanza)

- Minerals, and Sustainable Development Project (MMSD), states that there are approximately 3500 active mining waste facilities worldwide, consisting of waste rock dumps and tailing dams
- Other sources report over 18 400 TSFs globally18,400 (Baker, *et al.,* 2020)
- China alone is reported to have 13 000 TSFs, no global database exists to verify these numbers
- Approximately 329 TSFs exist in the Wits Basin (this figure needs to be verified)
- Some of TSFs are abandoned and not rehabilitated
- Some of the TSFs are unlined
- Some are partially vegetated

TSFs impacts (Source: Dr M Mpanza)

- A tailings storage facility is a facility designed and managed to contain the tailings produced by a mine.
- If unlined contribute to AMD

-surface water pollution

-ground water pollution

- If not vegetated, can be a major source of dust
- Human health impacts of metal toxicity
- Failure- January 2019 , Vale's iron ore tailings dam in Brumadinho, Brazil, killed 270 people, 11.7 million cubic meters of waste. Over five miles of destruction.
- Safety threat- TSFs are a playground for illegal miners/ Zama Zamas associated with crime.

Identified Risks/Hazards of Tailings and Tailings Storage Facilities

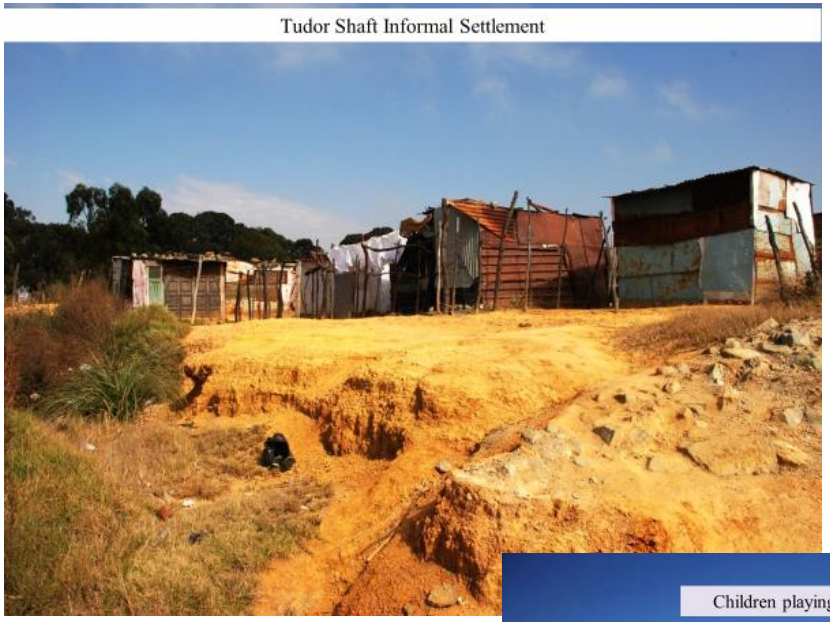
1. The airborne pathway, where windblown dust disperse outwards from mine sites.

2. The waterborne pathway, either via ground or surface water.

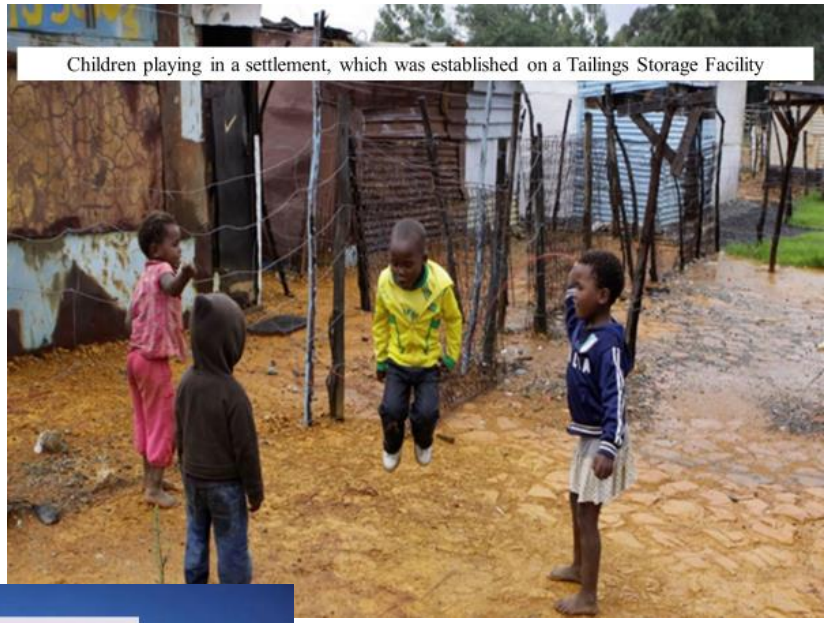
Identified Risks/Hazards of Tailings and Tailings Storage Facilities

3. Direct access, where people are contaminated after unauthorized entry to a mine site, or by living in settlements directly adjacent to mines or in some cases, living in settlements on the contaminated footprints of abandoned mines.

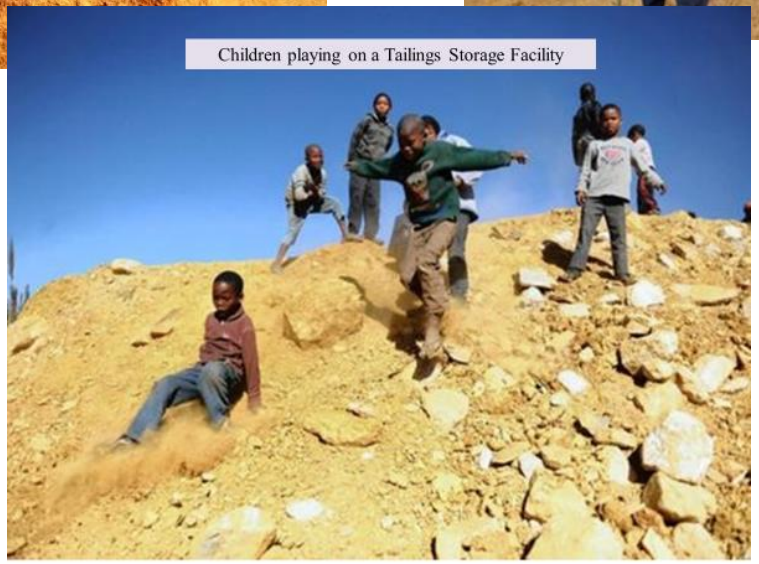
Tudor Shaft Informal Settlement



Children playing in a settlement, which was established on a Tailings Storage Facility



Children playing on a Tailings Storage Facility



Source: Natasha Griffiths

Geophagia (Eating of tailings)

Unauthorised entry onto Tailings Storage Facilities and the use of TSFs for recreational purposes

Photo: Francois van Vuuren

There has been a historical migration of generally elevated radioactive levels to the urban areas of Johannesburg central business district (CBD) indicating the **use of dump and waste material** for **building purposes** as well as downstream plumes in wetlands areas.

Reference: Esterhuyse, S, van Tonder, DM, Coetzee, H & Mafanya, T, 2008, Draft Regional Mine Closure Strategy for the East Rand Goldfield, Council of Geoscience, report no. 2008-0176, Pretoria.

Cattle grazing on soil containing tailings with a Tailings Storage Facility in the background

Current reality in SA

- Abandoned operations – ill … gal m… zamas")
- Poor issuance of closure certificates
- Mining Company insolvency- sudden closure
- Company business rescue-temporary closures
- Poor estimation of closure costs
- Inadequate Financial Provisions
- Demands for responsible tailings management do not end o… t… operation is closed

Source: Dr M. Mpanza

Past failures (Source: Dr M. Mpanza)

- TSF failure time line in South Africa

Past failures (Source: Dr M. Mpanza)

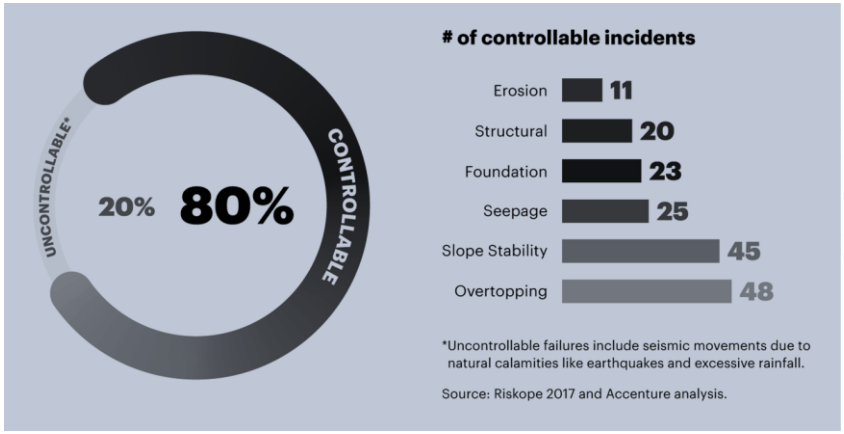
Jagersfontein Mine,11 September 2022 destroyed more than 160 homes, killed at least one person and hundreds of animals, and damaged more than 26 km2 of grazing

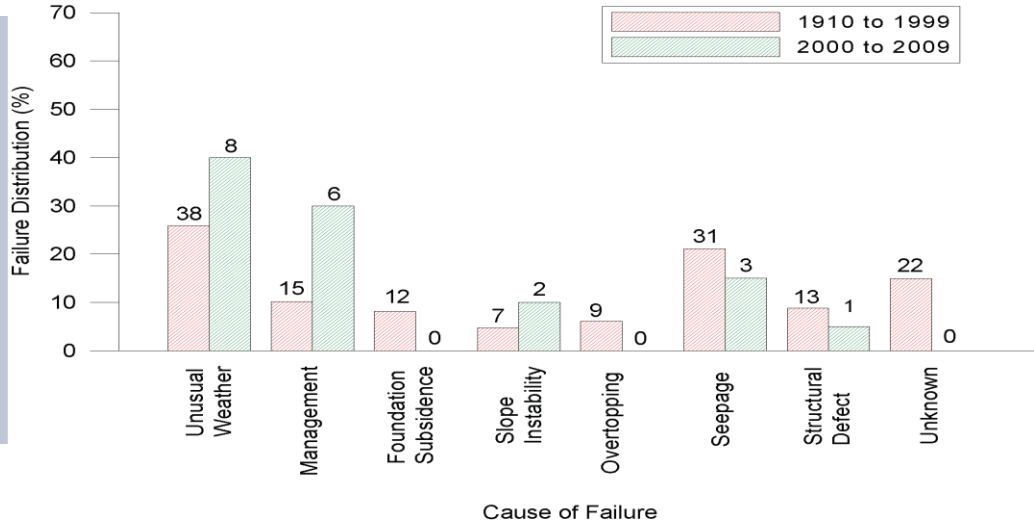
Merriespruit ,2 February 1994
50 mm of rain fell in 30 minutes; 17 people killed, 80 houses destroyed

Williamson Mine, Tanzania , 7 November 2022 , Dam wall breach

1976, Idaho, Teton dam, water erosion
300 million m^3
200 residences destroyed
14 deaths

Past TSF failures (Source: Dr M. Mpanza)



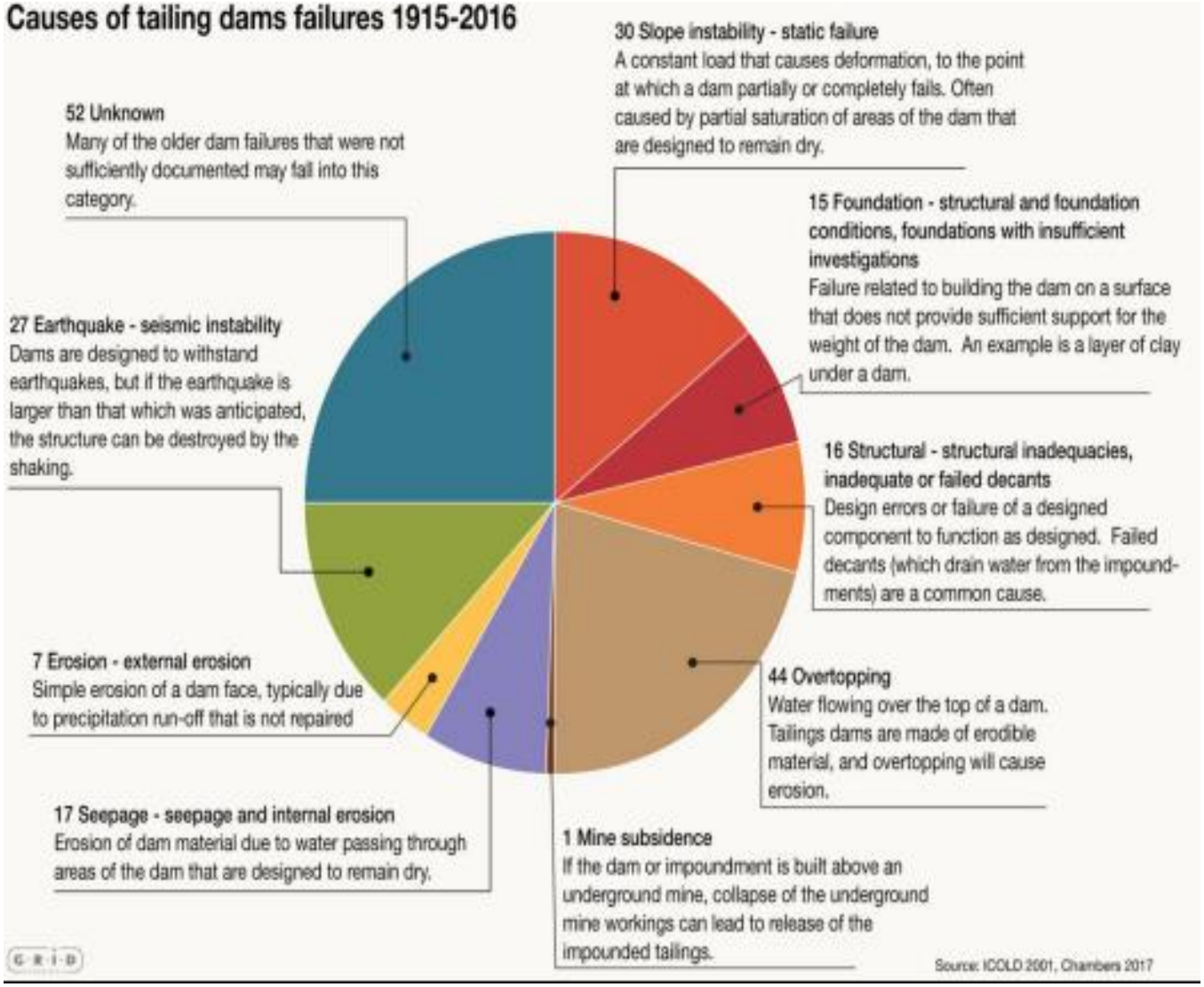


Brumadinho Brazil-led to the GISTM (Source: Dr M. Mpanza)

- January 2019, a tailings storage facility at Vale's Córrego de Feijão mine in Brumadinho, Brazil collapsed killing 270 people.
- 11.7 million cubic meters of waste
- Over five miles of destruction

Video of Brumadinho failure (Source: Dr M. Mpanza)

Causes of Failures of Tailings Storage Facilities

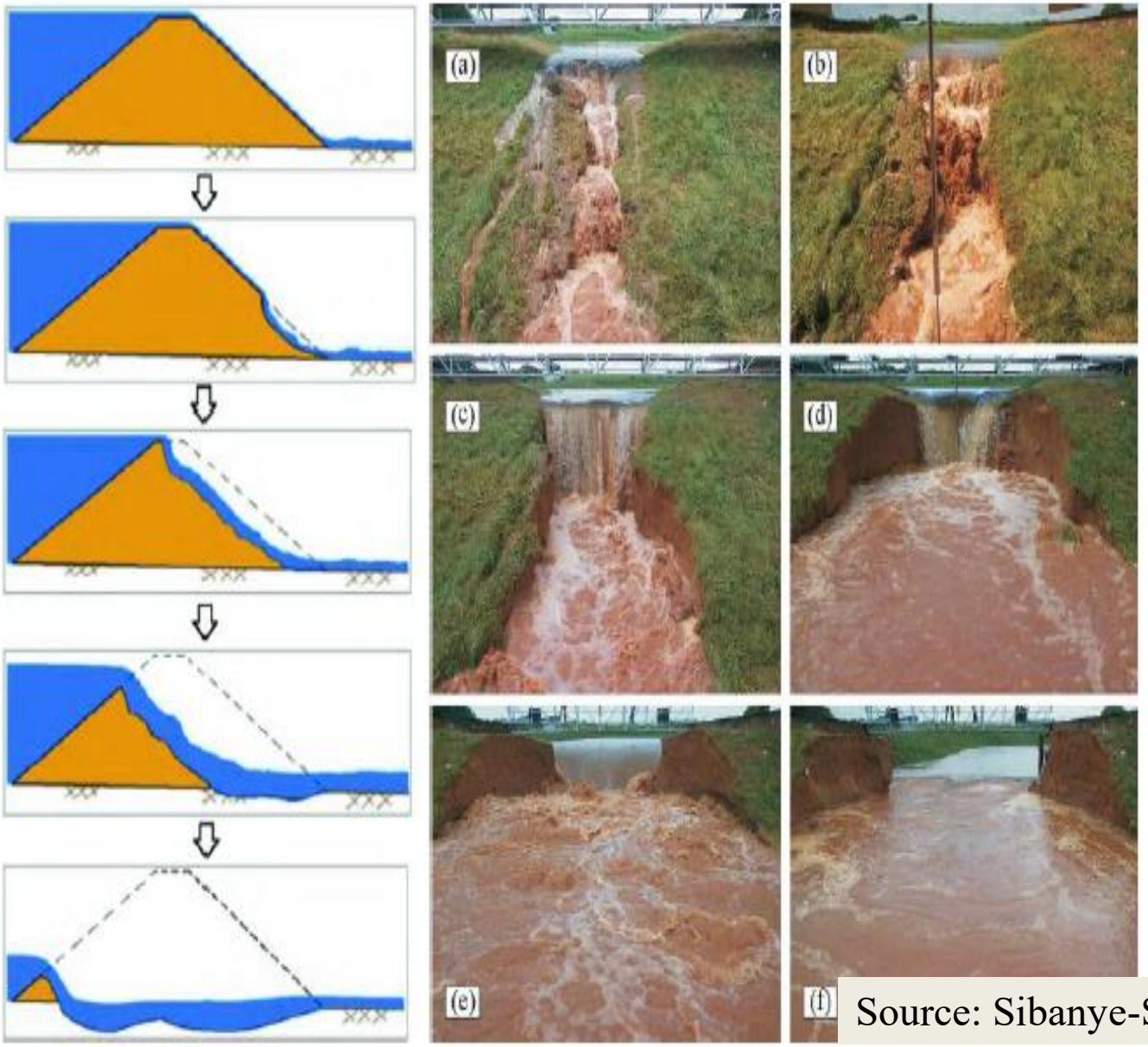


Erosion

Source: Oxpeckers

Slope Instability

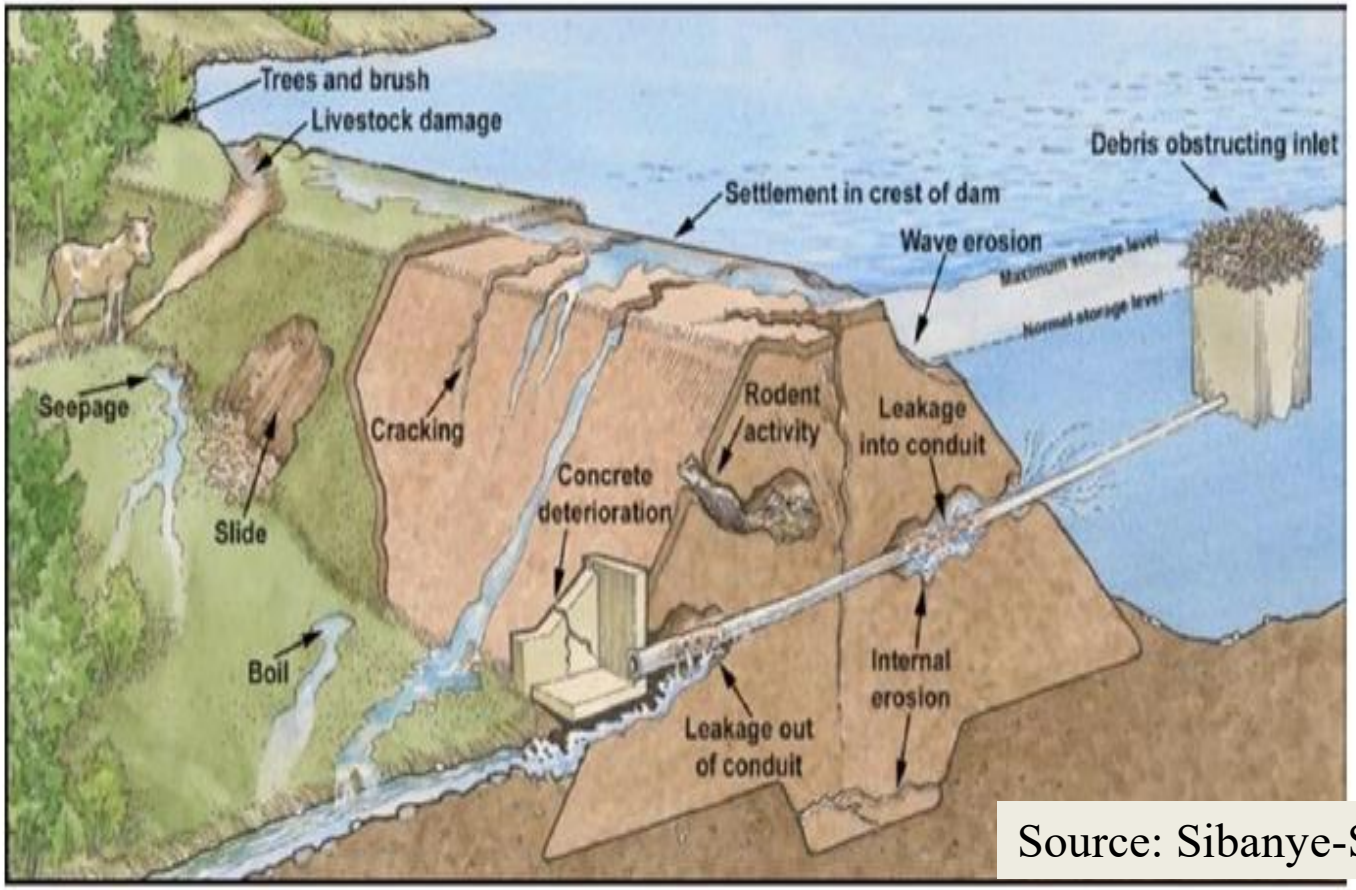
Overtopping - when the water volumes exceed the water storage capacity of the dam, resulting in w
flowing over the crest and eroding the outer wall as demonstrated below.



Source: Sibanye-Stillwater

Others – as seen in the illustration below

- Structural failure – materials used in dam construction fail
- Foundation failure – the foundation of the dam fails due to movement or construction
- Surface erosion – the embankment or settlement cracks
- Internal erosion – also known as a piping erosion
- **Theft or vandalism of piping, valves and equipment used to operate and monitor the safety of the dam**



Source: Sibanye-Stillwater

Discussion

Global action (Source: Dr M. Mpanza)

- Global Industry Standard Tailings Management

www.globaltailingsreview.org GISTM (Bruno Oberle)

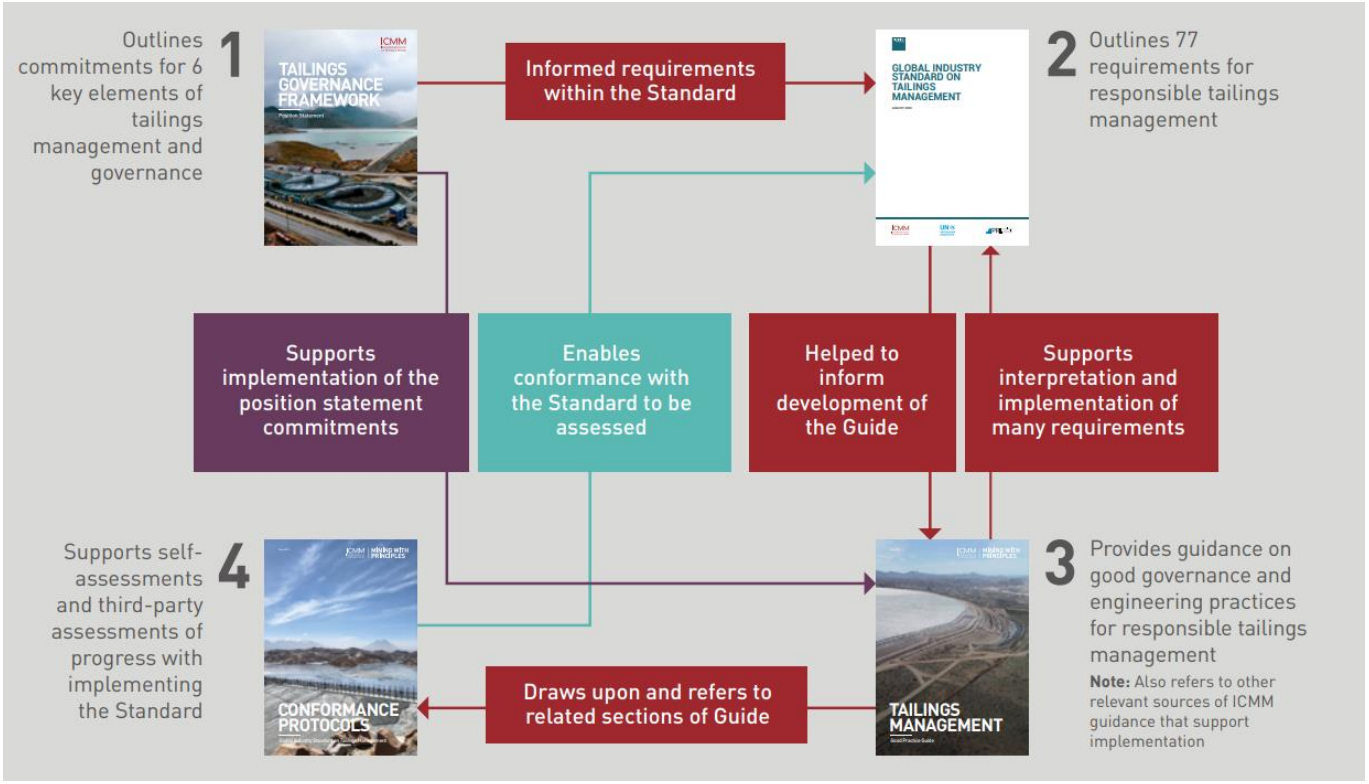
- The International Council on Mining and Metals (ICMM),

the United Nations Environment Programme (UNEP) and the Principles for Responsible Investment (PRI)

- The Church of England ethics and advisory committee on investment collaborated in 2020 to establish the GISTM
- The preamble: work needs to be done by national and/ or state level regulators to develop mechanisms that enable the identification, maintenance and/or restoration of abandoned or ‘orphaned’ facilities.

Link between ICMM and GISTM (Source: Dr M. Mpanza)

- Various documents of the International Council on Mining and Metals informed the GISTM



GISTM

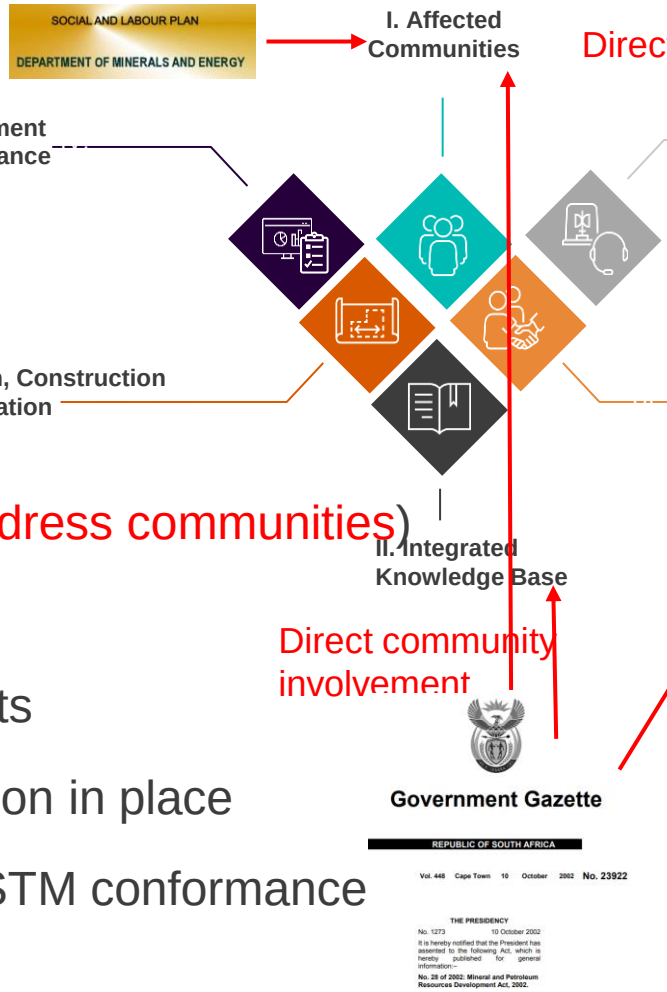
- Six topics

- 15 principles (1 & 15 address communities)

- 77 auditable requirements

- South Africa has legislation in place

Which can assist with GISTM conformance



GISTM


GISTM goal
ZERO harm to people and the environment requires integrated performance monitoring for ALL tailings dams...

GISTM Principles

I. Affected Communities

- Principle 1: Respect the rights of project-affected people and meaningfully engage them at all phases of the tailings facility lifecycle, including closure.

IV. Management and Governance

- Principle 8: Establish policies, systems and accountabilities to support the safety and integrity of the tailings facility.
- Principles 9: Appoint and empower an **Engineer of Record.**
- Principle 10: Establish and implement levels of review as part of a strong quality and risk management system for all phases of the tailings facility lifecycle, including closure.
- Principle 11: Develop an organisational culture that promotes learning, communication and early problem recognition.
- Principle 12: Establish a process for reporting and addressing concerns and implement whistleblower protections.

V.Emergency Response and Long-term recovery

- Principle 13: Prepare for emergency response to tailings facility failures.
- Principle 14: Prepare for long term recovery in the event of catastrophic failure.

III. Design, Construction and Operation

Principle 4: Develop plans and design criteria for the tailings facility to minimise risk for all phases of its lifecycle, including closure and post closure.

Principle 5: Develop a robust design that integrates the knowledge base and minimises the risk of failure to people and the environment for all phases of the tailings facility lifecycle, including closure and post-closure.

Principle 6: Plan, build and operate the tailings facility to manage risk at all phases of the tailings facility lifecycle, including closure and post-closure.

Principle 7: Design, implement and operate monitoring systems to manage risk at all phases of the facility lifecycle, including closure.

VI. Public disclosure and access to information

Principle 15
Publicly disclose and provide access to information about the tailings facility to support public accountability

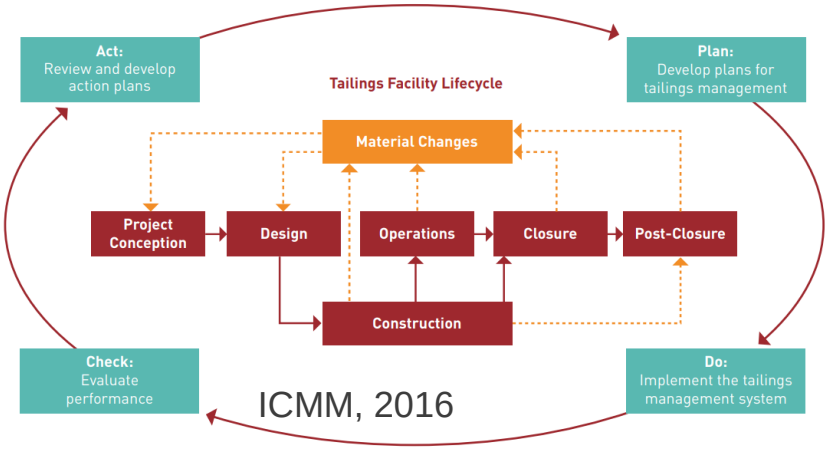
II. Integrated Knowledge Base

- Principle 2 : Develop and maintain an interdisciplinary knowledge base to support safe tailings management throughout the tailings' facility lifecycle, including closure
- Principle 3: Use all elements of the knowledge base - social, environmental, local economic and technical - to inform decisions throughout the tailings facility lifecycle, including closure.

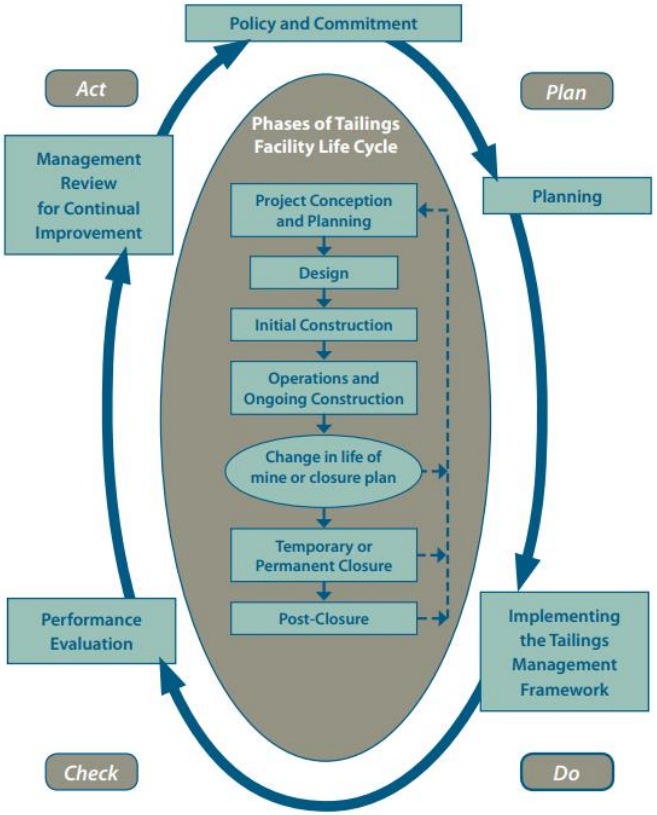
TSF life cycle

- It is important to understand the life cycle of TSFs

According to the ICMM the tailings lifecycle involves:
1. Project Conception
2. Design
3. Construction
4. Operations
5. Closure
6. Post-Closure



ICMM, 2016



MAC-Canadian Tailings Guide

GISTM


Community connection and response
Two-way comm. Network
Pre-impact assessment
Local risk knowledge adopted
Public awareness
Risk perception
Response in place
Evacuation plan
Institutional arrangement
Regulatory framework
Mandate
Roles and responsibilities
Interagency collaboration
Concept of operation
Earth data observation
Local hydro-met stations
Local seismic networks
DART BUOYS
AWS
Radars
Satellite observations
Survey Instruments
Risk communication
Mine community notified
Local community notified
Government notified
Data and information Collection
Mine Information centre
Drone comms
Satellite comms
Networks
Regional data
Dissemination and notifications methods
Siren towers
Text message
Mash box
Specialized networks
Others
Hazard detection
Hardware
Operating system
Data analysis software
Data integration software
Warnings and other infrastructure products
Watches
Advisories
Statements
Impact based forecasting/Warning
Hazard assessment
Vulnerability information
Impact and risk assessment
Hazard assessment
Observation
Criteria
Prediction models
Uncertainty assessment
01
02
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GLOBAL STANDARDS
Collaboration Enablement [Topic II]
Providing interdisciplinary knowledge sharing (P2)
Establishing auditable knowledge for TSF life-cycle (P3)
Operational Monitoring [Topic III]
Monitoring across life-cycle (P7)
Governance/Accountability [Topic IV]
Auditable system (P8)
Improve Competency [Topic IV]
Empower engineer of record with toolkit (P9)
Organisational culture change to support early problem recognition (P11)
Responsibility [Topic IV]
Establishing levels of system reviews – full life cycle to closure (P10)
Establishing process for reporting (P12)

Summary

- The GISTM, aims to prevent catastrophic failure and enhance the safety of mine tailings facilities across the globe
- It has the ambition of zero harm to people and the environment from tailings facilities
- Provides guidance for safely and responsibly constructing and managing mine tailings facilities
- It has the potential to strengthen ESG, across the mine's lifecycle

Definitions

List of words relating to the GISTM with explanations

What is a hazard?

Any substance, human activity, condition or other agent that may cause harm, loss of life, injury, health impacts, loss of integrity of natural or built structures, property damage, loss of livelihoods or services, social and economic disruption, or environmental damage.

.

What is a Catastrophic Failure?

A tailings facility failure that results in material disruption to social, environmental and local economic systems.

Catastrophic events typically involve numerous adverse impacts, at different scales and over different timeframes, including **loss of life, damage to physical infrastructure or natural assets, and disruption to lives, livelihoods, and social order.**

Catastrophic failures exceed the capacity of affected people to cope using their own resources, triggering the need for outside assistance in emergency response, restoration and recovery efforts.

Who are Project-Affected People?

People who may experience impacts from a tailings facility.

People affected by a tailings facility may include, for example, people who live nearby; people who hear, smell or see the facility; or people who might own, reside on, or use the land on which the facility is to be located or may potentially impact on.

Source: Harmony Gold Mining Company

Meaningful engagement

To demonstrate this respect, project-affected people must be afforded opportunities for **meaningful engagement** in decisions that affect them…throughout the tailings facility lifecycle.

What is meaningful engagement?

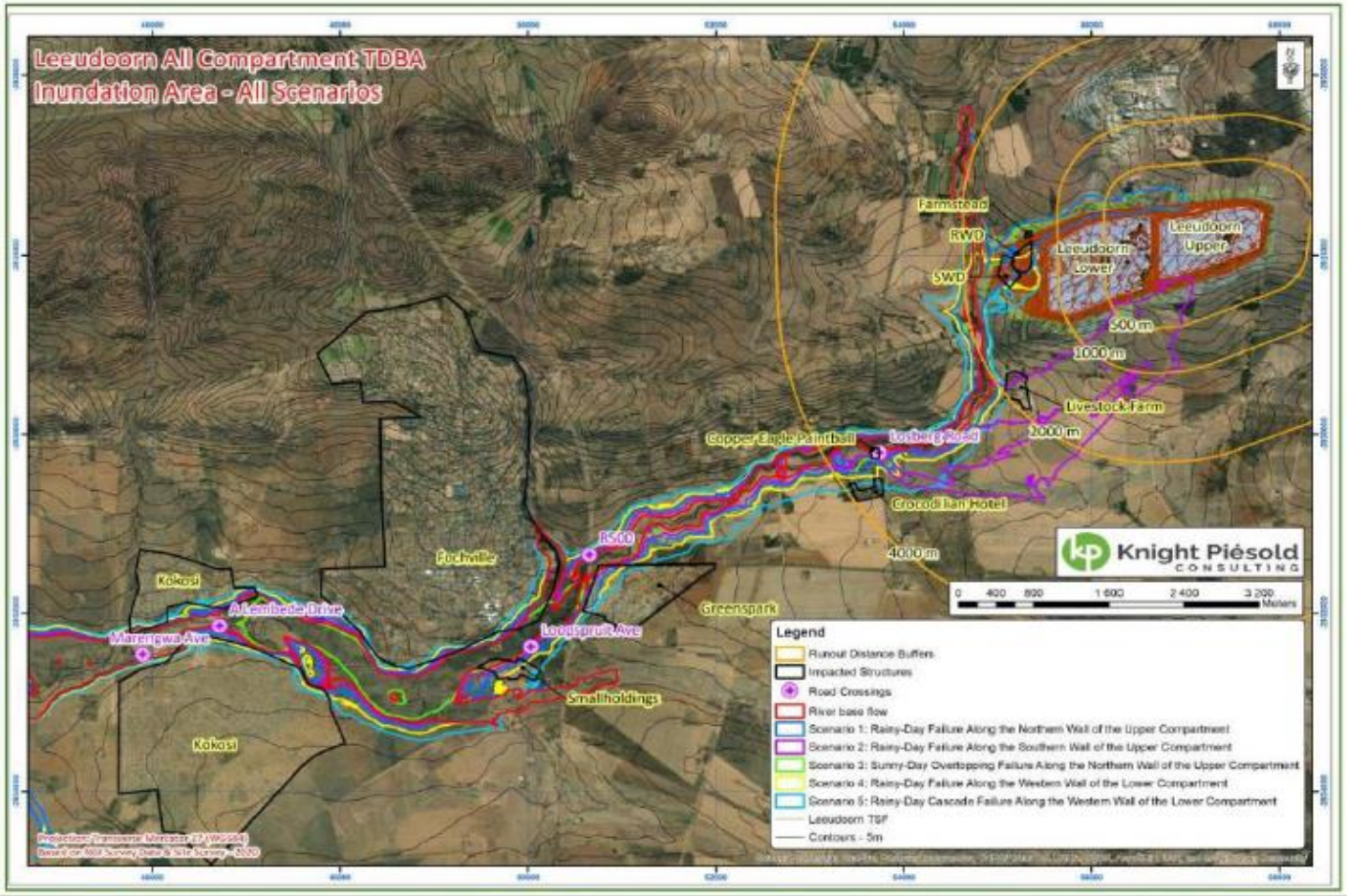
A process of **mutual dialogue** and decision-making whereby Operators have an obligation to **consult and listen** to stakeholder perspectives, and integrate those perspectives into their business decisions.

What is an Emergency Preparedness and Response Plan?

A site-specific plan developed to identify hazards, assess capacity and prepare for an emergency based on tailings facility credible flow failure scenarios, and to respond if it occurs.

DAM BREACH ASSESSMENT – LEEUDOORN (ALL SCENARIOS)

Source: Sibanye-Stillwater

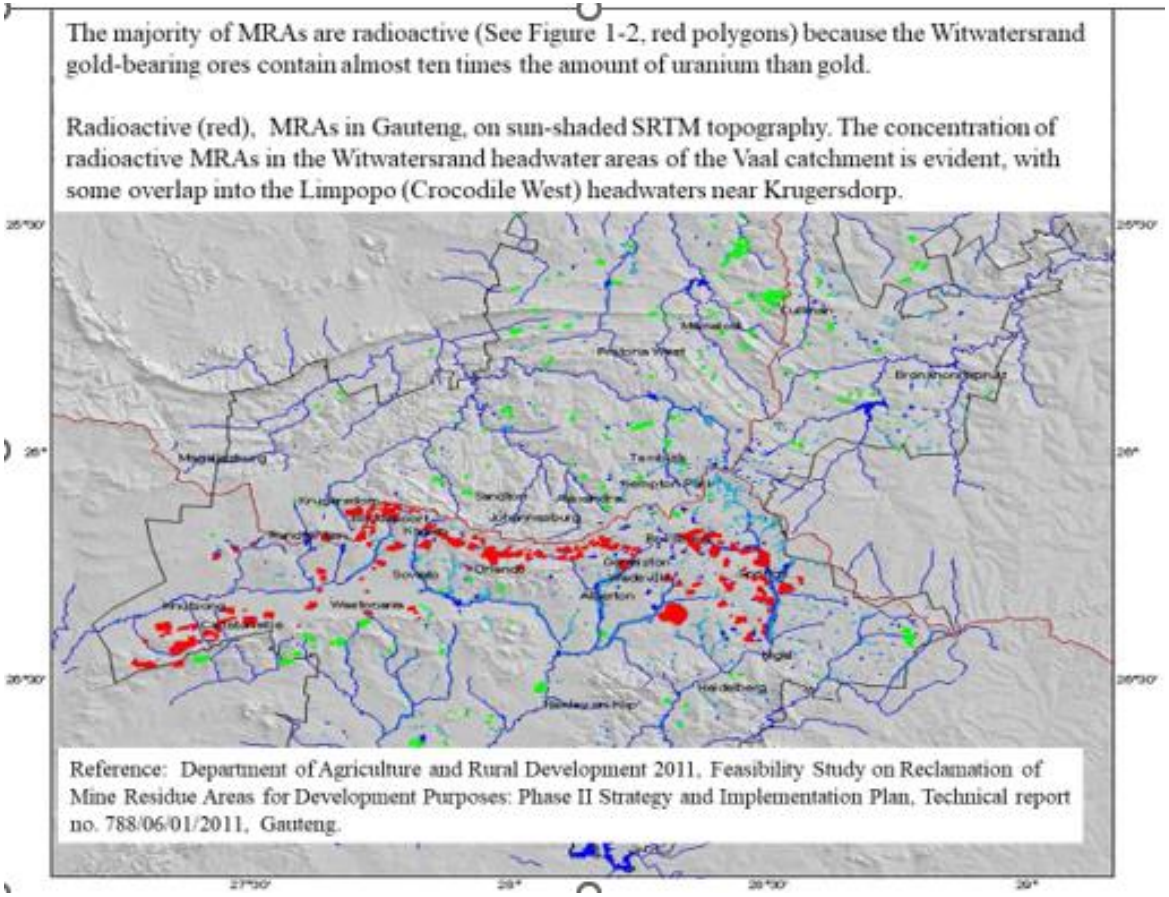


MINIMISATION OF RISKS TO COMMUNITIES FROM TAILINGS AND TAILINGS STORAGE FACILITIES

Risks to communities from tailings and tailings storage facilities can be minimised by the prevention of:

1.The uncontrolled current and future land uses on or within the zone of influence of Tailings Storage Facilities;

2.The encroachment of residential developments close to or on Tailings Storage Facilities;



MINIMISATION OF RISKS TO COMMUNITIES FROM TAILINGS AND TAILINGS STORAGE FACILITIES

3. Unauthorised entry onto Tailings Storage Facilities;

4. The inappropriate use of tailings and return water dams e.g.

4.1 the illegal mining of tailings or scavenging without the necessary authorisations;

4.2 the use of tailings for construction material;

4.3 recreational use;

4.4 spiritual rituals;

4.5 pica or geophagia;

4.6 grazing;

4.7 cultivation of edible crops;

4.8 watering of cattle; etc.

Discussion