Vedanta Limited

Sustainability Governance System

Guidance Note GN 05

Tailings Management Facilities

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1 INTRODUCTION

1.1 WHO IS THIS GUIDANCE NOTE AIMED AT?

This Guidance Note (GN) is aimed at all Vedanta subsidiaries, operations and managed sites, including new acquisitions. This GN is applicable to the entire operation lifecycle.

1.2 WHAT IS THE AIM OF THIS GUIDANCE NOTE?

A Tailings Management Facility (TMF) represents extreme potential risks as seen by failures in mining and other industries globally. A TMF failure can result is very high loss of life and major destruction to buildings and townships and to the environment including rivers and other receptors in the environment. This aim of this Guidance Note is to support implementation of the Vedanta TMF Performance Standard.

1.3 WHAT ISSUES DOES THIS GUIDANCE NOTE ADDRESS?

This Guidance Note presents details and outlines of key aspects of the Vedanta TMF Performance Standard.

1.4 HOW SHOULD THIS GUIDANCE NOTE BE USED?

This Guidance Note is mandatory, reflecting good practice and providing the basis for continual improvement of sustainability issues across the Vedanta business. The need for flexibility at a site depending upon specific circumstances or regulatory specific requirements is also recognised. This Guidance Note is not designed to be definitive text, nor is it designed to provide prescriptive methods and procedures for undertaking tasks.

In certain cases, there will be national and / or local regulatory requirements which address TMF operations and respective sites shall ensure that these requirements are identified and complied with.

The successful implementation of this Guidance Note is expected to require dedicated commitment from all of the Vedanta sites.

2 DESIGN ENGINEER RESPONSIBILITIES

The Design Engineer is the lead Vedanta engineer within each site operation who is responsible for the TMF on behalf of the location head.

This document outlines the specific responsibilities of the Owner's Engineer in the Vedanta TMF Standard and specifically in the six Annexures attached to the one-page standard.

2.1 TMF SITING

Annexure No. 1 lists the Good International Industry Practice site selection criteria for siting a TMF. The Owner's Engineer is <u>responsible to coordinate with various stakeholder and ensure managing the siting criteria program</u>. The actual work itself is typically performed by design consultants and often includes various departments within the operation. **The Owner's Engineer is responsible to make sure that all the criteria have been <u>evaluated for fatal flaws</u> and that Management has <u>signed off</u> each criterion.**

The TMF Siting Criteria and the *responsible parties* to address each are as follows:

- Potential for Ore body sterilization – *Exploration and Mine Planning Departments (applicable only for mining)*;
- Topography for long-term construction – *Topographic survey either by UAV or ground survey – typically a Survey Consultant*;

- Consider using previously constructed and/or natural geographic formations (e.g., existing pits, waste rock dumps, and/or natural slopes) – *Mine Planning and Land Departments*;
- Mine Planning - *Mine Planning, Exploration, Process and/or Power Plant, Land, Environment Social Responsibility (ESR) Departments*;
- Mine Layout - *Mine Planning, Exploration, Process and/or Power Plant, Land, Environment Social Responsibility (ESR) Departments, and Design/Survey Consultants*;
- Relationship of tailings facility to underground operation - *Mine Planning Department and Design/Survey Consultants*;
- Storage volume requirement over the life of the mine / Potential for future expansion - *Mine Planning, Process and/or Power Plant, Land, Environment Social Responsibility (ESR) Departments, and Design/Survey Consultants*;
- Proximity to process plant - *Mine Planning, Process and/or Power Plant, Land Departments, and Design/Survey Consultants*;
- Elevation and distance from the human habitation, sensitive environment receptor like water bodies, wet lands, heritage sites resulting in potential public health and safety risks, environment and economic risk for the business - *Land, Environment and Social Responsibility (ESR) Departments, and Design/Survey Consultants*;
- Meteorology (e.g. rainfall data) - *Environment and Social Responsibility (ESR) Departments;*
- Geotechnical and geological background (e.g. foundation conditions, seismic risk data) – *Design Consultant*;
- Need to respect the hydrogeological setting of the surrounding area (ground- and surface water) - *Design Consultant*;
- Existing land-use - *Land, Environment and Social Responsibility (ESR) Departments, and Design/Survey Consultants*;
- Adaptation of facility to surrounding area (e.g. dust, noise and odour control if there is residential population nearby) - *Land, Environment and Social Responsibility (ESR) Departments, and Design Consultants*;
- Natural and cultural environment - *Environment and Social Responsibility (ESR) Departments*; and,
- Biodiversity - *Environment and Social Responsibility (ESR) Departments*.

The Owner's Engineer, as the manager of the TMF Siting program, reviews the various studies and/or plans developed by Departments and Consultants and asks questions and requests clarifications to develop a full understanding of the program. Since the Owner's Engineer understands program's "big picture" he can discover knowledge gaps that the various Departments or Consultants can fill.

3 GEOTECHNICAL INVESTIGATION AND TMF DESIGN REPORT

3.1 GEOTECHNICAL INVESTIGATION

The parameters of a TMF related geotechnical investigation and should be developed by the designer and include the location, depths, types of sampling, and required laboratory testing that is to be performed. The actual investigation is typically performed by a geotechnical drilling company and the lab testing is performed by a qualified geotechnical laboratory.

The Owner's Engineer is responsible to review the overall program and make sure that the designer, driller, and laboratory are all in agreement on the geotechnical investigation with respect to the type of samples collected, the depth of drilling, and the standards followed. It is important that the driller have the appropriate equipment and experience to perform the testing required by the designer.

The Owner's Engineer may be required to develop access to the site investigation area, and working with the ESR Department, obtain clearance and if necessary, compensation to landowners and/or tenants. The Owner's Engineer may also need to arrange for an as-built survey of the geotechnical test locations performed by the Land Department or a Survey Consultant.

3.2 TMF DESIGN REPORT

The Owner's Engineer is responsible to review the design report to make sure that the designer has covered all of the relevant components of the TMF including return water ponds, pipelines, access roads, buffers, etc as outlined in Annexure No. 2. The Owner's Engineer should also inform the designer early in the project of any constraints such as buffers, future plant infrastructure areas, powerlines, roads, water treatment requirements, etc. so that the designer can incorporate these constrains into the TMF design.

The Owner's Engineer should also chair all design review meetings and seek review of the design from the various site departments. The Owner's Engineer is typically the primary Vedanta contact between the designer and the various Vedanta site Departments. The Owner's engineer will also be responsible for getting third party review of the design from a qualified and experienced designer / consulting agency and incorporated the recommendation in the design appropriately

4 ROLES AND RESPONSBILITY OF ENGINEER OF RECORED

Some India operations Vedanta have also assigned the Owner's Engineer with the added responsibility of Engineer-of-Record (EOR) and in other operations, the EOR role has been assigned to an external engineer or designer. At those sites where the EOR is an external consultant, the Owner's Engineer has the responsibility to support the EOR, setting up routine site visits, scheduling audits/reviews, and providing surveillance, monitoring, and construction data for the EOR's review.

5 CONSTRUCTON QUALITY ASSURANCE

The Owner's Engineer is responsible to make sure that the Construction Quality Assurance (CQA) is performed correctly. Typically, CQA is performed by a third-party consultant, but some operations have a dedicated Vedanta internal CQA team.

As noted in Annexure 4, the initial starter dam and raise construction should be monitored full-time, including the testing of the soil and geomembrane liner components and documented in a form of construction report. CQA is not just the process of recording the test data, but to track failed tests, document successful retests, and develop a comprehensive as-built construction report for all raise construction.

The Owner's Engineer should review the CQA test reports on a regular basis to ensure that when a test fails, the area represented by that failed test is reworked and retested until a passing test has been achieved. Once a test pasts, then construction in that area can proceed. This is especially important during soil compaction on embankments and geomembrane liner construction of TMF liner systems. In addition, the correct standard should be used whether it is based on laboratory testing or material strength properties provided by the manufacturer. CQA is performed on the Owner's behalf and the Owner's Engineer responsibility to confirm that proper tests and methods being performed and documented by the CQA consultant or owner's internal team.

The CQA test data and construction records, including as-built topographic survey serve as the basis to developing a construction as-built report (example table of contents included in Annexure No. 4). The construction as-built report should include record surveying of the construction and a comparison of the final construction limits and grades to the design drawings. The construction report should include a narrative that documents the field observation monitoring, field and laboratory testing of construction materials, defines limits of construction (by survey), and include construction sequence photographs. The report will also include and reference the design drawings and specifications as well as document any approved design changes made during construction.

The Owner's Engineer should review the construction report for accuracy and completion before it is submitted to the EOR. This construction documentation is very important since the Engineer-of-Record (EOR) will use the as-built construction report as a basis to determine if the construction meets the requirements of the design report, drawings, and specifications and any approved design changes.

6 TAILINGS MANAGEMENT PLAN

Each Vedanta operation has developed a site-specific TMF Management Plan. The Owner's Engineer is responsible to ensure that the TMF Team is aware of the requirements of the TMF Management Plan and to facilitate regular (at least annually) updates to the Plan. The Owner's Engineer should also be involved in the review of the routine TMF monitoring reports at a regular frequency, either daily or weekly reports or, at a minimum monthly, if the Owner's Engineer, depending on the TMF Team structure. It is important that issues noted on daily and weekly reports are transferred up the management chain of command so that critical issues can be addressed in a timely manner.

Note that some monitoring reports should be reviewed within a day or two to determine if there are any critical issues. This especially is important for embankment movement pins and piezometers. The Owner's Engineer, in concert with the TMF Team, should educate the monitoring staff to recognize when a monitoring report indicates a critical issue so it can be brought to management's attention immediately.

7 INTERNAL AUDIT CHECKLIST

The Owner's Engineer is responsible to make sure that the internal audit is performed quarterly. The Owner's Engineer should be either a participant or reviewer of the internal audit. The checklist for the internal audit is Annexure No. 5 of the Vedanta TMF Standard. Following the internal audit, the Owner's Engineer should follow up with the assigned corrective action plan and responsible person so that by the time of the next audit any deficiencies in the previous audit should be addressed.

8 DOCUMENTATION:

Permanent records must be maintained for each TMF covering at a minimum:

1. Risk assessment and mitigation plan.
2. Tailing Management plan.
3. Emergency response program and effectiveness evaluation report.
4. Investigation, design, construction reports over life of the asset.
5. Internal and external audit reports and corrective action plans.

ANNEXURE 1 - GOOD INTERNATIONAL INDUSTRY PRACTICE (GIIP) IN TAILING DAM SITING

While there are no specific criteria in site selection for tailing management facility, following factors are considered as Good International Industry Practice (GIIP) in managing environment, social and economic risk for the business risk over life of the TMF.

1. Potential for Ore body sterilization.
2. Topography for long-term construction
3. Consider using previously constructed and/or natural geographic formations (e.g., existing pits, waste rock dumps, and/or natural slopes)
4. Mine planning
5. Mine layout
6. Relationship of tailings facility to underground operation
7. Storage volume requirement over the life of the mine / Potential for future expansion.
8. Proximity to process plant.
9. Elevation and distance from the human habitation, sensitive environment receptor like water bodies, wet lands, heritage sites resulting in potential public health and safety risks, environment and economic risk for the business.
10. Meteorology (e.g. rainfall data)
11. Geotechnical and geological background (e.g. foundation conditions, seismic risk data)
12. Need to respect the hydrogeological setting of the surrounding area (ground- and surface water)
13. Existing land-use
14. Adaptation of facility to surrounding area (e.g. dust, noise and odour control if there is residential population nearby)
15. Natural and cultural environment
16. Biodiversity

As a part of the risk assessment, business will ensure that there is no fatal flaw in the proposed site / tailing dam location selection that would increase the environmental, social, public health and safety, and economic risk for the business significantly and making the project unsustainable. For example, location of the tailing dam upstream, in vicinity of the population, proximity to wetlands or biodiversity hotspot, heritage sites, etc.

ANNEXURE 2 - Geotechnical Investigation and TMF Design Report

TMF Design Report

There is no 'standard' approach to TMF Design Report as each TMF is unique. However, the TMF Design Report should consider and/or cover the following topics included in the typical report table of contents as follows:

EXECUTIVE SUMMARY

1.0 INTRODUCTION

1.1 Project Description and Background

2.0 SITE CONDITIONS

2.1 Topography and Physiography

Typical field investigation and Geotechnical report

There is no 'standard' approach to field investigations and geotechnical analysis, and should be carried out as per recommendation of the competent designer / engineering company. Based on the field investigation and geotechnical analysis, the geotechnical investigation report may cover following topics:

- Literature review for existing/ available geologic and geotechnical maps, reports of or surrounding the site.
- Site Reconnaissance
- Geological and Topographic mapping.
- Soil survey
- Sub surface exploration
  - Test boring done with in the footprint of the dam and appurtenant structure.
  - Test pits
  - Rock coring
- Sampling
  - Disturbed sampling
  - Undisturbed sampling
- Borrowed material study
- In-situ / Field testing
- Laboratory testing
  - Classification tests
  - Compaction tests
  - Strength tests
  - Consolidation tests
  - Permeability tests
- Geo technical analysis
  - Stability analysis
  - Seepage analysis
  - Settlement analysis

The extent and number of locations to be investigated will vary considerably depending on the site-specific conditions and existing information, as well as budgetary and jurisdiction-related constraints. Field investigations can include any number of the following:

- Shallow test pits excavated (to ~3 m) with backhoe (back actor), excavator or, in specific cases, through manual means (e.g. hand augers). These used to examine near-surface soils, carry out field classification and extract samples for laboratory testing. In some instances, it may be justified to widen the shallow test pits into investigation trenches.
- Boreholes drilled to hard rock/bedrock and/or groundwater whichever is the deeper. If bedrock is not likely to be encountered, the depth should be at least 50% greater than

the highest point of the embankment. Specialist advice should be sought by the tailings practitioner on the type of drilling equipment, diameter of hole, in situ testing to be carried out (including hydrogeological testing) and methods of sample recovery in order to obtain the information required for analysis and design purposes. In some cases, the boreholes may be converted to long-term monitoring bores or extraction wells.

- Cone penetration testing to characterize soft materials and pore pressures. CPT is an ideal method of investigation, particularly if there is a pre-existing TSF nearby. The results collected can be used to identify the stratigraphy, provide parameters for modelling and an indication of the propensity of the materials to liquefy.

- Geophysics is now a well-established technique to provide information on the sub-surface materials. It is a specialist area and advice should be sought from appropriately experienced personnel.

An indication of the types of investigations that may be considered for various design stages is provided in the following Table.

Study Level	Test Pits	Boreholes	CPT	Geophysics
Scoping	Possible	Unlikely	Very Unlikely	Very Unlikely
PFS (prefeasibility Study)	Typically, 10 to 50 depending on site size	Typically, 3, but in some circumstances none and in other cases up to 10 may be warranted	Unlikely	Unlikely
FS (feasibility study)	Supplementary to typically provide coverage of 1 test pit per 5 to 10 ha, or every 50 m along a perimeter embankment	Infill bores to provide information required for design and possibly monitoring. A total of least 6 per site (2 sections) but many more may be warranted.	Advisable depending on geology and location of the site. 5 to 10 locations depending on cost effectiveness.	May be justified depending on the complexity of the stratigraphy and the sensitivity of the downstream environment, or if tenement conditions preclude invasive investigations
DED (Detailed Engineering)	Could have been completed at FS level but infill pits may be required at targeted locations	Could have been completed at FS level but infill boreholes may be required at targeted locations or for future monitoring or seepage control	Could have been completed at FS level but may be required at targeted locations to improve confidence in parameter selection and optimize design	If not completed at FS level, would likely only be undertaken if there are uncertainties that need to be addressed

Typical Laboratory Testing

Samples are extracted from test pits, hand augers holes, boreholes or through CPT for the purpose of laboratory testing. It is important that appropriate testing is undertaken in order to support classification and obtain parameters for use in analysis and design. The laboratory test program should be carefully considered to ensure that the correct tests are stipulated, the correct number of tests are carried out and unnecessary tests are not undertaken. There is no 'one size fits all' and specialist advice should be sought by the tailing practitioner. Typically, testing will need to be carried out obtain the following information:

- The Tailings Dam closed after the mine reached its end of life, with all extractable ore processed.
- Classification of the materials to support development of the (hydro)geological model (e.g. particle size distribution, Atterberg limits, specific gravity)
- Strength of foundation and embankment materials for use in stability analysis

- Consolidation of foundation materials to inform the design
- Whether the materials are likely to be dispersive
- To identify candidate materials for use as construction materials and to obtain parameters (strength, permeability, filter compatibility) for use in analyses and design.

The laboratory test work program should be developed ahead of the field investigation plan so that suitable samples can be collected. Input from experienced geotechnical engineers is essential.

ANNEXTURE 4 - Construction Quality Assurance

Initial starter dam and raise construction should be monitored full-time, including the testing of the soil and geomembrane liner components and documented in a form of construction report. The Construction Quality Assurance (QA) should be performed by a third party consultant who has the responsibility to document and confirm that the construction was performed in accordance with the design, drawings, and specifications. This consultant is not just to record the test data, but to track failed tests, document successful retests, and develop a comprehensive as-built construction report for all raise construction.

The construction as-built report should include record surveying of the construction and a comparison of the final construction limits and grades to the design drawings. The construction report should include a narrative that documents the field observation monitoring, field and laboratory testing of construction materials, defines limits of construction (by survey), and include construction sequence photographs. The report will also include and reference the design drawings and specifications as well as document any approved design changes made during construction. This construction documentation is very important since the Engineer-of-Record (EOR) will use the as-built construction report as a basis to determine if the construction meets the requirements of the design report, drawings, and specifications and any approved design changes. An example table of contents for a TSF CQA Report is presented below.

Typical Table of Contents for CQA Report

1.0 INTRODUCTION

2.0 PROJECT SITE DESCRIPTION

2.1 Background
2.2 Design Basis
2.3 Construction Area(s)

3.0 CONSTRUCTION SUMMARY

3.1 Construction Materials and Borrow Sources
3.2 Construction Details
3.2.1 Project Staffing
3.2.2 Construction Equipment
3.2.3 Construction activities

4.0 CONSTRUCTION QUALITY CONTROL AND QUALITY ASSURANCE

4.1 Laboratory Tests
4.2 Embankment Foundation/Lifts Approval
4.2.1 Compaction Tests
4.3 Geotextile Manufacturer QA/QC Submittal

5.0 AS-BUILT SUMMARY

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ANNEXTURE 5 - Tailings Storage Facility Management Plan

The key document that incorporates and unifies all of the data, action items, responsibility matrix, and management reviews is the Tailings Storage Facility (TSF) Management Plan. The plan should include:

- Monitoring Requirements (Routine Inspections Daily, weekly, monthly, quarterly, annual)
- Sampling (Daily, weekly, monthly, quarterly, annual)
- Measurements (Daily, weekly, monthly, quarterly, annual)
- Record Keeping
- Management Reviews (monthly, quarterly, annually)
- Responsibilities Matrix (who is responsible for which task) Reporting
- Emergency Response

The plan should include forms which, can be customised, as well as serve as a repository for relevant TSF information. The TSF Management Plan will typically be updated after every raise so it will contain accurate information related to management of the TSF. An example Table of Contents for a Tailings Management Plan is presented below.

Typical Table of Contents for Tailings Management Plan

1.0 INTRODUCTION

1.1 Background and brief description of the project and tailing facility
1.2 Organization structure for tailing dam oms
1.3 Roles and responsibility
1.4 Competence and capability requirement
1.5 Management of change

2.0 DESIGN OBJECTIVES, DESIGN CRITERIA AND BASELINE CONDITIONS

2.1 Design objectives
2.2 Geotechnical investigation
2.3 Design criteria
2.3 Design details and drawings for dam development over life of mine

3.0 CONSTRUCTION QA / QC PROCEDURE AND RECORD KEEPING

4.0 TAILINGS SYSTEM COMPONENTS, OPERATIONS AND MAITNENANCE

4.1 Process plant tailings tank
4.2 Tailing storage capacity and production curve
4.3 Transfer pumps and tailings delivery pipeline design
4.4 Spigots and tailing deposition design.
4.5 Decant water system and return water system design
4.6 Groundwater monitoring wells
4.7 Piezometers
4.8 Under-drainage collection system
4.9 Under-drainage collection sump
4.10 Leachate Collection Recovery System (LCRS)
4.11 Basin liner
4.12 Standard operating and maintenance procedure during normal and emergency scenarios

5.0 MONITORING / SURVEILLANCE REQUIREMENTS AND RECORDS

5.1 Management structure
5.2 Inspection
5.2.1 Daily
5.2.2 Weekly
5.2.3 Monthly
5.2.4 Quarterly
5.2.5 Annual
5.3 Sampling
5.3.1 Daily
5.3.2 Monthly
5.3.3 Quarterly
5.4 Measurements
5.4.1 Daily
5.4.2 Weekly
5.4.3 Monthly
5.5 record keeping

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Annexure 6 - Internal Audit Checklist / Format

No.	Planning	GAP	Corrective Action	Person responsible and timeline
1	Select a TMF site based on Good International Industry Practice (GIIP) and fatal flaw analysis considering the topography, mine site layout, proximity to process plant, gradient, distance from human habitat, and important environment receptors such as water bodies, wetlands, heritage site, etc. **(Ref Annexure 1).**			
2	The TMF has current stage – storage capacity curve and it is in an area that allows for expansion to meet tailings storage requirements over the life of the mine / facility.			
3	Business has evaluated various tailing disposal methods including conventional slurry disposal, thickened tailings, paste tailing, and co-disposal methods etc. towards tailing related business risk mitigation at optimal cost of tailings disposal over life of the project.			
	Design			
4	TMF is designed in compliance with permit requirements and in consideration of national and international standards on dam design such as CDA, MAC, ICOLD, etc. with adequate margins of safety for prevailing climate, seismic, environmental conditions and the site's risk classification.			
5	The Designer/Engineering company has accounted for decommissioning, closure, and rehabilitation aspects in the design of the TMF to minimize business risk over life of the project.			
6	The Designer/Engineering company is actively involved in TMF site selection, planning, geotechnical investigation etc. prior design of the TMF and submitted the TMF investigation and design report in line with Vedanta TMF performance standards requirement.			
7	The Designer/Engineering company has provided a comprehensive TMF design including the TMF structure design, pipelining, and pumping systems design tailings delivery and decant systems design etc. in order to minimise business risk and optimize total cost of the tailing operation over the life of the TMF.			
	Construction			
8	Business has engaged a qualified contractor for construction and a qualified third-party consultant to monitor TMF construction work. The third party consultant submits comprehensive construction report in line with the Vedanta TMF performance standard.			
9	The Designer/Engineering company undertake periodic site visits during TMF construction to review and certify the completion of the construction work in with the design requirement.			
	Operation, Monitoring, and Surveillance (OMS)			
10	Business has developed a comprehensive Tailing Management Plan (TMP) including standard operation, Maintenance and surveillance (OMS) procedures and, defined roles and responsibilities for managing TMF in line with Vedanta TMF performance standard.			

No.	Planning	GAP	Corrective Action	Person responsible and timeline
11	The Designer/Engineering company has incorporated adequate surveillance and monitoring system / equipment such as piezometers, embankment survey monuments, etc. in the design, which subsequently incorporated in construction and monitored during operation phase towards evaluation of performance of TMF.			
12	Operation has developed documented monitoring systems which review at various level in line with Vedanta TMF standard.			
13	Business has developed comprehensive emergency response plan that is periodically evaluated through desktop assessments, mock drills, and updated annually at minimum.			
	Management system			
14	Business has designated "TMF Manager" supported by cross functional team from relevant function / department for effective management of the tailings operation.			
15	Business has identified significant Public health and Safety and environment hazards over life cycle of the project (siting, design, construction, operation, (temporary and final) closure and rehabilitation), and developed a risk register to manage these environment, public health and safety, social and economic risks in line with Vedanta risk management framework.			
16	Business undertake periodical risk assessment and develop risk mitigation plan. The TMF related risk and mitigation plan are discussed at various level at the unit, business and the Vedanta level.			
17	The Designer /Engineering company is engaged as "Engineer of record" who works seamlessly with the business in managing TMF over its complete the life cycles.			
18	Business has implemented the Vedanta - Change Management Standard for material changes in investigation, design, construction, operation, and monitoring processes including the people involved in managing these aspects.			
19	Business conducts periodical internal audits to check compliance against the Vedanta TMF standard and undertake appropriate corrective action.			
20	Business undertake third party independent audit of the tailing dam at prescribed frequency in the Vedanta TMF standard.			

- Business may develop detailed internal audit format using “Mining Associate of Canada (MAC) “Guide to Management of Tailing Facilities” (2011) and other relevant MAC documents.