Government of **Western Australia**
Department of **Mines and Petroleum**
Resources Safety and Environment Divisions

Guide to Departmental requirements for the management and closure of tailings storage facilities (TSFs)

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Foreword

This guide has been provided to assist tailings storage facilities (TSFs) designers and operators with preparing the required reports for managing a TSF. It describes the reports that should be submitted to the Department of Mines and Petroleum (DMP) in accordance with section 4 of the Mining Proposal guidelines as required by the *Mining Act 1978* and the *Tailings storage facilities in Western Australia – code of practice*.

While there is no definitive format required for these reports, certain information is required in order to assure DMP that a TSF can be managed safely.

As necessary, this guide will be updated to present required changes to each report. Refer to the latest online guide to ensure essential requirements are covered in submitted reports.

Notes:

1. *It is the responsibility of the Principal Employer, Mine Manager and tenement holder to comply with obligations that exist under the Mines Safety and Inspection Act 1994 and the Mines Safety and Inspection Regulations 1995 (e.g. contaminated sites, Environment Protection Act).*
2. *Authorised versions of the Act and regulations are available from the State Law Publisher (www.slp.wa.gov.au), the official publisher of Western Australian legislation and statutory information.*
3. *It is the responsibility of the Registered Manager or the competent person(s) involved in the TSF design to prepare :*
    - *an as-constructed report (construction report)*
    - *an operating manual*
    - *audit reports*
    - *a decommissioning plan.*
4. *A competent person means a person who is appointed or designated by the responsible person to perform specified duties which the person is qualified to perform by knowledge, training and experience (see the Mines Safety and Inspection Act 1994).*

Introduction

This guide has been prepared by the Department of Mines and Petroleum of Western Australia (DMP) to provide information for the consistent preparation of reports for tailings storage facilities (TSFs) in Western Australia. It provides both the technical basis and administrative framework that meets the legislative requirements currently covering the mining industry in Western Australia.

TSFs are an important part of most mining operations and should therefore be an integral part of the safety and environmental management systems of a mine. Effective tailings management requires development and implementation of these systems during:

- design (for more information see the separate *Guide to the preparation of a design report for tailings storage facilities (TSFs)*)
- construction (see chapter 2)
- operation (see chapter 3)
- inspection and audit (see chapter 4)
- decommissioning and closure of the TSF (see chapter 5).

These documents are required to align with the design objectives of the TSF, and take into account the provisions that relate to TSFs in the following:

- *Mines Safety and Inspection Act 1994* and Mines Safety and Inspection Regulations 1995
- *Mining Act 1978* and Mining Regulations 1981

These documents should be prepared by a competent person and commensurate with the level of complexity of the TSF and its hazard rating. Due consideration needs to be given to the requirements of other agencies and relevant Acts. For example:

- *Environmental Protection Act 1986*, Parts IV and V
- *The Rights in Water and Irrigation Act 1914*, Part III.

Note: Throughout this guide, the term retaining structures also refers to embankments and containment structures.

1 Preparation of the TSF design report

Refer to *Guide to the preparation of a design report for tailings storage facilities (TSFs)*.

2 Construction supervision and preparation of the TSF construction (as-constructed) report

2.1 Introduction

Construction supervision ensures that TSFs are built according to design and specifications. In Western Australia, TSF construction should be supervised by the competent person responsible for the TSF design, or their representative. The extent of supervision will depend on the complexity of the design, the size of the completed TSF and its hazard rating. The competent person involved in the supervision of the TSF construction should prepare an as-constructed report and certify that the as-constructed TSF meets design specifications and tolerances as detailed in the approved design report.

The as-constructed report is a record of actual ground conditions encountered, the construction processes undertaken, and contains as-constructed drawings. This report is used to validate design assumptions and as a tool to assess the performance during operation and after closure of a TSF.

The as-constructed report, together with monitoring data, forms the basis of the design and construction of any subsequent stages of TSF development and the successful operation and maintenance of a TSF. Therefore, it is important to ensure the accuracy, completeness and timeliness of as-constructed reports.

Where construction is staged between deposition cycles, a separate construction report should be prepared for each stage.

An as-constructed report must be prepared and submitted for Category 1 and 2 TSFs. For Category 3 TSFs the requirement for construction reports is determined on a case-by-case basis and imposed as mining tenement conditions.

It is preferred that the TSF construction report is submitted online through the DMP website at www.dmp.wa.gov.au.

2.2 Site conditions encountered

A detailed and accurate record of the site conditions encountered during construction is vital to assess the future performance of the TSF, both in the short-term and long-term. The information to be recorded includes:

- retaining structure foundation and storage floor conditions
- variations from expected conditions
- construction material characteristics
- variations from expected construction material
- locations and conditions of drill holes and test pits within the TSF footprint, and details of their sealing and backfilling
- volume of topsoil recovered and where it was stored.

2.3 Design modifications during construction

On some mining projects it is not uncommon for changes to be made during construction of a TSF because of unforeseen circumstances. The details of these modifications should be recorded during the construction process to reflect what has actually been built. The as-constructed report should describe and justify modifications required from the approved design, and include:

- list of modifications
- reasons for the modifications
- validation of the design modification to confirm it has minimal impact on the approved design.

Note: Where major modifications to the approved design are necessary to implement the construction (e.g. increased footprint involving additional land clearance), further regulatory approvals may be required before proceeding with the modified construction.

2.4 Construction details

The as-constructed report should provide brief and accurate descriptions of the construction processes undertaken to build each component of the TSF. It should also provide the results of the quality assurance inspection and quality control testing on the TSF for validation of the design that was outlined in the mining proposal. The items expected to be covered include:

- timing and duration of construction activities
- construction methods and equipment used
- supervision and inspection
- foundation treatment and storage floor preparation
- earthworks quality control testing strategies and results (e.g. compacted density, permeability, dispersivity)
- synthetic material quality control (e.g. HDPE liner, geo-fabric membrane)
- rework of material not meeting specifications
- sources and engineering properties of construction materials
- effects of variations, if any, of construction material properties from those expected
- quantities of construction materials used
- tailings delivery and discharge systems, including pipework
- water management structures (e.g. decant, return ponds, under-drainage, seepage cut-off trenches, keyways, surface water diversion)
- instrumentation (e.g. piezometers, settlement monitors)
- construction details of access ways.

2.5 As-constructed survey drawings

These survey drawings should provide an accurate record of the as-constructed TSF, and provide the basis for successful operation, future expansions, maintenance, decommissioning and closure of the TSF. They are expected to show the following:

- layout and post construction ground surface contours inside and outside the TSF

- nearby features (e.g. tenement boundaries, infrastructure, drainage paths)
- the retaining structure and storage floor profile
- buried pipework and cables
- monitoring instrumentation
- decant towers
- drains and surface drainage control measures
- process water and return water ponds
- seepage trenches
- boreholes, test pits and borrow pits within the TSF and their profile
- topsoil stockpiles, and capping material sources
- any design modifications that have occurred during construction.

Note: See Resources Safety's Mines survey – code of practice.

2.6 Certificate of compliance

As-constructed reports are required for Category 1 and 2 TSFs and are assessed by DMP inspectors.

Tailings may not be deposited in the new TSF unless the as-constructed report confirms that the construction meets the design intent. A Certificate of Compliance should be provided for the TSF construction, signed by the competent person and the relevant Registered Manager, to certify that construction has met the design intent. The as-constructed report may still be audited as part of DMP's commitment to quality control.

3 Preparation of the TSF operating manual

3.1 Introduction

A TSF operating manual is required for each TSF. It is integral to a successful tailings management plan and, and is aligned with the design objectives of the TSF. A carefully prepared operating manual will form part of the overall management plan that encompasses all aspects of managing a TSF while ensuring that the TSF can be rehabilitated and closed, and meet public expectations relating to environmental performance.

The TSF operating manual should identify all areas of TSF management requiring consideration during the operating phase of the TSF and outline a course of action if performance is inadequate. As the mining industry is required to take a long-term view of the storage of tailings, each operating manual should also address the rehabilitation, closure and post-closure monitoring requirements of the TSF.

3.2 Components of an operating manual

Components of the TSF that are influenced by general day-to-day activities, and that should be addressed in the operating manual, include:

- tailings deposition
- decant operation
- routine inspection and maintenance.

The following sections should be covered.

Summary of operational procedures

Describe general operational procedures, including:

- purpose of the TSF (e.g. providing maximum water recovery, maximising tailings storage capacity, reducing environmental impact, ensuring containment of tailings)
- layering requirements of deposited tailings
- slope angle of TSF beach
- drying time between successive depositions
- method to achieve supernatant water pond away from retaining structures, spigotting techniques and rotational schedule
- minimal operating freeboard requirements
- frequency of inspections.

Components of TSF

Describe the components of the TSF, including:

- tailings and deposition — in situ densities, optimum water returns)
- tilings pipe work — route, composition (steel or HPDE), flanges and connections
- spigots — construction and operation including maintenance
- decant and decant operation — pumping, supernatant water pond size, pipe network, valves and pumps
- underdrainage system and operation — operation and monitoring water flow

- position, type and purpose of instrumentation.

Inspections

Describe the required inspection regime that will check the TSF achieves desired outcomes, including:

- routine daily inspections — frequency of inspections (normally twice per production shift) and should cover
  - pipelines to and from the TSF
  - leak detection
  - spigots and valves
  - tailings deposition — flow, erosion, beach and freeboard
  - location and size of water pond
  - decant structure and decant pump
  - process water pond and water return pumps
  - underdrainage sump and flow from underdrains
  - any seepage from retaining structure toe
  - status of any secondary retaining systems
  - integrity of the retaining structure wall i.e. new cracks and or seepage
  - changes to existing cracks and or seepage
  - condition of windrows along crest of retaining structure wall
  - assessment of impacts to birds, wildlife or livestock that may be affected by tailings water consumption
- monthly inspections — these inspections ideally should be conducted by process plant management and should assess
  - retaining structures (cracking of retaining structure crest or batter slopes)
    - signs indicative of seepage along downstream retaining structure slope
    - water ponding relative to the retaining structure walls
    - tailings freeboard
  - status of any secondary retaining systems
  - tailings characteristics — any observable changes
  - spigotting/placement — distribution of tailings, beach angle and are the correct amount of spigots being used, condition of valves
  - decant system and operation
    - position of the pond surface (is it within the planned design)
    - water balance (is the system efficient to keep-up with the water generated from the tailings plus any water from a storm event?)
  - tailings and return water lines (free of leaks, integrity of bunds)
  - ground water monitoring (has it been performed and are any limits being exceeded?)

  - assessment of impacts to birds, wildlife or livestock, that may be affected by tailings water consumption
  - recordkeeping of inspection and monitoring results
  - evidence of analysis and assessments conducted, where required
- compliance inspections and audit — these inspections and audits should be carried out to ensure compliance with relevant legislation requirements.

Maintenance

The daily, weekly, monthly and annual maintenance schedule should address, with assigned responsibilities, the infrastructure that serves the TSF, including instrumentation.

Instrumentation and monitoring requirements

Describe the instruments and monitoring requirements of the TSF, including:

- description and purpose for the different instrumentation monitoring devices
- tolerance limits and trigger values clearly stipulated for the different measurements
- maintenance requirements of these devices
- calibration when required
- status of automatic flow measurement, any settlement monitoring and fault alarms.

Emergency action plan

A detailed description of this plan should include:

- emergency action triggers (e.g. freeboard less than design, elevated piezometer readings, retaining structure distress, overtopping)
- response actions — include an action plan for the various emergencies with contact details, muster points, actions to be taken, with provision for the following scenarios
  - tailings and return water line failure
  - process water pond pump failure
  - perimeter retaining structure failure
  - seepage
  - sever storm and rainfall events
- incident reporting of unwanted events.

4 Preparation of the TSF audit report

4.1 Introduction

TSF inspection, auditing and reporting must be carried out at the frequency prescribed by the tenement conditions relevant to the site. These reviews are to be conducted by competent persons and incorporate all relevant monitoring data and operational strategies for the relevant review period. The aim of the audit is to provide a technical report that compares measured and observed performance against operational and closure expectations specified in the mining proposal design report.

Where operational performance diverges from design expectation, the audit report is to include a list of actions to be taken to remediate the variation. Where the proposed changes to the operation and design of a TSF are significant, an addendum to the mining proposal is required that details and justifies the proposed modifications and verifies expected outcomes.

Performance monitoring can take numerous forms. The decisions on which performance indicators are to be monitored and the strategies to be implemented when monitoring these indicators will be influenced to a large degree by the potential impact each indicator can have on the TSF. Such decisions should be made with due consideration of all relevant factors by a competent person.

For example, the important role of the phreatic surface on the performance of TSF foundations, retaining structures and tailings beaches is well documented (e.g. ANCOLD 2012). It follows that where the stability of the TSF, at design, is significantly impacted by pore water pressures, appropriate strategies need to be put in place to monitor phreatic surfaces during the life of a TSF to ensure assumptions made at the design stage remain valid.

In addition to providing an on-going history of the TSF (vital at sites where staff retention rates are low), this information provides invaluable assistance with planning tailings management, scheduling TSF retaining structure raises, storage optimisation and improvements to general tailings management practices.

This guide sets out the preferred structure and contents of a periodic audit report for a “generic TSF”. For simplicity, the required information has been provided as a checklist to ensure all critical information has been included in the audit report before submission.

4.2 Report content

As mentioned, the aim of a TSF audit report is to provide a technical report that compares actual TSF performance at all stages of the life of the TSF against expectations specified in the mining proposal design report. The findings of these audits will assist with planning and scheduling ongoing tailings management strategies.

Generically, the audit report should contain the following information.

General description of the complete TSF

This should include a summary of:

- tailings management practices and any reclaim operations
- geometry and maximum height of the TSF
- site specific features

- significant incidents (e.g. retaining structure settlement, seepage), constraints or alterations to the TSF or operations from the original plan
- retaining structure lifts (e.g. height, methodology, materials)
- survey diagrams of the TSF and immediate surrounds, with spigot locations, at a scale that allows measurement to be taken. The diagrams should show
  - representative sections through the retaining structures and tailings illustrating cumulative changes in construction during each review period since inception
  - contours with spot elevations along walls and across tailings beaches and ponds
  - location and heights of all tailings infrastructure, pipelines, and spigot locations
  - any change in tailings and retaining structure profile during the period.

Note: Specific details of any retaining structure lifts will be included in the construction report.

Details of TSF operation

This should include:

- reconciliation of stored tailings volume and actual densities with expected values from the design report, with an assessment of available capacity remaining in terms of scheduling retaining structure lifts
- verification of the in situ physical and geotechnical properties, and phreatic surface within the tailings beach profile and retaining structures — for Category 1 and 2 TSFs, in situ strength, and the piezometric profiles within the retaining structures, stored tailings and foundations should be included from the time the first retaining structure raise is required
- verification of moisture content, consolidation or swell parameters and in-situ densities of the whole tailings profile (e.g. pH, residual chemical concentrations)
- results from any settlement and ground movement monitoring
- water balance studies and reconciliation, using slurry volumes, solids content, decant recovery, site rainfall and evaporation, seepage and retained moisture in tailings
- details of monitored seepage, groundwater quality and groundwater mounding and effect on environment
- verification of the hydrogeological, hydrological and climatic design models, through back-analysis of monitoring, testing, pumping and decant records, particularly during periods of extended rainfall, very low or very high evaporation, and plant shutdowns.

Note: Historical information is to be appended to data from current review periods.

Interpretation of monitoring results

Present interpretation of monitoring results, with tables and graphs, including:

- proposals for additional monitoring of identified problem areas
- implications of monitoring results (e.g. changed management practices or new works)
- proposals for any necessary seepage recovery systems.

Validate TSF design

Validate that design limits are still within intended design tolerances. Where tolerance limits are exceeded, the following should be undertaken:

- re-assessment of retaining structure design stability analysis (e.g. static and dynamic conditions) and, if required, dambreak re-assessments — during operation and after closure
- modification of design, if required, to bring stability analyses back to design tolerance limits and in line with emergency action plans
- review implications for future performance of the TSF if present observed and monitored trends continue
- initiate remedial actions to bring any divergent performance indicators back to design tolerance limits
- implement changes to operational procedures to bring any divergent performance indicators back to design tolerance limits
- establish ongoing performance monitoring and verification testing requirements.

The registered manager must formally commit to implement any actions recommended by the competent person and justify any variation from those recommendations.

Verify compliance with statutory requirements and mining proposal commitments

- List of any compliance directives issued by DMP in relation to the TSF (e.g. stop work order, improvement notice, direction to modify, record book entry, prohibition notice) with evidence of compliance.
- Confirmation of compliance with approved mining proposal and tenement conditions.

Updated tailings storage data sheet

An updated tailings storage data sheet should be including with the report.

4.3 Submission of an audit report

The TSF audit report is to be submitted online through the DMP website at www.dmp.wa.gov.au.

A covering letter should accompany the report detailing actions taken to implement the recommendations in the audit report.

Where the Registered Manager objects to implementing any of the recommendations by the auditor, they should provide written justification to DMP. Any alternative actions proposed by the Registered Manager should be supported by the auditor.

5 Preparation of the final TSF closure report

5.1 Introduction

TSFs are considered a high risk landform on a mine site. Before closure of the TSF, it is a requirement to safely decommission the infrastructure and rehabilitate the TSF such that it is safe, stable, non-polluting, erosion-resistant and self-sustaining, and its completed condition is acceptable to key stakeholders. In most cases TSFs will be classified as contaminated sites under the *Contaminated Sites Act 2003* and restrictions on future land uses and activities, and ongoing legal requirements may exist.

While a mine closure plan describes the closure details for the entire mine site, a final closure report for the TSF is required at the completion of the operational phase of the TSF to demonstrate how the long-term closure objectives will be achieved based on the final status of the TSF. Prior to the submission of a TSF closure report, a decommissioning and rehabilitation review should be conducted by a competent person to provide an engineering status report of the TSF to assist with planning for closure of the TSF.

5.2 Content of final closure report

Assuming that a mine closure plan has been approved for the mine site and issues such as stakeholder engagement, completion criteria and financial provisioning have been addressed (see *Guidelines for Preparing Mine Closure Plans*, June 2011), the final closure report for a TSF should present:

- closure objectives, obligations and commitments, and validation against agreed closure criteria
- closure work timeline
- identification and management of closure issues
- physical dimensions of the TSF and stored tailings quantities
- results and analysis of monitoring during operation, including
  - settlement
  - ground movement
  - groundwater and seepage
  - dust
  - impact on surrounding environment
- status of TSF, including
  - structural integrity of retaining structures
  - drainage structures
  - progress of rehabilitation
  - consolidation of tailings
  - in-situ densities and particle size of the tailings
  - tailings beach profile
  - retained moisture in tailings
  - phreatic surface

  - seepage
  - geochemical properties (e.g. radioactive aspects, fibrous materials, toxic substances, AMD potential)
  - geotechnical properties
- design details of proposed closure works, including
  - surface drainage works
  - encapsulation cells
  - retaining structure armouring
  - cover and its surface geometry
  - decommissioning of TSF infrastructure
- monitoring and maintenance program until relinquishment, including
  - revegetation
  - flood mitigation and drainage control
  - control of pests
  - groundwater quality
  - structural integrity of the TSF (e.g. retaining structure, covers)
  - pollution control
- stakeholder acceptance of final landform
- management of information, data and records.

The closure report should be supported by plans, sections and diagrams for key components of the TSF, including:

- as-constructed survey drawings of the TSF showing
  - representative retaining structure profiles
  - ground surface contours outside the TSF
  - elevations along walls and across the upper surface
  - drainage management features
  - surface water drainage systems
  - any diversion features around the TSF
- updated site plan depicting
  - rehabilitated TSF
  - relevant topographical features
  - contours
  - surrounding mine features
  - relevant cadastral information
- cross sections showing proposed geometry of the rehabilitated TSF and any associated structures

- drawings of infrastructure decommissioning works, including
  - decant
  - underdrainage
  - pipework.

Appendix 1 – Glossary

Closure	A whole-of-mine-life process, which typically culminates in tenement relinquishment. It includes decommissioning and rehabilitation
Decommissioning	A process that begins near, or at, the cessation of mineral production and ends with removal of all unwanted infrastructure and services
Rehabilitation	The return of disturbed land to a stable, productive and self-sustaining condition, consistent with the post-mining land use
Relinquishment	A state when agreed closure criteria have been met, government sign-off achieved, all obligations under the *Mining Act 1978* removed and bonds retired, and responsibility accepted by the next land user
Revegetation	Establishment of self-sustaining vegetation cover after earthworks have been completed, consistent with the post-mining land use
Safe	A TSF is considered to be safe when the stored materials are not released to the surrounding areas causing safety, health and environmental hazards, either during its operation or after the closure of the project and relinquishment of the land. The possible modes of release of stored and retaining materials include dusting, seeping, leaking, leaching, overtopping and retaining structure breaching
Stable	A TSF is considered to be stable when the retaining structures will not breach by any means, including shearing, slumping, settlement, piping or erosion, both during its operation and after closure of the project and relinquishment of the land