

Earthen Levee Embankment Inspection and Repair Guide



This guide has been developed to assist councils and landholders with the inspection and repair of levee embankments. It is not intended to replace expert advice. It is recommended that landowners obtain advice from an experienced levee embankment or dam engineer, or other relevant expert.

Inspection and Process

Levee embankment owners (owners) should undertake visual inspections of earthen levee embankments to assess for deformities and general integrity. Owners should identify any areas of concern and adequately outline the extent of area. This will assist owners and contractors in understanding the scope of remediation works required.

The inspection list provided is not exhaustive; it has been compiled as a general guide of things to look for, or be aware of, during levee embankment inspections.

Inspection “under load”

This guide focuses principally on what to look for during assessment of levee bank assets during normal conditions.

When levees are performing an active function under load from high water, it is recommended that they are inspected regularly (usually daily where criticality is high) by suitably trained individuals via appropriate means, such as on foot or using a small open vehicle to facilitate close inspection.

When under load, it is imperative that any areas of concern are identified and highlighted to a qualified engineering contractor for review as a matter of priority.

Identifying Structural Defects and Non-Conformances within Levee Embankments

The general dimensions (or form) of an earthen levee embankment can vary to suit site conditions, and other considerations, but will typically have the following arrangement:

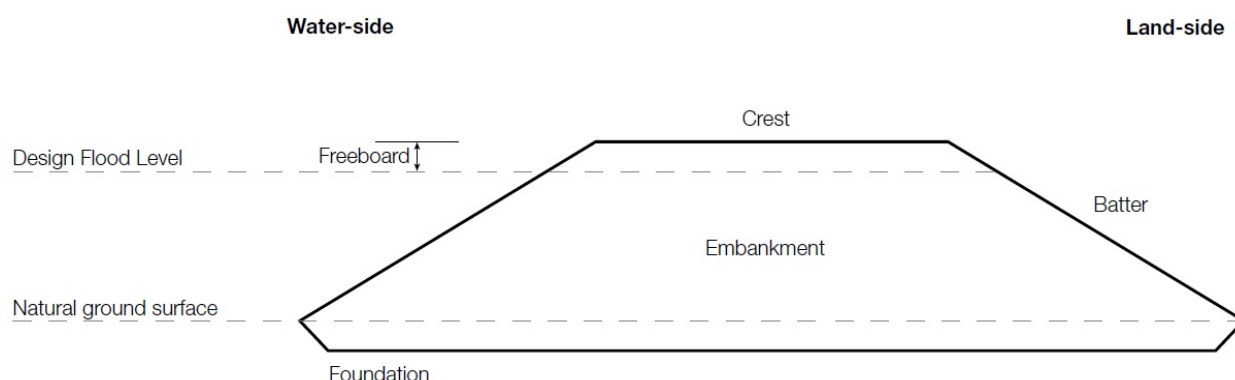


Figure 1 Simplified typical cross sectional arrangement of an earthen levee embankment


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When assessing levee embankments, it is important that all sections of the levee embankment are inspected. It is recommended to carefully inspect for, and consider, the following aspects as a minimum, as these aspects may indicate that there is an issue requiring remediation.

1)	Height, shape, size, and form of embankment.	<p>Does the embankment maintain the same geometrical attributes and key features as originally constructed i.e. height, batter slope, and crest width? Have you checked elevation using survey tools or benchmarks at appropriate intervals along the embankment?</p> <p>Variances to geometrical attributes and key features (including elevation) indicate there is an issue, which requires remediation. If the elevation of the embankment has lowered, the embankment may not provide the level of protection it was designed for. If the batter slope has changed (i.e. become more, or less, steep) or crest width has changed (i.e. become thinner), the integrity of the embankment may be compromised.</p> <p>If there are any variances, refer to the 'Remediation and Repair of Earthen Levee Embankments' section below.</p>
2)	Surface depressions, and material settlement, subsidence or slumping.	<p>The following images show an example of material settlement (first image) and surface depression (second image). Any surface depressions, material settlement, subsidence or slumping should be remedied. If these exist, refer to the 'Remediation and Repair of Earthen Levee Embankments' section below.</p> 

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3)	Surface erosion, ruts, voids, gullies, surface cracking, or animal burrows.	<p>The following images show an example of surface cracking (first image) and surface and gully erosion (second image). Any surface erosion, ruts, voids, gullies, surface cracking, or animal burrows should be remedied. If these exist, refer to the 'Remediation and Repair of Earthen Levee Embankments' section below.</p> <div data-bbox="531 495 981 1088"> </div> <div data-bbox="981 495 1431 1088"> </div>
4)	Tunnelling or subsoil erosion, and sinkholes (crab holes).	<p>The following images show examples of tunnelling and subsoil erosion. Any tunnelling, subsoil erosion or sinkholes (crab holes) indicate an integrity issue and should be remedied. If these exist, refer to the 'Remediation and Repair of Earthen Levee Embankments' section below.</p> <div data-bbox="531 1236 981 1830"> </div> <div data-bbox="981 1236 1431 1830"> </div>

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5)	Embankment accessibility and trafficability (if applicable).	Does the nature of the crest surface provide for suitable access i.e. even and uniform surface and appropriate width? If not, this may need to be remedied, so that the entire levee embankment can be accessed to be inspected, maintained or remediated.
6)	Water leakage or seepage through embankment.	<p>The following images show examples of water leakage and seepage. Any water leakage or seepage through an embankment indicate an integrity issue and should be remedied. If these exist, refer to the 'Remediation and Repair of Earthen Levee Embankments' section below.</p> 

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7)	Batter slope erosion (either side), or river bank erosion (including deterioration of any scour protection i.e. rock).	<p>The following images show examples of batter slope erosion. Any batter slope erosion (including deterioration of any scour protection) indicates an integrity issue and should be remedied. If this exists, refer to the 'Remediation and Repair of Earthen Levee Embankments' section below. River bank erosion at the base of the embankment may also indicate an integrity issue. If this is a concern, please obtain advice from a suitably qualified expert such as a geotechnical engineer.</p> <div data-bbox="531 571 1441 1167"> </div>
8)	Vegetation management.	<p>Are there any large, deep-rooted trees and shrubs impacting the embankment? If so, these should be removed. Note that professional assistance may be required for removal of large trees.</p> <p>Is there any other vegetation that obscures visual inspection or affects accessibility? If there are, these should be removed or trimmed so that the embankment can be appropriately accessed and inspected. Please refer to 'Remediation and Repair of Earthen Levee Embankments' section below for any subsequent work that should be undertaken as a result of any vegetation removal.</p>
<p>Note that a number of issues and deformities listed above may be more common or prominent in areas of the levee embankment where infrastructure (such as a pipe) penetrates or interacts with the embankment, or that experience concentrated or sustained use by livestock, vehicles, or other traffic.</p>		

Remediation and Repair of Earthen Levee Embankments

All necessary remediation or repair works should be undertaken so as to rectify (make good), manage, or remove any identified deficiencies in the levee embankment. Prior to the commencement of any works, levee embankment owners (owners) should review and action all health and safety concerns specific to the site. Owners should also ensure material

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sourced for remediation or repair works is suitable and readily available for immediate placement upon commencement of works.

Currently there is no Australian Standard for the construction or repair of levee embankments. In lieu of this it is recommended that landowners obtain advice from an experienced levee embankment or dam engineer or other relevant expert, with repairs to be undertaken in accordance with [SA Water Specification TG 0641 "General Technical Information for Geotechnical Design – Earth Dams"](#) & Australian Standard AS3798 "Guidelines for earthworks for commercial and residential developments".

The below guide to repairs is general in nature. Works specific to individual sites will be contingent on local circumstances and engineering advice.

In areas requiring remediation or repair works, the levee crest and batter slope should be cleared of vegetation (including roots), scour protection (including rock), and stripped of topsoil. This will allow for detection of hidden damage, deformities and issues that may impact on the integrity of the levee embankment.

The topsoil layer should be approximately 150mm thick as a minimum. Owners should ensure topsoil and vegetation is removed from the immediate works area and stockpiled separately to prevent cross contamination between materials and so topsoil can be re-spread if applicable.

If additional areas of damage or other integrity issues are identified in the levee embankment following these works, these need to be assessed and incorporated into the scope of works.

Owners should consider the footprint of the repair area and the extent of the repairs and sequence works so that a solid and safe working platform is maintained at all times with provision for access when and where required.

Where repairs require excavation or earthworks, the following should be considered:

- Repair areas should be suitably excavated to remove damage or deformities.
- Repair areas should be excavated back to a suitable layer within the embankment to allow for bonding to the underlying material.
- Existing embankment surface and repair areas should be suitably prepared and adequately dimensioned (or keyed) in the existing embankment to ensure a good bond between the future layer and the underlying material.
- Repair areas should be refilled with suitable material and sufficiently compacted in consistent and even horizontal layers. Individual layers should not exceed 250mm in thickness in accordance with SA Water Specification TG 0641.
- A suitable capping layer should be added to levee embankment batter and/or crest where applicable.
- Levee embankment should be profiled and graded so as to match the shape, size, and form of the original levee embankment, unless otherwise instructed by a suitably qualified engineer.
- Topsoil replacement or scour protection should be completed where appropriate.

Where repairs do not require excavation (i.e. geotextile, rock armouring), the following should be considered:

- Appropriateness of the material and/or product for application should be considered.
- Existing embankment surface should be suitably prepared for application of material and/or product.
- Install, apply, or place material and/or product in accordance with engineering advice and manufacturer's recommendations.
- Any material changes or changes to the form of the levee embankment should not be made unless otherwise instructed by a suitably qualified engineer.

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