

Attachment 2: Earth-mound Design Considerations

Introduction

As part of the FOCUS on Illegal Dumping project, HCCREMS engaged Terra Aqua Sustainable Solutions to provide guidance on security earth mound design. This guidance is provided, in summary form, to assist councils to design and construct effective earth mounds to prevent access by illegal dumpers.

Design considerations for earth mounds

The effectiveness of earth mounds depends heavily on a number of design factors and careful consideration of site suitability. Consider the following to determine if mounds are suitable for the site in question:

- Space available for mounding – Adequate space is needed to build well constructed mounds. The presence of a few trees can be accommodated (see Mound Concept 3), however, the area should be largely free of vegetation and obstacles;
- Risk of impacting threatened species – A site assessment and adequate research needs to be conducted on intended mounding areas to ensure threatened species will not be impacted by mounding. Further information and threatened species lists can be found at: www.threatenedspecies.environment.nsw.gov.au;
- Site slope – Level or close to level sites are ideal for mounding. Sloping sites will require careful keying of the soils and extra consideration of design and erosion control practices;
- Soil type – Clay based soils support the best mounding systems. Sandy soils will require the infilling of clay to establish a clay base beneath the surface area;
- Emergency access – Mounds designed to prevent access by 4WD vehicles will also prevent emergency vehicle access (e.g. Fire Brigades). If access for emergency vehicles is likely to be needed, a heavy-duty locked gate should be considered instead;
- Available mounding material – Earth mound material must be Virgin Excavated Natural Material or material subject to a Resource Recovery Exemption under the POEO (Waste) Regulation 2005 (visit <http://www.environment.nsw.gov.au/wr/wastewcmr/venm.htm> for further information). Pure clay materials are best for earth mound construction, particularly for larger mounds and the most vertical sections of mounds. 70% clay to 30% loam mixes are suitable for smaller mounds and mound sections requiring less support (such as the back, terraced section);
- Approval requirements – A development application may be required for mounding works as they will involve earthworks other than those allowed under the SEPP (Exempt and Complying Development Codes 2008);
- Site preparation - The keying of the surface where mounds are to be placed is essential, as it prevents water sliding between the natural surface and the new mound materials. Keying requires that the surface be ripped with machinery (either bobcat or backhoe bucket teeth), to ensure a complete joining of the two different material surfaces;

- Drainage – swale design should be incorporated into the mound design and installed to ensure water movement around mounds, and nearby vegetation will not undermine the mound, or kil vegetation.
- Maintenance – Regular monitoring and maintenance will be required such as maintaining clear swale drains to allow adequate drainage (and avoid flooding and erosion damage), topping up of mounds that have shrunk or been impacted by access attempts and replacement of plantings that have died;
- Typical work considerations – Worker safety, presence of services (check with 'Dial Before You Dig'), and erosion and sediment control practices need to be considered and managed.

Presented below are a number of mound design concepts suitable for different site situations.

Mound Concept 1: Sites with adequate space

Site requirements for this design to be suitable:

- Areas that have a clear 5 metres or more width, with no trees;
- Relatively level sites;
- Accessible to machinery.

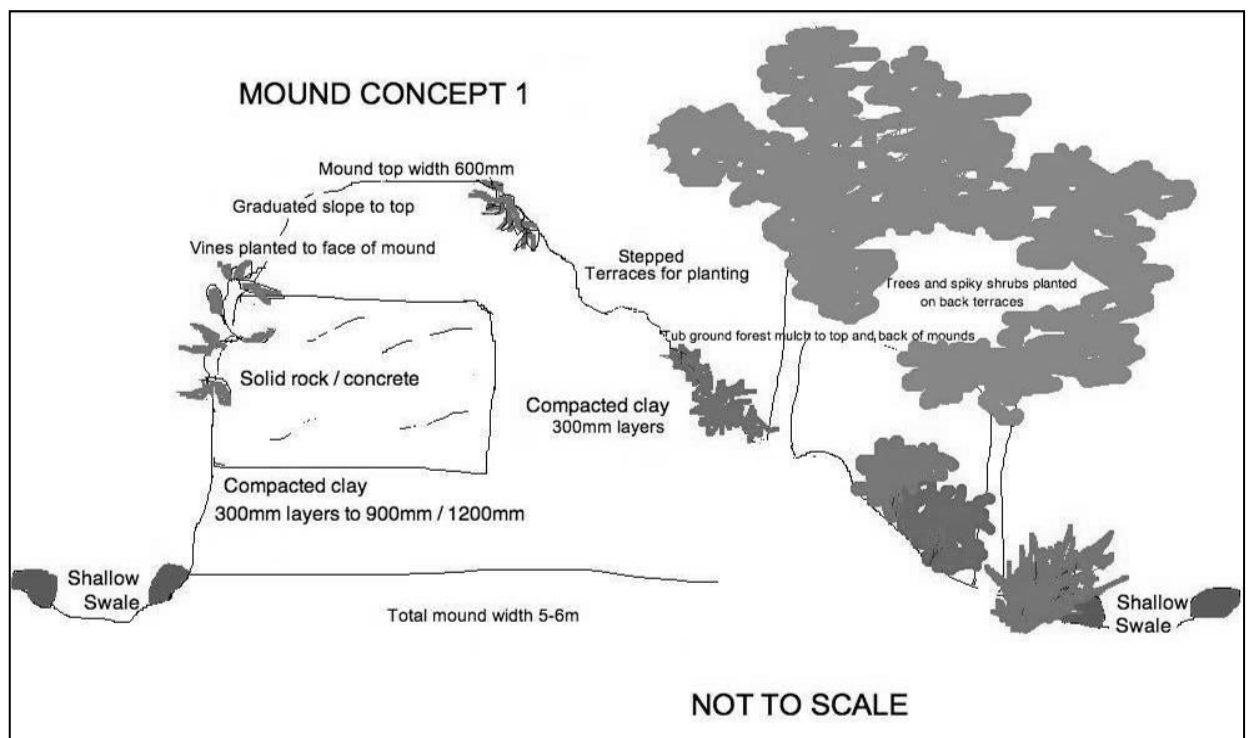


Image 1: Mound Concept 1

Description of design

The mound shown in **Image 1** is 2-3m in height and 5-6 m in width. Even well constructed mounds will compact and shrink over time, ending up 50%-75% of their original height. To be effective at preventing access from 4WD vehicles mounds

must be constructed a lot higher than their imagined finished height to take into account this shrinkage.

After initial keying of the surface using a Backhoe, the first vertical metre of the mound should be constructed from 300mm layers of compacted clay (using a Roller). It is then recommended a large (1m x 1m minimum), hard rock or concrete block be placed inside the mound section, toward the centre of the mound. If you are using hard rock it is advisable to use tough Martins Creek Boulder rather than soft sandstone. Multiple blocks/rocks will be needed depending on the length of the mound.

Layers of clay should be built up around the blocks to maintain the areas behind or on either side of the rock line placement. The addition of a block/ rock will help maintain mound structure and the mounding around the block will prevent easy removal of the block by vandals.

Topping layers of clay (compacted with a 'Wacker Packer') should then be added to reach 2-3 metres in height. The very top section of the mound should have a width of between 60cm and 1m. The reason for the narrowness of the top section is to limit the ability of 4WD vehicles to pass over the mound without bottoming out.

The front barrier section of the mound, facing the roadway or boundary of the property to be protected, should be as vertical as possible for the first metre, then gradually lean back on a 2:1 slope gradient, until the top of the mound is reached. Additional soil and forest mulch may then be added to the outside surface of the mound for later planting of natives.

The front and back of the mound should be planted in alternate cluster planting patterns to catch and help water meander down the slope and avoid erosion. The front (steep) section of the mound should be planted with small native grasses and vines suitable to the local area. Very small tubestock or viro-cell planting is recommended. Possible species may include:

- *Hardenbergia violacea* – False sarsparella;
- *Themeda australis* – Kangaroo grass;
- *Danthonia Spp.* – Wallaby grass;
- *Poa sieberiana* – Poa tussock grass;
- *Stipa Spp.* – Small Spear grass;
- *Kennedia rubicunda* – Dusky coral pea.

The back terraces of the mound are able to support larger shrub and small tree species. Use endemic species where possible. Possible species may include:

- Native eucalypt species, which do not grow too large and are endemic to your area;
- *Bursaria spinosa* – Black thorn;
- *Pultenaea villosa* – Furzy pea;
- *Daviesia ulicifolia* – Gorse bitter pea;
- *Acacia ulicifolia* – Prickly moses;
- *Acacia myrtifolia* - Red stemmed wattle;
- *Glochidion ferdinandi* – Cheese tree;
- *Hakea Spp.* (the spikier the better);

- *Banksia Spp.* – Smaller growing species to your area;
- *Hymenanthera dentata* - Native tree violet;

A swale system should be constructed at the foot of the mound system to direct water away from the front and back of the mound area. Swale drains should be wider and shallower rather than narrow and deep to prevent gullying and erosion of the drain system. Swale drains to the front of the mound system would normally be smaller in width and shallower than at the rear of the mounding system. Rocks should line the edges and sides of the swale drains to prevent erosion in heavy rainfall events. A concrete gutter system could in some cases act as a swale to the mound system when the system is fronting a tarred roadway.

Mound concept 2: Smaller boundary sites

Site requirements for this design to be suitable:

- Areas where a lower, narrower mound design is required, with few existing trees;
- Relatively level sites;
- Accessible to machinery.

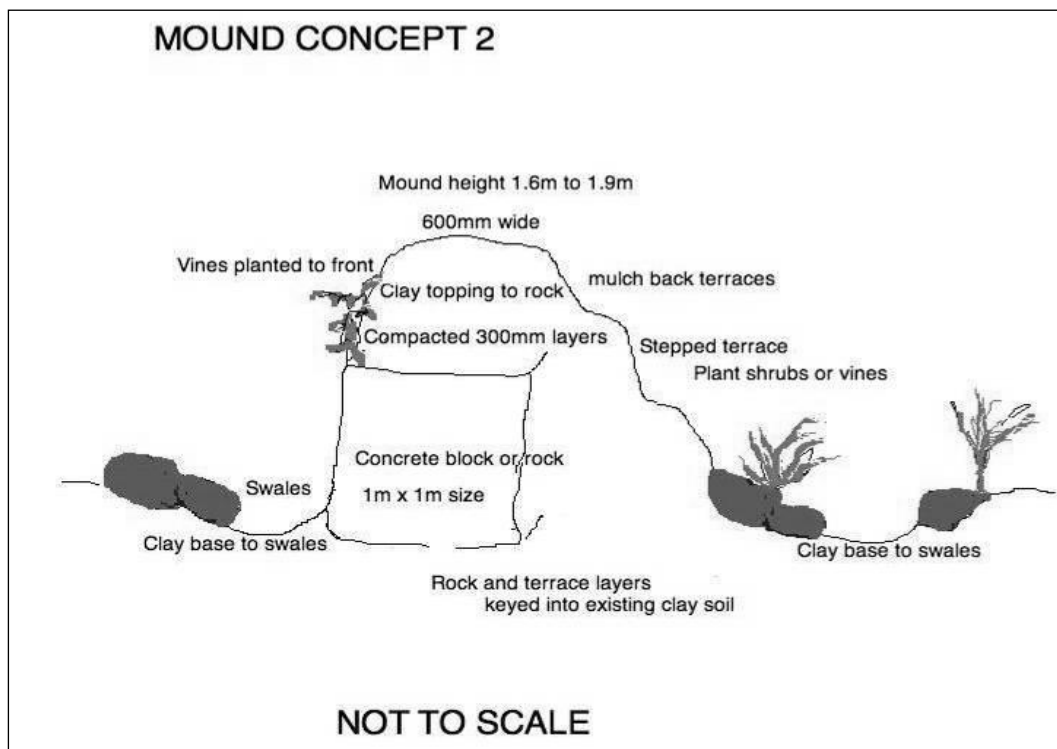


Image 2: Mound Concept 2

Description of design

The mound shown in **Image 2** is 1.6-1.9m in height. With shrinkage and compaction over time this mound may not deter determined 4WD drivers but will prevent access from average vehicles with trailers that intend to dump.

After initial keying of the surface using a Backhoe, a large (1m x 1m minimum), hard rock or concrete block is placed inside the mound section, toward the centre of

the mound. Multiple blocks/rocks will be needed depending on the length of the mound.

300mm layers of compacted clay should be built up around the blocks to maintain the areas behind or on either side of the rock line placement. The addition of a block/ rock will help maintain mound structure and the mounding around the block will prevent easy removal of the block by vandals.

Topping layers of clay (compacted with a 'Wacker Packer') should then be added to reach 1.6-1.9 metres in height. The very top section of the mound should have a width of between 60cm and 1m. The reason for the narrowness of the top section is to limit the ability of 4WD vehicles to pass over the mound without bottoming out. Additional soil and forest mulch may be added to the outside surface of the mound for later planting of natives.

The front and back of the mound should be planted in alternate cluster planting patterns to catch and help water meander down the slope and avoid erosion. The front (steep) section of the mound should be planted with small native grasses and vines suitable to the local area. Very small tubestock or viro-cell planting is recommended. Possible species may include:

- *Hardenbergia violacea* – False sarsparella;
- *Themeda australis* – Kangaroo grass;
- *Danthonia Spp.* – Wallaby grass;
- *Poa sieberiana* – Poa tussock grass;
- *Stipa Spp.* – Small Spear grass;
- *Kennedia rubicunda* – Dusky coral pea.

The back (terraced) section of the mound should utilise similar plants but may incorporate small endemic shrub plantings also.

A swale system should be constructed at the foot of the mound system to direct water away from the front and back of the mound area. Swale drains should be wider and shallower rather than narrow and deep to prevent gullying and erosion of the drain system. Swale drains to the front of the mound system would normally be smaller in width and shallower than at the rear of the mounding system. Rocks should line the edges and sides of the swale drains to prevent erosion in heavy rainfall events. A concrete gutter system could in some cases act as a swale to the mound system when the system is fronting a tarred roadway.

Mound concept 3: Sites with trees

Site requirements for this design to be suitable:

- Areas that have a clear 5 metres or more width, with few trees;
- Relatively level sites;
- Accessible to machinery.

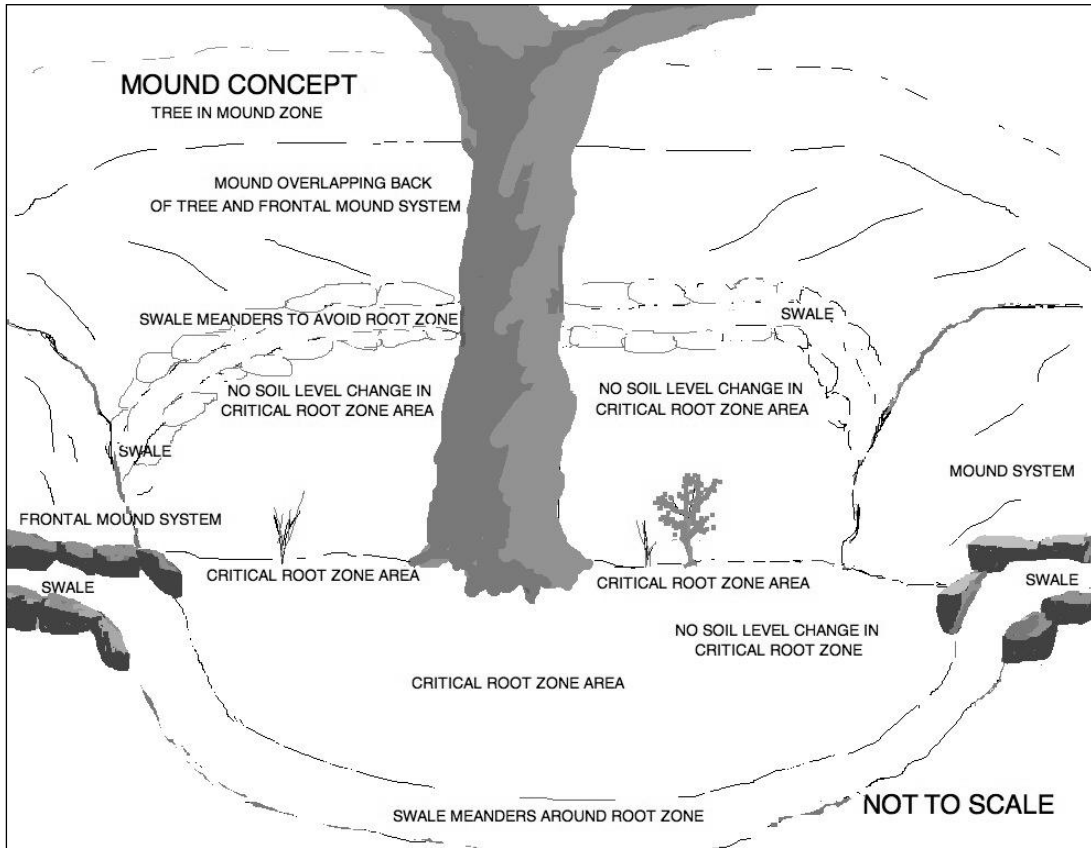


Image 3a: Mounding to accommodate tree

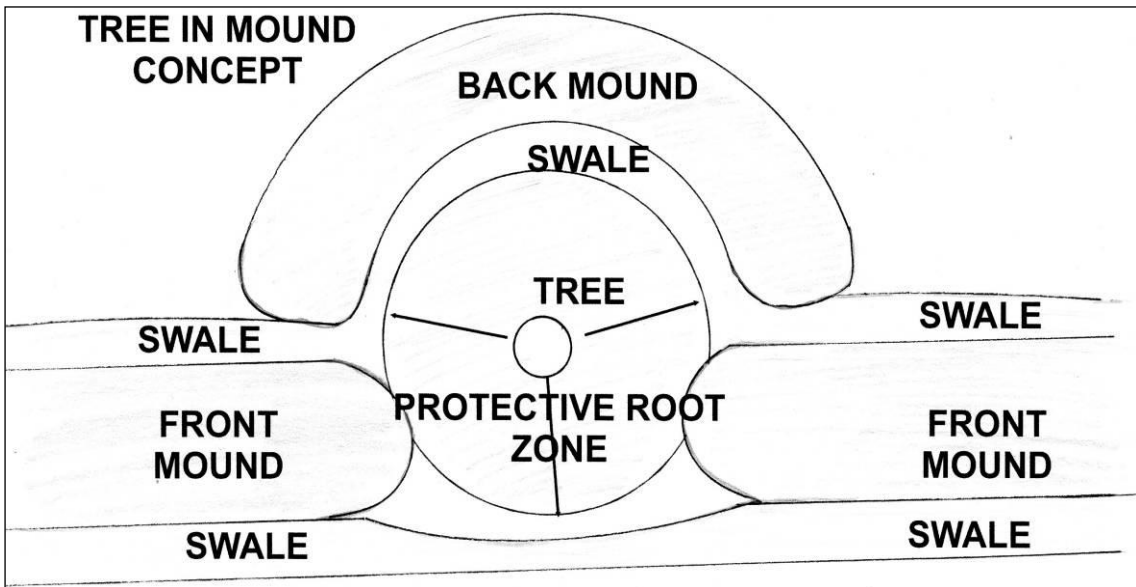


Image 3b: Mounding to accommodate tree (aerial view)

Description of design

The mound shown in **Image 3a** and **3b** has been built around a tree so that no fill material interferes with the tree's critical root zone. To prevent damage, disease and

potential death of trees it is essential that compaction, digging and filling do not occur in the area directly under a trees canopy (drip zone).

For further information regarding the protection of trees please see [AS 4970-2009 Protection of trees on development sites](#).

The rest of the mound design is the same as Mound Concept 1 (**Image1**).

Be aware that breaks in the mound system, needed to accommodate trees, will be a weakness in the barrier to access.