APPENDIX T

Spoil Management Strategy

GOWRIE TO HELIDON ENVIRONMENTAL IMPACT STATEMENT

IR_1536

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

Inland Rail Gowrie to Helidon EIS

Appendix T – Spoil Management Strategy

Australian Rail Track Corporation

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Abbreviations

Abbreviation	Explanation
ARTC	Australian Rail Track Corporation
ASS	Acid Sulfate Soils
B2G	New South Wales/Queensland Border to Gowrie Project
CBR	Californian Bearing Ratio
CEMP	Construction Environmental Management Plan
Ch	Chainage
CHMP	Cultural Heritage Management Plan
CLR	Contaminated Land Register
Cth	Commonwealth
draft Outline EMP	draft Outline Environmental Management
DTMR	Department of Transport and Main Roads
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EMR	Environmental Management Register
EP Act	Environmental Protection Act 1994 (Qld)
EP Regulation	Environmental Protection Regulation 2019 (Qld)
ERA	Environmentally Relevant Activity
G2H	Gowrie to Helidon
H2C	Helidon to Calvert Project
IECA	International Erosion Control Association
km	Kilometres
LGA	Local government area
LVRC	Lockyer Valley Regional Council
m^3	Cubic metres
mm	millimetres
PPP	Public Private Partnership
QLD/Qld	Queensland
QR	Queensland Rail
SMS	Spoil Management Strategy
TRC	Toowoomba Regional Council
t/y	Tonnes per year
UXO	Unexploded ordnance
WRR Act	*Waste Reduction and Recycling Act 2011* (Qld)

1 Overview

1.1 Purpose and scope

This Spoil Management Strategy (SMS) has been developed to guide the decision-making process for the management of spoil material generated by the Gowrie to Helidon (G2H) Project (the Project). The Project is one of 13 projects that make up the Inland Rail Program for the delivery of the 1,700 kilometre (km) rail line by 2027 and is one of five Inland Rail projects in Queensland (QLD). The Project will link the Border to Gowrie (B2G) project to Helidon to Calvert (H2C) (refer Figure 1.1).

The scope of this SMS extends to the construction of the Project an approximately 28 km railway, tunnel and supporting infrastructure such as roadworks. For the purpose of this SMS, spoil is defined as rock and material other than rock, that is generated through earthworks for the Project, which is either surplus to requirements or unsuitable for immediate reuse without treatment on the Project.

While the document provides the overall strategy for the management of spoil material generated by the Project, a Construction Environmental Management Plan (CEMP) and associated Waste Management Plan will be prepared during detailed design to confirm site-specific requirements in accordance with the draft Outline Environmental Management Plan (draft Outline EMP) (refer EIS Chapter 23: Draft Outline Environmental Management Plan).

This SMS should be read in conjunction with the Australian Rail Track Corporation (ARTC) Earthworks Material Specification (refer Appendix A).

1.2 Objectives

This SMS seeks to identify options for the beneficial reuse of spoil, in consideration of social, economic and environmental aspects of the Project. Reuse options will be assessed for suitability against a range of criteria with re-use internal to the Project to consider the elements of the Australian Rail Track Corporation (ARTC) Earthworks Material Specification and Earthworks Materials Management Framework as appropriate.

Key objectives of the SMS are to provide measures to:

- Manage spoil in consideration of the principles of the *Waste Reduction and Recycling Act 2011* (Qld) (WRR Act) hierarchy
- Manage spoil in accordance with identified sustainability initiatives for the Project, consistent with the Inland Rail Environmental and Sustainability Policy and the Inland Rail Sustainability Strategy
- Manage spoil in a manner that minimises adverse impacts on construction activities, timing and costs.

The WRR Act provides a strategic framework for managing waste by establishing a waste and resource management hierarchy, which is in the order of preference:

1. Avoid or reduce
2. Reuse
3. Recycle
4. Recover energy
5. Treat
6. Dispose.

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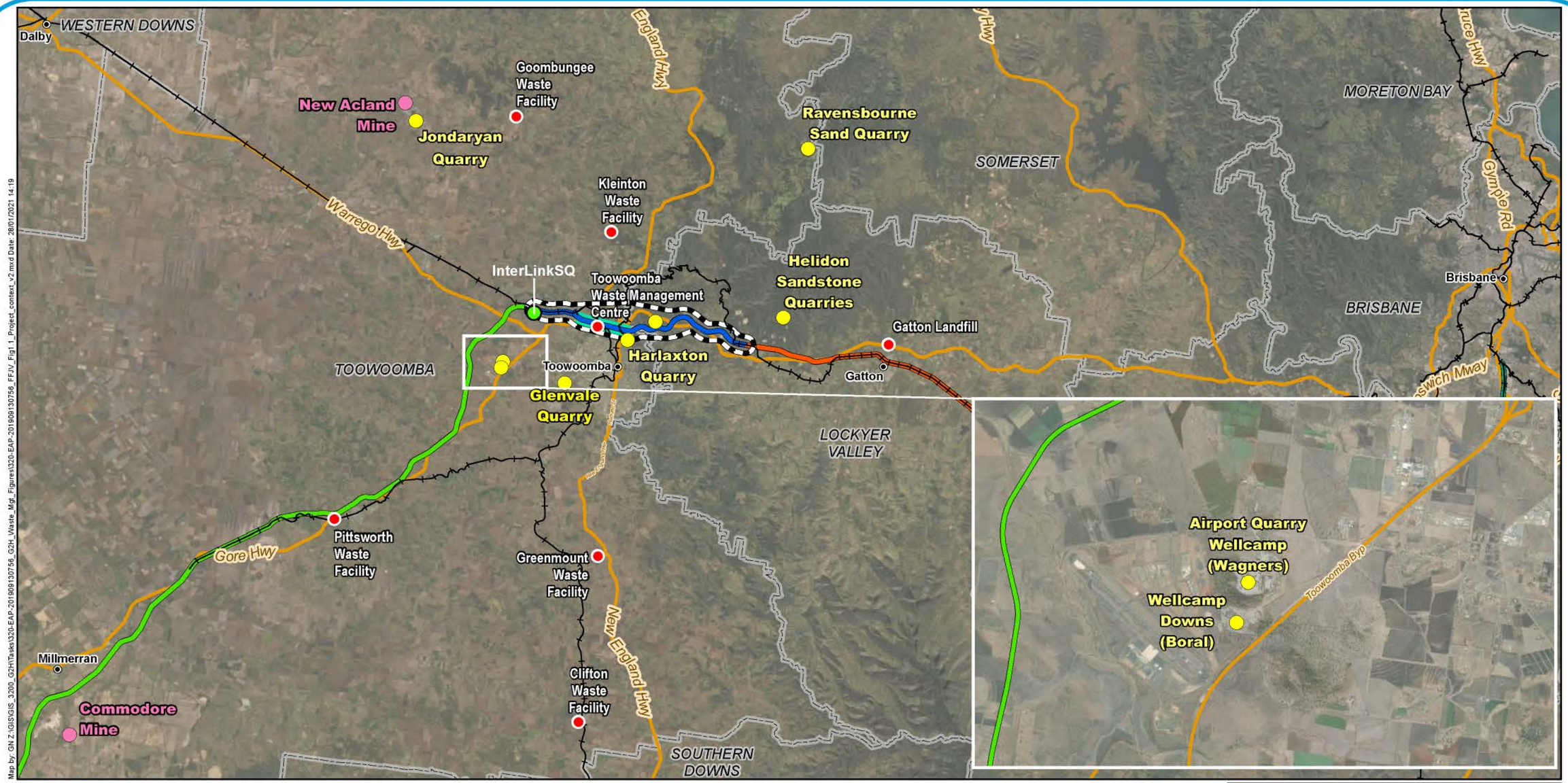

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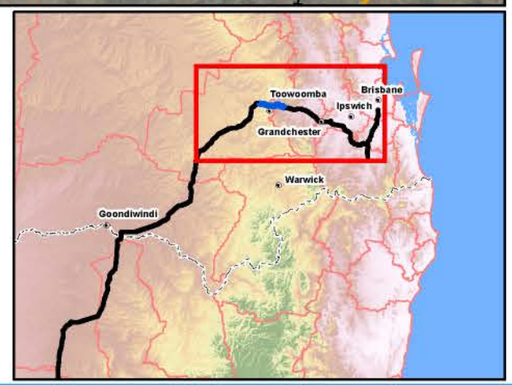
Legend

- Localities
- Waste facilities day, interim and final cap cover
- Quarry site rehabilitation
- Mine site rehabilitation
- InterLinkSQ
- B2G project alignment
- G2H project alignment
- H2C project alignment
- C2K project alignment
- K2ARB project alignment
- Existing rail
- Tunnel
- Major roads
- EIS investigation corridor
- Local Government Areas



A3 scale: 1:500,000

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Coordinate System: GDA 1994 MGA Zone 56

Gowrie to Helidon

Figure 1.1: Project context and spoil reuse opportunities

Table 1.1 details options for management of spoil generated by the Project. The options are presented in order of preference.

For the purposes of the Environmental Impact Statement (EIS) and the preparation of this SMS, production and management of spoil has been assumed to be limited to the rail corridor and associated construction works depicted on the design and quantified in the bill of quantities for the Project. This includes the stockpiling of material primarily from the excavation of the Toowoomba Range Tunnel at the western tunnel portal area.

The SMS encourages the identification of opportunities to use spoil from the Project on adjacent and proximal Inland Rail projects, including B2G. Integration with proximal Inland Rail projects will require assessment during the detailed design phase of each of the projects to ascertain the benefits and limitations (environmental, social, economic and cost) of cross-project reuse. This assessment would include an analysis of implications for the B2G Spoil Management Strategy which is the immediately adjacent Inland Rail project.

Table 1.1 Spoil management hierarchy

Rank	Options	Example
1	Avoid and reduce spoil	Reduce the amount of spoil generated by the Project, through reducing the extent and scale of cut where an immediate reuse opportunity in proximity to the source location does not exist, e.g. sections of the Project where a surplus of material will be generated
2	Reuse within the rail corridor (with or without treatment) and/or Project disturbance footprint	Reuse within the Project, subject to the material complying with the ARTC Earthworks Material Specification, to establish formation, fill embankments and mounds within short haulage distance of the source location. The material may also be used in drainage works (e.g. rip-rap), rehabilitation and restoration works in particular temporary areas required for construction, and landscaping.
3	Reuse for environmental works and land restoration (third parties)	Reuse for environmental works and land restoration, subject to the material complying with the relevant specifications for the materials intended use. Examples include: ■ Reuse in the rehabilitation of native vegetation ■ Reuse for landscaping ■ Reuse for land reinstatement, including mines (New Hope Acland) and quarries, subject to satisfying closure and operational requirements ■ Profile and capping soils (subject to demonstration of compliance with material specifications) for waste management facilities that are anticipating closure in the near future (e.g. Clifton, Goombungee, Pittsworth landfills) ■ Reuse for landfill covers (day and interim covers) and final capping (where deemed suitable).
4	Reuse on other development	Reuse for fill embankments and mounds on projects within a reasonable haulage distance from the source location (e.g. 50 km), subject to the material complying with the relevant specifications required for the intended purpose of the material. Priority will be given to the other sections of the Inland Rail Program. The material may also be provided to landholders directly impacted by the Project or on adjacent properties to facilitate local land use practices (e.g. upgrade access tracks, erosion controls etc).
5	Dispose	The design allows for the storage of excess material (i.e. spoil) from the construction of the tunnel as a stockpile within the proposed rail corridor at the western tunnel portal (i.e. disturbance footprint). The stockpile material will be reused for future projects outside or within the Project disturbance footprint including the reuse purposes shown in option 3. Consultation with TRC has indicated that there is limited capacity to accommodate spoil as a waste from the Project at the existing landfills; however, use as cover or final capping is considered an opportunity as noted above. Offsite disposal will only occur if the material is considered unsuitable without treatment for other uses, e.g. due to contamination.

Table 1.1 has been informed by consultation between ARTC and Toowoomba Regional Council relating to capacity of waste management infrastructure (including cover, closure and rehabilitation opportunities) and the potential for use at the proposed Charlton Sport Precinct development. Further consultation with TRC once final quantities are determined will be required to assess the viability of using material in these or other projects.

1.3 Further development

This SMS has been developed in response to the Project design as described in EIS Chapter 6: Project description. It will be reviewed and updated as the Project progresses through detailed design and into construction, in order to remain valid. Such updates will be required in response to:

- Changes to the design and subsequent changes to the volumes of material produced from the works
- Confirmation on the construction methods and construction staging to be implemented for delivering the Project, including the type of tunnel boring machine to be used and preferred methodology for the cuts
- Confirmation of the movement of material between the Inland Rail projects, including the consolidation and optimisation of haulage routes and reuse of material between projects (if at all)
- Outcomes from further geotechnical and environmental investigations, including for land contamination and soil mapping
- Changes in applicable legislation, policy and guidelines
- Consultation with, feedback from, landholders stakeholders and regulators
- Confirmation of contractual and commercial model for the execution of the Project including the nature and scope of incentives and key performance indicators associated with spoil production and its management
- Continuous improvement and evaluation of environmental management performance against environmental policies, objectives and targets.

This SMS will require revision through detailed design, prior to the commencement of construction to account of the final quantities spoil that will be produced through the construction the Project. The updated SMS should then be used to allow the Public Private Partnership (PPP) to develop detailed spoil management plans (including movement sequencing and timing). In the updating of the SMS, attention shall be paid to:

- Updating the traffic impact assessment for the Gowrie to Helidon Project (refer EIS Appendix U: Traffic Impact Assessment)
- Development of the Road Use Management Plan
- Development of the traffic management plans
- Revision of biosecurity management plans

These plans do not represent an exhaustive list and will need to be jointly developed by the PPP and relevant stakeholders including State Government Departments, TRC, Lockyer Valley Regional Council (LVRC) and emergency services.

2 Spoil production

For the purpose of this SMS, spoil is defined as rock and material other than rock, that is generated through earthworks for the Project, which is either surplus to requirements or unsuitable for immediate reuse without treatment on the Project.

The production and management of spoil for the Project has been limited to the Project disturbance footprint. The Project disturbance footprint includes permanent disturbance footprint including the rail corridor and other permanent works associated with the Project (e.g. where changes to the road network are required) as well as the temporary disturbance footprint where temporary disturbance is proposed during construction (e.g. laydown areas and compound sites).

The hierarchy of spoil management is largely driven by the cut and fill balance. The Project is anticipated to produce approximately 3,100,000 cubic metres (m^3) of excavated material during construction. A calculated 2,100,000 m^3 of excavated material is estimated to be suitable for immediate reuse as general fill for the construction of zoned embankments (refer Section 2.2.1).

A calculated excess of approximately 1,000,000 m^3 of spoil will be managed or treated with the potential for reuse. The majority of the excess material, approximately 730,000 m^3, will result from the construction of the tunnel (excluding the portals). The design allows for the material from the tunnel to be stockpiled within the Project disturabance footprint to be designated future railway land.

Where practicable, spoil will be reused within the Project disturbance footprint through treatment, amelioration or drying. While excess material from the construction of the tunnel (with or without treatment) will be stockpiled within the proposed railway corridor at the western tunnel portal.

The volume, characteristics and fate of spoil material is contingent on further detailed geotechnical investigations and detailed design being completed. Updating of the SMS subsequent to these activities will re-assess the viability of re-use of the material for adjoining Inland Rail projects or other projects in the region.

Offsite disposal will only occur if the material is considered contaminated and considered unsuitable without the opportunity for treatment for other uses.

The excess material and spoil management process is summarised in Figure 2.1. The opportunity to use excess suitable material on adjacent Inland Rail and non-Inland Rail projects will be explored as the highest priority and best option for the use of surplus material from the Project, as depicted in Figure 2.1.

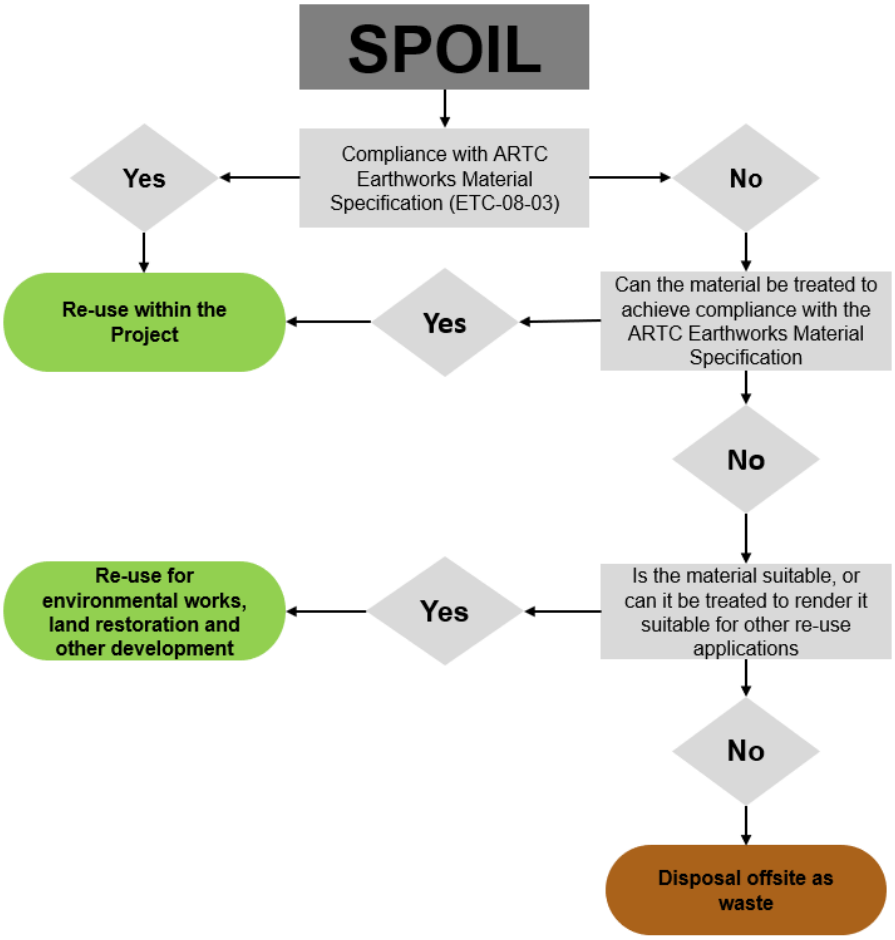


Figure 2.1 **Decision process for excess material and spoil management**

2.1 Spoil reduction

The Project design incorporates over 6.7 km of viaducts and bridge structures which reduces the extent of earthworks. This effectively reduces the extent of cuts required, but also limits options for reuse within the Project disturbance footprint.

The quantity of spoil generated has the potential to be reduced by:

- Refining the horizontal and vertical design and alignments to minimise the cut and fill quantities.
- Basalt material from the construction of the tunnel is reused as capping and structural material, rather than the current option of importing these material types. This would also potentially reduce the size of the stockpile to the western tunnel portal. The potential volume of basalt available along the tunnel alignment will be calculated following detailed geotechnical investigations
- Selecting construction methods that comparatively reduce the production of excess material
- Optimising the shape and size of batters to achieve a cut/fill balance within the Project disturbance footprint
- Quantifying and characterising the material expected to be generated during construction and treating/blending the material to render it suitable for a beneficial use.

Wherever practical, spoil material generation will continue to be minimised as the Project progresses through the detailed design and construction phases.

2.2 Earthworks material types and classification

The ARTC Earthworks Material Specification (refer Appendix A) describes material types, associated compliance criteria and classification/suitability of materials for use within the Inland Rail Program.

In line with this specification, the following sections identify both suitable and unsuitable material for use as a foundation for earthworks structures or for use as fill material within the Project disturbance footprint.

2.2.1 Suitable material

The Project is expected to produce approximately 2,100,000 m^3 of excavated material that is compliant with the ARTC Earthworks Material Specification and therefore suitable for immediate reuse (without treatment) as Type A, B, C or D general earth fill for the construction of zoned embankments. Definitions for each material type is provided in Appendix A. A cross section schematic of a zoned embankment for rail as outlined in the Earthworks Material Specification is provided in Figure 2.2.

Type A material (where identified in cuttings) can be selectively targeted, separated and re-incorporated into the outer part of zoned embankments, where durable and erosion resistant material is required (refer Figure 2.2).

The general earth fill upper zone must be general earth fill Type A and Type B. The lower zone may be general earth fill (Type A–D) or rockfill in accordance with their respective placement depth criteria (refer Figure 2.2).

The differentiation of the fill types is dependent on their particle size distribution, which determines the compaction ability of the general earth fill. This then determines the material's suitability for use as general earth fill during the construction of zone embankments as discussed below (refer Figure 2.2). Type A or Type B fill have a minimum California Bearing Ratio (CBR) of 3 per cent whereas Type C and D fill have a minimum CBR of 1 per cent.

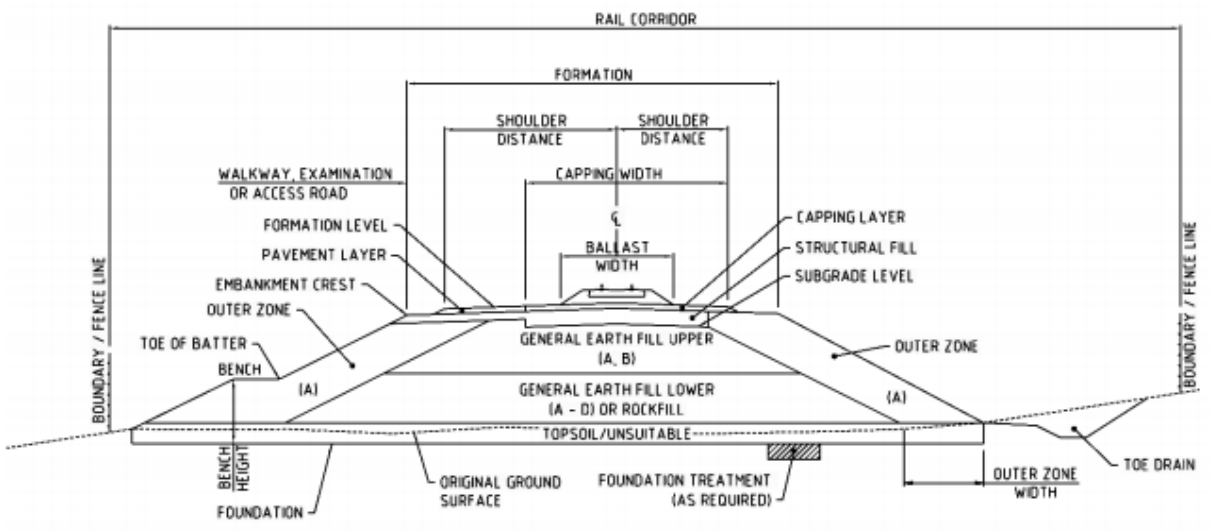


Figure 2.2 Schematic of zoned embankment cross section

Source: Earthworks Material Specification, ETC-08-03 rev 1.3, 2020

The Toowoomba Range Tunnel will intersect a variety of materials that will be determined through further detailed geotechnical investigation and detailed design. Preliminary assessment has identified the tunnel will encounter one or more of the following geological units:

- Tertiary age Main Range Volcanics consisting mainly of basalt
- Undifferentiated Tertiary Sediments
- In-filled Paleo Valley sediments consisting of basalts, tuffs, sandstones to mudstones

- Jurassic sandstones and siltstones of the Koukandowie Formation
- Basaltic colluvium mainly on the eastern side of the range; and
- Quaternary alluvium.

The suitability and extent of the material intercepted by the Toowoomba Range Tunnel cannot be estimated with accuracy due to the variable nature of basalt flows deposited on the undulating Jurassic sedimentary paleo topography. Typically, the spoil characteristics are monitored as the excavation progresses with samples taken directly from a temporary stockpile.

As such it has been assumed that this material will be stockpiled at the western tunnel portal, with the tunnel being constructed from west to east.

Based on preliminary geotechnical investigations the basalts, including the colluvium are likely to suitable for capping and structural fill, provided it can be stockpiled selectively and separated from the moderately and highly weathered material. Material from the Koukandowie Formation, Undifferentiated Tertiary Sediments are likely suitable for general fill (with treatment). While the boundaries between the geological units may also result in poor quality material.

As noted above, further geotechnical investigation and detailed design will further refine the characteristics and volume of material that will arise from construction activity. Once determined, this refined data will be incorporated into an update of the SMS and subordinate plans as required.

The Project's capacity to reuse material is also contingent on non-environmental or engineering considerations that will be determined as part of the execution strategy for the PPP delivery of the works. The reuse of material will need to be assessed against a range of criteria (including environmental, engineering, social and economic) that have not been defined for consideration in this EIS. The Project expects that these aspects will be incorporated into future iterations of the SMS as they become available and help to clarify the practical re-use of material.

2.2.2 Topsoils

Topsoil is variable across the Project alignment and is expected to typically range between 0.1 to 0.6 m. Topsoils developed overlying the Main Range Volcanics, alluvium and colluvium tend to be dominated by clay; whilst those developed over the areas underlain by the Koukandowie Formation and Gatton Sandstone are typically duplex soils with sandy surface soil and sodic, clayey subsoil.

A topsoil management plan will be developed as part of the CEMP to manage topsoil, including stripping, stockpiling and reinstatement. Non-contaminated topsoil (i.e. soils free from subsoil, other excavated materials, refuse, clay lumps, stones, timber or other rubbish) will need to be stockpiled and made available for the rehabilitation of earthworks. The topsoil stockpiles will be segregated where applicable in response to biosecurity matters and other risks, along with required treatments or uses in accordance with the CEMP.

2.2.3 Unsuitable material

The Project design will produce material that is not appropriate for immediate reuse within the engineered embankments. The ARTC Earthworks Material Specification classifies material as unsuitable based on the following properties:

- Compaction requirement: Materials that cannot be compacted to an acceptable density to achieve the required engineering design characteristics are not considered suitable for reuse. Silt, over wet material and material with organic matter may be un-compactable materials.
- Moisture content: Based on the natural moisture content, the material may either be too wet or too dry in its current condition to meet the required specifications or consistency. Treatments for improvement, such as spreading and addition of lime, can be undertaken to modify the moisture content and consistency of clayey soils.

- Organic content: Materials with organic content are typically considered unsuitable due to being highly compressible, degradable and susceptible to collapse. These materials may be suitable for use in topsoil and vegetation rehabilitation applications with blending.
- Dispersive: Dispersive materials (Emerson Class <4) have a high potential for erosion, therefore their usage is restricted to areas where they are not exposed to free water. Dispersive materials that can meet all other Type A to D general fill requirements may potentially be incorporated into the core of a zoned embankment or used together with adequate design solutions, such as chemical additives and compaction, to manage the soil behaviour.
- Contamination: Contaminants may be present in the material due to several factors. The presence of contaminated land has been assessed for the Project with the finding outlined in EIS Chapter 9: Land resources. Based on the land uses within the Project disturbance footprint and the findings of a desktop assessment, potential sources of contamination for the Project may include:
  - Agricultural activities: hydrocarbons (fuel and oil storage and use), pesticides and herbicides, asbestos and lead paint, arsenic (cattle dips), landfilling
  - Quarries: hydrocarbons (fuel and oil storage and use), metals/metalloids, hazardous materials
  - Landfilling and waste disposal: hazardous materials, hydrocarbons, metals/metalloids, phenols, polychlorinated biphenyls, phthalates, volatiles and pesticides and herbicides
  - Existing and former rail corridors: metals, asbestos, hydrocarbons, pesticides/herbicides
  - Roads: metals and hydrocarbons.
  - Unexploded ordnance (UXO)
  - Acid sulfate soils/rocks
  - Unknown fill material: Asbestos, metals/metalloids, hydrocarbons

Due to the elevated topography, no acid sulfate soils (ASS) are anticipated to occur within the Project disturbance footprint. Similarly, due to the geological setting and the characteristics of the mapped geological units, the risk of encountering naturally occurring asbestiform materials along the excavations is considered negligible.

A potential risk of an UXO (any sort of military ammunition or explosive ordnance which has failed to function as intended) has been identified for the Project. The Commonwealth Department of Defence UXO mapping identified the area between Chainage (Ch) 15.50 km to Ch 18.35 km as an area of risk, while the Helidon Explosive Reserve in proximity of the Helidon is a known explosives storage area. The Project also intercepts former Department of Defence Mount Lofty Rifle Range, where UXO may also be encountered. Areas identified at risk should be assessed to identify and then remove any unexploded ordinance prior to site or construction activities taking place.

- Reactivity: Reactive materials with significant shrink swell potential may lead to excessive movement within the fill. Reactive materials that can meet Type C/D fill requirements may potentially be incorporated into the core of a zoned embankment or used where they are protected from significant moisture variations. Alternatively, chemical treatment may be considered to modify the reactivity of the clayey materials. Reactive soils are anticipated to be present along the Project alignment, mainly west of the Great Escarpment, overlying the basalts and alluvium derived from basalt.
- Acidity: Acidic soils such as the surface layers of kurosols expected to be encountered generally with a pH less than 5.5. It is noted that in-situ treatments, such as the addition of lime, can be a successful method of ameliorating soil acidity. While the acidity of the soils has no impact on the engineering characteristics of the materials, the reusability of the stripped topsoil can be improved if the acidity is managed.

- Oversize materials: blasted or ripped rock with particles larger than 150 mm are typically excluded from earthworks, as they cannot be adequately compacted. The oversize material may be considered for use as rock fill or rip-rap, provided the relevant durability, shape and weight requirements are met. Oversize sedimentary rock fragments are typically broken down to approximately 150 mm size particles by tracked earthmoving machinery, such as excavators and dozers. It is expected that spoil blast material will need one or more of a combination of segregation, crushing and screening to be rendered suitable for use.
- Unstable: Colluvial material that has formed as a landslide debris is considered meta-stable and is known to be prone to slope instability. If encountered in the foundation of embankments or other structures, it will potentially need to be removed and replaced. However, the material itself is not considered unsuitable and can be considered for reuse, provided the engineering characteristics are within the maximum limits stated in the Project specification (ARTC 2019a). Potential landslide locations have been identified within the vicinity of the eastern tunnel portal.
- Atterberg Limits or weighted plasticity index values exceeding the maximum limits stated in the Project specification (ARTC 2019a).

Materials will be tested in accordance with AS 1289: Methods of testing soil for engineering purposes and AS4133: Methods of testing rock for engineering purposes (Standards Australia 2014 and 2009, respectively). In addition, additional soil surveys and contaminated land investigations will be undertaken during detailed design to identify and quantify the extent of contaminated material and at risk soils within the Project disturbance footprint.

All materials with one or a combination of the above characteristics may be specified as ‘unsuitable’ without treatment for use within the Project’s engineered embankments.

Geotechnically unsuitable materials are expected to occur within gullies, the alluvial plains, as colluvium at the toe of hills, and residual soils developed on sedimentary rocks. Unsuitable materials within the Project will predominantly include material from alluvium, colluvium and the Koukandowie Formation.

Unsuitable material as defined by the ARTC specification does not necessarily mean that the material cannot be used by the Project for other purposes (subject to assessment of suitability) such as landscaping mounds, noise attenuation bunds or thinly broadcast over disturbed areas and rehabilitation works. For the purposes of this SMS, anticipated material reuse potential has been based on the main geological units identified in the Project disturbance footprint.

2.2.3.1 Waste rock

Waste rock is a term typically derived from the resources industry, where waste rock sometimes has pyritic qualities.

EIS Chapter 9: Land resources provides information on the physical and chemical characteristics of rock generated from the Project, including management requirements in the event that acidic materials are encountered during Project activities. The geotechnical and soil investigation, which included site walkovers and geotechnical sampling, did not identify the presence of ASS or acid rock, which can occur naturally when sulphide minerals are exposed to air and water and accelerated through excavation activities which increase rock exposure to air, water and microorganisms.

Based on the geological conditions intersected by the Project, the likelihood of encountering acid rock is considered to be low. Therefore, all rock that is won through excavation has been assumed to be reused on the Project and is not defined as a waste (refer EIS Chapter 21: Waste and resource management). This is subject to the material being tested to determine the waste classification and suitability for reuse, in accordance with the guidelines, specifications and CEMP adopted for the Project.

If rock is not contaminated it may be crushed and reused onsite as aggregate for fill, construction pads/laydown areas or road base. Under the Environmental Protection Regulation 2019 (EP Regulation), an approval for Environmentally Relevant Activity (ERA) 33 is not required for the extraction of material from a place for constructing a road or railway at the place. An approval for ERA 33 will only be required for the crushing, milling, grinding or screening of material exceeding 5,000 tonnes per year if the activity is undertaken outside of the Project disturbance footprint. It has been assumed that such activities would be undertaken by a third-party commercial operation which would be responsible for obtaining the requisite ERA permit to allow this activity to occur. As such, these places are not included within this assessment.

In accordance with the draft Outline EMP (refer EIS Chapter 23: Draft Outline Environmental Management Plan), soil conditions across the Project disturbance footprint will be appropriately characterised at a suitable scale through additional geotechnical surveys during the detailed design phase of the Project to inform design and environmental management measures.

2.2.3.2 Contaminated material

A number of the land parcels within the Project footprint are listed on the Department of Environment and Science Contaminated Land Register (CLR) and Environmental Management Register (EMR), including the Toowoomba Waste Management Centre (landfill) and land parcels associated with the West Moreton System (Hazardous contaminant). It also assumed other land parcels of the West Moreton System are contaminated due to similar historic land use (for Hazardous Contaminant associated with arsenic herbicide use).

A Tier 1 Preliminary Site Investigation (contaminated land assessment) has been undertaken for the Project (refer EIS Chapter 9: Land resources), in line with the processes and guidance detailed in the National Environment Protection (Assessment of Site Contamination) Measure 1999 (Cth). As per EIS Chapter 9: Land resources, the disturbance of existing contaminated land during the construction phase of the Project has been identified as presenting a medium (mitigated) risk.

In accordance with the draft Outline EMP, a targeted contaminated land investigation will be undertaken during the detailed design phase (post-EIS) to determine the likelihood of contaminated land, potential risks to human health/environment and required management measures. A contaminated land management strategy has also been prepared for the Project (refer EIS Chapter 9: Land resources). Any contaminated land encountered as a result of Project activities will be segregated and stockpiled separately in accordance with regulatory requirements and procedures identified in the CEMP, including the Soil Management Sub-plan. Prior to construction, the contractor would ensure that the requirements of Chapter 5, Division 1 and Division 2, of the EP Regulation are adhered to, including the testing and characterisation of regulated wastes and their intended treatment or disposal.

EIS Chapter 20: Hazard and risk further details contaminated land that may arise as a result of the Project, providing an assessment of impacts and mitigation measures.

2.3 Spoil reuse in engineered embankments

Table 2.1 details technically feasible treatment options for unsuitable material that would allow reuse within the Project's engineered embankments. The proposed additional mitigation measures will require further investigation post-EIS. Quantities of spoil material reused would be monitored, in order to track performance against sustainability targets.

Table 2.1 Spoil reuse

Types of material	Initial mitigation	Proposed additional mitigation
Topsoil	Comprehensive soil surveys/mapping in accordance with relevant State government guidelines to be undertaken to describe and map out topsoil extents (including depths), opportunities (rehabilitation works) and risks (e.g. weeds, dispersive soils). All topsoil will be stripped and stockpiled and re-incorporated back into the works. Dispersive topsoil will be ameliorated to ensure suitability for reuse.	Further agronomic soils testing to be undertaken to confirm the suitability of soil chemistry for native plant growth and ameliorant requirements. Earthworks to be balanced based on expected volumes of topsoil generated along the alignment of the Project.
Toowoomba Range Tunnel	Stockpile material at the western tunnel portal, including material from the intermediate ventilation shaft and the eastern tunnel portal (to be initially constructed via mined tunnel and cut and cover)	Detailed geotechnical investigation to inform design and construction including updating the update the geological model. Further investigate the use of the basalt material as capping and structure fill for the Project and potentially the other Inland Rail projects. Further investigate the use of the basalt material and where applicable other material by local quarries.
Dispersive and Type B/C/D material recovered from cuttings	Assume all this material can be incorporated into a zoned embankment (as per ARTC Earthworks Material Specification). Type A material (where identified in cuttings) can be selectively won and re-incorporated into the outer part of zoned embankments. Type B and C material to be selectively won and incorporated into the upper parts of zoned embankments.	Further investigation and earthworks balancing between areas of cut and fill. Further trials to determine if lime amelioration of Type B/C/D material can be adopted in the outer zone of the embankment in lieu of Type A (non-dispersive material). Similarly, amelioration in lieu of adopting Type B and C (low plasticity general fill) material to be explored.
Potentially contaminated material	A Tier 1 Preliminary Site Investigation (contaminated land assessment) has been undertaken for the Project and confirmed that some sections of the Project disturbance footprint are contaminated. Extent and type of contamination to be further investigated — assume this can be incorporated/encapsulated within existing earthworks.	Further investigations to define contamination and encapsulation requirements. Compliance of materials with the appropriate contamination criteria (e.g. *National Environment Protection (Assessment of Site Contamination) Measure 1999 (Cth) guidelines*).
Acid sulfate soils (ASS)	Initial assessment (e.g. Australian Soil Resource Information System mapping and geotechnical investigations) indicates ASS is unlikely to be encountered in the Project disturbance footprint. Comprehensive soil surveys/mapping in accordance with relevant State government guidelines to be undertaken verify the initial assessment. If encountered, soils can typically be treated with an amount of neutralising agent that will counter their existing plus potential acidity.	Not applicable
Acid sulfate rock	Initial assessment of available petrographic reports and the geological history of the works indicates that acid rock drainage is unlikely to be encountered in the Project disturbance footprint. Assume not required	Not applicable

Types of material	Initial mitigation	Proposed additional mitigation
Structurally unsuitable material	Unsuitable material to be sent to spoil and ameliorated on site suitable for reuse in the Project	Establish treatment pads within laydown areas in proximity to where unsuitable materials are likely to be encountered e.g. overly wet soils recovered from low flood plain areas are to be dried or ameliorated before being incorporated back into the works as general earth fill.

Sustainability considerations with regards to spoil management are included in EIS Chapter 7: Sustainability. The nland Rail Environmental and Sustainability Policy, also provides sustainability-related commitments throughout design, construction and operation of the Project (refer EIS Appendix G. corporate Policies).

A summary of the reuse potential for material from the main geological units of the Project disturbance footprint is presented in Table 2.2.

Table 2.2 Anticipated material reuse - main geological units of the Project disturbance footprint

Geology	Lithology	Description/weathering	Anticipated material reuse
Alluvium	Clay, clayey sands and gravelly clay	Typically, dark coloured, low - high plasticity clay	Type C to Unsuitable Improved by treatment
Colluvium	Clay/gravelly clay variable soil rock matrix/cobbles/basaltic scree	Stiff to hard, high plasticity soils, MW or better scree	Type B to Unsuitable Rock fill 10-20% requires separation Improved by treatment
Main Range Volcanics	Basalt	Residual	Type B to Unsuitable Improved by treatment
		XW-HW	Type A to C
		MW	Type A to B Rockfill
		SW	Rockfill, Drainage Blanket
Koukandowie Formation	Sandstone	Residual	Type C/D
		XW-SW	Type A to C
	Siltstone	All Classes	Type C/D
	Interbedded	Residual	Type C/D
		XW-SW	Type A to C
	Claystone/Mudstone	All Classes	Type C/D to Unsuitable
Gatton Sandstone	Sandstone	Residual/XW	Type AB fill (subject to dispersivity and % passing 0.075 mm) Type C/D fill
		HW–MW	Rock fill (subject to % passing 0.075 mm) Type B Fill (subject to dispersivity)
		SW-FR	Bulk, select, structural fill, rockfill, Type A/B (subject to dispersivity)

A summary of the reuse potential for major cuttings in the Project is presented in Table 2.3. EIS Chapter 9: Land resources (Figure 9.4) shows the main surface geology intersected by the Project.

Table 2.3 Anticipated material reuse opportunity for engineered embankments - cuttings

Chainage start (km)	Chainage end (km)	Cut type	Avg. cut depth (m)	Max. cut depth (m)	Estimated suitability of cut material for reuse	Anticipated rock/soil type intersected	Potential additional mitigation
-480	-340	Box	1.9	3.1	20% Unsuitable 60% bulk fill C/D 20% bulk fill A/B	Shallow cuts, mainly in high plasticity clays residual soil and XW basalt	Lime treatment may allow reduction of unsuitable
2260	2330	Box	2.3	4.4			
3610	4200	Box	15.2	21.6	10% Class C/D 30% bulk fill A/B 60% structural fill Rock fill and drainage blanket	High plasticity clay residual soil and XW basalt, HW and better basalt	Basalt may require tracking, blending and/or screening for structural fill.
10250	10400	Box	20.6	15.5	10% bulk fill C/D 30% bulk fill A/B 60% structural fill Rock fill and drainage blanket	High plasticity clay colluvium derived from basalt MW or better basalt scree Interbedded HW sedimentary at depth	Basalt may require tracking, blending and/or screening for structural fill.
10580	10880	Side	10.6	23.5	50% bulk fill C/D 40% bulk fill A/B	Residual soil and XW-HW interbedded sedimentary rock, MW or better sedimentary rock at depth	Will require tracking. Subject to Emerson Class Number Limits
11170	11590	Box	14.7	31.6	50% bulk fill C/D 50% bulk fill A/B	Residual soil and XW-HW sedimentary rock MW or better sedimentary rock	Except Emerson Class Number Limits Will require tracking
12370	12770	Box	13.1	20.2	20% bulk fill C/D 80% bulk fill A/B	Residual soil and XW-HW sedimentary rock MW or better sedimentary rock	Except Emerson Class Number Limits Will require tracking
13150	14040	Side	9.7	21.3	10% Unsuitable 20% bulk fill C/D 70% bulk fill A/B	Residual soil, XW-HW sedimentary rock, colluvium from Ch12600 onwards	Except Emerson Class Number Limits Will require tracking
14080	14100	Side	4.2	23.1	10% Unsuitable 60% bulk fill C/D 30% bulk fill A/B	Shallow sidelong cut in predominantly colluvium / residual soil, over XW-MW sedimentary rock	Except Emerson Class Number Limits Will require tracking
14330	15720	Box	15.1	28.5	20% bulk fill C/D 80% bulk fill A/B	Residual soil and XW-HW sandstone, MW or better sandstone	Except Emerson Class Number Limits Will require tracking
17560	17820	Box	27.4	45.7	20% bulk fill C/D 80% bulk fill A/B	Residual soil and XW-HW sandstone MW or better sandstone	Except Emerson Class Number Limits Will require tracking

Chainage start (km)	Chainage end (km)	Cut type	Avg. cut depth (m)	Max. cut depth (m)	Estimated suitability of cut material for reuse	Anticipated rock/soil type intersected	Potential additional mitigation
19410	19670	Box	11.7	29.4	20% bulk fill C/D 80% bulk fill A/B	Residual soil and XW-HW sandstone, MW or better sandstone	Except Emerson Class Number Limits Will require tracking
20360	20500	Box	10.0	16.0	20% bulk fill C/D 80% bulk fill A/B	Residual soil and XW-HW sandstone, MW or better sandstone	Except Emerson Class Number Limits Will require tracking
20550	20660	Box	8.6	13.9			

Table notes:

E = Embankment, C = Cut, RS = Residual Soil, XW = Extremely Weathered, HW = Highly Weathered, MW = Moderately Weathered, m = metre

2.4 Spoil reuse for rehabilitation and operational landfill purposes

As per the requirements of the Earthworks Material Specification and the Earthworks and Material Management Framework the Project will seek to optimise earthworks to reduce the quantum of spoil produced in addition to optimising the amount of material that can be beneficially used within the Project disturbance footprint (and adjacent projects). Once these options have been exhausted, the Project will seek to beneficially reuse spoil material for the rehabilitation of mines and quarries in proximity to the Project. As a result, the material will be stockpiled at the western portal within the Project disturbance footprint for reuse in those future projects.

The reuse of Project won materials for this purpose will be contingent on further discussions and negotiations with the operators/owners of these projects to ensure that the timing and quantum of the material and its physical/chemical properties are suitable for this purpose. Furthermore, design and operational requirements and resource sterilisation aspects will form part of the consideration before accepting the materials generated by the Project.

In summary the following spoil reuse options as per the requirements of the Earthworks Material Specification and the Earthworks and Material Management Framework the will be considered for the management of any material that is not suitable to be reused within the Project and is stockpiled at western tunnel portal:

- The material may be used for the construction Rail Maintenance Access Roads, road embankments and mounds within short haulage distance of the source, reused for rehabilitation and landscaping, or
- The material may potentially be used as fill material for other projects including the Inland Rail B2G and H2C projects, along with Toowoomba Regional Council's Charlton Sports Precinct development.
- Rehabilitation of the existing quarries within the vicinity (50 km) of the Project, as identified through discussions with operators (e.g. Harlaxton and Withcott quarries)
- Daily cover for waste management facilities (e.g. Toowoomba Waste Management Centre)
- Noise attenuation mounds and/or landscaping mounds
- Profile and capping soils (subject to demonstration of compliance with material specifications) for waste management facilities that are anticipating closure in the near future (e.g. Clifton, Goombungee, Pittsworth landfills.)
- Fill material for the extension of the rail formation for future passing loops
- Beneficial use off-site, subject to treatment and/blending of unsuitable material (due to contamination or geotechnical aspects) with chemical additives which will allow for reuse and avoid disposal
- Subject to suitability, incorporation into commercial soil manufacturing processes (e.g. Candy Soil)

- Rehabilitation of the Toowoomba Bypass laydown area at Withcott
- Any spoil material that cannot be reused without treatment e.g. due to contamination, saturation or geotechnical reasons will be disposed at a designated waste facility that accepts spoil with those characteristics.

The location of major spoil reuse opportunities outside the Project disturbance footprint are presented in Figure 1.1. The adjoining B2G and H2C projects and also the InterLinkSQ project have the potential to accept the spoil (subject to it being deemed suitable) as general fill in these projects.

There is also an opportunity for the generated spoil to be used as daily and interim cover at waste management facilities.

The Toowoomba Waste Management Centre is the closest major waste management facility to the Project (adjoins the intermediate ventilation shaft at Cranley) which can receive clean fill material. The Gatton Landfill approximately 15 km east of the Project also has the capacity to received clean fill material. There are also a number of other landfill sites within the region (i.e. in Toowoomba and Lockyer Valley local government areas (LGAs) and surrounding LGAs)) that are scheduled for closure during the anticipated construction period and these sites may require fill for profiling and capping purposes.

The quantity and quality of excess material available from the Project and the capacity of the landfill sites to receive this material will be determined in consultation with the operator/owners of these facilities during detailed design.

In addition, known active quarries in proximity to this Project have the potential to accept spoil to be used for rehabilitation activities. However, the acceptance of the material for this purpose is subject to the following:

- Timing of the production of the spoil which will be determined through the detailed design and execution phases of the Project and will need to correspond with rehabilitation requirements
- Quality of the material (chemical/contaminant composition) which requires further investigation and assessment as part of future Project phases and will need to be compatible with closure/rehabilitation requirements
- Rehabilitation needs/closure requirements for the facilities and operational considerations which will need to be compatible with the use of Project spoil for this purpose
- Closure timing for the facilities, ensuring that sterilisation of reserves does not occur
- Bio-security (e.g. weeds) characteristics of the spoil as determined through future detailed investigations to inform design and assess compatibility with the requirements of the receiving sites.

In addition to the above, Project-won material may be reused for operational landfill purposes (application of day and interim covers) and for the capping and closure of landfill cells (final capping soils). Similar to the mines and quarries above, the reuse of this material will be contingent on the landfill operator's requirement for the material, its timing and whether this coincides with infrastructure development on the site.

Potential localities for the beneficial reuse of material are presented on Figure 1.1

The beneficial reuse of spoil for the above purposes will require further negotiation and consultation with operators and will be informed by:

- Detailed design of the Project
- Final earthworks optimisation
- Detailed characterisation of the material
- Earthworks sequencing, staging and logistics
- End user requirements
- Commercial negotiations.

2.5 Spoil disposal

Spoil disposal is considered to be the least preferable option for material generated by the Project. Offsite disposal will only occur if the material is considered unsuitable without treatment for other uses, e.g. due to contamination, geotechnical or saturation reasons.

Spoil reuse, as opposed to spoil disposal, is preferable from a social, environmental and financial perspective. The disposal of spoil material to licensed facilities is costly due to transportation and landfill costs; however, it should be noted that the Waste Reduction and Recycling Regulation 2011 prescribes certain waste streams (including clean soil) as exempt from landfill levy payment.

During detailed design and construction, the Project will seek to reuse as much material as possible in accordance with the hierarchy of material management options specified in Table 1.1 and will stockpile any excess spoil from the tunnels construction at the western tunnel portal. This material may also be reused by the Project at a future date or by other projects in the area including the B2G project or the Toowoomba Regional Council's Charlton Sports Precinct development.

Waste management facilities in the Toowoomba and Lockyer Valley LGAs will have the potential to accept spoil arising from the Project, though consultation with the councils has indicated that there is limited capacity. These facilities may also accept clean soil materials for use as day and intermediate covers and/or capping soils (if deemed suitable) and, therefore, could be considered a material reuse opportunity.

ARTC will continue to engage with relevant parties prior to the construction of the Project to confirm these potential spoil disposal sites. Consultation undertaken with operators is further described in EIS Appendix D: Consultation report.

3 Spoil onsite handling

3.1 Spoil storage and stockpile management

To avoid stockpiling and material double handling, the Project intends to immediately reuse excavated material as it is generated. However, if the stockpiling of excavated material as spoil cannot be avoided due to construction planning, this material will be stockpiled within the Project disturbance footprint. Stockpiles will be located as close as possible to the source of the excavated material and will be stockpiled by separable material type. The proposed construction laydown areas will have sufficient capacity to accommodate stockpiled materials.

Stockpile sites for spoil material will be established and managed in accordance with the following criteria:

- Located within the Project disturbance footprint
- Located sufficient distance from the existing Queensland Rail (QR) track (preferably outside their corridor) to avoid impediments to access to the rail corridor or rail infrastructure
- Located outside of easements and access roads to avoid impediments to access to utilities or to properties
- Located away from areas of concentrated water flow, watercourses and wetlands
- Situated within access to the Project or approved road network
- Located on level land above flood areas, unless measures are implemented to manage flooding
- Located to minimise the need for heavy vehicles to travel on local streets and through residential areas
- Located to reduce impacts on sensitive receptors (i.e. visual, air and noise impacts)
- Located on land that does not require the removal of remnant vegetation, threatened species or important habitat (other than already permitted)
- Located away from the tree protection zone of trees. The tree protection zone is an area around a tree trunk that must be protected to ensure stability of the tree in the ground and can be calculated using AS 4970-2009: Protection of trees on development sites (Australian Standards 2009).
- Located on land that does not impact on heritage sites (other than already permitted)
- Erosion and sediment controls will be implemented, operated and maintained in accordance with the draft Outline EMP and CEMP
- The CEMP will detail soil and water management measures consistent with the International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control (IECA 2008)
- Watering, vegetation or cover of long-term stockpiles (i.e. in place greater than 2 years) to reduce the likelihood of erosional loss of materials.

Segregated stockpiles will be constructed to avoid cross-contamination of topsoil, spoil material requiring treatment or disposal (i.e. asbestos/hazardous waste) and material for reuse. Topsoil stockpiles will be managed so they retain their biological function and seed bank for reuse. Contaminated materials will be segregated and stockpiled separately, in accordance with relevant legislative requirements and procedures identified in the draft Outline EMP and CEMP.

The details of spoil management (including movement and stockpile locations) is contingent upon the construction contractor's preferred construction methodology and earthworks sequencing which will be determined as part of the execution planning for the Project. At the current design stage, details of earthworks movements and subsequently specific details on stockpile locations are yet to be confirmed and will be finalised during the detailed design stage.

The exact location of the spoil stockpile areas will be determined during the pre-construction phase once the construction contractor has been appointed however, as noted in Section 2 a large stockpile are is proposed at the western tunnel portal.

3.2 Tunnel spoil stockpile

Tunnel construction activities are the main source of excess material (estimated to be 730,000 m^3) that will contribute to the tunnel spoil stockpile.

To minimise the movement or spoil and/o the disposal of the material offsite, it is anticipated that a permanent spoil stockpile will be required for the tunnel works at the western tunnel portal fronting Morris Road and Boundary Street at Gowrie Junction within the railway corridor. The conceptual location of the spoil stockpile at the western tunnel portal is shown in Figure 3.1.

The stockpile is estimated to be 600 m x 200 m, and up to 6 m high. The stockpile will be profiled and vegetated for the purposes of soil/material stabilisation and to mitigate amenity impacts (e.g. noise and scenic amenity) during construction and operations.

Subject to further consultation, further investigation and detailed design, the material may be deemed suitable for reuse by the Project in the future or by planned future projects such as the B2G project or other projects within the Toowoomba region. These opportunities will be further explored as part of the next phases of project development.

3.3 Biosecurity matters

Activities associated with the management of spoil may provide pathways for the spread of biosecurity matters (e.g. weeds, diseases pests etc). The *Biosecurity Act 2014* (Qld) mandates a general biosecurity obligation to prevent or minimise the biosecurity risks. Local councils also identify species of local concern, including matters not listed under the provisions of the *Biosecurity Act 2014* (Qld) and have developed biosecurity management plans for the identification and control of these matters in accordance with local laws and State legislation.

The following information will be considered in meeting ARTC's general biosecurity obligation:

- Prior to clearing and other ground disturbances, identify restricted matter flora species and where applicable other matters (e.g. diseases such as Myrtle rust) in the area through pre-construction surveys and consultation with Biosecurity Queensland, local council pest management officers, local environmental groups and supporting landholders
- Ensure that weed impacted topsoil is not reused in rehabilitation works, unless it is treated and sterilised in an appropriate manner
- Use designed access tracks for transportation of spoil material and avoid known biosecurity matter areas (e.g. weed infestations), where practicable
- Clean equipment such as boots, vehicles, plant and machinery when "dirty sites" (i.e. land parcels where restricted matter flora species are known to occur)
- Implement weed hygiene protocols and washdown procedures for construction vehicles and equipment
- Dispose of weed material in appropriate waste receptacles within designated locations (a specific pest and weed management sub-plan will be developed during the detailed design stage of the project to specify individual weed treatment requirements).

A biosecurity management plan will be developed to support the construction phase of the Project, with the plan to complement biosecurity management plans implemented by the State, TRC, LVRC, natural resource management groups and/or landholders.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Western portal

Eastern portal

Ventilation shaft

Gowrie

Withcott

Toowoomba

TOOWOOMBA

LOCKYER VALLEY

Gowrie Ck

Murphys Ck

New England Hwy

Warrego Hwy

Toowoomba Conn Rd

Toowoomba Byp

Oaky Ck

Rocky Ck

Six Mile Ck

Little Oaky Ck

Gatton Ck

Hume St

Ruthven St

0 2 4 6 8 10 12 14 16 18 20 22

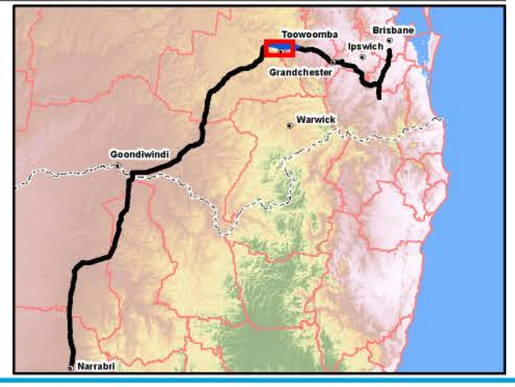
Map by: GN Z:\GIS\GIS_3200_G2H\Tasks\320-EAP-20190913075 6_G2H_Waste_Mgt_Figures\320-EAP-20190913075 6_FFJV_Fig3.1_spoil_stockpile_v2.mxd Date: 28/01/2021 14:34

Legend

- 5 Chainage (km)
- Localities
- Existing rail
- Spoil haulage routes
- B2G project alignment
- G2H project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Tunnel
- EIS investigation corridor
- Local Government Areas
- Spoil stockpile

Rail earthworks cut and fill

- Cut
- Fill



A3 scale: 1:70,000

0 1 2 3 4 5km

Future Freight
Integrating Community, Environment and Engineering

Issue date: 28/01/2021 Version: 2

Coordinate System: GDA 1994 MGA Zone 56

Gowrie to Helidon

Figure 3.1: Spoil stockpile and haul routes

3.4 Archaeological potential

Aboriginal cultural heritage potentially impacted by the Project will be identified, assessed and managed under Cultural Heritage Management Plans (CHMPs). CHMPs for the Project (CLH017009) were developed in 2018 between ARTC and the Aboriginal parties relevant to the Project, being the former registered native title claimant for the Western Wakka Wakka People native title claim and the registered native title claimant for the Yuggera Ugarapul People native title claim and approved under *the Aboriginal Cultural Heritage Act 2003* (ACH Act).

For non-Indigenous cultural heritage, a Heritage Management Plan will be developed by the construction contractor as part of the CEMP prior to construction with the plan to be implemented and adhered to during constriction. The Heritage Management Plan will detail the specific measures to be implemented during construction to minimise the potential for impacts, manage heritage and the procedures for any unexpected finds in accordance with heritage legislation and ARTC procedures.

4 Spoil transport

4.1 Haul routes

Spoil that is being reused within the Project disturbance footprint or reused by the adjoining Inland Rail projects (likely to be B2G, though efficiencies between the Project and H2C are likely east of Lockyer Creek) and does not require transportation on public roads, will be transported by articulated dump truck to match excavator productivity. However, some of these haul routes will at the very least require the crossing of the local road network, including Murphys Creek Road.

In addition, there will be a requirement to haul excavated material from tunnelling activities (e.g. cut and cover and tunnel boring) at the eastern tunnel portal at Ballard to the laydown area at the western tunnel portal, Gowrie Junction or distributed along the Project alignment. Similarly, excavated material from the construction of the intermediate ventilation shaft at Cranley will also be transported to the laydown area at the western tunnel portal, Gowrie Junction.

The haul routes will use a combination of local and State-controlled roads, with haul routes selected to minimise the impact to local traffic and the community. The proposed haul routes are depicted in Figure 3.1. The spoil will be transported by registered road trucks, with access roads (permanent and temporary) linking the Project to the local road network. The impacts on the local road networks from the haul routes are assessed as part of traffic impact assessment (refer EIS Appendix U: Traffic impact assessment).

Any material that cannot be reused within the Project disturbance footprint and is being reused off-site or disposed of at a waste management facility or quarry, will be transported in appropriately licensed vehicles. The construction contractor will ensure that these facilities/external projects accepting material for reuse or disposal have the capacity to receive spoil.

4.2 Hours of works

Spoil material haulage will be restricted to standard construction hours where possible to minimise environmental harm and public amenity nuisance. The construction program will be based on the following worksite hours (unless approved otherwise):

- General construction activities:
  - Monday to Friday – 6.30 am to 6.00 pm
  - Saturday – 6.30 am to 1.00 pm
- No work planned on Sundays or public holiday
- Underground tunnel construction activities, including the laydown area at the western tunnel portal
  - 24 hours a day, 7 days a week
- Track possessions will proceed on a 7-day/24-hour calendar basis.

Track possessions (QR's West Moreton System rail corridor) will generally be allocated over weekend periods, with extended track possessions occurring over holiday or non-seasonal periods (i.e. outside of grain movement periods). Works outside of standard construction hours will occur throughout the duration of the construction program and will involve:

- Track works including tamping, ballast profiling, earthworks and formation works
- Delivery of concrete, steel, and other construction materials delivered to site by heavy vehicles
- Movements of heavy plant and materials
- Arrival and departure of construction staff during shift change-overs
- Roadworks to arterial roads

- Traffic control crews, including large truck mounted crash attenuator vehicles, medium rigid vehicles, and lighting towers
- Incident response including tow-trucks for light, medium, and heavy vehicles.

Alternative construction rosters to suit delivery and industrial relations issues may be investigated by the construction contractor.

5 Review and improvement

The SMS will be revisited at contract award to incorporate changes to the Project which may occur subsequent to the EIS submission and prior to execution of the works, to incorporate any Project-specific criteria by which the strategy will be measured. The SMS will be revised and further developed throughout the construction of the Project to incorporate additional data that has not been confirmed at this point of the Project, to reflect detailed design considerations, encountered field conditions such as unexpected presence of ASS and the outcomes of continuous monitoring of environmental performance. Revisions will also be triggered through changes to or any improvements occurring in the Project processes.

During the execution of the Project, the SMS will be reviewed and revaluated annually during the construction phase (unless a revision is triggered earlier as a result of process or methodology change) against the Project-specific criteria with the aim of assessing the significance of impacts to optimise the reuse of spoil material and to discourage landfill disposal. As a minimum, the criteria will reflect the objectives set out in the Queensland Waste Management and Resource Recovery Strategy (Department of Environment and Science 2019) and will be optimised based on the observations made during this phase including:

- Unexpected quantities of unsuitable material due to geotechnical or biological contaminants (e.g. weeds)
- Incorrect handling of spoil material
- Changes in the capacity of the waste management facilities in accepting the spoil material
- Increase in demand for spoil to be used as fill in adjacent projects.

During the construction phase of the Project, the actual quantities of spoil generated will be re-assessed against these quantities and the proportional contribution to the region's waste streams will be re-evaluated and improvements in performance will be sought to maximise the reuse of spoil for beneficial purposes both within and outside of the Project disturbance footprint.

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APPENDIX T

INLAND RAIL

Spoil Management Strategy

ARTC Earthworks materials specification

GOWRIE TO HELIDON ENVIRONMENTAL IMPACT STATEMENT

IR_1536

ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

Division / Business Unit: Inland Rail
Function: Earthworks (Construction)
Document Type: Specification

Earthworks Materials Specification

ETC-08-03

Applicability

NSW	QLD	VIC	SMS

Publication Requirement

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0-9000-PEN-00-SP-1002 – Rev 2.1

Document Status

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1.3	08 Jul 20	Inland Rail & Technical Standards	Stakeholders	Manager Standards	General Manager Technical Standards 24/07/2020

Amendment Record

Amendment Version #	Date Reviewed	Clause	Description of Amendment
1.0	12 May 17		First Issue
1.1	23 Nov 17	All	Revision to align with issue of ETC-08-04. Addition of section for geotextile classification and compliance. Additional update to scope following ONRSR comments, as well as clauses 4.1, 4.7 & 4.11.
1.2	25 Sep 19	1.5	Add Procedure Owner section and remove ‘Confidential’ from title page.
1.3	08 Jul 20	All	Minor revision of Sections 1–7. Addition of section for geogrid classification and compliance. Added Earthworks Materials Management Framework to Section 4.1 and flowchart to Appendix B.

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1 Scope and Purpose

1.1 Purpose

The purpose of this Specification is to provide earthworks material types and compliance requirements. Complying earthworks materials shall be used to construct a stable foundation and formation suitable for ballast and track to be constructed upon, along with associated earthworks for drainage elements, such that it maintains stability and meets safety and performance standards over the design life.

1.2 Scope

This Specification defines earthworks material properties for construction of railway earthworks for the Inland Rail Program (the Program).

This Specification is intended to be tailored to suit the materials available within the Program. The design information and values provided in the following sections are deemed to comply. Variation to this Specification requirements must be in accordance with Section 7. The proposed values must be consistent with design requirements and acceptance of the proposed values is at the sole discretion of the Superintendent.

This Specification allows for unconventional alternative engineered materials, such as use of stabilised materials, geosynthetics or other solutions. Proposals for use of alternative engineered materials and their compliance requirements must be in accordance with Section 7 and subject to appropriate ARTC review and acceptance. If an alternative material specification is accepted, material properties and other relevant information must be documented in a Project Specific Specification and on drawings approved by the Superintendent.

1.3 Precedence

The following order of precedence shall be adopted when undertaking construction of earthworks which form part of the Works:

1. the Drawings;
2. Project Specific Specifications;
3. this Specification;
4. ARTC standard drawings;
5. Australian Standard requirements, regulations and industry guidelines.

Where there is a discrepancy, the Contractor must request clarification in writing from the Superintendent prior to proceeding with the works containing the discrepancy.

1.4 Project Documents

The execution of earthworks in accordance with this Specification requires compliance to overarching Project and Program requirements. The Contractor’s attention is drawn to the following documents:

- The Project General Conditions of Contract.
- The Project Environmental Management Plan.
- The Project Primary Approval Document and Conditions of Approval.
- The Project Quality Plan.

1.5 Document Owner

The Manager Standards is the document owner and is the initial point of contact for all queries relating to this Specification.

2 Definitions

Unless defined otherwise in the relevant Contract, terms used in this Specification will have the following meanings assigned in Table 1 to Table 3 and Figure 1 to Figure 4.

Table 1 Contractual Definitions

Term	Definition
Approve(d)	Means approved in writing by the Superintendent.
Contract	Commercial document entered into between the Principal and the Contractor detailing the terms of the engagement of the Contractor by the Principal contractually obligated to perform the Works.
Contractor	Any partnership, joint venture, company, corporation, or trust who has entered into a Contract with the Principal to perform the Works prescribed in the Contract.
Designer	The company/individual engaged by the Principal or the Contractor to undertake design.
Design Services Agreement	Means the agreement entered in to, or to be entered in to, between the Principal and Designer for design works.
Drawing	The latest approved revision of the project drawings.
Geotechnical Engineer	A qualified geotechnical engineer, geologist or engineering geologist, with experience and knowledge in soil-structure interactions.
Principal	A client who awards a contract to a Contractor for completion of a job or project in accordance with terms of the contract.
Project	A package of works within a Program as determined by ARTC.
Program	Means the Inland Rail Program.
Project Quality Plan	Means the Contractor's Project Quality Plan (PQP) for the Project, prepared in accordance with the Program Quality Plan.
Project Specific Specification	Will mean a Specification developed by the Contractor for a project specific requirement that is not covered under the latest revisions of ARTC standards and specifications.
Quality System	A documented Quality System prepared by the Contractor in accordance with this Specification and Australian Standard for Quality System AS/NZ ISO 9001.
Rail Corridor	The rail corridor is the land on which the railway is built. It comprises all property typically bounded from fence line to fence line, or if there are no fences, everywhere within 15 m either side of the outermost parts of track, unless otherwise indicated.
Site	Means the location or portion of land related to the Project works. The site may include land both inside and outside of the rail corridor.
Specification	A Specification consists of a written document that delineates the requirements regarding the materials, products, equipment, systems, standards, workmanship and quality aspects involved with the execution of the work to be undertaken and fulfilment of the Contract. Reference to this specification document includes all other relevant documents referred to in this specification.
Standard	A consensus on what is required or should be done. A Standard consists of a written document that delineates the requirements regarding a particular material, product, process or service.

Term	Definition
Superintendent	Means the person(s) appointed by the Principal to act as the nominated Principal's Representative and includes the Superintendents Representative. In general, the Superintendent's role is to 'administer' the contract and ensure the contractual obligations are performed. Under a traditional construction contract, the superintendent has two separate and distinct roles: to act as agent for the principal; and to act as an independent certifier.
Works	Means the whole of the work to be executed in accordance with the Contract, including variations provided for by the Contract. Work includes the provision of materials unless agreed otherwise.

In addition to the definitions listed in Table 1 the following railway construction definitions appearing in this Specification will have the following meanings:

Table 2 Railway Earthworks Definitions

Term	Definition
Ballast	Ballast is a free draining coarse aggregate used to support railway tracks.
Batter	A constructed slope (cut or fill) commonly of uniform gradient.
Bench	Bench is a near horizontal break in a slope (cut or fill) to break the continuity of an otherwise long slope to improve its stability or to catch and arrest slide material. Bench crossfall and width configuration is determined by slope design.
Borrow Area/Pit	An area/pit where excavations are made for the procurement of additional material.
Bound Material	A granular material with sufficient stabilising agents added to produce a material with a significant tensile strength.
California Bearing Ratio	A measure of the load-bearing capacity of soils, typically in a re-compacted and saturated state, or in situ.
Capping Layer	A layer or layers of graded crushed rock or other engineered fill within the Formation, usually provided for the purpose of sealing the earthworks from surface water and structurally supporting the track.
Certified Materials	Materials certified as virgin materials, clean materials or suitable for the intended land use in accordance with the relevant regulatory waste classification or categorisation requirements.
Cess	The area from the edge of the ballast profile to either the crest of the embankment or the toe of the cutting.
Cess Drain	The surface drain outside the sleepers to drain water from the ballast.
Compaction	The process whereby the dry density of a material is increased by mechanical or other means.
Compacted Lift Thickness	The lift thickness of a placed fill material after compaction.
Contaminated Materials	Any material containing a chemical substance(s) at above background levels and posing, or potentially posing, a risk of harm to human health, the environment, water supply or agriculture, based on applicable legislation and standards.
Cut/Cutting	Earthworks constructed by excavation.
Design CBR	The Californian Bearing Ratio (CBR) determined by design for nominated test conditions using statistical analysis or other appropriate methods.

Term	Definition
Earth Excavation	Rippable or excavatable material. All materials such as earth, clay, sand, gravel, weathered or loose rocks which can be removed by ripping or excavation, without regard to stockpiling, loading or carting, as defined for bulk excavation and confined excavation non-rippable materials in the Earthworks Construction Specification ETC-08-04.
Earth Fill	Fill material consisting of fine and coarse particles evenly distributed throughout the layer filling voids so that when compacted produces a dense stable embankment. As larger sized rock fragments are added to an earth fill, at some point the "earth fill" becomes a "rock fill" with predominantly coarse-grained gravel, cobble and boulder sized rock fragments.
Earthworks Materials Management Framework	The framework for reuse of site won or generated earth and rock materials, where the reuse: • Is genuine, rather than a means of waste disposal. • Is beneficial or fit for purposes. • Will not cause harm to human health, the environment. • Will not adversely impact current and future rail infrastructure, maintenance or operations.
Embankment	Earthworks constructed by placement of fill for the purpose of constructing an overlying formation.
Fill	Earth or rock materials placed as a part of the construction process.
Formation	Earthworks constructed by material, usually capping and structural fill, placed between the Subgrade Level and Formation Level below the ballast (refer to Figure 4).
Formation Level	The level of the formation surface, also referred to as the top of formation.
Foundation	The soil or rock material immediately underlying and supporting any earthworks undertaken as part of the Works.
General Earth Fill	An earth fill material complying with Section 4.4 of this Specification.
General Earth Fill Lower	The bottom portion of a Zoned Embankment (refer to Figure 2).
General Earth Fill Upper	The top portion of a Zoned Embankment (refer to Figure 2).
Geocomposite	A product combining a geogrid layer overlaying a geotextile layer for reinforcement, separation and filtration applications.
Geosynthetics	The range of polymeric products comprising eight main categories: geotextiles, geogrids, geonets, geomembranes, geosynthetic clay liners, geofoam, geocells and geocomposites.
Geosynthetic Reinforced Embankment	An embankment that utilises geosynthetics to improves its stability. Geosynthetic reinforcement may be used for the following applications: • As embankment basal reinforcement (e.g. load transfer, piled embankments and platforms). • Within reinforced embankment (batter slope ≤ 70°).
Geosynthetic Reinforced Soil Structure	A structure that utilises geosynthetics in its design so as to form a stable composite structure. Geosynthetic reinforcement may be used for the following applications: • Retaining walls. • Within Reinforced Soil Structure with batter slope ≥ 70°.
Homogenous Embankment	Earthworks constructed by placement of a uniform fill material. Not a Zoned Embankment.
Layer	One or more uniformly compacted lifts of a given material.

Term	Definition
Land Use Criteria	The maximum concentration of contaminants recommended for safe use under a generic land use scenario applicable to the site as outlined in the National Environment Protection (Assessment of Site Contamination) Measure 1999 Amendment 2013.
Lift	The placement of a fill material within the compacted thickness limits in this Specification.
Loose Lift Thickness	The thickness of a placed fill material prior to compaction.
Lot	A portion of material or a section of the Works which has been constructed and supplied under uniform conditions and contains material of uniform quality and is homogeneous with only minor and random variation in characteristics (such as density, moisture, thickness, material type, colour, and finish) or a single finished item of work which includes several materials or work types (e.g. construction of a culvert in place).
Main line	The line normally used for running trains through and between locations.
Maximum Dry Density	The dry density which can be achieved under a specified compaction effort at the Optimum Moisture Content.
Moisture Ratio	The ratio of moisture content to Optimum Moisture Content.
Optimum Moisture Content	The percentage of moisture in a soil at which the soil can be compacted to its greatest density for a specified amount and type of compaction effort.
Outer Zone	The portion of a Zoned Embankment encapsulating structural fill and general earth fill (refer to Figure 2).
Reinforcement	The improvement of the earthworks by introducing a geosynthetic to enhance lateral restraint or bearing capacity using interlocking of particles.
Rock Fill	A material, meeting the requirements of Section 4.7, which when placed, produces an embankment deriving its stability from the mechanical interlock of the coarser particles, rather than from the compaction of finer material around the coarser particles. Rock fill may contain large open voids.
Select Fill	Material for use adjacent to structures or in other distinct applications that require specific properties defined for that purpose.
Siding	A section of railway track, connected to a running line or another siding, on which rolling stock can be placed clear of the running line and normally used for purposes such as stabling, loading, rolling stock maintenance or passing of trains.
Spoil	Material surplus to the Contract requirements which must be managed onsite or disposed of off the Site, as per Earthworks Materials Management Framework (Appendix B).
Stabilisation	The permanent physical and chemical alteration of materials to enhance their physical properties. Stabilisation binders include, but are not limited to, granular, salts, organic and polymer compounds, hydrated lime, Portland Cement, slag, fly ash, bitumen, and combinations thereof.
Stripped Surface Level	The ground surface after clearing and grubbing and topsoil stripping operations have been completed.
Structural Fill Layer	A layer or layers of engineered fill, usually placed to provide a gradational structural support zone between the Subgrade Level and Capping Layer.
Subgrade Level	The finished surface of an embankment or cutting upon which the formation is constructed.
Surplus	That which remains when use or need is satisfied.

Term	Definition
Topsoil	The upper most layer of the soil usually dark in colour and rich in organic material.
Track	The infrastructure upon which rolling stock travels. Track can be designated as uni-directional or bi-directional. Track is formed through the combination of rails, rail connectors, sleepers, ballast, points, crossings, and substitute devices where used. Also referred to as the Track Structure (refer to Figure 4).
Unsuitable Material	All material identified as unsuitable, as defined in Section 4.11, for use as a foundation for earthworks or structures or for use as fill material in its present position or condition in consideration of both geotechnical and environmental aspects.
Waste	Waste means any: (a) discarded, rejected, unwanted, surplus or abandoned matter; or (b) otherwise discarded, rejected, unwanted, surplus or abandoned matter intended for: (i) recycling, reprocessing, recovery, reuse, or purification by a separate operation from that which produced the matter; or (ii) sale, whether of any value or not (National Environment Protection (Movement of Controlled Waste between States and Territories) Measure 1998).
Weighted Plasticity Index	Defined as the value of the Plasticity Index (PI) times the percent passing the 0.425 mm sieve.
Zoned Embankment	An embankment comprised of zones of different types of fill materials (refer to Figure 2).

The abbreviations listed below where used in the Specification, will have the following meaning:

Table 3 Abbreviations

Abbreviation	Meaning
ARTC	Australian Rail Track Corporation
AS	Australian Standard
ASTM	American Society for Testing and Materials
BoD	Basis of Design
BS	British Standard
CBR	California Bearing Ratio
D_{50}	Particle size represented by the 50% passing, AS 1289.3.6.1
D_{85}	Particle size represented by the 85% passing, AS 1289.3.6.1
EN	European Standard
EOS	Equivalent Opening Size, AS 3706.1, AS 3706.7 or EN ISO 12956
EOTA	European Organisation for Technical Assessment
G Rating	Geotextile strength rating = $(L \times h_{50})^{1/2}$
h_{50}	Drop cone puncture resistance (mm) of the geotextile material, AS 3706.5
HDPE	High Density Polyethylene
ISO	International Standard
ITP	Inspection Test Plan

Abbreviation	Meaning
L	Burst strength (N) of geotextile material, AS 3706.4
MDD	Maximum Dry Density
MR	Moisture Ratio
NATA	National Association of Testing Authorities
NEPM	National Environmental Protection (Assessment of Site Contamination) Measure
OMC	Optimum Moisture Content
PET	Polyester (polyethylene terephthalate)
PI	Plasticity Index
PP	Polypropylene (also known as polypropene)
PQP	Project Quality Plan
Q_{100}	Flow rate through the geotextile material, in $l/m^2/s$, under 100 m constant head conditions, AS 3706.9
R_c	Reduction factor for creep
R_d	Resistance to installation damage
R_m	Reduction factor for manufacture
R_{uv}	Resistance to UV
RMS	Roads and Maritime Services - NSW
SMDD	Standard Maximum Dry Density
T_s	Tensile Strength
UTS	Ultimate Tensile Strength
Ψ	Permittivity of the geotextile material, in S^{-1}, under 100 m constant head conditions, AS 3706.9

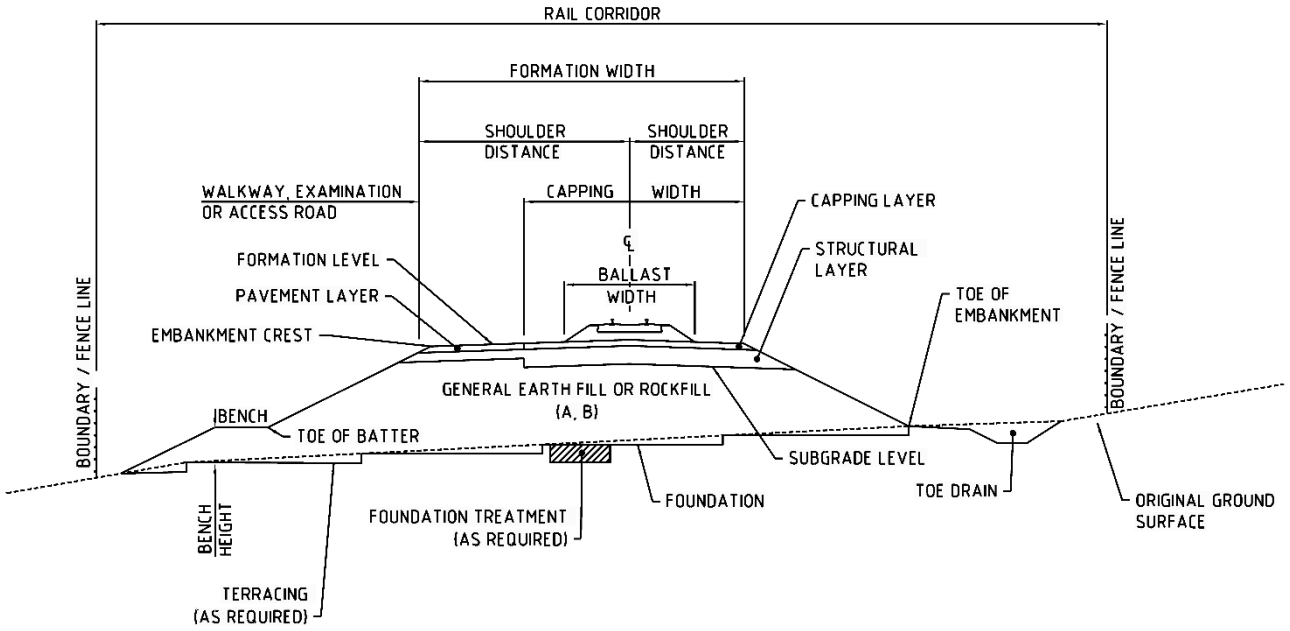


Figure 1 Schematic of Homogeneous Embankment Cross Section

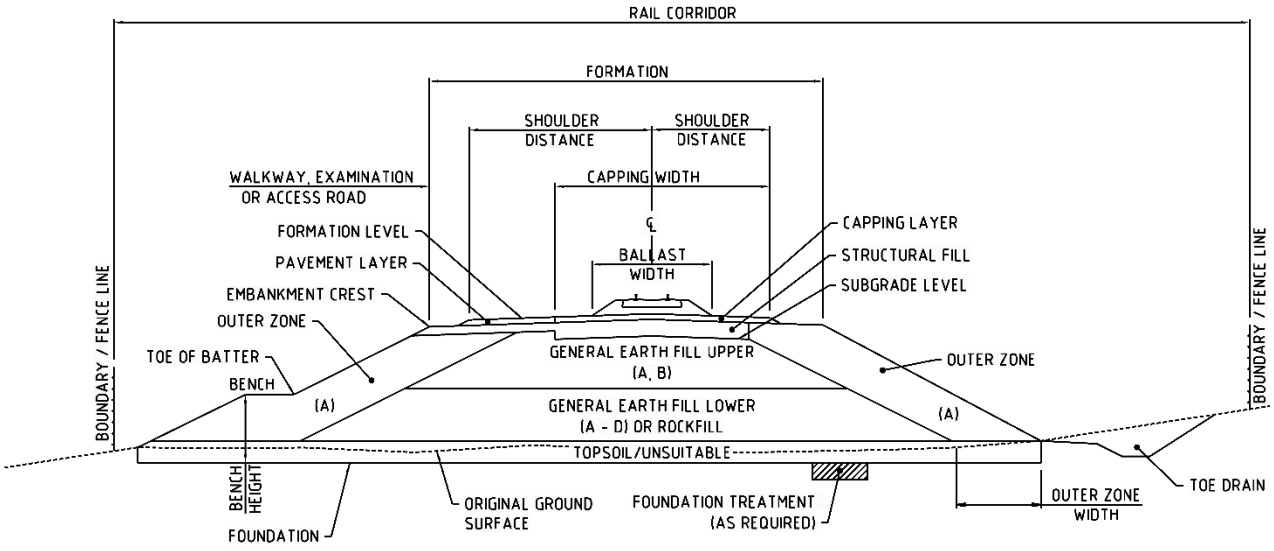


Figure 2 Schematic of Zoned Embankment Cross Section

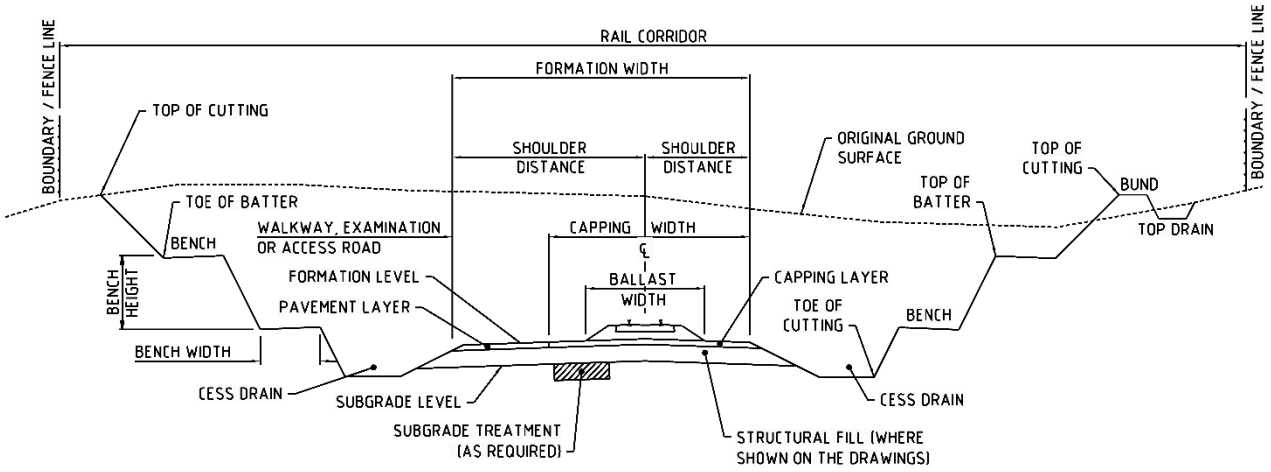


Figure 3 Schematic of Cutting Cross Section

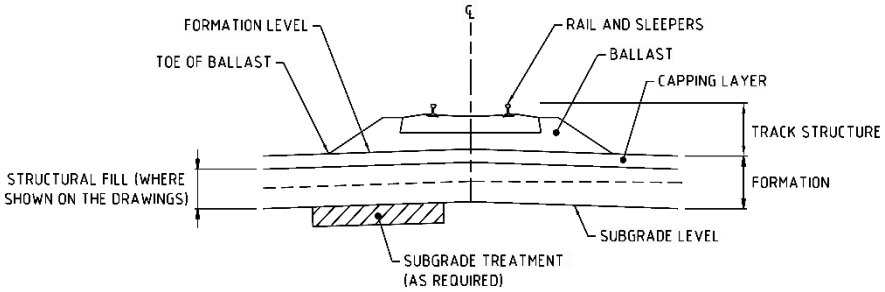


Figure 4 Schematic of Formation and Track

3 Codes and Standards

All design, materials, equipment, workmanship and installations must comply with the latest revision of the Project Standards and Specifications, ARTC Engineering Standards, relevant rail authorities and Australian Standards (AS) relating to the relevant element or component of Works unless otherwise noted in this Specification.

The following codes and standards apply for the Project, and any discrepancy between standards and this Specification must be referred to the Superintendent for clarification.

AS 1012	Methods of testing concrete
AS 1141	Methods for sampling and testing aggregates
AS 1289	Methods of testing soil for engineering purposes
AS 1672	Building Limes
AS 1726	Geotechnical Site Investigations
AS 2001	Methods of test for textiles
AS/NZS 2041	Buried Corrugate Metal Structures
AS 2159	Piling—Design and Installation
AS 2758	Aggregates and rock for engineering purposes
AS 3705	Geotextiles—Identification, marking and general data
AS 3706	Geotextiles—Methods of test
AS/NZS 3725	Design for installation of buried concrete pipes
AS 3972	General purpose and blended cements
AS 4133	Methods of testing rocks for engineering purposes
AS 4489	Test Methods for Limes and Limestones
AS 5101	Methods for preparation and testing of stabilised materials
AS 7638	Railway Earthworks
AS/NZS ISO 9001	Quality management systems - requirements
ASTM D1603	Standard Test Method for Carbon Black Content in Olefin Plastics
ASTM D4355	Standard Test Method for Determination of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc-Type Apparatus
ASTM D4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D5321	Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear
ASTM D5818	Standard Practice for Exposure and Retrieval of samples to Evaluate Installation Damage of Geosynthetics
ASTM D6637	Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method

ASTM D7737	Standard Test Method for Individual Geogrid Junction Strength
BS 8006-1	Code of practice for strengthened/reinforced soils and other fills
EN ISO 10319	Geosynthetics—Wide-width tensile test
EN ISO 12956	Geotextiles and geotextile-related products—Determination of the characteristic opening size
EOTA TR41	Non-reinforcing hexagonal geogrid for the stabilization of unbound granular layers by way of interlock with the aggregate
RMS T102	Pre-treatment of road construction materials by compaction
RMS T103	Pre-treatment of road construction materials by artificial weathering

The latest ARTC Engineering Standards and Codes of Practice are available from www.artc.com.au/.

4 Earthworks Materials

4.1 General

The Contractor must:

- Only use earthworks materials approved for use by the Superintendent. Earthworks materials may include site won earthworks materials and waste material that has been confirmed as suitable for the proposed use in accordance with relevant state authority environmental requirements, in consideration of requirements relating to waste minimisation and classification, geotechnical and environmental properties.
- All earthworks materials must comply with relevant landuse criteria for contaminants.
- Stockpile, test (to Australian Standards) and gain approval of all materials in accordance with their classification prior to placement.
- Ensure all earth fill materials have a uniform grading and must not be gap graded between the coarse limit of the grading envelope to the fine limit of the grading envelope, or vice versa, unless specified otherwise.
- Undertake appropriate testing of all construction material sources to confirm compliance to this Specification.
- Where surplus earthworks materials are proposed to be reused, comply with the requirements of the Earthworks Materials Management Framework in Appendix B.
- Evaluate the suitability of non-potable water by field and laboratory testing at the discretion of and approved by the Superintendent.
- Ensure saline water with chemical composition exceeding the limits specified in AS 2159 is not used in fill material where steel elements or steel reinforced concrete are buried, or where vegetation is to be established.

Subgrade materials must be tested in accordance with General Earth Fill CBR requirements.

Prior to construction, all compliance tests must be completed for each material type and source. Test reports must not be older than 12 months. Classification conformance criteria must be determined by sampling of sources, stockpiles and Lots. Placement conformance criteria must be determined by appropriate test methods post placement.

Embankments must be comprised of materials derived from excavated cuts, borrow pits, quarries and other approved sources.

All variations from the material requirements outlined in Section 4.2 to Section 4.10 must be specified in accordance with Section 7.

4.2 Capping Material

Capping material must be a well-graded natural or artificially blended gravel/soil. It is required to have sufficient fines to allow for compacting to high densities by static or vibratory steel-tyred rollers or by ballasted pneumatic-tyred rollers. Capping material must be capable of providing structural support to the ballast layer and shedding water from the ballast away from the formation.

Capping material must comply with the following Table 4 requirements unless varied by design.

Table 4 Capping Material Requirements

Criteria	Test Method[4]	Compliance
Classification		
Artificial Weathering[1,5]	RMS T103	Pre-treatment
Repeated Compaction[1,5]	RMS T102	Pre-treatment
Particle Size Distribution	AS 1289.3.6.1	
% Passing 26.5 mm sieve		100
% Passing 19.0 mm sieve		80–100
% Passing 9.5 mm sieve		55–100
% Passing 2.36 mm sieve		30–70
% Passing 425 μm sieve		12–40
% Passing 75 μm sieve		5–25
Particle Shape	AS 1141.14	< 30% passing 2:1 caliper ratio
Flakiness Index	AS 1141.15	≤ 40
Wet/Dry Strength	AS 1141.22	≥ 85 kN wet < 35% variation
Liquid Limit	AS 1289.3.1.1 or 3.1.2	≤ 30 (35 for arid areas)
Plastic Limit	AS 1289.3.2.1	≤ 20
Plasticity Index	AS 1289.3.3.1 or 3.3.2	6–12 (6–15 for arid areas)
Linear Shrinkage	AS 1289.3.4.1	3.0–7.5
Weighted Plasticity Index	AS 1289.3.6.1/3.3.1	140–360
Maximum Dry Density	AS 1289.5.1.1	≥ 2.0 t/m^3
California Bearing Ratio[2]	AS 1289.6.1.1/5.1.1 4 day soaked, 9 kg surcharge, to 100% SMDD at OMC	≥ 50%
Classification test frequency[3]		1 test per 1,000 t
Permeability		
Permeability	AS 1289.6.7.1	< 5 × 10^{-7} m/s
Permeability test frequency[3]		Min. 2 tests per source material

Notes:

1 *Material that is susceptible to break down or fracturing during compaction must be subject to pre-treatment. Tests performed post placement for conformity with this table do not require pre-treatment.*
2 *CBR to be determined by design.*
3 *Refer to Section 7.2 for variations to test frequencies.*
4 *Refer to Section 7.3 for alternative test methods.*
5 *These tests to be completed prior to construction works (classification conformance) and may be applied during the construction works at the discretion of the Superintendent.*

4.3 Structural Fill Material

Structural fill must be a material with properties which when placed, provides a gradational support zone over the underlying material. Structural fill is typically used to provide a stable formation for the support of the track infrastructure and a stable construction platform for the placement, compaction and maintenance of the capping layer and track.

Structural fill material must comply with the following Table 5 requirements unless varied by design.

Table 5 Structural Fill Material Requirements

Criteria	Test Method[6]	Compliance
Classification		
Repeated Compaction[1,7]	RMS T102	Pre-treatment
Particle Size Distribution	AS 1289 Clause 3.6.1	
% Passing 75 mm sieve		100
% Passing 53.0 mm sieve		80–100
% Passing 2.36 mm sieve		15–100
% Passing 425 μm sieve		10–70
% Passing 75 μm sieve		5–30
Liquid Limit	AS 1289.3.1.2	≤ 40
Plasticity Index	AS 1289.3.3.1	≤ 20
Wet/Dry Strength[7,8]	AS 1141.22	≥ 85 kN wet < 35% variation
Emerson Class[7]	AS 1289.3.8.1	≥ 3
Weighted Plasticity Index	AS 1289.3.6.1/3.3.1	≤ 800
Maximum Dry Density[7]	AS 1289.5.1.1	≥ 1.8 t/m^3
California Bearing Ratio[2]	AS 1289.6.1.1/5.1.1 4-day soaked[3], 9 kg surcharge[4], to 100% SMDD @ OMC	≥ 8%
Classification test frequency[5]		1 test per 2,000 t

Notes:

1 *Material that is susceptible to break down or fracturing during compaction must be subject to pre-treatment. Tests performed post placement for conformity with this table do not require pre-treatment.*
2 *CBR to be determined by design.*
3 *Period (number of days) of CBR soaking may be varied according to climatic and drainage conditions and the embankment design.*
4 *Surcharge may be increased in accordance with AS 1289.6.1.1.*
5 *Refer to Section 7.2 for variations to test frequencies.*
6 *Refer to Section 7.3 for alternative test methods.*
7 *These tests to be completed prior to construction works (classification compliance) and may be applied during the construction works at the discretion of the Superintendent.*
8 *Wet/dry Strength to be tested when 9.5 mm fraction exceeds 30%.*

4.4 General Earth Fill Material

The purpose of general earth fill is to provide a stable embankment for the support of the track infrastructure and a stable construction platform for the placement, compaction and maintenance of the structural fill layer, capping layer and track superstructure.

Selection of fill materials must be appropriate to the adopted design and performance expectations. General earth fill materials must comply with the following Table 6 requirements unless varied by design.

The outer zone material for a zoned embankment (Figure 2) must be durable, erosion resistant material (General Earth Fill Type A). The general earth fill upper zone must be general earth fill Type A and Type B. The lower zone may be general earth fill (Type A–D) or rockfill in accordance with their respective placement depth criteria.

General earth fill materials are to be compacted using the compacted layer method with density compliance measured using relative compaction tests or using a project specific method specification where the performance is demonstrated by a compaction trial. The thickness of a single stone must be not less than one-third its length and the maximum size of a single stone must not exceed two-thirds of the layer thickness.

Table 6 General Earth Fill Material Requirements

Criteria	**Test Method[5]**	**Compliance**				
		Homogenous Embankment	**Zoned Embankment**			
			A	**B**	**C**	**D**
Classification						
Particle Size Distribution	AS 1289.3.6.1					
% Passing 150 mm sieve		100	100	100	100	100
% Passing 75.0 mm sieve		100	100	80–100	80–100	80–100
% Passing 37.5 mm sieve		60–100	80–100	60–100	60–100	
% Passing 75 μm sieve		15–30	15–30	8–40	< 50	
Plasticity Index	AS 1289.3.3.1	7–30	7–30	7–30	≤ 50	≤ 50
Weighted Plasticity Index	AS 1289.3.6.1 /3.3.1	500–1200	500–1200	< 2200	< 3200	< 4000
Emerson Class	AS 1289.3.8.1	≥ 3	≥ 3	≥ 3	No criteria	
California Bearing Ratio	AS 1289.6.1.1 /5.1.1 4-day soaked[1], 9 kg surcharge[2], to equivalent compaction level[6] of 95% SMDD @ OMC	≥ 3%			≥ 1%	

Criteria	Test Method[5]	Compliance				
		Homogenous Embankment	Zoned Embankment			
			A	B	C	D
Classification test frequency[3]		1 test per 5,000 t			1 test per 10,000 t	
Closest depth below Formation Level (m)[4]		0.35	0.35	1.0	1.5	2.0

Notes:

1 *Period (number of days) of CBR soaking may be varied according to climatic and drainage conditions and the embankment design.*
2 *Surcharge may be increased in accordance with AS 1289.6.1.1.*
3 *Refer to Section 7.2 for variations to test frequencies.*
4 *Closest depth below Formation Level may be varied by geotechnical design and supporting documentation.*
5 *Refer to Section 7.3 for alternative test methods.*
6 *Equivalent Compaction Level is provided as coarse materials may not be able to be tested using standard test methods, alternative test methods (Note 5) are to be nominated to demonstrate general compliance to these compaction levels.*

4.5 Select Fill Adjacent to Structures

Compacted select fill material must be placed adjacent to structures where the fill depth is greater than 3 m. The select fill must be durable and not disintegrate in water or when exposed to the weather, and must comply with Table 7 requirements unless varied by design. At depths equal to or less than 3 m, fill material must comply with Table 5 of this Specification.

Table 7 Select Fill Material Requirements

Criteria	Test Method[3]	Compliance
Classification		
Artificial Weathering[1,4]	RMS T103	Pre-treatment
Repeated Compaction[1,4]	RMS T102	Pre-treatment
Particle Size Distribution	AS 1289.3.6.1	
% Passing 53.0 mm sieve		100
% Passing 2.36 mm sieve		< 50
% Passing 75 μm sieve		< 15
Liquid Limit	AS 1289.3.1.2	≤ 30
Plasticity Limits	AS 1289.3.2.1	≤ 20
Plasticity Index	AS 1289.3.3.1	6–15
Weighted Plasticity Index	AS 1289.3.6.1/3.3.1	180–300
Maximum Dry Density[4]	AS 1289.5.1.1	≥ 2.0 t/m^3
California Bearing Ratio	AS 1289.6.1.1/5.1.1 4-day soaked, 9 kg surcharge, to 100% SMDD @ OMC	≥ 50%

Criteria	Test Method[3]	Compliance
Particle Density[4]	AS 1141.6.1	≥ 2.6 t/m^3
Wet/dry Strength[4,5]	AS 1141.22	≥ 85 kN wet < 35% variation
Aggregate Crushing Value[4]	AS 1141.21	≤ 30%
Aggregate Flakiness Index[4]	AS 1141.15	≤ 40%
Degradation Factor[4]	AS 1141.25	≥ 50
Weak Particles[4]	AS 1141.32	≤ 0.5%
Classification test frequency[2]		1 test per 500 t

Notes:

1 *Material that is susceptible to break down or fracturing during compaction must be subject to pre-treatment. Tests performed post placement for conformity with this table do not require pre-treatment.*
2 *Refer to Section 7.2 for variations to test frequencies.*
3 *Refer to Section 7.3 for alternative test methods.*
4 *These tests to be completed prior to construction works (classification compliance) and may be applied during the construction works at the discretion of the Superintendent.*
5 *Wet/dry Strength to be tested when 9.5 mm fraction exceeds 30%.*

4.6 Bedding Sand

Bedding sand for pipes, culverts and other miscellaneous structures must be well graded natural or crushed quarry product sands sourced from designated sources, free from organic or other materials harmful to pipes, concrete, structures and the environment and be complying with Table 8 requirements unless varied by design.

Table 8 Bedding Sand Material Requirements

Criteria	Test Method[2]	Compliance
Classification		
Particle Size Distribution	AS 1289.3.6.1	
% Passing 6.7 mm sieve		100
% Passing 0.075 mm sieve		0–20
Plasticity Index	AS 1141.23	≤ 30%
Test frequency[1]		Two per source

Notes:

1 *Refer to Section 7.2 for variations to test frequencies.*
2 *Refer to Section 7.3 for alternative test methods.*

4.7 Rock Fill

Rock fill derives its stability from mechanical interlock and requires a method specification for compliance. Rock fill must be strong, hard durable rock obtained from sources approved by the Superintendent and must comply with Table 9 requirements unless varied by design.

Table 9 Rock Fill Material Requirements

Criteria	Test Method[2]	Compliance
Classification		
Particle Size Distribution	Visual assessment for mechanical interlock and size distribution.	
% Passing 600 mm		100
% Passing 4.75 mm		0–10
Point Load Test	AS 4133.4.1	≥ 1.0 MPa
Particle Density	AS 1141.6.1	≥ 2.3 t/m
Wet/dry Strength	AS 1141.22	≥ 85 kN wet < 35% variation
Secondary Mineral Content	AS 1141.26	< 20%
Particle Shape	Visual Assessment	The thickness of a single stone must be not less than one-third its length
Test frequency[1]		1 test per 5,000 t
Closest depth below Formation Level (m)[3]		1.5

Notes:

1 Refer to Section 7.2 for variations to test frequencies.

2 Refer to Section 7.3 for alternative test methods.

3 Closest depth below Formation Level may be varied by geotechnical design and supporting documentation.

4.8 Rock Protection

Rock protection must be clean, sound, dense and durable rock that will not disintegrate in water or when exposed to the weather. Rock protection is to comply with the requirements of Table 9 Rock Fill Material Requirements, with the exception of grading and particle shape. Rock protection should be non-acid forming, angular, blocky and well graded with dimensions ranging nominally from 100 mm to 1000 mm. The thickness of a single stone must be not less than one-third its length. Rock protection may be used for protecting embankments and structures from scour and erosion. Rock protection must be obtained from sources approved by the Superintendent.

4.9 Drainage Blanket Material

Drainage blanket material must be durable, not disintegrate in water or when exposed to the weather, and must comply with Table 10 requirements unless varied by design. The drainage blanket material must be spread in uniform lifts to achieve the specified compacted layer thickness in such a manner as to avoid damage to geosynthetics or structures.

Table 10 Drainage Blanket Material Requirements

Criteria	Test Method[2]	Compliance
Classification		
Particle Size Distribution	AS 1141.11, AS 1141.12	
% Passing 63.0 mm sieve		100
% Passing 37.5 mm sieve		20–100
% Passing 26.5 mm sieve		0–55
% Passing 19.0 mm sieve		0–5
% Passing 75 μm sieve		0–0.5
Los Angeles Value (Grading A)	AS 1141.23	≤ 30%
Particle Shape	AS 1141.14	< 30% passing 2:1 caliper ratio
Flakiness Index	AS 1141.15	≤ 40
Particle Density	AS 1141.6.1	≥ 2.3 t/m^3
Water Absorption	AS 1141.6.1	≤ 2%
Wet/dry Strength	AS 1141.22	≥ 100 kN wet < 25% variation
Test frequency[1]		One per source

Notes:

1 Refer to Section 7.2 for variations to test frequencies.

2 Refer to Section 7.3 for alternative test methods.

4.10 Other Drainage Materials

All other drainage materials, including controlled low strength materials (CLSM, Appendix A of AS 3725), filter material and lean mix concrete (e.g. 5 MPa concrete), must be specified in accordance with the relevant Australian Standards (such as AS 2041 and AS 3725).

4.11 Unsuitable Material

4.11.1 General

The following materials are deemed unsuitable materials and must not be used in the constructed works unless otherwise treated and approved by the Superintendent in accordance with the Earthworks Construction Specification ETC-08-04.

4.11.2 Inherently Unsuitable

Inherently unsuitable materials are:

- Materials susceptible to piping, such as fine single sized sand, windblown sand and non-cohesive silt.
- Materials containing high organic content, vegetable matter, large rocks, gypsum, debris, or other materials that could cause the fill not to compact to specification.
- Organic soils with Unified Soil Classifications of Pt, OH, or OL (AS 1726).
- Contaminated materials or prescribed waste materials as classified by relevant legislation, with the exception of materials deemed suitable from a contamination and geotechnical perspective.

4.11.3 Unsuitable Materials by Virtue of Position

Unsuitable materials by virtue of position are soil having insufficient strength to carry the loads that will be superimposed on the completed fill without excessive settlement, swell, erosion or loss of stability.

4.11.4 Unsuitable by Moisture Content

Unsuitable materials by moisture content will be materials not meeting the specified moisture requirements or having a moisture content that may adversely impact the Works.

4.12 Stabilised Material

A Project Specific Specification for the use of stabilised materials must be developed which includes, but not limited to:

- Results and details of laboratory testing (test methods to demonstrate short and long term performance criteria).
- Stabilisation method (plant mixed or in situ).
- Stabilisation trial sections and Quality Assurance / Quality Control procedures to meet requirements of this Specification and the Earthworks Construction Specification ETC-08-04.
- Alternative test methods (Section 6.3) for stabilised material may be nominated as part of the Project Quality Plan (PQP).

The Project Specific Specification for stabilisation must be submitted to the Superintendent for approval prior to any stabilising work commencing.

Materials may be chemically stabilised by an approved binder(s) to produce a stabilised material. The design criteria for stabilised fill must be determined based on meeting the long-term design performance criteria. Chemical stabilisation may include lime, cement, bitumen, polymers or other proprietary products. In addition to CBR strength requirements, Uniaxial Compressive Strength (AS 1141.51 or AS 5101.4) must be < 1.5 MPa at minimum 28-days curing and 4-hour soak using standard compactive effort to prevent cracking and preclude bound materials from within the formation.

The stabilising agent must be determined based on laboratory mix design testing to confirm the percentage of binders added to a material to meet the specified design criteria.

Bulk lime for stabilisation must comply with requirements of hydrated or quick lime (AS 1672) with a minimum Calcium Hydroxide ($Ca(OH)_2$) of 85% (AS 4489.6.1).

Bulk cement for stabilisation must comply with requirements of AS 3972, Type GP (General Purpose) or GB (General Blended) cement.

Water used for stabilisation must be of potable standard unless the chemical composition of non-potable water is demonstrated to not adversely affect stabilisation.

5 Geosynthetics

5.1 General

The requirements of this section are applicable to geosynthetics for use as separation, filtration, stiffening and reinforcing elements in earthworks and miscellaneous structures (such as culverts, pipe trenches and drainage blankets). This section does not apply to geosynthetic reinforced embankments or geosynthetic reinforced soil structures (RSS) which require compliance to detailed designs for those elements.

Geosynthetics shall not be placed less than 400 mm below the Formation Level, with the possible exception at stations, turnouts, and other discrete sections of track not likely to be subject to rail bound (mechanised) formation renewal.

Where geocomposites or both geogrids and geotextiles are specified at the same level, geotextiles must be placed below geogrids, and the geotextile layer shall be compliant with Strength Class C and Filtration Class I or II in accordance with Tables 11 and 12 respectively.

A certificate demonstrating compliance with this Specification shall be provided by the Contractor to the Superintendent prior to use for each geosynthetic used. All test results on which the test certificates are based shall not be more than one year old, measured from the date of supply.

A lot size for geosynthetics shall be 10,000 m^2 or part thereof. The Superintendent or the Design Drawings may require additional conformance testing of representative samples from lots by the Contractor.

5.2 Geotextiles

5.2.1 General

The requirements of this section are applicable to geotextiles for use as separation or filtration elements in earthworks.

Unless specified otherwise on the Drawings, geotextiles must meet the following requirements:

- The fibres of the geotextile and thread used in joining lengths must consist of long chain synthetic polymers composed of at least 95% by mass of polyolefins or polyesters.
- The geotextile filaments must be rot-proof, chemically stable and must have low water absorbency.
- Filaments must resist delamination and maintain their relative dimensional stability in the geotextile.
- Non-woven geotextiles must have filaments bonded by needle punching, heat or chemical bonding processes.
- Woven geotextiles must have filaments interlaced in two sets, mutually at right angles. One set must be parallel to the longitudinal direction of the geotextile.
- Geotextiles must be free of any flaws which may have an adverse effect on the physical and mechanical properties of the geotextile.
- Geotextiles must be stabilised against ultraviolet radiation such that when tested in accordance with AS 3706.11 they must have retained strength of at least 50% after 672 hours of test exposure. A certificate not more than a year old must be provided by the manufacturer.
- Testing of geotextiles must be undertaken using test methods in accordance with AS 3706.

5.2.2 Strength Class

Geotextiles, where required for separation or filtration, are referenced by a Strength Class which must meet the requirements of Table 11.

Where a Strength Class is specified on the Drawings for a specific installation, a geotextile with a Strength Class at least equal to that stated must be used and the Contractor must check the strength requirements for the specific application complies with the requirements of the Earthworks Construction Specification.

Table 11 Geotextile Strength Classifications

Strength Class	Elongation[1] AS 3706.4	Grab Strength (N) AS 2001.2.3.2	Tear Strength (N) AS 3706.3	G Rating AS 3706.4
A	≥ 30%	500	180	900
	< 30%	800	300	1350
B	≥ 30%	700	250	1350
	< 30%	1100	400	2000
C	≥ 30%	900	350	2000
	< 30%	1400	500	3000
D	≥ 30%	1200	450	3000
	< 30%	1900	700	4500
E	≥ 30%	1600	650	4500

Notes:

1 Elongation to differentiate woven from non-woven geotextiles must be the elongation % at puncture corresponding to maximum puncture strength determined in accordance with AS 3706.4. In general, woven geotextiles will puncture at elongations less than 30% and non-woven geotextiles will puncture at elongations equal to or greater than 30%.

5.2.3 Filtration Class

Geotextiles, where required for separation or filtration, are referenced by a Filtration Class which must meet the requirements of Table 12.

Table 12 Geotextile Filtration Classifications

Filtration Class	Flow Rate Q_{100} ($L/m^2/s$)[1] AS 3706.9	Permittivity ψ (s^{-1})[1] AS 3706.9	Equivalent Opening Size EOS (mm)[1] AS 3706.1, AS 3706.7 or EN ISO 12956
I	≥ 50	≥ 0.5	≤ 0.12
II	≥ 50	≥ 0.5	≤ 0.25
III	≥ 30	≥ 0.3	≤ 0.12
IV	≥ 20	≥ 0.2	≤ 0.25
V	≥ 10	≥ 0.1	≤ 0.12
VI	≥ 10	≥ 0.1	≤ 0.25
VII	≥ 5	≥ 0.05	≤ 0.3
VIII	≥ 5	≥ 0.05	≤ 0.6

Notes:

1 *Slit film woven type geotextile is not permitted for Filtration Classes I, II, III, IV, V and VI.*

2 *Additional technical advice on EOS, Q_{100} and Ψ is required where water flow may undergo reverse flow characteristics.*

3 *Additional technical advice on EOS is required for highly dispersive clay soils, gap graded soils, fine silt soils or artificially derived soils such as fly ash. Combined soil/geotextile testing may be required, and additional granular filters may be appropriate.*

4 *The Superintendent may direct additional testing of geotextiles where unforeseen conditions are encountered which may impede the function of the geotextile. These may include locations where water flow may undergo reverse flow characteristics or where high dispersive clay soils, gap graded soils, fine silt soils or artificially derived soils such as fly ash are encountered.*

5.3 Geogrids

5.3.1 General

The requirements of this section are applicable to geogrids (and geocomposites) for use as reinforcement and increasing shear strength by constraining the movement of aggregates in the shear zone of ballast, capping, structural, general fill and subgrade materials in earthworks.

Geogrids are polymeric geogrids formed by a regular network of connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock or earth particles to function primarily as reinforcement.

Geogrids (and geocomposites) may be used for the following applications (Table 13), subject to compliance to Section 5.1:

- Stiffen capping and structural layers to control uneven formation movements and cracking over stabilised or expansive layers.
- Reinforce structural fill layer to improve bearing capacity, reduce layer thickness, reduce vertical deformation and control differential settlement.
- Reinforce subgrades to improve bearing capacity and foundation treatments (E3 and C4, ETC-08-04).
- Reinforce/stabilise the ballast layer to reduce ballast movements, breakage, control differential settlement and reduce maintenance costs.

Table 13 Geogrid Class Applications

Geogrid Class	Grid structure	Application
GC1	Uniaxial or biaxial	Capping, structural, general fill and subgrade CBR > 3%
GC2	Multiaxial	Capping, structural, general fill and subgrade CBR > 2%
GC3	Uniaxial or biaxial	Ballast, general fill and subgrade CBR ≤ 3%
GC4	Multiaxial	General fill and subgrade CBR ≤ 2%
GC5	Multiaxial	Ballast

When the geogrid reinforcement is to be placed directly onto general fill or subgrade, then a geotextile layer compliant with Strength Class C and Filtration Class I or II shall be placed below the geogrid.

The Contractor must provide design documents that include numerical simulation to demonstrate performance of each geogrid and geocomposite used in the earthworks, and test results to demonstrate interlocking and interaction between granular particles and geogrids. Additional performance-based evidence may be provided by the Contractor, or directed by the Superintendent, including but not limited to, large scale triaxial testing and rail based field and/or laboratory trials to determine deformations measured at reinforcement level, subgrade level and sleeper level.

5.3.2 Uniaxial/Biaxial Geogrid

Uniaxial geogrids shall have elongated structure and biaxial shall have a square structure, with polymer bars orientated in two directions.

A uniaxial or biaxial geogrid may be formed by either stretching and drawing a punched sheet of polymer bars, by welding together highly orientated discrete bars of polymer or by weaving together discrete polymer bars into a network that can be coated if necessary to protect the polymer strips. Uniaxial or biaxial geogrids shall be manufactured using High Density Polyethylene (HDPE), polypropylene (PP) and/or polyester (PET).

Uniaxial and biaxial geogrids, where required for reinforcement, are referenced by a Geogrid Class which must meet the requirements of Table 14.

Table 14 Uniaxial/biaxial Geogrid Classification

Geogrid Class	Junction Strength (mm) 2% strain ASTM D7737-11	T_s [1] (kN/m) 2% strain ASTM D6637-11, D4595 or EN ISO 10319	R_d [2] (%) ASTM D5818-11	R_{uv} (%) ASTM D4355-07	Coefficient of direct shear[3] (%) ASTM D5321-14, D5321M-14
GC1	≥ 9.5	≥ 10.5	≥ 85	≥ 90	≥ 75
GC3	≥ 12.5	≥ 14	≥ 85	≥ 90	≥ 75

Notes:

1 *Minimum tensile strength (T_s) in principal direction for uniaxial and both directions for biaxial grids. T_s @ 2% ≤ UTS × R_d × R_{uv} × R_c × R_m.*

2 *Particle size grading used for the installation damage test ASTM D5818 to be the overlying material layer.*

3 *Direct shear test shall apply vertical stress of 50 kPa, 100 kPa and 150 kPa. Base layer shall consist of granular material with friction angle of 30°.*

5.3.3 Multiaxial Geogrid

Multiaxial geogrid shall have a hexagonal structure with ribs orientated in three directions. The resulting triangular-shaped apertures are defined by ribs of rectangular cross section having a high degree of molecular orientation which is continuous through the node. Welded or woven junctions shall not be accepted.

A multiaxial geogrid is formed by stretching and drawing a punched sheet of polymer into a network of hexagonal ribs. Multiaxial geogrids shall be manufactured using PP with a minimum of 2% finely divided carbon black, well dispersed in the polymer matrix to inhibit attack by ultraviolet light, determined in accordance with ASTM D1603-06. Multiaxial geogrids manufactured using HDPE or PET shall not be accepted.

Multiaxial geogrids, where required for reinforcement, are referenced by a Geogrid Class which must meet the requirements of Table 15.

Table 15 Multiaxial Geogrid Classification

Geogrid Class	Hexagon Pitch (mm) EOTA TR41 B.4	Radial Secant Stiffness (kN/m) 0.5% strain EOTA TR41 B.1	Radial Secant Stiffness (kN/m) 2% strain EOTA TR41 B.1	Radial Secant Stiffness Ratio EOTA TR41 B.1	Junction Efficiency (%) EOTA TR41 B.2	Weight (kg/m²) EOTA TR41 B.3
GC2	80 (±4)	390 (-75)	290 (-65)	0.80 (-0.15)	100 (-10)	0.220 (-0.035)
GC4	80 (±4)	480 (-90)	360 (-65)	0.80 (-0.15)	100 (-10)	0.270 (-0.035)
GC5	120 (±6)	540 (-90)	400 (-100)	0.80 (-0.15)	100 (-10)	0.300 (-0.035)

Notes:

1 *Tolerances presented in brackets represent 99.7% tolerance criteria.*

6 Quality Plan

6.1 Contractor's Project Quality Plan

The Contractor's PQP must detail how the Contractor will manage, test and control the quality of the materials under this Specification. The Contractor may develop appropriate statistical techniques to support any request to the Superintendent for variance in the number of samples per Lot or minimum testing frequency for the materials as specified in this Specification using the method for statistical analysis presented in the Earthworks Construction Specification ETC-08-04.

All materials must be tested in accordance with this Specification, Australian Standards and the Earthworks Construction Specification unless approved otherwise by the Superintendent. Samples of material proposed for use must be tested and results considered in the final selection of material and its use within the earthworks.

7 Variations

7.1 Variation to Material Tests, Methods and Compliance Criteria

All variations to ET-08-03 must be documented in Specification Variation Compliance Forms (Appendix A1) and are subject to approval by the Superintendent.

Statistical analysis and criteria for reducing Classification Conformance and Placement Conformance compliance testing must be in accordance with the Project Quality Plan and ETC-08-04.

7.2 Variation of Testing Frequencies

If consistent test results can be demonstrated, the Contractor may apply to the Superintendent for a reduction in test frequency for that particular quality control test method and source. The frequency of testing may be increased at the discretion of the Superintendent if the test results demonstrate a high degree of variability which could affect the design assumptions or the quality of the completed construction.

7.3 Alternative Test Methods

Alternative test methods may be proposed by the Designer or Contractor to confirm the parameters of the earthworks materials.

The Designer or Contractor must obtain approval from the Superintendent prior to using any alternative test methods; and provide a detailed report on trials conducted using the alternative test methods and correlation factors to the compliance test requirements of the applicable materials specification. The report must also include statistical analysis and criteria for reducing compliance testing, in accordance with the Program Quality Plan.

Appendix A – Specification Variation Compliance Forms

A1. Variance to Material Specification and Compliance

Compliant material criteria are specified in Section 4. The forms below are to be completed where there is a deviation from compliant values.

Table 16 Capping Material Variance

Criteria	Test Method[4]	Variance
Classification		
Artificial Weathering[1,5]	RMS T103	
Repeated Compaction[1,5]	RMS T102	
Particle Size Distribution	AS 1289.3.6.1	
% Passing 26.5 mm sieve		
% Passing 19.0 mm sieve		
% Passing 9.5 mm sieve		
% Passing 2.36 mm sieve		
% Passing 425 μm sieve		
% Passing 75 μm sieve		
Particle Shape	AS 1141.14	
Flakiness Index	AS 1141.15	
Wet/Dry Strength	AS 1141.22	
Liquid Limit	AS 1289.3.1.1 or 3.1.22	
Plastic Limit	AS 1289.3.2.1	
Plasticity Index	AS 1289.3.3.1 or 3.3.2	
Linear Shrinkage	AS 1289.3.4.1	
Weighted Plasticity Index	AS 1289.3.6.1/3.3.1	
Maximum Dry Density	AS 1289.5.1.1	
California Bearing Ratio[2]	AS 1289.6.1.1/5.1.1 4-day soaked, 9 kg surcharge, to 100% SMDD at OMC	
Classification test frequency[3]		
Permeability		
Permeability	AS 1289.6.7.1	
Permeability test frequency[3]		

Notes:

1 *Material that is susceptible to break down or fracturing during compaction must be subject to pre treatment. Tests performed post placement for conformity with this table do not require pre-treatment.*

2 *CBR to be determined by design.*

3 Refer to Section 7.2 for variations to test frequencies.
4 Refer to Section 7.3 for alternative test methods.
5 These tests to be completed prior to construction works (classification conformance) and may be applied during the construction works at the discretion of the Superintendent.

Table 17 Structural Fill Material Variance

Criteria	Test Method[6]	Variance
Classification		
Artificial Weathering[1,7]	RMS T103	
Repeated Compaction[1]	RMS T102	
Particle Size Distribution	AS 1289 Clause 3.6.1	
% Passing 53.0 mm sieve		
% Passing 2.36 mm sieve		
% Passing 425 μm sieve		
% Passing 75 μm sieve		
Liquid Limit	AS 1289.3.1.2	
Plasticity Index	AS 1289.3.3.1	
Wet/Dry Strength[7,8]	AS 1141.22	
Emerson Class[7]	AS 1289.3.8.1	
Weighted Plasticity Index	AS 1289.3.6.1/3.3.1	
Maximum Dry Density[7]	AS 1289.5.1.1	
California Bearing Ratio[2]	AS 1289.6.1.1/5.1.1 4-day soaked[3], 9 kg surcharge[4], to 100% SMDD @ OMC	
Classification test frequency[5]		

Notes:
1 Material that is susceptible to break down or fracturing during compaction must be subject to pre-treatment. Tests performed post placement for conformity with this table do not require pre-treatment.
2 CBR to be determined by design.
3 Period (number of days) of CBR soaking may be varied according to climatic and drainage conditions and the embankment design.
4 Surcharge may be increased in accordance with AS 1289.6.1.1.
5 Refer to Section 7.2 for variations to test frequencies.
6 Refer to Section 7.3 for alternative test methods.
7 These tests to be completed prior to construction works (classification compliance) and may be applied during the construction works at the discretion of the Superintendent
8 Wet/dry Strength to be tested when 9.5 mm fraction exceeds 30%.

Table 18 General Earth Fill Material Variance

Criteria	Test Method[5]	Homogenous Embankment	Zoned Embankment			
			A	B	C	D
Classification						
Particle Size Distribution	AS 1289.3.6.1					
% Passing 150 mm sieve						
% Passing 75.0 mm sieve						
Passing 37.5 mm sieve						
% Passing 75 μm sieve						
Plasticity Index	AS 1289.3.3.1					
Weighted Plasticity Index	AS 1289.3.6.1/3.3.1					
Emerson Class	AS 1289.3.8.1					
California Bearing Ratio	AS 1289.6.1.1/5.1.1 4-day soaked[1], 9 kg surcharge[2], to equivalent compaction level[6] of 95% SMDD @ OMC					
Classification test frequency[3]						
Closest depth below Formation Level (m)[4]						

Notes:

1 *Period (number of days) of California Bearing Ratio (CBR) soaking may be varied according to climatic and drainage conditions and the embankment design.*
2 *Surcharge may be increased in accordance with AS 1289.6.1.1.*
3 *Refer to Section 7.2 for variations to test frequencies.*
4 *Closest depth below Formation Level may be varied by geotechnical design and supporting documentation.*
5 *Refer to Section 7.3 for alternative test methods.*
6 *Equivalent Compaction Level is provided as coarse materials may not be able to be tested using standard test methods, alternative test methods (Note 5) are to be nominated to demonstrate general compliance to these compaction levels.*

Table 19 Select Fill Material Variance

Criteria	Test Method[3]	Variance
Classification		
Artificial Weathering[1,4]	RMS T103	Pre-treatment
Repeated Compaction[1,4]	RMS T102	Pre-treatment
Particle Size Distribution	AS 1289.3.6.1	
% Passing 53.0 mm sieve		
% Passing 2.36 mm sieve		
% Passing 75 μm sieve		
Liquid Limit	AS 1289.3.1.2	
Plasticity Limits	AS 1289.3.2.1	
Plasticity Index	AS 1289.3.3.1	
Weighted Plasticity Index	AS 1289.3.6.1/3.3.1	
Maximum Dry Density[4]	AS 1289.5.1.1	
California Bearing Ratio[4,5]	AS 1289.6.1.1/5.1.1 4-day soaked, 9 kg surcharge, to 100% SMDD @ OMC	
Particle Density[4]	AS 1141.6.1	
Wet/dry Strength[4,5]	AS 1141.22	
Aggregate Crushing Value[4]	AS 1141.21	
Aggregate Flakiness Index[4]	AS 1141.15	
Degradation Factor[4]	AS 1141.25	
Weak Particles[4]	AS 1141.32	
Classification test frequency[2]		

Notes:

1 *Material that is susceptible to break down or fracturing during compaction must be subject to pre-treatment. Tests performed post placement for conformity with this table do not require pre-treatment.*
2 *Refer to Section 7.2 for variations to test frequencies.*
3 *Refer to Section 7.3 for alternative test methods.*
4 *These tests to be completed prior to construction works (classification compliance) and may be applied during the construction works at the discretion of the Superintendent.*
5 *Wet/dry Strength to be tested when 9.5 mm fraction exceeds 30%.*

Table 20 Bedding Sand Material Variance

Criteria	Test Method[2]	Variance
Classification		
Particle Size Distribution	AS 1289.3.6.1	
% Passing 6.7 mm sieve		
% Passing 0.075 mm sieve		
Plasticity Index	AS 1141.23	
Test frequency[1]		

Notes:

1 Refer to Section 7.2 for variations to test frequencies.

2 Refer to Section 7.3 for alternative test methods.

Table 21 Rock Fill Material Variance

Criteria	Test Method[2]	Variance
Classification		
Particle Size Distribution	Visual assessment for mechanical interlock and size distribution.	
% Passing 600 mm		
% Passing 4.75 mm		
Point Load Test	AS 4133.4.1	
Particle Density	AS 1141.6.1	
Wet/dry Strength	AS 1141.22	
Secondary Mineral Content	AS 1141.26	
Particle Shape	Visual Assessment	
Test frequency[1]		
Closest depth below Formation Level (m)[3]		

Notes:

1 Refer to Section 7.2 for variations to test frequencies.

2 Refer to Section 7.3 for alternative test methods.

3 Closest depth below Formation Level may be varied by geotechnical design and supporting documentation.

Table 22 Drainage Blanket Material Variance

Criteria	Test Method[2]	Variance
Classification		
Particle Size Distribution	AS 1141.11, AS 1141.12	
% Passing 63.0 mm sieve		
% Passing 37.5 mm sieve		
% Passing 26.5 mm sieve		
% Passing 19.0 mm sieve		
% Passing 75 μm sieve		
Los Angeles Value (Grading A)	AS 1141.23	
Particle Shape	AS 1141.14	
Flakiness Index	AS 1141.15	
Particle Density	AS 1141.6.1	
Water Absorption	AS 1141.6.1	
Wet/dry Strength	AS 1141.22	
Test frequency[1]		

Notes:

1 Refer to Section 7.2 for variations to test frequencies.

2 Refer to Section 7.3 for alternative test methods.

A2. Variance to Formation Geometry Specific Design Requirements

Track configurations, including minimum layer thicknesses, track centres and shoulder distances, must comply with those dimensions detailed in Table 20 below. All crossfalls to the formation are 1:30, unless otherwise shown on the Drawings.

Table 23 Design Specific Formation and Shoulder Geometry Requirements

Item	Minimum Value	Design Value
	mm	
Formation Geometry		
Capping layer thickness	150	
Capping width (from track centreline)	3500	
Structural Fill layer thickness	200	
Structural Fill width (from track centreline)	3500	
General Earth Fill A compacted layer thickness	150	
General Earth Fill B-D compacted layer thickness	150	
Outer Zone width	1000	
Distance from toe of embankment to toe drain	2000	
Distance from toe of cutting to cess drain	0	
Formation Shoulder Geometries (from track centreline)		
Main Line and Passing Loops	3500	
Siding	3000	
Special Width Requirements Shoulder Geometries (from track centreline)		
Shunters and guards parallel walkways	4250	
Train examination areas	5500	
Train examination areas with parallel access road	7750	
Clear Access Road Geometry		
Clear access road width	3000	

Requirements of EGH-20-01 shall apply to formation geometry.

A3. Variance to Cutting Geometry Project Specific Design Requirements

Batter slopes in cuttings in excess of 3 m high and closer than 6 m from the track centreline must be determined on the advice of a geotechnical engineer. Variations to the typical geometry values provided must be supported by a geotechnical risk assessment and geotechnical design.

Table 24 Design Specific Cutting Geometry Requirements

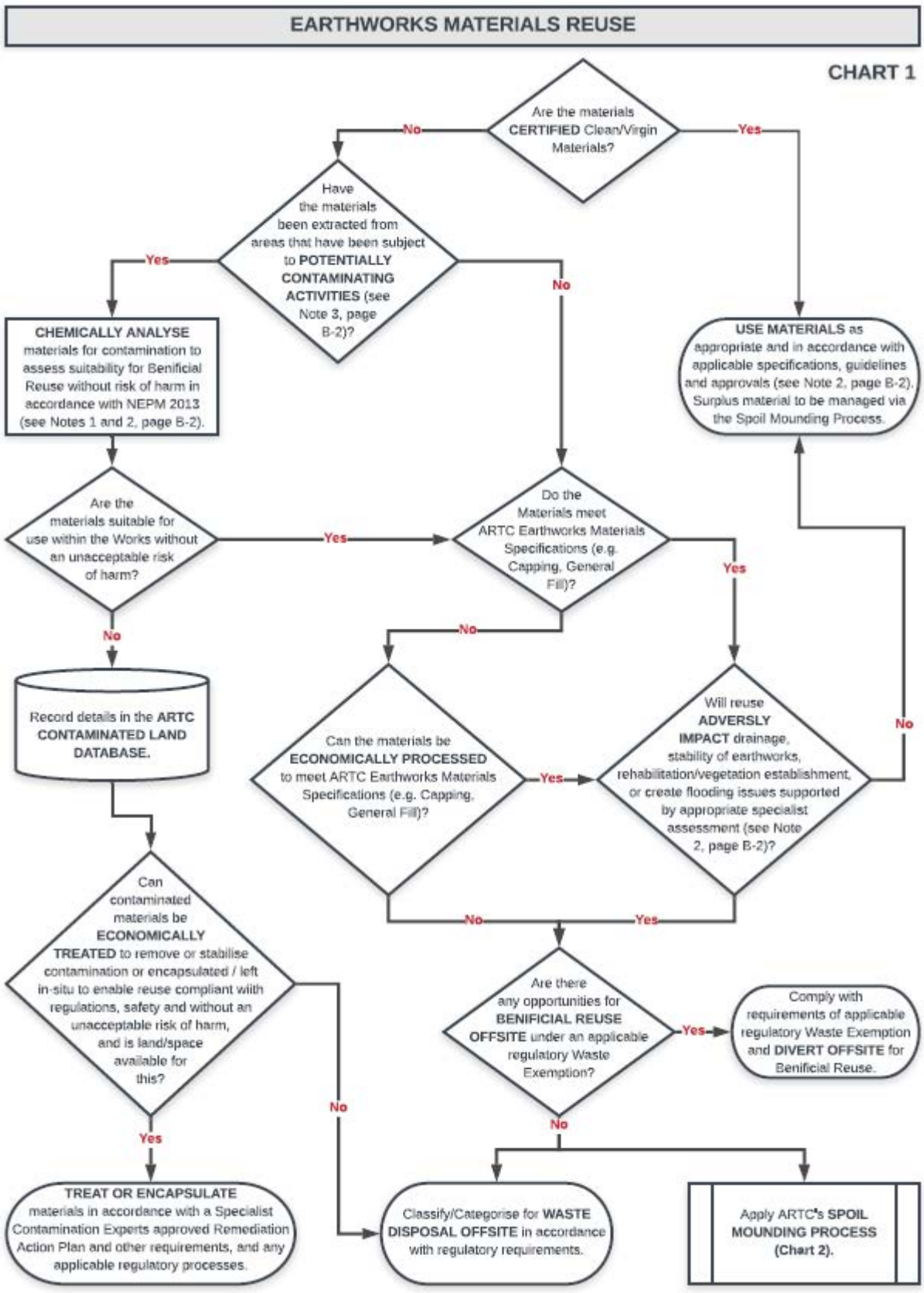
Material		**Slope**			
		Typical		**Design**	
		Horizontal	**Vertical**	**Horizontal**	**Vertical**
1	Sand	2	1		
2	Wet clay, loose gravel	2	1		
3	Sandy clay, boulders and clay, compacted gravelly soil, General Earth Fill A and rockfill, talus	1.75	1		
4	Residual soil to extremely weathered, very low strength, highly fractured rock	1.5	1		
5[1]	Sound shale dipping sharply towards railway formation, tight cemented gravel	N/A	N/A		
6[1]	Distinctly weathered, low strength, well developed, closely spaced bedding or fractured rock	N/A	N/A		
7[1]	Slightly weathered, medium strength, massive to widely spaced bedding or fractured rock	N/A	N/A		

Notes:

1 A geotechnical engineer must confirm batter slope design.

Requirements of EGH-20-01 shall apply to cutting geometry.

Appendix B – Earthworks Materials Management Framework



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EARTHWORKS MATERIALS REUSE (Cont.)

NOTES TO CHART 1

1. General

All sampling and analysis date/reports (geotechncial, contamination & hydrological) must be tracked and registered to teh material movements and stockpile locations for the duration of the project, and following project handover particularly where permanent spoil mounds are built.

2. Reference Material

- National Environmental Protection (Assesment of Site Contamination) Measure 1999 Amendment 2013 (NEPM 2013).
- Earthworks Materials Specification ETC-08-03 and Earthworks Construction Specification ETC-08-04.
- Wastem Contamination and/or Hazardous Materials Assessment Management Plans.
- Hydrological Investigations and Plans.
- All applicable Approval Conditions, Environmental Impact Assessments, and Hydrology and Flooding Programmes.

3. Potentially Contaminating Activities

- Acid / alkali plant and formulation
- Acid sulfate soils sites
- Acid sulfate rock sites
- Ammunition manufacture and usage (e.g. shooting ranges)
- Any land registered on ARTC Contaminated Land Database or any state regulatory authority's database
- Asbestos production, handling or disposal
- Asphalt/bitumen manufacturing
- Commercial engine and machinery repair sites
- Battery manufacturing or recycling
- Boat/ship building, marinas, slip ways and associated boat yards
- Boiler or kiln usage
- Chemical manufacture and formulation (e.g. fertilisers, paints, pesticides, photography, plastics, solvents)
- Chemical pesticide and storage usage
- Defence use
- Drum conditioning works
- Dry cleaning establishments
- Environmental incidents or spills
- Electrical transformers
- Ethanol production plant
- Explosives industries
- Fertiliser manufacturing plants
- Fill material imported onto a site from a potentially contaminated source
- Foundry Operations
- Gas works
- Herbicide manufacture
- High salinity areas
- Illegal dumping
- Industrial activities involving hazardous chemicals in significant quantities
- Iron and steel works
- Landfill sites, including on-site waste disposal and refuse pits
- Depots - machinery, vehicle, locomotive maintenance
- Metal treatments (e.g. electroplating) and abrasive blasting
- Firefighting training and use of firefighting foam
- Metal smelting, refining or finishing
- Mineral processing
- Mine sites involving waste rock or tailings deposits
- Naturally occurring asbestos
- Oil or gas production or refining
- Paint formulation and manufacture
- Pesticide manufacture and formulation sites
- Petroleum product or oil and chemical storage (including Underground Petroleum Storage Systems)
- Pharmaceutical manufacture and formulation
- Power stations
- Printing Radio-active material usage (e.g. hospitals)
- Railway yards
- Refuelling locations (including Direct into Locomotive - DIL refuelling)
- Scrap yards and recycling facilities
- Sewage treatment plant
- Sheep and cattle dips
- Sites of fires involving hazardous materials, including fire fighting foam use
- Sites of incidents involving release of hazardous materials
- Spray storage and mixing sites (e.g. for orchards)
- Spray painting industries
- Tanning and associated trades
- Textile operations
- Tyre manufacturing and retreading works
- Wood preservation and storage or cutting of treated timber
- Wool scouring

EARTHWORKS MATERIALS SPOIL MOUNDING

CHART 2