

Specification
For
Civil and Earthworks

Pr9902



Unitywater

Pr9902 - Specification for Civil and Earthworks

Documents Details

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1. Purpose

- 1.0.1 The purpose of this Specification is to set down minimum requirements for undertaking all civil and earth works, associated civil and earth works activities and testing relating to a nominated project.
- 1.0.2 This Specification shall be read in conjunction with relevant project drawings (where applicable), Job Specification and supplementary specifications.

2. Scope

- 2.0.1 This Specification applies to works constructed by contract, sub-contract or hire labour and may be used for a Lump Sum or Schedule of Rates contract. To the extent applicable, this Specification shall also apply to the design of civil and earthworks activities.
- 2.0.2 This Specification shall be used in conjunction with the stated requirements of the Local Government or other authority in whose area the works are to be constructed. This includes State Government legislation concerned with the undertaking of works on sewerage systems. It also includes Work, Health and Safety legislation.

3. References

3.1. General

- 3.1.1 All work carried out under this specification shall comply in all aspects (i.e. in design, construction, testing and performance) with the latest relevant Australian (AS), British (BS) and IEC Standards and standards in the following sections.
- 3.1.2 Reference to specific clauses of the various codes is intended to highlight those points and shall not be taken to imply a lesser importance for all other applicable clauses.
- 3.1.3 All the works shall conform to the Rules and Regulations of the Statutory Authorities having jurisdiction over the Site.
- 3.1.4 If the requirements of this Specification do not articulate the minimum requirements of the statutory regulations and standards, the regulatory requirements are taken to apply. If the requirements of this Specification are more exacting than the minimum requirements of the statutory regulations and standards, the former shall apply.
- 3.1.5 All Materials, fittings, accessories and equipment supplied by the Contractor shall be new and the best obtainable of their kind and shall comply in all respects with the requirements of the relevant Standards Australia specifications.
- 3.1.6 The Contractor shall undertake his own assessment as to the type of material to be excavated and sub-surface conditions and shall allow for any dewatering, timber shuttering and shoring that may be required.

3.2. Applicable Legislation and Regulation

- 3.2.1 At least the following legislation and related regulation shall apply:
 - a. *Work Health and Safety Act 2011* (Qld);
 - b. *Work Health and Safety Regulation 2011* (Qld);
 - c. *Water Supply (Safety and Reliability) Act 2008* (Qld);
 - d. *Environmental Protection Act 1994* (Qld);
 - e. *Queensland Building Services Authority Act 1991*;

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f. *Professional Engineers Act 2002.*

3.3. Codes of Practice (ratified by Legislation)

SEQ Water Supply and Sewerage Design and Construction Code

The SEQ Water Supply and Sewerage Design and Construction Code (*SEQ WS&S D&C Code*) is available via the SEQCODE website: www.seqcode.com.au.

- 3.3.1 The requirements of the South East Queensland Water Supply and Sewerage Design and Construction Code (SEQ WS&S D&C Code) shall supersede the requirements of this specification where advised in the Job Specification. In this case the requirements of this specification shall only apply where no requirement is provided in the SEQ WS&S D&C Code.
- 3.3.2 If the Job Specification does not reference SEQ WS&S D&C Code, the requirements of SEQ WS&S D&C Code shall apply where no requirements are stated in this specification.

3.4. Codes of Practice (not ratified by Legislation)

- 3.4.1 The following Codes of Practice apply to works carried out under this Specification:
- Department of Transport and Main Roads Standard Specifications;
 - Queensland Manual of Uniform Traffic Control Devices;
 - Erosion and Sediment Control Manual*, Sunshine Coast Regional Council;
 - Concrete Pipe Selection and Installation Manual, Concrete Pipe Association of Australia.

3.5. International and Australian Standards

- 3.5.1 All design, equipment and works shall comply with the current edition of the following standards:

Standard	Title
Quality Systems	
AS 2990	Quality Systems for Engineering and Construction Projects
AS 3901	Quality Systems for Design/Development, Production, Installation and Servicing
AS 3902	Quality Systems for Production and Installation
AS 3903	Quality Systems for Final Inspection and Test
Drawings	
AS 1110	Technical Drawings
AS 1101	Graphical Symbols for General Engineering
AS 1102	Graphical Symbols for Electrotechnology
Materials and Workmanship	
AS 1074	Steel tubes and tubulars for ordinary service
AS 1163	Structural steel hollow sections
AS 1289	Methods of testing soils for engineering purposes
AS 1302	Steel reinforcing bars for concrete
AS 1379	The specification and manufacture of concrete
AS 1554.1	Welding of steel structures

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Standard	Title
AS 1608	Preservative – Treated farm fencing timber
AS 1650	Hot-dipped galvanised coatings on ferrous articles
AS 1725	Galvanised rail-less chainwire security fences and gates
AS 1830	Iron castings – Grey cast iron
AS 2124	General Conditions of Contract
AS 2187	Explosives – Storage, transport and use
AS 2188	Explosives – Relocatable magazines for storage
AS 2423	Galvanised wire fencing products
AS 2758	Aggregates and rock for engineering purposes
AS 2868	Classification of machinery for earthmoving, etc.
AS 3600	Concrete structures
AS 3678	Structural steel – Hot-rolled plates, floor-plates and slabs
AS 3679	Structural steel – Hot-rolled bars and sections
AS 3706	Geotextiles – Methods of test
AS 3725	Loads on buried concrete pipes
AS 3798	Guidelines for earthworks for commercial and residential developments
AS 4058	Precast concrete pipes (pressure and non-pressure)
AS 4139	Fibre-reinforced concrete pipes and fittings
AS 4373	Pruning of amenity trees
AS 4970	Protection of trees on construction sites

4. Definitions/Abbreviations

Term	Meaning
Earthworks	All operations necessary to excavate earth and rock from the proposed site irrespective of type and sub-surface conditions, to borrow or import embankment material for use as specified, to construct embankments including placing selected material as specified, to backfill around in situ structures, and to remove and replace unsuitable material below the subgrade.
Subgrade	The trimmed or prepared surface of the road formation on which the pavement and shoulders are constructed. Unless otherwise shown in the drawings, the subgrade in cross section is parallel to the pavement surface.
Proprietary Products	Proprietary Products - any product or item manufactured for the intended purpose typically included in supplier's catalogues and/or given supplier reference numbers.
Services/Public Utilities	Services/Public Utilities – underground and overhead electrical and communication cables, water supply, sewer, drainage, gas and oil pipes and all associated fittings, structures and protective devices or treatments.

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Term	Meaning
RDD (Std)	RDD (Std) – Relative Dry Density of in situ material expressed as a percentage of the maximum dry density of the material using Standard Compaction procedures as specified in sections 9.15 and 9.19.
Superintendent	As defined in the General Conditions of Contract called up in the Contract document (such as 2124-1992 or AS 4000). If no General Conditions of Contract are in place, the Unitywater employee authorised to issue instructions to the Contractor(s).

5. General Requirements – Civil and Earth Works

5.1. Setting out of Works

- 5.1.1 The Contractor shall set out the works based on datums and reference marks indicated on the drawings using an experienced Engineering or Registered Surveyor. The Contractor shall promptly advise the Superintendent if nominated project reference marks are unable to be located.
- 5.1.2 Sufficient line and level pegs shall be placed to ensure adequate control of all construction activities.
- 5.1.3 The Contractor shall re-establish any Permanent Survey Marks or reference marks required for setting out of the works which are disturbed as part of his operations.

5.2. Traffic Control and Road Signage

- 5.2.1 All traffic control and road signage shall be in accordance with the Manual of Uniform Traffic Control Devices published by the Queensland Department of Transport and Main Roads.
- 5.2.2 Traffic control shall ensure at all times the safe passage of vehicles and pedestrians through and around the site and physical separation of traffic from construction activities.

5.3. Real Property Survey Pegs

- 5.3.1 The Contractor shall mark all real property survey pegs, including easement pegs, by a 600 mm high painted stake before work commences on the adjacent pipeline. The Contractor shall take full responsibility for the maintenance of such pegs once he commences work on the contract and if any are disturbed he shall arrange replacement by a licensed surveyor at his own expense.

5.4. Care for and Relocation of Existing Fencing

- 5.4.1 Fences, other than those specifically noted for removal, shall be maintained at all times with special care taken to prevent straying of stock if grazing is carried out on adjoining lands.
- 5.4.2 If during construction work there is a need for removing a section of fencing, the Contractor shall store the fence in an approved manner, and after the construction is completed the Contractor shall reinstall the fence to its previous condition and location or as directed by the Superintendent.
- 5.4.3 If fences are required to be cut or moved, the Contractor shall erect temporary fences for stock containment as agreed with the property owner or as directed by the Superintendent.
- 5.4.4 The location and dimensions of the temporary fence shall provide a similar level of security to the section of fencing removed.

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- 5.4.5 Where fences are to be cut for access, wire shall be drawn tight to end posts, suitably struted, and suitable gates provided, if directed, for closure after working hours or when no work is in hand on the site
- 5.4.6 Any fence, or part thereof, damaged by the Contractor's works shall be repaired immediately with appropriate materials in consultation with the owner and Superintendent.
- 5.4.7 Re-erected fencing shall be true to line and posts installed vertically.
- 5.4.8 No relocated fencing shall be erected to a standard below that which existed prior to relocation.

5.5. Work Within Private Property

- 5.5.1 The Contractor shall confine all work within private property to minimise disturbance. Disturbance within private property shall not extend beyond the area required for the works as agreed with the Superintendent. If directed by the Superintendent, the Contractor shall erect a temporary barrier fence or marker to define the limits of the construction area. Activities outside the limits of the construction area shall not be permitted without the expressed permission of the Superintendent.
- 5.5.2 It is the Contractor's responsibility to give prior notice to private property owners of any construction activities that may affect them or their property. General notification is to occur two weeks prior to commencing these activities and specific notification at least 48 hours prior to clearing or excavation work. Notwithstanding the above, notification periods and formats shall comply with current legislation.

5.6. Work within Road Reserves

- 5.6.1 All work within road reserves shall comply with the following:
- Work shall proceed without interruption to traffic and any steps necessary for the protection of the public during construction shall be taken;
 - Warning signs, flashing lights and other traffic control devices shall be erected in accordance with the relevant road authorities' requirements;
 - Work which is likely to reduce traffic flow shall be carried out between 9.00 a.m. and 3.00 p.m. only (unless otherwise specified or agreed with the Superintendent) and shall be organised so as to cause minimum disruption to pedestrians and access to adjacent properties. One lane of traffic under 'STOP-GO' control must remain open at all times along all roads;
 - Trenches shall not be left open overnight;
 - Work shall be carried so as not to detrimentally affect the existing drainage provisions of the roadway.

5.7. Notification of Impact on Adjacent Properties

- 5.7.1 It is the Contractor's responsibility to give prior notice to private property owners of any construction activities that may affect them or their property. General notification is to occur two weeks prior to commencing these activities and specific notification 48 hours prior to work commencing.
- 5.7.2 Notification shall be in a form approved by the Superintendent and include the nature and expected duration of impact and both business hours and after hours telephone numbers for the Contractor in the event of difficulties arising.

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5.8. Overhead and Underground Services

- 5.8.1 The Contractor shall note the presence of overhead and underground services on the works site. Special care shall be taken in the vicinity of electricity services.
- 5.8.2 The locations of some underground services may be indicated on the drawings and are based on information supplied by the respective Authorities where such information is available.
- It is emphasised that information supplied regarding these services is tentative only with respect to both details of services shown and the existence of other services not shown.
- Neither the Principal nor the Superintendent warrants the completeness or accuracy of the information given, and the Contractor is required to make enquiries into the presence and location of underground services with the relevant Authorities.
- 5.8.3 The attention of the Contractor is drawn to the fact that private underground and overhead services and individual services to premises from public utility mains may not be shown on the drawings.
- 5.8.4 The Contractor shall verify the position of each underground service before commencement of excavation. The Contractor shall pre-locate the services as to depth, alignment and extent or size, so as to ensure such services are not adversely affected. Hand excavation may be necessary to close proximity to services until the exact location is determined.
- 5.8.5 Trenches containing underground services shall be backfilled so that the subgrade is restored as nearly as possible to its original state of compaction. Where selected backfill has been placed by other utilities and has had to be removed, it shall be replaced by the same type of selected material. All backfill shall be carefully deposited in the trench and around the utility service in layers and adequately compacted by proper hand rammers and tampers or by use of effective mechanical equipment.
- 5.8.6 Extra care shall be taken by the Contractor to recompact excavations near existing underground pipework, so that foundations of that pipework are restored, and more especially when recompacting in the vicinity of low flexibility pipework.
- 5.8.7 The Contractor shall be held responsible for any damage caused to existing overhead or underground services. In case of failure or damage, the Contractor shall immediately notify the service provider and arrange for repairs to be undertaken. If there is any delay, the Superintendent will arrange for repairs to be carried out by the Principal or others and the full cost of such repairs shall be borne by the Contractor. If in the opinion of the Superintendent the failure or damage causes an emergency situation, then remedial action will be taken by the Principal and the full cost of such action shall be borne by the Contractor.
- 5.8.8 Only those persons qualified to undertake repairs on the relevant services shall be permitted to perform the work with the prior approval of the service authority.

5.9. Alterations to Public Utility Services

- 5.9.1 Where it is necessary to carry out alterations to existing overhead or underground services, this work will be arranged by the Contractor unless otherwise specified.
- 5.9.2 The Contractor shall allow to co-ordinate and work around service authorities where relocations are necessary during the Contract.
- 5.9.3 The Contractor shall promptly advise the Superintendent of any services affecting the works which were not previously identified so that appropriate action can be taken.

5.10. Joining to Existing

- 5.10.1 All work shall be joined to existing so that the level, grade and alignment neatly matches that of the existing construction. Where joining to existing concrete, bitumen, asphalt and other

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hard surface covers, the existing construction shall be saw-cut and broken away to enable a straight joint to be constructed.

- 5.10.2 When connecting to an existing pipeline the Contractor shall arrange with the Superintendent to have the flow interrupted. Such interruptions shall be limited to the time and duration approved by the Superintendent in writing.
- 5.10.3 The Contractor shall prepare an approved contingency plan prior to commencing any connection work.

5.11. Damage to Existing Facilities

- 5.11.1 All work shall be carried out to avoid damage to existing facilities which do not form part of the works including, but not limited to, adjacent works, private property, public utilities, fences, trees, survey marks, etc.
- 5.11.2 Any damage caused during the work shall be made good by the Contractor to the owner's satisfaction at no cost to the Principal.
- 5.11.3 Any materials, debris, silt etc. deposited on adjacent property shall be removed to the satisfaction of the owner and Superintendent at no cost to the Principal.
- 5.11.4 Fences, other than those specifically noted for removal, shall be maintained at all times with special care taken to prevent straying of stock if grazing is carried out on adjoining lands. If fences are required to be cut or moved, the Contractor shall erect temporary fences for stock containment as agreed with the property owner or as directed by the Superintendent.

6. General Requirements - Material

6.1. Standards

- 6.1.1 Unless otherwise specified, all materials, methods and workmanship shall be in accordance with the relevant Australian Standard or best practice industry standard where no Australian Standard exists.

6.2. Material Requirements

- 6.2.1 The Contractor shall supply all the materials required to complete the Contract in accordance with the issued drawings and specifications unless stated otherwise elsewhere in this Contract. All materials and equipment supplied shall be new and of the best industrial quality and manufacture.

6.3. Samples

- 6.3.1 Where approval of materials by the Superintendent is required, at least one of each item or a 5 kg sample of soil/gravel type materials plus a copy of any relevant supporting information shall be submitted. Further samples may be required as directed by the Superintendent.
- 6.3.2 Work involving the samples shall not be commenced until samples have been approved by the Superintendent.
- 6.3.3 Materials incorporated into the works shall match approved samples. Approved samples shall be kept in good condition on the site for reference until practical completion.
- 6.3.4 Delay caused by late submission or inadequacy of samples shall not be a reason for extension of time.

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6.4. Proprietary Products

- 6.4.1 Where a proprietary product is nominated in this specification, it shall be the Contractor's responsibility to guarantee and, if requested, submit evidence, that the product will be satisfactory, structurally adequate, durable and safe for the intended purpose and also complies with all relevant Federal, State and Local Government regulations, laws and standards and Australian Standards (if applicable).
- 6.4.2 In cases where a particular manufacturer, supplier, installer, trade name, brand name, catalogue or reference number is stated in drawings or specifications, such identification does not imply exclusive preference for that product but indicates the required properties. The Contractor may submit alternatives offering similar properties or characteristics for approval by the Superintendent. Available technical information and any other relevant information in support of the proposed substitution shall be submitted by the Contractor.

6.5. Concrete

- 6.5.1 Concrete work shall comply with the requirements of the Job Specification and Unitywater's Specification for Building and Structural Works.
- 6.5.2 Concrete used for the construction of manholes, and the restoration of concrete surfaces shall be Class S32.
- 6.5.3 Concrete used for backfilling trenches under roads, Types 2 and 3 construction, and in other situations directed by the Superintendent shall be Class N20 in accordance with AS 1379.

6.6. Manhole Covers and Frames

- 6.6.1 Manhole covers and frames shall be in accordance with the SEQ WS&S D&C Code.

6.7. Water Required for Works

- 6.7.1 Wherever possible, the Contractor shall utilise recycled water. The Contractor shall organise for transporting the effluent to the structure at a rate and quantity agreed with the Principal. The Principal does not guarantee the available volume of treated effluent, rate at which the effluent can be supplied or the standard of the effluent.
- 6.7.2 Where the use of potable water is approved by the Principal, the Contractor shall not use a standpipe on a hydrant until such time as an application has been made to the Principal and a permit issued for the use of a hydrant. Any fees which the Principal may impose for the use of the standpipe shall be paid by the Contractor and shall be included in his Schedule of Rates or Contract Sum as applicable for carrying out the work.
- 6.7.3 The Contractor shall pay to the Principal at the rate nominated in the Contract for all potable water supplied by the Principal, where no rate is nominated in the Contract, the rate shall be in accordance with Unitywater's latest 'non-residential water and sewerage pricing' as published on Unitywater's website .
- 6.7.4 The Contractor shall take care to ensure that the pH of the water during testing is maintained within a safe range to avoid the risk of corrosion to galvanised steel, aluminium and other metalwork.
- 6.7.5 Where water is required for hydrostatic testing purposes, the Principal may accept the use of recycled water in lieu of potable water sources. The Contractor shall make all necessary pumping and transportation provisions to obtain the required volumes of recycled water.
- 6.8.1 All timber used for trench shoring and the restoration of timber structures shall be suitable for the use. The timber shall be thoroughly seasoned, sound, straight and free from sapwood, large loose knots, waness, shakes, gum veins, cores and other defects.

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- 6.8.2 Timber used for restoration shall be cut, matched and framed in a tradesman like manner. The timber shall be properly arised and shall hold to true dimensions when fixed in position.
- 6.8.3 The Superintendent may direct that timber used in trench shoring shall remain in place in the trench in order to protect adjoining improvements.

7. Clearing and Grubbing

7.1. Work Operations

- 7.2.1 Clearing includes the following operations:
- Removal of trees, stumps, scrub, shrubs and overhanging branches (including sealing any cut areas on limbs with a compound suitable to the tree species);
 - Setting aside and stacking any trees required by the Principal;
 - Removal of all artificial obstructions to ground level including demolishing buildings, fences and other structures, removing rubbish (including car bodies etc.) and any other encumbrance not specifically scheduled;
 - Disposing of cleared materials.
- 7.2.2 Grubbing includes the following operations:
- Removal of roots, stumps, fallen timber and other vegetable matter to a depth of not less than 300 mm below ground surface;
 - Removal of rocks and artificial obstructions such as concrete foundations, retaining walls, abandoned services, etc. to a depth of not less than 300 mm below ground surface;
 - Disposing of grubbed materials;
 - Filling and compacting grub holes with approved material.

7.2. Proportions of Work

- 7.2.1 Unless otherwise specified, clearing and grubbing shall be carried out in the following areas:
- Full width of completed earthworks (including catch banks and catch drains if applicable) plus a further 1 m width on each side or to property boundaries, whichever is the lesser;
 - Any branches overhanging the proposed structure or proposed disturbance area.

7.3. Limitations on Clearing

- 7.3.1 The Australian Standard 4970-2009 *Protection of trees on development sites* and AS4373-2007 *Pruning of Amenity Trees* should be adhered to.
- 7.3.2 The Superintendent may require the Contractor to construct the works so that certain trees or other flora shall be preserved without damage and without interference to their limbs and roots. Trees, shrubs and overhanging branches to be left undisturbed within cleared areas are shown on the drawings or demarcated with bunting line or ATF fencing in advance by the Superintendent.
- 7.3.3 No construction activities shall be carried out within the Tree Protection Zone (TPZ) of trees to be retained unless prior approval is obtained from the Superintendent.
- 7.3.4 Clearing is to be kept to an absolute minimum and is not to extend beyond the limits of the earthworks required for construction of facilities. The Contractor shall supply and install an orange heavy duty barrier mesh fence to partition off areas of vegetation not to be disturbed during construction.

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- 7.3.5 All vegetation cleared in the course of constructing the asset, with exception to previously cleared tree hollows, shall be wood chipped or mulched, irrespective of size. The wood chip or mulch is to be stockpiled on site or as directed by the Superintendent to be used as mulch in the landscaping works.
- 7.3.6 Trees shall not be cut down outside of the construction areas without the approval of the Superintendent, and the Contractor shall protect all trees from damage.
- 7.3.7 In the process of clearing, trees inside the perimeter of the construction area shall be felled inwardly, unless it is unsafe to do so.
- 7.3.8 Unless directed by the Superintendent, or shown on the drawings, no tree outside the defined areas for clearing shall be removed or pruned in accordance with AS4970 and AS4373.
- 7.3.9 Precautions shall be taken to avoid unnecessary damage to stream beds/banks or vegetation protecting them.
- 7.3.10 Where selective clearing of trees is required, they will be clearly marked with spray liner in advance by the Superintendent. Protected trees such as engaged, vulnerable or near threatened (EVNT) species should be demarcated with bunting line or ATF fencing and not marked with spray liner. Marked trees shall be felled and handled to avoid damage to trunks. Trunks of these trees shall be trimmed of branches and stacked in approved areas away from the works.

7.4. Erosion and Sediment Control

- 7.4.1 The Contractor must carry out work in such a way that avoids environmental impacts arising from erosion and sedimentation.
- 7.4.2 Prior to carrying out earthworks, the Contractor shall submit an erosion and sediment control plan to the Superintendent for approval. The erosion and sediment control plan must be developed by an suitably qualified professional who is certified as a Registered Professional Engineer Queensland (RPEQ) or who has completed an erosion and sediment control training course, such as that offered by the International Erosion Control Association for Certified Professional in Erosion & Sediment Control (CPESC,) or equivalent. Plans shall be based upon the following guidelines and manuals (in order of precedence):
 - a. Sunshine Coast Regional Council – Erosion and Sediment Control Manual (version 1.2);
 - b. Engineers Australia publication – “Soil Erosion and Sediment Control – Engineering Guidelines for Queensland Construction Sites;
 - c. International Erosion Control Association – Best Practice Erosion and Sediment Control, November 2008.
- 7.4.3 The Contractor shall not commence earthworks until the erosion and sediment control plan has been approved by the Superintendent.
- 7.4.4 The Contractor carry out the works in accordance with the approved erosion and sediment control plan, and maintain the functionality of erosion and sediment control measures throughout the duration of the works.

7.5. Filling Grub Holes

- 7.5.1 Any holes and localised depressions in cleared and grubbed areas shall be filled to the level of the surrounding ground surface. Fill material shall be similar to the surrounding ground material or material specified for construction of embankments.
- 7.5.2 Place and compact fill material in holes and depressions to not less than 95% RDD (Std).

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7.6. Disposal of Cleared and Grubbed Material

- 7.6.1 Unless otherwise specified, all cleared and grubbed materials shall be removed from site and disposed of in accordance with relevant Commonwealth, State and Local Government laws and regulations.
- 7.6.2 Where specified, suitable vegetation may be chip mulched and used for restoration and landscaping works. The maximum size of chip shall fit within a prism measuring 100 mm x 50 mm x 20 mm. Species considered to be noxious or environmental weeds shall not be chip mulched and shall be removed from site as described above.
- 7.6.3 Unless otherwise specified, burning on site will not be permitted.
- 7.6.4 Logs must not be placed at the toe of embankments or used as retaining walls.

8. Stripping of Topsoil

8.1. Stripping Definition

- 8.1.1 Stripping of topsoil shall include:-
 - a. Stripping the topsoil from the site;
 - b. Stockpiling topsoil.

8.2. Material Requirements

- 8.2.1 Topsoil obtained from the site shall be the darker coloured organically rich layer of soil stripped from the surface of the site prior to bulk earthworks. It may contain grass, grass roots and other natural vegetation except trees and shrubs.

8.3. Construction

- 8.3.1 Stripping of topsoil shall generally occur after clearing and grubbing operations and prior to other earthworks.
- 8.3.2 The Contractor shall, prior to excavation, remove the topsoil or material to the depth of 100 mm (whichever is the greater) from the site of all excavations and site earthworks and stockpile, for later re-spreading.
- 8.3.3 Topsoil shall be stockpiled in an area approved by the Superintendent. It shall be placed to a maximum height of 1.5 m. If stockpiled for more than 3 weeks, it shall be sown with an approved grass seed mix or covered in geofabric or coir/jute matting material.
- 8.3.4 All stripped areas other than beneath proposed embankments or above cuttings shall be left in a neat, free-draining condition.

9. Earth Works

9.1. Measurements of Earthworks Volumes

- 9.1.1 The quantities of earthworks shown in the bill or schedule have been calculated as follows:
 - a. Excavation – the solid volume of bulk excavated material determined from the shapes and dimensions specified in the documents excluding the material associated with localised excavations for various components of the works;
 - b. Embankment fills/backfills – the compacted volume of material determined from the shapes and dimensions specified in the documents.

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- 9.1.2 Where earthworks items are Schedule of Rates, constructed quantities shall be determined by the same procedures used in the design process, unless otherwise approved. These procedures are available, upon request, from the Superintendent.
- 9.1.3 Excavation to structures and footings for Schedule of Rates items shall be measured as the calculated volume, in m³, determined from the plan area of the permanent footing or structure between the ground level and the approved level at the underside of the footing or structure, or, if blinding concrete is shown or ordered, the level of the underside of the blinding concrete. No allowance will be made for over excavation.

9.2. Surface Drainage of Earthworks

- 9.2.1 Earthworks shall be constructed such that water will drain at all times from cuttings and embankments.

9.3. Tolerances

- 9.3.1 All earthworks shall be finished to reasonably smooth and uniform surfaces so as to conform to the specified position, widths, heights and shapes within the following tolerances.
- 9.3.2 For horizontal tolerances, the horizontal location of any point on a layer surface shall not differ from that specified by more than ± 50 mm except for the following situations:
- 9.3.3 If specified batter points are found not to lie on the ground surface, derived batter points shall be established by extending batter lines to the ground surface;
- 9.3.4 For edges not adjacent to any other structure, the tolerance shall be $- 50$ mm $+ 200$ mm (where the + tolerance is in the direction that increases the width of the earthworks);
- 9.3.5 Where joining to existing work, new work shall be joined in a smooth manner as shown on the drawings or as directed by the Superintendent.
- 9.3.6 For vertical tolerances, finished surface levels of earthworks layers shall not vary from specified or calculated levels by more than the following:

Table 1 -Accepted Finished Surface Level Variances

Location	Tolerance
Subgrade	± 25 mm where pavement thickness > 200 mm ± 10 mm where pavement thickness ≤ 200 mm
Tops of embankments other than subgrade: in rock/predominantly rock in other-than-rock	± 75 mm ± 40 mm
Tops of benches or berms	± 35 mm
Inverts of drains	± 40 mm

- 9.3.7 In addition to the above, the finished subgrade shall be graded such that the gap between a 3 m long straight-edge placed anywhere on the surface shall not exceed 15 mm, due allowance being made for design shape where relevant.

9.4. Crossfalls

- 9.4.1 The crossfall of the surface of the finished subgrade shall not deviate from that shown on the drawings by more than an average of 0.5% measured at three random locations within any 20

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m length. A template and spirit level shall be kept on the site and made available to the Superintendent for checking crossfall when requested.

9.5. Batters

- 9.5.1 No portion of batters shall project beyond the shape specified by more than 300 mm or one-third of the height of the batter whichever is the lesser.
- 9.5.2 No portion of a cut batter shall overhang the outside edge of the table drain or outermost point of the road formation.
- 9.5.3 Batters shall continue in smooth lines around curves.

9.6. Excavation – General Requirements

- 9.6.1 The Contractor's attention is drawn to Part 6.3, Division 3 of the *Work Health and Safety Regulation 2011* in relation to excavation. All excavation must be carried out in accordance with the Regulation.
- 9.6.2 Excavation shall be taken to include:-
- Loosening in-situ material;
 - Selection of material for use in upper portions of embankments;
 - Excavating, loading and carting loosened material;
 - Unloading carted material;
 - Disposing of unloaded material at disposal areas;
 - Trimming and compacting material at bottom of excavations;
 - Finishing and trimming batters.
- 9.6.3 All excavations shall be taken out accurately to the lines and levels shown on the drawings.
- 9.6.4 All surfaces to receive concrete foundations, floors or sloping walls, shall be neatly trimmed and cleaned of all loose materials.
- 9.6.5 All excavations taken beyond the levels shown on the drawings shall be refilled with materials furnished and placed by the Contractor by a method approved by the Superintendent. The material shall be blinding concrete where the adjacent structure is concrete. Elsewhere the material shall be selected material from the excavations compacted to the standard as given below for filling beneath structures.
- 9.6.6 Following excavation to formation level, the exposed surface shall be prepared by proof rolling to identify any soft locations.
- 9.6.7 All areas identified as soft shall be excavated and replaced with blinding concrete or selected material in accordance with section 9.17.
- 9.6.8 Excavated material from structures shall be stockpiled clear of works in such a manner as to encourage the drying out of wet material.
- 9.6.9 Excavated material from the excavations not required for backfilling shall be disposed of off-site. The Contractor shall be responsible for the disposal of such material.

9.7. Excavation Planning and Monitoring

- 9.7.1 The Contractor shall take every precaution to safeguard existing structures and avoid undermining or disturbing structures during excavation and construction.

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- 9.7.2 Prior to commencing excavation the Contractor shall submit an Excavation Plan and excavation shall not commence until the plan has been approved by the Superintendent. The plan shall set out:
- Sequence of works to ensure that slopes are stable and that excessive unbalanced loads do not occur;
 - The methodology for dealing with trafficability, on site;
 - Stability calculations;
 - Dewatering systems where necessary, including minimisation of impacts of dewatering;
 - Any additional stabilisation measures that may be required;
 - A monitoring program for existing structures;
 - Structures that require movement monitoring during excavation. The Contractor must seek the advice of a RPEQ to determine which existing structures require monitoring during excavation; and
 - A contingency plan to be implemented in the event that excess movement of adjacent structures is encountered.
- 9.7.3 For structures identified in the Excavation Plan as requiring monitoring for movement and prior to commencing excavations the Contractor shall install marker points at locations on the wall of the existing structures in a manner approved by the Superintendent for the purpose of detecting movement of the structure.
- 9.7.4 The levels of the marks shall be measured at least twice at not less than 24-hour intervals to an accuracy of ± 2 mm prior to commencing excavation.
- 9.7.5 During the excavation work the Contractor shall resurvey the marks to the same accuracy as prior to commencing work and after completion of work on any workday and also following heavy rainstorms or wherever there is a visual indication that the marks no longer hold true and shall compare results with the initial datum survey.
- 9.7.6 Should the level difference exceed 5 mm from the pre-excavation survey at any location, the Contractor shall immediately advise the Superintendent and cease excavation until the Superintendent approves re-commencement of work.
- 9.7.7 Notwithstanding the above, the Contractor shall be responsible for any movement of existing structures caused by excavation, and shall undertake any necessary rectification works to repair structures damaged as a result of such movement.

9.8. Classification of Excavated Materials

- 9.8.1 Excavation may be scheduled as a single item to include all types of materials or as separate items to specifically include or exclude 'rock'.
- 9.8.2 Where excavation is scheduled as a single item to include all materials, no claim for extra payment will be considered for any rock or hard material encountered.
- 9.8.3 Where a separate item is scheduled for 'Excavation in rock', rock shall be deemed to be material which cannot be ripped at a production rate exceeding the rate shown in the following table for a particular class of crawler tractor as defined in AS 2868. The tractor shall be fitted with a heavy duty single tyne matching ripper and be in good working condition.

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Table 2 - Tractor Production Rate

Class of Tractor	m ³ per hour
150C	50
200C	75
300C	90

- 9.8.4 Proving material to be rock shall be the Contractor's responsibility. The Superintendent shall have the right to nominate an operator for the machine and to direct operations of the tractor during the proving operation.
- 9.8.5 Rock shall also include boulders greater than 0.8 m³ in volume.
- 9.8.6 Notwithstanding that the work may form part of a lump sum contract, where a separate item is scheduled for 'Excavation in rock', payment shall be made at the scheduled rate per m³ solid volume in place calculated from observed rock levels, survey data and measurements shown on the drawings. In such circumstances, the quantity of 'Excavation in other than rock' for which payment is made shall be varied so that the total quantity of 'Excavation' remains unchanged.

9.9. Selection of Material

- 9.9.1 Excavation and cutting shall be worked so that the best available material in the opinion of the Superintendent is used in the upper portion of embankments (typically within 300 mm of upper surface of formation or subgrade).

9.10. Subgrade in Cut

- 9.10.1 The material at subgrade level shall provide a stable, dense surface which displays no visible movement under construction equipment.
- 9.10.2 Generally, in-situ material directly below the subgrade shall be compacted to not less than 97% RDD (Std) to a depth of 150 mm below subgrade.
- 9.10.3 However, in areas where there is rock material and also in any other areas nominated in writing by the Superintendent, the excavation shall continue to a depth of 150 mm + 75 mm below the subgrade. The bottom of the excavation shall be free of loose material and free draining.
- 9.10.4 Backfilling of extended excavation in rock cuttings, up to subgrade height, shall be with cement stabilised material in accordance with Clause 9.18.
- 9.10.5 In other situations where extended excavation is ordered, backfilling to subgrade level shall be with selected gravel fill material in accordance with Clause 9.16.
- 9.10.6 Where the cross-section is partly in cut and partly in fill, any additional backfilling with selected or stabilised material shall extend over the full width of the formation.
- 9.10.7 Where no Schedule of Rates items exist for this work, additional excavation and backfilling to subgrade level shall be paid for as a variation.

9.11. Batters in Cuttings

- 9.11.1 Cut batters shall be free of loose material and trimmed neatly to the shapes specified.
- 9.11.2 Where topsoiling of batters is specified, batters shall be stepped so that they will hold topsoil.
- 9.11.3 Topsoiling of batters shall commence as soon as practicable, but not later than 14 calendar days following stepping.

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9.12. Excavation for Culverts and/or End Structures

- 9.12.1 The widths of excavations for culverts and end structures shall be the minimum necessary for their construction and placement of fills/backfills against them.
- 9.12.2 Where in-situ material at the bottom of an excavation is other than rock, the material shall be compacted to no less than 95% RDD (Std) to a depth 150 mm below the bottom of the excavation.

9.13. Excavation for Drains, Culvert Inlet/Outlet Drains

- 9.14.1 Culvert and pipe inlet/outlet drains shall be constructed to transition smoothly to existing adjacent drainage channels or ground level directed by the Superintendent.
- 9.14.2 All drains shall have a continuous positive drainage slope in the required direction

9.14. Excavation Requirements for Structures

- 9.14.1 Excavations for foundations of structures shall be to competent material. Competent material is defined as undisturbed natural material which will safely carry the foundation bearing pressures as determined in the design. The Contractor shall undertake geotechnical testing as necessary to satisfy the Superintendent the foundation surface is suitable.
- 9.14.2 The Contractor shall take all necessary precautions to protect excavations and all personnel and equipment in or about them, including provision of all necessary temporary works and equipment. Upon completion of construction, all temporary works shall be removed carefully to avoid damage to the finished structure.
- 9.14.3 When competent material has been reached, the foundation surface shall be completely dewatered and all unsuitable material shall be removed. The foundation shall then be presented for inspection by the Superintendent. No work which will cover the surface of the foundation shall proceed until the foundation has been inspected and approved by the Superintendent.
- 9.14.4 Following approval of the foundations, a 50 mm minimum thickness layer of blinding concrete shall be placed over the foundation material where shown on the Drawings or as otherwise directed by the Superintendent.
- 9.14.5 If, in the opinion of the Superintendent, the foundation material has deteriorated since the time the foundation was approved and before blinding concrete has been placed, additional material shall be removed to competent material before blinding concrete is placed.
- 9.14.6 The foundation shall be re-presented for further inspection and approval by the Superintendent.
- 9.14.7 These additional requirements shall be carried out at no cost to the Principal.
- 9.14.8 Excavations shall be closely monitored by the Contractor's supervisory staff at all times to ensure that the surface below the structures' floors is excavated neatly to the lines and levels on the drawings.
- 9.14.9 Any over-excavation by the Contractor not ordered by the Superintendent in writing, under any structure shall be made good by refilling such over-excavation with cement modified granular fill or blinding concrete at the Contractor's expense.
- 9.14.10 Where the foundation material is unsuitable the Superintendent may order the Contractor in writing to undertake additional excavation.
- 9.14.11 The refilling material below the structures' footings shall be blinding concrete or better.
- 9.14.12 The excavation for structures shall be taken out accurately to the lines and levels shown on the drawings.

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9.14.13 Prior to construction of the structure the top 200 mm of the sub grade shall be compacted with a vibrating roller or other approved means to a minimum density index of 70% (AS 1289.5.6.1) or 98% of maximum dry density for Standard Compaction.

9.15. Embankment Construction

9.15.1 Embankment construction shall be taken to include:

- a. Preparing ground surface;
- b. Forming benches (if required) on which to compact embankment material;
- c. Supplying embankment fill material from excavation areas, borrow areas and importing from other areas as specified or approved;
- d. Placing and compacting embankment fill material including all necessary watering, mixing, drying-out, and compaction operations;
- e. Installing embankment geofabrics (as required);
- f. Carrying out special treatments at top portions of road embankments including forming shoulders where construction of shoulders is not specified as a separate item;
- g. Finishing batters.

9.15.2 Embankments shall be constructed to the shape and other requirements specified.

9.15.3 Following completion of structures the Contractor shall backfill the excavations to the levels shown on the drawings.

9.15.4 The embankment and backfilling shall be placed in layers not exceeding 250mm thick (measured loose) and consolidated with vibrating rollers or other approved means.

9.15.5 Fill material used for the construction of road embankments may be other-than-rock, rock or a mixture of other-than-rock and rock.

9.15.6 Fill material used for the construction of other embankments shall be other-than-rock or predominantly other-than-rock, unless otherwise specified.

9.15.7 Hard non-naturally occurring materials (e.g. broken concrete) may be treated as "rock", subject to approval by the Superintendent.

9.15.8 All embankment fill material shall be free of organic matter and other deleterious material.

9.15.9 Size limitations for rock shall apply as specified.

9.15.10 Prior to placement of any embankment fill material, the ground surface under areas of embankment shall be prepared as follows:

- Stripping Vegetation – Notwithstanding the requirements for clearing, grubbing, backfilling and compacting stump holes, the whole area under embankments shall be stripped of all grasses and other vegetable material;
- Stripping Topsoil – Where stockpiling and respreading of topsoil is specified, sufficient topsoil with grass shall be stripped from the surface and stockpiled for this purpose;
- Filling Holes and Localised Depressions – Holes and localised depressions shall be filled to the level of the surrounding ground surface using embankment fill material. Fill material shall be compacted to not less than 95 % RDD (Std);
- Drying Out Wet Material – Wet material under embankment areas shall be drained and dried out so that embankment material can be compacted to the density specified and no visually obvious vertical movement occurs under compaction equipment. If springs or

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seeps are found such that surface drainage will not allow in-situ material to be dried out, other techniques shall be employed as directed by the Superintendent;

- Compaction of Material below Ground Surface – Where the ground surface at the road centreline is more than 300 mm below the subgrade of road embankments or is under other embankments, the material below ground surface shall be compacted to not less than 95 % RDD (Std) to a depth of 150 mm below ground surface;
 - Where the ground surface at the road centreline is between 300 mm and 150 mm below the subgrade, the material below ground surface shall be compacted to not less than 97 % RDD (Std) to a depth of 150 mm below ground surface;
 - Where the ground surface at the road centreline is less than 150 mm below subgrade, the material below ground surface shall be compacted to not less than 97 % RDD (Std) to a depth of 300 mm below subgrade;
 - If the material below the ground surface is too wet or too dry to compact to the above specification, the moisture content shall be adjusted by tyning the material to the appropriate depth and suitably drying or wetting as required;
- Filling Lowered Areas – If the ground surface on which embankments are to be constructed is lowered below the original height as a result of clearing and grubbing and stripping operations and/or compaction and/or any other ground surface preparation treatment, except for stripping topsoil, the supplying, placing and compacting of additional embankment fill material which necessarily results from such lowering shall form part of ground surface preparation for embankment;
 - Where the ground surface on which an embankment is to be constructed has a transverse slope steeper than 1 in 8, a horizontal bench not less than 300 mm high shall be cut into the ground surface at the toe of the embankment to enable embankment construction to proceed in horizontal layers of uniform thickness.
 - Where the ground surface has a transverse slope steeper than 1 in 3, a series of horizontal benches not less than 300 mm high shall be cut into the ground surface to be covered by the embankment.

9.15.11 Embankment construction shall be carried out by one or both of the following methods:

- a. Compacted Layer Method;
- b. Rockfill Method.

9.15.12 Construction methods that involve tipping of material over the sides of a constructed section of embankment shall not be allowed.

9.15.13 The compacted layer method of construction shall be employed where the embankment fill material is other-than-rock or predominantly other-than-rock:

- Where the fill material contains rock, the rock shall be of size not greater than two-thirds the uncompacted layer depth;
- All fill material shall be placed uniformly in layers for the full width and length of the embankment. The thickness of uncompacted layers shall not exceed 300 mm unless otherwise approved by the Superintendent;
- The minimum thickness of uncompacted layers shall be 150 mm; a lesser thickness of newly placed fill material may be employed, provided that the underlying material is loosened prior to placement of fill;
- The compacted thickness of the loosened material and the newly placed fill material shall not be less than 150 mm;

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- Where material is loosened below ground surface, the compacted depth requirements of Clause 9.5.3 (e) shall apply to the material below the loosened material;
- Road embankment fill material within 300 mm of subgrade, including that in the shoulders, shall be compacted to not less than 97 % RDD (Std);
- All other embankment fill material shall be compacted to not less than 95% RDD (Std);
- Where shoulders are to be constructed using pavement materials, the compaction standards specified for the pavement shall apply to the shoulders;
- Embankment material shall be placed and compacted at a moisture content within plus 3% and minus 20% of optimum moisture content (standard compaction);
- At all times the Contractor shall ensure that no water is permitted to pond in or adjacent to the embankment and that the surface of the embankment is free draining.

9.15.14 The rockfill method shall be used where the material is predominantly rock and mechanical interlock is available for stability:

- Fill material shall be placed, dozed, ripped, rolled, worked and broken until stable interlock is achieved and no further lowering of the surface occurs. The embankment shall be constructed in continuous, horizontal layers not greater than 1.5 m deep. No rock placed in fills shall be over 1.25 m greatest dimension. Side dumping will not be allowed and the fill is to be advanced by full width construction. The advancing ends of layers shall be concave, with the shoulder face well in advance of the middle;
- The minimum thickness of uncompacted layers shall be one and a half times the maximum size of rock in the layer or 150 mm, whichever is greater.

9.15.15 Where embankment fill material changes from rock (or predominantly rock) to other-than-rock (or predominantly other-than-rock), and the voids in the previously placed rock are not completely filled with other-than-rock, a geofabric filter shall be installed at the interface between the rock and other-than-rock fill materials.

9.15.16 Prior to installing the geofabric, the surface voids in the rock at the interface shall be filled with smaller rock to provide effective and continuous support for the fabric and the other-than-rock fill material.

9.15.17 Embankment material placed in the zone within 600 mm of subgrade level shall consist of material suitable for placement using the compacted layer method. In addition, material placed in the zone within 300 mm of subgrade level shall not contain rock particles with any dimension greater than 80 mm.

9.15.18 The material at subgrade level shall provide a stable, dense surface which displays no visible movement under construction equipment.

9.15.19 Batters shall be free of loose material and trimmed neatly to the shapes specified. Refer to 9.5.1 for tolerances.

9.15.20 Where topsoiling of batters is specified, they shall be roughened to the details shown on the Drawings. Time limitations shall apply to vegetation of batters following topsoiling as specified in landscaping specifications.

9.15.21 Where the roadworks in cross-section are part road embankment and part road cutting in rock, construction of the road embankment using normal embankment materials shall cease 150 mm below subgrade, i.e. at the level of the excavation operation specified in Clause 9.10.3 for subgrade in rock cuttings.

9.15.22 Embankment above this level shall be constructed using materials as specified in Clause 9.10.3.

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9.16. Backfilling

- 9.16.1 Backfilling for water retaining structures shall not be carried out until after the successful filling and water testing of the structure.
- 9.16.2 Where the Contractor wishes to backfill against the structure in order to support formwork for another part of the structure, the Contractor shall perform the hydrostatic test prior to backfilling.
- 9.16.3 Alternatively, the Contractor may commence backfilling upon submission of test results demonstrating compliance with the design concrete strength, remove the filling after the structure is completed and then carry out the hydrostatic test.
- 9.16.4 Under no circumstances shall the Contractor be permitted to test the watertightness of the structure with the backfilling in place.

9.17. Selected Gravel or Loam Fill/Backfill

- 9.17.1 Where specified, selected gravel fill or loam fill shall be used in embankment construction, and fill and/or backfill around bridges, culverts and other in-place structures. Work operations shall include:
- Supply of fill/backfill materials;
 - Placing and compacting fill/backfill materials;
 - Finishing surfaces of fills/backfills.
 - Fill/backfill material shall be free from soluble salts, organic matter, clay and other deleterious matter.
 - Gravel and loam materials shall have the following minimum properties:

Table 3 - Required Gravel and Loam Characteristics

AS Sieve Size (mm)	Percent (by mass) Passing Sieve	
	Gravel	Loam
37.5	100	100
9.5	60 – 85	100
2.36	25 – 70	70 – 100
0.60	15 – 50	15 – 50
0.075	3 – 30	3 - 30
Other Properties: Linear Shrinkage (Passing 2.36 mm)	8 max.	6 max.

- 9.17.2 In addition, gravel material retained on 2.36 mm sieve shall be sound stone.

9.18. Cement Stabilised Fill/Backfill Below Subgrade

- 9.18.1 Cement stabilised fill shall be used to backfill additional excavation below subgrade in rock cuttings (refer Clause 9.10.3). Work operations shall include:-
- Supply of fill/backfill material;
 - Placing and compacting fill/backfill material;
 - Finishing surfaces of fills/backfills.

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- 9.18.2 Fill/backfill material shall be at least Subtype 3.3 unbound pavement material, Gradings C or D, as specified in the Department of Transport and Main Roads Standard Specification MRTS05 Unbound Pavements, stabilised using 1 part cement to 30 parts soil aggregate (loose volume).
- 9.18.3 Cement stabilised fills/backfills shall be constructed for the excavated depth as specified in Clauses 9.10.3 and 9.12.2, directly below subgrade in cuttings in rock and in road embankments where the cross-section of the roadworks is part embankment and part cutting in rock. The fills/backfills shall be constructed over the full width of the road formation.
- 9.18.4 Any overbreak which occurs below 225 mm excavation depth below subgrade in cutting in rock (refer to Clause 9.10.3), shall be backfilled with cement stabilised fill/backfill material.
- 9.18.5 The stabilised fill/backfill material shall be placed and compacted in one layer and compacted to not less than 97 % RDD (Std).
- 9.18.6 The top surfaces of the fills/backfills shall be finished to the subgrade shape.

9.19. Fill/Backfill against In-Place Structures

- 9.19.1 This clause specifies requirements for fill/backfill against in-place structures and includes requirements for side and overlay zones to box culvert structures. Works operations include:
- Supply of fill/backfill material;
 - Placing and compacting fill/backfill material against structures and in side zones and overlay zones to box culverts;
 - Finishing surfaces of fills/backfills.
- 9.19.2 The filling around structures shall be placed in uniform layers and compacted. The material shall comply with the following standards of compaction as detailed in various parts of AS 1289 *Methods of Testing Soils for Engineering Purposes* unless noted otherwise:
- Sand – The density index measured in accordance with AS 1289.5.6.1 Clause 4b shall not be less than 65%;
 - Material other than sand – This material shall achieve a compaction of not less than 95% of the maximum dry density using standard compaction as determined by AS 1289.5.1.1, Standard Compaction (2003).
- 9.19.3 Under Pavements, the material shall comply with the following standards of compaction as detailed in various parts of AS 1289, *Methods of Testing Soils for Engineering Purposes*, unless noted otherwise:
- Sand – The density index measured in accordance with AS 1289.5.6.1 Clause 4b shall not be less than 75%;
 - Material other than sand – This material shall achieve a compaction of not less than 100% of the maximum dry density using standard compaction as determined by AS 1289.5.1.1, Standard Compaction (2003).
- 9.19.4 Where filling is required under structure footings, the fill material shall be Class N20 concrete.
- 9.19.5 Where filling is required generally under structures (other than footings), the filling shall be placed in uniform layers and be compacted. The material shall comply with the following standards of compaction as detailed in various parts of AS 1289 *Methods of Testing Soils for Engineering Purposes*:
- Sand – The density index measured in accordance with AS 1289.5.6.1 shall not be less than 75%;

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- b. Material Other Than Sand – This material shall achieve a compaction of not less than 100% of the maximum dry density using standard compaction as determined by AS 1289.5.1.1 – Standard Compaction (2003).
- 9.19.6 The backfilling of pipe trenches shall be as follows (unless it is otherwise stated on the drawings):
- Under new pavements, the Contractor shall backfill all pipelines with compacted sand up to subgrade level. The pavement shall then be constructed on the completed subgrade. The compaction of material above the sand level shall comply with the relevant roadwork's construction specifications;
 - Under existing pavements, the Contractor shall backfill all pipelines with compacted sand to within 450 mm of the finished level and compacted lean mix concrete shall be placed to within 50 mm of the finished level. The lean mix concrete shall be placed in uniform layers of 200 mm maximum thickness compacted with 6 passes of a heavy duty vibrating plate compactor. The road crossing shall be surfaced with bituminous concrete to the same thickness as the existing pavement, but not less than 50mm;
 - Under topsoiled areas and other areas outside the limit of the excavation and backfilling for roadworks, the material shall be placed in 300 mm layers and compacted to the standard given in section 3.
- 9.19.7 Where a geotextile membrane is damaged or must be penetrated, the Contractor shall cut and lap the geotextile membrane in accordance with the manufacturer's recommendations.
- 9.19.8 Bedding and surround material shall be clean sand complying with the following grading requirement:

Table 4 - Bedding material grading

Sieve Size	Percentage by weight passing AS sieve
9.6	100
4.8	95-100
2.4	80-90
1.2	15-25
0.6	10-20
0.3	5-10
0.15	0-5

- 9.19.9 Sand shall be either washed or sourced from a non-marine environment to minimise the salinity of the material.
- 9.19.10 Material passing the 1.1mm sieve shall have a minimum linear shrinkage of 3% and a maximum loss under the miniature abrasion test of 20%.
- 9.19.11 Material supplied to site shall be free of any foreign matter — twigs, grass etc.
- 9.19.12 Following completion of the structures, and bulk filling where provided, the excavated material shall be spread over the site such that the filling levels are 100mm below final levels.
- 9.19.13 Any settlement of any backfilling taking place during the defects liability period shall be refilled and regraded by the Contractor to plan levels.
- 9.19.14 The terms side zone and overlay zone refer to specific layers and zones of material shown on the Standard Drawings for installation of box culverts.

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- 9.19.15 All fill/backfill material shall be free from soluble salts, organic matter, clay, and other deleterious matter.
- 9.19.16 Unbound materials (excluding sand) shall be gravel or loam and have properties as specified in Clause 9.17.1.
- 9.19.17 Cement treated material shall comply with the requirements of section 9.18.
- 9.19.18 Sand shall be natural sand, manufactured sand, or a mixture of natural and manufactured sands.
- 9.19.19 Side zone material used for the backfill of box culverts shall conform to the grading requirements specified in Clause 9.17.1.
- 9.19.20 Overlay zone material used for the backfill of box culverts shall conform to the requirements of section 9.17 except that 100% of the material shall be less than 150 mm and at least 80 % shall be less than 75 mm.
- 9.19.21 Placing and compacting operations shall not damage in-place structures. Where the fill/backfill material is placed against precast/preformed structures, the operations shall be carried out in accordance with any manufacturer's recommendations except as otherwise provided for in this specification.
- 9.19.22 Fill/backfill material shall not be placed until structures have been completed and approved, and any specified curing periods for material in the structure have elapsed.
- 9.19.23 All material shall be placed and compacted uniformly in layers. The thickness of uncompacted layers shall not exceed 100 mm.
- 9.19.24 Where material is placed on opposite sides of a structure, the difference in level of compacted material on opposing sides shall not exceed 150 mm.
- 9.19.25 Construction operations which involve puddling or jetting of material shall not be employed without prior approval by the Superintendent.
- 9.19.26 Fill/backfill material, side zone material and overlay zone material placed within 300 mm of the subgrade shall be compacted to not less than 97 % RDD (Std). All other fill/backfill material, side zone material and overlay zone material shall be compacted to not less than 95 % RDD (Std).
- 9.19.27 Where fills/backfills extend to subgrade, the top surfaces of the fills/backfills shall be finished to subgrade shape.
- 9.19.28 In certain instances (e.g. backfill to culverts), the Superintendent may give approval to substitute a non-cohesive material for the specified fill material.
- 9.19.29 Where such approval is given the following conditions shall apply:-
- a. Non-cohesive material shall not be used within 300 mm of the subgrade surface;
 - b. Non-cohesive material shall be compacted to a density index of not less than 70.
- 9.19.30 Non-cohesive material shall be compacted by flooding and the use of immersion vibrators or by such other means as will achieve the specified compaction standard.

9.20. Respreading of Topsoil to Earthworks Areas

- 9.20.1 Where specified, topsoil shall be spread to a minimum thickness of 50 mm over batters and earthworks areas.
- 9.20.2 Batters shall be prepared as specified in clauses 9.3.5 and 9.5.11.
- 9.20.3 Topsoiling shall be carried out progressively as earthworks are completed and as soon as possible in the construction program.

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9.21. Borrowing Operations

- 9.21.1 Where material obtained from excavations is insufficient for the construction of embankments and other fills/backfills, material may be borrowed from areas within or outside of the site as specified or otherwise approved by the Superintendent.
- 9.21.2 Borrow areas shall be cleared and grubbed according to the procedures specified section 7. The removed grass and other suitable vegetable matter, together with sufficient topsoil to maintain viability of the vegetable matter, shall be stockpiled for subsequent spreading over these areas after borrowing operations are completed in accordance with section 8.
- 9.21.3 Where practical, and with prior approval of the Superintendent, additional material may be obtained by uniformly increasing the width of cuttings; flattening batter slopes to provide catch points at a uniform distance from the roadway; rounding the tops of batters; removing residual prisms of earth or rock; or such other manner as the Superintendent may direct.
- 9.21.4 Where approved by the Superintendent, Borrow Pits may be excavated to provide additional embankment material.
- 9.21.5 Borrow Pits shall not be deeper than 400 mm, (unless approved by the Superintendent), shall have side slopes not steeper than 1 in 3 and shall be graded to drain away from the roadworks unless approval is given for the excavations to be drained into existing drainage structures.
- 9.21.6 The edges of Borrow Pits shall be at least 3 m clear of the works, property boundaries, fences, utility services and drainage structures.
- 9.21.7 Borrow Pits away from the works shall be trimmed to a neat and tidy shape without undue delay. Stockpiled grass, vegetable matter and topsoil shall be spread uniformly over the surface of the excavation after borrowing is complete.

9.22. Blasting in Cuttings

- 9.23.1 Unless expressly permitted by the Superintendent, blasting shall not be utilised by the Contractor

9.23. Swamp Treatment

- 9.23.1 Unless otherwise specified, swamp treatment shall be carried out using one of the following methods as shown on the drawings or as directed by the Superintendent.
- 9.23.2 Where the depth of swamp material is less than 300 mm swamp treatment will not apply and removal of the material shall be carried out as normal preparation of embankment in accordance with section 9.15 of this Specification.
- 9.23.3 General work operations include:
- Excavation of swamp material;
 - Cartage to disposal areas;
 - Tipping and spreading excavated material in disposal areas;
 - Supply of approved backfill material;
 - Backfill of excavated area.
- 9.23.4 Backfill material shall be approved by the Superintendent and shall not disintegrate or break down under the action of weather, water or traffic.
- 9.23.5 Where the swamp materials are being totally or partially excavated, the operations of excavation and backfilling and excavation of displaced materials shall be carried out concurrently, except where excavation results in a stable trench, in which case excavation and backfilling may be carried out as separate operations.

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- 9.23.6 Excavated material shall be neatly deposited clear of all existing and proposed structure openings, watercourses and drains, and clear of the sides of the excavation. The deposited material may abutt the embankment slope providing it is trimmed level or battered away from the embankment slope in a manner that will allow the embankment slope to drain to the swamp or side drains as the case may be.
- 9.23.7 The backfill material shall form the base of the embankment. The surface of the backfill shall be kept trimmed so that it is free from mounds and hollows.
- 9.23.8 Immediately a height has been reached in the trench or embankment such that controlled placing in layers and compaction of material can be achieved, the remainder of the embankment shall be placed and completed by the methods specified in section 9.17.
- 9.23.9 For the consolidation and/or gravity displacement method, work operations include:
- Placing embankment fill material and/or surcharge material over swamp areas;
 - Staged construction as specified;
 - Temporary pavement construction as specified;
 - Removal of surcharge material if applicable and trimming of embankment;
 - Disposal of re-use of surcharge material if applicable.
- 9.23.10 Material placed into swamp areas shall be approved by the Superintendent and shall not break down under the action of weather, water or traffic.
- 9.23.11 Surcharge material (if applicable) shall be as specified or as approved by the Superintendent.
- 9.23.12 Embankment shall be placed over swamp in lifts of controlled thickness parallel to the designed grade line and to the designed embankment widths to allow for consolidation and/or displacement of the underlying swamp material for the full width of the embankment.
- 9.23.13 End dumping will be permitted only to a thickness necessary to support the hauling equipment. The advancing end of the dumped material shall be controlled by dozing or moving forward a face for the full width of the embankment in a manner that will prevent swamp material forming pockets or being incorporated into the deposited material.
- 9.23.14 The controlled placing or stage construction will be stated in the drawings or may be directed by the Superintendent and the initial surcharge grade lines may be shown above the completed design grade lines where a surcharge is required to complete the consolidation or displacement of the swamp materials.
- 9.23.15 Temporary pavement shall be constructed as specified to provide for traffic while the surcharge is in place.
- 9.23.16 On completion of consolidation or displacement of the swamp material and consolidation of the embankment, the surcharge material shall be removed, used for flattening the embankment batters, or as otherwise directed, and the embankment completed to design grade lines, cross sections and to the tolerances specified in section 9.3 of this Specification.
- 9.23.17 Where it becomes evident in the opinion of the Superintendent that the displacement and consolidation period will exceed the Contract completion time by more than the maintenance period, the Superintendent may direct that the work be accepted and that work required to complete the embankment to design grade lines be deleted from the Contract. The Superintendent may direct in such a case that temporary paving and surfacing work be carried out if necessary to carry traffic pending the later completion of the embankment to the final design grade lines.

9.24. Foundation Inspection

- 9.24.1 The Contractor shall engage an independent geotechnical engineer with NPER accreditation to certify that the foundations are suitable.

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9.24.2 All footing and floor foundations shall be inspected and approved by the Superintendent, in writing, before footing and floor construction commences.

9.25. Earthworks Inspection and Testing

9.25.1 The Contractor shall engage an independent geotechnical engineer with NPER accreditation to undertake inspection and testing of site earthworks in accordance with AS 3798. Filling under structures shall be subject to Level 1 inspection and testing and the geotechnical engineer shall provide a certificate expressing his opinion on whether the work complies with the specifications and drawings. All other site earthworks shall be subject to Level 2 sampling and testing.

10. Road Formation Components

10.1. General

10.1.1 The Contractor shall construct the roadworks and drainage to the details shown on the Project drawings and specifications.

10.1.2 Earthworks, drainage, and kerb and channel shall be constructed in accordance with the Project drawings and specifications. The kerb and channel profiles shall be in accordance with the IPWEAQ standard drawing SEQ R-080.

10.1.3 Gravel pavement, sprayed bituminous surfacing and asphalt surfacing shall be supplied and constructed in accordance with the following Department of Transport and Main Roads technical specifications:

- a. MRTS01 Introduction to Technical Standards;
- b. MRTS50 Specific Quality System Requirements;
- c. MRTS11 Sprayed Bituminous Surfacing;
- d. MRS05 Unbound Pavements;
- e. MRTS05 Unbound Pavements;
- f. MRS30 Dense Graded and Open Graded Asphalt;
- g. MRTS30 Dense Graded and Open Graded Asphalt.

10.1.4 The specifications shall be applied in conjunction with the following Annexures included in the Contract documents:

- a. MRTS11.1 Sprayed Bituminous Surfacing - Annexure
- b. MRS05.1 Unbound Pavements - Annexure
- c. MRTS05.1 Unbound Pavements- Annexure
- d. MRS30.1 Dense Graded and Open Graded Asphalt- Annexure
- e. MRTS30.1 Dense Graded and Open Graded Asphalt- Annexure

10.1.5 Testing required by the above standards shall be completed to the minimum requirements of the relevant specification and shall be arranged and paid for by the Contractor. The cost of all testing, based on the design quantities of materials, shall be borne by the Contractor.

10.1.6 No extra payment will be made to the Contractor for any delays occasioned because of testing. Testing shall be carried out by a testing company or firm with NATA certification, and which has been approved by the Superintendent.

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10.2. Shoulders

- 10.2.1 Where shoulders are required on new work or on sections to be reconstructed, they shall be constructed as shown in the drawings.
- 10.2.2 Unless otherwise specified, material used in the top 100 mm of shoulders shall be a soil aggregate mixture free from vegetable matter and lumps of clay and shall have the following properties:

Table 5 - Materials for Shoulder Formation

AS Sieve Size (mm)	Percent (by mass) Passing Sieve
26.5	100
2.36	50 - 90
0.075	15 - 30
Other Properties: Linear Shrinkage (Passing 2.36 mm)	2 - 8

- 10.2.3 Material retained on the 2.36 mm sieve shall be sound stone.
- 10.2.4 Unless otherwise specified, the material in the lower courses of the shoulders shall conform to the requirements specified in Clause 9.6.2 for selected gravel or loam fill.
- 10.2.5 Shoulders shall be constructed for their full width and depth to not less than 98% RDD (Std).

10.3. Table Drains and Diversion Blocks

- 10.3.1 Table drains shall be constructed to the profiles and locations shown on the drawings. They shall be graded evenly to ensure a positive drainage slope in the required direction.
- 10.3.2 At all culverts and at intervals not exceeding 60 m on grades up to 4%, 30 m on grades 4% to 8% and 15 m on grades over 8% (except in cuttings), table drains shall be blocked by a diversion block and water diverted by means of a diversion drain into culverts or catch drains as shown on the drawings, or as directed by the Superintendent.
- 10.3.3 Diversion blocks shall consist of not less than 1 m³ of well compacted cohesive material.
- 10.3.4 Where table drains cross accesses to private properties or side roads and details of the crossings are not specified, the drain shall be constructed so as to be trafficable to crossing vehicles.

10.4. Diversion Drains

- 10.4.1 Diversion drains shall be uniformly graded, with ample fall, so as to facilitate the flow of water. They shall have an excavated cross section area at least equal to the cross sectional area of the table drains carrying water to them and shall be cut to a profile which shall allow maintenance by a grader. If so ordered, material excavated from diversion drains shall be banked on the low side of the drain at least 0.3 m from the edge of the drain.

10.5. Catch Banks

- 10.5.1 Catch banks shall be constructed on the high side of road cuttings or as indicated on the drawings to divert water away from batters. They shall be constructed during early stages of earthworks using excavated site material.
- 10.5.2 Catch banks shall be between 1.5 m and 3.0 m away from the edge of a cutting unless the contour of the surface makes it necessary to keep it further away to preserve fall. The bank

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shall be constructed in a smooth kink-free line but may be neatly diverted around large trees or rocks whilst preserving fall.

- 10.5.3 Where the slope of the ground permits, catch banks shall be turned out away from the roadworks at frequent intervals in a manner which will minimise scour from surface flows. Turnouts shall not be directed into existing scours. Catchbanks shall be terminated at culvert inlet drains.
- 10.5.4 Unless otherwise specified, catch banks shall be a minimum of 1 m wide at the top and the top shall be a minimum of 0.3 m above the bottom of the toe of the drain formed by the bank. Batters shall be not steeper than 1:3.
- 10.5.5 Catch banks shall be trimmed and lightly compacted by wheel rolling.

10.6. Catch Drains

- 10.6.1 Catch drains shall be constructed where shown on the drawings or in situations where catch banks would not function.
- 10.6.2 Catch drains shall be between 1.5 m and 3.0 m away from the edge of a cutting unless the contour of the surface makes it necessary to keep it further away to preserve fall in the drain. Drains shall be constructed in a smooth kink-free line but may be neatly diverted around large trees or rocks whilst preserving fall.
- 10.6.3 Where hard rock occurs in the adjacent cutting, catch drains may be deleted with approval from the Superintendent. In such cases, alternative provision for leading surface water to culverts must be made.
- 10.6.4 Where the slope of the ground permits, water shall be turned out of catch drains at frequent intervals in a manner which will minimise scour from surface flows. Turnouts shall not be directed into existing scours.
- 10.6.5 Catch drains shall be constructed during early stages of earthworks on the high side of road cuttings.
- 10.6.6 Unless otherwise specified, they shall be cut not less than 0.3 m into solid ground and shall be a minimum of 0.3 m wide at the base. Side batters shall be not steeper than 1:3. Gradients shall be such to ensure a continuous positive slope in the required direction.
- 10.6.7 Excavated material from the drain, if not required for other embankment, shall be placed on the low side of the drain to form a bank. Such banks shall be trimmed and lightly compacted by wheel rolling.
- 10.6.8 Catch drains shall, where practical, be terminated at inlet/outlet drains to culverts. A diversion block of in-situ material shall be left in at the ends of catch drains for the purpose of dispersing water into culvert inlet/outlet drains (refer Clause 10.2).

10.7. Turnouts and Entrances to Private Properties

- 10.7.1 Turnouts and entrances to private properties shall be constructed in accordance with details shown on the drawings. The following work operations are included:-
- 10.7.2 Supply of all materials to specified requirements.
- 10.7.3 Constructing earthworks, drainage, pavement, surfacing, road furniture and landscaping as specified.
- 10.7.4 Convenient access to driveways, properties and buildings shall be provided and maintained at all times wherever possible. Where this is not achievable, alternative arrangements shall be negotiated by the Contractor with occupiers of affected properties.
- 10.7.5 Where an existing access is to be eliminated and replaced as part of the work, the existing access shall not be closed until replacement access facilities are open and usable.

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11. Supplying and Laying Geotextiles

11.1. Work Operations

11.1.1 Works operations for supplying and laying geotextiles includes:

- a. Supply geotextiles;
- b. Storage of geotextiles;
- c. Localised excavations (if required);
- d. Utilising/disposing of excavated material (if applicable);
- e. Placing, joining and fixing geotextiles.

11.2. Material Requirements

11.2.1 Geotextiles shall be proprietary products of non-woven manufacture consisting of randomly oriented continuous filaments bonded to form a fabric of relatively uniform thickness and density by processes of needle punching, heat or chemical bonding.

11.2.2 Filaments shall consist of polyester polyamide, polyolefines, polyvinyl or similar approved materials used either singly or in combination. They shall be rot-proof, chemically stable, unaffected within a pH range of 4 to 10 and have low water absorbency. The fabric shall be stabilised against the effects of ultra violet radiation and shall retain at least 80% of its strength rating (G Rating) after four weeks exposure to sunlight at the site.

11.2.3 Geotextiles shall be free of any flaws which may have an adverse effect on their physical or mechanical properties.

11.3. Applications

11.3.1 Unless otherwise specified, geotextiles shall have the following properties prior to exposure to sunlight:

Table 6 - Required Geotextile Properties

Application	Property		
	G Rating (Austroads)	Flow Rate under 100 mm head (Q ₁₀₀) (AS 3706.9-90)	Pore Size Dry Sieve (EOS) (AS 3706.7-90)
Subsoil Drains Bandage Covers to Culvert Joints	> 900	> 50 l/m ² /s	< 200 µm (granular soils) < 150 µm (cohesive soils)
Drainage Blankets	> 1350	> 50 l/m ² /s	< 200 µm (granular soils) < 150 µm (cohesive soils)
Under Gabions and Mattresses	> 2000	> 50 l/m ² /s	< 200 µm (granular soils) < 150 µm (cohesive soils)
Under/Within Embankments	> 2000 (on smooth even surfaces)	-	< 200 µm

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Application	Property		
	G Rating (Austroads)	Flow Rate under 100 mm head (Q ₁₀₀) (AS 3706.9-90)	Pore Size Dry Sieve (EOS) (AS 3706.7-90)
	> 2700 (on uneven surfaces)		
Under Rockfill Protection	> 2700	-	< 200 µm

11.4. Storage of Geotextiles

- 11.4.1 Geotextiles shall be stored under protective cover or wrapped with a waterproof and ultra violet protective sheeting.
- 11.4.2 Geotextiles shall not be stored directly on the ground or in any manner in which they may be affected by heat.
- 11.4.3 The method of storage shall also accord with any other recommendations by the manufacturer.

11.5. Construction

- 11.5.1 Where necessary, localised excavations shall be carried out to permit installation. Geotextiles shall be installed as shown on the Drawings.
- 11.5.2 Geotextiles shall be placed just ahead of associated advancing construction work. During construction, geotextiles shall be exposed to sunlight for the minimum possible time.
- 11.5.3 Joints in geotextiles shall be made by overlapping, sewing, or other methods recommended by the manufacturer. If the amount of overlap is not specified, it shall be a minimum of 500 mm. Sewing shall be carried out using an approved portable industrial sewing machine and an approved durable polyester or polyester/cotton blend sewing thread, the thread to have minimum breaking load of 20 kg.
- 11.5.4 No construction equipment shall stand or travel directly on the laid geotextile without approval. A minimum 200 mm of cover material shall be placed over geotextile prior to construction equipment travelling over the area concerned.
- 11.5.5 Any punctures in the geotextile shall be repaired to the satisfaction of the Superintendent.
- 11.5.6 Geotextiles used in trenches shall be placed so as to conform loosely to the shape of the trenches.
- 11.5.7 Where geotextiles are used to line subsoil drainage trenches, they shall fully envelop drainage material in the trench and be folded over the drainage material with a minimum 300 mm overlap at the top of the trench. Steel spikes at 3 m maximum spacing, or other approved methods, shall be used to secure the overlap.

12. Linings to Drains and Channels

12.1. Work Operations

- 12.1.1 Work operations include the following:
- a. Supply of construction materials;

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- b. Localised excavations;
- c. Utilising/disposing excavated material;
- d. Compacting material below surfaces to be lined;
- e. Constructing linings.

12.2. Construction

- 12.2.1 Where necessary, localised excavations shall be carried out to permit construction of linings in drains and channels. Where insitu material on or against which linings are to be constructed is other-than-rock, the material shall be compacted to not less than 97% RDD (Std) to a depth of 150 mm.
- 12.2.2 In-situ material shall be graded to provide a continuous fall to outlets and prevent lodgement of water.
- 12.2.3 Linings in drains and channels shall be constructed as shown on the Drawings. Concrete linings shall be constructed without foundation bedding.
- 12.2.4 Concrete work shall comply with the requirements specified in section 15.
- 12.2.5 Riprap protection shall be carried out as specified in section 29.
- 12.2.6 Stonepitching work shall comply with section 27.2.3.
- 12.2.7 Steel-wire mattress protection work shall comply with Clause 33 of Department of Main Roads Standard Specification MRS 11.03 "Drainage, Retaining Structures and Protective Treatments".

13. Side and mitre drains

13.1. Side drain construction

- 13.1.1 Side drains and mitre drains shall be constructed to the details and locations shown on the drawings. Work operations include:-
 - a. Supply of all construction materials;
 - b. Trenching and localised excavations (including saw cutting if specified);
 - c. Utilising/disposing excavated material;
 - d. Installing drainage pipes (including clean-outs, outlets, fittings and jointing operations);
 - e. Placing, jointing and fixing geotextiles and textile sleeves (where required);
 - f. Installing, jointing and fixing prefabricated strip filter drains (where required);
 - g. Placing and compacting trench backfill material;
 - h. Restoration of surface of trench (where required);
 - i. Constructing outlets to manholes, gullies and outlet headwalls;

13.2. Material Requirements

- 13.2.1 Unless otherwise specified, subsoil drainage pipes shall be perforated corrugated P.V.C. or polythene pipes as specified in the drawings. The minimum size of pipe shall be 100 mm diameter.

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- 13.2.2 Clean out pipes shall be P.V.C. as detailed in the drawings and shall include all necessary fittings.
- 13.2.3 Geotextiles and textile sleeves shall be proprietary products and shall comply with the requirements specified in section 11.
- 13.2.4 Where specified, Strip Filter Drains shall be proprietary products comprising a plastic core of nominal thickness not less than 40 mm, designed to allow the drainage of water along the drain and encased by a non-woven geotextile which complies with the requirements specified in Clause 12.
- 13.2.5 The plastic core shall permit the passage of high water flows, and shall have a crush strength not less than 100 kPa.
- 13.2.6 Unless otherwise specified or indicated on the drawings, trench backfill material shall be free-draining crushed or granular material which conforms to the following grading requirements.

Table 7 - Trench Backfill Material Grading

AS Sieve Size (mm)	Percentage Passing by Mass
19.0	100
9.5	100
4.75	90 – 100
1.18	45 – 80
0.30	10 – 30
0.15	0 – 10
0.075	0 - 1

- 13.2.7 In the case of a side drain where drainage material is fully encased by geofabric, the grading of the drainage material shall be such that 100% passes the 19.0 mm AS Sieve.

13.3. Storage of Materials

- 13.3.1 Storage and handling of geotextiles, textile sleeves and strip filter drains shall be in accordance with the manufacturer's recommendations. The drains shall not be exposed to heat or direct sunlight to the extent that their physical and/or mechanical properties are diminished.
- 13.3.2 Materials shall not be stored directly on the ground. Storage arrangements shall protect the materials from damage and soiling.

13.4. Construction

- 13.4.1 Trenches shall be excavated to the dimensions shown in the drawings. The bottom of the trench shall be trimmed to provide a minimum fall of 1 in 250 towards the outlet for pipe type drains and not less than 1 in 150 for strip filter type drains.
- 13.4.2 Where subsoil drains are installed in existing pavements, the edge of the trench shall be neatly saw cut prior to excavation to at least the depth of the hard surfacing.
- 13.4.3 Unless otherwise specified, clean-outs shall be located at the heads of all subsoil drains and at subsequent spacings not exceeding 60 m for pipe type drains and 50 m for strip filter type drains.
- 13.4.4 Installation of filter fabric shall employ the operations specified in section 11.

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- 13.4.5 Where an outlet, inlet, or clean-out pipe passes through the filter fabric, a separate piece of fabric of sufficient size shall be wrapped around the pipe and flared against the main fabric to provide an effective seal.
- 13.4.6 Subsoil drains shall be joined in accordance with the manufacturer's recommendations. Clean-out pipes shall be joined to the subsoil drains using oblique tee connections.
- 13.4.7 Trench backfill material used where a textile sleeved drain or a strip filter drain is employed shall be damp when placed in the trench. The material shall be placed in layers not exceeding 200 mm loose thickness and shall be compacted to not less than 95% RDD (Std). Trench backfill material used where a geotextile trench surround is employed shall be compacted to achieve effective mechanical interlock between particles.
- 13.4.8 Where subsoil drains are constructed under the pavement or shoulders, they shall extend to the underside of the lowest pavement layer, unless specified otherwise on the drawings.
- 13.4.9 Elsewhere, the filter material shall extend to within 150 mm of the ground surface and the top 150 mm of the trench backfilled with an impervious material which shall be compacted to not less than 95% RDD (Std).
- 13.4.10 Where subsoil drains are constructed in existing pavements, the pavement shall be restored to a similar depth and standard as the adjacent pavement.
- 13.4.11 Clean-outs and outlets shall be constructed to the details shown on the drawings.
- 13.4.12 Where underground drainage exists or is being constructed, side drain connections shall be constructed into manholes and/or gullies as shown on the drawings or as directed by the Superintendent. Where there is no underground drainage a concrete headwall shall be provided at the outlet end of the side drain pipe. Unless otherwise specified, the headwall shall be 150 mm thick and shall extend for a minimum of 150 mm on all sides of the pipe. Where the outlet is through a batter, the surface of the headwall shall conform to the batter slope.
- 13.4.13 Concrete work shall employ the operations specified in section 15.
- 13.4.14 Grouted stone pitching work shall employ the operations specified in section 27.4.

14. Existing Underground Services

- 14.1.1 Notwithstanding that existing services may be shown on the Drawings the Contractor shall liaise directly with the appropriate authorities and shall ascertain the position of all services and shall be responsible for the full cost of repairs for any damage thereto caused by the Contractor's operations.
- 14.1.2 The Contractor shall be responsible for accurately determining the location and level of all underground services within and adjacent to the works area.
- 14.1.3 The drawings do not necessarily show the precise location and level of all underground services. Information shown on the drawings is provided only for guidance to the Contractor and neither the Principal nor the Superintendent represents that this information is necessarily complete or accurate.
- 14.1.4 The Contractor shall locate all services and other equipment belonging to any and all Public Utilities Providers and use due care when constructing adjacent to the services and other equipment to protect such services from damage.
- 14.1.5 This shall include hand excavation to expose such services or equipment where they cross the line of or fall within the limits of trench excavation and alike. Any cost for repair of damage to services or other equipment caused by the Contractor shall be borne entirely by the Contractor.

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- 14.1.6 Where the Contractor locates a service that is not shown on the plans or is shown in a different location to that shown on the plans, the Contractor shall immediately advise the Superintendent. The Superintendent shall assess the need for any design alterations and/or subsequent Contract costs.
- 14.1.7 No additional payment will be made for completed work that needs to be altered as a result of a service not being located prior to construction proceeding.
- 14.1.8 Before excavating adjacent to any existing power poles, the Contractor shall assess whether or not the excavation operation will disturb the pole's foundations. The Contractor shall be responsible for the provision of any necessary counter measures to ensure that his operations will not reduce the capacity of any pole to support its loads.
- 14.1.9 The Contractor shall arrange for Energex to support any pole where adjacent excavation may or will affect pole stability.
- 14.1.10 The Contractor shall make all machinery operators aware of the presence of live overhead wires and shall make arrangements if necessary for the protection of these wires.
- 14.1.11 In the case of any damage occurring to buried or overhead services, the matter must be immediately reported to the Superintendent, Plant Supervisor and in the case of third party owned services, the Company concerned.

15. General Concrete Work

- 15.1.1 Concrete work shall conform to the requirements of the Job Specification and the *Specification for Building and Structural Works (Pr9903)*.

16. Concrete Kerb and Channel

16.1. Kerb construction

- 16.1.1 This specification applies to construction of cast-in-situ concrete kerb, channel, inverts, kerb and channel, kerb crossings and transition sections between these components. It also applies to installation of precast kerb and/or channel blocks. It does not apply to kerbs cast integrally with structures.
- 16.1.2 Throughout this specification the term "kerb and channel" shall be taken to include kerb, channel, inverts, kerb crossings and transition sections unless otherwise indicated.

16.2. Material Requirements

- 16.2.1 Concrete shall be N32 with a maximum aggregate size of 10 mm.
- 16.2.2 For work by extrusion machine, the slump shall be the maximum that will allow extruded concrete to maintain its shape without support immediately after pouring.
- 16.2.3 Compressible packing shall be bitumen impregnated fibre board or other approved packing.
- 16.2.4 Precast concrete kerb and/or channel blocks shall be proprietary products.
- 16.2.5 Kerb adaptors for household roof water drains shall be approved proprietary products.

16.3. Method

- 16.3.1 For work of unbroken length in excess of 20 m, construction shall be only by extrusion machine. For unbroken lengths of 20 m or less, construction may be by extrusion machine or stationary formwork.

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- 16.3.2 For the purposes of defining unbroken lengths, incidental items such as kerb crossings and kerb ramps do not constitute a break in length.
- 16.3.3 Precast concrete kerb and/or channel blocks shall be used where specified or as approved by the Superintendent.

16.4. Excavation and Foundation Requirements

- 16.4.1 Where necessary, localised excavation shall be carried out to permit construction of kerb and channel. The bottom of such excavations shall be compacted to not less than 98% RDD (Std) to a depth of 150 mm below the base of excavations.
- 16.4.2 Where it is necessary to excavate existing pavement to construct kerb and channel, the limit of excavation shall be 500 mm in front of the kerb and channel unless otherwise approved. Prior to such excavation, any existing asphaltic concrete, bitumen or concrete surfacing shall be neatly saw cut to a depth at least equal to the thickness of the surfacing.
- 16.4.3 All kerb and channel shall be constructed on a graded crushed rock foundation compacted to not less than 98% RDD (Std).
- 16.4.4 Where kerb and channel is constructed in association with pavement, foundation material shall be the same type as the pavement material. Unless otherwise specified, foundation material in other cases shall be Subtype 2.3 Grading B, C or D in accordance with Department of Transport and Main Roads Standard Specification MRTS05 Unbound Pavements.
- 16.4.5 The foundation shall be not less than 75 mm thick or shall extend to subgrade level, whichever gives the greater thickness of foundation.
- 16.4.6 Width of the foundation shall be not less than 500 mm or the width of the extrusion machine (or mould) plus 300 mm.
- 16.4.7 The foundation shall be trimmed and compacted to provide a smooth and even surface.
- 16.4.8 Immediately before placement of concrete, the foundation shall be watered to moisten the foundation material but not to the extent that free water remains on the surface.

16.5. Construction

- 16.5.1 When constructed on existing sealed pavement, the depth of kerb to medians and traffic islands shall be 130 mm unless otherwise specified. Where pavement construction is also involved, unless otherwise specified, such kerb shall be of depth 130 mm plus 50 mm or 130 mm plus asphaltic concrete wearing course thickness, whichever is the greater.
- 16.5.2 Concrete work shall be carried out in accordance with section 15. Exposed surfaces shall have a steel trowelled finish to a smooth dense surface free of voids and cracks.
- 16.5.3 Joins to kerb and channel in which concrete has hardened (whether constructed under this contract or not) shall be prepared by cutting the two surfaces to be connected square and vertical.
- 16.5.4 Expansion joints shall be made at regular intervals not exceeding 20 m. The joints shall be made by installing 6 mm maximum thickness compressible packing in the full cross section of the kerb and channel. Where relevant, joints shall be located to line up with expansion joints in adjacent structures.
- 16.5.5 Contraction joints between expansion joints shall be made at regular intervals not exceeding 5 m. The joints shall be made by forming grooves 40 mm deep and not more than 6 mm wide in all exposed surfaces of the kerb and channel. All grooves shall be normal to the top surface and square to the alignment of the kerb and channel.
- 16.5.6 All joints shall be formed within 30 minutes of concrete pouring.

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- 16.5.7 Crossings shall be provided in accordance with details shown on Standard Drawings. The edges of all concrete shall be neatly arised.
- 16.5.8 Where kerb and channel is constructed by an extrusion process, the extrusion machine shall be fitted with a tamper and an automatic control which allows adjustment of the position of the forming mould while the machine is in operation.
- 16.5.9 The horizontal and vertical alignments of kerb and channel shall be controlled by means of a sensor working to a control line. The finished kerb and channel shall be well compacted and shall have exposed surfaces free from voids and honeycombing.
- 16.5.10 For kerb and channel pours using stationary formwork, both the kerb and the channel must be poured simultaneously. Pouring of the kerb and channel at different times will not be permitted.
- 16.5.11 Forms shall be securely fixed to the specified line and level using a combination of bracing, staking, spreaders and clamps to ensure no movement of forms occurs during placement and compaction of concrete. Forms shall be mortar tight and clean before placing concrete.
- 16.5.12 The kerb face form may be removed to allow finishing to proceed while the concrete is green. Unformed surfaces shall be float finished without rendering.
- 16.5.13 Precast concrete kerb/channel blocks shall not be utilised unless agreed in writing by the Superintendent or required by the Contract documentation. Where approval to use precast sections is received, the requirements of this clause shall apply.
- 16.5.14 Kerb, blocks and channel blocks shall be laid on bedding of minimum thickness 50 mm. Bedding material shall comply with section 9.17 and shall be compacted to the relevant standard specified below:-
- a. Cohesive material – to not less than 95% RDD (Std);
 - b. Non-cohesive material – to a density index of not less than 70.
- 16.5.15 Where kerb blocks and channel blocks are to be fixed to the surface of asphalt or concrete, epoxy adhesion agent shall be used. The epoxy adhesion agent shall be spread evenly over the entire surfaces to be in contact.
- 16.5.16 Epoxy adhesion agent shall be a proprietary product.
- 16.5.17 In addition to the requirements of section 24, the alignment and top surface of adjoining blocks shall vary by not more than 3 mm abrupt.
- 16.5.18 Blocks installed on horizontal radii 12 m or less shall be precast to the required radii or shall be straight blocks cut to ensure the jointing requirements specified herein are complied with. Where blocks are precast to radii, each shall be clearly marked to indicate its radius.
- 16.5.19 Kerb blocks and channel blocks shall have watertight cement mortar joints. Cement mortar shall be used within 1 hour of mixing and shall not be retempered.
- 16.5.20 Joints shall be finished to give smooth surfaces uniform with the surfaces of the blocks. The thickness of joints shall not be less than 7 mm or greater than 13 mm. Exposed surfaces of blocks shall be cleaned of cement mortar coating as soon as possible after the joint mortar has hardened. No roadworks operations shall be carried out adjacent to the kerb and channel work until 48 hours after its construction.

16.6. Tolerances

- 16.6.1 The horizontal and vertical alignments of kerb and channel shall not vary from those specified by more than ± 10 mm. Notwithstanding the above tolerances, the alignments of the kerb and channel shall have smooth lines and kerb and channel shall be free draining (refer Clause 24.9).
- 16.6.2 Tolerance on cross sectional dimensions shall be ± 5 mm.

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16.6.3 Irregularities along any surface of kerb and channel shall not vary by more than 5 mm from the bottom of a 3 m straight edge, due allowance being made for specified grade changes and curves.

16.7. Backfilling

16.7.1 Unless otherwise approved, backfill shall be placed and compacted no more than 3 days after pouring concrete. Extreme care should be taken not to damage concrete surfaces during backfilling operations. Desirably, concrete should be cured for seven days before any other roadworks operations are carried out adjacent to concrete surfaces.

16.7.2 Where kerb and channel has been constructed against an existing pavement, the pavement in front of the kerb and channel shall be filled and compacted with Sub-Type 2.1 pavement gravel and surfaced with a minimum 50 mm DG14 asphalt in accordance with Department of Transport and Main Roads Standard Specifications MRTS05 and MRTS30 respectively, unless otherwise specified.

16.8. Water Test

16.8.1 The Contractor shall carry out a water test on channels where the longitudinal grade is less than 1%. Water shall be discharged into the channel to check uniformity of flow along the channel. After the flow has ceased, water shall not pond to a depth of more than 5 mm in any section of channel. This test shall be carried out as soon as possible after the concrete in the channel has hardened.

17. Concrete Gullies, Manholes and Chambers

17.1.1 Concrete gullies, manholes and chambers are to be designed and constructed in accordance with the SEQ Water Supply & Sewerage Design & Construction Code (SEQ WS&S D&C Code).

18. Precast Reinforced Concrete Pipes, Box Culverts and Fibre Reinforced Concrete Pipes

18.1. Work Operations

18.1.1 Work operations for precast Reinforced Concrete Pipes, Box Culverts and Fibre Reinforced Concrete Pipes include:

- a. Supply of all construction materials;
- b. Delivery, unloading and stacking of materials on site;
- c. Clearing of line of drain and/or saw-cutting of road surfacing (if required);
- d. Localised excavations including loading and hauling of excavated material;
- e. Utilising/disposing of excavated material;
- f. Compacting material at bottom of trenches;
- g. Trench maintenance and shoring in accordance with statutory requirements and safe work practice;
- h. Placing and compacting foundation bedding material;
- i. Laying and jointing pipe and culvert components;
- j. Cutting pipe and culvert components as required;

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- k. Installing concrete end blocks, infill material and lean mix to box culverts as specified;
- l. Backfilling of haunch, overlay and backfill/embankment zones;
- m. Restoration of surfaces as specified;
- n. The terms foundation bedding, haunch zone, side zone and overlay zone refer to the various.

18.2. Material Requirements

- 18.2.1 Precast concrete pipes shall comply with AS 4058. The size and class of pipe used shall be as shown on the drawings. Unless otherwise shown, all joints shall be flush joints. Sand bands or other approved external sealing devices shall be proprietary products to suit the pipes used.
- 18.2.2 Fibre reinforced pipes shall comply with AS 4139. The size and class of pipe shall be as shown on the drawings.
- 18.2.3 Precast concrete culverts shall comply with the Department of Main Roads Standard Specification MRS 11.24 - Manufacture of Precast Concrete Culverts except that where the internal width or height of a culvert exceeds 3.6 m or the depth of fill over a culvert exceeds 1.5 m, the culvert components shall comply with other requirements specified in the Contract Documents or by the Principal.
- 18.2.4 Foundation bedding and/or haunch zone material shall be gravel, loam, sand or mixtures thereof.
- 18.2.5 It shall be free from soluble salts, organic matter, clay and other deleterious matter and, unless otherwise specified, shall comply with the following grading limits:-

Table 8 - Grading for Precast Concrete Pipes and Culverts Bedding

AS Sieve Size (mm)	% Passing By Mass
19.0	100
2.36	50 – 100
0.60	20 – 90
0.30	10 – 60
0.15	0 – 25
0.075	0 - 10

- 18.2.6 Foundation bedding and/or haunch zone material shall have a maximum linear shrinkage of 6.
- 18.2.7 Geotextiles shall comply with section 11.
- 18.2.8 Cement mortar shall consist of one part cement to three parts of clean sharp sand mixed with only sufficient water to obtain the required consistency. It shall be used within 30 minutes of mixing and re-tempering shall not be permitted.
- 18.2.9 Concrete used in culvert end blocks shall be N20 with 10 mm maximum aggregate size.
- 18.2.10 Concrete infill between adjacent walls of multiple cell culverts shall be 1 part Type GP cement to 10 parts aggregate (loose volume). Maximum aggregate size shall be 10 mm.
- 18.2.11 Lean mix concrete shall have 1 part of Type GP cement to 10 parts aggregate, loose volume.

18.3. Tolerances

- 18.3.1 Pipe and culvert components shall be installed at the locations specified.

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- 18.3.2 Horizontal and vertical alignments shall not exhibit noticeable irregularities.
- 18.3.3 Pipes and culverts shall have a positive drainage slope along the whole of their length and, where relevant, shall join neatly to existing structures.
- 18.3.4 Unless otherwise specified, horizontal alignments of pipes and culverts shall not vary from those specified by more than + 100 mm.
- 18.3.5 Invert levels of pipes and culverts shall not vary from those specified by more than + 10 mm, provided that in no case shall grades depart from those specified by more than 1% (absolute).
- 18.3.6 Notwithstanding these tolerances, the minimum cover over pipes and culverts shall not be less than that shown on the drawings or the following dimensions if not shown on drawings:
 - a. 300 mm for concrete pipes and 400 mm for fibre reinforced concrete pipes;
 - b. 100 mm for concrete box culverts.

18.4. Construction

- 18.4.1 This specification applies to Type H2 support for precast reinforced concrete pipes in accordance with AS 3725. It is also valid for Types U and H1 support. For other types of support (H3, HS1, HS2, HS3) refer to job specification or specifications contained in the Concrete Pipe Selection and Installation Manual, Concrete Pipe Association of Australia.
- 18.4.2 Construction materials shall be stored neatly on site so as not to create a hazard. Particular attention shall be paid to:
 - a. Erosion and sediment control of soil and gravel stockpiles;
 - b. ensuring pipes, culverts and gravel materials do not cause restrictions to access or sight distance for vehicles, cyclists or pedestrians;
 - c. Overhead electricity or communication cables are not damaged during unloading or tipping operations.
- 18.4.3 Where necessary, the line of the drain shall be cleared of any stumps, roots, etc. or any man-made obstacles prior to excavation. Cleared materials shall be disposed of in accordance with section 7.6. Where the drain is to be installed by trenching through existing roads, bitumen, asphalt or concrete surfacing shall be neatly saw cut wider than the proposed trench width to a depth at least equal to the depth of the existing surfacing.
- 18.4.4 The Contractor shall be solely responsible for the maintenance and shoring of trenches and will be liable for any damage which may be caused to any structure, water pipes, conduits, etc. through the collapse of trenches or shoring. The Contractor's attention is drawn to the trenching provisions of the Workplace Health and Safety Act.
- 18.4.5 The base of the excavation shall be trimmed to the specified line and levels and shall be graded to provide a continuous fall to the outlet end of the drain.
- 18.4.6 Where in-situ material at the bottom of an excavation is other than rock, the material shall be compacted to not less than 95% RDD (Std) to a depth 150 mm below the bottom of the excavation.
- 18.4.7 Should the excavation to the required foundation at the bottom of the bed level reveal material which in the opinion of the Superintendent is unsuitable, the trench shall be over-excavated to a depth required to remove the unsuitable material and refilled with compacted material conforming to the requirements for the bedding zone (refer Clause 26.2.2). Any additional excavation and backfilling ordered in writing by the Superintendent shall be paid for as a variation.
- 18.4.8 Excess excavated material from trenching operations shall be disposed of in accordance with section 7.6.

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- 18.4.9 The trench width for pipe installation in both trench condition and embankment condition shall be as shown on the drawings.
- 18.4.10 For an embankment installation, the positive projection of the pipe shall be 0.7 times the pipe outside diameter, or less. Where the projection of the pipe above natural ground surface is greater than 0.7 times pipe outside diameter, it will be necessary to construct the embankment to a height above top of bed level at least equal to 0.3 times pipe outside diameter, prior to laying the pipe, and to a width equal to at least of 1.0 times pipe nominal diameter on each side of the trench wall.
- 18.4.11 The embankment shall be constructed in accordance with the requirements of section 9.15. A trench shall then be cut through the constructed embankment.
- 18.4.12 The required trench for the installation, to the width and depth shown on the drawings, shall be excavated centrally through the above compacted select fill material.
- 18.4.13 Excavation shall be to line and level shown on the drawings to provide for a pipe bedding zone for the trench width and thickness of:
- 100 mm for pipe nominal diameter \leq 1500 mm;
 - 150 mm for pipe nominal diameter $>$ 1500 mm.
- 18.4.14 The widths of excavations for culverts and end structures shall be the minimum necessary for their construction and placement of fills/backfills against them, provided that such widths shall not exceed those shown on the Standard Drawings.
- 18.4.15 Foundation bedding shall provide continuous even support to pipe and culvert components and shall be constructed to the minimum widths and thicknesses shown on the drawings.
- 18.4.16 Foundation bedding zone material shall be compacted to the following standards:-
- Cohesive material – to not less than 95% RDD (Std);
 - Non-cohesive material – to a density index of not less than 60.
- 18.4.17 Sand shall be compacted by flooding and the use of immersion vibrators or by such other means as will achieve the specified compaction standard.
- 18.4.18 For pipes with sockets protruding beyond the barrel outside surface, chases shall be dug into the bed and foundation if necessary, in the appropriate positions, so that each pipe is supported along the full length of the barrel and the socket is not subjected to point loading.
- 18.4.19 Where possible, laying shall commence at the downstream end of the line and work progressively upstream.
- 18.4.20 The ends of components shall be free of any foreign matter at time of jointing.
- 18.4.21 Butt and flush joints pipe and culvert components shall abut one another, and a bandage cover shall be employed on the outer surfaces to seal the joints. The joint gap in flush joint pipes shall conform to the manufacturer's specification.
- 18.4.22 Bandage covers shall comprise:
- 1 layer of nonwoven fabric; or
 - Approved plastic/natural rubber bands.
- 18.4.23 Fabric covers shall have a width sufficient to overlap adjacent components not less than 50 mm. Fabric covers shall not be wrinkled, and shall adhere to the outer surfaces of the adjacent components. The ends of fabric covers shall be secured in accordance with the manufacturer's recommendations.
- 18.4.24 Plastic/natural rubber covers shall be installed in accordance with manufacturer's recommendations.

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- 18.4.25 Joints in reinforced concrete pipes shall be filled with cement mortar to give a neat smooth surface uniform with the surface of the pipe. Surfaces to receive mortar shall be kept wet until mortar is placed.
- 18.4.26 Where the word "TOP" is marked on pipes or where lifting holes are provided, the pipes shall be laid with the word/hole uppermost. Lifting holes shall be plugged or otherwise closed off in an approved manner after the pipe is installed.
- 18.4.27 Spigot and socket joints shall be made using the appropriate rubber rings and pipes laid with the socket end upstream.
- 18.4.28 Reinforced concrete box culvert components shall be installed in accordance with details shown on the drawings.
- 18.4.29 Where precast concrete crown or slab units are to be laid in the trench as the base of the culvert, they shall be placed directly on not less than 75 mm foundation bedding material in other-than-rock and 150 mm in rock. Bedding shall be compacted in accordance with Clause 26.4.7.
- 18.4.30 Where precast concrete crown units are installed on a cast-insitu concrete base slab or where precast crown units and precast concrete slabs are joined, they shall be seated using continuous cement mortar pads.
- 18.4.31 Where precast concrete slabs are used as the base of the culvert, an extra slab shall be laid in the line so that each crown is seated half on one slab and half on the next.
- 18.4.32 Lifting lugs shall be cut off close to the unit. The exposed ends of the embedded portions of the lug shall be given two coats of a tar epoxy paint.
- 18.4.33 Where spanning slabs are installed, locating dowels, as specified, shall be installed in the tops of the units and the spanning slabs seated onto adjacent units, all as shown in the Drawings.
- 18.4.34 All surplus mortar shall be removed from the installation before it hardens.
- 18.4.35 In multiple cell culverts, gaps between lines of installed cells shall be a minimum of 40 mm and filled as follows:-
- 18.4.36 Concrete end blocks extending not less than 250 mm along the gap shall be constructed to full height at each end of the culvert. Vertical steel dowels shall be installed in the end blocks, as specified.
- 18.4.37 After the end blocks have been cured, the remaining gaps between the blocks shall be dry packed with concrete infill material.
- 18.4.38 Where spanning slabs are installed, the space between slabs shall be filled with lean mix concrete. 24 hours shall elapse prior to the placement of any other fill material over the culvert concerned.
- 18.4.39 Precast pipe and culvert components shall be cut to length and shape where necessary to suit manholes, chambers and gullies.
- 18.4.40 Cutting operations shall provide neat end surfaces.
- 18.4.41 The cut surfaces of reinforced concrete pipe and culvert components shall be given two coats of tar epoxy paint or covered with a minimum of 20 mm cement mortar.
- 18.4.42 Backfilling of reinforced concrete box culvert structures shall comply with the requirements of section 16.7.
- 18.4.43 Backfilling of pipes shall be carried out in three stages identified as (a) Haunch Zones, (b) Overlay Zone and (c) Backfill or Embankment fill.

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- 18.4.44 The Haunch Zone shall extend from the top of the Bedding Zone up to 0.3 times the pipe outside diameter and shall be select fill material complying with the requirements of section 32.3.2.
- 18.4.45 The material shall be placed over the full width of the trench either in layers not exceeding 150 mm compacted thickness and compacted by conventional methods or compacted in one operation by saturation and vibration to achieve a minimum Density Index (DI) of 60 for non-cohesive material or 95% RDD (Std) for cohesive materials.
- 18.4.46 The Overlay Zone shall extend from the top of the Haunch Zone up to 300 mm above the top of the pipe and around the pipe measured radially from any point and shall be fill material consisting of material from the excavation or elsewhere. It shall not contain any stones larger than 150 mm, nor more than 20% with a size between 75 mm and 150 mm.
- 18.4.47 Backfill or Embankment fill shall be the remainder of the backfilling and shall consist of any available material up to finished levels as shown on the drawings.
- 18.4.48 Overlay or Backfill material placed within 300 mm of the subgrade shall be compacted to not less than 97% RDD (Std). All other overlay/backfill material shall be compacted to not less than 95% RDD (Std).
- 18.4.49 Where backfills extend to the subgrade, the top surface shall be finished to subgrade shape.
- 18.4.50 Where trenches are shored with sheeted walls, the following requirements shall apply to removal of shoring:
- No struts, waling or other supports shall be removed until the top of compacted backfilling has reached the level of these supports.
 - No wall sheeting is to be totally removed from the trench until the level of the compacted backfill is within 1500 mm of the surface.
 - No wall sheeting is to be removed, in dewatered trenches, until the level in water table between natural ground and backfill material is less than 500 mm.
- 18.4.51 Wall sheeting is to be withdrawn or removed in such a manner that the pipe and compacted bed and haunch support are not disturbed during such withdrawal or removal.
- 18.4.52 Where applicable, and unless otherwise specified, trench surfaces shall be reinstated to a standard to match the existing surface prior to the works in accordance with relevant specifications or good industry practice.

19. End Structures to Culverts

19.1. Work operations

- 19.1.1 End structures to reinforced concrete pipes and box culverts shall be constructed using the methods specified on the drawings and schedules and shall include the following work operations:-
- Supply of construction materials;
 - Localised excavations;
 - Utilising/disposing excavated material;
 - Constructing end structures;
 - Constructing aprons;
 - Finishing and curing concrete.

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19.2. Material Requirements

19.2.1 Steel Reinforcement shall be Grade 400Y unless otherwise specified.

19.3. Construction

- 19.3.1 Where standard drawings show details of concrete end structures, stonepitched or other forms of end structures specified shall be constructed generally to the same shapes, with no dimensions less than those specified.
- 19.3.2 Where necessary, localised excavations shall be carried out to allow construction of end structures.
- 19.3.3 Concrete work shall comply with the requirements specified in Clause 11.
- 19.3.4 Stonepitching shall employ the construction operations specified in Clause 13.
- 19.3.5 Unless otherwise specified, end walls shall be constructed parallel to the road centreline or, where pipes are not associated with roadworks, at right angles to the pipe centreline.
- 19.3.6 Endwalls, wingwalls and concrete aprons shall be constructed without a foundation bedding.
- 19.3.7 Where specified, endwalls and wingwalls shall be formed monolithically.
- 19.3.8 Construction of endwalls and wingwalls shall include the construction of integral cut-off walls, where specified.
- 19.3.9 Construction of aprons shall include construction of integral cut-off walls, construction of integral energy dissipaters if specified, and installation of dowel bars.
- 19.3.10 Stonepitched endwalls and wingwalls shall be capped with a cement mortar coping not less than 25 mm thick. The coping shall be trowelled to provide smooth, even surfaces with neat edges.

20. Precast Concrete End Structures to Culverts

20.1. Work Operations

- 20.1.1 Work operations for precast concrete end structures to culverts shall include at least:
- Supply of construction materials;
 - Localised excavations;
 - Utilising/disposing excavated material;
 - Placing and compacting foundation bedding material;
 - Placing and jointing end structures.

20.2. Material Requirements

20.2.1 Precast concrete end structures shall be proprietary products.

20.3. Construction

- 20.3.1 End structures shall be installed as specified in the Standard Drawings.
- 20.3.2 Where necessary, localised excavations shall be carried out to allow installation of precast concrete end structures to culverts.
- 20.3.3 End structures shall be laid on a foundation bedding which provides continuous even support. Foundation bedding material shall be compacted to the relevant standard specified below:-

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- a. Cohesive material – to not less than 95% RDD (Std);
 - b. Non-cohesive material – to a density index of not less than 70.
- 20.3.4 Joints between end structures and culverts shall be filled with cement mortar. The joint areas shall be thoroughly cleaned and wetted just prior to filling. All joints shall be finished smooth and uniform with the surfaces of the end structures.
- 20.3.5 Any holes and recesses provided in end structures to assist installation shall be neatly plugged or filled with cement mortar.
- 20.3.6 Mortared joints and filled holes and recesses shall be cured for a period of not less than 48 hours. Fill/backfill operations against end structures shall not be carried out during this curing period.

21. Concrete Margins, Batters and Aprons

21.1. Work operations

- 21.1.1 Concrete margins, batters and aprons shall be constructed to details shown on the drawings. They shall include the following work operations:
- a. Supply of all construction materials;
 - b. Localised excavations;
 - c. Utilising/disposing excavated material;
 - d. Compacting material below surfaces covered by margins, batters and aprons;
 - e. Constructing margins, batters and aprons (including cut-off walls);
 - f. Installing steel sleeves (if specified);
 - g. Providing weepholes (if specified).

21.2. Material Requirements

- 21.2.1 Concrete, reinforcing steel and steel sleeves shall comply with the requirements shown on the drawings.

21.3. Construction

- 21.3.1 Where necessary, localised excavations shall be carried out to permit construction of concrete margins, batters and aprons, and associated cut-off walls. Where the in-situ material is other than rock, the material shall be compacted to not less than 97% RDD (Std) to a depth of 150 mm.
- 21.3.2 Concrete margins, batters and aprons shall be constructed without foundation bedding.
- 21.3.3 Concrete work shall comply with the requirements specified in section 15.

22. Cast In situ Concrete Culvert Components

22.1. Work operations

- 22.1.1 In-situ cast concrete culvert structures shall be constructed to the details shown on the drawings and shall include the following work operations:-
- a. Supply of all construction materials;

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- b. Localised clearing and excavations;
- c. Utilising/disposing of excavated material;
- d. Preparation and compaction of foundations;
- e. Fabricating and placing steel reinforcement;
- f. Placing and compacting concrete;
- g. Supplying and placing embedded dowel bars as specified;
- h. Finishing and curing concrete;
- i. Backfilling of completed structure, as specified.

22.2. Material Requirements

22.2.1 Materials shall be as specified on the drawings.

22.3. Construction

22.3.1 Where necessary, localised excavations shall be carried out to permit construction of cast-in-situ culvert components. Clearing and grubbing where required shall comply with the requirements of section 7. Excavation shall comply with section 9.12.

22.3.2 Where the foundation is rocky or soft, the Superintendent may direct that the ground under the walls and/or floor be excavated to a depth greater than that shown in the drawings and the trench filled with approved selected gravel backfill as specified in section 9.17. Any additional excavation and backfilling ordered in writing by the Superintendent, shall be paid for as a variation.

22.3.3 Unless otherwise specified, cast-in-situ concrete bases, footings, infill floors, abutments, piers and "unitary" box culverts shall be constructed without a foundation bedding.

22.3.4 Concrete work shall comply with the requirements of section 16.

22.3.5 Construction of bases, footings, infill floors, abutments and piers, and "unitary" box culverts shall include construction of nibs and integral cut-off walls.

22.3.6 Construction of bases and footings shall include installation of embedded dowel bars for abutments and piers where specified. Construction of abutments and piers shall include installation of embedded dowel bars for slab decks and kerbs. Slab decks and kerbs shall be constructed monolithically.

22.3.7 Weep holes shall be provided as shown in the drawings.

22.3.8 Backfilling shall be carried out as specified in Clause 9.8.

23. Concrete End Plugs for Existing Pipes or Culverts

23.1. Work operations

23.1.1 Concrete end plugs shall be constructed where specified to seal off existing pipes or culverts which are taken out of service but which are not specified to be removed or demolished. The following work operations are included:

- a. Supply of construction materials;
- b. Placing and compacting concrete;
- c. Finishing and curing concrete.

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23.2. Construction

- 23.2.1 Concrete work shall comply with the requirements specified in section 16
- 23.2.2 The thickness of the plugs shall be not less than 500 mm. Plugs shall completely seal the ends of the pipes or culverts.

24. Temporary Seals to Pipes or Culverts

24.1. Work operations

- 24.1.1 Temporary seals shall be constructed to pipes and culverts where shown on the drawings. Work operations shall include:
 - a. Supply of all construction materials;
 - b. Installation of timber seals.

24.2. Materials

- 24.2.1 Timber seals shall comprise 25 mm thick hardwood boards.

24.3. Construction

- 24.3.1 Hardwood boards shall be cleated together to form a solid seal to the satisfaction of the Superintendent.

25. Removal/Demolition of Concrete Kerbs and Channels and Concrete Slabs

25.1. Work operations

- 25.1.1 Concrete kerbs, channels, kerb and channel including kerb crossings and concrete slabs shall be removed/demolished as shown on the drawings and shall include the following work operations:
 - a. Localised excavations;
 - b. Removing/demolishing concrete kerbs, channels and slabs;
 - c. Utilising/disposing of excavated and removed/demolished material;
 - d. Backfilling/finishing resulting excavations.

25.2. Construction

- 25.2.1 Care shall be taken to avoid damage to adjacent facilities.
- 25.2.2 Where adjacent road or footpath hard surfacing (e.g. bitumen, asphalt, concrete, etc.) is to be left in place as the final surface finish, a saw-cut to the full depth of the adjacent surfacing shall be made along the length of the section to be removed and the excavated material removed carefully to form a neat, clean, vertical face.
- 25.2.3 Where only part of a section of concrete kerb, channel or slab is to be removed/demolished, the joint to the existing section shall be saw-cut full depth to provide a neat, clean, vertical face.

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25.2.4 Resulting excavations shall be backfilled as specified, or where not specifically stated, in accordance with the requirements of section 9.16 using selected loam material as specified in Section 9.17.1

26. Removal/Demolition of Gullies, Manholes and Chambers

26.1. Work operations

26.1.1 Gullies, manholes and chambers shall be removed/demolished as specified and shall include the following work operations:

- a. Localised excavations;
- b. Removing/demolishing gully, manhole and chamber structures;
- c. Utilising/disposing of excavated and removed/demolished materials;
- d. Finishing/backfilling excavations.

26.2. Construction

26.2.1 Where necessary, localised excavations shall be carried out to enable removal/demolition. Gullies, manholes and chambers shall be carefully removed to avoid damage to adjacent facilities.

26.2.2 Culvert excavations shall be finished/backfill as specified in section 9.17.

27. Removal/Demolition of Culverts and Culvert End Structures

27.1. Work operations

27.1.1 Culverts and structures shall be removed/demolished as specified and shall include the following work operations:

- a. Localised excavations;
- b. Removing/demolishing culverts and end structures;
- c. Utilising/disposing of excavated and removed/demolished materials;
- d. Stacking removed culvert/end structure components if required;
- e. Finishing/backfilling excavations.

27.2. Construction

27.2.1 Where necessary, localised excavations shall be carried out to enable removal/demolition.

27.2.2 Where culvert components are required to be removed and stacked, they shall be removed and stacked so as to avoid damage. Culvert units shall be stacked neatly in lines in an accessible position approved by the Superintendent, at least 1 m clear of all works, watercourses, drains, fences or timber.

26.2.3 Culvert excavations shall be finished/backfill as specified in section 9.17.

27.2.3 Stonepitching

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27.3. Description

28.1.1 Stonepitching refers to construction of grouted rock facing or walls as specified in the drawings. The term stonepitching shall include work described as rock masonry, rubble masonry, grouted pitching and rock wall. Stonepitching does not include ungrouted rock facing referred to as rockfill or riprap protection.

27.4. Work Operations

28.2.1 Work operations for stonepitching include:

- a. Supply of all construction materials;
- b. Localised excavations;
- c. Utilising/disposing excavated material;
- d. Placing foundation bedding material (if specified)
- e. Construction of footings and toe/cut-off walls if specified;
- f. Placing cement mortar;
- g. Placing rock by hand;
- h. Constructing concrete capping on top of stonepitched walls (if specified);
- i. Installation of drainage weep holes.

27.5. Material Requirements

28.3.1 Stonepitching rock shall be selected from sound igneous, metamorphic or approved sedimentary rock that will not disintegrate in water or when exposed to the weather.

28.3.2 Rock shall be clean, hard, durable and free from soft seams or other imperfections.

28.3.3 Unless otherwise specified, rock shall be of size of not less than 150 mm and not greater than 300 mm (minimum dimension) except in the case of smaller stones used for wedging.

28.3.4 Where specified, rock shall be selected to match existing stonepitching in size, shape and colour.

28.3.5 Mortar shall consist of one part Type GP cement to three parts clean sand (1:3) with sufficient water added to give it a plastic like texture. Mortar shall be able to retain its shape and not flow like a liquid. It shall be used within one hour of mixing and shall not be retempered.

28.3.6 Hydrated lime may be incorporated into the cement mortar to the extent of 1 part hydrated lime to 10 parts of Type GP cement (loose volume). Hydrated lime shall be an addition to, and not a replacement for, the cement.

27.6. Construction

28.4.1 Where necessary, localised excavations shall be carried out to permit construction of stonepitching including foundations, footings and toe/cut-off walls.

28.4.2 Stonepitching shall be constructed to shapes, details and dimensions shown on the drawings.

28.4.3 Unless otherwise specified, stonepitching shall be finished with a closed face whenever it is part of a drainage structure or it is to be used as a trafficable surface. For a closed face, mortar shall be trowelled flush with the face of the stone.

28.4.4 Unless otherwise specified, open face construction shall be used in other situations. For open face construction, mortar shall be set back 50 mm behind the face of the stone.

28.4.5 Where specified, foundation bedding material shall be compacted as follows:-

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- 28.4.6 Cohesive material – to not less than 95% RDD (Std).
- 28.4.7 Non-cohesive material – to a density index of not less than 70.
- 28.4.8 All rock shall be cleaned and thoroughly wetted before placing.
- 28.4.9 Rocks shall be placed so as to form irregular joints and bedded on cement mortar. All rocks shall be interlocked and wedged with smaller size rock as necessary, so that no single rock may be easily dislodged and no large voids remain between rocks. Joints shall be 25 mm nominal width.
- 28.4.10 All voids shall be filled with cement mortar and/or smaller size rock.
- 28.4.11 Where stonepitching is to be trafficable, care shall be taken to provide a smooth running surface.
- 28.4.12 Where stonepitching is employed for batter protection, toe rocks shall be of size not less than 250 mm.
- 28.4.13 Exposed rock surfaces shall be cleaned free of any coating of cement mortar.
- 28.4.14 A 50 mm thick 15 MPa concrete capping shall be constructed along the top of stonepitched walls. Capping width shall correspond to the specified wall thickness.
- 28.4.15 Where specified, 100 mm diameter weep holes shall be placed at approximately 1 m intervals at the toe of stonepitched walls and at a rate of one hole per 2 m² for the balance of the area unless otherwise specified. The rear of weep holes shall be covered by geotextile fabric securely taped in place and surrounded by free-draining granular material approximately 100 mm thick.

27.7. Tolerances

- 28.5.1 Exposed surfaces shall have a relatively smooth, even, neat appearance true to line, level and planes shown on the drawings.
- 28.5.2 The finished exposed surface shall be within 20 mm over 1 metre and 50 mm over 3 metres of the specified lines and within 50 mm of specified levels. The thicknesses of the work shall not be less than the specified dimensions.
- 28.5.3 Where a straight edge 3 metres long is laid along the front, back or top surface of a concrete capping, the surface shall not vary by more than 10 mm from the straight edge except on curves.

28. Rockfill Protection

28.1. Rockfill Protection

- 29.1.1 Rockfill protection to banks, batters and abutments shall be constructed as shown on the drawings and in accordance with this specification. It shall include the following work operations:
- Supply of construction materials;
 - Excavation;
 - Localised excavation;
 - Utilising/disposing excavated material;
 - Placing, jointing and fixing geotextile;
 - Constructing Rockfill;
 - Constructing hand-packed face of Rockfill.

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28.2. Material Requirements

- 29.2.1 Rock shall be sound igneous, metamorphic or approved sedimentary rock that will not disintegrate in water or when exposed to the weather.
- 29.2.2 Rock shall be of a size not less than 200 mm and the least dimension of any rock shall be not less than half its greatest dimension.
- 29.2.3 Geotextiles shall comply with the requirements of section 11 and shall have a G Rating of > 2700.

28.3. Construction

- 29.3.1 Excavations and localised excavations shall be carried out to permit construction of toe/cut-off walls.
- 29.3.2 Rockfill protection shall be constructed to the shapes and details shown on the Drawings.
- 29.3.3 A geotextile membrane shall be installed at the interface between the rock protection and the embankment material.
- 29.3.4 The face shall be hand packed with selected rock so that gaps between rocks are completely filled with smaller stones.

29. Riprap Protection

29.1. Riprap protection

- 30.1.1 Riprap protection of drainage channels or embankments shall be constructed as shown on the drawings and in accordance with this specification. It shall include the following work operations:
 - a. Supply of construction materials;
 - b. Localised excavations;
 - c. Utilising/disposing excavated material;
 - d. Dumping or otherwise placing rock.

29.2. Material Requirements

- 30.2.1 Rock shall be sound igneous, metamorphic or approval sedimentary rock which will not break down in water or when exposed to the weather.
- 30.2.2 Unless otherwise specified, rock employed for riprap protection shall be not less than 150 mm in diameter and not greater than 500 mm in diameter.

29.3. Construction

- 30.3.1 Where necessary, localised excavations shall be carried out to permit construction of riprap protection. Riprap protection shall have a uniform appearance overall, and shall not have noticeable overall irregularities in horizontal and vertical alignments.
- 30.3.2 Rocks shall be placed in a manner which ensures that larger rocks are uniformly distributed throughout the protection work, and that smaller rocks effectively fill the spaces between the large rocks without leaving any large void. Layers of placed rock shall be of even thickness and of even grading.
- 30.3.3 Placing operations shall be carried out to minimise the risk of rock running loose from the riprap protection zone. Any rock escaping from this zone shall be recovered.

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- 30.3.4 Where riprap protection of embankments is specified, placement shall occur progressively with construction of the embankment so that at no time is the constructed level of the riprap protection more than 1 m vertical height below the constructed level of the embankment.

30. Restoration and Revegetation of Surfaces

30.1. Topsoiling

- 31.1.1 All areas that are excavated and filled except under buildings and concrete structures shall be covered with topsoil.
- 31.1.2 Excavation and fill levels shall be trimmed below finished surface levels to allow for topsoil placement. The depth of such trimming below finished levels shall be not less than 150mm.

30.2. Restoration and Revegetation of Surfaces

- 31.2.1 All surfaces shall be restored in such a manner that they conform generally to the levels, grades and types of surface material existing before the work was commenced.
- 31.2.2 Restored surfaces shall be maintained in such a way as to avoid any hazard or inconvenience the public, Unitywater staff or the contractor's staff. In private properties, routes of normal access shall be restored to a safe and trafficable condition by the close of work each day.
- 31.2.3 Garden soil, to a maximum depth of 300 mm shall be replaced during backfilling with material approved by the Superintendent as equivalent to that removed.
- 31.2.4 In grassed areas, the top 150 mm of the backfilling shall be carried out with material approved by the Superintendent as equivalent to that removed. Where turfs have been removed, they shall be replaced on this material and top dressed.
- 31.2.5 Areas affected shall be cleared up, the surfaces made good and all surplus materials carted away.
- 31.2.6 All improvements on premises which have been damaged by the Contractor shall be replaced so as to be the equal or better of those existing before the Contractor's operations. Where infrastructure on private premises cannot be restored within two (2) days, it shall be re-erected to the satisfaction of the Superintendent in a temporary location until such time as permanent restoration can be carried out unless agreed otherwise with the occupier.
- 31.2.7 All restoration work shall be to the satisfaction of the Superintendent. Initial cleaning up shall be carried out as soon as backfilling is completed and restoration in private premises shall be completed within seven (7) days after backfilling. Beyond this time the Superintendent may arrange to have the work carried out at the Contractor's expense.
- 31.2.8 The Contractor shall, from time to time, as required, provide and place any pavement material, topsoil or other material that may be necessary to make good any subsidence and shall ensure that the restored surfaces are maintained throughout the duration of the Contract in conformity with the level of the adjoining surfaces to allow the safe and convenient passage of traffic.
- 31.2.9 The Principal may require that designated areas receive special restoration using any one of a number of special techniques which are available. These may include re-seeding, turfing, hydraulic seeding and mulching and may include provision for the protection of newly restored surfaces using fibre matting.
- 31.2.10 The choice of restoration technique must be made prior to completion of clearing and stripping activities, taking into consideration:
- a. The pre- construction and post-construction landform of both the immediate construction area and that adjacent to the construction site – on steep slopes

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hydromulching or turf application is the preferred approach and the restoration area must, after its establishment period blend seamlessly into the surrounding area;

- b. The type of pre-clearing and pre-stripping vegetation in both the immediate construction area and that adjacent to the construction site – wherever possible vegetation is to be restored in keeping with the pre-construction landscape;
- c. A preference to use turf in areas where there is a need for quick, well established grass cover such as within residential developments, along footpaths, parks with (uncontrolled) public access and other public access areas with a high trip risk and in high erosion risk areas;
- d. Where turf has been used in the restoration, ensure there is a well prepared and scarified sub-grade (i.e. sandy loam topsoil) and where necessary, roll the laid turf to enable adequate contact with the subgrade. The turf should be even with the ground and with no undulations. The edge of the turf patch should be made flush with the surrounding 'non-turfed' areas and 'feathered out'. Topsoil and an approved seed mix may need to be used where top dressing is required, particularly on the edges of the turf patch and/or where gaps between the turf strips are visible;
- e. Where hydromulch or turf has been used in the restoration, necessary implementation of a watering regime that ensures watering occurs as necessary (having due regard to local weather conditions) and consistently to attain established root structures and uniform ground cover for a period of no less than 12 weeks;
- f. A preference for hydromulching on steep slopes, large land areas, areas where laying or maintaining turf represents a challenge (e.g. 'disconnected' areas along a construction corridor, access by watering truck difficult/restricted);
- g. Where hydromulching or seeding is to be used in the restoration, seasonal and weather conditions are to be considered in making the choice of seed mix and time of application (so as to provide greatest success of establishment), additional binders required on steeper slopes and use of Australian native seed mix in areas within and adjacent to areas of regional ecosystem significance.

- 31.2.11 For areas nominated by the Principal to be re-seeded, the Contractor shall remove the top 100 to 150 mm of sand and/or soil including vegetable matter and stockpiled for later re-use.
- 31.2.12 On completion of backfilling the material removed in accordance with the preceding operation shall be spread uniformly over the disturbed area and covered with a slight cover of topsoil to minimise wind erosion and leaching out.
- 31.2.13 The whole of the disturbed area shall then be seeded with an approved mixture of grass seeds and fertilizer including trace elements suitable for the locality.
- 31.2.14 The approved mixture shall be spread at the rate of not less than 2.9 g per 100 m².
- 31.2.15 The mixture shall be lightly raked in and the whole area immediately hand watered. Watering in compliance with the Local Government regulations and section 6.7 shall then be carried out.
- 31.2.16 For areas nominated by the Superintendent to be turfed, the surface of the backfilled trench and adjoining area shall be raked smooth at a depth of 75 mm below the required finished surface level.
- 31.2.17 The turfs shall be of *cynodon dactylon* (green couch) or other approved grass suitable for the locality.
- 31.2.18 The grass shall be of good quality free from paspalum, nut grass, oxalis and other weeds.
- 31.2.19 Turfs shall be cut 300 mm wide x 3 m length approximately, and 50 mm - 60 mm thick. Turfs shall be cut and delivered to the site so as to minimise time between delivery and laying. If

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necessary, the turfs shall be stacked, well-watered and protected from the sun. All rolls of turf shall have the grass facing inwards.

- 31.2.20 For areas nominated by the Superintendent, the Contractor shall use hydraulic seeding and mulching (referred to as hydromulching).
- 31.2.21 Only qualified personnel with a proven ability to apply hydromulching treatment shall be employed by the Contractor to perform this work.
- 31.2.22 Seed, fertiliser, wood-fibre mulch, water and binder shall be thoroughly mixed together to provide a slurry and shall then be applied under pressure on to the area to be treated by means of hydromulching equipment specifically designed for this purpose.
- 31.2.23 Prior to spraying the slurry, the Contractor shall cover the area to be treated with topsoil to a depth of 75 mm. Spraying of the slurry shall be carried out as soon as possible after topsoiling, but not later than 2 weeks.
- 31.2.24 The topsoiled area shall first be watered with a fine water spray to thoroughly moisten the soil to a depth of at least 25 mm without inducing any erosion. Spraying of the slurry shall then take place while the topsoil is still moist.
- 31.2.25 After the slurry has been sprayed any further watering as ordered by the Superintendent will be paid for at the tendered rate per kilolitre. Application rates for south-east Queensland shall be as listed in the following table. The Contractor shall submit alternative mixes to the Superintendent for approval for areas with different climatic conditions.

Table 9 – Materials for Hydromulching

Material	Rate of Application	
<ul style="list-style-type: none"> Wood-fiber Defibrated pinus radiata dyed green 	2.5 tonnes/ha	
<ul style="list-style-type: none"> Binder Anionic bitumen emulsion 50/50 bitumen/water or Polymer Binder 	1000-2000 L/ha Max.250 L/ha	
<ul style="list-style-type: none"> Certified seed 	Summer Mix	Winter Mix
<u>Primary Cereal Cover</u> Japanese millet Perennial rye grass	25 kg/ha 40 kg/ha	
<u>Secondary Grass Cover</u> Green couch Rhodes grass	15 kg/ha 15 kg/ha	25kg/ha 15 kg/ha
<ul style="list-style-type: none"> Fertiliser Type to be approved by the Superintendent 	250-400 kg/ha	

- 31.2.26 Summer shall be defined as from October to March inclusive. Winter shall be defined as from April to September inclusive.
- 31.2.27 Areas to be protected shall be covered with a heavy duty fibremat or mulch (either wood chip or gravel [20-40mm]). The heavy duty fibrematting erosion control blankets if used (such as Enviromat, coir/jute mats similar approved by the Superintendent) shall be supplied and laid to the manufacturer's recommendations. Where used, gravel and wood chip mulch shall be underlain with geofabric to prevent weed growth.

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30.3. Disposal of Spoil

- 36.3.1 All excavated material that is surplus to the earthworks requirements or is rocky, concrete or deleterious in nature and cannot be reused elsewhere within the construction site (e.g. for landscaping, sound barriers, etc.) shall be removed from site and transported to an approved Waste Disposal Site (landfill) by the Contractor.
- 36.3.2 Where the Contract is a lump sum, the cost of removal from the site, transport and disposal fees shall be deemed to be included in the Lump Sum of the Contract.

31. Compliance Testing

31.1. Working operations

- 37.1.1 The Contractor is responsible for performing sufficient tests to ensure that the works comply with the standards and requirements of this specification.
- 37.1.2 Minimum testing frequencies shall comply with the limits specified in the Schedule of Minimum Compliance Testing, Table 36.1 unless otherwise approved by the Superintendent.
- 37.1.3 Additional testing may be ordered by the Superintendent.

31.2. Standard Test Methods

- 37.2.1 Unless otherwise specified, all testing of soils materials, earthworks and subgrade shall be conducted in accordance with AS 1289 "Methods of Testing Soils for Engineering Purposes". Standard Test Methods are listed in Table 36.2.
- 37.2.2 All testing is to be carried out in a N.A.T.A. registered laboratory acceptable to the Superintendent, or other such laboratory as the Superintendent may direct.
- 37.2.3 The Contractor shall arrange for one copy of the results of every test taken to be forwarded directly to the Superintendent by the Laboratory.

Table 10 - Standard Test Methods

Property to be Tested	Specification/Test Method
Particle size distribution (Grading)	AS 1289 3.6.1
Liquid Limit (LL)	AS 1289 3.1.2
Plastic Limit (PL)	AS 1289 3.2.1
Linear Shrinkage (LS)	AS 1289 3.4.1
Relative Dry Density [RDD (Std)]	
2.1 Laboratory Standard Compaction	AS 1289 5.1.1/5.5.1
2.2 Field Dry Density (Sand Replacement)	AS 1289 5.4.1
2.3 Nuclear Moisture/Density	AS 1289 E8.1
Density Index	AS 1289 5.6.1
Minimum and Maximum Dry Density of a Cohesionless Material	AS 1289 5.5.1
Concrete Compressive Strength	AS 1012

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31.3. Payment for Testing

- 37.3.1 Unless otherwise specified, material tests shall be borne by the Contractor.
- 37.3.2 Payment for manufacture, handling, curing and testing of concrete test cylinders shall be borne by the Contractor.
- 37.3.3 No extra payment will be made to the Contractor for any delays occasioned because of testing or re-testing.

Table 11 - Schedule of Minimum Compliance Testing

Activity and Sub-Activity	Test Parameter	Ref. Clause	Test Method	Minimum Testing Frequency
CLEARING AND GRUBBING				
Extent of Work	Area/extent	7.2	Visual inspection	1 test per 2,000 m ² or part
Filling grub holes and localised depressions	RDD	7.5 9.5.3 (c)	Standard compaction AS 1289 5.1.1/5.5.1 AS 1289 5.8.1, 5.4.1/ 5.6.1	1 test per 2,000 m ² or part (if ordered)
EARTHWORKS				
Geometry	Location	9.2.1	Survey/visual inspection	1 test per 50 m
	Level	9.2.2	Survey/visual inspection	1 test per 50 m
	Crossfall	9.2.3	Spirit level	1 test per 50 m
	Batter Shape	9.2.4	Visual inspection	1 test per 50 m
Subgrade	Level	9.2.2	Survey/visual inspection	1 test per 20 m
	Profile	9.2.2	Visual inspection	1 test per 20 m
	RDD	9.3.4 9.7.3 9.3.4	Standard compaction AS 1289 5.1.1/5.5.1 AS 1289 5.8.1, 5.4.1/ 5.6.1	1 test per 500 m ² or part

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Activity and Sub-Activity	Test Parameter	Ref. Clause	Test Method	Minimum Testing Frequency
	Visible Movement	9.5.10	Visual inspection under load test	1 load test run per lane
4 Base of Excavation: Culverts/End Structures	RDD	9.3.6	Standard compaction AS 1289 5.1.1/5.5.1 AS 1289 5.8.1, 5.4.1/ 5.6.1	1 test per 50 m ² or part (if ordered)
5 Foundation of Structures	Bearing Capacity	9.4.1 9.4.3 9.4.5	Visual inspection	1 test per structure/foundation (if ordered)
6 Embankment Ground surface preparation	RDD	9.5.3 (e)	Standard compaction AS 1289 5.1.1/5.5.1 AS 1289 5.8.1, 5.4.1/ 5.6.1	1 test per 750 m ² or part 1 test per 500 m ² per layer or part
7 Fill/Backfill	Layer Thickness	9.5.6	Visual inspection	1 test per 500 m ² per layer or part
	RDD	9.5.6 9.7.3	Standard compaction AS 1289 5.1.1/5.5.1 AS 1289 5.8.1, 5.4.1/ 5.6.1	1 test per 500 m ² per layer or part 1 test per material type
8 Rockfill	Layer Thickness	9.5.7	Visual inspection	1 test per material type
SELECTED GRAVEL/LOAM FILL MATERIAL	Grading	9.6.2	AS 1289 3.6.1	1 test per structure/line
	Linear Shrinkage	9.6.2	AS 1289 3.4.1	1 test per material type

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Activity and Sub-Activity	Test Parameter	Ref. Clause	Test Method	Minimum Testing Frequency
FILL/BACKFILL AGAINST IN-PLACE STRUCTURES	Material Type	9.8.2	Visual inspection	1 test per 500 m ² or structure
	Grading (overlay zone)	9.8.3	AS 1289 3.6.1	1 test per 500 m ² per layer or part or structure
	Layer Thickness	9.8.3	Visual inspection	
	RDD	9.8.3	Standard compaction AS 1289 5.1.1 AS 1289 5.8.1, 5.4.1	1 test per 500 m ² or part
	Density Index	9.8.4	AS 1289 5.6.1, 5.5.1	
ROAD FORMATION COMPONENTS Shoulders	Grading	10.1.2	AS 1289 3.6.1	1 test per material type (if ordered)
	Linear Shrinkage	10.1.2	AS 1289 3.4.1	1 test per material type (if ordered)
	RDD	10.1.3	Standard compaction AS 1289 5.1.1/5.5.1 AS 1289 5.8.1, 5.4.1/ 5.6.1	1 test per 500 m ² or part
Table Drains, Catch Banks, Catch Drains	Geometrics	10.2 10.4.3 10.5.3	Visual inspection	1 test per 50 m
Concrete Work	Compressive Strength Maximum Aggregate Size	11.1.2	AS 1012	2 cylinders/10 m ³ cumulative batch size or part
STONEPITCHING				

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Activity and Sub-Activity	Test Parameter	Ref. Clause	Test Method	Minimum Testing Frequency
Bedding	RDD	13.4	Standard compaction AS 1289 5.1.1 AS 1289 5.8.1, 5.4.1	1 test per 100 m or part
	Density Index	13.4	AS 1289 5.6.1, 5.5.1	
Geometry	Geometrics	13.4 13.5	Visual inspection	1 test per 25 m or part
SIDE AND MITRE DRAINS				
Backfill	Grading	17.2	AS 1289 3.6.1	1 test per material type
	RDD	17.4	Standard compaction AS 1289 5.1.1/5.5.1 AS 1289 5.8.1, 5.4.1/ 5.6.1	1 test per 50 m
Geometry	Geometrics	17.4	Visual inspection	1 test per 50 m
KERB AND CHANNEL				
Base of excavation	RDD	24.5	Standard compaction AS 1289 5.1.1/5.5.1 AS 1289 5.8.1, 5.4.1/ 5.6.1	1 test per 200 m or part (if ordered)
	Crushed rock foundation or bedding	RDD	AS 1289 5.8.1, 5.4.1	1 test per 200 m or part (if ordered)
Crushed rock foundation or bedding	Density Index	24.6.4	AS 1289 5.6.1	1 test per material type
	Grading	24.5	Supplier docket	1 test per material type
Crushed rock foundation or bedding	Type	24.5	Supplier docket	1 test per material type
	Geometry	Geometrics	24.6.1 24.6.4 24.7 24.9	Visual inspection Water test

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Activity and Sub-Activity	Test Parameter	Ref. Clause	Test Method	Minimum Testing Frequency
Concrete	Compressive Strength Maximum Aggregate Size	24.3	AS 1012	1 test per 200 m or part
CONCRETE GULLIES, MANHOLES AND CHAMBERS Concrete	Compressive Strength Maximum Aggregate Size	25.2	AS 1012	1 test per 10 m ³ cumulative
Base of excavation	RDD	25.3	Standard compaction AS 1289 5.1.1/5.5.1 AS 1289 5.8.1, 5.4.1/ 5.6.1	1 test per chamber (if ordered)
Location	Position	25.5	Visual inspection/survey	1 test per structure
Backfill	RDD	9.8	Standard compaction AS 1289 5.1.1/5.5.1 AS1289 5.8.1, 5.4.1/ 5.6.1	1 test per structure where back forms used (if ordered)
REINFORCED CONCRETE PIPES, BOX CULVERTS AND FIBRE REINFORCED CONCRETE PIPES Foundation bedding/Haunch Zone material	Grading Linear Shrinkage	26.2.2 26.2.2	AS 1289 3.6.1 AS 1289 3.4.1	1 test per material type 1 test per material type
Geometry	Geometrics	26.3	Visual inspection/survey	1 test per manhole/end structure location
Base of excavation	RDD	26.4.4	Standard compaction	1 test per 50 m or part (if ordered)

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Activity and Sub-Activity	Test Parameter	Ref. Clause	Test Method	Minimum Testing Frequency
Bedding			AS 1289 5.1.1/5.5.1 AS 1289 5.8.1, 5.4.1/ 5.6.1	
	RDD Density Index	26.4.7 26.4.8.3	Standard compaction AS 1289 5.1.1 AS 1289 5.8.1, 5.4.1 AS 1289 5.6.1, 5.5.1	1 test per 50 m or part
Backfilling	RDD Density Index	26.4.10	Standard compaction AS 1289 5.1.1 AS 1289 5.8.1, 5.4.1 AS 1289 5.6.1, 5.5.1	1 test per 50 m or part for each zone or layer
Concrete	Compressive Strength	30.3	AS 1012	1 test per 20 m ³ cumulative