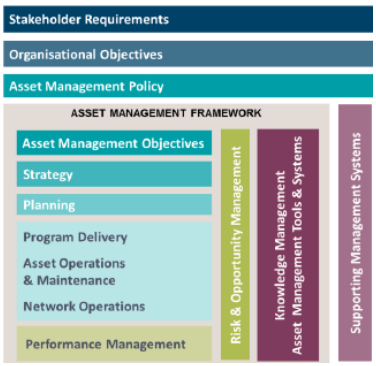
Transmission Substation Earthworks, Roads and Drainage

Design Standard (Technical Specification)



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RESPONSIBILITIES

Western Power's Engineering & Design Function is responsible for this document

CONTACT

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Contents

Revision Details

Version	Date	EDM Version	Description
0	February 2020	11	First Issue
1	March 2023	12	Design review and update
2	March 2024	13	Standard Online Update

1. Introduction

This Technical Specification outlines the minimum requirements for the construction of earthworks, roads, and drainage for Western Power Transmission Substation projects.

1.1. Purpose and Scope

The requirements outlined in this specification are intended to cover the following items associated with the construction of earthworks, roads, and drainage for Western Power Transmission Substation:

- Clearing, root and stump removal, removal of topsoil and surface preparation
- Supply, testing, placing, compaction, and acceptance criteria of earthworks
- Supply, testing, construction, and compaction of pavements
- Supply, testing and construction of bituminous surfacing
- Supply and construction of concrete kerbing
- Supply and construction of drainage works

This specification applies to both 'Greenfield' and 'Brownfield' sites.

1.2. Acronyms

Acronym	Definition

1.3. Definitions

Terms and definitions used in this document

Term	Definition
AAPA	Australian Asphalt Pavement Association
AS	Australian Standard
AS/NZS	Australian/New Zealand Standard
Brownfield site	Site with existing or previous electrical assets
DGA	Dense Graded Asphalt
EDM	Enterprise Document Management
Engineer	Person which is a Member of the Institution of Engineers Australia (MIEAust)
Greenfield site	New site with no previously installed electrical assets
MRWA	Main Road Western Australia

SoW	Scope of Work

1.4. References

References which support implementation of this document

Table 1-1 References

Reference No.	Title

2. Supporting Documentation[1]

3. Compliance

3.1. General[2]

All temporary works, shop drawings, materials, plant, equipment, workmanship, fabrication, and installations must comply with the latest revision of the Western Power technical documents such as Standards, Specifications, and relevant Australian Standards relating to the relevant component of the works unless otherwise noted in this specification or advised at the time of Tender.

There should not be any deviation from the provisions of the relevant standards and specifications without obtaining written approval from Western Power.

All work and materials must comply with higher-level Western Power technical documents, such as relevant Network Standards and Functional Specifications.

This Technical Specification should encompass all requirements of the relevant Australian Standards which are current at the time of issue. These relevant Australian Standards are listed in Table 3-1 below. A period will be set when the Technical Specification needs to be reviewed. If significant changes occur on an Australian Standard which affects safety, then an out of cycle review can be completed.

Table 3-1 Standards and Guidelines

Standard Number	Standard Title
AS 1254	PVC Pipes and Fittings for Storm or Surface Water Applications
AS 1289	Methods of Testing Soils for Engineering Purposes - General Requirements and List of Methods (inclusive)
AS 1597.2	Precast Reinforced Concrete Box Culverts
AS 1657	Fixed Platforms, Walkways, Stairways and Ladders- Design Construction and Installation

[1] See Western Power Internal Document
[2] See Western Power Internal Document

Standard Number	Standard Title
AS 1672	Limes and Limestones
AS 1726	Geotechnical Site Investigations
AS 2008	Residual Bitumen for Pavements
AS/NZ 2032	Installation of PVC Pipe Systems
AS 2041	Buried Corrugated Metal Structures
AS 2150	Hot Mix Asphalt- A guides to Good Practice
AS 2436	Guide to Noise Control on Construction, Maintenance and Demolition Sites
As 2601	Demolition of Structures
AS 2758.1	Aggregates and Rock for Engineering Purposes – Concrete Aggregates
AS 2891.5	Method of Sampling and Testing Asphalt - Determination of Stability and Flow - Marshall Procedure
AS 3500	Plumbing and Drainage
AS 3600	Concrete Structures
AS 3706	Geotextiles
AS 3798	Guidelines for Earthworks on Commercial and Residential Developments
AS 4058	Precast Concrete Pipes (Pressure and Non Pressure)
AS 4139	Fibre Reinforced Concrete Pipes and Fittings
AS 4902	General Conditions of Contract for Design and Construct
AS 4906	Minor Works Contract Conditions (Principal Administered)
AS 4910	General Conditions of Contract for Supply of Equipment with Installation
AS 4911	General Conditions of Contract for Supply of Equipment without Installation
AS 5065	Polyethylene and Polypropylene Pipes and Fitting for Drainage and Sewer Applications
	MRWA Specification 302: Earthworks
	MRWA Specification 501: Pavements
	MRWA Specification 503: Bituminous Surfacing
	MRWA Specification 504: Asphalt Surfacing
	MRWA Specification 511: Materials for Bituminous Surfacing Treatments
	Cocks et al.: A Guide to the Selection and Use of Naturally Occurring Materials as Base and Sub-base in Roads in WA
AP-T68-06	Austroads Design Guide – Update of the Austroads Sprayed Seal Design Method
AP-T236-13	Austroads Design Guide – Update of the Double seal design method
	Main Roads Western Australia publication 6706/02/133
	MRWA Engineering Road Note 14 – Guide to Spreading Aggregate in Seal

Standard Number	Standard Title
	Vic Roads test method RC131.01
WA 110.1	Moisture Content: Convection Oven Method
WA 115.1	Particle Size Distribution: Sieving and Decantation Method
WA 120.2	Liquid Limit: Cone Penetrometer Method
WA 122.1	Plasticity index
WA 123.1	Linear Shrinkage
WA 133.1	Dry Density/Moisture Content relationship: Modified Compaction Fine and Medium Grained Soils
WA 134.1	Dry Density Ratio
WA 136.1	Moisture Ratio (Percent)
WA 140.1	Maximum Dry Compressive Strength
WA 141.1	California Bearing Ratio
WA 216.1	Flakiness Index
WA 220.1	Los Angeles Abrasion Value
WA 220.2	Los Angeles Abrasion Value of Crushed Limestone
WA 313.2	Surface Profile: Three Metre Straight Edge
WA 324.1	Dry Density: Sand Replacement Method
WA 324.2	Dry Density and Moisture Content: Nuclear Method
WA 330.1	Layer Thickness: Direct Measurement
WA 915.1	Calcium Carbonate Content
	Aboriginal Heritage Act (Latest Version)
	Dangerous Goods Safety Act (Latest Version)
	Dangerous Goods Safety (General) Regulations (Latest Version)
	Dangerous Goods Safety (Storage and Handling of Non Explosives) Regulations
	Environmental Protection Act (Latest Version)
	Environmental Protection (Clearing and Native Vegetation) Regulations (Latest Version)
	Environmental Protection Regulations (Latest Version)
	Environmental Protection (Noise) Regulations (Latest Version)
	Explosive and Dangerous Goods Act (Latest Version)
	Noise Abatement Act (Latest Version)
	Noise Abatement (Annoyance of Residence) Regulations (Latest Version)
	Occupational Safety and Health Act (Latest Version), and
	Occupational Safety and Health Regulations (Latest Version).

3.2. Acceptance Criteria

Compliance with the requirements of this specification for materials and construction of earthworks, roads and drainage shall be based on the minimum requirements and acceptance criteria set out in this specification, the construction SoW of the project, construction drawings included in the project deliverables and relevant Australian Standards and Guidelines listed in Table 3-1.

3.3. Order of Precedence

Where this specification is inconsistent with another document making up the construction SoW of the project, the following order of precedence shall apply to determine which document prevails to the extent of inconsistency with (a) being the highest precedence and (e) being the lowest:

a) the specific terms and conditions of the construction SoW of the project

b) the 'Policies and Guidelines' of the project

c) any construction drawings included in the project deliverables

d) any specific technical requirements stipulated to the project works

e) this Technical Specification

3.4. Certification

The contractor shall submit test reports or certificates for all materials and construction tests used in the construction of earthworks, roads and drainage stating compliance with the specification and applicable Western Power technical documents and or Australian standards together with such details and parameters required to be supplied by those documents and or project quality plan to the Western Power representative for acceptance.

Requirements for test reports or test certificates are provided in the relevant Australian Standards listed in Table 3-1. All such testing shall be carried out by an independent NATA-accredited laboratory approved by the Western Power representative.

4. Preliminaries

4.1. Clearing

4.1.1. Limit of Clearing

The Contractor shall physically mark on the ground the boundaries of the areas to be cleared and assist the Western Power's Representative to identify and mark trees and/or vegetation to be retained, if any, within the affected areas. Unless specifically stated on the project drawings, no clearing of trees and vegetation shall be permitted more than 2 meters beyond the extent of earthworks and construction works in the Contract. Areas erroneously cleared beyond this distance shall be fully reinstated to original conditions and approved by the Western Power (WP) Representative.

4.1.2. Protection of Services and Removal of Vegetation

The Contractor shall locate, identify, and protect all existing services within the work areas before clearing, grubbing, and topsoil removal work on site. The Contractor shall be responsible for any damage caused to services during execution of the Contract.

Trees and other vegetation shall be stockpiled and treated as described elsewhere in the Contract for their potential re-use (following mulching) in the reinstatement of the batters and areas affected by the proposed project. Where not otherwise required for inclusion in the SoW, all stockpiled vegetation is to be removed from site to an approved disposal site in a condition and manner suitable to the local and/or appropriate authorities. The excess material shall not be burned on site. Any trees to be maintained shall be clearly marked and identified before the commencement of clearing works.

4.1.3. Erosion Control

The clearing operations should be carried out to avoid erosion, contamination, and sedimentation of the site, surrounding areas, watercourses, streams, and other drainage systems.

4.1.4. Root and Stump Removal and Surface Preparation

The Contractor shall remove the following over the entire area of construction as shown on the project drawings:

- All trees, logs, stumps, boulders, roots, and scrub. Vegetation, stumps and roots greater than 25 mm in diameter shall be removed (grubbed) to 600 mm below the natural ground level or 400 mm below the finished cut surface.
- Existing rubbish, structures, and slabs, including foundations (except where approved by the WP Representative).
- Topsoil to a depth identified in the project drawings (Refer to Section 4.2). Stumps shall be removed off-site and disposed of in a manner suitable to the local and/or appropriate authorities or can be used on other construction sites as approved in writing by the WP Representative.

4.1.5. Reinstatement of Stump Voids

All stumps shall be fully removed, and the excavation of the hole left by the removal of stumps shall be backfilled with material meeting the requirements for imported fill as described in this document, which shall be compacted in a manner and to a density not less than that required to satisfy the requirements for placement of fill materials as described in this document.

The base of the void left by the stump removal shall be watered and compacted with a vibrating plate, as appropriate, before the fill is placed. The approved selected fill shall be placed in layers not exceeding 300 mm and compacted to the specified density.

4.2. Topsoil

4.2.1. Definition

Topsoil is defined as the layer of surface material containing humus, roots, plants, and organic material exceeding one per cent by weight.

4.2.2. Stockpiling of Topsoil

Unless otherwise stated, topsoil containing organic matter shall be stored on-site for later spreading on batters. Before the commencement of bulk earthworks, topsoil to a minimum depth of 100mm or as specified in the geotechnical investigation report shall be removed and placed in a stockpile for later reuse. Reference should be made to the geotechnical report at tender stage to assess the likely depth of topsoil that needs to be removed from the site. The topsoil stockpile shall not exceed a height of 3.0m. The Contractor shall ensure that competent operators utilise appropriate plant and equipment to ensure that

the subsoil and topsoil layers are not mixed, and the subsoil surface is not affected during the stripping and stockpiling process.

4.2.3. Removal of Topsoil

There should be an allowance for the removal, stockpiling, disposal of excess quantities and respreading of topsoil to a depth of no less than 100mm or specified in the geotechnical investigation report from the planned area of the site to be cleared after removal of the existing vegetation. All topsoil and vegetation from identified weed-infested areas shall be stripped appropriately and deposited in the nominated spoil sites or authorised waste disposal sites.

The Contractor shall ensure that all machinery used in removing of weed-infested topsoil shall be cleaned before and between operations to prevent the introduction and spread of weeds outside weed-infested areas across the site.

4.2.4. Reuse of Topsoil

Stockpiled topsoil can be used for reinstatement of any disturbed areas as approved in writing by the Western Power representative.

4.2.5. Excess Topsoil

Unless otherwise stated, any topsoil remaining after respreading of topsoil over batters shall be disposed of at an approved disposal site. The Contractor shall, however, minimise the removal of topsoil off-site.

5. Earthworks and Pavements Lot Classification

5.1. Bulk Earthworks and Pavements (Large Scale Works)

The following clauses define a Lot:

- The maximum size of a Lot is limited to the quantity of work that is the subject of a single conformance decision
- The whole of the works included in the Lot shall be continuous
- The Lot has been produced by the same works process
- The Lot has been brought to completion at the same time
- The Lot shall appear to be of a constant quality without obvious changes in attribute values, whether or not these attributes form part of the acceptance criteria.

All Compaction Tests shall be adequately distributed to give a good representation of the whole area. For compaction compliance, the characteristic dry density ratio (Rc) value should be used, calculated according to the following equation and k-values:

$$R_C = R - ks$$

Where:

R = mean of the results of dry density ratio tests (or the mean of the results of the percentage of Marshall Density tests) on the Lot being assessed, reported to the nearest 0.1 per cent.

k = multiplier as detailed in Table 5-1.

s = standard deviation of the results of dry density ratio tests (or the standard deviation of the results of the percentage of Marshall Density tests) on the Lot being assessed.

Table 5-1: Lot testing multipliers

Works Component	No. of tests/lot	k
Embankment Foundation	6	0.50
Embankment Construction	6	0.50
Bedding & Embankment Backfill for Culverts and Drainage Structures	3	0.31
Subgrade Preparation	6	0.50
Sub-base	9	0.59
Basecourse	9	0.59

For dryback compliance, the Characteristic Moisture Content (DMC) value should be used, calculated according to the following equation.

$$DMc = m + ks$$

Where:

m = average of the sample moisture contents on the Lot being assessed

k = is the multiplier as detailed in Table 5-1

s = standard deviation of the sample moisture content determinations taken

The Contractor shall note on the record where any item fails to meet the specified requirement and the planned remedial action to be taken.

5.2. Small Works and Foundations

For small works (as defined in the Contract) and for assessment of foundation conditions for structures, the following frequency of testing shall be undertaken to a depth of at least 0.9 m below the base of footings, ground slabs, pavement subgrade and pavement layers by testing:

- Each spread footing excavation.
- At 2.5 m centres along strip footing excavations.
- On a grid at 5 m centres beneath slab-on-ground floors.
- One test per 250 m^2, in access road, hardstand area, or each layer of placed fill material.

The testing shall be undertaken using a calibrated Perth Sand Penetrometer (PSP) in clean imported and in situ sand.

The Contractor shall note on the record where any item fails to meet the specified requirement and the planned remedial action to be taken.

6. Earthworks

6.1. Scope

This section covers the description and required standards for placing earthworks material for construction, including excavation requirements. The contractor shall allow for all effects of material bulking, shrinkage, consolidation, compaction, waste, and over excavation in earthworks construction.

The general approach to earthworks on site is as follows:

- Ensure suitable materials are reused in appropriate locations to limit imported fill
- Ensure embankment foundations are well compacted before placing fill
- Ensure embankment layers are well compacted.
- Ensure that pavement subgrade is well prepared before placement of pavement layer.

The Contractor shall:

- Maintain site drainage and prevent water ponding on the area of the earthworks during and after construction.
- Undertake work sequencing and appropriate care to ensure the safety and stability of work.
- Protect all existing and new services and infrastructure against damage due to the Contractor's activities on site.
- Implement suitable dust control measures to prevent sensitive receptors from being affected by dust during earthworks and all ongoing construction activities.

6.2. Standards

Earthworks shall be completed per the following:

- AS 3798-2007 Guidelines on Earthworks for Commercial and Residential Developments
- AS 1289 Methods of Testing Soils for Engineering Purposes.

6.3. Safety

The Contractor shall be responsible for ensuring the stability of all excavation and trenching works on site with regards to personnel safety, plant, equipment, existing services, buildings, structures, etc.

The Contractor shall adhere to the following requirements:

- Work Safe regulations.
- An excavation management plan shall be implemented to provide a safe bench, slope or shoring system detailed and designed by a competent geotechnical engineer where excavations exceed 1.5m in depth
- The Contractor shall ensure that all excavations are maintained safely for the duration of the project, including but not limited to, the erection of suitable safety barricades, warning signs, and hazard light.

6.4. Drainage of Works

During construction, surface water shall be effectively diverted from the Works to ensure proper flushing for storm and subsoil water across and beyond the Works. The flow of stormwater and drainage along existing gutters and water tables shall be uninterrupted. These requirements shall apply equally to off-site construction, including access roads, borrow areas and stockpiles.

Diversion drains, trenches and pumps shall be utilised as required to ensure all excavations are kept dry during construction. The surface of the earthworks shall be shaped to drain away from the earthworks area. The disposal of groundwater during construction shall be per legislative requirements. The Contractor shall be responsible for obtaining the necessary approvals for groundwater disposal on the project.

6.5. Stockpiles

The selected stockpile sites should be approved by the WP Representative and shall be selected to cause minimum disturbance or destruction to natural vegetation and trees. Stockpile sites shall be cleared, and all topsoil removed before stockpiling commences. Material in the stockpile shall be deposited and removed to maintain a well-graded and regularly shaped stockpile that drains naturally and avoids surface water accumulation on or around the stockpile at all times. Open channels or piped drains shall be constructed if necessary to achieve this aim. The maximum height of a stockpile shall not exceed 3.0 m unless otherwise approved by the WP Representative. Stockpiled material shall be free of timber, vegetation, or rubbish.

6.6. Borrow Sites

Borrow sites that are selected should be approved by the WP Representative. Permission to borrow sites from the property owners on terms satisfactory to Western Power should be arranged.

Fill imported from borrow sites shall comply with the fill material requirements.

Borrow areas shall be maintained in a tidy, graded and formed condition to drain into natural watercourses and avoid soil erosion.

Materials should be removed and excavated only to levels approved by the WP Representative. If material is removed without the WP Representative approval, the area shall be re-filled, consolidated and restored.

Before commencing excavation from a borrow area, the following details should be submitted to the WP Representative for approval:

- Plans and cross-sections of the areas to be excavated
- Proposed drainage system during and on completion of excavation, including erosion and sediment control measures to be implemented
- Access routes to the borrow areas
- Certification that the material quality meets the requirements of this specification, including assessment of dieback, contamination, and presence of acid sulfate soil. Certification shall occur within 12 months of the material's use

Generally, the WP Representative will require that:

- Batter slopes in the excavation be flatter than 3 to 1 (horizontal to vertical)
- Bases of the borrow pits be at least one metre above nearby creek beds and be sloped towards the creek beds at a slope steeper than 0.5 per cent

- Topsoil should be stripped and stockpiled before excavation commences and spread over the excavated area on completion

6.7. Batters

The tops and toes of batters shall be located within -50 mm to +200mm horizontally of their design location. Fill batters shall be formed by overfilling, compaction and cutting back the batters to the design shape, allowing for any topsoil placement as elsewhere specified or depicted on the drawings. The levels and locations of the tops and toes of completed batters shall include topsoil to be re-spread.

The erosion damage to batters occurring during the Contract and defects liability periods, including reinstatement of batters, and cleaning out drains should be rectified.

6.8. Testing of Earthworks

Earthworks testing shall be undertaken at the frequency outlined in Section 5. Inspection, sampling and testing of the earthworks for acceptance shall be carried out and approved by the WP Representative. Additional testing must be undertaken if the WP Representative concludes that the tests carried out are inadequate or unsatisfactory or the supplied materials do not conform to the requirements of the Contract or any other previously approved non-conforming specifications.

During the normal work shifts, the work associated with the compaction of embankment fill and backfill around structures shall be planned to allow reasonable access for the WP Representative or its staff to carry out inspections and review testing methods and results.

The operation of compaction equipment, excavation plant or other activities that influence compaction testing shall be suspended or directed elsewhere while testing is in progress. Delays or inconveniences due to compaction or other testing requirements for controlling the attainment of the specified compaction standards shall not entitle any monetary compensation or extensions of time.

The WP Representative will always be guided by the compaction testing results in the field when determining the actual compaction achieved. Even with the results of alternative in-situ tests, the WP Representative may direct that any area that, in his opinion, has not been compacted to the required standard shall be re-compacted.

6.9. Proof Rolling (Embankment Foundation)

The exposed surface shall be proof-rolled to ensure that no soft or loose zones are present before the placement of fill or pavement material (subgrade). Proof rolling shall be carried out as directed by the WP Representative and shall consider the in situ strength, material type and moisture content of the embankment foundation soils. In fill areas, proof rolling may be omitted where saturated foundation conditions are encountered, subject to approval by the WP Representative and the Geotechnical Engineer.

The embankment foundation shall be compacted to a minimum dry density ratio (modified compaction effort) of 90% for cohesive soils and 92% for non-cohesive soils to a minimum depth of 300 mm (or as required by the Geotechnical Report). Density testing to confirm the required level of compaction shall be undertaken using a nuclear density meter to AS 1289.5.8.1 or another approved method. Perth Sand Penetrometer testing to AS 1289.6.3.3 may be used in sand with less than 5% fines (material passing the 0.075 mm sieve size) following calibration by a NATA-accredited laboratory to each sand type in which the testing is undertaken. The calibration shall be provided to the WP Representative for acceptance. Density testing shall be performed to ensure the embankment foundation density has been achieved before adding fill materials.

Where the embankment foundation is not saturated, no less than five passes of an operating vibrating roller having a minimum static mass of 10 tonnes shall be applied. In some instances, static compaction may be required before applying of vibratory compaction. Where the material in the embankment foundation contains more than 20% by mass of material retained on a 37.5mm sieve the compaction shall be by a vibratory pad-foot or grid roller or similar approved by the WP Representative.

The vibratory pad-foot roller shall be a self-propelled roller with a total static mass of not less than 10 tonnes and a centrifugal force on the drum of not less than 150kN in the frequency range of 20 to 30 Hertz. The rolling speed for the vibratory roller shall not exceed 7km per hour. Only driven drum rollers shall be used.

During proof rolling, the WP Representative shall be notified in the event of any shoving/heaving of the surface or movement of water to the surface. The WP Representative shall make a direction regarding any remedial treatment to be applied to each area of concern. The use of a working platform to provide a stable surface for compaction of the foundation may be approved by the WP Representative. Where the surface is observed to heave during proof rolling, the following remedial measures shall be undertaken as approved by the WP Representative:

- Removal of the unsuitable foundation material and replacement with approved compacted fill. Localised dewatering to facilitate compaction may be required where the groundwater level is close to the level at which the compaction is applied; or
- The installation of a geo-fabric or geo-grid (grade to be approved by the Western Power Representative) in conjunction with granular fill (crushed limestone or clean sand) to provide a working platform over the weak foundation material.
- Following over-excavation and replacement or placement of the working platform, the Contractor shall apply a minimum of five passes of an operating vibrating roller having a minimum static mass of 10 tonnes to confirm that a stable platform has been achieved.

6.10. Cut Material

Material won from cuts suitable for use as fill may be incorporated into the earthwork fill areas, subject to the materials meeting the criteria for fill listed in this section. Material that does not meet the requirements of this Specification may be considered for re-use in fill areas, following approval by the WP Representative. Cut materials excess to requirements shall be disposed of at an approved disposal site. The cut material used in embankments shall be free from cobbles and boulders and meet the size detailed below. It shall be free from clods, stumps, roots, sticks, vegetable matter or other harmful materials. Any over-excavation below the subgrade surface shall be backfilled with fill-quality material. Any backfilled material below the subgrade surface shall be compacted as specified for embankment construction.

All oversized material with dimensions greater than 53 mm shall be reduced in size or shall be removed from excavated material intended to be used as fill.

Any on-site material used as fill shall have an organic content of less than 1% by mass.

6.11. Excavations

6.11.1. General

The Contractor shall implement the safety measures during excavation as detailed in Section 6.3. Excavations in cut sections, including benching, shall be carried out to the shapes shown in the Drawings and to the specified tolerances.

6.11.2. Classification of Rock

Rock shall be defined as that material that cannot be ripped by a D9 dozer, with an experienced operator, at a rate of more than 30 m^3 (bank/solid) per hour and shall include hard boulders each of greater than one m^3 in volume. The volume of rock defined above shall be the actual solid volume of rock material only, calculated from the rock surface to the design level of removal. Rock excavation in trenches is defined as that material that cannot be ripped and excavated by 30 tonne or greater mass excavator in good condition with a 600mm wide rock bucket fitted with new rock teeth and an experienced operator at a rate exceeding 20 m^3 (bank) per hour.

For bored foundations, the Contractor shall provide suitable drilling equipment to penetrate the rock conditions to meet the design requirements. The Geotechnical Report provides advice on the rock conditions that may likely be encountered during the installation of bored foundations.

6.11.3. Blasting

Blasting shall not be considered for removal of rock or any materials in a "Brownfields" site. It shall only be permitted on "Greenfields" sites by prior written permission of the WP Representative, whose decision shall not override those of appropriate authorities holding relevant regulatory powers. The Contractor shall be liable for any accident, damage or injury to any person, property or infrastructure resulting from using explosives. The Contractor shall survey of all structures within the region of influence of the proposed blasting site to determine their pre-blast condition.

6.12. Earthworks Materials

6.12.1. Approval of Imported Materials

The extraction, blending, and manufacture of raw materials for use in earthworks shall be done with suitable plant and equipment such that homogenous and uniform materials are produced for delivery to the site. Naturally occurring materials, which, after sampling and testing, are found to be satisfactory for use with no additional blending or manufacturing processes, shall comply with the requirements of this Specification. Imported materials to be used as fill shall, as far as reasonably possible, be from one source and of a uniform nature and quality.

The source for all fill material shall be clean and free from vegetation, contamination, clay, organic materials, plastic, construction rubble, asbestos, acid sulfate soils, industrial or commercial rubbish, hydrocarbons, and asbestos and be certified as "Dieback-free" with certification occurring within 12 months of use of the material. Reference to unsuitable fill materials is provided in AS 3798, "Guidelines on earthworks for commercial and residential developments". Any imported material used as fill shall have an organic content of less than 1% by mass.

No recycled materials shall be used on-site unless the WP Representative approves.

All materials should also comply with the Department of Environment's requirements for clean fill as defined within their publication "Landfill Waste Classification & Waste Definitions" 1996 (or the latest version as amended).

Blended materials shall not be used in earthworks construction without complete testing and the WP Representative's prior approval of the results. A work methodology shall be submitted to the WP Representative to document the quality management during the mixing process. Failure to follow the submitted plan shall permit the WP Representative to reject the usage of that blended material within the construction works.

If the WP Representative determines that the materials proposed for incorporation or already placed on site do not meet the criteria outlined in this Specification and do not meet compliance with the requirements outlined in this Specification, the material shall be removed from site and be replaced with materials that comply.

The WP Representative may instruct that materials that have become non-conforming are to be removed, blended, reprocessed, or stabilised to improve their properties. Any remedy to be applied to non-conforming materials is to be submitted to the WP Representative before undertaking further works in the area of the non-conforming lot.

6.12.2. Material Quality and Testing Frequency

All arrangements and payments should be made for laboratory costs registered by the National Association of Testing Authorities (NATA) to perform the testing at frequencies nominated in Table 6-4. Assessment of the suitability of the imported material for use as fill shall be per the requirements outlined in Table 6-1 to Table 6-3. The Contractor shall provide the results of those tests to the WP Representative before the commencement of the use of those materials. The materials shall not be used in the construction works without the WP Representative's prior approval of the results. Changes in the quality of materials proposed to be used in the construction works shall require separate testing and the WP Representative's prior approval of the results before using that material in construction works.

Table 6-1: Particle Size Distribution of Imported Fill (Type 1 Fill)

% Passing by Dry Weight (AS1289.3.6.1)	Sieve Size (mm)
100	53.0
85-100	37.50
60 – 100	19.00
50 – 100	9.50
45 – 100	4.75
30 – 100	2.36
20 – 100	1.18
5 – 100	0.425
3 – 30	0.150
1 – 10[1]	0.075

Notes:

(1) Maximum limits of 5% shall apply for backfill material behind retaining walls.

Table 6-2: Particle Size Distribution of Imported Fill (Type 2 Fill)[2]

% Passing by Dry Weight (AS1289.3.6.1)	Sieve Size (mm)
100	53.0
85 – 100	37.50
60 – 100	19.00
50 – 100	9.50

% Passing by Dry Weight (AS1289.3.6.1)	Sieve Size (mm)
45 – 100	4.75
30 – 100	2.36
20 – 100	1.18
5 – 100	0.425
3 – 30	0.150
1 – 20[1]	0.075

Notes:

(1) Maximum limits of 5% shall apply for backfill material behind retaining walls.
(2) Type 2 fill shall only be used if approved by the WP Representative. Perth sand penetrometer testing cannot be utilised for compaction control compliance with Type 2 fill. Not to be used within 1.0 m of finished level or as specified on the drawings

Table 6-3: Material Properties of Imported Fill

Test	Test Method	Type 1 Fill	Type 2 Fill[2]
Maximum Liquid Limit	AS 1289.3.1.1	30%	35%
Maximum Linear Shrinkage	AS 12893.4.1	1%	5%
Maximum Plasticity Index	AS 1289.3.3.1	Non Plastic	12%
Soaked CBR @ 95%MMDD[(1)]	AS1289.6.6.1	> 12	> 10
Maximum Particle Size	AS 1289.3.6.1	53 mm	53 mm

Notes:

(1) MMDD Modified maximum dry density (AS 1289.5.2.1)
(2) Not to be used within 1.0 m of finished level or as specified on the drawings

The Contractor shall regularly produce and submit verified records to the WP Representative to confirm that the specification requirements have been achieved at the frequencies outlined in Table 6-4. Field density testing shall be completed and certified by an independent NATA-registered laboratory. The laboratory shall calibrate the field density testing apparatus against laboratory tests per AS 1289. Field density tests may consist of nuclear density testing to AS 1289.5.8.4, sand replacement testing to AS 1289.5.4.1 or Perth Sand Penetrometer testing to AS 1289.6.3.3 (where appropriate).

Table 6-4: Frequency of Testing

Test	Test Method	Test Frequency
Fill Materials Testing		
Particle Size Distribution	AS 1289.3.6.1	1 test per 1,000m^3 of each type of material
Linear Shrinkage	AS 1289.3.4.1	1 test per 1,000m^3 of each type of material

Test	Test Method	Test Frequency
Plasticity Index	AS 1289.3.3.1	1 test per 1,000m^3 of each type of material
Maximum Modified Dry Density/Optimum Moisture Content	AS 1289.5.2.1	1 test per 2,000m^3 of each type of material
California Bearing Ratio (CBR)	AS 1289.6.6.1	1 test per 2,000m^3 of each type of material
Earthworks Testing		
Finished Earthworks Levels	Surveyed as-constructed drawing showing finished contours	1 per project
Compaction control during construction	AS 1289.5.2.1, 5.4.1, 5.8.4	At the frequency presented in Section 5

6.13. Lime Stabilisation

6.13.1. General

Where soft clayey subgrade materials are encountered, the WP Representative may direct the Contractor to lime stabilise the subgrade materials. The depth and extent of stabilisation shall be agreed upon with the WP Representative or as specified on the project drawings. Stabilisation shall include preliminary loosening of the Pavement Layer, mixing and compacting the pavement material as necessary, spreading lime over the area to be treated, and the thorough blending of in-situ pavement material, lime and water as required to produce a homogeneous stabilised layer over the specified lengths and widths. The Contractor shall safely handle and use the quicklime/slaked lime and provide adequate protection to the workforce, the public, stock, and property. This section addresses the requirements where lime stabilisation is required.

6.13.2. Materials

Lime for stabilisation of any Pavement Layer shall comply with the requirements of AS 1672. The lime shall be sufficiently dry to flow freely during application. The Contractor shall arrange lime delivery and have on-site bulk storage facilities. The Contractor shall be responsible for all arrangements regarding the transfer of lime between delivery vehicles, on-site bulk storage facilities and lime spreaders.

6.13.3. Plant and Equipment

6.13.3.1. Lime Spreader

The spreading equipment shall be a mechanical stabilising agent spreader that has been specifically designed for such work. The spreader shall be capable of uniformly distributing lime and accurately controlling the spread rate such that when mixing is complete, the lime content shall be per the requirements of Section 6.13.5.

The spreader shall be equipped with gates to vary spread width and with electronic weigh scales to give daily totals of product use.

6.13.3.2. Stabilising Machine

Cutting, pulverising, mixing, adding water, and spreading blended material shall be accomplished using a machine specifically designed for pavement recycling. The stabilising machine's rotor action shall be such that the rotor revolves in an upward and forward cutting direction. The rotor shall be of the recycler type and fitted with bullet teeth cutting tips.

Rotary hoes and other implements normally used for agricultural work shall not be used. The stabilising machine shall also satisfy the following requirements:

- Be capable of producing a uniformly mixed material throughout the specified depth of the work.
- Be equipped with a variable depth of cut control and an accurate gauge to measure the depth of cut, which is readily visible to the operator.
- Have provision for adding water automatically through a system comprising a pump, flow meter, variable control valve and full width spray bar. Each nozzle on the spray bar shall be fully and independently adjustable, and the water pump shall have the capacity to supply a minimum of 900 litres per minute.

6.13.4. Preliminary Treatment

The Contractor shall be responsible for determining whether pre-loosening and mixing the in situ material is necessary. Under no circumstances shall the first loosening and mixing operation of the Pavement Layer exceed the final stabilised depth.

6.13.5. Spreading of Lime

Lime shall be spread uniformly at a controlled rate over the area to be stabilised using a suitable lime spreader.

The lime stabilised Pavement Layer shall contain an average of not less than the equivalent percentage of hydrated lime (calcium hydroxide) as determined by lime demand testing per Vic Roads test method RC131.01. The percentage stated shall be a percentage of the dry mass of the Pavement Layer material. The Contractor shall keep daily records of the amounts of lime used and actual spread rates achieved per section treated and make such records available to the WP Representative upon request.

The actual spread rate of lime achieved shall be determined by either:

- placing three trays each of approximately one-third of a square metre in area in front of the lime spreader and measuring the mass of lime deposited on the trays for each lot, or
- by the use of an on-board electronic weigh scale system.

The percentage lime (P%) shall be calculated thus:

$$P = \frac{M \times 100}{A \times T \times MDD}$$

Where

M = total mass of lime (kg) as determined by one of the following methods:

- on each tray
- on-board electronic weight scale system.

A = method (a) total area of the trays (m^2), method (b) total measured area spread (m^2)

T = Thickness to be stabilised (mm) (including allowances for tolerances and trimming)

MDD = Maximum Dry Density of the pavement material without the addition of lime (kg/m^3)

The percentage of lime determined for each tray per this clause shall be maintained within ± 10% by mass of the specified lime content throughout the stabilisation works.

The use of method (b) in determining the values 'M' and 'A' is subject to satisfactory calibration of the measuring device and the production of associated certification per the Contractor's Quality System. Audits on this method shall be carried out using the measuring tray method.

Once the lime has been spread, no plant other than that needed for spreading or mixing and spreading the mixed material shall be permitted to travel over the area to be stabilised.

6.13.6. Incorporation of Lime

The spreading of lime shall not proceed when rain is imminent. The spread lime shall be incorporated into the Pavement Layer immediately following the spreading operation. All spread lime shall be incorporated into the Pavement Layer within the same working day. Lime shall not be spread when the prevailing wind velocity is sufficient to make the lime particles airborne.

Cutting, pulverising, mixing, adding water, and spreading of mixed material shall take place as a single operation within the stabilising machine.

Cutting, pulverising, mixing, adding water, and spreading mixed material shall continue until the maximum size of all material (other than rock) is not greater than 25mm, and the lime and water are uniformly incorporated into the mixed material without streaks or pockets of lime.

6.13.7. Moisture Content

Compaction shall be carried out at a moisture content at any point in the Lot within the range of the Optimum Moisture Content ± 2%.

The Contractor shall be responsible for achieving and maintaining the required moisture content by controlling the amount of water added during the mixing process within the stabilising machine.

6.13.8. Compaction

Compaction and trimming of the mixed material to shape and level shall be completed within the same working day the lime is incorporated into the Pavement Layer. The mixed material shall be compacted to the Characteristic Dry Density Ratio as shown in Table 6-5 or greater.

The Contractor shall be responsible for any additional stabilising, including the supply and incorporation of additional lime, required due to non-compliance with this clause as directed by the WP Representative.

6.13.9. Rework

If a completed layer of lime stabilisation does not satisfy all of the requirements of the Specification and has to be reworked, the Contractor shall repeat all the requirements for Lime Stabilisation without the addition of lime.

Rework shall include any disturbance to the surface of the lime stabilized layer during trimming to meet shape or level requirements undertaken after the working day that the lime is incorporated into the Pavement Layer. The rework depth shall not be less than the full depth of the affected layer.

6.13.10. Construction Joints

When the stabilising work cannot be completed in one continuous operation, the Contractor shall provide construction joints at each discontinuity in the operation.

Construction joints shall be made transverse to and/or parallel to the direction of the stabilising run and just before the commencement of the next stabilising run.

The joints shall be formed by cutting back into the compacted stabilised material to form a vertical face. The loose trimmed material shall be removed from the joint before the next section is mixed, compacted, and disposed of to the Contractor's spoil area.

6.13.11. Preliminary Trial

The Contractor shall carry out a preliminary trial of the proposed stabilising operations. The trial shall determine:

- The effectiveness of the plant.
- The number of passes of the stabilising machine necessary to achieve the specified mixing.
- The trial section shall be located within the Works area.
- Before conducting such a trial, the Contractor shall agree with the WP Representative on the location, length, and width of trial section(s) within the Works.

6.14. Placement and Compaction of Materials

Fill materials shall be spread in un-segregated uniform layers spread no greater than 300mm or less than 100 mm loose thickness before grading and compaction. Each layer worked shall be generally parallel to the finished surface and shall, where practicable, extend to the full width of the embankment at that particular level. The placed material shall be protected against the effects of rain, stormwater, over-watering, heaving and erosion from any source.

6.14.1. Preparation of Surface for Next Lift

The surface of each compacted layer shall be lightly scarified (other than cohesionless sand) before placing further fill and shall not spread any further fill on any compacted area (including in situ material) until approved to do so by the WP Representative.

6.14.2. Acceptance of Layer

Placement of fill over any preceding layer shall not proceed without the completion of compaction and the WP Representative's approval of the condition of the preceding layer. Compaction test results for the preceding layer shall be provided to the WP Representative for review and acceptance.

6.14.3. Compaction Moisture Content

Fill materials and in situ materials shall be moisture conditioned to target a moisture content between the optimum moisture content ± 2% for that material as determined by WA 133.1 or 133.2. In granular, free draining materials, compaction outside of this range is permissible. The Contractor shall demonstrate, however, to the WP Representative that compaction outside of this range, is achievable.

6.14.4. Level Control

The final levels of the cut and filled areas shall be surveyed on a grid of no more than 10 square meters, and a copy of the results shall be supplied to the WP Representative. The maximum tolerance for horizontal position at any point shall be ±50 mm (horizontally) from the design level. The maximum vertical tolerance for vertical position at any point shall be ±25 mm (vertically) from the design level. All final fill and cut surfaces shall be free draining with no local depressions greater than 15 mm depth under a 3 m straight edge.

No placement of pavement or surfacing materials shall proceed without the WP Representative's approval of the levels and compaction of the cut and fill areas.

6.15. Compaction Limits

The embankment foundation, subgrade and select fill shall be placed and compacted per the details provided in Table 6-5 at the frequencies outlined in Table 6-4. Testing shall be carried out by an independent NATA-accredited testing authority. Lot acceptance shall be on a statistical basis per the requirements outlined in Section 5.

Table 6-5: Compaction Requirements for Embankment Foundation, Subgrade and Select Fill (Density Ratio*)

Description	Minimum Characteristic Dry Density Ratio - Cohesive Material (%)	Minimum Characteristic Dry Density Ratio Non Cohesive Material (%)
Embankment Foundation (to a minimum depth of 300mm or as noted in the geotechnical report)	90% MMDD	92% MMDD
Subgrade (upper 300mm of earthworks or below pavements)	--	96% MMDD
Select Fill (below 300mm)	95% MMDD	95% MMDD

Notes:

1.* Density Ratio: In situ density expressed as a percentage of Modified Maximum Dry Density according to AS 1289.5.2.1, AS 1289.5.3.1, AS 1289.5.4.1 and AS 1289.5.8.1

7. Pavements and Hardstands

7.1. Scope

This section of the construction specification deals with the supply, placement, spreading, compaction, and grading to the level of pavement layers for roads and hardstand storage areas. It also provides the requirements for types and quality of materials, supply, placement, and construction.

7.1.1. Hardstand Areas

Hardstand areas, as commonly required by Western Power, are used to provide a trafficable surface. Depending on the design requirements, the hardstand may comprise one or more layers of selected sub-base or base course material as defined on the project drawings. The hardstand is constructed to provide support for storage, construction, and maintenance plants. Following completion of the construction, an overlay of single-sized crushed stone is (maybe) required around substation yards to provide minor surface protection, off-surface drainage, and electrical safety.

7.1.2. Pavements

Depending on traffic loading and design requirements, the pavements may comprise single or multi-layers made up of selected materials that meet the specified quality requirements. Typical pavement types are access roads and internal or external roads providing entry to substations. The project drawings detail the pavement and surfacing requirements.

7.2. Materials

7.2.1. General

All pavement materials shall be of uniform quality within each type of material and use and free of organic material, clay, topsoil, vegetation, and other harmful materials. The WP Representative shall be advised of the source of proposed pavement materials, and the test results shall be submitted for the Western Power representative approval from representative samples taken from the pit or the commercial quarry. Recycled materials shall not be used without prior approval from the WP Representative.

Mixing differing materials to provide road construction materials shall not be permitted without the Western Power representative's prior approval of the management of the mixing, stockpiling and testing processes. If blending is undertaken, laboratory testing shall be undertaken to confirm that the blended material meets the requirements of this Specification.

7.2.2. Water for Use in Pavement Construction

Water used in any pavement construction, or the pavement material manufacture process shall comply with the requirements of Main Roads Western Australia publication 6706/02/133 "Water to be used in Pavement Construction" and shall be clean and substantially free from detrimental impurities such as oils, salts, acids, alkalis, and vegetable substances. Water sources classified by the relevant Water Authority as potable water shall be exempt from this requirement.

7.2.3. Crushed Limestone

7.2.3.1. General

Crushed limestone is the generic name for Tamala Limestone, commonly found on the Swan Coastal Plain. Crushed limestone may be used as a base course material in unsealed pavements, in sealed pavements if stabilised with bitumen or as a sub-base material. Crushed limestone may also be used to form a select subgrade in areas where weak embankment foundation conditions are encountered. Limestone shall not be used as a base course material where a seal or asphalt is applied to the surface.

The pavement design requirements are detailed in the project drawings.

7.2.3.2. Crushed Limestone Quality Requirements

Crushed limestone materials considered for use as Sub-base or as Base Course material within an unsealed pavement shall comply with the quality criteria detailed in Table 7-1.

Crushed limestone for the project shall be free of harmful materials, including vegetation and clay. The material shall be stockpiled on a clean prepared surface and shall not be contaminated by the underlying surface upon which it is stored.

Table 7-1: Material Properties of Crushed Limestone

Property		Limits	Test Method
Particle Size Distribution (1)	Nominal Aggregate Size	40mm	AS 1289.3.6.1
	AS Sieve Size(mm)	% passing by dry weight	
	75	100	
	19	55-85	
	2.36	35-65	
Maximum Linear Shrinkage		1.0%	AS 1289.5.4.1
Los Angeles Abrasion Value of Crushed Limestone(2)		20% Min - 60% Max	WA 220.2
California Bearing Ratio (Soaked) at 94% MMDD(2)		>50%	AS 1289.6.1.1 and AS 1289.5.2.1
Calcium Carbonate Content ($CaCO_3$)		60% Minimum	WA 915.1

Notes:
(1) Allowance must be made during crushing in the pit for particle breakdown during loading, mixing, placement and compaction.
(2) The percentage retained on the 19mm sieve shall be crushed to -19mm and mixed into the test sample for testing.

7.2.3.3. Frequency of Quality Testing for Crushed Limestone

The WP Representative shall be provided with the test results demonstrating the proposed material meets the criteria before its use on Site, with new representative tests carried out every 1000m³ or part thereof. Generic supplier test results shall not be accepted.

7.2.4. Bitumen Emulsion Stabilised Limestone Basecourse

7.2.4.1. General

Bitumen Emulsion Stabilised Limestone (BSL) shall be produced adding a minimum of 2.0% residual bitumen by mass to crushed limestone material as specified in this clause. The limestone shall be free from sand, roots, and other foreign material and shall conform to the particle size distribution and material property requirements for 20mm nominal size crushed limestone (following mixing), as detailed in Table 7-2.

Table 7-2: Material Properties of Crushed Limestone For Bitumen Stabilisation

Property	Limits	Test Method	
Particle Size Distribution (1)	Nominal Aggregate Size	20mm	AS 1289.3.6.1
	AS Sieve Size(mm)	% passing by dry weight	
	26.5	100	
	19	90-100	
	4.75	60 - 90	
	1.18	35 - 75	

Property	Limits	Test Method	
Los Angeles Abrasion Value of Crushed Limestone [2]		20% Min - 60% Max	WA 220.2
Dispersion of Bitumen in Soil[3]		Class 1	WA 717.1
Bitumen Content – Centrifuge Method		2.0% Min – 2.2% Max	WA 730.1

Notes:

(1) Allowance must be made during crushing in the pit for particle breakdown during loading, mixing, placement and compaction.
(2) The percentage retained on the 19mm sieve shall be crushed to -19mm and mixed into the test sample for testing.
(3) Compliance for bitumen dispersion of any lot shall be based on the results of the assessment of 3 samples randomly selected from the lot being judged and tested in accordance with Test Method WA 717.1. All results must have a dispersion of Class 1; however, the WP Representative may accept the material if one of the three samples has a dispersion of Class 2.

7.2.4.2. Bitumen Emulsion

The bitumen emulsion used to stabilise (modify) the crushed limestone shall be Grade ASS/170-60 emulsion complying with the requirements of AS 1160 “Bitumen Emulsion for Construction and Maintenance of Pavements”. The emulsifier used in the manufacture of the emulsion shall be Vinsol resin. All water added during the mixing process and field moisture requirements during construction shall contain a wetting agent such as “Teepol”, “Comprox”, or an equivalent approved product, which shall be added at a rate of 1 litre of wetting agent per 4000 litres used.

7.2.4.3. Mixing

The mixing process shall produce a homogeneous mixture of limestone, bitumen, and water in which the bitumen is uniformly distributed in the form of a thin film covering the particles of the crushed limestone. Mixing shall be carried out as a batch or continuous process in a suitable plant. This plant shall include measuring equipment that will determine the mass of bitumen emulsion added to a known mass of bitumen emulsion. Before using the proposed for the modification process, it shall be certified to the WP Representative that the plant is capable of determining the amount of bitumen emulsion added to the limestone to within ±0.2% of the specified amount.

7.2.4.4. Curing

All stabilised limestone shall be stockpiled for at least three days before delivery to site. The mixture shall have a moisture content of at least 95% of the Optimum Moisture Content as determined per the Modified Compaction test to AS 1289.5.2.1. The moisture content shall be determined per AS 1289 2.2.1 on samples taken from trucks before delivery.

7.2.5. Laterite Gravel

7.2.5.1. General

Lateritic gravel is naturally occurring pedogenic, pisolithic gravel typically won by ripping, stockpiling, and loading. This specification applies to constructing a base course layer, and laterite with a lower quality may be used for sub-base if approved by the WP Representative.

Lateritic gravel, as proposed to be brought to Site, shall be free of vegetation, organic matter or clay clods and shall not be contaminated with the material upon which it is stored before supply from the source or before being used in pavement construction. The material shall be from a certified “Dieback-free” source (within the last 12 months) and all delivery trucks shall be washed down or demonstrated as dieback-free before delivery to the Site.

7.2.5.2. Laterite Gravel Quality Requirements for Base Course

The laterite gravel used as base course shall conform to the criteria detailed in Table 7-3 and Table 7-4.

Table 7-3: Particle Size Distribution Requirements of Laterite Gravel for Use as Base Course

Sieve size (mm)	% passing by dry weight
37.5	100
19.0	71-100
9.50	50-81
4.75	36-66
2.36	25-53
1.18	18-43
0.425	11-32
0.075	4-19
0.0135	2-9

Table 7-4: Other Material Properties for Laterite Base Course

Test	Limit	Standard
Liquid Limit	Not >30%	AS 1289.3.1.1
Plasticity Index	Not >6%	AS 1289.3.3.1
Linear Shrinkage	Not >3%	AS 1289.3.4.1
MDCS (1)	>2.3 MPa	WA 140.1
Soaked CBR at 98% MMDD (2)	Minimum 80%	AS 1289.6.1.1 and AS 1289.5.2.1
Dryback	Not >85% OMC(3)	WA 136.1

Notes:

(1) MDCS Maximum Dry Compressive Strength
(2) MMDD Modified Maximum Dry Density
(3) OMC Optimum Moisture Content at MMDD

The WP Representative should be provided with the test results demonstrating the proposed material meets the above criteria before its use on Site, with additional representative tests at every 1,000m³ or part thereof. Generic supplier test results shall not be accepted.

7.2.5.3. Laterite Quality Requirements for Sub-base

The laterite gravel for use as a sub-base shall conform to the criteria detailed in Table 7-5 and Table 7-6.

Table 7-5: Particle Size Distribution Requirements of Laterite Gravel for Use as Sub-base

Sieve size (mm)	% passing by dry weight
75.0	100

Sieve size (mm)	% passing by dry weight
37.5	80-100
19.0	50-100
9.50	36-81
4.75	25-66
2.36	18-53
1.18	13-43
0.425	8-32
0.075	3-19

Table 7-6: Other Material Properties for Laterite Sub-base

Test	Limit	Standard
Liquid Limit	Not >30%	AS 1289.3.1.1
Plasticity Index	Not >10%	AS 1289.3.3.1
Linear Shrinkage	Not >4%	AS 1289.3.4.1
Soaked CBR at 96% MMDD(2)	Minimum 50%	AS 1289.6.1.1 and AS 1289.5.2.1
Dryback	Not >85% OMC(2)	WA 136.1

Notes:

(1) MMDD Modified Maximum Dry Density

(2) OMC Optimum Moisture Content at MMDD

The WP Representative should be provided with the test results demonstrating the proposed material meets the above criteria before its use on Site, with additional representative tests at every 1,000m³ or part thereof. Generic supplier test results shall not be accepted.

7.2.6. Crushed Rock Base Course

Crushed rock material shall consist of finely crushed rock quarried from an approved source. It shall consist of quartzite, granite, diorite, ironstone, or other stone of approved hardness and durability. It shall be free from clay lumps, overburden, excess organic, or other harmful materials.

Crushed rock base course material shall be thoroughly mixed with water to produce a homogeneous product suitable for placement into the final position.

Coarse aggregate (retained 4.75mm sieve) shall consist of clean, hard, durable, angular rock fragments produced by crushing sound unweathered rock and shall not include materials that break up when alternately wetted and dried.

Fine aggregate (passing 4.75mm sieve) shall consist of crushed rock fragments or a mixture of crushed rock fragments with natural sand or clayey sand. Crushed rock fine aggregate from each source shall, except as to size, comply with all the provisions specified for coarse aggregate.

The material shall vary from coarse to fine uniformly and consistently. The material shall not be gap-graded as represented by the grading crossing from the maximum limit for one sieve size to the minimum limit for another. and shall conform as closely as possible to the specified target grading.

The materials shall be certified as “Dieback free” (certification within 12 months of use) at the time of delivery to site.

The crushed rock shall conform to the criteria detailed in Table 7-7 and Table 7-8. Allowance shall be made for changes in the material properties during transportation, stockpiling, loading, working and compaction.

Table 7-7: Particle Size Distribution Requirements for Crushed Rock Base Course

Sieve size (mm)	Target grading	Grading Limits
	% passing by dry weight	
26.5		100
19.00	100	95-100
13.2	82	70-90
9.5	70	60-80
4.75	50	40-60
2.36	38	30-45
1.18	25	20-35
0.600	19	13-27
0.425	17	11-23
0.300	13	8-20
0.150	10	5-14
0.075	8	5-11

Table 7-8: Other Material Properties for Crushed Rock Basecourse

Test	Limits	Test Method
Liquid Limit	Not >25%	AS 1289.3.1.1
Plasticity Index	Not >6%	AS 1289.3.3.1
Linear Shrinkage	Not >1.5%	AS 1289.3.4.1
Soaked CBR at 98% MMDD (1)	Minimum 100%	AS 1289.6.1.1 and AS 1289.5.2.1
Flakiness Index	Not >30%	WA 126.1
Los Angeles Abrasion Value	Not>35%	WA 220.1
Maximum Dry Compressive Strength	Not <2.3MPa	WA 140.1
Dryback	Not >60% OMC (2)	WA 136.1

Notes:

(1) MMDD Modified Maximum Dry Density
(2) OMC Optimum Moisture Content at MMDD

The WP Representative shall be provided with the test results demonstrating the proposed material meets all the above criteria before its use on site with test results provided for representative samples taken for every 1000 m^3 of material supplied. Generic supplier test results shall not be accepted.

7.3. Pavement Materials Testing

The Contractor shall arrange and pay for a testing authority registered with NATA to perform each test nominated in this Specification. Test results for the tests nominated shall be provided to the WP Representative for approval for each material type proposed for pavement construction. Where changes to the quality or nature of each material type are observed, the Contractor shall undertake additional testing at the frequencies outlined in this Specification at no additional cost to Western Power.

7.4. Placement and Compaction Requirements

Pavement materials shall be placed and spread in a manner not likely to cause segregation of the components or size fractions. The materials shall be spread uniformly, with moisture conditioned and not more than 250mm loose thickness and not less than 100mm loose thickness.

Any corrections made to thicknesses of pavement materials after compaction shall be made only after tyning the surface to be corrected to a depth of not less than 100mm or the depth of the layer (whichever is less). The re-worked layer shall be tyned, re-graded and compacted without lamination, segregation, or contamination of the component materials.

Compaction plant items shall be selected for their appropriateness for the material to be placed and operated by relevantly licensed, experienced operators in a controlled, uniform manner to achieve uniform compaction in all materials.

The pavement compaction requirements are detailed in Table 7-9.

Table 7-9: Pavement Material Compaction Specification

Pavement Layer	Characteristic Dry Density Ratio (%) MMDD (1)
Base Course (Crushed Rock, Laterite Gravel)	Not <98
Basecourse (Bitumen Stabilised Limestone, Limestone (Unsealed Application))	Not <96
Sub-base (Laterite Gravel)	Not <96
Sub-base (Crushed Limestone)	Not <94
Selected Subgrade Fill	Not <96
Non Cohesive Fill	Not <95

Notes:

(1) MMDD Modified Maximum Dry Density Ratio AS 1289.5.2.1

In situ density of the compacted layers shall be determined using a Nuclear Density Meter per AS 1289.5.8.1. The moisture content of the tested layer shall be determined by oven drying per AS 1289.2.1.1. Density and dryback testing shall be undertaken at a frequency outlined in Section 5 at a rate of not less than one test per 500 m^2 of pavement material placed.

Repairs to the locations tested shall be made using materials identical to those being tested and shall be locally compacted to the same condition as the adjacent pavement.

The Contractor shall produce and submit promptly, following completion of the testing, verified records to the WP Representative to confirm that the Specification requirements have been achieved. The results of the testing shall be supplied to the WP Representative as soon as possible. The layer shall not be accepted until the WP Representative has viewed and approved the test results.

The WP Representative may also elect to have separate independent tests performed. The repairs to the tested pavement, as necessary to render the pavement uniform for compaction and level, shall be made.

7.5. Aggregate Cover in Switch Yards

Where nominated on the project drawings, the Contractor shall supply and spread aggregate over the completed Switchyard. This is to be carried out after the construction and installation of all sub-surface and surface-mounted structures and services, including cables, drainage, earthing, foundations, plinths, buildings, etc.

The material shall be natural hard, crushed, uniformly graded material comprising unweathered stone from a single source for uniformity of appearance. The material shall be free of any contaminants and other size stones. Unless otherwise stated this aggregate shall be a nominal single-size 20mm concrete aggregate conforming to the requirements of AS 2758.1.

The material shall be spread at a nominated single thickness over the designated areas shown in the drawings. The thickness shall be not less than 100 mm after spreading and compaction by the spreading plant only.

7.6. Level Tolerances of Pavement Materials

After compaction and grading of any layer of pavement material, the surface shall be uniform in appearance, tightly bonded and shall conform to the following tolerances:

Horizontally

- +/- 50 mm

Vertically

- Subbase surface tolerance of +/- 15 mm at any point
- Basecourse surface tolerance of +/- 10 mm at any point
- +/- 5 mm of the lip of a kerb, where the pavement is to be constructed to the lip level of the kerb and gutter.

Layer Thickness

- Subbase +/- 15 mm of the layer thickness specified at any point
- Base +/- 10 mm of the layer thickness specified at any point.

Shape

- No point on the surface of any pavement layer should vary by more than 5-10 mm from a 3 m straight edge (DTEI SA 2007, RTA 2007a, VicRoads 2008b)
- At no location should water pond on the surface of any pavement layer.

The written confirmation of ‘as-built’ pavement levels shall be given to the WP Representative within 24 hours of the levels being taken.

7.7. Dryback of Pavement Layers

Each pavement layer shall be constructed to the dimensions and details shown on the Drawings and to the Specification requirements and compacted to the appropriate Minimum Dry Density Ratio as detailed in Table 7-9. The pavement materials shall be dried back to the characteristic moisture content detailed in Table 7-10.

Table 7-10: Dryback Requirements for Pavement Layers

Pavement Layer	*Dryback Characteristic Moisture Content (DCMC)
Sub-base	
Natural Gravel, Crushed Limestone and Laterite	Not >85% OMC
Basecourse	
Laterite Gravel	Not >70% OMC
Bitumen Emulsion Stabilised Limestone (BSL)	Not >85% OMC
Crushed Rock Base Course	Not >60% OMC

Notes:

(1) *The in-situ moisture content of the pavement layer must be below the indicated value expressed as a % of the Optimum Moisture Content (OMC) of the material.

8. Specification for Bituminous Surfacing

8.1. Scope

This section covers the manufacture, delivery, laying and testing of bituminous surfacing, including priming, seals and dense graded asphalt for road pavements.

8.2. Materials for Bituminous Surfacing

8.2.1. Bitumen

All bitumen used, whether as residual bitumen or for manufacturing cutback bitumen, polymer-modified bitumen, or bitumen emulsion, shall be a straight run, slightly blown or blended product prepared by distillation from crude bituminous base oils. The bitumen shall be homogeneous. It shall not foam when heated to 205°C. The formation of a thin layer of bubbles will not be regarded as foaming.

The bitumen shall be a straight run slightly blown bitumen distilled from an asphaltic base petroleum. The grade is to be Class 170 or Class 320. An approved polymer specified by the pavement designer may also be used. The bitumen shall conform to AS 2008.

Class 170 and Class 320 bitumen shall conform to the properties shown in Table 8-1 at the time of manufacture and at any time until the bitumen is used.

Table 8-1: Bitumen Quality Requirements

Method of Test	Property	Class 170		Class 320	
		Min	Max	Min	Max
AS 2341.2 or AS 2341.3	Viscosity at 60°C, Pa.s	160	230	260	380

Method of Test	Property	Class 170		Class 320	
		Min	Max	Min	Max
AS 2341.2 or AS 2341.3 or AS 2341.4	Viscosity at 135°C, Pa.s	0.30	0.50	0.40	0.65
AS 2341.12	Penetration at 25°C, (100g, 5s), pu (1 pu = 0.1 mm)	55	78 (Note)	40	-
AS 2341.7	Density at 15°C, kg/m³	1000	-	1000	-
AS 2341.14	Flash Point, °C	250	-	250	-
AS 2341.8	Matter insoluble in toluene, percent	-	1.0	-	1.0
AS 2341.10	Short-term effect of heat and air (Rolling Thin Film Oven Test)				
AS 2341.2 or AS 2341.3	Viscosity of residue at 60°C as percentage of original	-	300	-	300
AS 2341.11	Ductility at 15°C, mm	400	-	Not Applicable	
AS/NZS 2341.13 or WA 716.1	Durability Value (for C170 bitumen used in sprayed sealing only)	9 days or greater		Not Applicable	

Notes:

(1) The Penetration value can exceed the maximum limit of 78 if the result for Viscosity at 60°C has been verified by a second laboratory to the laboratory that did the initial testing.

8.2.1.1. Handling and Transport

Procedures as detailed in the AUSTROADS publication "Bitumen Sealing Safety Guide" shall be followed when loading, transporting, heating, circulation, blending, transferring, and sampling bitumen and cutback bitumen. The supplier and carrier shall also observe the provisions and be licensed to perform delivery and heating per the Dangerous Goods Safety (Storage And Handling Of Non-Explosives) Regulations 2007 (WA) with respect to the transport of Dangerous Goods, including Flammable Liquids.

Residual bitumen shall be loaded into road tankers at temperatures between 170°C and 205°C or per the safe loading requirements of the facility where the bitumen is being loaded.

The tanker shall be equipped with facilities to enable circulation, heating and mixing of the bitumen before unloading. Operations involving heating and circulating of bitumen shall only be done by appropriately trained personnel.

8.2.2. Medium Curing Cutting Oil

The medium curing cutting oil used in priming shall conform to the requirements outlined in Table 8-2.

Table 8-2: Medium Curing Cutting Oil Requirements

Property	Requirement	Test Method
Initial boiling point	132-160°c	ASTM D86
Final boiling point	265°c Max	ASTM D86
Temperature at 50% recovery	220°c Max	ASTM D86

Property	Requirement	Test Method
Flash point (Pensky Martin Closed)	35°c	AS 2106
Density at 15□c	780-820 kg/m3	AS 2341.7
Percentage aromatics	15% Min (volume)	ASTM D1319
Miscibility with equal parts of Class 170 bitumen	Complete, no precipitation	
Viscosity at 40□c	1.0-1.4 mm^2/s	ASTM D445
Water content	0.05% Max	AS 2341.9

8.2.3. Slow Curing Cutting Oil

Slow curing cutting oil used in pre-coating for spray seals shall be the recognised petroleum product distillate fuel oil conforming to the requirements outlined in Table 8-3.

Table 8-3: Slow Curing Cutting Oil Requirements

Property	Requirement	Test Method
Initial boiling point	170-195°c	ASTM D86
Final boiling point	360-400°c	ASTM D86
Temperature at 50% recovery	250-2900c	ASTM D86
Flash point (Pensky Martin Closed)	65°c Min	AS 2106
Miscibility with equal parts of Class 170 bitumen	Complete, no precipitation	
Viscosity at 40□c	2.0–4.0 mm2/s	ASTM D445
Water content	0.05% Max	AS 2341.9

Supply of certified Automotive Distillate, with a statement that it had been supplied without change as slow curing Cutting Oil, is acceptable.

8.2.4. Bitumen Emulsion

8.2.4.1. General

Bitumen emulsion used for the application of a primerseal, or sprayed seal shall be a cationic rapid setting emulsion (Grade CRS/170-60) conforming to the requirements of AS 1160.

Bitumen emulsion for the application of a tack coat under asphalt shall be Cationic Slow Setting grade CSS/170-60, conforming to the requirements of AS1160.

Alternative specifications can be submitted by the Contractor provided that:

- Bitumen content - the residual bitumen content of the emulsion must be stated.
- Additives - the addition of up to 2% by volume of additives may be required by the WP Representative.
- Patents - the emulsion to be used shall be manufactured under an approved patent.

The Contractor must set out facilities and have spray tankers available for spraying emulsion directly onto the road.

8.2.4.2. Handling and Transport

Bitumen emulsion shall be loaded into road tankers at a temperature that ensures the product remains stable and per the manufacturer's instructions. Road tankers shall be lagged and have thermometers suitably located to give a representative temperature reading of the product in the tanker. The tanker shall have facilities to enable circulation and mixing of bitumen emulsion before unloading.

Operations involving the heating and circulating of bitumen emulsion shall only be done by appropriately trained personnel.

Water used to dilute bitumen emulsion shall be compatible with the emulsion. The water shall be added to the emulsion at a suitable temperature. Emulsion shall not be added to the water.

8.2.5. Aggregate for Sprayed Sealing

The aggregate used for surfacing roads shall consist of clean, tough, durable fragments free from an excess of thin or elongated pieces, free from soft or disintegrated pieces, stone coated with dirt, clay, organic matter, or other harmful matter, per AS 2758.2.

Source rock shall be selected from an approved quarry site such that the feed to the primary crusher is fresh, hard, and durable rock, free from clay, organic matter, weathered (except as allowed below) or friable material, and is consistent in appearance. A classification system for rock material weathering is defined AS 1726.

The proportions of weathered rock material in the source rock shall not exceed the following limits by mass:

- Slightly weathered rock - 10% maximum
- Distinctly weathered rock - 0.1% maximum
- Extremely weathered rock - 0.1% maximum
- Residual soil - 0% maximum

Aggregate shall be the product of crushing and screening sound stone quarried from an approved source. The type and size of aggregate shall be as specified in the construction drawings.

Selection and processing of rock from the source shall be such that the crushed material is of uniform quality, free from soft or weathered particles, clay or other harmful matter and shall conform to the requirements shown in Table 8-4.

Table 8-4: Spray Sealing Aggregate Requirements

Property	Requirement	Test Method
Moisture Content	Dry (free of visible surface moisture)	AS 1289.2.1.1 or AS 1289.2.1.2
Los Angeles Abrasion Value (Note 2)		
Granite and other rock types	35% maximum	AS 1141.23
Basalt	25% maximum	AS 1141.23
Flakiness Index (Note 2)	35% maximum (Note 4)	AS 1141.15
Average Least Dimension (Note 3)	Report	AS 1141.20.1 or WA 215.1
Water Absorption	2% maximum	AS 1141 6.1

Property	Requirement	Test Method
Wet Strength	100kN minimum	AS 1141.22
Wet/Dry Strength Variation	35% maximum	AS 1141.22
Stripping Test Value (Note 1)	10% maximum	AS 1141.50
Degradation Factor	50 minimum	AS 1141.25.2
Secondary Mineral Content (Note 5)	25% maximum	AS 1141.26
Petrographic Examination	Statement of suitability for use as a sealing aggregate	

Notes:

(1) The aggregate shall be tested in a clean dry condition without precoating. The binder shall include 0.5% by volume of one of the approved adhesion agents listed at Section 8.2.7.
(2) Not applicable for crusher dust, sand, 7 mm, and 5 mm aggregate.
(3) ALD is the mean of three samples from a roadside stockpile used in calculating the Binder Application Rate as referenced in the Contract specification. Where the aggregate is supplied direct from a quarry the size of a lot for the purpose of testing must not exceed 1000 m^3.
(4) Applicable to the mean of three results for each lot.
(5) This test is only applicable to basic igneous rock.

The aggregate shall be of a uniform colour and appearance for the whole of the application. Other than for Flakiness Index, Moisture Content and Average Least Dimension, testing for conformance shall only be undertaken on either 10 mm or 14 mm sized aggregate.

If testing shows that material delivered to the stockpile does not conform to these specifications, such material shall be removed from the site and replaced with suitable aggregate.

The flakiness index of granite shall not exceed 35% (mean of three results for each lot).

The limits on the percentage of aggregate passing Australian Standards sieves by mass of sample shall be as outlined in Table 8-5.

Table 8-5: Aggregate Grading Requirements

Nominal Grading of AS sieve	5mm	7mm	10mm	14mm
16.0mm	-	-	-	100%
13.2mm	-	-	100%	80-100%
9.50mm	-	100%	80-100%	0-20%
6.70mm	100%	80-100%	0-20%	0-2%
4.75mm	80-100%	0-25%	0-2%	-
2.36mm	0-30%	0-2%	-	-
1.18mm	0-1.0%	0-0.5%	0-0.5%	0-0.5%
600 microns	-	-	-	-

8.2.6. Precoating Agent

Except for fine aggregates such as sands and crusher dust, all aggregate used as cover material with Class 170, Class 320, Polymer Modified binder or cut-back binder shall be precoated with a distillate or bitumen based precoating fluid meeting the requirements of this specification.

Precoating crushed aggregate for bitumen emulsion surfacing work is not required.

8.2.6.1. Distillate Precoating Fluid

Unless otherwise specified or approved by the WP Representative, the standard Precoating Fluid shall be Slow Curing Cutting Oil with 0.5% by volume of an approved adhesion agent for sprayed sealing works. Slow curing cutting oil shall be a recognised petroleum product distillate fuel oil conforming to the requirements shown in Table 8-6.

Table 8-6: Pre-coating Requirements

Property	Specification Limits	Test Method
Distillation °C		ASTM D86
Initial boiling point	170°C - 195°C	
Final boiling point	360°C - 400°C	
Temperature at 50% recovery	250°C - 290°C	
Flash point °C	65 minimum	AS 2106
Viscosity at 40°C mm^2/S	2.0 - 4.0 mm^2/s	ASTM D445
Miscibility with equal parts Class 170 bitumen	Complete no precipitation	
Water content %	0.05% maximum	AS 2341.9

8.2.6.2. Bitumen Based Precoating Fluid

Where specified or approved by the WP Representative, bitumen based Precoating Fluid shall be a blend of Slow Curing Cutting Oil, Class 170 Bitumen, and an approved adhesion agent for sprayed sealing works. The blend may contain between 15% and 30% by volume of bitumen and shall contain 0.5% by volume of adhesion agent. The fluid shall not contain any other materials, whether they are bituminous materials, fuels, solvents, water, or oils.

8.2.7. Adhesion Agent

Adhesion agents shall be added to the sprayer on site, dissolved in the hot binder and thoroughly mixed. The binder shall be sprayed within 12 hours of adding the adhesion agent to the binder. An approved adhesion agent shall be added at a rate of 0.5% by volume of binder to all bituminous binders used for application in primes, primerseals and seals, except bitumen emulsion. The approved adhesion agents are given in the Table 8-7. Alternative adhesion agents may be considered, but the WP Representative must provide approval before using them. If alternatives are proposed, evidence of successful previous use must be provided.

Table 8-7: Approved Adhesion Agents

Type
Bitumite Concentrate
Redicote BE
Diamin TO-L
Rhodaval DA 410
Aggrebond PC
Evotherm PC 1770

The Adhesion Agent for asphalt mixes shall be hydrated lime conforming to AS 1672.1. For mixes produced in rural regions where the inclusion of hydrated lime may be impractical, an approved liquid adhesion agent, shown in Table 8-7, shall be added to the asphalt binder to promote adhesion. When liquid adhesion agents are used, the concentration of adhesion agent in the binder tank at any time during production shall be between 0.5% to 1.0% by mass of the binder. The adhesion agent shall have been added to the binder no more than 48 hours before the asphalt production.

8.2.8. Protective Paper

A heavy-duty protective paper such as bitumen laminated paper shall be used for all starts, finishes and to protect other features. The paper shall be held securely in place during spraying operations and shall be of sufficient width and strength to prevent overspray during running starts and spillage during removal. A suitable minimum standard is Sisalkraft 310, or equivalent approved by the WP Representative, with a minimum width of 900 mm.

8.2.9. Aggregate for Asphalt Works

Source rock shall be processed to produce crushed and/or screened aggregate suitable for asphalt works. The aggregate shall be of uniform quality, clean, hard, durable, and free from excess dust, clay, organic matter, and elongated particles. The aggregate shall be of a uniform colour and appearance for the whole of the application. Coarse aggregate is defined as the material retained on a 2.36 mm sieve. Physical properties of crushed aggregates shall conform to the requirements of Table 8-8. Other than for the Flakiness Index, testing for conformance shall only be undertaken on either 10 mm or 14 mm sized aggregate.

Table 8-8: Aggregate Requirements for Asphalt

Property	Specification Limits	Test Method
Los Angeles Abrasion Value		
Granite and other rock types	35% maximum	AS 1141.23
Basalt	25% maximum	AS 1141.23
Flakiness Index	35% maximum	AS 1141.15
Water Absorption	2% maximum	AS 1141 6.1
Wet Strength	100kN minimum	AS 1141.22
Wet/Dry Strength Variation	35% maximum	AS 1141.22

Property	Specification Limits	Test Method
Stripping Test Value - Only applicable to regional plants	10% maximum	AS 1141.50
Degradation Factor	50 minimum	AS 1141.25.2
Secondary Mineral Content (Note 1)	25% maximum	AS 1141.26
Petrographic Examination	Statement of suitability for use as an asphalt aggregate	

Notes:

(1) Only applicable to basic igneous rocks

Fine aggregate is defined as all material retained on a 75 micron Australian Standard Sieve and passing a 2.36 mm Australian Standard Sieve and shall consist of clean, tough, durable grains free from clay, loam, or other foreign matter. Fine aggregate shall only consist of crushed rock material. When the fine aggregate is tested per AS 1141.5, the water absorption shall not exceed 2%.

Aggregate shall be loaded, transported and stockpiled in such a manner as not to cause contamination, loss of material or deterioration of properties. Any aggregate that is considered contaminated or otherwise non-conforming or unsuitable for use at any stage before use shall not be used. Aggregates are to be stockpiled only in agreed suitable free draining areas and do not allow contamination with other stockpiles or surrounding or floor materials.

8.3. Plant for Bituminous Surfacings

The management of all plant and equipment used to undertake the work under the Contract shall be addressed in the Quality Plan per AS/NZS ISO 9001.

8.3.1. Bitumen Sprayers

A mechanical sprayer shall be used to apply all primes, primerseals and seals. The sprayer shall comply with the relevant standards for sprayers. The sprayer shall have a current certification and be in good working and mechanical condition.

Bitumen sprayers shall be of 2,700 litres minimum capacity and comply with the requirements for bitumen sprayers of "Specification for Mechanical Sprayers of Bituminous Materials" issued by AUSTROADS. In addition to the above requirements, the sprayer dipstick shall be calibrated in 50 litre increments. Unless the sprayer is of the air pressure type, the spray bar shall be fully circulating.

The sprayer shall have been tested for uniformity of transverse distribution and calibrated for overall application rates. The tests shall have been performed within three months before the use of the sprayer for spray rates at least 15 per cent higher than required for the Works.

Before the use of the sprayer in the Works, the Contractor shall make the calibration certificate for the sprayer available to the WP Representative.

The WP Representative may require the sprayer to be made available free of charge for inspection and testing before or during the execution of the works.

The WP Representative may request before the commencement of Works, or at any time during the Works, that the sprayer be tested for uniformity of spray bar output, particularly transverse application, per WA 340.1. The test will be conducted for the maximum spray bar width to be used in this Contract. The requirements for the spray bar output and distribution are shown below:

- The mean binder application rate of the width tested shall not exceed ± 10% of the binder application rate at 15°C specified for the Works
- Every tile used in the test that was fully coated shall have a binder application rate within 15% of the mean binder application rate for the width tested
- Not more than two consecutive tiles that have been fully coated shall have a binder application rate exceeding ± 10% of the mean binder application rate for the width tested

If the sprayer does not conform to the above requirements, it shall not be used on the Works. Subsequent tests to confirm conformity will be at the Contractor's cost. Any delays to site operations because of conducting these tests are not claimable as separate costs.

The Contractor shall use Copley EAN 18 (W) End Nozzles, or equivalent as approved by the WP Representative, for spraying edges. Copley AN18 nozzles, or equivalent as approved by the WP Representative, shall be fitted to the remainder of the spray bar.

8.3.2. Aggregate Spreaders

Aggregate spreading equipment, including truck mounted box spreaders shall be capable of spreading aggregate uniformly both transversely and longitudinally at the specified application rate over the entire length and width of each spray application.

8.3.3. Rollers (For Sealing)

Rubber tyred rollers shall be three wheel tandem rollers of between 6 and 15 tonnes gross weight, and the load per metre of any wheel shall not exceed 5 tonnes.

Pneumatic tyred power rollers shall be of the self-propelled type weighing not less than 15 tonnes gross weight, have multi wheels each exerting a minimum load of 10 kN and have "square section" tyres at a pressure of not less than 700 kPa.

8.3.4. Rollers (For Compaction of Asphalt Wearing Course Layers)

Self-propelled steel wheel rollers and pneumatic tyred rollers meeting the requirements of AS 2150 shall be used. Vibratory pneumatic tyred rollers may be used. All rollers shall be fitted with reticulation to water wheels or tyres to prevent pick up of asphalt and be fitted with scrapers to clean the wheels or tyres.

Vibratory compaction shall be discontinued in areas where such vibrations could cause damage to adjacent buildings or structures. Under these conditions, initial compaction of the asphalt shall be achieved using the self-propelled static steel-wheeled rollers of appropriate mass to meet the compaction requirements.

8.3.5. Brooms

A drag broom, consisting of fixed brushes fitted to a frame, shall be used and capable of distributing loose cover material laterally and longitudinally. The drag broom shall not dislodge particles embedded in the binder or damage the surface in any way. Brooms shall be angled, height adjustable and suspended under rubber-tyred rollers. The road broom shall be a mechanically or power-driven roller unit capable of removing excess cover aggregate and other loose material from the pavement surface without damage to the existing surface or the seal surface.

A rotary road broom of approximately 2 metres in width is required, and the broom must be capable of being turned up to 45 degrees either way.

The rotary-drawn broom must be capable of being used as a drag broom or a drag broom must be provided.

Hand brooms and other hand implements shall also be provided as required to supplement the road and drag brooms.

8.3.6. Precoater

Aggregate shall be precoated using a precoating machine capable of applying a uniform film of precoating agent to cover the surface of the aggregate at a controlled and variable rate. The precoater shall have sufficient output capacity to maintain an adequate supply to the bitumen sprayer/s. The precoater shall be capable of screening dirt/foreign matter (both oversized and undersized materials) from the aggregate during its operation.

8.3.7. Graders

Blade graders shall weigh not less than 5 tonnes and have a wheelbase of not less than 4.5 metres and a blade not less than 3 metres long. The cutting edge shall be checked for straightness against a straight edge.

8.3.8. Water Tankers

Water tankers shall have boom sprays and a quick acting valve (plug cock or similar).

8.3.9. Bitumen Tankers

Road tankers shall be lagged and have thermometers suitably located to give representative temperature readings of the product in the tank. The tanker shall be equipped with facilities to enable circulation, heating and mixing of the bitumen before unloading. Operations involving heating and circulating of bitumen shall only be done by appropriately trained personnel.

8.3.10. Pavers

Asphalt shall be spread by a purpose-built self-propelled paving machine except when site constraints require hand spreading. Hand spreading shall be kept to a minimum. The spreader shall be as described in AS 2150 and equipped with a ski or laser control system and crossfall controller to maintain levels, suitable sensing equipment to provide longitudinal joint matching, and all necessary control devices to maintain levels and lines. The paving machine shall also be equipped with a vibrating screed capable of achieving 85% of the final compaction.

8.4. Preparation For Final Surfacing

Before the placement of bituminous surfacing, the following shall apply:

- Base course Surface

Before priming or primersealing, the base course surface shall be swept using a mechanically operated rotary or suction broom to provide a uniformly clean surface free of loose sand, stone, dust, or other foreign matter. Hand brooming or scraping shall be used to remove any foreign matter adhering to the pavement. No binder shall be applied until the base course has dried back. A light water spray sufficient to lay the surface dust but not significantly wet the base course should be applied immediately before application of the bituminous binder. Loose surface material against kerbing shall be removed by handwork if necessary.

- Existing Bituminous Surface

Where the pavement surface to be sprayed is an existing bituminous surface, all defects shall be repaired, and the surface shall be swept using a mechanically operated rotary or suction broom to provide a uniformly clean surface fee of loose sand, stone dust, and other foreign matter. Hand brooming or scraping shall be used to remove any foreign matter adhering to the pavement. Surface correction asphalt may be applied if required.

8.4.1. Prime

A prime consisting of 40% residual Class 170 bitumen and 60% power kerosene shall be applied to all base course surfaces before application of the surfacing layers. The prime shall be applied uniformly over the whole area to be treated at a rate of 0.6 L/m². Before priming, the base course shall be broomed free of all loose material and dirt, and any defects made good.

Splash guards shall be supplied and used to protect property (i.e., Kerbs etc.), traffic, and adjoining work from damage.

The prime shall be cured for a minimum of three days. The WP Representative may approve a shorter curing period in hot, dry weather.

8.4.2. Primerseal

Where extended cool conditions are experienced, the WP Representative may accept an emulsion primerseal instead of a prime. Where a primerseal is placed below asphalt layers, cutter shall not be used in the application of the primerseal. The preliminary primerseal binder application rates are presented in Table 8-10.

8.4.3. Seal

A 10/5 mm emulsion spray seal shall be applied below all asphalt surfacings or as shown on the Drawings. Approval may be provided by the WP Representative for a single coat primerseal where extended cool conditions are experienced. The required application rates for the spray seal are detailed in Table 8-10.

The Contractor shall ensure that any damage to the spray seal is repaired before application of the asphalt surface.

8.4.4. Tack Coat

A tack coat shall be provided when asphalt is applied to a bituminous surface (seal or asphalt). Tack coat shall comprise CRS 170/60 grade diluted emulsion. The tack coat shall be applied uniformly over the whole area to be treated at a rate of 0.6 L/m². It shall be applied only to a clean, dry surface. No asphalt shall be placed on the tack coat until the emulsion has broken and the water has substantially been evaporated. Arrangement of the work shall be organised to provide a period of time between applying a tack coat and laying asphalt, which will meet these requirements. The laying of asphalt on the newly applied tack coat will not be permitted under any circumstances unless approved by the WP Representative.

The WP Representative shall direct the length of the tack coat that may be placed beyond that point at which the spreading of asphalt is to be undertaken and the period of time that must elapse before spreading commences on the tack coat. The length of the tack coat permitted ahead of the work shall be determined with regard to all the conditions at the site of the work and the possibilities of damage to the tack coat. In dusty conditions, every precaution shall be taken to avoid freshly tack-coated surfaces from being contaminated by dust or other windblown foreign material.

8.5. Spray Seal Surfacing

8.5.1. General

This section applies to spray seal surfacing, where the spray seal forms the final wearing surface.

The primed road shall not be left open to traffic. Surfacing is to be carried out to the width shown on the drawings.

The Contractor shall be responsible for cutting back the binder with medium curing cutting oil as required to ensure a good bond to the cover aggregate.

The percentage of cutting oil to be added to Class 170 bitumen shall depend on the anticipated road temperature per Table 8-9. Ideally, sealing should be undertaken during warm, dry conditions, and the amount of cutting oil should be minimised.

Table 8-9: Cutting Oil Requirements

Anticipated Pavement Temperature °C	Percentage of Medium Curing Cutting Oil (by volume)
25	6
30	4
35	2
40	0

Notes:

(1) Only applicable to basic igneous rocks

If the aggregate is clean and freshly precoated, reduce to proportion of medium curing cutting oil by 2%. The percentage of cutting oil may be varied from that specified in the above table with the approval of the WP Representative to allow for the nature and condition of the aggregate, traffic conditions and anticipated changes in climatic conditions.

The cutting back of the polymer-modified binder shall be per the manufacturer's requirements.

The bitumen shall include 0.5% by mass of the binder of an approved adhesion agent.

Unless otherwise specified in the design, the preliminary seal binder application rates for residual bitumen (Class 170 or Class 320) and residual polymer modified binder (PMB) for tender purposes shall be per Table 8-10.

Table 8-10: Spray Sealing Application Rates

Binder Type	Seal Type	Aggregate Size	Total Binder Application Rate L/m^2 at 15°C
Emulsion Primerseal	Single/Single Seal (CRS 170/60)	7 mm	1.0
	Single/Single Seal (CRS 170/60)	10 mm	1.3
Emulsion Seal (below asphalt)	Double/Double Seal (CRS 170/60)	1st coat 10mm	0.9
		2nd Coat 5mm	1.1
	Single/Single Seal (C170)	14mm	1.6

Binder Type	Seal Type	Aggregate Size	Total Binder Application Rate L/m^2 at 15°C
Hot Bitumen Final Seal (Forming Final Wearing Surface)	Single/Single Seal (C170)	10mm	1.4
	Double/Double Seal (C170)	1st Coat 14mm	1.3
		2nd Coat 7mm	0.8
Emulsion Seal (Forming Final Wearing Surface)	Double/Double Seal (CRS 170/60)	1st coat 10mm	0.9
		2nd Coat 5mm	1.3

The Contractor shall be responsible for adjusting the specified binder blend and application rates to suit climatic conditions, the existing surface texture, traffic conditions, and base course porosity to ensure penetration and bonding to the base per the Austroads Spray Seal Design Method outlined in the technical report AP-T68/06 and AP-T236. The WP Representative shall be advised of any changes to the specified binder and binder application rates before the application of the prime.

The specified application rates for seals are the residual bitumen application rates in L/m2 at 15°C. The actual application rate to be applied shall be adjusted for the percentage of medium curing cutting oil or water in the binder and for the spraying temperature at which the binder other than bitumen emulsion is applied.

Table 8-11: Recommended Temperature Adjustments

Observed Temperature T°C	Factor for T°C	Observed Temperature T°C	Factor for T°C	Observed Temperature T°C	Factor for T°C
15	1.00	80	0.9597	145	0.9207
20	0.9969	85	0.9567	150	0.9177
25	0.9937	90	0.9536	155	0.9148
30	0.9906	95	0.9506	160	0.9118
35	0.9875	100	0.9476	165	0.9089
40	0.9844	105	0.9446	170	0.9060
45	0.9813	110	0.9416	175	0.9031
50	0.9782	115	0.9385	180	0.9002
55	0.9751	120	0.9356	185	0.8973
60	0.9720	125	0.9326	190	0.8944
65	0.9689	130	0.9296	195	0.8915
70	0.9658	135	0.9266	200	0.8886
75	0.9628	140	0.9236		

Notes:

(1) Factors for intermediate temperatures may be obtained by direct interpolation.

The following formula shall be used to make adjustments:

Actual spray rate (L/m^2) = Specified residual bitumen rate x Factor 1 x Factor 2

Where:

Factor 1 = 100/ (100-% cutting oil or water)

Factor 2 = 1/Factor for spraying temperature from Table 8-11.

No adjustments need to be made to the application rates for primes sprayed at ambient temperatures and for which the spray rates are specified in terms of the total binder. No adjustments need to be made for the spraying temperature of bitumen emulsion.

Unless otherwise specified in the design, the preliminary aggregate spread rates for tender purposes shall be per Table 8-12.

Table 8-12: Aggregate Spread Rates

Aggregate Size (mm)	Spread Rate m^2/m^3 (1)
14	90-120
10	110-150
7(2)	140-180
5(2)	160-220

Notes:

(1) The higher spread rates, i.e., those that result in less aggregate per unit area may be more appropriate for double/double seals.

(2) 7 and 5 mm aggregate is generally not intended to be spread in a single stone thick layer except as part of a double coat seal.

The Contractor shall be responsible for adjusting these rates to achieve a stable surfacing with a well-bound interlocked stone mosaic free of flushing, bleeding, and stripping. Hand spreading may be allowed at tapers.

The design levels given on the drawings indicate the levels of the finished road surface.

8.5.2. Pavement and Weather Conditions for Application

No binder shall be applied during wet or rainy conditions or when adverse weather conditions may occur during or shortly after the application of the binder.

- Bitumen or Cutback Bitumen

  No bitumen or cutback bitumen binder shall be applied when the pavement temperature is less than 25°C for a seal, less than 20°C for a primerseal and less than 10°C for a prime. No seal shall be applied when the pavement surface is wet except as provided by the light application of water.

- Bitumen Emulsion

  No bituminous emulsion binder shall be applied when the pavement temperature is less than 10°C.

8.5.3. Binder Application

The binder shall be sprayed onto areas as detailed in the construction drawings or as otherwise specified. The Contractor shall nominate a proposed spraying program to minimise joints and the delay between spraying, aggregate application and rolling.

The mixture shall be sprayed as soon as possible after heating and any quantity heated to a temperature within 10 degrees Celsius of the maximum temperature specified shall be sprayed that same day.

The binder shall be heated to the spraying temperature specified in Table 8-13.

Table 8-13: Spraying Temperature Requirements

Material	Grade or % Cutting Oil in Binder	Spraying Temperature Range °C	
		Minimum	Maximum
Bitumen	Class 170	170	180
Cutback Bitumen	2	160	175
	4	155	165
	5	150	160
	6	145	155
	10	130	140
	60	Ambient	
Bitumen Emulsion	CRS/170-60	35	50

Notes:

(1) The spraying temperatures for polymer modified binders are only indicative. The manufactures recommendations should be adhered to at all times.

The binder spraying for each spray run shall start and finish on protective paper (as specified in this Specification). The sprayer shall start each run at least 10 m before the protective paper, cross the paper at its correct spraying speed and maintain this speed until the finishing paper has been crossed. The protective paper and any split binder shall be removed and disposed of in an approved manner. Where the direct use of a mechanical sprayer is impractical, the binder may be applied using a hand lance fed from the mechanical sprayer.

Where any blockage or partial blockage of sprayer nozzles occurs, spraying shall cease immediately. The defective area shall be rectified, and a new sprayer run started to complete the areas concerned.

After each sprayer run, the quantity of binder sprayed shall be checked against the area covered, and any necessary adjustments shall be made to ensure the target application rate is achieved in subsequent runs.

Splash guards shall be supplied and used to protect property, traffic, and adjoining works from being sprayed with binder. Where spray drift, defacement, or contamination occurs, it shall be removed and made good at the Contractor's cost. Kerbs, drainage, structures, and all other works likely to be stained by bitumen shall be adequately protected. Any staining shall be made good.

The volume of binder sprayed for each run shall be determined by dipping the tank after each run and recording the volume of binder in the tank to the nearest 50L. The sprayer must be dipped whilst parked on level ground.

The binder shall be sprayed onto areas as detailed in the drawings or as otherwise specified in the design. The sprayed binder edge shall conform to the following requirements:

- the sprayed edge shall not deviate from the specified edge by more than 50 mm
- the rate of deviation of the sprayed edge from the specified edge lines shall not exceed one in four hundred (1:400)

- tapers to accommodate variations in specified width shall be at one in one (1:1), except at floodway exits, which shall be at one in twenty (1:20)

The Contractor shall take all necessary precautions to prevent the binder from adhering to any existing structure. Any damage or defacement shall be made good immediately upon completion of sealing work at no additional costs.

After applying a prime, a period of at least three days or more extended period, as determined to be necessary for the prime to cure and dry, shall elapse before the seal binder is applied. Construction and other traffic shall not be allowed on a prime.

After applying the first coat of a double/double seal or cutback bitumen seal, the binder for the second coat shall not be applied until the first coat has been covered with aggregate, rolled, broomed, and excess aggregate removed.

After applying the first coat of a double/double bitumen emulsion seal, the binder for the second coat shall not be applied until the first coat has been covered with aggregate, rolled, broomed, and excess aggregate removed, and the binder of the first coat has completely broken and cured to form a stable mat leaving no water in the binder.

8.5.4. Aggregate Application and Rolling

The aggregate shall be rolled with the equipment outlined in this Specification. The following work practices should be adhered to:

8.5.4.1. First Coat of a Seal

- The first aggregate coat shall be uniformly spread using a suitable mechanical spreader. Aggregate spreading shall commence immediately after spraying, and the first roller pass shall follow immediately behind the spreader and be completed within 5 minutes of spraying before bitumen emulsion binder breaking where applicable. Wet or damp aggregate shall not be used with bitumen or cutback bitumen treatments. Damp aggregate may be used with bitumen emulsion binders.
- The aggregate shall be applied commencing at the low edge of the pavement in successive runs parallel to that edge.
- This requirement may be waived at tapers depending upon the method of application of the binder for the taper.
- The aggregate shall be placed to form a uniform stone mosaic of single particle thickness, in almost continuous interlocked contact, with the particles generally oriented with their least dimension vertical. In order to meet this requirement, it may be necessary to apply the aggregate initially at a rate slightly less than what appears optimum so that some binder is visible between the stones. Additional aggregate shall be applied to bare or insufficiently covered areas as necessary.
- The additional aggregate shall be applied before the completion of four complete coverages of rubber-tyred rolling.
- Immediately after application of the cover material, the surface shall be rolled with rubber-tyred rollers to the minimum number of complete coverages specified over the whole area. Rollers shall be operated at speeds less than 7 km per hour for the first four complete coverages. Drag brooming shall be carried out after every second complete rolling coverage. If the emulsion has not broken and cured or the broom has any tendency to dislodge aggregate, the Contractor shall defer or eliminate the drag brooming. Where drag brooming is eliminated, the Contractor shall substitute light hand brooming.

- The aggregate application shall be spread within 8 minutes, and the specified number of complete coverages with the roller shall be completed within 15 minutes of the application of the binder. The length of spray runs shall be limited to comply with this requirement.
- All loose aggregate not incorporated in the mat at the completion of rolling and brooming shall be removed from the pavement before applying the binder for the second coat but after the binder has completely broken and cured. The loose aggregate shall be removed in such a manner as to prevent the removal of aggregate incorporated in the first coat.

8.5.4.2. Second Coat (Smaller Aggregate)

- The second aggregate coat shall not be applied to the first coat until the binder of the first coat has completely broken and cured to form a stable seal leaving no water in the binder. All excess aggregate not incorporated in the first coat mat shall be removed from the pavement before applying the binder for the second coat. The excess aggregate shall be removed in such a manner as to prevent damage to the first coat.
- The first coat of aggregate may require to be sprayed with water prior to the application of the binder for the second coat.
- The second aggregate coat shall be spread and rolled as specified for the first coat. This work shall be completed within 15 minutes of the application of the second binder coat.
- The new seal should not be swept or trafficked until the emulsion has completely broken, leaving no water, and the binder has had adequate curing to attain full strength, ensuring stone retention after unrestricted trafficking.

The application of the aggregate surface sweeping must be undertaken as follows:

- Any loose aggregate not incorporated in the seal mat after the completion of rolling and curing of the second aggregate coat shall be swept off the seal surface without damage to the seal or shoulder and removed from the roadway. Where the roadway to be sealed is kerbed the excess aggregate may be swept hard against the kerb during interim sweeping operations but shall be picked up and removed during the final sweeping.
- Where the roadway to be sealed is kerbed, the excess cover material shall be picked up by a suction broom without damage to the seal. The excess cover material may be swept hard against the kerb during interim sweeping operation but shall be picked up and removed by a suction broom to an approved location.
- The initial sweeping shall occur before the completion of the days work. A second sweeping shall be carried out at the commencement of the following days work. The Contractor shall carry out subsequent sweepings as necessary for the following 7 days to ensure that no loose stones remain on the road surface.
- The Contractor shall install symbolic “loose stones” signs and other temporary traffic management signs immediately after sealing. The signs shall remain in place on each section of the Works for the following 7 days after completion of sealing.

In single/single seals, the aggregate shall be placed to form a uniform single particle thick stone mosaic in almost continuous interlocked contact, with the particles generally oriented with their least dimension vertical. In the first coat of a double/double seal, the aggregate should be applied at a slightly lighter rate (less aggregate) than with a single/single seal.

The aggregate should not be overspread, and it may be necessary to apply the aggregate at a rate that appears slightly less than optimum so that some binder is visible between the stones. Additional aggregate

shall be applied to any bare or insufficiently covered areas as necessary before the completion of rolling. During the application of the second coat of a double/double seal, the aggregate should be spread at a rate sufficient to fill the voids in the first application.

Immediately after application of the cover material, the surface shall be rolled with rubber-tyred rollers to give a minimum of twelve complete passes of the whole area. Where initial rolling is with a rubber-tyred roller, the first pass should be without significant overlap. Subsequent passes should overlap by approximately one-third of the effective roller width.

Back rolling shall be continued until proper interlocking of the aggregate and adhesion of the binder to the stone has taken place and the bitumen emulsion binder has completely broken and cured to form a stable mat leaving no water in the binder.

Traffic shall not be allowed on any seal treatment until it is stable enough to carry vehicles without undue damage. Traffic speed shall be restricted to less than 40 km/hour for at least 24 hours.

After completion of all seal treatments, all surplus aggregate shall be removed by sweeping in such a manner as to prevent damage to the sealed surface and traffic. Sweeping shall not take place until seven days after rolling has been completed.

8.5.5. Works Records

The Contractor shall keep accurate daily application records, including the following for each sprayer run:

- Date
- Location
- Length, width, and area
- Binder type used
- % of cutter and adhesion agent in the binder
- Spraying temperature
- Hot volume of binder applied and hot application rate
- Cold volume of binder applied and cold application rate (at 15°C)
- Aggregate size
- Volume of aggregate used and aggregate spread rate
- Pavement temperature
- Aggregate precoating details.
- Methodology
- Description and models of equipment used.

A copy of the spray records shall be submitted to the WP Representative at the completion of each day's work.

8.6. Asphalt Surfacing

8.6.1. General

Where nominated on the drawings, dense-graded asphalt supplied by a specialist supplier and installer shall be placed by a purpose-designed paving machine to the nominal minimum compacted thickness(es) shown on the drawings.

Unless otherwise specifically described elsewhere in this document, the manufacture, mix design and application of asphalt shall generally comply with AS 2150-2005 “Hot Mix Asphalt- Guide to Good Practice”.

8.6.2. Asphalt Mixes

The Contractor shall submit a job mix design for approval by the WP Representative before use on the project. All asphalt shall be assessed per the standard procedures for the Marshall design method, as shown in Table 8-14.

Table 8-14: Asphalt Assessment

Assessment Criteria	WA Specification
Stability & Flow of Asphalt: Marshall Method	WA 731.1
Maximum Density of Asphalt: Rice Method	WA 732.2
Bulk Density & Void Content of Asphalt	WA 733.1

Asphalt shall be a mix of clean, dry, graded, coarse and fine aggregates, mineral filler, and bitumen per the current relevant Australian Standard(s).

The binder shall be Class 170 or Class 320 bitumen (as specified on the project drawings).

The asphalt mix design shall comply with the requirements provided in Table 8-15. All testing must be undertaken in a NATA-accredited laboratory, and the results shall be presented on NATA-endorsed reports.

Table 8-15: Asphalt Mix Designs

Sieve size (mm)	AC7 Nominal 7mm size	AC10 Nominal 10mm size	AC14 Nominal 14mm size
19			100
13.2		100	93 – 100
9.5	100	95 – 100	79 – 89
6.7	85 – 100	78 – 88	63 – 73
4.75	70 – 87	63 – 73	49 – 59
2.36	44 – 65	40 – 48	33 – 41
1.18	29 – 48	25 – 32	22 – 32
0.60	19 – 35	18 – 24	15 – 23
0.30	12 – 25	12 – 17	10 – 18
0.15	8 – 16	8 – 12	6 – 11
0.075	5 – 8	3 – 5	2 – 5
Bitumen Content (by percentage mass of whole mixture) and Grade	5.0% - 7.0% (Class 170 Bitumen)	5.4% ± 0.3% (Class 170 Bitumen	4.7% ± 0.3% (Class 320 Bitumen)
Hydrated Lime (by percentage mass of total aggregate)	1.5%	1.5%	1.5%

Sieve size (mm)	AC7 Nominal 7mm size	AC10 Nominal 10mm size	AC14 Nominal 14mm size
Marshall Properties			
Marshall Compactive Effort	50 Blow	50 Blow	75 Blow
Marshall Voids (%)	3.0 – 5.0	3.0 – 5.0	4.0 – 7.0
Minimum Marshall Stability (kN)	6.0	6.0	8.0
Marshall Flow (mm)	2.0 – 4.0	2.0 – 4.0	2.0 – 4.0
Minimum Characteristic Compaction Level (% Marshall)	≥93	≥93	≥93

Production tolerances around the target mix shall be as specified in Table 8-16.

Table 8-16: Asphalt Production Tolerances

Sieve Size (mm)	Tolerances in percentage passing by mass
37.5	±7
26.5	
19.0	
13.2	
9.5	
6.70	
4.75	
2.36	±5
1.18	±5
0.600	±4
0.300	±4
0.150	±2.5
0.075	±1.5
Binder content, percentage buy mass of total mix	±0.3

Notes:

(1) Tolerances refer to a permissible range of property values around a specified or a design target within which single test results are allowed to fall. Asphalt production is a series of continuous processes, and it is preferable to use statistical methods to establish suitable tolerances for process control and product acceptance. In the absence of statistical methods, test result values within the tolerance range shown in the above table may generally be used to indicate production that requires not corrective action. Individual test result values greater than, and up to twice, the tolerances shown may be acceptable, provided corrective action is taken in the form of checking the process, making adjustments if necessary and undertaking further testing to verify production within desired tolerances.

The fine aggregate shall comprise a mixture of one or more natural sands and crusher dust. The natural sands shall consist of clean, tough, rough-surfaced grains, free from clay, loam, mica, lumps, or other

foreign matter. Crusher dust shall consist of a uniformly graded product from the crushing of clean sound stone.

Mineral filler shall consist of a finely divided mineral material of a type and from a source approved by the WP Representative. It shall be thoroughly dry and free from lumps of any kind.

If filler is required to be added to the mixture in order to make it comply with the specified limits of the paving mixture, it shall consist of Portland cement, ground limestone, stone dust, or other approved material.

Hydrated lime shall comply with the requirements of the current relevant Australian Standard.

The asphalt mix design shall be submitted to the WP Representative for approval at least 7 days before laying.

The temperature of the mixed asphalt shall be measured and recorded at the discharge point of the pugmill or mixing drum. The temperature of the asphalt shall not exceed 170°C for dense graded asphalt manufactured with Class 170 or 320 bitumen.

8.7. Asphalt Placement

8.7.1. Supervision

The spreading or compaction shall only be undertaken under the supervision of a certified experienced laying supervisor. Asphalt spreading & rolling procedures, including equipment and plant schedule shall be submitted to the WP Representative for approval before construction. All works shall be carried out to the full supervision & satisfaction of the WP Representative. No mix shall be spread on wet surfaces or during wet weather.

8.7.2. Storage and Handling

Binders shall be heated and stored to meet the requirements of this Specification and the AAPA Advisory Note 7 - Guide to the Heating and Storage of Binders for Sprayed Sealing and Asphalt Manufacture.

8.7.3. Transportation of the Mixture

The mixture shall be transported from the mixing plant to work in sealed vehicles with metal-bodied trucks previously cleaned of all foreign materials. The vehicles shall be suitably insulated to maintain the minimum delivery temperatures required by this Specification. Each load shall be covered with canvas or other suitable material of sufficient size to protect it from the effects of the weather. The inside surface of all vehicles used for hauling the mixture may be lightly lubricated with a thick oil or soap solution just before loading, but excess lubricant will not be permitted.

The temperature of the asphaltic concrete delivered to the point of spreading shall be between 140°C and 165°C. Any load outside the allowable temperature range or that shows signs of drainage of the binder will be rejected and shall not be placed on the road.

An accurate shielded pavement temperature thermometer shall be provided for the use of the WP Representative.

Sasobit may be used in the production of dense graded asphalt when the asphalt is being transported over long distances or where the asphalt is being paved in cold weather. The Sasobit shall be used at a dosage rate of 1.5% by mass of the binder and shall be mixed to produce a uniform distribution through the asphalt mix.

8.7.4. Placing or Spreading of the Mixture

Before delivery of the mixture, the prepared base shall be cleaned of all loose or foreign material. The mix shall be laid upon a clean and dry base only when rain is not imminent, and the pavement temperatures meet the following requirements. The minimum asphalt placement temperatures outlined in Table 8-17 shall apply unless approved by the WP Representative.

Table 8-17: Asphalt Minimum Placement Temperatures

Mix Type	Binder in Mix	Minimum pavement temperature when wind speed < 20 km/hr	Minimum pavement temperature when wind speed ≥ 20 km/hr
DGA	C170 or C320 bitumen	15°C	20°C
DGA	C170 or C320 bitumen with Sasobit	10°C	15°C

Mixing and placing of asphalt will not be permitted when the surface of the road is wet or cold winds chill the mix to the extent that spreading, and compaction are adversely affected.

The asphalt shall be spread to produce a layer of specified compacted thickness and tamped using a power-driven spreading machine at the highest elevation of the cross section of the pavement. It shall spread without tearing, gouging, or shoving to produce a surface free from waves, depressions, or other defects.

A corrector course may be required where there are departures from the design thickness by more than 10mm from a 3-metre straight edge. The corrector thickness shall not be greater than 5 times (x) the largest aggregate dimension. The mixture shall be spread to such lines, levels, and camber as detailed in the approved drawings or as directed by the WP Representative.

Adjoining the edge of a lane that has been spread, tamped and rolled, the asphalt shall be spread to a thickness, making due allowance for compaction as required, such that after compaction, the finished surface shall comply with this Specification. Adjoining a lane that has been spread and tamped but the outer edge of which has not been completed, the asphalt shall be spread to the height of the unrolled material at that edge (see longitudinal joints).

The paver shall be operated so that the material does not accumulate along the sides of the receiving hopper. Any material which has become cold due to a delay in the transport of the mix or for any other reason shall be removed. Where the end of the spread material has cooled due to a delay in the delivery of the mix or when resuming work on the next day, a transverse joint shall be formed by cutting the spread material to a vertical face before any fresh mix is spread. More than one longitudinal joint will not be permitted if the total width of the paving is less than 7.4 metres.

In the event of faulty operation of the paver causing irregularities in the spread material, work shall be suspended until the fault is rectified. If the irregularities are of a minor nature and the source has not cooled appreciably, it will be permissible to spread a thin layer of fresh mix by hand, level it with board rakes and roll quickly. Should this treatment fail to produce a surface of acceptable texture and regularity, or if the faults left by the spreader are of appreciable depth, then the defective surface shall be removed, and fresh material shall be laid as previously described.

The temperature of the mix when it is tipped into the paver shall not be less than 135°C. Spreading shall proceed without undue delay and initial rolling of the mix shall commence at a temperature of not less than 120°C.

Immediately after any mat is spread and before roller compaction is commenced, the surface shall be checked, and inequalities adjusted. All fat, sandy, segregated, hungry or dusty accumulation from the paver shall be removed by rake or hoe and replaced with a satisfactory mix. Irregularities in alignment and grade along the outside edge shall be corrected by the addition or removal of mix before the edge is rolled. Only personnel who are capable of performing the work incidental to the correction of all pavement irregularities shall be employed. Special attention shall be given to the straight-edging of each course immediately following the initial rolling. In narrow base widening, deep or irregular sections, intersections, turn-outs, or driveways, where it is impracticable to spread and finish, level, or surface mixtures by machine methods, acceptable hand methods may be used as directed or approved by the WP Representative.

Where any mix is to be spread by hand, it shall be dumped on a steel dump board outside the area on which it is to be spread. The mix shall immediately be distributed into place in a loose layer of uniform density and to the correct levels. “Slinging” of mix from shovels shall be avoided. It shall be spread without tearing, gouging, or showing to produce a surface free of waves, true to line, level, and camber. All coarse aggregate remaining on the surface shall be removed and the surface adjusted as directed by the WP Representative after spreading and before compaction. A heated steel hand tamper shall be allocated to be used in places inaccessible to the roller.

The asphalt shall be placed at a rate such that allows sufficient rolling to achieve the specification requirements.

Placing of the mixture shall be as continuous as possible and to the full satisfaction of the WP Representative.

All debris, waste, and surplus material shall be removed from the site, and all structures, kerbs, and other surfaces shall be left clean and intact/undamaged.

8.7.5. Compaction

8.7.5.1. General

Uniform compaction to the required density shall be achieved before the temperature of the mix falls below 90°C. The complete operation shall be ensured, from mixing to final compaction, is maintained within the specified temperature ranges. If complete compaction of the mixture is not possible at a temperature above 90°C, work shall cease unless it can be proven to the satisfaction of the WP Representative that the specified compaction is being attained at the lower temperature.

After spreading, the mixture shall be thoroughly and uniformly compacted soon after being spread. For compaction, the mix shall be rolled uniformly using self-propelled steel wheel rollers and pneumatic tyred rollers meeting the requirements of AS 2150. Vibratory pneumatic tyred rollers may be used. All rollers shall be fitted with reticulation to water wheels or tyres to prevent pick up of asphalt and be fitted with scrapers to clean the wheels or tyres.

A sufficient number of rollers shall be available on site commensurate with the rate of supply of asphalt and the output of the paving machine.

For compacting confined areas, a small roller and/or a mechanical impact type or vibrating type hand-operated compactor of size and mass shall be provided.

Undue delays in rolling freshly spread mixture will not be tolerated. Rolling shall start longitudinally at the sides and proceed toward the centre of the pavement overlapping on successive passes by at least 150mm. Successive passes of the roller shall be of slightly different lengths.

Roller speed shall be uniform. Stops and starts shall be controlled so that displacement (shoving) of the asphalt mix does not occur when changing direction. Any shoving occurring as a result of changing direction or from any other cause shall be corrected at once by the use of rakes and of fresh asphalt when required. Under no circumstances shall rolling be continued if the asphalt begins to shove and crack. The rate of rolling shall be such that displacement and cracking of the mix do not occur.

Rollers shall be kept in continuous operation as much as practicable and in such a manner that all parts of the pavement receive substantially equal compaction. In the event of a delay in the laying operation, rolling is to be carried out as close as practicable to the paving machine. Rollers shall not be parked on work carried out the same day.

Final rolling shall consist of not less than four (4) passes of the self-propelled smooth steel roller weighing not less than 10 tonnes, but in any case, shall be sufficient to remove all pneumatic tyre roller marks and produce a smooth, dense, and tight surface.

8.7.5.2. Tamping

Along kerbs, channels, headers, manholes and similar structures, and at all places not accessible to the roller, thorough compaction shall be achieved by means of hot tampers. The joints between these structures and the mixture must be effectively sealed.

In all areas inaccessible to normal rolling equipment, special techniques such as the use of heated hand tampers, light hand-held rolling equipment shall be used to achieve the surface finish and degree of compaction specified for other areas. Particular care shall be used in such areas, and only experienced staff shall be employed.

Any course after final compaction shall be smooth and true to the established levels crown and grade. The course shall have the minimum thickness as detailed on the drawings and shall at no point vary more than +5mm or –0mm.

Any low or defective areas shall be immediately remedied by cutting out the defective area and replacing it with a fresh, hot mixture that shall be immediately compacted to conform to the surrounding area and thoroughly bonded to it. The surface of the finished course shall be free from protrusion exceeding +5mm as measured with a 3-metre straight edge. Notwithstanding the above, the surface shall be free draining at all times without any ponding of water on any part of the asphalts surface.

8.7.6. Compaction Standards

After final compaction, the finished asphalt shall have compacted densities of equal to or greater than 93% of the Characteristic Marshall density as determined by AS2150: 2005. Core samples of the compacted asphalt will be taken, and the field density will be determined. Core samples should be taken within 24 hours of placement of a lot. The samples will be taken for the full depth of the asphalt. All core sample holes shall be cleaned out and filled with a fresh, hot mixture that shall be immediately compacted to conform to the surrounding area.

8.7.7. Surface Finish

The surface of the compacted asphalt shall be smooth and true to the specified crown and grades, be of uniform appearance, free of dragged areas, cracks, open textured patches and roller or paver marks. Any section of asphalt that is loose or broken, mixed with dirt or other impurities, or is in any way defective, shall be removed and replaced. When using the 3-metre straight edge, per WA 313.2, the shape of the compacted asphalt shall be deemed to be conforming when the maximum deviation from a 3m straight edge, placed in any position on the surface of a layer does not exceed the limits specified in Table 8-18. A 3-metre straight edge shall be provided with each paver.

The upper surface of the compacted asphalt shall be within 5 mm of the final design levels. For construction work, the thickness of the compacted asphalt layers shall be within 5 mm of the specified thickness.

Table 8-18: Surface Shape

Direction of Measurement	Maximum Deviation	Maximum rate of Change of Deviation
Longitudinal	3 mm	1.0 mm per 240 mm
Transverse	5 mm	1.0 mm per 240 mm

8.7.8. Joints

8.7.8.1. General

Joints shall be constructed in such a manner that they are waterproof. The finished surface at all joints shall have the same texture, density, and smoothness as elsewhere. Except for joints with a previous day's work, all joints shall be formed while the asphalt is hot and in a readily compactable condition and when the temperature of the mix is greater than 90°C.

Asphalt shall be spread in such a manner as to minimize the number of joints in the pavement or carriageway, and unless otherwise specified or the WP Representative consents otherwise, the layout of joints shall conform to the following requirements:

- Longitudinal and transverse joints shall be formed in a careful manner, well bonded, and sealed. Joints between old and new pavements or between successive day's work shall be carefully constructed to ensure a thorough and continuous bond between the old and new surfaces. The edge of the previously laid course shall be cut back to its full depth to expose a fresh surface, after which the hot mixture shall be placed in contact with it and raked to a proper depth and grade. Hot smoothers or tampers shall be employed to heat up the old pavement sufficiently without burning to ensure a proper bond
- Before placing the mixture against surfaces of longitudinal joints, kerbs, gutters, headers, manholes or other surfaces, the contact surfaces shall be tack coated, as directed by the WP Representative
- In constructing the joint along an adjoining edge of kerb, gutter or pavement, just enough of the hot material shall be carried back to fill any space left open. A clean and neat joint shall be formed
- Any longitudinal joint from a previous day's work that is distorted shall be cut back to its full depth to expose a fresh surface before additional materials are laid alongside it
- All longitudinal joints shall be parallel to the centre line of the carriageway. Special care shall be taken in forming longitudinal joints at all intersections to avoid joint layouts and an appearance that would tend to miss-direct traffic from the designed travel paths. Jointing in critical traffic path areas shall be approved by the WP Representative before the placing of the wearing course. Transverse joints shall be at right angles to the direction of spreading and cut to a straight vertical face for the full depth of the layer
- Where asphalt is required to match the existing surface, road or other fixture, the material shall be placed in such a manner as to provide a smooth riding surface across the junction. Where required, sufficient existing pavement shall be removed to enable a smooth riding surface across the junction
- Transverse joints shall be at right angles to the direction of spreading and shall be saw-cut to a straight vertical face for the full depth of the layer or course. At a formed joint, the layer or course shall be

checked longitudinally with a straight edge, and if there is any loss of shape, the end of the lane shall be cut back with a power saw to remove the area with defective shape

8.7.8.2. Nominal Maximum Aggregate Size

The nominal size of the aggregate with thickness of the asphalt and tolerances shall conform to the Table 8-19.

Table 8-19: Nominal Maximum Aggregate Size with Asphalt Thickness and Tolerances

Nominal Asphalt Size	Required Asphalt Placement Range	Tolerances
7 mm	Compacted thickness of not less than 20mm and not greater than 35 mm.	(+ 5mm) (- 0mm)
10 mm	Compacted thickness of not less than 25mm and not greater than 40mm	(+ 5mm) (- 0mm)
14 mm	Compacted thickness of not less than 35mm and not greater than 55mm	(+ 5mm) (- 0mm)

8.7.8.3. Riding Quality

The riding quality of the surface should be smooth. On new work, if required by the WP Representative or specified on project drawings, the roughness of the finished surface, as measured by a roughness meter or laser profiler, should be not greater than the value given in Table 8-20.

Table 8-20: Maximum Values of Roughness

Road Types	NAASRA Roughness Index	Test Methods
	Maximum roughness, counts/km	Maximum International Roughness Index, IRI
Major roads	50	1.8

9. Concrete Kerbing

9.1. Introduction

This section outlines the requirements for the specification and construction of concrete kerbing.

Concrete kerbing shall be laid by a specifically designed plant and with experienced personnel, all to the profiles and dimensions as specified and/or on the drawings included in the specification.

9.2. Concrete Quality

Concrete for cast in situ kerbing shall be per Technical Specification – Transmission Substation Concrete.

9.3. Setting Out

Setting out of the kerbs, profile, and alignment shall be carried out on the rear of the kerb. Spikes and nails shall not be driven onto the pavement surface.

9.4. Kerbing Base

The surface to receive the kerbing shall be compacted with a vertical rammer, free of loose material, before the placement of the concrete from the extruder machine. Where specified, the kerb shall be placed in an excavated trench to the minimum dimensions shown and without damage to the line of abutting material at the front face of the kerb.

9.5. Cleanliness

Adjacent visible surfaces shall not be stained or contaminated with concrete residue at any time of the kerb installation process. Excess materials shall be removed from the site and not left behind the kerb.

9.6. Expansion Joints

Expansion joints shall be created by mechanically sawing a 6mm wide cut vertically through the full depth of the kerb profile (without damage to adjacent surfaces), and this cut shall be sealed by placing a foam backing cord into the cut as bridging leaving a 25mm deep from the top of the kerbing surface and be fully filled with grey gun-grade butyl-mastic sealant or equivalent and finished to 3mm below the top surface of the kerb. These joints shall be at a spacing to suit the characteristics of the sealant without separation from the adjacent cut concrete faces but not exceeding 4m. They shall also be installed at every tangent point on horizontal curves and adjacent to structures incorporated into the line and ends of the kerb.

9.7. Contraction joints

Contraction joints shall be formed at the mid-point between expansion joints with a mechanically cutting a 6mm gap to at least 50% of the kerbing's vertical depth and subsequently completely sealing the cut with grey gun-grade butyl-mastic sealant or equivalent approved and finished to 3mm below the top surface of kerb to prevent ingress of sand.

9.8. Tolerances

The kerbing shall be laid and formed to the true alignment and levels specified. The road edge and the back face of the finished kerbing shall be parallel. The top surface of the kerb shall be parallel and have the same level as the finished sealed road levels and grading and shall be free from any depressions.

9.9. Hand Work

In areas inaccessible to the kerbing machine only, small sections of the kerbing may be constructed by hand methods to an identical standard, profile, and condition as that kerbing lay by a machine.

9.10. Curing

Within two hours of the concrete placement, all exposed surfaces of the kerbing shall be protected from moisture loss for a further period of no less than 5 working days by covering with a continuous plastic sheet or by use of a visibly evident sprayed curing compound, applied per the manufacturer's instructions.

9.11. Protection of the Works and Safety at Brown Field Sites

In order to minimise the potential effect on operating electrical plants in Brownfield sites and/or to minimise potential airborne rubbish, the use of plastic sheeting requires complete and adequate control against loss and displacement arising from any cause until removed. The contractor shall be responsible for

the protection of the works constructed under SoW from damage from any source, including vandalism and/or malicious damage to the fresh concrete.

Backfilling to the kerb shall not proceed until after 5 working days following the placement of the concrete.

10. Drainage

10.1. Introduction

The work under this section includes the supply and installation of drainage, including underground pipework, culverts, end/headwalls, manholes, gullies (grates), stone pitching, oil/water separation systems, and subsoil drainage.

All materials, labour, supervision, consumables, and plants necessary to construct and install the drainage works shall be supplied, as shown on the drawings, included in, or described in the specification.

10.2. Pipe work/culverts

The pipes and fittings shall be as shown on the drawings for dimensions, class/grade, and jointing type and shall comply with the relevant Australian Standards governing their manufacture and/or installation. These include:

10.2.1. Handling

These pipes shall be handled, laid, jointed and backfilled per this specification, or in the absence of specific detail in those documents or this specification relating to their use (including as shown on the drawings), the drainage system components shall be installed per their respective manufacturer's written recommendations.

10.2.2. Excavations

Excavations for buried drainage shall be undertaken, allowing for access for personnel, backfill replacement and compaction, and safety of adjacent slopes and/or shoring. The bedding for the drainage shall bear only on the barrel of pipes (i.e., not on collars, etc.) or uniformly on the base of box culverts. There shall be not less than 150mm of clean granular material over any non-granular material, all compacted to the same standard of adjacent material. No contact with the drainage components shall be permitted from rock, services, or materials.

10.2.3. Backfill

Backfill under the barrel of pipes shall be hand-tamped to the same uniform standard as adjacent earthworks until the use of mechanical compaction can proceed without damage to or relocation of the laid pipe work. Penetrometers tests shall be undertaken on the backfill to demonstrate that the bedding and all backfill are compacted to the requirements of this document.

10.2.4. Setting Out

The drainage pipes or culverts shall be laid in a uniform grade between headwalls or manholes and shall be set to the appropriate reduced level, invert, or obvert levels and grades as shown on the drawings, all controlled from surveyed endpoints and consistent survey or boning rods between those points. Collared pipe drains shall be constructed with their collars at the lower end of each pipe and shall be laid from the lowest part first. The horizontal locations of all components of the drainage system shall not vary by more than ±50mm from their design location or more than ±5mm from their design level.

10.2.5. End Walls/Head Walls

These walls shall be precast or constructed in situ as shown on the drawings and shall be joined to the protruding pipework in a manner appropriate to and consistent with the type of pipes specified and installed, while that jointing shall ensure no loss of soil from behind the wall from any cause over the design life specified in the SoW.

10.3. Manholes

10.3.1. Materials

Manholes shall be constructed from cast in-situ concrete or precast reinforced well liners with lids of reinforced concrete, including a cast-in grate with hinges, solid lid or with manhole openings as shown on the drawings. Cast in-situ manholes shall be constructed per the requirements for concrete structures.

10.3.2. Excavation

Manholes made of well liners shall be installed where possible by strictly controlled excavation from within the liner to avoid undercutting of the soil adjacent to the liner and to maintain intimate contact of the liner with the adjacent soil while keeping the liner(s) vertical at all times.

Excavation of soil other than that which will allow installation by excavation from within the liners shall be as for the installation of foundations. This includes adequate over-excavation for the safety of battered slopes, adequate safe personnel access into and egress out of the excavation, shoring if necessary and backfill materials and compaction to suit the earthworks/road works through which the manhole is installed. The base material on which the manholes sit in excavated holes shall be similarly compacted.

10.3.3. Internal Excavation

Liners installed by internal excavation that fail to remain vertical (taken as greater than 1 horizontal to 25 vertical) shall be removed and installed by open excavation.

Installation of multiple successive liners to obtain design depths shall only be undertaken with vertically adjacent liner sections strapped together across the horizontal joints sufficient to avoid separation and/or overturning of the liners.

10.3.4. Dewatering

Dewatering necessary for installation of the liners shall only be undertaken in such a manner to prevent ingress of soil into the liner, which could cause loss of soil contact on the outside of the liner. Dewatering may be done by spears on the outside of the liners, or the excavation of the material shall be done from underwater.

Loss of significant material from outside the liner shall entitle the WP Representative to direct the liner removal and installation in an open excavation as above.

10.3.5. Cut Outs in Manholes

Holes for pipe entries in the manholes shall be cut by mechanical means where possible. The whole formation shall not cause any further damage to the manhole liner adjacent to those points of pipe work entry/exit. The hole oversize shall be minimised, and the hole shall be grouted using cement-rich mortar sufficient to prevent loss of soil from behind the liner from any cause.

10.3.6. Step Irons

Step irons complying with AS 1657 - 1992 shall be installed for access into each manhole, where shown on the drawings.

10.3.7. Concrete Floors

Concrete floors not less than 100mm thick shall be installed in every well liner manhole and, unless founded in non-cohesive soils, shall have a 300mm diameter formed hole in the centre of the manhole floor, filled with 20mm aggregate where shown on the drawings.

10.4. Stone Pitching

Stone pitching shall be installed in those areas shown on the drawings and shall comprise unweathered and well-cemented natural clean stone spalls free from dust, clay, dirt, and other harmful material, generally spherical between 75mm and 150mm diameter rock with 250mm thickness in Rip-Rap form of protection. These shall be placed close-packed on compacted soil and fully grouted with a cement-rich sand mortar or small aggregated concrete mix to the full depth of the spalls.

10.5. Subsoil drainage

Subsoil drainage shall be constructed as shown on the drawings. Excavated non-granular material shall be disposed of off-site as spoil. The sides of excavations shall be as close to vertical as possible, provided the working depth does not exceed 900 mm.

10.5.1. Geotextile

Geotextile fabric shall be non-woven material and have a high ultraviolet resistance as shown on the drawings and shall be inserted in the excavation and aggregate laid in the fabric as shown and per AS 3706.11 and the pipe lain in the orientation as per the manufacturer's recommendations (i.e., slot up or down as appropriate).

Product certificates of compliance from the supplier shall be submitted to the WP Representative for approval before the use of geotextile.

Aggregate shall be placed and compacted over the pipe until at the level of the top of the aggregate where shown on the drawings. The geotextile fabric shall be lapped and fixed over the top of the aggregate, and the remainder of the excavation shall be backfilled and compacted as per the details shown on the drawings or as described in this specification.

10.5.2. Slotted Pipe

Slotted pipe shall be laid at the invert levels and grades as shown on the drawing with slots oriented to the bottom of the pipe. Flush out/ rodding eye points shall be installed as detailed on the drawings and at intervals of not more than 15m and at all changes of direction.

10.5.3. Aggregate

Unless otherwise nominated, aggregate shall be a single-size material having a 20mm nominal aggregate size. The aggregate shall be placed and compacted by hand to the level of the underside of the drainpipe.

Appendix A: Approval Record and Document Control[3]

[3] See Western Power Internal Document