Shellharbour City Council

Shellharbour Engineering Construction Code

shellharbour.nsw.gov.au

19/11/2019

LIST OF SPECIFICATIONS IN THE CONSTRUCTION CODE

0136 GENERAL REQUIREMENTS (CONSTRUCTION)

1 GENERAL

1.1 RESPONSIBILITIES

General

It should be noted clearly by all parties that project personnel are contracting to the Developer/Applicant and not to Council. It is the responsibility of the Applicant to ensure that all works are carried out in a sound and efficient manner, in accordance with sound engineering practice and principles, and are completed in accordance with the approved Engineering Drawings and Specifications.

Final approval of the works rests with the Council, on the assurance of Council's Engineer that the Engineering Drawings and Specifications have been complied with, and the construction satisfactorily completed.

If irregularities occur and are not rectified to the satisfaction of Council's Engineer or if work is covered before an inspection has been made, no guarantee is given that the works will be accepted when application is made.

Where the work is for the Council's Capital Works Programme, the contract is between the Contractor and Council. The context of the Contract will determine which contract is applicable.

Project Manager

For developments involving complex engineering issues it is recommended that the Applicant engages the services of an experienced Project Manager. It is the Project Manager's responsibility to ensure the works are carried out in accordance with the development consent and to co-ordinate the delivery of the works.

Once the Project Manager has been engaged, Council's officers will have only one contact that is coordinating the progress of the development. Time delays often arise where inexperienced Applicants try to share the project management role.

The Project Manager must be readily available and have sufficient authority and ability to discuss and resolve problems and act as the principal contact with Council.

A Developer who chooses to adopt this role must be aware that Council does not become involved in coordinating activities or giving advice beyond Council responsibilities.

Principal Certifying Authority

The Applicant must appoint a Principal Certifying Authority (PCA) for each development project. The PCA must be appointed a minimum of 2 days before the commencement of works.

Council must be appointed as the Principal Certifying Authority for subdivisions. An application form to nominate Council as the Principal Certifying Authority can be located on Council's website.

Certifying Authority

Council or an Accredited Certifier must be appointed to issue a Construction Certificate for proposed subdivision and development works, and Council must be appointed to undertake Compliance Inspections for subdivision and development works. These roles are mutually exclusive and need not be carried out by the same Certifying Authority.

The Certifying Authority for the compliance inspections will inspect the work to ensure the contractor carries out the work in accordance with the approved Engineering Drawings and Council's Specification. Any critical stage inspections nominated by the PCA will also need to be carried out by the Certifying Authority.

Accredited Certifiers do not have authority to carry out inspections for works on Public Roads where approval for the works is granted pursuant to the Roads Act, unless authorised by the Roads Authority.

Superintendent/Supervisor

The Project Manager is to nominate a person to supervise all works on site. It is not the Certifying Authority's role to supervise construction. The Superintendent/Supervisor is to liaise with the Project Manager regarding any instruction by the Certifying Authority. It is the Superintendent/Supervisor's role to ensure that all works are carried out in accordance with the contract, approved Engineering Drawings, Council's Specification, relevant legislation and engineering best practice.

Principal Contractor

The Project Manager must appoint a Principal Contractor for the works who must be the holder of a contractor licence (if any residential building work is involved) and notify the Principal Certifying Authority of any such appointment.

It is the Principal Contractor's role to ensure that all works are carried out in accordance with the contract, approved Engineering Drawings, Council's Specification, relevant legislative requirements and engineering best practice.

The Principal Contractor is responsible for the actions of any sub-contractors on the site. Any instruction issued by Council's Engineer to a sub-contractor is considered to be an instruction issued to the Principal Contractor. It is the Principal Contractor's responsibility to ensure that procedures are in place on site to ensure that instructions to the sub-contractor are directed through appropriate channels.

The Principal Contractor must ensure that they comply with their responsibilities under the Work Health and Safety Act. All contractors must have a current Workers Compensation Insurance Policy for all employees as required by Statute.

1.2 PRECEDENCE

General

Work-sections and referenced documents:

- The requirements of other work-sections of the specification override conflicting requirements of this work-section.
- The requirements of the work-sections override conflicting requirements of their referenced documents.
- The requirements of referenced documents are minimum requirements.

1.3 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *0173 Environmental management (AUS-SPEC)*.
- *1101 Traffic management*.
- *1196 Boundary fencing for road reserves*.

Cross referencing

Within the text:

- Work-section titles are indicated by *Italicised* text.
- Clause titles are indicated by **BOLD** text.

Hold and witness points

General: **SUBMISSIONS** and/or **INPSECTIONS** align with **ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS**.

1.4 REFERENCED DOCUMENTS

Contractual relationships

General: Responsibilities and duties of the principal, contractor and superintendent are not altered by requirements in the documents referenced in this specification.

Current editions

General: Use referenced documents (including test methods) which are the editions, with amendments, current 3 months before the closing date for tenders, except where other editions or amendments are required by statutory authorities.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviations apply:

- AS: Australian Standard.
- BIM: Building Information Modelling.
- CAD: Computer Aided Design.
- ESD: Ecologically sustainable development.
- ICSM: Intergovernmental Committee on Surveying and Mapping.
- NATA: National Association of Testing Authorities.
- TBS: To Be Supplied.
- WHS: Work Health and Safety.

Definitions

General: For the purposes of this contract the definitions given in Austroads AP-C87 and the following apply:

- Authorities: Includes service agencies and Road Authorities.
- Documented: Documented, as documented and similar terms mean contained in the contract documents.
- Geotechnical site investigation: The process of evaluating the geotechnical characteristics of the site in the context of existing or proposed construction.
- Give notice: Give notice, submit, advise, inform and similar expressions mean give notice (submit, advise, inform) in writing to the contract administrator.
- Hold point: A mandatory verification position in the contract beyond which work cannot proceed without the designated authorisation.
- Local (government) authority: A body established for the purposes of local government by or under a law applying in a state or territory.
- Manufacturers' and suppliers' recommendations: Recommendations, instructions, requirements, specifications (and similar expressions) provided in written or other form by the manufacturer relating to the suitability, use, installation, storage and/or handing of a product.
- Obtain: Obtain, seek and similar expressions mean obtain (seek) in writing from the contract administrator.
- Permanent marks: Survey control marks that are permanent by nature and are uniquely defined in the state control survey. Also known as State survey marks (SSM) or Bench marks (BM).
- Principal: Principal has the same meaning as owner, client and proprietor and is the party to whom the contractor is legally bound to construct the works.
- Professional engineer: A person who is Registered in relevant discipline on the National Engineering Register (NER) a corporate member of Engineers Australia or eligible to become a corporate member registered on NER, and has appropriate experience and competence in the relevant field.

- Progressive inspections: Inspections that are required progressively on a component during the course of the project.
- Proprietary: Identifiable by naming the manufacturer, supplier, installer, trade name, brand name, catalogue or reference number.
- Provide: Provide and similar expressions mean supply and install and include development of the design beyond that documented.
- Provide: Provide and similar expressions mean supply and install and include development of the design beyond that documented.
- Registered testing authority:
  . NATA accredited laboratory: An organisation accredited by the National Association of Testing Authorities (NATA) to test in the relevant field; or
  . An organisation outside of Australia registered by an authority recognised by NATA through a mutual recognition agreement; or
  . An organisation recognised as being a Registered Testing Authority under legislation at the time the test was undertaken.
- Required: Required by the contract documents, the local council or statutory authorities.
- If required: A conditional specification term for work which may be shown in the documents or is a legislative requirement.
- Road authority: As defined by the *Roads Act* in the state where the road is located.
- Statutory authority: A public sector entity created by legislation, that is, a specific law of the Commonwealth, State or Territory.
- Superintendent: Superintendent has the same meaning as Contract Administrator or Principal's representative. The Superintendent may be party to the contract or appointed by the Principal to administer the contract. The powers, duties and authorities of the Superintendent are covered in the contract. These can be changed in writing at any time during the contract.
- The Superintendent for a Council funded project is Council's Authorised Person. The Superintendent for a private development is the developers Superintendent. Note that for a private development project, that Council's Engineering Development Officer will have Hold Points to release that sit above those of the Principal's Superintendent.
- Supply: Supply, furnish and similar expressions mean supply only.
- Survey mark: A survey peg, bench mark, reference mark, signal, alignment, level mark or any other mark used or intended to be used for the purpose of setting out, checking or measuring the work.
- Tests – completion: Tests carried out on completed installations or systems and fully resolved before the date for practical completion, to demonstrate that the installation or system, including components, controls and equipment, operates correctly, safely and efficiently, and meets performance and other requirements. The superintendent may direct that completion tests be carried out after the date for practical completion.
- Tests – pre-completion: Tests carried out before completion tests, including:
  . Production: Tests carried out on a purchased item, before delivery to the site.
  . Progressive: Tests carried out during installation to demonstrate performance in conformance with this specification.
  . Site: Tests carried out on site.
  . Type: Tests carried out on an item identical with a production item, before delivery to the site.
- Tolerance: The permitted difference between the upper limit and the lower limit of dimension, value or quantity.
- Verification: Provision of evidence or proof that a performance requirement has been met or a default exists.
- Witness point: A nominated position, in the different stages of the Contract, where the option of attendance may be exercised by the Superintendent, after notification of the requirement.

1.6 CONTRACT DOCUMENTS

Services diagrammatic layouts

General: Layouts of service lines, plant and equipment shown on the drawings are diagrammatic only, except where figured dimensions are provided or calculable.

Before commencing work:

- Obtain measurements and other necessary information.
- Coordinate the design and installation in conjunction with all trades.

Levels

General: Spot levels take precedence over contour lines and ground profile lines.

Common text

1.7 SUBMISSIONS

Requirement

General: Submit the following, as documented:

- Authority approvals: Notes of meetings with authorities whose requirements apply to the work and evidence that notices, fees and permits have been sought and paid, that authority connections are complete and that statutory approvals by the authorities whose requirements apply to the work have been received.
- Certification: Certification of conformance to documented requirements.
- Design: Design data and certification of proposed work, if required and as documented.
- Materials : Products and materials data, including manufacturer's technical specifications and drawing, evidence of conformance to product certification schemes, performance and rating tables and installation and maintenance recommendations.
- Work-as-executed drawings: To EXECUTION, **WORK-AS-EXECUTED DRAWINGS**. One design file in accordance with the ADAC specification, which is available on Council's website.
- Samples: Representative of proposed products and materials and including proposals to incorporate samples into the Works, if any to EXECUTION, **SAMPLES**.
- Shop drawings: To EXECUTION, **SHOP DRAWINGS**.
- Substitutions: To MATERIALS**, GENERAL, Substitutions**.
- Tests:
  - Inspection and testing plan consistent with the construction program including details of test stages and procedures.
  - Certificates for type tests.
  - Test reports for testing performed under the contract to EXECUTION, **TESTS**.

Contractor review: Before submissions, review each submission item and check for coordination with other work of the contract and conformance to contract documents.

Submission: To the superintendent.

Execution details

Working area and site facilities:

- Site facilities: Submit a proposal for positioning of all units, services including septic or sewer, rubbish collection, storage areas and security fencing.
- Alternative site facilities: Submit proposal with full details for the use of alternative site facilities in existing buildings.

Adjoining property: Submit one endorsed copy of each record of adjoining property inspection.

Signage: Submit all safety and project signs for approval before sign manufacture or purchase.

Alternative construction: Submit detailed working drawings, design calculations and specifications and certification by a Professional Engineer experienced in the alternative construction design, verifying conformance of the design.

Submission times

Default timing: Make submissions at least 5 working days before ordering products or starting installation of the respective portion of the Works.

Identification

Requirement: Identify the project, contractor, subcontractor or supplier, manufacturer, applicable product, model number and options, as appropriate and include relevant contract document references. Include service connection requirements and product certification.

Non-conformance: Identify proposals that do not conform with project requirements, and characteristics which may be detrimental to successful performance of the completed work.

Errors

Errors: If a submission contains errors, make a new or amended submission as appropriate, indicating changes made since the previous submission.

Hard copy submissions

- Loose documents larger than A3: One transparency on heavyweight plastic film the same size as the standard contract drawings.
- Loose documents up to and including A3: One copy.

Notice

General: Give notice so that inspection may be made of the following:

- Items to be supplied by the principal: Delivery to site.
- Existing utility services: Discrepancies from documented location.
- Relocation and alterations to existing utility services: Proposed removal, diversion or cutting into existing service.
- Supplied survey setting out information: Transfer of survey marks.

Attendance

General: Provide attendance for documented inspections and tests.

Underground works: If notice of inspection is required for parts of the works that are to be concealed, advise when the inspection can be made before concealment/backfilling.

Public Liability Insurance Policy

Contractors or sub-contractors engaged on Development or Subdivisional Works or when working in or connecting to public roads shall obtain Public Liability Insurance for a minimum cover value of $20million before commencing construction. The policy shall specifically indemnify Council from all claims arising from the execution of works.

A copy of the Public Liability Insurance policy shall be forwarded to Council prior to commencement of works noting the policy expiration date. The period of the policy must be sufficient to complete the subject works.

2 MATERIALS

2.1 GENERAL

Manufacturers' or suppliers' recommendations

General: Provide and select, if no selection is given, transport, deliver, store, handle, protect, finish, adjust and prepare for use the manufactured items in conformance with the recommendations of the manufacturer or supplier.

Proprietary items/systems/assemblies: Assemble, install or fix in conformance with the recommendations of the manufacturer or supplier.

Project modifications: Advise of activities that supplement, or are contrary to the recommendations of the manufacturers or supplier.

Sealed containers

General: If materials or products are supplied by the manufacturer in closed or sealed containers or packages, bring the materials or products to point of use in the original containers or packages.

Prohibited materials

General: Do not provide the following:

- Materials, exceeding the limits of those listed, in the Safe Work Australia Hazardous Chemical Information System (HCIS).

Substitutions

Identified proprietary items: Identification of a proprietary item does not necessarily imply exclusive preference for the identified item, but indicates the necessary properties of the item.

Alternatives: If alternatives to the documented products and materials, methods or systems are proposed, submit sufficient information to permit evaluation of the proposed alternatives, including the following:

Evidence that the performance is equal to or greater than that specified.

- Evidence of conformity to a cited standard.
- Samples.
- Essential technical information, in English.
- Reasons for the proposed substitutions.
- Statement of the extent of revisions to the contract documents.
- Statement of the extent of revisions to the construction program.
- Statement of cost implications including costs outside the contract.
- Statement of consequent alterations to other parts of the Works.

Availability: If the documented products or systems are unavailable within the time constraints of the construction program, submit evidence.

Criteria: If the substitution is for any reason other than unavailability, submit evidence that the substitution:

- Is of net enhanced value to the principal.
- Is consistent with the contract documents and is as effective as the identified item, detail or method.

Costs: Pay the cost of submissions and of evaluations and tests of proposed alternatives, whether subsequently adopted or not. The costs will be calculated at the current charge-out rates of the relevant consultant(s).

2.2 ITEMS TO BE SUPPLIED (TBS) BY THE PRINCIPAL

General

Supply of items: Items listed in the **Items to be supplied by principal schedule** will be supplied free of charge to the contractor for installation in the Works.

Requirement: Unload and take delivery, inspect for defects and take care of the TBS items. Return unused items to the principal.

Time of delivery: Give notice of the required time of delivery for TBS items.

Damaged or defective: Give notice of any TBS item found damaged or defective within 2 days of taking delivery. If the contractor does not report damage or defect it is deemed that the TBS item was free from damage or defect when received and the contractor is responsible for any replacement or making good.

Storage: Store, protect and insure of all TBS Items received.

Pipe culverts supplied by the principal

Time of delivery: Give 30 days' notice of the required time of delivery.

Supplied: Pipe culverts are supplied by the principal at no cost to the contractor for the actual length laid of pipe culvert required under the contract.

Additional pipe culverts: If any pipe culverts are required in addition to those supplied, it is the responsibility of the contractor to supply at no cost to the principal.

3 EXECUTION

3.1 THE SITE

Working hours

Working hours: Operational hours of plant, including the entry and/or departure of heavy vehicles, is restricted to 7 am to 6 pm Monday to Friday and 8 am to 1 pm on Saturdays and not permitted on Sundays or Public Holidays. Work outside of these hours is not permitted without approval.

Working area and site facilities

Working areas: Restrict construction working areas and areas for temporary site facilities, including the storing of materials, use of plant and erection of sheds, to areas documented on the drawings. Do not work or occupy areas outside of the designated areas.

Alternative site facilities: If proposing to use existing buildings adjacent to, or in close proximity to, the Works as alternative site facilities, obtain approval.

Security: Take security measures for the safe keeping of any plant, equipment, tools, materials or other property.

Temporary fencing: Provide and maintain temporary fencing and warning signage during the contract to prevent unauthorised entry into the property.

Existing fencing: Reinstate the existing fencing and remove temporary fencing before the date of practical completion.

Site restrictions

- Status: Reports supplied for information only are not contract documents.

Protection of persons and property

Temporary works: Provide and maintain required hoardings, barricades, guards, fencing, shoring, temporary roadways, footpaths, signs, lighting, watching and traffic control.

Accessways, services: Do not obstruct or damage roadways and footpaths, drains and watercourses and other existing services in use on or adjacent to the site. Determine the location of the services.

Property: Do not interfere with or damage property which is to remain on or adjacent to the site, including adjoining property encroaching onto the site, and trees.

Rectification

Accessways, services: Rectify immediately any obstruction or damage to roadways and footpaths, drains and watercourses and other existing services in use on or adjacent to the site. Provide temporary services whilst repairs are carried out.

Property: Rectify immediately any interference or damage to property which is to remain on or adjacent to the site, including adjoining property encroaching onto the site, and trees.

Adjoining property

Notice: At least 10 working days before commencing work, submit to owners and occupants of adjoining property written notice of intention to commence work and an outline description of the type and extent of work.

Revealed encroachments: If the works reveal unknown encroachments of adjoining property on to the site or of existing site structures on to adjoining property, immediately seek instructions.

Records: For properties described in the **Adjoining properties to be recorded schedule**:

- Inspect the properties with the superintendent and owners and occupants of the properties, before commencement of work.
- Make detailed records of conditions existing within the properties, especially structural defects and other damage or defacement.
- Arrange for at least 2 copies of each record, including drawings, written descriptions, and photographs, to be endorsed by the owners and occupants, or their representatives, as evidence of conditions existing before commencement of work.

Endorsed copies: Submit one endorsed copy of each record. Keep the other endorsed copy on site.

- Purpose of submission: Information only.

Site investigation

Geotechnical and environmental reports: For information only. The geotechnical information, including information on contaminants, provides information on the nature of the ground at each tested part and is not a complete description of conditions existing at or below ground level.

Contractor's responsibility: Examine and assess the following:

- Geotechnical information and the site to determine the impact on the construction of the Works.
- The in-situ moisture content likely at the actual time the work is carried out.

3.2 EXISTING UTILITY SERVICES

Existing services

Subsurface utilities: Information shown on the drawings relating to underground or submerged utilities is accurate to the following quality level, to AS 5488:

Location: Before starting earthworks, locate and mark existing underground services in the areas which will be affected by the earthworks operations including clearing, excavating and trenching.

Utility services: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables.

Services verification: Contact the persons listed in the **Utility authority contacts schedule** to verify the location of utility services.

Discrepancies: If there is any conflict between the actual location or elevation of any service and the location or elevation of any service shown on the drawings, give notice.

Sensitivity of utilities: Identify those utilities such as optical fibre cables sensitive to the vibration from heavy duty compaction rollers.

Excavation adjacent to utility services: Use only utility authority approved methods of excavation.

Limitations to work methods: Include in work method procedures, any restrictions required by the relevant authority, such as vibrations in the vicinity of underground and overhead facilities.

Protection of services

Precautions: Secure and protect existing gas, water, drainage pipes, sewers, electric conduits and other existing services both underground and overhead.

Repair to existing: Repair any damage caused to existing gas, water, drainage pipes, sewers, electric conduit and other existing services to the approval of the relevant authority.

Relocation and alterations to existing utility services

Alterations: Give notice and obtain approval, if removal, diversion or cutting into existing utility services is required.

Redesign of works: If vibration of road building equipment is a problem then consider a change to the works design to consider different pavement materials such as reinforced concrete subbase and asphalt base and wearing course.

Liaison with utility authority: Include the following:

- Allowance in the program for coordination.
- Allowances in the program for installation by utility authority contractor during the Works.
- Allowance for adjustments to site plant and equipment.
- Allow utility authority contractor to work on or near the site and do not interfere with the operations.
- Reinstatement and backfilling of service trenches to the requirements of the utility authority.

Restrictions: Obtain approval before proceeding with the following:

- Stop work due to utility authority operations.
- Relocation of utility services due to equipment or methods of operation.

Relocations of services by the contractor: Arrange all relocations or alterations to the **Relocation/alteration to services (by contractor) schedule**.

Relocations of services by the principal: Relocations and expected program to **Relocation/alteration to services (by principal) schedule**. Do not commence the Works before completion of the relocation/alteration of the services.

Maintenance responsibility: The contractor is not responsible for the maintenance of any facilities or structures installed or constructed by the utility authorities.

Programming and duration of utility alterations and relocations:

- Give notice of the expected date of completion of each part of the Works required to be completed before the utility services listed in this work-section can be relocated.
- Do not proceed with final trimming or subsequent parts of the work until work on the utility services within that area is complete.

- Delays due to work by authorities: If required, allow utility authorities to remove, relocate, or work on their facilities before continuing the Works.

Extension of time: The Contractor is entitled to extensions of time if the utilities have not been relocated by these dates and this causes delay to the Contract.

3.3 CONSTRUCTION PLANT

Office for superintendent as agreed by Council

Temporary services

Sewer: Make a temporary connection to an existing sewer where one is available. Provide a portable toilet as an alternative. Cap temporary sewer connection at completion.

Water supply: Provide temporary water supply for site facilities. Remove on completion.

Electricity supply: Provide any temporary electricity supply required for site facilities. Remove on completion.

Temporary fencing

Requirement: Provide temporary fencing to site facilities as documented, to the *1196 Boundary fencing for road reserves* work-section and as follows:

- Type: 1.83 m high galvanized chain fabric mesh fence.
- Gate: Galvanized tubular steel vehicular access gate.
- Covering to fencing: Full height hessian or shade cloth screen.

Removal: Remove temporary fencing at practical completion.

Advertising signs

Requirement: No advertising is permitted on the site except for the following:

- Approved project signs.
- Manufacturer's name or names of owner on items of construction plant.
- Contractor's mail box.

Project work signs

Requirement: Provide project-specific work signs and as follows:

- Locate where directed.
- Maintain in good condition for duration of the work.
- Obtain permission for removal.
- Remove on completion.

Timing:

- Installation: No later than one week from receiving the notice of possession of site.

3.4 BUILDING THE WORKS

Program of work

Construction program: Show the following:

- Sequence of work.
- Critical paths of activities related to the work.
- Allowance for holidays.
- Allowance for relocation of utility services alterations and relocation.
- Activity inter-relationships.
- External dependencies including provision of access, document approvals and work by others.

- Periods within which various stages or parts of the work are to be executed.

Time scale: Working days.

Updated program: Identify changes since the previous issue, and show the estimated percentage of completion for each item of work.

Program chart: Display in the contractor's site office an up-to-date bar chart and network diagram based on the construction program.

Provision for Traffic

Where applicable, the Applicant shall provide a Traffic Management Plan and/or any Traffic Control Plans to Council prior to commencement of works. The Traffic Management Plan shall consider site access and the route in which construction traffic will travel to and from the site.

In respect of construction work adjoining existing streets or pavements, the Applicant shall provide proper fencing, barriers, signs, lighting and supervision of all work and such temporary roadwork and footways, as may be necessary for the accommodation and protection of pedestrians, vehicles, the public and animals.

Appropriate traffic warning signs shall be erected in accordance with the requirements of AS1742 (2014) – "Manual of Uniform Traffic Control Devices" and/or RMS Work Near Traffic "Traffic Control at Work Sites Version 4".

If necessary, the Applicant shall provide for traffic by its diversion to an alternative route approved by Council's Engineer, or by the formation of side tracks alongside the work, or by the construction of one-half of the road at a time, leaving the other half available for traffic.

The temporary closing of a road and/or the provision of a temporary road shall be undertaken in accordance with the provisions of the Local Government Act and Roads Act. All costs involved shall be borne by the Applicant. It is recommended that early contact be made with Council's Engineer for any road closure proposal to ensure all necessary approvals are obtained, including that of the Local Traffic Committee where necessary.

All Traffic Control Plans must be prepared by a suitably qualified contractor with the appropriate training and certification from the Roads & Maritime Services (RMS).

Site meetings

General: Attend site meetings throughout the contract and arrange attendance of appropriate subcontractors.

Meeting agenda: Include performance measures, coordination of program and work under the contract and resolution of any questions regarding the intent or interpretation of the documents.

Minutes: Site meetings will be chaired and minuted by the superintendent. Copies of the minutes will be issued to all present at the meeting and others concerned with the matters discussed.

Work by others

Requirement: Coordinate the Works with simultaneous and/or adjacent work by others and liaise with other contractors and authorities to avoid disruption, delays and possible conflict.
Access: If required, allow free access for completion of any work by others.

Public Utility Conduits

Prior to the commencement of the works, the Applicant shall obtain details from the various Public Utility Authorities, of their requirements for service conduits in the work area.

Service conduits shall be provided at locations specified by the relevant Authority and in accordance with their requirements.

Conduits within the road reserve shall be laid normal to the road centre line and be of sufficient length to extend minimum 300mm beyond the back edge of the kerb. The conduits shall be laid prior to the construction of the pavement sub-base, backfilled in accordance with the requirements of Section 6.5 of these Specifications and shall have a minimum cover of 500mm below lip of gutter level.

The location and type of conduit shall be clearly and permanently marked on the kerb and gutter. Water conduits shall be marked “W”, electricity conduits marked “E”, telecommunications conduits marked “T” and gas conduits marked “G”.

Services are to be laid concurrently with the construction works where possible and are to be in place prior to final acceptance by Council.

Service trench excavation shall be no closer than 300mm from the back of kerb.

Where service conduits are laid in existing sealed roads the trench shall be backfilled with 14:1 sand/cement mix to 200mm below finished pavement level followed by 150mm of compacted DGB 20 and 50mm of hot-mix asphalt.

The existing road shall be saw cut 300mm beyond the trench on each side. The sections shall be removed and the new asphalt minimum 50mm installed flush with the adjoining roadway.

Alternative construction

Requirement: If the use of alternative materials, design or methods of construction is permitted, prepare detailed working drawings, design calculations and specifications for the alternative.

Documentation: Provide 2 sets of CAD working drawings and any supporting calculations.

Revisions: Attend to any required revisions to drawings or calculations and resubmit 2 sets of the revised drawings and calculations.

Certification: Provide certification by a Professional Engineer experienced in the alternative construction design, verifying conformance of the design.

Submission timing: At least four weeks before construction of the relevant part of the work is scheduled to commence.

Approval to proceed: Do not commence the Works until an endorsed set of working drawings has been returned.

3.5 SURVEY CONTROL

General

Road construction survey: To ICSM QA Specification G71.

Permanent and cadastral survey marks: Provide verification by a registered surveyor that a search has been carried out before starting the Works and all permanent and cadastral survey marks have been identified and recovered, if required.

Supplied survey setting out information

Certification: Before starting the Works, check the digital design model provided for discrepancies between the model and the drawings.

Provision of marks: The superintendent will provide permanent marks shown on the drawings and establish bench marks related to the level datum.

Transfer of marks: Transfer permanent survey marks clear of the operations before any of the survey marks on base lines or various control lines are affected by the Works.

Relocation of survey control: Obtain approval for the relocation of survey control, establishment of recovery pegs, or setting out or levelling.

Protection: Protect all supplied survey marks. If survey marks are damaged or destroyed, re-establish the survey marks.

Set out pegs

Recovery pegs: Provide and fix adequate recovery pegs in suitable locations adjacent to the elements of work.

Removal: Remove all pegs and profiles at practical completion.

Survey equipment

Requirement: Use electronic total stations and ancillary equipment for survey tasks in conformance with the following:

- Electromagnetic distance measuring device (EDM): Standard deviation for error < 5 mm + 5 ppm.
- Horizontal and vertical circles: Angular measurement standard deviation for error < 3 seconds of arc.
- One second of arc minimum count.
- Diametrical vertical circle reading and automatic tilt compensator.
- Capability to electronically record and store field data such as horizontal and vertical angles, distances, point notation, target and instrument heights.
- The calibration procedure and calibrated at all times.
- Calibrated immediately after any repairs.

Laser and global positioning construction control systems

Horizontal and longitudinal alignment control requirements:

- Offset pegs 500 mm from the surface design edge of subgrade.
- Clearly mark chainages on the pegs.
- Spacing between pegs:
  . < 50 m on the straights.
  . < 20 m on curves including all curve tangent points.
- Place pegs vertically.
- Tolerance: ± 25 mm to the exact horizontal location.
- Protect from disturbance.

Removal: Remove all pegs at practical completion.

3.6 SAMPLES

General

Incorporation of samples: Only incorporate samples in the Works which have been endorsed for inclusion. Do not incorporate other samples.
Retention of samples: Keep endorsed samples in good condition on site, until the date of practical completion.
Unincorporated samples: Remove on completion.

3.7 SHOP DRAWINGS

General

Documentation: Include dimensioned drawings showing details of the fabrication and installation of structural elements, building components, services and equipment, including relationship to building structure and other services, cable type and size, and marking details.

Diagrammatic layouts: Coordinate work shown diagrammatically in the contract documents, and prepare dimensioned set-out drawings.

Record drawings: Amend all documented shop drawings to include changes made during the progress of the work and up to the end of the defects liability period.

3.8 WARRANTIES

General

Requirement: Name the principal as warrantee. Register with manufacturers as necessary. Retain copies delivered with components and equipment.

Warranty period: Start warranty periods at acceptance of installation.

3.9 WORK-AS-EXECUTED DRAWINGS

Recording, format and submission

Progress recording: Keep one set of drawings, CAD or BIM files on site at all times, expressly for the purpose of marking changes made during the progress of the Works.

One design drawing file in accordance with the ADAC specification, which is available on Council's website.

Drawing layout: Use the same borders and title block as the contract drawings.

Quantity and format: Conform to SUBMISSIONS.

Endorsement: Certify and date all record drawings.

Accuracy: If errors in, or omissions from, the record drawings are found, amend the drawings and re-issue in the quantity and format documented for SUBMISSIONS.

Date for submission:

- Draft submission: 2 weeks before the date for practical completion.
- Final submission: Before issue of final certificate.

Roadworks: Certify all changes to the contract drawings and actual values of all levels, endorsed by a registered surveyor.

Public utilities

Public utilities: Record as required by the work-sections.

Surface utilities: Record information on background or submerged utilities to the documented quality level, conforming to AS 5488.

3.10 OPERATION AND MAINTENANCE MANUALS

General

Authors and compilers: Personnel experienced in the maintenance and operation of equipment and systems installed, and with editorial ability.

Referenced documents: If referenced documents or work-sections require that manuals be submitted, include corresponding material in the operation and maintenance manuals.

Contents

Requirement: Include the following:

- Table of contents: For each volume. Title to match cover.

- Directory: Names and contact details of principal consultant, subconsultants, contractor, subcontractors and name of main contact.
- Work-as-executed drawings: Complete set of record drawings, full size.
- Drawings and technical data: As necessary for the efficient operation and maintenance of the Works.
- Project description: General description of the Works.
- Product descriptions:
  . Name and contact details of the manufacturer and supplier of products installed.
  . Schedules of products, stating locations, and dates of manufacture. Provide a unique code number cross-referenced to the record and diagrammatic drawings and schedules for each product installed.
  . Manufacturers' technical literature for products installed, assembled specifically for the project, excluding irrelevant matter. Mark each product data sheet to clearly identify specific products used in the Works.
- Certificates:
  . Certificates from authorities.
  . Copies of manufacturers' warranties.
  . Product certification.
  . Test certificates for each service installation and all equipment.
  . Test reports.
  . Commissioning reports.
- Operation procedures.
- Maintenance procedures:
  . Detailed recommendations for periodic maintenance and procedures, including schedule of maintenance work including frequency and recommended tests.
  . Emergency procedures, including telephone numbers for emergency services, and procedures for fault finding.
  . Safety data sheets (SDS).

Format – electronic copies

Printing: Except for drawings required in the WORK-AS-EXECUTED DRAWINGS clause, provide material that can be legibly printed on A4 size paper.

Scope: Provide the same material as documented for hardcopy in electronic format.

Quantity and format: Conform to SUBMISSIONS – electronic copies.

Format – hard copy

General: A4 size loose leaf, in commercial quality, 4 ring binders with hard covers, each indexed, divided and titled. Include the following features:

- Cover: Identify each binder with typed or printed title *OPERATION AND MAINTENANCE MANUAL*, to spine. Identify title of project, volume number, volume subject matter, and date of issue.
- Dividers: Durable divider for each separate element, with typed description of system and major equipment components. Clearly print short titles under laminated plastic tabs.
- Drawings: Fold drawings to A4 size with title visible, insert in plastic sleeves (one per drawing) and accommodate them in the binders.
- Pagination: Number pages.
- Ring size: 50 mm maximum, with compressor bars.
- Text: Manufacturers' printed data, including associated diagrams, or typewritten, single-sided on bond paper, in clear concise English.

Number of copies: 3.

Date for submission
Draft submission: 2 weeks before the date for practical completion.

Final submission: Before issue of final certificate.

3.11 TESTING

Attendance
General: Provide attendance on tests.

Testing authorities
General: Except for site tests, have tests carried out by a Registered testing authority.

Test instruments: Use instruments calibrated by a Registered testing authority.

Test reports
General: Indicate observations and results of tests and conformance or non-conformance with requirements.

Notice
Inspection: Give sufficient notice for inspection to be made of the testing as documented.

Controls
General: Calibrate, set and adjust control instruments, control systems and safety controls.

Certification
General: On satisfactory completion of the installation and before the date of practical completion, certify that each installation is operating correctly.

3.12 COMPLETION

Reinstatement
General: Before the date for practical completion, clean and repair damage caused by installation or use of temporary work and restore existing facilities used during construction to original condition.

Completion of Works

When the Project Manager considers that the works have been completed, they will arrange for the lodgment of all necessary compliance documentation for the review of the Certifying Authority and make arrangements for a final inspection.

3.12.1Compliance documentation

The following documentation must be reviewed by the Certifying Authority prior to the issue of a Compliance Certificate attesting to the satisfactory completion of the works. If the review of this documentation identifies any non-compliances, then these matters shall be brought to the attention of the Principal Certifying Authority for further action. One hard copy and one electronic copy of all compliance documentation must be submitted to Council.
Pipe repairs that have been endorsed by Council Engineers must be detailed and included in the subdivision compliance documentation. The Work-As-Executed plans shall clearly note the location of any repaired pipeline. Additional documentation shall be included that demonstrates testing documentation of the repair product and the applicators warranty that the repairer has guaranteed, and both meet the pipelines minimum design life of 100 years.

Geotechnical Report

The final submission requires lodgement of a geotechnical report prepared by a practicing geotechnical engineer.

The report is to detail the matters relating to road pavement compaction, lot filling, earthworks and lot classification and compliance with Council's Specification. The report is to be accompanied by the Geotechnical Engineer Certificate certifying that the required compactions were achieved in accordance with Council's Specification and/or relevant Australian Standards.

A lot fill diagram must be provided where lots have been filled. The diagram will show fill areas in different colours or hatching for depths of fill in 300mm increments. The diagram will apply to all lots that have been filled in excess of 300mm.

Easement Certificates

The final submission requires lodgement of a Surveyor's Certificate from a Registered Surveyor. This certificate will certify that all pipes, structures and services are located within their respective easements.

Material Compliance Certificates

Material Compliance Certificates for all road pavement materials will be required to be submitted prior to issue of the Subdivision Certificate or upon completion of the works.

All materials shall comply strictly with Council's Specification or Council's written approval of alternate materials.

Engineer's Certificates

Where structural work has been undertaken on a project, a certificate from a suitably qualified Registered Structural Engineer must be lodged, certifying the adequacy of the structure.

Slope Junction Plan (Inter-allotment Drainage)

A slope junction plan indicating location, depth and offsets from boundaries of all slope junctions shall be prepared by the project engineer/surveyor and submitted to Council.

Street/Public Lighting and Utility Installations

Utility Authority Compliance Certificates are to be provided demonstrating that all necessary services have been installed to the standards and requirements of the respective authority.

Adjoining Owners Clearance

Where work has been carried out on adjoining properties, a written clearance from the respective owners stating their satisfaction with completed works must be lodged with the final document submission.

3.13 FINAL INSPECTION

Following review of the compliance documentation including the "Final Inspection" checklist, the Certifying Authority shall undertake a final inspection of the works. Any defects or non-compliances identified in the review of compliance documentation or during the inspection are to be rectified prior to the issue of a Compliance Certificate certifying that the works have been satisfactorily completed.

Where Council is not the Certifying Authority it is recommended that Council is invited to participate in the final inspection so that any issues are identified at the same time as those raised by an independent Certifying Authority. It is advised that where Council is the Principal Certifying Authority for subdivisions and other development a final inspection shall be undertaken prior to the issue of any Subdivision/Occupation Certificate.

Note: The Final Inspection Certificate issued by the Certifying Authority at the time of inspection of s68 (EP&A Act) or s138 Roads Act) works is not the final sign-off. Final sign- off does not occur until a formal letter from Council's Development Engineering Unit is issued to the Applicant.

3.14 SUBDIVISION CERTIFICATE

Prior to the issue of a Subdivision/Occupation Certificate the Principal Certifying Authority shall be satisfied that all matters specified in the EP&A Act and the development consent have been met. In this regard any application for a Subdivision/Occupation Certificate shall be accompanied by the following documentation:

3.14.1 Statement of compliance with the development consent

The development consent needs to be reviewed regularly during the works. The application for a Subdivision/Occupation Certificate shall be accompanied by a Statement of Compliance detailing how each condition of the development consent has been met.

3.14.2 Compliance certificate

Prior to the issue of a Subdivision/Occupation Certificate, Council will require the submission of a final Part 4A Compliance Certificate, with one hard copy and one electronic copy of supporting compliance documentation, including WAE plans, as required by Council's Specification.

Where Council is not the Principal Certifying Authority the same documentation shall accompany the prescribed notice of issue of the Subdivision/Occupation Certificate.

It is the responsibility of the Certifying Authority to ensure that all works have been carried out in accordance with the development consent, approved Engineering Drawings and Council's Specification. The final Compliance Certificate shall clearly certify that these requirements have been met. The final Compliance Certificate shall not be issued if any works, other than works that are to be bonded, are outstanding.

Acceptance of works by the principle certifying authority

The Principal Certifying Authority must undertake a final inspection of the subdivision or development works. Prior to the issue of a Subdivision Certificate / Occupation Certificate any deficiencies identified with the works must be rectified to the satisfaction of the Principal Certifying Authority.

3.14.3 Subdivision plan and 88B instrument

Any subdivision plan and/or 88B Instrument must be consistent with the plan and conditions approved with the development consent. The subdivision plans and 88B shall indicate:

- Road Names in accordance with Council's "Road Naming Policy". A copy of the policy can be found on Council's website.
- All necessary legal instruments required to affect the development consent

3.14.4 Section 73 Sydney Water and other utility authorities' certificate

All subdivision applications in the Shellharbour Local Government Area must be accompanied by a s73 Certificate from Sydney Water as required by the EP&A Act.
Compliance Certificates from other Utility Authorities may be required by conditions of the development consent.

3.15 BOND

Prior to the issue of Subdivision Certificate/Occupation Certificate the following bond types are to be lodged, as required by Council's Engineer:

- Maintenance
  - Asphaltic Concrete – final layer (where permitted by Council's Engineer)
  - Outstanding Works (where permitted by Council's Engineer)

Council will not accept Outstanding Works Bonds for works on private lands or land not in Council's future ownership.

All bonds must be in accordance with Council's adopted Fees and Charges.

Bond amounts must be verified by Council. Confirmation of bond amounts will be undertaken by Council upon written request.

BONDED WORKS: The Developer's obligations will be complete when the defects liability period has elapsed, and all bonds have been returned.

A request for the release on a Maintenance bond shall be supported by new CCTV footage (maximum 4 weeks old) of all stormwater drainage shall be undertaken and submitted to the Certifying Authority. Pipelines are to be clean and free of debris and silt. CCTV of dirty silted lines will not be accepted. Defects shall be notified to Council / PCA for approval of repair procedures prior to any repairs being made. Repairs are to be made to the satisfaction of the Council and revised CCTV footage and inspection report submitted to demonstrate rectification works have been completed. All repairs are to have certification of 100 years design life.

3.15.1 Subdivisions

Upon the issue of a Subdivision Certificate the works will enter the Maintenance Period. During this period any defects which become evident will be the responsibility of the Applicant to rectify. The Maintenance Period is a minimum of 12 months from the issue of the Subdivision Certificate. The Maintenance Period may be extended by the Council subject to consideration of the development status and for the purposes of further monitoring any matters that become evident during this period. An inspection shall be undertaken by Council at the end of the Maintenance Period, with any defects identified to be rectified to the satisfaction of Council's Engineer and a satisfactory inspection by Council. At the end of the Maintenance Period, following the rectification of any defects, and a satisfactory inspection by Council, bonds will be released, and Council will issue a formal acceptance of the works.

Letter of Undertaking in Lieu of Bond

3.15.2 Other development

Following the Final Inspection by the Principal Certifying Authority the works will come under a Maintenance Period of at least 12 months. The Maintenance Period may be extended by the Council subject to consideration of the development status and for the purposes of further monitoring any defects that become evident during this period. At the end of the Maintenance Period, following the rectification of any defects, bonds will be released, and Council will issue a formal acceptance of the works.

3.15.3 Contributions for outstanding works

In limited circumstances Council may accept a monetary payment for outstanding works, in lieu of a bond, to discharge the developer of their obligations. An application to make a monetary payment in lieu of providing a bond shall be made in writing. If agreed to, any such payment will be subject to a quotation by Council. The quotation shall allow for relevant administration costs and a surcharge allowing for indexation where works will be delayed.

3.15.4 Contributions for outstanding works

Additional CCTV may be required at the end of defects inspection as directed by Council.

4 MEASUREMENT AND PAYMENT

4.1 PAYMENTS

General

Payments items for the Works: To *0152 Schedule of rates (Construction)*.

4.2 MEASUREMENT

Methodology

Method of measurement for civil engineering work: To ASMM.

Non-conforming work: For non-conforming work apply the nominated deductions to the rates given to pay items for that work in *0152 Schedule of rates (Construction).*

5 ANNEXURE

5.1 SELECTIONS

Adjoining properties to be recorded schedule

Title	Owner	Description

Items to be supplied by the principal schedule

Purpose in works	Material type	Location	Approx. quantity available	Cost as a rate excl. GST	When available	Work-section clause

Relocation/alteration to services (by the contractor) schedule

Type of utility or service	Owner	Location	Requirement

Relocation/alteration to services (by the Principal) schedule

Type of utility or service	Owner	Location	Requirement	Timing

Type of utility or service	Owner	Location	Requirement	Timing

Utility authority contacts schedule

Authority	Name	Position	Phone number	Fax number
Water and sewerage				
Electricity				
Gas				
Telephone				
Telstra				
Optus				

5.2 ANNEXURE – SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS Execution details Working area and site facilities	H	Positioning of all units and services for site facilities	1 week before installation	Installation of site facilities
SUBMISSIONS Execution details Working area and site facilities	H	Alternative site facilities in existing buildings	2 weeks before installation	Installation of site facilities
INSPECTIONS, Notice Items to be supplied by the principal	W	Delivery to site	2 days	-
INSPECTIONS, Notice Existing utility services	W	Discrepancies from documented location	1 week	-
INSPECTIONS, Notice Relocation and alterations to	W	Relocation and alterations to existing utility services	1 week	-

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
existing utility services				
INSPECTIONS, Notice Supplied survey setting out information	W	Transfer of survey marks	2 days	-
*H = Hold Point, W = Witness Point				

5.3 ANNEXURE – PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
0136.1 Site establishment	Lump sum.	All costs associated with site establishment, including all documented facilities, site security, fencing, signage, etc.
0136. 2 Office for superintendent	Lump sum.	All costs associated with the provision of the documented facilities.
0136.3 Items from principal	Each. Calculate for each type and quantity of each type of item/material.	All costs associated with receiving, storing and handling items to be supplied from principal.
Traffic management	Lump sum.	To the *1101 Traffic management* work-section.

5.4 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 5488	2013	Classification of Subsurface Utility Information (SUI)
ASMM	1998	ASSM - Civil engineering measurement
Austroads AGPD		Guide to project delivery
Austroads AGPD03	2014	Contract management
Austroads AP-C87	2015	Austroads glossary of terms. 2015 edition.
ICSM QA Specification G71	2009	Intergovernmental Committee on surveying and mapping - Road construction surveys
Safe Work Australia		Hazardous chemical information system

0161 QUALITY MANAGEMENT (CONSTRUCTION)

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide a project quality management system (QMS) as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.

1.3 STANDARDS

General

Standard: To AS/NZS ISO 9001 and Austroads AGPD05.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviations apply:

- CAR: Corrective action request.
- ITP: Inspection and test plan.
- NATA: National Association of Testing Authorities.
- NCR: Non-conformance report.
- NNC: Notice of non-conformance.
- QA: Quality assurance.
- QAR: Quality assurance representative (principal).
- QMR: Quality management representative (contractor).
- QMS: Quality management system.
- WAE: Work-as-executed.

Definitions

For the purpose of this work-section, the definitions given in AS/NZS ISO 9000 and the following apply:

- As-built drawings: Copies of the design drawings with as-built changes (including repaired defects) marked up to scale with references to the relevant design change notices:
  - Interim as-built drawings are the as-built drawings at the stage of closure of the lot package.
  - Final as-built drawings are the as-built drawings incorporating the changes for all lot packages and are generally submitted before final completion of the project.
- Asset: A physical component of a road system or network. Typical assets include sections of pavements, bridges, culverts, traffic signals, signs, road furniture, road reserves etc.
- Certification: A written assertion of facts.
- Construction records: All lot records, non-conformance reports, design change notices, site instructions, photographs and interim as-built drawings applicable to a lot package.
- Corrective action request: A formal advice/instruction to the contractor requesting action to eliminate the cause of a detected nonconformity.
- Defect: A work lot non-conformance which continues to exist.

- Defect register: A register of all defects maintained by the contractor. Recorded as either OPEN or CLOSED.
- Disposition: Action taken to resolve non-conformance (Lot specific).
- Hold point: A mandatory verification position in the contract beyond which work cannot proceed without the designated authorisation.
- Inspection and test plan: The document identifying the required inspections and tests of the works. It includes verification check points designated as Hold point, Witness point and Review point.
- Lot: Any part of the works that has been constructed/manufactured under a continuous operation of uniform conditions and is homogeneous with respect to material and general appearance.
- Lot-package: One or more work lots of the same work kind collated under the same inspection and test plan.
- Non-conformance report: A mandatory (standard format) submission by the contractor that details the non-conforming work and the contractor's proposed disposition of the non-conformance.
- Notice of non-conformance: Formal instruction to the contractor of product non-conformance to documented requirements. It automatically creates a Hold Point and requires an NCR from the contractor.
- Performance audit (Process audit, technical procedure audit, methods audit): An evaluation of whether nominated methods and procedures are being adhered to in practice.
- Principal: The asset owner. Does not include agents such as the Superintendent or Independent certifier.
- Product: The result of a set of interrelated or interacting activities which transforms inputs into outputs.
- Product audit (Conformance audit, Service audit): An assessment of the conformity of the product with the specified technical requirements.
- Qualified registered surveyor: A surveyor who is eligible for membership of the Surveying and Spatial Sciences Institute as a registered surveyor.
- Quality assurance (QA): The systematic action necessary to give confidence of satisfactory quality. An element of QA is quality control.
- Quality assurance representative (QAR): Appointed by the principal for a specific project and responsible for the auditing, review and surveillance of procedures and documentation required by the contractor's approved Quality plan.
- Quality checklists: Forms completed during the manufacture/construction process verifying key steps, and records required for the Quality register. Checklists apply to each identified lot of work.
- Quality management representative (QMR): Also known as Project quality representative, appointed by the contractor for a specific project with the authority and responsibility for the implementation and operation of the Quality plan, so that QMS requirements are not subordinated to design and productivity.
- Quality plan: A management plan prepared by a contractor for a specific project, complying with relevant standards, setting out policies, management responsibilities, procedures and systems that will be used to ensure and demonstrate achievement of specified project requirements.
- Quality register: The files containing all quality control records including test results, completed check lists, certificates of compliance and consignment dockets for materials procured.
- Quality management system: The organisational structure, responsibilities, procedures, processes and resources for implementing quality management.
- Quality management system requirements: The administrative activities affecting quality that will be implemented and controlled so that the product or a service meets documented quality requirements.
- Registered testing authority:
  . An organisation registered by the National Association of Testing Authorities (NATA) to test in the relevant field; or

. An organisation outside of Australia registered by an authority recognised by NATA through a mutual recognition agreement; or
. An organisation recognised as being a Registered Testing Authority under legislation at the time the test was undertaken.

- Review point: Other check points other than hold points and witness points requiring verification of requirements and collection of records.
- Special processes: Those processes, the results of which cannot be directly examined to establish full conformance. Assurance of satisfactory conformance depends on evidence generated during the process.
- System audit: An examination of the documented quality management system represented by the quality manual, quality plan and quality register to evaluate their effectiveness in meeting the requirements of Australian Standards and the contract documents.
- Validation: Confirmation, through the provision of objective evidence, that requirements for a specific intended use or application have been fulfilled.
- Witness point: A nominated position, in the different stages of the Contract, where the option of attendance may be exercised by the Superintendent, after notification of the requirement.
- Works: All labour, plant, equipment and materials required to complete a project in conformance with the contract documents.

2 PROJECT QUALITY MANAGEMENT SYSTEM

2.1 GENERAL REQUIREMENTS

Conformance

Work on-site and off-site: Conform to the QMS described within the Quality plan including products and services for all works under the contract.

Contract documents: The QMS does not pre-empt, preclude or otherwise negate the requirements of any part of the contract documents.

Responsibility: QMS requirements do not relieve the contractor of the responsibility to conform with the contract documents. The Contractor is responsible for correcting all non-conformances.

System requirements

QMS: Plan, develop, implement and maintain a documented QMS conforming to this work-section, and AS/NZS ISO 9001, with the following purpose:

- Proposed work methods consistent with documented requirements.
- Adequate and complete ITPs and checklists.
- Implementation of approved work methods.
- Adherence to Hold and Witness Points.
- Appointment of QMR and QAR.

Format: If the format of the QMS documents differ from the format of AS/NZS ISO 9001, provide a matrix outlining how the documented requirements are addressed by the QMS.

2.2 DOCUMENTATION REQUIREMENTS

General

QMS documentation requirements: Include the following:

- Quality policy and objectives.
- Procedure documents.
- Work instructions.
- Forms.

- Quality plan(s).
- Specification(s).
- Relevant external documents.
- Records.

Changes: Immediately implement changes to the project Quality plan and QMS if the following occurs:

- Specification requirements are not adequately addressed.
- Non-conformity resulting from the Quality plan or QMS.
- Audit initiates changes to the QMS.
- Practices have changed.

Records: Provide copies of any quality records within 14 days of request.

Project Quality plan

Requirement: Plan, develop, implement and maintain a Quality plan to AS/NZS ISO 9001 and AS/NZS ISO 10005. Include the following:

- Progressive documentation of new procedures as the work types become evident.
- Planning and control systems: Description of critical processes and activities, including verification for product control.
- Coordination with the contractor's corporate Quality manual.
- Project specific quality system: Information and direction for personnel about the specific quality practices, resources, sequence of activities, controls and checks that must be implemented during the works.
- Controlled conditions: Documentation to explain how each work process will be carried out.
- Organisation structure: Details of the specific responsibilities and authorities of the key personnel nominated for the management of the project.
- QMR: Qualifications and technical experience, together with responsibilities and authorities to resolve quality matters.
- Details of the personnel or contracted testing organisations who will be conducting each type of conformance inspection and testing of completed works, their experience, qualification and responsibilities.
- Details of the person authorised to change construction processes on site.
- ITPs and checklists to verify the works conform with the contract documents.
- Purchasing quality requirements:
  - Critical characteristics of purchased products that affect the quality of the final product.
  - Method of communication with suppliers.
  - Methods used to evaluate, select and control suppliers.
  - The facilities and services that will be outsourced.
  - Material samples: The approved sample is the quality benchmark.
- Purchasing quality verification.
- Procedure for corrective action to AS/NZS ISO 9001 clause 10.2.
- Registered testing authority: Terms of registration and current signatories for the organisation providing testing and test reports.
- End-of –contract review procedures.

Control of documents

Requirement: To AS/NZS ISO 9001 clauses 7.5.3 and AS/NZS ISO 10005 clauses 5.6 and 5.7.

Register: Maintain a register of each part of the Quality plan. Register the number, date and recipient(s). Reissue to all registered recipient(s) when the Quality plan is changed, superseded or recalled, as required.

Requirement: Document in the Quality plan the method of keeping quality registers, tracking and handling of NCR's, NNC's and site correspondence.

Quality register: Implement and maintain systematic records, indexed and filed so that the records are retrievable and accessible to the Superintendent or an appointed quality auditor within one working day of request.

Register of method statements: Provide a register listing all method statements (both standard and job specific) including the title, identifier and revision status.

Construction records: Certify the completeness and compliance of construction records as each section of the work is completed.

Location: State in the quality plan where records are to be located.

WAE: Keep records of any amendments to design details for inclusion in WAE drawings in accordance with the ADAC specification, which is available on Council's website.

Quality audit schedule: Include a quality audit schedule with the project quality plan in conformance with AS/NZS ISO 19011.

Audit reports: Provide copies to the Superintendent as requested.

2.3 RESOURCE MANAGEMENT

General

Requirement: To AS/NZS ISO 9001 clause 7.1 and AS/NZS ISO 10005 section 5.8.

Provision of resources: Determine and provide resources for the successful implementation of the project Quality plan.

Limited availability: If a resource has limited availability, identify how demand from other projects/contracts will be satisfied.

Human resources: Provide personnel with the appropriate education, training, skills and experience for the project.

Infrastructure: Identify, provide and maintain the infrastructure required to achieve product conformity.

Work environment: Establish and manage the work environment to achieve product conformity.

2.4 PRODUCT REALISATION

Planning and design

Planning: To AS/NZS ISO 9001 clause 8.3 and AS/NZS ISO 10005 clause 5.11. Include the following:

- Quality objectives and requirements for the product.
- Processes and documents specific to the product.
- Required verification, validation, monitoring, measurement, inspection, test activities and the criteria for acceptance of the product.
- Records required as evidence that the realisation processes and resulting products conform.

Design: Verify the following, for conformance with the documented requirements and AS/NZS ISO 9001:

- Temporary structures.
- Checking of permanent structures for construction loadings.
- Lifting devices for manufactured items.
- Alternative permanent structures or structural components proposed.

- Concrete mixes for structures and pavements and asphalt mixes for permanent works.
- Traffic control, temporary roadways and detours.
- Permanent works where design is nominated in the contract.

2.5 CONSTRUCTION AND SERVICE PROVISION

Control

Method statements: Detail the construction processes for all activities scheduled in **Construction activities schedule**.

Content: Include the following:

- Sequence of operations.
- Documented procedures and work instructions.
- Types of equipment required, capability, maintenance and calibration.
- Any special working environment requirements.
- Personnel competency and skills required.
- Criteria for workmanship and tolerances.
- Materials required.
- Safety requirements.
- Reference documents.
- Records produced.
- Planning.
- Verification measures.
- Inspection, test and control points.
- Monitoring of continuous suitability.
- Responsibility for implementing and monitoring work process controls and rectifying any deficiencies.

Checklist: Provide a checklist, including the relevant inspection and test points, surveying control points, Hold Points, Witness Points and the officer responsible to verify each check point.

System audit: Audit each Method statement during operation of the process.

Absence of a Method statement: If a Method statement for a particular activity is required and none is submitted, this is a Hold Point.

Lot identification

Lots: Divide all items of work into lots as follows:

- Limits: Before sampling, choose lots within the limits given in the relevant work-section.
- Lot size: Not exceeding one day's output for each work process being tested.
- Lot numbering: Allocate unique lot numbers compatible with the construction program. Use lot numbers as identifiers on all QMS data.
- Field identification: Physically identify each lot and clearly identify lot boundaries. Maintain identification until the lot has achieved the specified quality.

Work on a lot: Do not start work before the field identification is established.

Lot boundaries: When boundaries of a lot change, update the quality register.

Lot identification system: Make sure all site records and sample numbering systems allow easy identification of all test results and the materials incorporated in the works.

Traceability

General: Provide and maintain records of components for audit. Traceability is required as follows:

- Concrete: Start the trace at the batch plant and finish at the location where the concrete is incorporated in the works.
- Asphalt: Start the trace at the batch plant and finish at the location where the asphalt is incorporated in the works.
- Stabilised material: Start the trace at the batch plant and finish at the location where the material is incorporated in the works.
- Steel: Start the trace at the steelworks and finish at the location where the steel is incorporated in the works. Record the steel heat number, testing details and final location of installation.

Batch details: Record all batch quantities, mix and dispatch time, testing details and location of placement.

Control of monitoring and measuring equipment

Equipment accuracy: Maintain inspection, testing and measuring equipment able to produce the degree of accuracy required by the referenced test methods.

Records: Demonstrate accuracy with regular records of calibration.

2.6 MONITORING, MEASUREMENT AND ANALYSIS

General

Requirement: Demonstrate conformance of the works by systematic inspection and tests.

Testing and sampling: Conduct testing by a registered testing authority accredited for the documented test methods and sampling procedures. Include the latest NATA advice of the terms of registration and current signatories within the quality plan.

Sampling personnel: From the registered testing authority and supervised by the approved signatory.

Sampling locations: Propose sampling locations for approval before proceeding.

Lots: All conformance inspections and tests are based on lots. In all cases the samples are considered representative of the lot and test results are required to meet the appropriate lot tolerances.

Test results: Provide a registered testing authority report on test results, including certification that correct sampling procedures have been followed.

In-process and conformance inspections: Review the results for each lot to confirm that all tests have been carried out to verify conformance.

Verification: Certification by the QMR.

Reinstatement: Reinstate all core holes, test holes, excavations and any other disturbance resulting from any testing activity to the standard in the relevant work-section.

Frequency of testing

Minimum frequency of testing: Not less than that stated in the relevant work-section.

Request for reduced frequency of testing: Submit a proposal with supporting statistical analysis, verifying consistent conformance to the quality requirements.

Random sampling

Requirement: Use random sampling techniques for each lot for the control of compaction of continuous layer of earthworks, selected subgrade zone, flexible pavement layers and asphalt layers.

Test locations: Determine test locations for random sampling in conformance with AS 1289.1.4.1.

Location restrictions: Do not restrict sampling to locations dimensioned or otherwise defined for setting out the works in the drawings or specification.

Inspection and test plans

ITP: Establish and progressively maintain a system to demonstrate inspection and testing in conformance with AS/NZS ISO 9001 clause 9.1 and AS/NZS ISO 10005 clause 5.18.

Minimum information for ITP (or ITP forms): Include the following:

- Person responsible for carrying out in-progress and final inspections or testing.
- Proposed inspection or test methods and recording of results.
- Acceptance criteria and frequency of inspection and testing.
- Specification tolerances.
- Person responsible for reviewing inspection and test results, evaluating whether work conforms, determining future action when work does not conform and closing out work lots.
- Measures to control non-conformity.
- When statistical analysis of test results is required.
- Person responsible for performing the final review of results to confirm that all inspections and tests have been carried out to verify complete conformity for each lot.
- Time limits for testing, submission, Hold Points and Witness Points that are nominated in the specifications.
- Identification of Hold Points or Witness Points.
- Checklist for each lot.

Submission of ITPs: Submit the ITPs, construction procedures and **Construction activities schedule** 10 working days prior to commencing any construction activities.

Test register

Lot identification register: Include the following information:

- Three-dimensional surveyed location of each lot, including the chainage of the start and finish points, lateral location and layer location and/or the particular structure (e.g. pier or abutment number, concrete placement number).
- Indication of conformance or non-conformance.
- Summary of test results.
- Location of test sites including test identification numbers.
- For non-conforming lots, allocate a new number to the resubmitted/subdivided lot(s), with reference to the original lot number.

Inspection and test status: Show either on the ITP records or physically mark in the field the conformance status for each lot.

Hold points

Notice of inspection: Give notice in advance of a Hold Point being reached.

Requirements for approval to proceed: Provide the following:

- Information required by the specification or relevant work-section.
- Certification that the particular lot/process is conforming.
- Certification that all underlying and adjacent lots affected by the lot in question are conforming.
- The appropriate form (checklist, NCR or NNC) at least 24 hours before the proposed placement/construction of the next lot.

Witness point: If the Hold Point has resulted from an NCR or NNC, approval may be conditional on a Witness Point being included.

Release of Hold Points: The Contractor is responsible for the release of hold Points subject to audit by the QMR and QAR from time to time.

2.7 SURVEY CONTROL

Requirements

Survey control: Establish and maintain a system, for measurement, calculation and recording procedures appropriate to the following:

- Set-out of the works.
- Verification of conformance with the drawings and specification in relation to dimensions, tolerances and three-dimensional position.

Determination of lengths, areas or volumes of materials or products, where required for measurement of work.

Method statement: Describe the control parameters for special processes which cannot be fully verified by inspection and testing. Address all potential errors that may be introduced by survey methods.

Surveyor qualifications: Appoint qualified surveyors or survey technicians to supervise and take responsibility for all surveying control.

Equipment and procedures: Capable of attaining the documented tolerances.

Survey locations: Surveying for conformance verification is not restricted to the locations used to set out the works.

Conformance verification surveys: Perform verification surveys not later than one working day after the lot or component has become accessible for survey.

Control of documents

Survey conformance report: Submit a survey conformance report for each lot or component where design levels, position and/or tolerances have been specified. Reference the relevant field book page numbers.

Information required: Indicate the difference between actual and documented values for position and level (defined by co-ordinates or chainage and offset) and provide certification by the qualified surveyor responsible for the verification survey.

Survey records: Provide all survey records including equipment calibration records and non-conformity registers.

Field book pages: Include the following, clear labels, date and signature by the surveyor, cross indexed references to equipment used and lot/component identification.

Recorded data: Retain any automatically recorded data used for verification surveys, including a printout of both raw (field) data and reduced data.

Audit trail: Prepare procedures to describe the records system, including the method of storing and indexing of electronic records and the computer software used for the reduction of survey measurements and calculations.

2.8 RISK ASSESSMENT

Reliability of the QA System

Reliability assessment: Conform to the following:

- Provide construction documentation, recording compliance with construction procedures and inspection and test plans.
- Assessment criteria and ratings to AGPD05 Table 6.2.
- Monitoring frequency to AGPD05 Table 6.3.

2.9 CONTROL OF NON-CONFORMING WORKS

General

Detection and reporting: Report any works that depart from the documented requirements on an NCR form within two working days of detection, including the proposed disposition.

Proposed disposition: Include any of the following:

- Proposed additional works to bring the lot up to the documented standard.
- Proposed replacement of all or part of the lot to bring it up to the documented standard.
- A request to use the lot for a reduced level of service, if allowed by the documented requirements.
- For incidental defects, a request that the Superintendent accept the lot without alteration, as an exception with or without alteration to the respective unit rates.

Monitoring and measuring

NCR: A Hold Point until non-conformance is rectified and Hold point is released.

Progress: Do not cover up non-conforming works until a disposition has been accepted/approved and implemented.

Reworking: If the non-conformance can be rectified by reworking the lot with the original process, an NCR is not required. Maintain a record of the non-conformance to aid continual improvement.

Conformance: Verify that reworked/replaced lots conform to the documented requirements.

Discrepancy: If there is any discrepancy in test results, the Superintendent's test results will prevail.

Control of documents

CAR: Review and improve the QMS to eliminate the cause of identified non-conformance.

NCR: Submit an NCR based on the proforma in the **ANNEXURE** including the following:

- Details of non-conformance.
- Proposed disposition.
- Provision for attachments.
- QAR comment/approval/rejection.
- Completion of disposition.
- Release of Hold Point.
- Corrective action to improve quality.
- Close-out of NCR.

Authorised representative: Sign off all actions by authorised representatives of the contractor and superintendent as appropriate.

Register: Implement and maintain a numbering and registration system for all NCRs and NNCs, including cross referencing as required.

Corrective action

Requirement: Review and improve the Quality plan to eliminate the causes of the non-conformance to prevent recurrence.

Proposed corrective action: Indicate the corrective action appropriate on the NCR form.

2.10 COMPLETION

Finalisation

Quality register: Submit a copy within one month of the date of practical completion. If requested, also provide a copy of all quality records and the **Construction records schedule**.

Record management: Provide an electronic copy of the design and construction records of final completion in a format to archive the records in the principal's asset management system.

Defects liability period: Resolve and close-out all quality non-conformance before the end of the defects liability period.

Review

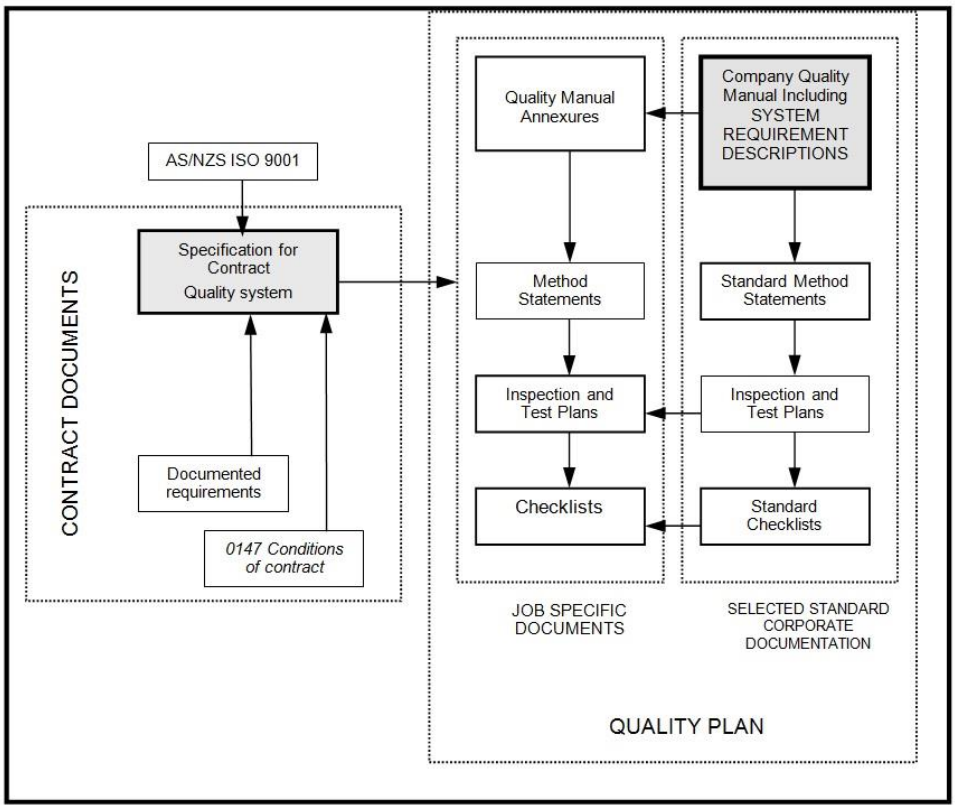
Requirement: Organise meeting(s) to review the quality system and technical issues met on the project, and identify the lessons to be learned for future projects, including the following:

- Identification of non-conformances and the implementation of corrective action.
- Issues arising from inspections and audits.
- Contract documentation issues.
- Design and technical issues.
- Safety issues.

Timing: Hold meeting(s) before the date for practical completion so that key personnel are still available to participate in review process.

3 ANNEXURES

3.1 ANNEXURE – PROJECT QMS DOCUMENTATION FLOW CHART



3.2 ANNEXURE – PROFORMA NON-CONFORMANCE REPORT (NCR)

NON-CONFORMANCE REPORT	**NCR No**: Date:
CONTRACT: PRODUCT OR SERVICE: SUBCONTRACTOR (if appropriate): INSPECTION & TEST PLAN (ITP) No:	
LOT No AND DESCRIPTION/LOCATION:	
DETAILS OF NON-CONFORMANCE:	
PROPOSED DISPOSITION:	
PROPOSED CORRECTIVE ACTION:	
IS A SUPPLEMENTARY REPORT ATTACHED?	YES ☐ No ☐
PRINCIPAL:	APPROVED ☐ REJECTED ☐
COMMENT:	
PRINCIPAL SIGNATURE:	DATE:
DISPOSITION COMPLETED (Contractor):	DATE:
RELEASE OF HOLD POINT (Superintendent):	DATE:
CLOSE OUT OF NON-CONFORMANCE REPORT (Contractor QMR):	DATE:

3.3 ANNEXURE –SCHEDULE

Construction activities schedule

Work-section	**Activity requiring a method statement**

Construction records schedule

Construction records	**Reporting variables (Work-sections)**
ITPs including list of Hold points and Witness points	
Test sampling register	

Construction records	Reporting variables (Work-sections)
Construction records traced to the lot register	
As-built drawings	
Notice of non-conformance register	
Defects register - OPEN	
Defects register - CLOSED	

3.4 ANNEXURE – PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
0161.1 Quality system documents and records	Lump Sum	All costs associated with the preparation and submission of the Quality plan, the provision of the QMR on site and the maintenance of the quality records during the course of the contract.
0161.2 Quality verification and control	Lump Sum	All costs for inspections, conformance surveys and testing required to verify that all aspects of the works conform to the quality assurance provisions of the contract.

3.5 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1289		Methods of testing soils for engineering purposes
AS 1289.1.4.1	1998	Sampling and preparation of soils - Selection of sampling or test sites - Random number method
AS/NZS ISO 9000	2016	Quality management systems - Fundamentals and vocabulary
AS/NZS ISO 9001	2016	Quality management systems - Requirements
AS/NZS ISO 10005	2006	Quality management systems - Guidelines for quality plans
AS/NZS ISO 19011	2014	Guidelines for auditing management systems
Austroads AGPD05	2018	Guide to project delivery- Road Constructions quality assurance

0257 LANDSCAPE – ROAD RESERVE AND STREET TREES

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide road reserve landscaping and street trees, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.
- *1102 Control of erosion and sedimentation (Construction)*.

1.3 STANDARDS

General

Storage and handling of pesticides: To AS 2507.

Tree stock: To AS 2303.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviations apply:

- N:P:K: Nitrogen: Phosphorous: Potassium ratio.

Definitions

General: For the purposes of this work-section the definitions given in AS 2303 and the following apply:

- Ameliorant material: Additives used to make or improve soil.
- Anionic bitumen: A type of bituminous emulsion where dispersed particles comprise a bituminous binder and are negatively charged.
- Size index: Numerical expression of the size or physical bulk of a tree stock above ground.

1.5 SUBMISSIONS

Execution details

Soil amelioration recommendations: If required, the source of ameliorant material, rates and methods of incorporation.

Plant material: Submit details of proposed fertiliser to be used.

Soil conditioning: If other than gypsum is proposed, submit details.

Transplanting trees: Submit a program for regular fertiliser applications during the plant establishment and maintenance period.

Products and materials

Imported topsoil: Submit evidence verifying the following:

- Suitability of each soil type for its documented use.
- Similarity to naturally occurring local soil.
- Suitability for establishment and on-going viability of the site vegetation.
- Absence of any weed propagules or contaminants.

Plant provenance: Submit documentation that all plant material has been grown from locally provenanced stock. If this is not achievable give notice.

Plant source: Submit documentation that all plant material has been grown from locally sourced stock (or local endemic species). If this is not achievable give notice.

- Species: Submit written certification that all plant material is true to the required species and type.

Trees: Submit evidence of conformance to AS 2303.

Seed supply: Submit the name(s) of the proposed seed supplier(s).

Samples

General: Submit representative samples of each material, packed to prevent contamination and labelled to indicate source and content.

Bulk materials: Submit a 5 kg sample, of documented materials with required test results.

Tests

Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

1.6 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Slopes and drains: Prepared surface for cultivation and conditioning.
- Plants on arrival at site.
- Landscape planting: Set out of plants, soil conditioner and fertiliser.
- Transplanting street trees:
  . Final orientation of the tree.
  . Watering, fertilising and root cutting: In existing location.
  . Watering, fertilising and root cutting: In relocated location.

2 MATERIALS

2.1 GENERAL

Specimen plants

Plant source: Conform to the following:

- Obtain plants from nursery stock located in an area with similar climate to the site of the Works.

Non-containerised stock: Program the preparation of specimen plants so that they are ready for transplanting to site when required.

Transportation

Requirement: Transport plants to the site without physical damage or drying out.

Optimal plant condition

General: Maximum initial impact at the time of project opening.

2.2 TOPSOIL

General

Topsoil: To AS 4419 and as follows:

- Free of weed propagules and contaminants and suitable for the establishment and ongoing viability of the selected vegetation.
- Maximum soluble salt content: 0.06% by mass.

Health warning: To AS 4419, on packaging or invoice for bulk supply.

Management of stockpiles and batters

Requirement: To **Management of stockpiles and batters** in *1102 Control of erosion and sedimentation (Construction)* work-section.

2.3 FERTILISER AND MULCHES

Fertiliser

Type: Organic.

N:P:K ratio:

- Slopes and open drains: 80:36:20.
- Mass planting: 63:18:28.

General mulch types

Organic landscape mulch: To AS 4454.

Composition:

- Fines (by volume): < 5%.
- Woodchip (maximum size): < 50 mm.
- Leaf mulch (by volume): < 25%.

Quality: Free of deleterious and extraneous matter including weeds, soil, sticks and stones.

Synthetic weed blocking fabric: To AS 4843.

Hydromulch

Material: Straw, chaff, wood fibre paper pulp finely shredded to a maximum dimension of 10 mm.

Prohibited material: Meadow hay and weeds. If using paper pulp, do not exceed 50% by mass of total mulch.

Binder: Grade ASS, slow setting anionic bitumen to AS 1160.

Straw mulch

Material: Straw matrix.

Prohibited material: Meadow hay and weeds.

Binder: Grade ASS slow setting anionic bitumen to AS 1160.

Straw mat finished thickness: > 20 mm.

Hardwood stakes

General: Pointed at one end, as follows:

- Marker stakes (for tube stock): 15 x 15 x 800 mm.
- Stakes (for advanced stock): 2 stakes, 25 x 25 x 2000 mm.

- Stakes (for super advanced stock): 3 stakes, 50 x 50 x 3000 mm.

2.4 PLANT MATERIAL

Seed

Requirement: Conform to the following:

- Grass and clover: Pre-packed commercially with an accompanying certificate of germination.
- Native seed: Deliver to the site in separate lots for each species and variety, clearly labelled to show species, variety and weight.

Storage: Do not take possession of the seed more than seven days before sowing is to occur. Store seed in clean, airtight containers and keep away from direct sunlight. Do not expose seed to the elements at any stage during storage.

Replacement: Replace if seed batch is not true to type.

Turf

Description: 25 mm depth of dense, well rooted, vigorous grass growth with 25 mm depth of topsoil and free of weeds, soil pests and diseases.

Prohibited material: Kikuyu grass.

Supply: As rolls in long lengths of uniform widths, in sound unbroken condition.

Width of rolls: > 300 mm.

Seed and turf table

Material	**Species**	**Minimum application rate (kg/ha)**
Seed		
- Grass	Rye Corn (April-August) or	60
	Japanese Millet (September-March)	60
	Hulled Couch	5
	Red Clover (Inoculated)	5
	White Clover (Inoculated)	5
	'Elka' Perennial Rye	5
- Native	Acacia dealbata	
	Acacia buxifolia	1
	Acacia decurrens	1
	Acacia pravissima	1
	Leptospermum lanigerum	1

Material	Species	Minimum application rate (kg/ha)
	Hardenbergia violacea	0.5
	Kennedia prostrata	0.5
	Acacia implexa	0.2
	Banksia marginata	0.2
	Bursaria spinosa	0.2
	Callistemon pallidus	0.2
	Dodonaea viscoca	0.2
Turf grass		
- Medians - Verges/Footpaths - Other Areas	Couch Buffalo Couch	Refer to Drawings

Plant supply

Requirement: Conform to the following:

- Healthy, of good form and not soft or forced.
- Large robust root systems.
- Not root bound.
- Free from disease and insect pests.
- Hardening off: Deliver all plants to a site within the locality of the works at least four weeks before planting out.
- Plant root systems: Maintain root moisture at all times with particular attention to watering during the on-site period before and during planting.
- Planting hole depths: Equal to the depth of container soil.
- Trees: Single leading shoot.

2.5 STREET TREES - ABOVE GROUND ASSESSMENT

General

Labelling: Clearly label individual plants and batches.

- Label type: To withstand transit without erasure or misplacement.
- Indication of north: Label the northerly aspect during growth in the nursery for trees in containers greater than 100 L or of Size Index greater than 140 and maintain during transit.

Supply

Requirement: Supply tree stock conforming to AS 2303, **Small container grown trees table** and the following:

- Site environment: Grown and hardened off to suit anticipated site conditions at time of delivery.
- Root development: Grown in their final containers for more than 12 weeks.

. Plants less than 25 L size: over more than 6 weeks.
. Plants greater than 25 L size: over more than 12 weeks.

- Native species susceptible to attack by native pests: Maximum 15% of a tree's foliage showing evidence of previous attack and no actively feeding insects.
- Pruning wounds: Restrict fresh (i.e. recent, non-calloused) pruning wounds) to less than 20% of total tree height.

Balance assessment criteria: To AS 2303 Appendix E.

Small container grown trees height ranges table

Minimum root ball diameter or container size	**Height range (m)**	
	Thin-stemmed species	**Thick-stemmed species**
150 mm (1.8 L)	0.4 – 0.6	0.3 – 0.5
170 mm (2.6 L)	0.5 – 0.7	0.4 – 0.6
200 mm pot (4 L)	0.7 – 0.9	0.6 – 0.8
200 mm bag (5 L)	0.8 – 1.0	0.7 – 0.9
250 mm (8 L)	1.0 – 1.2	0.8 – 1.0
300 mm (15 L)	1.2 – 1.5	1.0 – 1.2

2.6 STREET TREES- BELOW-GROUND ASSESSMENT

Supply

Requirement: Supply tree stock conforming to AS 2303 and the following:

- Trees with a calliper at ground level less than 40 mm: Make sure the diameter of any non-conforming roots at the extremity of the rootball is less than 25% of the calliper.
- Trees with a calliper at ground level greater than or equal to 40 mm: Make sure diameter of any non-conforming roots at the extremity of the rootball is less than 10 mm.
- Root ball depth: Not greater than maximum depth documented.

Testing

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Quality verification: If material/product quality verification can be obtained from the supplier, documented tests need not be repeated.

3 EXECUTION

3.1 GENERAL

Transport and storage

Requirement: Inspect all plants at the time of delivery and reject non-conforming plants.

Program

Requirement: Conform to the following:

- Between September and May: Plant exposed surfaces before the area exceeds 1 ha.
- Between June and August: Do not carry out planting to exposed surfaces without approval.

Preparation

Herbicide treatment: Spray herbicide as follows:

- Type: Glyphosphate.
- Rate: 9 litres/200 litres water/ha.
- Program: Maintain sprayed areas undisturbed for 2 weeks.

Pesticide treatment: In the following form, as documented:

- Liquid:
  - . Application rate: 5 litres/hydromulch/ha.
  - . Powder: 10 kg/ha.

Herbicides and pesticides: To the Australian Pesticides and Veterinary Medicines Authority (APVMA) register.

Soil conditioning: Provide as follows:

- Gypsum application rate: 400 g/m².
- Application: Conform to the following:
  - . Spread evenly over the subsoil by a mechanical spreader and topsoil on the same day.
  - . Thoroughly mix into the topsoil whilst the topsoil is being removed from stockpiles.
  - . Apply conditioners other than gypsum to the supplier's recommendations.

Fertiliser treatment: Provide as follows:

- Application rate: 1000 kg/ha.

Seed mixing: Provide as follows:

- Mix, pre-treat and place seed in the sowing equipment for each operation on site.
- Sow seed on the day of mixing with pesticide.

Watering

General: Conform to the following:

- Potable or sourced from areas without toxins, pollutants or any substance which may adversely affect plant growth.
- Initial watering: To a uniform moisture condition without run-off.
- After turfing: Re-water to a uniform moisture condition without run-off.
- After sowing: If required, re-water to a uniform moisture condition without causing rills in the surface, daily for 15 days.
- Excessive rilling: If watered areas result in excessive rilling, rehabilitate by re-preparing and re-sowing the affected area.

3.2 SLOPES FLATTER THAN 3H TO 1V

Preparation of the surface

Cultivation: Before applying topsoil, tine to a depth of 200 mm to produce a loose surface and remove all large stones, rubbish and other materials that may delay germination.

Cultivation depth: 50 mm for a roughened surface with soil lumps not exceeding 50 mm.

Topsoil

Application: Apply uniformly to an average compacted thickness of 50 mm with a minimum compacted thickness of 30 mm at any location.

Application of pesticide

Timing: Immediately before sowing.

Pesticide type: Powder form.

Application: Mix thoroughly with the seed, in conformance with **EXECUTION**, **GENERAL**, to the equivalent mass of seed to be spread on 1 hectare of the surface.

Grassing

Seeding:

- Application: Distribute evenly, by a mechanical seeder following the finished contours wherever possible.
- Depth: 5 mm as sown, or 5 mm cover by raking or harrowing.
- Fertiliser: Apply concurrently with seeding, as documented.

Turfing:

- Laying: On the prepared topsoiled surface and perpendicular to the direction of water flow.
- Joints: Butt runs of turf hard against each other and topdress with topsoil.
- Slopes 5:1 to 3:1: Peg turf and remove pegs when established.

Topdressing:

- Timing: 4 to 6 weeks after laying turf.
- Requirement: Correct any undulations or unevenness in the established turf.

Maximum slope for areas to be maintained by a ride-on mower with a 2 m wide deck: 4:1.

3.3 SLOPES STEEPER THAN 3H TO 1V

Methods

General: Vegetate slopes by one of the following methods, as documented:

- Apply topsoil and hydromulch.
- Apply topsoil, hydroseed and straw mulch.
- Hydroseed.

Preparation of the surface

General: Remove all loose material from fill batters and cut batters.

Timing: No more than seven days before seeding.

Cultivation: Lightly tine or roughen the surface parallel to the contours.

Topsoil

Application: Conform to the following:

- General: Apply uniformly to an average thickness of 50 mm, with a minimum compacted thickness of 30 mm at any location.
- Stepped batters: Loosely fill with topsoil.

Hydromulching or hydroseeding

Watering: Water dry surfaces with a fine spray before applying the hydromulch.

Pesticide:

- Timing: Apply during preparation of the hydromulch or hydroseed slurry.
- Pesticide type: Liquid.

Equipment: Clean and free of contamination from previous operations.

Mix: Add materials as documented to the slurry storage tank and agitated to maintain a uniform consistency during application.

Application: Uniformly over the whole surface.

Weather conditions: Do not apply hydromulch or hydroseed under the following weather conditions at the site:

- Temperature: > 35°C.
- Winds exceed: 15 km/hr.
- During rain periods or when rain appears imminent or if the surface is saturated.

Wetting agent:

- Application rate: 1 litre/1000 litres of mix water.

Hydromulching or hydroseeding table

Material	**Application rate per hectare of surface**	
	Hydromulching	**Hydroseeding**
Vegetable mulch (kg)	1500	Nil
Water (L)	35,000	20,000
Binder (L)	1200	Nil
Wetting agent (L)	35	20

Straw mulching

Application: Apply uniformly with a suitable blower.

Rate: 250 bales (each of 20 kg) of straw per hectare of surface.

Bitumen emulsion: Incorporate as a spray into the air stream of the mulch blower.

- Application rate: 2500 litres per hectare of surface.

Straw mat thickness: ≥ 20 mm at any location.

3.4 OPEN DRAINS

Preparation of the surface

Topsoil: Spread to an average compacted thickness of 50 mm, with a minimum compacted thickness of 30 mm at any location.

Timing: Complete vegetation within 7 days of the completion of open drain excavation.

Grass seeding

Application: Apply uniformly by one of the following methods and conform to the **Seed and turf table**:

- Mechanical sowing.
- Hydromulching or hydroseeding.
- By hand.

Surface protection

Requirement: Protect all or part of the sown surface by one of the following methods, as documented:

- Bitumen emulsion: Spray the surface with an anionic slow setting bitumen emulsion to Grade ASS of AS 1160 at a rate of 1 litre of bitumen emulsion per square metre of surface.

- Organic fibre mat: Line the channel with an organic fibre mat.
  - . Lay runs of matting along the direction of water flow loosely on the soil surface and not stretched.
  - . Slot upstream end of matting into a trench 150 mm wide by 150 mm deep and pinned to the base of the trench at 200 mm centres.
  - . Backfill the trench with soil and compact by foot.
  - . Overlap adjacent runs of matting 100 mm with the higher run lapped over the lower run and pinned matting along the sides of each run at 500 mm centres and along the middle of each run at 1000 mm centres.
  - . Overlap ends 150 mm wide with the higher run end lapped over the start of the lower run and pinned at 200 mm centres.
- Pins: U shaped pins of 4 mm gauge wire, 50 mm wide and 150 mm long legs.
- Turfing: Butt runs of turf hard against each other and place perpendicular to the direction of water flow in the drain. Pin into position at 500 mm centres. Topdress seams of turf with topsoil.

3.5 LANDSCAPE PLANTING

Conditions

General: Do not carry out landscape planting when temperature is above 35°C or below 10°C.

Timing: Carry out planting within 7 days of site seeding operations.

Preparation

Weed management: Conform to the following:

- Herbicide spray: Conform to **EXECUTION, GENERAL** and the following:
  - . Program: Maintain sprayed areas undisturbed for 2 weeks.
  - . Spray drift: Make sure there is no contact with planted material.
- Weed management by synthetic weed blocking fabric:
  - . Extent: 800 mm surrounding each proposed planting.

Fertilising (N:P:K): Conform to the following:

- Ratio: 63:18:28.
- Application rate: 5 kg/m².

Mass planting in mulched bed

Surface preparation: Rip the surface at 500 mm centres to a depth of 300 mm and break up the top 200 mm of the planting bed by cultivation to a maximum size of 50 mm.

Mulch: Spread 75 mm thick.

Individual planting

Preparation: Loosen a planting area 600 mm diameter to a depth of 400 mm.

Mulch: Spread 75 mm thick to 600 mm radius around the plant.

Planting

Method: Remove the localised mulch. If required, root prune to make sure all circling roots have been either severed or aligned radially into the surrounding soil. Place the plant, backfill the planting hole with topsoil and compact lightly so as to minimise subsidence without compacting the backfill. Avoid mixing mulch with topsoil.

Stakes and ties: Advanced and super advanced stock:

- Drive stakes 300 mm deep and 200 mm clear of the plant.
- Ties: 50 mm wide hessian webbing strips, attached loosely.

Watering: 10 litres of water per hole before the mulch is respread over the disturbed area.

Mulching: Replace, and leave the plant stem clear.

Care of landscape planting
Watering: Water all plants, from the time of planting, every second day for the first twelve weeks at the following rates, per plant:

- Tube stock: 5 L.
- Advanced trees: 10 L.
- Super advanced (25 L): 30 L.
- Semi-mature (75 to100 L): 50 L.

Replacement: Replace missing plants, dead plants and unhealthy plants with plants of similar size and quality and of identical species and variety to the plant being replaced.

Weed and grass growth in mulched areas: Control with herbicide, in conformance with the manufacturer's recommendations at monthly intervals during the construction period and contract maintenance period. Replace plants damaged by herbicide application.

3.6 STREET TREES

Unpaved areas
Excavation:

- Containers < 75 litre: Twice the diameter of the root ball.
- Containers ≥ 75 litre: Three times the diameter of the root ball.
- Depth: Root ball plus 100 mm. Loosen the compacted sides, and the bottom a further 100 mm.

Soil conditioning: If clay is present, add 1 kg of agricultural gypsum soil conditioning.

Accessories and drainage: Fit trunk collar guard, root barrier and subsoil drainage measures before backfilling.

Backfill: Topsoil.

Mulch: 75 mm thick and 50 mm clear of plant stem.

Initial watering: 50 litres per tree applied in stages during backfilling.

Watering basin: Construct around the base of each individual plant, consisting of a raised ring of soil capable of holding at least 10 L.

Paved areas
Excavation:

Containers < 75 litre: Twice the diameter of the rootball.

Containers ≥ 75 litre: Three times the diameter of the rootball.

Depth: Rootball plus 100 mm. Loosen the compacted sides, and the bottom a further 100 mm.

Accessories and drainage: Fit trunk collar guard, root barrier and subsoil drainage measures before backfilling.

Mulch: 10 mm screenings 75 mm thick.

Initial watering: 50 litres per tree applied gradually.

Structural soil table

Type	Description	Fertiliser	Depth	Location
Structural soil 20 mm	75% 20 mm crushed river gravel 25% filler soil of 1 part screeded dolomite to 1 part screeded sandy loam	Trace element mix: 300 g/m^3 Potassium nitrate: 500 g/m^3 Ammonium nitrate: 500 g/m^3 Superphosphate: 500 g/m^3 Ion sulphate: 1.5 kg/m^3 8/9 month Controlled release: 2 kg/m^3 Gypsum: 500 g/m^3 Magnesium sulphate: 400 g/m^3 Magrilime: 600 g/m^3	100 mm	If pavements are installed around existing trees, replace 20 mm road base when the total soil depth available is 100 mm or less.
Structural soil 40 mm	80% 40 mm basalt aggregate 20% filler soil of 1 part screeded dolomite to 1 part screeded sandy loam	Trace element mix: 300 g/m^3 Potassium nitrate: 500 g/m^3 Ammonium nitrate: 500 g/m^3 Superphosphate: 500 g/m^3 Ion sulphate: 1.5 kg/m^3 8/9 month Controlled Release: 2 kg/m^3 Gypsum: 500 g/m^3 Magnesium sulphate: 400 g/m^3 Magrilime: 600 g/m^3	Varies	Tree plantings in pavements, courtyards, carparks and kerbsides.

Porous bonded gravel

Backfill: Allow for base aggregate and gravel.

Filter fabric: Lay over growing medium and pre-cut to size.

Base aggregate: 5 to 7 mm crushed blue metal, laid 70 mm deep and hand consolidated.

Porous paving: Mix and place to the manufacturer's recommendations.

3.7 TRANSPLANTING STREET TREES

General

Requirement: Conform to the **Transplanting schedule**.

Conditions: Select a time for transplanting with regard to the appropriate season, time of operation, rootball diameter and depth, lifting methods and weather conditions.

Preparation

Watering: Establish a temporary trickle irrigation system, or manually water the intended trees for a period of two weeks before ball excavation work.

Fertilising: Apply one application of liquid fertiliser mix to the foliage and roots as appropriate to the species. Apply sufficient liquid fertiliser mix to allow the spray to drip from foliage and soak into the rootball. Do not spray the fertiliser mix on excessively hot, dry or windy days.

Rootball

General: Minimise the cutting of roots. Use only sharp tools, water blasting or water cutting. Trees whose root balls have been excavated by backhoe or excavator are not acceptable.

Initial cut: Conform to the following:

- Manually or by chain trenching machine.
- 250 mm beyond the required finished root ball dimensions to allow any damaged roots to be trimmed back to final dimensions and sealed.

Hand trimming: Conform to the following:

- To 100 mm less than the required finished rootball dimension. Cut back and seal with an approved horticultural sealer all roots greater than 25 mm diameter.

Outcome: Conform to the following:

- A symmetrical root ball in balance with the overall size of the tree except where the limitations of individual tree planter openings requires specific tailoring of the root ball dimension.
- A root ball size in the best interests of each specimen.

Backfilling: Backfill and lightly compact with clean sand, free of any foreign matter, pathogens or any substances likely to be deleterious to future root growth. Apply sufficient root inducing formulation, at the manufacturer's recommended concentration, to effectively saturate the backfill in the trench.

Maintenance of on-site plant material

Watering: Maintain a trickle irrigation system around each tree, located within the trenched rootball perimeter. Program the system to supply water at an optimum rate to encourage healthy growth and avoid desecration through excessive transpiration following the pruning of the roots. Monitor the system until the tree is lifted and transplanted.

Pruning requirements and qualifications: To AS 4373.

Requirement: Take precautions to safeguard the health and well-being of all on-site plant material before lifting and transplanting.

Lifting and transplanting

Lifting: Thoroughly irrigate to the full depth of the root ball two days before transplanting each specimen. Do not fracture the ball of soil around the root system. Maintain ball in firm condition during transplanting by wrapping in hessian or other appropriate open weave material, securely tied.

Storage: Transport transplanted trees to a designated nursery site. Store and maintain until ready for planting.

Planting: Avoid disturbance to the rootball during moving and planting. After placement, remove the rootball wrapping and ties by cutting.

Backfill level: Replant trees at the same level or slightly higher than their original grade.

Watering: At the completion of transplanting, water the rootball thoroughly and continue to water until established.

3.8 LOCATION OF PLANTING

General

Requirement: Do not obstruct access to services or sightlines to signage. Do not obstruct pedestrian or vehicular traffic.

Street trees

Ground clearance:

- Clearance height at maturity: 2.4 m.
- Clearance height at time of planting: 1.5 m.

Setbacks: Locate trees to achieve mature canopy clearances from the following:

- Electricity or telecommunications poles or pillars: > 4 m.
- Streetlights: > 7.5 m.
- High voltage transmission lines: > 4 m radius.
- Stormwater drainage pits: > 2 m.
- Kerbs measured to the back of the kerb: 750 mm to 1000 mm.
- Driveways: > 3 m.
- Intersections measured from the face of the kerb of the adjoining street: > 10 m.
- Existing trees: The combined mature canopy width.

Roundabouts

Setback: From the inside edge of the kerb as follows:

- 0 to 1 m: Pavement material.
- 1 to 3 m: Shrubs/groundcovers, as documented with a maximum mature unpruned height of 600 mm above the road pavement.
- 3 m and over: Trees and shrubs/groundcovers, as documented.

Median islands

Setback: From the inside edge of the kerb as follows:

- 0 m to 0.3 m: Pavement material.
- 0 m to 1 m: Groundcovers, as documented, 200 mm high with minimal pruning requirements.

3.9 CLEARING OF EXISTING TREES AND OTHER VEGETATION

Approval advice and information must be sought from Council prior to any removal, pruning, impact upon or disturbance of any existing trees, landscape feature or other vegetation within the Shellharbour Local Government Area.

Landscaping Plans for any proposed development must clearly detail that the protection of existing trees and other landscape features, other than any existing trees and natural landscape features authorised for removal, pruning, impact upon or disturbance, will be carried out as specified in AS 4970.

All initial procedures for the protection of existing trees and landscape features, as detailed in AS 4970, must be installed prior to the commencement of any earthworks, demolition, excavation or construction works on the development site.

The works and procedures involved with the protection of existing trees and other landscape features are to be carried out by suitably qualified and experienced persons or organisations. This work should only be carried out by a fully insured and qualified Arborist.

Suitable qualifications for an Arborist are to be a minimum standard of Australian Qualification Framework (AQF) Level 3 in Arboriculture for the actual carrying out of tree works, and Australian

Qualification Framework (AQF) Level 3 in Arboriculture for the preparation of Preliminary Site Assessment, Development Impact Assessments, Tree Protection Plans, Tree Health Assessments and Tree Risk Assessments.

3.10 GUIDELINES FOR TREES AND SHRUBS

The Landscaping Plans must include a planting schedule.

The planting schedule must clearly detail the planting positioning, species by botanical and common names, quantities, planting sizes and the estimated size of the plant at approximately 12 years maturity.

The planting schedule must also detail the proposed establishment and maintenance programme.

The Landscaping Plans must demonstrate that the existing cultural and heritage amenity (where relevant), as well as any existing surrounding trees and ecological communities, have been a consideration in the preparation of the proposed planting schedule for the development site.

The contractor shall supply and plant trees and shrubs of the types detailed on the approved Landscaping plans. Trees and shrubs shall be planted in the locations shown on the Landscaping Plans. Root barriers to the kerb and concrete paths/cycleways are required in new or existing roadway construction.

After installing the trees and shrubs, the developer shall ensure that sufficient watering, care and repair is carried out to sustain the new plantings throughout the maintenance and establishment period.

Installation of new street trees or the protection of existing street trees shall;

- Ensure that the necessary street tree installation and their proposed establishment schedules are clearly shown in the Landscaping Plans.
- All street trees at time of planting must have well-constructed tree guard protection installed.
- Bollards are considered acceptable as one form of tree guard. If bollards are used then they are to be in minimum 1.8 metre lengths, which will allow for 1.2 metre above ground exposure and 0.6 metre buried support. Bollards are to be a minimum 150 mm x 150 mm width. If timber bollards are to be used then they need to have a minimum durability of H4 CCA.
- Very large trees such as Eucalyptus, Angophora, Araucaria etc should not be designed into any road median, nature strip or road verge unless agreement to install these very large spreading and growing tree types is first sought from the Consent Authority.
- That all the street trees are sourced in a minimum 45 litre container size, are not multi-stemmed and can stand alone without the need for staking.
- Street trees spacing of 18 metres apart (from main stem to main stem) should be considered as a standard guide for installation numbers requirements.
- Street trees are to have root barrier controls to the kerb and other essential infrastructure (e.g. concrete paths) as well as a minimum 750 mm distance between trees and concrete paths/cycleways is to be provided where possible.

3.11 STREET TREE SELECTION

1. Tree species must be suitable species to suit the natural climatic conditions of the area and must be approved prior to any street tree installation by Council's Tree Management Officer and the Landscape Technical Officer

2. Tree stock must be vigorous, free from pest and disease, good habit, strong healthy root system. Stock that show signs of root damage, root curl, root restriction or multi-stemmed will not be accepted.

3. Species selected as street trees must avoid damage to the kerb or pavements and shall not comprise of “strong root system”

4. Tree species shall not produce large, fleshy hazardous fruits that can create slip hazards on hard surfaces and or contain any spiky hazardous parts that can cause damage to any parts of the body.

5. Tree species should be native species, provide native habitat for native fauna and should be of landscape character of the development area

6. *Eucalyptus spp.* Will not be acceptable for street tree planting unless otherwise approved by Council’s Tree Management Officer and Landscape Technical Officer

7. Tree species must not include species listed in the document titled Shellharbour City Council Development Control Plan Appendix 7 ‘Undesirable Plant Species’ or listed within the environmental weed or noxious weed list.

8. Trees species for the use under overhead power lines should have a mature height of 3 metres or be a species that is aesthetically acceptable to regular pruning to obtain a 3metre clearance from overhead wires. (General rule of thumb if a tree has a mature height of 5metres the tree should be planted a 5metre clearance from the nearest overhead power line)

9. Tree species proposed on all RMS owned roads, Shellharbour Road, Illawarra Highway, Tongara Road & Princes Hwy must be frangible species, trees which breaks under the impact of a motor vehicle. (plants with stems equal to or less than 70-100mm when measured from 300mm above the finished ground level. Groundcovers and shrubs are all generally frangible except for large shrub species that exceed 3.5mts in mature height. Alphitonia excels is considered a frangible species.

10. Installation of street trees located along Central Avenue Oak Flats and Terry Street Albion Park are heritage listed trees and any replacement trees are required to continue the street tree planting of the tree species Lophostemon confertus.

11. The contractor shall supply and plant trees and shrubs of the types detailed on the approved Landscaping plans. Trees and shrubs shall be planted in the locations shown on the Landscaping Plans. Root barriers to the kerb and concrete pedestrian paths and/or share-ways are required in new or existing roadway construction.

3.12 STREET TREE INSTALLATION

1. One tree to be planted on each lot centrally positioned between each property side boundary within the nature strip, corner lots will require a planting of 2 trees and larger lots will require trees to be installed at intervals of 6-10 metre spacings. A minimum 75 Litre, tree height of 2.5metres from ground level with a calliper of 35mm (NATSPEC) per tree.

2. Trees must be set back a **minimum** 900mm from the back of the kerb or where a footpath exists the tree must be planted midway between the footpath and kerb.

3. All trees to be fitted with root barrier adjacent to the back of the kerb and adjacent to the edge of the concrete pavement, type of root barrier to be approved by Council’s Tree Management Officer and Landscape Technical Officer

4. All trees to be fitted with watering pipes and or watering weir at the base of the tree with an application of organic mulch at a 75mm depth

5. Trees are to be fitted with 2 hardwood stakes with 50mm hessian ties, fixed in a figure 8 stapled to the hardwood stakes to support each tree. Stakes are to be installed clear of rubbing any of the tree's branches and trunk. All bamboo or wooden stakes provided with potted plant material at the time of purchase must be removed.

6. Trees to be installed with a minimum 75mm depth of organic mulch applied a minimum 500mm diameter surrounding the base of the trunk. (inorganic mulch is not acceptable)each tree is to be fitted with a minimum 1m x1.5m timber edging secured with galvanised screws to timber pegs is required to be installed at the base of the tree constructed from the back of the kerb., where space allows tree pits should be installed at a maximum 1.5m x 1.5m.

7. Trees proposed within hard surfaces are required to be fitted with either a permeable aggregate, resin bound, steel grate and fitted with strata cell system

8. Understorey planting is not permissible with street tree planting

9. Inorganic mulch, weed mat and plastic is not permissible with street tree planting

10. Street tree planting must take into account overhead wires and underground services, trees proposed under overhead wires should have a maximum mature height of 3 metres

11. After installing the trees and shrubs, the developer shall ensure that sufficient watering, care and repair is carried out to sustain the new plantings throughout the maintenance and establishment period.

3.13 STREET TREE CLEARANCES

1. minimum 1.5 metre from a stormwater pit.

2. minimum 2 metre either side of a driveway or vehicular crossing.

3. minimum 3 metre from services, telecommunications, streetlight posts and stormwater outlets

4. minimum 8 metre from signage and road intersections.

5. minimum 10 metres from pedestrian crossings or pedestrian nominated access points (pram ramps) and traffic signals.

3.14 ROAD RESERVES

1. Any landscaping within road reserves (median strips, roundabouts, verges, refuge islands), must be designed and installed with regards to future maintenance of the landscaping and to the satisfaction of Council.

2. Entry statements proposed to greenfield subdivision must be contained wholly within private property and not within any land to be dedicated to Council

3. All road verges/nature strips of major, minor and collective roads are to be completed with a low maintenance turf laid in a stretcher bond fashion from the back of the kerb to the lot boundaries of each residential lot

4. Trees used within a road reserve and or median strip, must be a minimum size of a 75lt bag and must have a minimum 2 metre clear trunk from ground level at the time of installation

5. Landscaping within a road reserve must be set back a minimum of 500mm from the back of the kerb and within a median strip must be set back 500mm from the concrete apron, landscaping must not obscure any signage and the use of frangible species should be sought

6. Large trees such as Eucalyptus spp, Angophora spp, Toona spp should not be designed into any road median, nature strip or road verge without an agreement with Council.

7. Landscape within road reserves and median strips must have a 10 metre visual clearance zone from an approaching side of any pedestrian access point of crossing. Low growing species having a maximum mature height of 300mm can be used within the 10 metre clear zone.

8. Decomposed granite is not permissible within any road reserve

9. Landscaping within any median strip having a width of less than 2 metres in a speed zone of 80kms is not permissible and less than 4 metres in a speed zone greater than 80kms.

10. Landscape proposed within roundabouts must have a 2000mm set back from the outer edge of the roundabout in a 60km zone and a 1000mm clearance zone in a 40km zone and planted with a plant species that has a maximum mature height of 300mm

11. Where landscaping is proposed within roundabouts and median strips a 1mt concrete apron is required. The use of innovative designed concrete pavement incorporated with soft landscape should be considered.

12. Plant species used in roundabouts must have a maximum mature height of 300mm or less and must be a low maintenance species. Mixed species planting should be avoided

13. Trees and shrubs shall not be planted close to car parking spaces or bays in public open space such that the planting would obstruct the opening of doors or safe manoeuvring of vehicles

4 ANNEXURES

4.1 ANNEXURE– SELECTIONS

Project requirements schedule

Property	**Value/Required? ***	
Samples	Yes ☐	No ☐
Plants freight responsibility agreement	Yes ☐	No ☐
Street trees:		
- Labelling frequency		
- Specific pruned form	Yes ☐	No ☐
- Included bark: Exception	Yes ☐	No ☐
- Paved areas: Excavation for structural soil	Yes ☐	No ☐
- Porous bonded gravel thickness (mm)		

Property	Value/Required? *
*Check the box applicable for the project.	

Plant material supply schedule

Botanical name	Common name	Container volume size (L)	Height range (m)	Calliper (mm)	Quantity (+10%)

Transplanting schedule

Botanical name	Common name	Description

Specimen plants schedule

Botanical name	Common name	Description

Street tree accessories schedule

Property	A	B	C
Tree guards: Product			
Tree guards: Size			
Tree guards: Finish			
Tree grates: Product			
Tree grates: Size			
Tree grates: Size of openings			

Property	A	B	C
Tree grates: Material			
Tree grates: Finish			
Tree collar guards	200 mm length of 100 mm diameter agricultural pipe split lengthways.		

Street tree subsoil drainage schedule

Property	A	B	C
Drainage cells: Product			
Drainage cells: Size of cell panel			
Drainage cells: Filter fabric			
Drainage cells: Location	Planting excavations adjacent roadway kerbing		
Subsoil drainage disposal			
Root barrier: Product			
Root barrier: Depth	600 mm		
Root barrier: Location	Planting excavation adjacent to, and within 4 m of roadway kerbing		

Porous bonded gravel schedule

Property	A	B	C
Tree surround surfacing: Product			
Tree surround surfacing: Filter fabric			
Tree surround surfacing: Gravel			

4.2 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
INSPECTIONS, Notice Slopes and drains	W	Preparation of surface for cultivation and conditioning.	2 days after preparing surface	
INSPECTIONS, Notice	H	Physical damage or drying out	3 days before planting	Planting

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
Plants on arrival at site				
INSPECTIONS, Notice Landscape planting	H	Set out of plants, soil conditioner and fertiliser	2 days before backfilling	Backfilling -
INSPECTIONS, Notice Transplanting street trees	H	Final orientation of the tree	2 days before rootball pruning	Rootball pruning.
INSPECTIONS, Notice Transplanting street trees	W	Watering, fertilising and root cutting in existing location	2 days before transplanting	-
INSPECTIONS, Notice Transplanting street trees	W	Watering, fertilising and root cutting in relocated location	2 days before transplanting	-
*H = Hold Point, W = Witness Point				

4.3 ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Seed, imported soil and mulch supply

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Trees	Dispatch tree stock inspection form	1 contract	1 Contract	AS 2303 Appendix C
Imported topsoil	Material quality:			
	- pH	10,000 m²	1 per 500 m³ *	AS 4419
	- Organic content	10,000 m²	1 per 500 m³ *	AS 4419
	- Soluble salt content	10,000 m²	1 per 500 m³ *	AS 4419
Mulch for planting	Material quality	1 contract	1 Contract	AS 4454
* Note: or part thereof, per lot.				

4.4 ANNEXURE - PAY ITEMS

Pay items	Unit of measurement	Schedule Rate inclusions
0257.1 Vegetation of slopes flatter than 3H to 1V		
0257.1(1) Vegetation - Seeding	m^2	All costs associated with the vegetation of slopes by seeding

Pay items	Unit of measurement	Schedule Rate inclusions
		other than the cost of watering, and supply of imported topsoil.
0257.1(2) Vegetation - Turfing	m^2	All costs associated with the vegetation of such slopes by turfing other than the cost of watering, and supply of imported topsoil.
0257.1(3) Watering determination of volume: By calibrated dipstick readings or other approved method.	kL	All costs associated with supply and delivery of the water and the watering of the seeded and/or turfed areas.
0257.2 Vegetation of slopes steeper than 3H to 1V		
0257.2(1) Preparation of surface other than stepped batters	m^2	All costs associated with the preparation of the surface for vegetation other than the cost of supply of imported topsoil
0257.2(2) Preparation of surface of stepped batters	m^2 on the batter slope	All costs associated with the preparation of the batter slope for vegetation other than the cost of supply of imported topsoil.
0257.2(3) Hydromulching	m^2	All costs associated with hydromulching other than the watering of dry surfaces.
0257.2(4) Hydroseeding	m^2	All costs associated with hydroseeding other than the watering of dry surfaces.
0257.2(5) Straw mulching	m^2	All costs associated with straw mulching.
0257.2(6) Watering Determination of volume: By calibrated dipstick readings or other method approved.	kL	All costs associated with supply and delivery of the water and the watering of dry surfaces.
0257.3 Vegetation of open drains		
0257.3(1) Preparation and Topsoiling of drains	m^2	All costs associated with preparation of the surface for sowing.
0257.3(2) Mechanical sowing	m^2	All costs associated with sowing and fertilising.
0257.3(3) Hydromulching	m^2	All costs associated with hydromulching other than the watering of dry surfaces.
0257.3(4) Hydroseeding	m^2	All costs associated with hydroseeding other than the watering of dry surfaces.
0257.3(5) Hand sowing	m^2	All costs associated with sowing by hand.
0257.3(6) Spray with bitumen emulsion	m^2	All costs associated with the supply and spraying of bitumen emulsion.

Pay items	Unit of measurement	Schedule Rate inclusions
0257.3(7) Lining with organic fibre mat	m^2	All costs associated with the supply and placement of organic fibre mat.
0257.3(8) Turfing	m^2	All costs associated with the supply and placement of turf.
0257.3(9) Watering determination of volume: By calibrated dipstick readings or other method approved	kL	All costs associated with supply and delivery of the water and the watering of dry surfaces and all treated drain areas.
0257.4 Landscape planting		
0257.4(1) Provision of mulched bed for mass planting	m^2	All costs associated with the preparatory work of the mulched bed before planting.
0257.4(2) Mass planting	Each plant	All costs associated with the planting in the mulched bed and subsequent care of each plant.
0257.4(3) Individual landscape planting of stock	Each plant	All costs associated with the preparatory work, planting and subsequent care of each plant.
0257.5 Supply of imported topsoil	The cubic metre measured loose in the truck as delivered	All costs associated with the supply and delivery of the topsoil to the site. Placing and spreading of the topsoil is excluded from this pay item and is included in the specific activity pay items for vegetation or planting as appropriate.
0257.6 Street trees		All costs associated with supply and delivery of paved and unpaved areas and porous bonded gravel.
0257.7 Transplanting street trees		All costs associated with preparation, root ball pruning and maintenance of on-site plant material.
Traffic management	Lump sum	To the *1101 Traffic management* work-section
Erosion and sedimentation		To the *1102 Control of erosion and sedimentation (Construction)* work-section
Earthworks		To the *1112 Earthworks (Road reserve)* work-section

4.5 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1160	1996	Bitumen emulsions for construction and maintenance of pavements
AS 2303	2015	Tree stock for landscape use

AS 2507	1998	The storage and handling of agricultural and veterinary chemicals
AS 4373	2007	Pruning of amenity trees
AS 4419	2003	Soils for landscaping and garden use
AS 4454	2012	Composts, soil conditioners and mulches
AS 4843	2001	Synthetic weed blocking fabric

0257 LANDSCAPE – OPEN SPACE AND PLAYGROUND LANDSCAPE

1 GENERAL

1.1 RESPONSIBILITIES

General

This Specification provides landscaping procedural advice and landscaping design advice for open space and public open space areas within the Shellharbour LGA, including environmental, recreational, cultural, structural and ornamental landscaping.

Open space allocation should be consistent with Council's current open space requirements.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.
- *1102 Control of erosion and sedimentation (Construction)*.

1.3 STANDARDS

General

Storage and handling of pesticides: To AS 2507.

Tree stock: To AS 2303.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviations apply:

- N:P:K: Nitrogen: Phosphorous: Potassium ratio.

Definitions

General: For the purposes of this work-section the definitions given in AS 2303 and the following apply:

- Ameliorant material: Additives used to make or improve soil.
- Anionic bitumen: A type of bituminous emulsion where dispersed particles comprise a bituminous binder and are negatively charged.
- Size index: Numerical expression of the size or physical bulk of a tree stock above ground.

1.5 SUBMISSIONS

Execution details

Soil amelioration recommendations: If required, the source of ameliorant material, rates and methods of incorporation.

Plant material: Submit details of proposed fertiliser to be used.

Soil conditioning: If other than gypsum is proposed, submit details.

Transplanting trees: Submit a program for regular fertiliser applications during the plant establishment and maintenance period.

Products and materials

Imported topsoil: Submit evidence verifying the following:

- Suitability of each soil type for its documented use.
- Similarity to naturally occurring local soil.
- Suitability for establishment and on-going viability of the site vegetation.
- Absence of any weed propagules or contaminants.

Plant provenance: Submit documentation that all plant material has been grown from locally provenanced stock. If this is not achievable give notice.

Plant source: Submit documentation that all plant material has been grown from locally sourced stock (or local endemic species). If this is not achievable give notice.

- Species: Submit written certification that all plant material is true to the required species and type.

Trees: Submit evidence of conformance to AS 2303.

Seed supply: Submit the name(s) of the proposed seed supplier(s).

Samples

General: Submit representative samples of each material, packed to prevent contamination and labelled to indicate source and content.

Bulk materials: Submit a 5 kg sample, of documented materials with required test results.

Tests

Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

1.6 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Slopes and drains: Prepared surface for cultivation and conditioning.
- Plants on arrival at site.
- Landscape planting: Set out of plants, soil conditioner and fertiliser.

2 MATERIALS

2.1 GENERAL

Specimen plants

Plant source: Conform to the following:

- Obtain plants from nursery stock located in an area with similar climate to the site of the Works.

Non-containerised stock: Program the preparation of specimen plants so that they are ready for transplanting to site when required.

Transportation

Requirement: Transport plants to the site without physical damage or drying out.

Optimal plant condition

General: Maximum initial impact at the time of project opening.

2.2 TOPSOIL

General

Topsoil: To AS 4419 and as follows:

- Free of weed propagules and contaminants and suitable for the establishment and ongoing viability of the selected vegetation.
- Maximum soluble salt content: 0.06% by mass.

Health warning: To AS 4419, on packaging or invoice for bulk supply.

Management of stockpiles and batters

Requirement: To **Management of stockpiles and batters** in *1102 Control of erosion and sedimentation (Construction)* work-section.

2.3 FERTILISER AND MULCHES

Fertiliser

Type: Organic.

N:P:K ratio:

- Slopes and open drains: 80:36:20.
- Mass planting: 63:18:28.

General mulch types

Organic landscape mulch: To AS 4454.

Composition:

- Fines (by volume): < 5%.
- Woodchip (maximum size): < 50 mm.
- Leaf mulch (by volume): < 25%.

Quality: Free of deleterious and extraneous matter including weeds, soil, sticks and stones.

Synthetic weed blocking fabric: To AS 4843.

Hydromulch

Material: Straw, chaff, wood fibre paper pulp finely shredded to a maximum dimension of 10 mm.

Prohibited material: Meadow hay and weeds. If using paper pulp, do not exceed 50% by mass of total mulch.

Binder: Grade ASS, slow setting anionic bitumen to AS 1160.

Straw mulch

Material: Straw matrix.

Prohibited material: Meadow hay and weeds.

Binder: Grade ASS slow setting anionic bitumen to AS 1160.

Straw mat finished thickness: > 20 mm.

Hardwood stakes

General: Pointed at one end, as follows:

- Marker stakes (for tube stock): 15 x 15 x 800 mm.
- Stakes (for advanced stock): 2 stakes, 25 x 25 x 2000 mm.

- Stakes (for super advanced stock): 3 stakes, 50 x 50 x 3000 mm.

2.4 PLANT MATERIAL

Seed

Requirement: Conform to the following:

- Grass and clover: Pre-packed commercially with an accompanying certificate of germination.
- Native seed: Deliver to the site in separate lots for each species and variety, clearly labelled to show species, variety and weight.

Storage: Do not take possession of the seed more than seven days before sowing is to occur. Store seed in clean, airtight containers and keep away from direct sunlight. Do not expose seed to the elements at any stage during storage.

Replacement : Replace if seed batch is not true to type.

Turf

Description: 25 mm depth of dense, well rooted, vigorous grass growth with 25 mm depth of topsoil and free of weeds, soil pests and diseases.

Prohibited material: Kikuyu grass.

Supply: As rolls in long lengths of uniform widths, in sound unbroken condition.

Width of rolls: > 300 mm.

Seed and turf table

Material	Species	Minimum application rate (kg/ha)
Seed		
- Grass	Rye Corn (April-August) or	60
	Japanese Millet (September-March)	60
	Hulled Couch	5
	Red Clover (Inoculated)	5
	White Clover (Inoculated)	5
	'Elka' Perennial Rye	5
- Native	Acacia dealbata	
	Acacia buxifolia	1
	Acacia decurrens	1
	Acacia pravissima	1
	Leptospermum lanigerum	1

Material	Species	Minimum application rate (kg/ha)
	Hardenbergia violacea	0.5
	Kennedia prostrata	0.5
	Acacia implexa	0.2
	Banksia marginata	0.2
	Bursaria spinosa	0.2
	Callistemon pallidus	0.2
	Dodonaea viscoca	0.2
Turf grass		
- Medians - Verges/Footpaths - Other Areas	Couch Buffalo Couch	Refer to Drawings

Plant supply

Requirement: Conform to the following:

- Healthy, of good form and not soft or forced.
- Large robust root systems.
- Not root bound .
- Free from disease and insect pests.
- Hardening off: Deliver all plants to a site within the locality of the works at least four weeks before planting out.
- Plant root systems: Maintain root moisture at all times with particular attention to watering during the on-site period before and during planting.
- Planting hole depths: Equal to the depth of container soil.
- Trees: Single leading shoot.

Full Title Block Requirements	**Plan Legend**	**Plant Schedule**	**Detail Drawing**	**Landscape Specifications**	**Maintenance Program**
Location Scale Plan No. Precinct No. Lot No. Drawing No. Date Applicant North Point Scaled layout of the site	Lot boundary Extent of works Contours/proposed levels Services/new service locations Street signage locations Streetlight locations Concrete surfaces/edging Turf areas Mass Planting locations Tree Planting locations Park furniture locations Playground equipment locations Soft Fall location Fencing, bollards etc locations Bus stops, driveway locations	Plant symbol Botanical Name Plant quantities Container size Grid spacings Staking requirements	Street tree planting and tree planting Mass planting Mulch/Softfall/Wetpour Turf Landscape edging Retaining Walls Concrete pavements Park furniture/Utilities Services/Water Outlets	Services Soils Turf Mulch Plants/Planting Turf Fertiliser Staking and Tying	Plant Replacement Stakes and Ties Pruning Mulch Replacement Pest and Disease Control Weed Eradication Watering Soil Subsidence Maintenance Regime

3 EXECUTION

3.1 GENERAL

Transport and storage

Requirement: Inspect all plants at the time of delivery and reject non-conforming plants.

Program

Requirement: Conform to the following:

- Between September and May: Plant exposed surfaces before the area exceeds 1 ha.
- Between June and August: Do not carry out planting to exposed surfaces without approval.

Preparation

Herbicide treatment: Spray herbicide as follows:

- Type: Glyphosphate.
- Rate: 9 litres/200 litres water/ha.
- Program: Maintain sprayed areas undisturbed for 2 weeks.

Pesticide treatment: In the following form, as documented:

- Liquid:
  - . Application rate: 5 litres/hydromulch/ha.
  - . Powder: 10 kg/ha.

Herbicides and pesticides: To the Australian Pesticides and Veterinary Medicines Authority (APVMA) register.

Soil conditioning: Provide as follows:

- Gypsum application rate: 400 g/m².
- Application: Conform to the following:
  - . Spread evenly over the subsoil by a mechanical spreader and topsoil on the same day.
  - . Thoroughly mix into the topsoil whilst the topsoil is being removed from stockpiles.
  - . Apply conditioners other than gypsum to the supplier’s recommendations.

Fertiliser treatment: Provide as follows:

- Application rate: 1000 kg/ha.

Seed mixing: Provide as follows:

- Mix, pre-treat and place seed in the sowing equipment for each operation on site.
- Sow seed on the day of mixing with pesticide.

Watering

General: Conform to the following:

- Potable or sourced from areas without toxins, pollutants or any substance which may adversely affect plant growth.
- Initial watering: To a uniform moisture condition without run-off.
- After turfing: Re-water to a uniform moisture condition without run-off.
- After sowing: If required, re-water to a uniform moisture condition without causing rills in the surface, daily for 15 days.
- Excessive rilling: If watered areas result in excessive rilling, rehabilitate by re-preparing and re-sowing the affected area.

3.2 SLOPES FLATTER THAN 3H TO 1V

Preparation of the surface

Cultivation: Before applying topsoil, tine to a depth of 200 mm to produce a loose surface and remove all large stones, rubbish and other materials that may delay germination.

Cultivation depth: 50 mm for a roughened surface with soil lumps not exceeding 50 mm.

Topsoil

Application: Apply uniformly to an average compacted thickness of 50 mm with a minimum compacted thickness of 30 mm at any location.

Application of pesticide

Timing: Immediately before sowing.

Pesticide type: Powder form.

Application: Mix thoroughly with the seed, in conformance with **EXECUTION**, **GENERAL**, to the equivalent mass of seed to be spread on 1 hectare of the surface.

Grassing

Seeding:

- Application: Distribute evenly, by a mechanical seeder following the finished contours wherever possible.
- Depth: 5 mm as sown, or 5 mm cover by raking or harrowing.
- Fertiliser: Apply concurrently with seeding, as documented.

Turfing:

- Laying: On the prepared topsoiled surface and perpendicular to the direction of water flow.
- Joints: Butt runs of turf hard against each other and topdress with topsoil.
- Slopes 5:1 to 3:1: Peg turf and remove pegs when established.

Topdressing:

- Timing: 4 to 6 weeks after laying turf.
- Requirement: Correct any undulations or unevenness in the established turf.

Maximum slope for areas to be maintained by a ride-on mower with a 2 m wide deck: 4:1.

3.3 SLOPES STEEPER THAN 4H TO 1V

Methods

General: Vegetate slopes by one of the following methods, as documented:

- Apply topsoil and hydromulch.
- Apply topsoil, hydroseed and straw mulch.
- Hydroseed.

Preparation of the surface

General: Remove all loose material from fill batters and cut batters.

Timing: No more than seven days before seeding.

Cultivation: Lightly tine or roughen the surface parallel to the contours.

Topsoil

Application: Conform to the following:

- General: Apply uniformly to an average thickness of 50 mm, with a minimum compacted thickness of 30 mm at any location.
- Stepped batters: Loosely fill with topsoil.

Hydromulching or hydroseeding

Watering: Water dry surfaces with a fine spray before applying the hydromulch.

Pesticide:

- Timing: Apply during preparation of the hydromulch or hydroseed slurry.
- Pesticide type: Liquid.

Equipment: Clean and free of contamination from previous operations.

Mix: Add materials as documented to the slurry storage tank and agitated to maintain a uniform consistency during application.

Application: Uniformly over the whole surface.

Weather conditions: Do not apply hydromulch or hydroseed under the following weather conditions at the site:

- Temperature: > 35°C.
- Winds exceed: 15 km/hr.
- During rain periods or when rain appears imminent or if the surface is saturated.

Wetting agent:

- Application rate: 1 litre/1000 litres of mix water.

Hydromulching or hydroseeding table

Material	**Application rate per hectare of surface**	
	Hydromulching	**Hydroseeding**
Vegetable mulch (kg)	1500	Nil
Water (L)	35,000	20,000
Binder (L)	1200	Nil
Wetting agent (L)	35	20

Straw mulching

Application: Apply uniformly with a suitable blower.

Rate: 250 bales (each of 20 kg) of straw per hectare of surface.

Bitumen emulsion: Incorporate as a spray into the air stream of the mulch blower.

- Application rate: 2500 litres per hectare of surface.

Straw mat thickness: ≥ 20 mm at any location.

3.4 OPEN DRAINS

Preparation of the surface

Topsoil: Spread to an average compacted thickness of 50 mm, with a minimum compacted thickness of 30 mm at any location.

Timing: Complete vegetation within 7 days of the completion of open drain excavation.

Grass seeding

Application: Apply uniformly by one of the following methods and conform to the **Seed and turf table**:

- Mechanical sowing.
- Hydromulching or hydroseeding.
- By hand.

Surface protection

Requirement: Protect all or part of the sown surface by one of the following methods, as documented:

- Bitumen emulsion: Spray the surface with an anionic slow setting bitumen emulsion to Grade ASS of AS 1160 at a rate of 1 litre of bitumen emulsion per square metre of surface.
- Organic fibre mat: Line the channel with an organic fibre mat.
  - Lay runs of matting along the direction of water flow loosely on the soil surface and not stretched.
  - Slot upstream end of matting into a trench 150 mm wide by 150 mm deep and pinned to the base of the trench at 200 mm centres.
  - Backfill the trench with soil and compact by foot.
  - Overlap adjacent runs of matting 100 mm with the higher run lapped over the lower run and pinned matting along the sides of each run at 500 mm centres and along the middle of each run at 1000 mm centres.
  - Overlap ends 150 mm wide with the higher run end lapped over the start of the lower run and pinned at 200 mm centres.
- Pins: U shaped pins of 4 mm gauge wire, 50 mm wide and 150 mm long legs.
- Turfing: Butt runs of turf hard against each other and place perpendicular to the direction of water flow in the drain. Pin into position at 500 mm centres. Topdress seams of turf with topsoil.

3.5 LANDSCAPE PLANTING

Conditions

General: Do not carry out landscape planting when temperature is above 35°C or below 10°C.

Timing: Carry out planting within 7 days of site seeding operations.

Preparation

Weed management: Conform to the following:

- Herbicide spray: Conform to **EXECUTION, GENERAL** and the following:
  - Program: Maintain sprayed areas undisturbed for 2 weeks.
  - Spray drift: Make sure there is no contact with planted material.
- Weed management by synthetic weed blocking fabric:
  - Extent: 800 mm surrounding each proposed planting.

Fertilising (N:P:K): Conform to the following:

- Ratio: 63:18:28.
- Application rate: 5 kg/m².

Mass planting in mulched bed

Surface preparation: Rip the surface at 500 mm centres to a depth of 300 mm and break up the top 200 mm of the planting bed by cultivation to a maximum size of 50 mm.

Mulch: Spread 75 mm thick.

Individual planting

Preparation: Loosen a planting area 600 mm diameter to a depth of 400 mm.

Mulch: Spread 75 mm thick to 600 mm radius around the plant.

Planting

Method: Remove the localised mulch. If required, root prune to make sure all circling roots have been either severed or aligned radially into the surrounding soil. Place the plant, backfill the planting hole with topsoil and compact lightly so as to minimise subsidence without compacting the backfill. Avoid mixing mulch with topsoil.

Stakes and ties: Advanced and super advanced stock:

- Drive stakes 300 mm deep and 200 mm clear of the plant.
- Ties: 50 mm wide hessian webbing strips, attached loosely.

Watering: 10 litres of water per hole before the mulch is respread over the disturbed area.

Mulching: Replace, and leave the plant stem clear.

Care of landscape planting

Watering: Water all plants, from the time of planting, every second day for the first twelve weeks at the following rates, per plant:

- Tube stock: 5 L.
- Advanced trees: 10 L.
- Super advanced (25 L): 30 L.
- Semi-mature (75 to100 L): 50 L.

Replacement: Replace missing plants, dead plants and unhealthy plants with plants of similar size and quality and of identical species and variety to the plant being replaced.

Weed and grass growth in mulched areas: Control with herbicide, in conformance with the manufacturer's recommendations at monthly intervals during the construction period and contract maintenance period. Replace plants damaged by herbicide application.

3.6 GUIDELINES FOR TREES AND SHRUBS

The Landscaping Plans must include a planting schedule.

The planting schedule must clearly detail the planting positioning, species by botanical and common names, quantities, planting sizes and the estimated size of the plant at approximately 12 years maturity.

The planting schedule must also detail the proposed establishment and maintenance programme.

The Landscaping Plans must demonstrate that the existing cultural and heritage amenity (where relevant), as well as any existing surrounding trees and ecological communities, have been a consideration in the preparation of the proposed planting schedule for the development site.

The contractor shall supply and plant trees and shrubs of the types detailed on the approved Landscaping plans. Trees and shrubs shall be planted in the locations shown on the Landscaping Plans.

After installing the trees and shrubs, the developer shall ensure that sufficient watering, care and repair is carried out to sustain the new plantings throughout the maintenance and establishment period.

4 ANNEXURES

4.1 ANNEXURE– SELECTIONS

Project requirements schedule

Property	Value/Required?*	
Samples	Yes ☐	No ☐
Plants freight responsibility agreement	Yes ☐	No ☐

Plant material supply schedule

Botanical name	Common name	Container volume size (L)	Height range (m)	Calliper (mm)	Quantity (+10%)

Transplanting schedule

Botanical name	Common name	Description

Specimen plants schedule

Botanical name	Common name	Description

Porous bonded gravel schedule

Property	A	B	C
Tree surround surfacing: Product			

Property	A	B	C
Tree surround surfacing: Filter fabric			
Tree surround surfacing: Gravel			

4.2 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
INSPECTIONS, Notice Slopes and drains	W	Preparation of surface for cultivation and conditioning.	2 days after preparing surface	
INSPECTIONS, Notice Plants on arrival at site	H	Physical damage or drying out	3 days before planting	Planting
INSPECTIONS, Notice Landscape planting	H	Set out of plants, soil conditioner and fertiliser	2 days before backfilling	Backfilling -
*H = Hold Point, W = Witness Point				

4.3 ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Seed, imported soil and mulch supply

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Trees	Dispatch tree stock inspection form	1 contract	1 Contract	AS 2303 Appendix C
Imported topsoil	Material quality:			
	- pH	10,000 m²	1 per 500 m³ *	AS 4419
	- Organic content	10,000 m²	1 per 500 m³ *	AS 4419
	- Soluble salt content	10,000 m²	1 per 500 m³ *	AS 4419
Mulch for planting	Material quality	1 contract	1 Contract	AS 4454
* Note: or part thereof, per lot.				

4.4 ANNEXURE - PAY ITEMS

Pay items	Unit of measurement	Schedule Rate inclusions
0257.1 Vegetation of slopes flatter than 3H to 1V		
0257.1(1) Vegetation - Seeding	m^2	All costs associated with the vegetation of slopes by seeding

Pay items	Unit of measurement	Schedule Rate inclusions
		other than the cost of watering, and supply of imported topsoil.
0257.1(2) Vegetation - Turfing	m^2	All costs associated with the vegetation of such slopes by turfing other than the cost of watering, and supply of imported topsoil.
0257.1(3) Watering determination of volume: By calibrated dipstick readings or other approved method.	kL	All costs associated with supply and delivery of the water and the watering of the seeded and/or turfed areas.
0257.2 Vegetation of slopes steeper than 3H to 1V		
0257.2(1) Preparation of surface other than stepped batters	m^2	All costs associated with the preparation of the surface for vegetation other than the cost of supply of imported topsoil
0257.2(2) Preparation of surface of stepped batters	m^2 on the batter slope	All costs associated with the preparation of the batter slope for vegetation other than the cost of supply of imported topsoil.
0257.2(3) Hydromulching	m^2	All costs associated with hydromulching other than the watering of dry surfaces.
0257.2(4) Hydroseeding	m^2	All costs associated with hydroseeding other than the watering of dry surfaces.
0257.2(5) Straw mulching	m^2	All costs associated with straw mulching.
0257.2(6) Watering Determination of volume: By calibrated dipstick readings or other method approved.	kL	All costs associated with supply and delivery of the water and the watering of dry surfaces.
0257.3 Vegetation of open drains		
0257.3(1) Preparation and Topsoiling of drains	m^2	All costs associated with preparation of the surface for sowing.
0257.3(2) Mechanical sowing	m^2	All costs associated with sowing and fertilising.
0257.3(3) Hydromulching	m^2	All costs associated with hydromulching other than the watering of dry surfaces.
0257.3(4) Hydroseeding	m^2	All costs associated with hydroseeding other than the watering of dry surfaces.
0257.3(5) Hand sowing	m^2	All costs associated with sowing by hand.
0257.3(6) Spray with bitumen emulsion	m^2	All costs associated with the supply and spraying of bitumen emulsion.

Pay items	Unit of measurement	Schedule Rate inclusions
0257.3(7) Lining with organic fibre mat	m^2	All costs associated with the supply and placement of organic fibre mat.
0257.3(8) Turfing	m^2	All costs associated with the supply and placement of turf.
0257.3(9) Watering determination of volume: By calibrated dipstick readings or other method approved	kL	All costs associated with supply and delivery of the water and the watering of dry surfaces and all treated drain areas.
0257.4 Landscape planting		
0257.4(1) Provision of mulched bed for mass planting	m^2	All costs associated with the preparatory work of the mulched bed before planting.
0257.4(2) Mass planting	Each plant	All costs associated with the planting in the mulched bed and subsequent care of each plant.
0257.4(3) Individual landscape planting of stock	Each plant	All costs associated with the preparatory work, planting and subsequent care of each plant.
0257.5 Supply of imported topsoil	The cubic metre measured loose in the truck as delivered	All costs associated with the supply and delivery of the topsoil to the site. Placing and spreading of the topsoil is excluded from this pay item and is included in the specific activity pay items for vegetation or planting as appropriate.
Traffic management	Lump sum	To the *1101 Traffic management* work-section
Erosion and sedimentation		To the *1102 Control of erosion and sedimentation (Construction)* work-section
Earthworks		To the *1112 Earthworks (Road reserve)* work-section

4.5 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1160	1996	Bitumen emulsions for construction and maintenance of pavements
AS 2303	2015	Tree stock for landscape use
AS 2507	1998	The storage and handling of agricultural and veterinary chemicals
AS 4373	2007	Pruning of amenity trees
AS 4419	2003	Soils for landscaping and garden use
AS 4454	2012	Composts, soil conditioners and mulches
AS 4843	2001	Synthetic weed blocking fabric

`

0281 BUSHFIRE PERIMETER TRACKS (CONSTRUCTION)

`

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide bushfire perimeter tracks, as documented. Ensure that the work is undertaken to minimise the disturbance of the natural surroundings and to minimise the need for future maintenance.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *0257 Landscape - road reserve and street trees*.

1.3 INTERPRETATION

Definitions

General: For the purposes of this work-section the following definitions apply:

- Batter: The face of an embankment or cutting, produced as a result of earthmoving operations involving cutting and filling.
- Borrow area: An area or excavation from which soil, clay, sand, rock or gravel has been excavated for a specific purpose.
- Contour cultivation: Cultivation to prepare the rehabilitation area on the contour. On steep slopes the land is terraced or benched.
- Cross bank (whoa-boy): An earth hump constructed across a track so that runoff is effectively diverted from it. Cross banks are designed to handle larger flows than cross drains, using one of the following methods:
  - Infall cross bank: Used to direct water off the track surface where it is inappropriate to direct water to the side of the road.
  - Outfall cross bank: Used to remove water from table drains at outfall locations.
- Cross drains: Drains of various forms that hinder the flow of water down a track and divert it across the track's surface. The capacity of the drain is defined by its cross-section. Cross drains are designed to handle smaller flows than cross banks but larger flows than can be controlled by crossfall drainage.
- Crossfall drainage: Drainage which occurs when the surface of a track has sufficient cross slope to cause water to flow across and off the surface, rather than along it. Stormwater drainage for unsealed tracks can be classified as follows:
  - Crown: Where water sheds from both sides.
  - Infall: Where water flows into the hillside.
  - Outfall: Where flow is away from the hillside.
- Culvert: A pipe or similar structure used to direct water under the track.

- Earth windrow: A soil ridge built along the track edge during construction or maintenance. Where used to direct runoff to a stable outlet, it is known as a windrow drain.
- Erosion classes in relation to soil types:

`

- . Class A: Low soil erodibility. Brown and red soils derived from finer sediments and metasediments.
- . Class B: High soil erodibility. Red soils on fine granites, fine sandstones and basalt.
- . Class C: Very high soil erodibility. Grey and yellow soils derived from granites, sediment and metasediment, especially coarse grained types.
- . Class D: Extreme soil erodibility. Unconsolidated sediment. This is unsuitable for perimeter tracks.

- Perimeter track: A track constructed and/or maintained expressly for fire management purposes.
- Table drain: Excavated open channels, running parallel with and forming part of the track formation. Table drains direct runoff to disposal areas further downslope.

1.4 SUBMISSIONS

Authority approvals

Requirement: Submit details of all authority approval before commencing the works for which the approval is granted, including the following:

- Vegetation clearing permit: Submit, if required.

2 EXECUTION

2.1 GENERAL

Bushfire management

Bushfire management planning: Conform to fire management manual requirements by the state fire authorities.

Connection to existing tracks

Connection: Connect new perimeter tracks by suitable intersections with existing access tracks.

2.2 EROSION AND SEDIMENT CONTROL

General

Maintenance: Reduce the risk of erosion by establishing and maintaining low grass and ground cover vegetation, less than 0.3 m high, on the tracks in designated areas.

2.3 TRACK AND TRAIL EROSION CONTROL MEASURES

Water divergent banks

Requirement: Minimum 400 mm high and 500 mm wide.

Water divergent bank distance table

Slope (°)	Bank distance apart (m)
1	150
2	130
3	110
4	90
5	70

Preventing water erosion

Slopes below 5°: Contour cultivation.

Slopes between 5° and 10°: Combination of contour ripping or contour furrowing in conjunction with contour cultivation. Construct furrows and rips precisely on the contour:

`

- Contour ripping: Rip to a depth of 60 to 90 mm with single or multiple ripper (by bulldozer). Use two tines spaced 1 m apart, with individual rip lines spaced 2 to 6 m apart, depending on slope angle.
- Contour furrowing: Use a single tine, fitted with a mould board attachment, to lift soil from the furrow to form a small bank on the downhill side.

2.4 EARTHWORKS

Minimum disturbance

Requirement: Construct tracks with minimal disturbance to the soil and vegetation both on and adjacent to the track, by slashing or blading the surface vegetation. Do not blade soil, unless required to build track bench on side slopes to form drainage line approaches, or to make rough surfaces trafficable. Follow the contour of the land to reduce the amount of cut and fill. Maximum crossfall: 1:10.

Work adjacent to watercourses: Contain sediment and stabilise work area during construction and within 1 week of disturbance to the following:

- Temporary sediment traps: Construct devices to remove sediment from sediment-laden runoff flowing from areas of 0.5 ha or more before the runoff enters stormwater drainage systems, natural watercourses or adjacent land.
- Waste barriers: Construct and maintain to prevent debris from entering natural watercourses.
- Batter protection: Minimise scour of newly formed batters during and after embankment by diverting runoff from the formation away from the batter until vegetation is established.
- Removal: Remove all measures when revegetation is established on formerly exposed areas before the end of the contract. Remove from the site, or otherwise dispose, all materials and components used for the temporary erosion and sedimentation control works, as documented and in conformance with regulatory authorities' requirements.

Work on swampy or unstable ground: Reinforce with synthetic earth geogrid.

Cut batters

Requirement: Construct cut batters as follows:

- Batters up to 1.5 m high for Class A soil: Cut vertically to reduce area of exposed disturbed soil.
- Batters higher than 1.5 m: Provide stabilisation measures including laying back, revegetation and drainage, if required.
- Dispersive soils: If encountered, grade batter to allow placement of a 200 mm (deep) layer of non-dispersive soil on the batter.

Fill batters

Requirement: Construct fill batters as follows:

- All soil classes: Not steeper than 2H:1V.
- Batters higher than 1.5 m on Class B, C and D soils: Provide stabilisation measures, such as drop down drains or hay mulching.
- Dispersive soils: If encountered, grade batter to allow placement of a 200 mm (deep) layer of non-dispersive soil on the batter.
- Vegetation debris or erosive materials: Do not use in fill batters.

Borrow sites

Requirement: Limit in size, minimise sediment leaving the borrow site and revegetate progressively as the site is worked out.

Location: Do not locate borrow sites near drainage lines or streams.

Stockpile topsoil

Requirement: Stockpile topsoil and litter (free of timber debris) in a recoverable location for respreading over disturbed areas.

`

Timber clearing

Clearing: Maximum 0.5 m on either side of the track, including overhanging branches, to 5 m clear height.

Method: Clear by felling rather than dozing to limit the amount of soil disturbance.

Waste: Dispose of all vegetation debris matter off site.

2.5 CROSS BANKS

General

Requirement: Construct where water runs down the track on slopes with a gradient of 20% or less and as follows:

- Dimensions: 400 to 450 mm (high) x 500 mm (wide).

Cross banks spacing table

Grade of track (%)	Maximum distance between banks (m)
Less than 2	120
2 to 4	60
4 to 8	30
More than 8	15
Source: IECA Book 5.	

Cross bank outlet points

Requirement: To regional guidelines with adjustments made for existing track conditions and sited as follows:

- Free from blockages by stumps or rocks.
- Runoff spills into undisturbed vegetation without flowing back onto the track or discharge into a sediment trap.
- If the track runs parallel to a watercourse: Sheet water off the track through an adjoining riparian zone. Filter sediment from stormwater runoff before it enters the watercourse.
- If the track runs along a ridge: Discharge stormwater evenly off each side of the ridge.

Construction

Method: Use one of the following construction methods:

- Cut and fill: Rip lines across the track area at a grade of 0.3%, cut a shallow channel along this line. Place excavated material on the downside of the channel, compact and smooth out to form a bank with even batters and a level top.
- Imported soil material: Grade to a maximum of 0.3 to 0.5% along the up slope edge.

Cross bank dimensions:

- Length: 6 m.
- Depth: Size to prevent runoff from overtopping the bank.
- Crest width: Size to allow for vehicle access over the cross bank.

Shaping and compacting: Shape bank with tractor blade to form a smooth and even bank with batters no steeper than 1V:5H. Track roll or wheel roll the length to obtain maximum compaction. Clean loose earth from the channel of the bank by sweeping with tractor blade.

`

2.6 DRAINAGE LINE CROSSING

Crossings

Requirement: Construct drainage line and watercourse crossings as documented and as follows:

- At right angles to the channel.
- Where the channel is straight, with well-defined banks.
- Do not use log dam crossings.
- Approaches to stream crossing: Cover with non-erodible materials, such as rock or gravel. If suitable material is not available, layout track and drainage to prevent sediment-laden water from running into the watercourse.

Protection of watercourse: Construct a cross bank immediately above the access cut. If access is longer than 15m, construct additional flow diversions down the cutting.

Material disposal: Remove cleared vegetation and other debris from the floodplain if it can cause damage to downstream structures when carried away by floodwaters.

Protection of embankments: Protect with suitable abutments, such as concrete, timber, logs or rocks.

Fords

Requirement: Construct fords, as documented.

Streams with a history of washouts: Provide a stabilised bed of synthetic 3D cellular mat filled with natural bedding material, for example. sand or gravel.

Culverts and turnouts

Requirement: Construct culverts and headwalls, as documented.

Alignment: To the natural alignment of the drainage line or watercourse.

Prohibited: Do not use culverts where there will be blockage from debris.

Water turnouts: Construct where soil type, structure or slope is highly erodible, including where there is minimal vegetative cover and heavy rainfall.

Culvert/turnout spacing table

Road gradient	**Soil type - maximum average spacing (m)**			
	Clay, silt, fine sand, ash	**Sand, very fine gravel, pumice**	**Gravel with some sand**	**Clean gravel**
5%	200	300	400	500
10%	100	150	200	250
Source: Department of Fire and Emergency Services Authority of Western Australia (DFES) *WA Gov Firebreak.* Table 6.				

Bridges

Requirement: Construct bridges, as documented.

Temporary bridge crossings: Form from timber or culvert bridging slab, suspended between well anchored logs.

`

Disturbance

Requirement: Minimise soil and vegetation disturbance. Seed disturbed areas to *0257 Landscape - road reserve and street trees* to minimise erosion.

Waste material dumping: Do not dump timber, scrub, soil or debris in drainage lines and watercourses. Stack well above flood levels.

Tree and vegetation removal

Requirements: Conform to state legislation, regulations and the authorising bodies.

2.7 REVEGETATION

Disturbed areas

Built up areas: Provide revegetation as documented on the development/subdivision plan and to *0257 Landscape - road reserve and street trees*.

Application: Revegetate immediately following the disturbance while the soil is still loose, irrespective of the growing season. Apply a maintenance dressing of fertiliser and seed to suit revegetation works.

Revegetation method: Use one of the following methods:

- No revegetation required: Forest litter and native flora providing natural vegetation and stabilisation.
- Short term revegetation: Provide annual grasses (Wimmera ryegrass) or cereals, e.g. cereal or rye oats (autumn/winter) or millet (spring/summer), and fertiliser.
- Long term revegetation: Provide perennial grasses, with or without a cover crop such as oats, cereal rye oats (autumn/winter) or millet (spring/summer), and fertiliser.

3 ANNEXURES

3.1 ANNEXURE – PAY ITEMS

Pay items	Unit of measurement	Schedule rate inclusions
0281.1 Perimeter tracks	Linear metre measured along the centreline of track as documented	All activities required to construct the tracks including clearing, earthworks, batters, cross drains, banks and revegetation

3.2 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

IECA Book 5	2012	Best practice erosion and sediment control - A field guide for construction site managers

0319 AUXILIARY CONCRETE WORKS

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide cast, pre-cast and sprayed concrete, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.

1.3 STANDARDS

General

Specification and supply of concrete: To AS 1379.

Concrete materials, design and construction: To AS 3600.

Concrete structures for retaining liquids: To AS 3735.

Design, installation and testing of post-installed and cast-in fastenings: To AS 5216.

1.4 INTERPRETATION

Definitions

General: For the purposes of this work-section the definitions given in AS 1379, AS 3600 and the following apply:

- Ambient temperature: The air temperature at the time of mixing and placing of concrete.
- Early age strength: A mean compressive strength at 7 days exceeding the values shown in AS 1379 Table 1.2.
- Expansion joint: A closing control joint with the joint surfaces separated by a compressible filler to allow axial movement due to thermal expansion or contraction with changes in temperature or creep. It may include unbound dowels to assist vertical deflection control.
- Sprayed concrete: Concrete pneumatically applied at high velocity on to a surface. Application may be either a wet or dry process, to produce a sound homogeneous product with a surface finish reasonably uniform in texture and free from blemishes. Sprayed concrete is also called Shotcrete.
- Weather – cold: Ambient shade temperature less than 10°C.
- Weather – hot: Ambient shade temperature greater than 30°C.

1.5 SUBMISSIONS

Certification

Design: Submit certification verifying conformance of the formwork design for in-situ box culverts and retaining walls.

Completed formwork: Submit certification verifying conformance of completed formwork, including the suitability of the formwork for the documented surface finish class.

Execution details

Modifications: Submit details of any proposed on-site modifications to the documented reinforcement.

Welding: Submit details of any proposed welding of steel reinforcement.

Splicing: Submit details of any proposed mechanical splicing of steel reinforcement.

Galvanizing repair: Submit proposals for any repair to damaged galvanizing of steel reinforcement.

Coring: Submit details of any proposed cutting or coring required in hardened concrete.

Elapsed delivery time: Submit details of any proposed methods for cooling or heating wet concrete before placement.

Measurement of materials: Submit proposal to measure materials by volume for on-site mixing for minor concrete works.

Placing: Submit proposals for mixing, placing, finishing and curing concrete including the following:

- Changes to the concrete mix.
- Curing and protection methods.
- Handling, placing, compaction and finishing methods and equipment, including pumping.
- Site storage, mixing and transport methods and equipment, if applicable.
- Temperature control methods.
- Details of any proposed sequential placement of slabs.

Placing under water: Submit detailed method statement for proposed placement of concrete under water.

Construction joints: Submit details of any emergency construction joints included in the works.

Repair of defects: Submit details of the proposed method of defect repair.

Surface repairs: Submit details of the proposed method of surface repair.

Method statement: Submit method statement for all sprayed concrete works.

Products and materials

Curing compounds: Submit details of any proposed liquid membrane forming curing compound, including evidence of conformance to the documented requirements.

Machine mixing: Submit details of proposed concrete mix when on-site machine mixing is proposed.

Samples

Coloured concrete: Submit sample blocks of coloured concrete before casting final concrete.

Sprayed concrete sample panels: Submit 3 sample panels for each mix proposed.

Shop drawings

Submit shop drawings to a scale that best describes the detail, showing the following:

- Location: The location of any cores, anchors, fixings or embedded items, including any requirement to displace reinforcement.

Subcontractors

Pre-mixed subcontractors: Submit details of proposed pre-mixed concrete suppliers.

Tests
Quality: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

Cores and test acceptance: Submit proposed locations of test cores.

Other tests: Submit results, as follows:

- Loading: If applying superimposed loads to a future load bearing concrete structure, within 21 days of placing concrete, complete tests to demonstrate that 95% of the concrete design strength has been achieved.

1.6 INSPECTIONS

Notice
General: Give notice so that inspection may be made of the following:

- Base preparation: Completed and prepared base before laying underlay or placing concrete.
- Completed formwork: Completed formwork following certification by professional engineer.
- Steel reinforcement placement: Completed steel reinforcement placement before placing concrete.
- Galvanizing repair: Any repaired galvanizing of steel reinforcement before placing concrete.
- Emergency hand mixing: Emergency hand mixing of concrete due to mechanical failure.
- Sprayed concrete sample panels: Concrete spraying of sample panels.

2 MATERIALS

2.1 CONCRETE

Properties
Concrete mix and supply: Conform to the following:

- Normal-class: To AS 1379 clause 1.5.3.
  - Properties: As documented in the **Normal-class concrete properties schedule**.
- Special-class: To AS 1379 clause 1.5.4.
  - Properties: As documented in the **Special-class concrete properties schedule**.

Consistency
Stockpile: If uniform, consistent colour is documented, stockpile sand, cement and aggregates at the beginning of the project to minimise colour variations.

Aggregates
Standard: To AS 2758.1.

Cement
Standard: To AS 3972.

Age: Less than 6 months old.

Storage: Store cement bags under cover and above ground.

Supplementary cementitious materials
Fly ash: To AS/NZS 3582.1.

Slag: To AS 3582.2.

Amorphous silica: To AS/NZS 3582.3.

Water
Standard: To AS 1379 clause 2.4.

Requirement: Clean, free from oil, acid, alkali, organic or vegetable matter and including not more than 500 mg/l of chloride ions.

Coloured concrete
Manufacture: Produce 4 sample blocks of each coloured concrete using the proposed mix and method before casting final concrete.

Sample block size (nominal): 300 x 300 x 50 mm.

Chemical admixtures
Standard: To AS 1478.1, used to the manufacturer's recommendations.

Recycled materials
Standard: Refer to 8200 Recycle material specifications

2.2 FORMWORK

General
Form linings, facings and release agents: Compatible with any finishes applied to concrete.

Lost formwork: Free of timber or chlorides, and not to impair the structural performance of the concrete members.

Plywood formwork
Material: To AS 6669.

Grade: To suit the documented design dimensions, loading and surface quality.

Joints: Seal the joints consistent with the surface finish class.

Tolerances: To AS 3610.1 Table 3.3.5.1.

2.3 REINFORCEMENT

Fibre reinforcement
Standard: To AS 3600 Section 16 and CIA CPN35.

Steel fibres: To ISO 13270 or EN 14889-1.

Steel reinforcement
Standard: To AS/NZS 4671.

Properties: To the **Steel reinforcement properties schedule**.

Fabrication tolerances: To AS 3600 clause 17.2.2.

Surface condition: Free of loose mill scale, rust, oil, grease, mud or other material which would reduce the bond between the reinforcement and concrete.

Storage: Store reinforcement above the surface of the ground and protect from damage and from deterioration by exposure.

Protective coating
Standard: To AS 3600 clause 17.2.1.2.

Requirement: For concrete elements containing protective-coated reinforcement, provide the same coating type to all that element's reinforcement and embedded ferrous metal items, including tie wires, stools, spacers, stirrups, plates and ferrules, and protect other embedded metals with a suitable coating.

Epoxy coating: High build, high solids chemically resistant coating.

- Thickness: 200 µm minimum.

Galvanizing: To AS/NZS 4680:

- Sequence: If fabricating after galvanizing, repair damaged galvanizing and coat cut ends.
- Zinc-coating (minimum): 600 g/m^2.

Accessories

Reinforcement supports: To AS/NZS 2425.

Tie wire: Galvanized annealed steel 1.25 mm diameter minimum.

2.4 PRECAST UNITS

General

Requirement: Provide proprietary precast units as documented.

Materials, components and equipment for manufacture: To AS 3850.1.

Planning, design, construction, transportation, erection and installation: To AS 3850.2.

Marking

Identification: Identify all units with easily visible markings that will be hidden once the unit is installed, including the following:

- Date of manufacture.
- Manufacturer's name or registered mark and location of manufacture.
- Maximum mass of unit in kg.
- Batch number.
- Correct orientation of unit.

2.5 MISCELLANEOUS

Surface hardeners, sealants and protectors

Supply: If documented, provide proprietary products to the manufacturer's recommendations.

Polymeric film underlay

Standard: To AS 2870 clause 5.3.3.2.

Curing compounds

Standard: To AS 3799.

Liquid membrane-forming curing compound: Compatible with the following:

- The water retention requirements of AS 3799.
- The concrete, and any applied finishes, including toppings and render.
- The surface colour required for visually important surfaces.

2.6 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Quality verification: If material/product quality verification can be obtained from the supplier, documented tests need not be repeated.

3 EXECUTION

3.1 GROUND PREPARATION

Rock foundations

Minimum depth: Excavate a minimum depth of 150 mm, or as documented, into the rock for retaining walls, headwalls and wingwalls.

Mass concrete blinding

In-situ walls: Place a mass concrete blinding slab on the prepared subgrade before constructing wall footings.

Blinding thickness:

- Earth foundation: Minimum 50 mm.
- Rock foundation: Minimum 50 mm above the highest point of rock.

Restriction: Do not place forms or other materials on the blinding within 48 hours of the blinding being placed.

Base preparation

Requirement: Prepare base, as follows:

- Graded prepared subgrade: Blind with sand to create a smooth surface free from hard projections. Wet the sand just before laying the underlay, where documented.
- Concrete blinding: Remove projections above the plane surface, and any loose material.

Polymeric film underlay installation

General: Where documented, lay underlay over the base, as follows:

- Lap joints at least 200 mm and seal the laps and penetrations with waterproof adhesive tape.
- Face the laps away from the direction of concrete pour.
- Patch or seal punctures or tears before placing concrete.
- Cut back as required after concrete has gained strength and formwork has been removed.

3.2 FORMWORK

General

Standard: To AS 3610.1.

Robustness: Provide formwork of adequate strength to carry all applied loads, including the pressure of fresh concrete, vibration loads, weight of workers and equipment, without loss of shape.

Stripping: Provide forms that can be removed without causing damage to the completed structure.

Side forms: In earth excavations, provide side forms to prevent contact between concrete and the in-situ earth.

Corners above ground: Provide 25 mm bevelled fillet at re-entrant angles, and chamfer at corners.

Steel linings: Clean off any rust and apply rust inhibiting agent before use.

Design

General: The design of formwork is the contractor's responsibility.

Certification: For in-situ box culverts and retaining walls, obtain certification by a professional structural engineer, experienced in formwork design, verifying conformance of the design.

Fittings and embedments

Requirement: Make provision for the accurate location and firm support of fittings, bolts, anchorages and formers of holes and recesses, as documented.

Temporary fittings for the support of the formwork: Arrange to allow removal without damage to the concrete.

Embedments: Fix through formwork to prevent movement, or loss of slurry or concrete, during concrete placement.

Openings

Inspection: In vertical forms, provide form openings or removable panels for inspection and cleaning at the base of columns, walls and deep beams.

Access: For thin walls provide access hatches for placing concrete so that concrete does not fall a distance greater than 2 m.

Release agents

Application: Before placing reinforcement, apply a release agent to form linings and facings.

Staining: If commercial quality form oil or grease is used, make sure that surfaces to be exposed will not become stained or discoloured.

Application: Spread the coating uniformly in a thin film and remove any surplus before placing concrete.

Unlined timber forms: Wet the timber thoroughly before oiling.

Visually important surfaces

Surface finish classes 2 or 3: Set out the formwork to give a regular and symmetrical arrangement of panels, joints, bolt holes, and similar visible elements in the formed surface.

Formwork panels: Provide formwork for exposed surfaces from panels having uniform widths of not less than 1 m and uniform lengths of not less than 2 m, except where the dimensions of the member formed are less than these dimensions.

Plywood panels: Conform to the following:

- Orientation: Grain of the outer plies perpendicular to the studding or joists.
- Thickness: Not less than 15 mm thick, where attached directly to the studding or joists.
- Variations: If plywood less than 15 mm thick is used, provide a continuous backing of dressed material of 20 mm minimum thickness.

Mild steel form surfaces: Counter-sink all bolt and rivet heads and grind back all welds to an even and smooth surface.

Completed formwork

Certification: Obtain certification by a professional engineer, experienced in formwork design and construction, verifying conformance of the completed formwork, including the suitability of the formwork for the documented surface finish class.

3.3 STEEL REINFORCEMENT PLACEMENT

General

Fixing: To AS 3600 clause 17.2.5 and as documented.

Modifications

Requirement: Record any on-site modifications to the documented reinforcement, including position, splice location, spacing or cover, to accommodate concrete placement or the requirements of AS 3600.

Dowels

Fixing: If a dowel has an unpainted half, embed this in the concrete placed first.

Grade: 250 N.

Cover

Concrete cover generally: To AS 3600 clause 4.10.

Concrete cover for structures retaining liquids: To AS 3735 clause 4.4.

Supports

Requirement: Provide reinforcement supports, as follows:

- Able to withstand construction and traffic loads and maintain the concrete cover, as documented.
- With a protective coating if they are ferrous metal extending to the surface of the concrete.
- Use plastic or concrete supports with galvanized or zinc-coated reinforcement.

Spacing:

- Bars: ≤ 60 bar diameters.
- Mesh: ≤ 600 mm.

Supports over underlay: Prevent damage to polymeric film underlays. If appropriate, place a metal or plastic plate under each support.

Projecting reinforcement

Protection: If starter or other bars extend beyond reinforcement mats or cages, through formwork or from cast concrete, provide a plastic protective cap to each bar until it is cast into later work.

Tying

Requirement: Secure the reinforcement against displacement at intersections with either wire ties, or clips. Bend the ends of wire ties away from nearby faces of formwork or unformed faces to prevent the ties projecting into the concrete cover.

Beams: Tie stirrups to bars in each corner of each stirrup. Fix other longitudinal bars to stirrups at 1 m maximum intervals.

Mats: For bar reinforcement in the form of a mat, secure each bar at alternate intersections

Fibre reinforced concrete: To AS 3600 Section 16.

Welding

General: If welding of reinforcement is proposed, conform to AS/NZS 1554.3.

Bending

Restriction: Use only bars with bends as documented. If required to bend or straighten bars do not use heat and use only methods that will not damage the steel.

Splicing
Standard: To AS 3600 clause 13.2.

Lapped splices: Provide laps in reinforcing bars as documented and securely tie together in a minimum of two places.

Lapping of reinforcing mesh: Overlap each sheet of reinforcing mesh a minimum length of the spacing of the wires running perpendicular to the edge of the sheet, plus 25 mm.

Staggering: Stagger splices as documented.

Galvanizing repair
Damaged galvanizing: If galvanizing is damaged, propose repairs to AS/NZS 4680 Section 8.

3.4 CORES, FIXINGS AND EMBEDDED ITEMS

Fasteners
General: Install fasteners to manufacturers' recommendations and AS 5216 Appendix D.

Location
Requirement: Produce shop drawings showing the proposed locations, clearances and cover of any cores, fixings or embedded items, indicating any proposed repositioning or displacement of reinforcement.

Coring
Requirement: If cutting or coring of hardened concrete is proposed, prepare details.

Adjoining elements
Fixings: Provide fixings -for adjoining elements. If required, provide for temporary support to the adjoining elements during concreting, to prevent movement.

Protection
General: Grease threads. Protect embedded items against damage.

Compatibility: Provide inserts, fixings and embedded items that are compatible with each other, with the reinforcement and with the documented concrete mix and the documented surface finish.

Corrosion: In external or exposed locations, galvanize anchor bolts and embedded fixings.

Structural integrity
Position: Fix cores and embedded items to prevent movement during concrete placement. In locating cores, fixings and embedded items, displace but do not cut reinforcement, and maintain documented cover to reinforcement.

Isolation: Isolate embedded items to prevent water tracking to concrete providing minimum cover to reinforcement.

Tolerances
Requirement: Maximum deviation from correct positions:

- Anchor bolt groups for structural steel: To AS/NZS 5131.
- Cores and embedded items generally: 10 mm.
- Other fixing bolts: 3 mm.

3.5 PRE-MIXED CONCRETE SUPPLY

General
Addition of water: To AS 1379 clause 4.2.3.

Transport and production equipment: Use equipment which:

- Prevents segregation or loss of materials.
- Supplies a homogenous product suitable for placing and compaction.

Delivery information: For each batch, obtain a delivery docket and keep a record of the information required by AS 1379, and the following:

- Special class performance concrete: Documented performance and type of cement binder.
- Special class prescription concrete: Details of mix, additives, and type of cement binder.
- Method of placement and climate conditions during pour.
- Name of concrete delivery supervisor.
- Project assessment carried out each day.
- The concrete element or part of the works for which the concrete was ordered, and where it was placed.
- The total amount of water added at the plant and the maximum amount permitted to be added at the site.

Pre-mixed concrete subcontractors

Requirement: Compile a list of names and contact details of proposed pre-mixed concrete suppliers, and alternative source of supply in the event of breakdown of pre-mixed or site mixed supply.

Elapsed delivery time

General: Make sure that the e-lapsed time between the wetting of the mix and the discharge of the mix at the site is in conformance with the **elapsed delivery timetable**. Do not discharge at ambient temperature below 10°C or above 30°C unless approved heating or cooling measures are taken to deliver concrete within the range 5°C to 35°C.

Elapsed delivery timetable

Concrete temperature at time of discharge (°C)	Maximum elapsed time (minutes)
5 – 24	120
24 – 27	90
27 – 30	60
30 – 35	45

3.6 ON-SITE MIXING

Machine mixing

Requirement: Mix all materials by machine, conforming to the following:

- Mixer requirements: Use a mixer which will uniformly distribute the materials throughout the batch.
- Mixer capacity: Use a mixer with capacity for one or more whole bags of cement to be used per batch of concrete. Do not exceed the manufacturer's rated capacity of the mixer with the volume of the mixed material.
- Mixing time: Allow a mixing time for each batch of not less than 1.5 minutes after all ingredients are assembled in the mixer, and before any portion of the batch is removed.
- Total mix discharge: Discharge the entire contents of a batch from the mixer before placing any new materials in the mixer for the next batch.

Emergency hand mixing

Restrictions: Hand mixing is only permitted if there is a breakdown of mechanical mixing equipment. Provide notice if hand mixing is required and conform to the following:

- Hand mix in small quantities no greater than 0.25 m^3 per batch, to complete a section of the work or reach a suitable construction joint. Do not start a new section of work.
- Hand mix on a water-tight platform of sufficient size to allow the mixing of at least two batches simultaneously. Use an amount of cement 10% more than required for machine mixed concrete.

Procedure: Conform to the following:

- First mix the fine aggregate and cement until a uniform colour is obtained, and then spread on the mixing platform in a thin layer.
- Spread the coarse aggregate, previously drenched with water, over the fine aggregate and cement in a uniform layer and turn the whole mass over as further water is added with a rose sprinkler.
- After the water is added, turn the mass at least three times, not including shovelling into barrows or forms, until the mixture is uniform in colour and appearance.

Measurement of materials

General: Measure all materials by weight, except if necessary:

- Water: Measure by volume with an approved adjustable water-measuring and discharging device.
- Cement: Measure by bags as packed by the manufacturer. Proportion batches on the basis of one or more unbroken bags of cement, assumed to weigh 40 kg per bag.

Bulk cement: Weigh in an individual hopper and keep separate from the aggregates until the components of the batch are discharged from the batching hopper.

Measurement by volume for minor works: Not permitted, without approval.

Measuring by volume: Minor concrete works only

Mixing by volume on site: If measurement by volume is approved, proportion the materials to produce a mix free of voids and having the documented strength at 28 days.

Volume batching: Use the nominal proportions documented in the **Volume batching table**.

Volume batch table

MPa	Parts by volume		
	Cement	Fine aggregate	Coarse aggregate
20	1	2	3

Fine aggregate bulking: If the fine aggregate contains sufficient moisture to produce ‘bulking’ in excess of 10%, increase the volume of fine aggregate by a corresponding amount.

Batch measurement: Measure the volumes of fine and coarse aggregates for each batch in boxes or bins, as follows:

- Measure the aggregates loose (i.e. without compaction) in the boxes and strike off level.
- Do not undertake measurements by shovels or like methods.
- Arrange batch proportions for each batch to contain 1 bag of cement. Assume one 40 kg bag of cement to have a volume of 27.5 litres.

3.7 PLACING AND COMPACTION

Preparation

Cleaning: Before placing concrete, remove free water, dust, debris and stains from the area, the forms and the formed space.

Water: Moisten the area before placing concrete: Remove any ponding water.

Placing

Method: Avoid segregation and loss of concrete and minimise plastic settlement. Maintain a nominally vertical and plastic concrete edge during placement.

Horizontal elements: Place concrete in layers not more than 300 mm thick. Compact the following layer into previous layer before previous layer has taken initial set.

Vertical elements: Limit the free fall of concrete to a maximum of 2 m.

Compaction

Methods: Use immersion and screed vibrators accompanied by hand methods as appropriate to remove entrapped air and to fully compact the mix.

Vibrators: Do not allow vibrators to contact set concrete, reinforcement or items including pipes and conduits embedded in concrete. Do not use vibrators to move concrete along the formwork. Avoid causing segregation by over-vibration.

Placing records

Logbook: Keep on site and make available for inspection a log book recording each placement of concrete, including the following:

- Date.
- Specified grade and source of concrete.
- Slump measurements.
- The portion of work.
- Volume placed.

Rain

Protection: During placement and before setting, protect the surface from damage.

Time between adjacent placements

General: As documented in the **Minimum time delay schedule**.

Placing in cold weather

Cement: Do not use high alumina cement.

Temperature limits: Maintain the following temperature limits:

- Freshly mixed concrete: ≥ 5°C.
- Formwork and reinforcement before and during placing: ≥ 5°C.
- Water: Maximum 60°C when placed in the mixer.

High early strength cement: If deteriorating weather conditions are predicted, use high early strength cement.

Temperature control: Heat the concrete materials, other than cement, to the minimum temperature necessary so that the temperature of the placed concrete is ≥ 5°C.

Admixtures: Do not use calcium chloride, salts, chemicals or other material in the mix to lower the freezing point of the concrete.

Frozen materials: Do not allow frozen materials or materials containing ice to enter the mixer, and keep free of frost and ice any formwork, materials, and equipment coming in contact with the concrete.

Freezing: Prevent concrete from freezing.

Placing in hot weather

Handling: Prevent premature stiffening of the fresh mix and reduce water absorption and evaporation losses.

Temperature limits: Maintain freshly mixed concrete at the following temperature limits:

- Normal concrete in footings, walls, slabs, culverts and drainage structures: ≤ 35°C.
- For concrete strength grade less than 40 MPa, with section thickness ≥ 1 m in all dimensions: ≤ 27°C.
- For concrete strength grade 40 MPa or greater, with section thickness ≥ 600 mm in all dimensions: ≤ 27°C.
- Formwork and reinforcement before and during placing: ≤ 35°C.

Evaporation control barriers: Erect barriers to protect freshly placed concrete from drying winds.

Temperature control: Select one or more of the following methods of maintaining the temperature of the placed concrete at 35°C or less:

- Cool the concrete using liquid nitrogen injection before placing.
- Cover horizontal transport containers.
- Spray the coarse aggregate using cold water before mixing.
- Use chilled mixing water or ice.

Placing under water

General: Do not place under water unless conditions prevent dewatering.

Minimum cement content for the mix: Increase by 25%.

Method: Prepare a detailed method statement if proposing to place concrete under water.

Extruded concrete

Surface slurry: Where the extrusion machine is equipped with a slurry receptacle place small quantities of cement-sand slurry, comprising two parts plasterer's sand and one part cement (by volume), together with sufficient water to bring it to a semi-fluid condition, and feed onto the surface of the concrete at a rate sufficient to produce a smooth and uniform finish.

3.8 CURING

General

Requirements: Taking into account the average ambient temperature at site over the relevant period affecting the curing, adopt procedures to make sure of the following:

- Curing: Cure continuously from completion of finishing when the concrete has set sufficiently not to be damaged by the curing process, until the total cumulative number of days or fractions of days, during which the air temperature in contact with the concrete is above 10°C, conforms to the following, unless accelerated curing is adopted:
  - . High early strength concrete: 3 days.
  - . Other concrete: 7 days.
- End of curing period: Prevent rapid drying out at the end of the curing period.
- Protection: Maintain at a reasonably constant temperature with minimum moisture loss, during the curing period.

Curing compounds

Application: Provide a uniform continuous flexible coating without visible breaks or pinholes, which remains unbroken at least for the required curing period after application.

Substrates: Do not use wax-based or chlorinated rubber-based curing compounds on surfaces forming substrates to applied finishes, concrete toppings and cement-based render.

Self-levelling toppings: If used also as curing compounds, conform to AS 3799.

Visually important surfaces: Apply curing compounds to produce uniform colour on adjacent surfaces.

Cold weather curing

Temperature: Maintain concrete surface temperatures above 5°C for the duration of the curing period.

Hot weather curing

Requirement: If the concrete temperature exceeds 25^0C, or the ambient shade temperature exceeds 30^0C, protect from drying winds and sun by using an evaporative retarder until curing is commenced.

Water curing

Method: Select a method of ponding or continuously sprinkling to prevent damage to the concrete surface during the required curing period.

3.9 JOINTS

Construction joints

Location: Do not relocate or eliminate construction joints, or form undocumented construction joints. If emergency construction joints are made necessary by unforeseen interruptions to the concrete pour, provide details of the action taken.

Finish: Butt join the surfaces of adjoining pours. In visually important surfaces make the joint straight and true, and free from blemishes impermissible for its surface finish class.

Preparation: Roughen and clean the hardened concrete joint surface. Remove loose or soft material, free water, foreign matter and laitance. Dampen the surface just before placing the fresh concrete and coat with a neat cement slurry.

Expansion joints

Joint filling: Fill with jointing materials as documented. Finish visible jointing material neatly flush with adjoining surfaces.

Preparation: Before filling, dry and clean the joint surfaces, and prime.

Watertightness: Apply the jointing material so that joints subject to ingress of water are made watertight.

Jointing materials: Provide jointing materials compatible with each other, and non-staining to concrete in visible locations.

Bond breaking: Provide back-up materials for sealants, including backing rods, which do not adhere to the sealant.

Foamed materials (in compressible fillers): Closed-cell or impregnated, not water absorbing.

3.10 FORMED SURFACES

General

Surface finish: Provide formed concrete finishes as documented in the **Formed surface finishes schedule** and conforming to AS 3610.1 Table 3.3.2.

Formwork removal

Extent: Remove all formwork, including formwork in concealed locations, but excepting lost formwork.

Timing: Do not damage concrete works through premature removal of formwork. Do not disturb forms until concrete is hardened enough to withstand formwork movements and removal without damage. It is recommended to maintain all formwork in place, after placement of concrete, for the following minimum periods, provided that the ambient air temperature does not drop below 10°C during that period:

- Mass concrete retaining walls, headwalls, wingwalls, gully pits, sumps and similar drainage structures: 2 days.
- Reinforced concrete walls when height of pour each day is:
  . Under 0.6 m: 1 day.
  . 0.6 m to 3 m: 2 days.
  . 3 m to 6 m: 3 days.
  . 6 m to 9 m: 5 days.
- Supporting forms under deck slabs of culverts: 10 days.

Concrete containing special additives: In case of concrete containing special additives, confirm that the recommended stripping times are still appropriate.

Protection of concrete during form removal: Remove forms so that the concrete will not be cracked, chipped or otherwise damaged. Do not use crowbars or other levering devices for exerting pressure on the fresh concrete to loosen the forms.

Removal of hole formers: Remove hole formers such as pipes and bars as soon as the concrete has hardened sufficiently to prevent damage to the concrete.

Curing

General: If formwork is stripped before the minimum curing period continue curing the exposed faces until the curing period elapses.

Repair of defects

Physical quality evaluation: To AS 3610.1 clause 3.3.

Repair method: If defect repair is required, obtain approval of the proposed method before commencing repairs.

3.11 UNFORMED SURFACES

General

Surface finish: To be compatible with any documented applied finish, as documented.

Finished levels: Strike off, screed and level slab surfaces to the documented finished levels and tolerances.

Finishing methods – surfaces other than wearing surfaces

General: Compact and tamp, screed off and finally dress with a wooden float to an even surface, also:

- Drain or otherwise promptly remove any water which comes to the surface.
- Roughen all future contact surfaces, so that the coarse aggregate at the surface is firmly embedded but not forced below the surface.

Finishing methods – wearing surfaces

General: Compact then screed off the surface with a vibrating screed, or hand screed if the distance between forms perpendicular to the direction of screed is no greater than 2 m.

Correction: Immediately following compaction and screeding test and correct for high or low spots.

Final finish: Finish the surface true and uniform and free of any glazed or trowelling finish and finally dress with a wooden template or float.

Surface to receive asphalt: After compacting, screeding and correcting, dress with a wooden float and finally broom to produce a rough surface.

Textured patterned surface: Finish coloured, textured or patterned surfaces, as documented.

Tolerances
Finished surface: Conform to the following maximum deviations from documented values:

- Concrete structures not adjacent to road pavements:
  . Absolute level: ± 25 mm.
  . Alignment: 25 mm.
- Concrete structures adjacent to road pavements (e.g. drainage pits):
  . Absolute level: ± 10 mm.
  . Alignment: 10 mm.
- Longitudinal surfaces greater than 10 m in length: 5 mm from a 3 m straightedge, subject to any necessary allowances for vertical and horizontal curves.

Surface repairs
Method: If surface repairs are required, obtain approval of the proposed method before commencing repairs.

3.12 PRECAST UNITS

Lifting and handling
General: Conform to the handling and installation requirements of the ASCC National code and AS 3850.2.

Requirement: Lift and support units only at designated points. Use handling methods which do not overstress, warp or damage the units.

Site conditions: Only lift units when the wind and temperature conditions allow handling and fixing consistent with the structural capability and geometry of the unit.

Cranes: To AS 2550.1.

Temporary bracing and propping: To AS 3850.2 Section 5.

Attachments
Requirement: Remove temporary attachments after erection. Seal and rectify residual recesses.

Installation
Fixing: Fix the units securely and accurately in their final positions to AS 3850.2 Section 6.

Ancillaries: Provide components and materials, including fasteners, braces, shims, jointing strips, sealant, flashings, grout and mortar, necessary for the installation of the units.

Storage
Support points: When storing elements support units only at designated support points.

Protection: Adequately store and protect units to prevent warping, twisting, crushing, cracking, discolouration, staining and any other damage, until they are installed in their final location.

3.13 SPRAYED CONCRETE

Detail
Minimum thickness: 75 mm.

Colour: Spray coloured concrete lining in open drains to match the adjoining rock colour.

Strength
Minimum cement content: 380 kg/m^3 as discharged from the nozzle.

Minimum compressive strength: 25 MPa at 28 days when tested by means of 75 mm diameter cores taken from in-place sprayed concrete.

Method statement
Requirement: Prepare a method statement for all sprayed concrete works to include details of the proposed procedure, plant, materials and mix proportions.

Sprayed concrete sample panels
Requirement: Prepare sample sprayed concrete test panels on 750 mm square hardboard panels as follows:

- Quantity: 3 panels for each mix proposed.
- Thickness: 75 mm.
- Conditions: Similar to those where works will take place.
- Method: Apply concrete in the same manner, using materials including steel reinforcing fabric, equipment, pressures and curing that will be used in the works.

Sample test cores
Securing, accepting and preparing test specimens: To AS 1012.9.

Testing: To AS 1012.14.

Cores: Cut four 75 mm diameter cores from one test panel for each proposed mix approximately 48 hours after the panel has been sprayed and test as follows:

- As for cores from in-situ sprayed concrete. One core compression test at 3 days, one core at 7 days and the remaining two cores at 28 days.

Defective core: If any of the cores reveals defects such as lack of compaction, dry patches, voids or sand pockets or exhibits an unacceptable surface finish, modify the mix design and/or method of placement and prepare fresh test panels for testing and inspection.

Surface preparation
Earth: Grade, trim, compact and dampen earth surfaces before applying the sprayed concrete. Take any necessary precautions to prevent erosion when the sprayed concrete is applied.

Rock: Clean off loose material, mud and other foreign matter that might prevent bonding of the sprayed concrete onto the rock surface. Dampen the rock surfaces before applying the sprayed concrete.

Corrugated steel pipes: Clean off loose material, mud and any other foreign matter that might prevent bonding of the sprayed concrete to the steel.

Water flow: Remove free water and prevent the flow of water which could adversely affect the quality of the sprayed concrete.

Application for sprayed concrete
Procedure: Begin application at the bottom of the area being sprayed and build up making several passes of the nozzle over the working area.

Technique: Hold the nozzle so that the stream of material is as near as possible to perpendicular to the surface being coated.

Spraying around reinforcement: If spraying around reinforcement, spray concrete behind the reinforcement before concrete can accumulate on the face of the reinforcement.

Protection of adjoining surfaces: Protect adjoining surfaces not requiring sprayed concrete from splash and spray rebound.

Regulation: Regulate the velocity of discharge from the nozzle, the distance of the nozzle from the surface and the amount of water in the mix so as to produce a dense coating with minimum rebound of the material and no sagging.

Rebound: After the initial set, as work proceeds, remove and dispose of splash and rebound material from the surface by air-water jet or other suitable means.

Wind problems: If wind causes separation of the nozzle stream, discontinue spraying.

Air temperature: If air temperature is less than 5°C, do not spray.

Construction joints

General: Keep construction joints to a minimum.

Forming: Form joint by placing or trimming the sprayed concrete to an angle between 30° and 45° to the sprayed concrete surface.

Preparation: Clean and wet by air-water jet the joint edge before recommencing concrete spraying.

Curing

Commencement: Commence curing within one hour of the application of sprayed concrete with water or colourless wax emulsion curing compound conforming to AS 3799 and applied to conform to manufacturer's specifications.

Water curing: If water curing, keep the surface of the sprayed concrete continuously wet for at least seven days.

3.14 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Concrete tests

Slump: To AS 1379 clause 5.2.

Test sample location: Spread the site sampling evenly throughout the concrete placement.

Sampling frequency: Provide a minimum of one sample from each 50 m^3 of concrete.

Cores and test acceptance

General: If test specimens fail to achieve the documented 28 day strength, arrange for cores to be taken from the corresponding concrete to AS 3600 clause B6 and nominate proposed core locations.

Acceptance: For acceptance, demonstrate conformance of the average strength of cores with the documented 28 day strength requirements to AS 3600 clause B6.

Failure of cores

Deduction: If cores taken fail to satisfy the strength requirements, apply the deduction provisions in **ANNEXURE – DEDUCTIONS**.

Completion tests

Liquid retaining structures: Liquid tightness to AS 3735.

3.15 COMPLETION

Loading

Prohibition: Do not apply any superimposed load to any part of what will become a load bearing structure within 21 days of placing concrete, unless it can be demonstrated that 95% of the design strength of the concrete has been achieved.

Protection

Protection: Protect the concrete from damage due to construction load over-stresses, physical and thermal shocks, and excessive vibrations, particularly during the curing period.

Surface protection: Protect finished concrete surfaces and applied finishes from damage.

4 ANNEXURES

4.1 ANNEXURE - SELECTIONS

Normal-class concrete properties schedule

Property	Foundations, mass concrete retaining walls	Drainage structures, mass concrete footings, pitching, linings, miscellaneous minor concrete work	Reinforced culverts, headwalls, base slabs, large sign structure footings, reinforced retaining walls	Safety barriers	Extruded concrete
Strength grade/characteristic compressive strength f'_c (MPa)	20	20	32	40	20
Maximum aggregate size (mm)	40	20	20	20	14
Slump (mm)					
Air entrainment - air volume (%)					
Assessment process					

Special-class concrete properties schedule

Property	A	B	C
Strength grade/characteristic compressive strength f'_c (MPa)			
Maximum aggregate size (mm)			
Slump (mm)			

Property	A	B	C
Air entrainment - air volume (%)			
Assessment process			
Drying shrinkage			
Bleeding (mL/mm^2)			
Cement type			
Density of hardened concrete (kg/m^3)			
Density of plastic concrete (kg/m^3)			
Duration of air drying			
Early age strength (MPa)			
Flexural strength (MPa)			
Indirect tensile strength (MPa)			
Mineral oxide content			
Mix type			
Water:cement ratio maximum			

Steel reinforcement properties schedule

Property	A	B	C
Shape			
Ductility class			
Strength grade			

Minimum time delay schedule

Between (pour locations)	Minimum period between adjacent pours (days)
Adjacent pours abutting horizontal construction joints in walls	
Adjacent pours abutting vertical construction joints in walls	

Between (pour locations)	Minimum period between adjacent pours (days)
Floor slab construction joints	
Pour strips and adjacent concrete	
Retaining wall construction joints	

Formed surface finishes schedule

Property	A	B	C
Location			
Surface finish class to AS 3610.1			
Form lining type			
Colour control			
Bolt hole filling			
Surface finish type			

4.2 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Certification Design	H	Certification of formwork design conformance	3 days before erecting formwork	Erection of formwork
SUBMISSIONS, Certification Completed formwork	H	Certification of completed formwork conformance	1 day before placing concrete	Placement of concrete
SUBMISSIONS, Tests Loading	H	Results to show that concrete has achieved 95% of its design strength	1 day before applying superimposed load	Application of super-imposed load
SUBMISSIONS, Execution details Coring	H	Details of any proposed cutting or coring required in hardened concrete	3 days before coring concrete	Concrete coring
SUBMISSIONS, Products and materials Machine mixing	H	Details of proposed concrete mix for on-site machine mixing of concrete	7 days before on-site concrete mixing	On-site concrete mixing

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Execution details Measurement of materials	H	Proposal to measure materials by volume for on-site mixing for minor concrete works	7 days before on-site concrete mixing	On-site concrete mixing
SUBMISSIONS, Execution details Repair of defects	H	Details of the proposed method of defect repair	3 days before repairing defect	Repair of defect
SUBMISSIONS, Execution details Surface repairs	H	Details of the proposed method of surface repair	3 days before repairing surface	Repair of surface
SUBMISSIONS, Execution details Method statement	H	Detailed method statement for sprayed concrete works	14 days before spraying concrete	Sprayed concrete works
SUBMISSIONS, Samples Sprayed concrete	H	3 sample panels for each proposed mix	10 days before spraying concrete for works	Sprayed concrete works
INSPECTIONS, Notice Base preparation	W	Completed and prepared base	1 day before laying underlay or placing concrete	-
INSPECTIONS, Notice Completed formwork	W	Completed formwork	1 day before placing concrete	-
INSPECTIONS, Notice Steel reinforcement placement	W	Completed installed steel reinforcement, including cores fixings and embedded items fixed in place	1 day before placing concrete	-
INSPECTIONS, Notice Galvanizing repair	W	Repairs to damaged galvanizing of steel reinforcement	1 day before placing concrete	-
INSPECTIONS, Notice Emergency hand mixing	W	Emergency hand mixing of concrete due to mechanical failure	Immediately after mechanical failure	-
INSPECTIONS, Notice Sprayed concrete sample panels	W	Concrete spraying of sample panels	3 days before spraying sample panels	-
*H = Hold Point, W = Witness Point				

4.3 ANNEXURE – MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Concrete constituent materials	Material quality – Supplier's documentary evidence and certification of:			
	Cement	1 mth's prod'n	1 per week	AS 3972
	Fly ash	1 mth's prod'n	1 per month	AS 3582.1
	Water	1 contract	1 per contract	AS 3583.13, AS 1289.4.2.1
	Admixtures	1 mth's prod'n	1 per month	AS 1478.1
	Steel reinforcement	1 delivery	1 per production batch	AS/NZS 4671
	Fine aggregates			
	Grading	1 wk's prod'n	1 per 200 m^3 concrete*	AS 1141.11.1
	Moisture content	N/A	1 per day	
	Sulphate soundness	1 contract	1 per contract	AS 1141.24
	Bulk density	1 contract	1 per contract	AS 2758.1
	Unit mass (Particle density)	1 contract	1 per contract	AS 2758.1
	Water absorption	1 contract	1 per contract	AS 2758.1
	Material finer 2 m	1 contract	1 per contract	AS 2758.1
	Deleterious material (impurities/reactive)	1 contract	1 per contract	AS 2758.1
	Coarse aggregates			
	Grading	1 wk's prod'n	1 per 200 m^3 concrete*	AS 1141.11.1
	Moisture content	N/A	1 per day	
	Wet strength	1 contract	1 per contract	AS 1141.22
	Wet/dry strength variation	1 contract	1 per contract	AS 1141.22
	Wear	1 contract	1 per contract	AS 1141.23
	Crushing value	1 contract	1 per contract	AS 1141.21
	Sulphate soundness	1 contract	1 per contract	AS 1141.24
	Particle shape	1 contract	1 per contract	AS 1141.14
	Fractured faces	1 contract	1 per contract	AS 1141.18
	Bulk density	1 contract	1 per contract	AS 2758.1
	Unit mass (Particle density)	1 contract	1 per contract	AS 2758.1
	Water absorption	1 contract	1 per contract	AS 2758.1
	Material finer 75 m	1 contract	1 per contract	AS 2758.1
	Weak particles	1 contract	1 per contract	AS 2758.1
	Light particles	1 contract	1 per contract	AS 2758.1

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
	Deleterious materials (impurities/reactive)	1 contract	1 per contract	AS 2758.1
	Iron unsoundness	1 contract	1 per contract	AS 2758.1
	Falling/dusting unsoundness	1 contract	1 per contract	AS 2758.1
Mix design	Compressive strength	1 contract mix	1 per mix per contract	AS 1012.9
	Aggregate moisture content	1 contract mix	1 per mix per contract	
	Consistency – slump	1 contract mix	1 per mix per contract	AS 1012.3.1
	Air content	1 contract mix	1 per mix per contract	AS 1012.4.2 Method 2
	Shrinkage	1 contract mix	1 per mix per contract	AS 1012.8.4AS 1012.13
Concrete	Consistency – slump	15 m³	1 per batch	AS 1012.3.1
	Compressive strength (7 and 28 day)	15 m³	As per the **Project assessment strength grade sampling table**	AS 1012.1 AS 1012.8.1 AS 1012.9
Concrete placement	Finished levels	15 m³	1 per element or 1 per 15 m length	Survey and 3 m straightedge
	Surface dimensions	Single fabrication	As required to confirm design dimensions	Measure
Sprayed concrete	Test panels and cores	1 contract	4 cores from 1 test panel of each mix design	AS 1012.9 AS 1012.14
	Compressive strength cores	15 m³	2 per 15 m³	AS 1012.9 AS 1012.14
* Note: or part thereof, per lot.				

4.4 ANNEXURE - PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
0319.1 20 MPa Concrete works	m³ of concrete supplied and placed	Include all operations involved in ground preparation, formwork, concrete supply, placement, compaction, joints, finishing, curing and testing. Where documented, include the supply and placement of reinforcing steel.
0319.2 32 MPa Concrete works	m³ of concrete supplied and placed	Include all operations involved in ground preparation, formwork, concrete supply, placement,

Pay items	Unit of measurement	Schedule rate scope
		compaction, joints, finishing, curing and testing. Where documented, include the supply and placement of reinforcing steel.
0319.3 40 MPa Concrete works	m^3 of concrete supplied and placed	Include all operations involved in ground preparation, formwork, concrete supply, placement, compaction, joints, finishing, curing and testing. Where documented, include the supply and placement of reinforcing steel.
0319.4 Precast units	'Each' precast unit, as documented	All costs associated with the supply and installation of the precast unit.
0319.5 Sprayed concrete	m^2 of sprayed concrete in place	Include all the operations involved in the surface preparation, spraying, jointing, removal of splash and rebound material, curing and testing.

4.5 ANNEXURE - DEDUCTIONS

General

Deductions: Conform to the following:

- Concrete payment rates: At the scheduled rates provided the concrete meets the documented strength requirements.
- Reduction in payment rates: Where any concrete does not reach the documented strength, at the scheduled rate of payment reduced by 2% for each 1%, or fraction thereof, by which the strength of the specimen fails to reach the documented strength, up to a maximum deficiency of 10%.
- Rejection: If the deficiency in strength exceeds 10%, the concrete represented by the specimens may be rejected, in which case no payment will be made for the work nor for any remedial work to rectify the deficiency.

4.6 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1012		Methods of testing concrete
AS 1012.1	2014	Sampling of concrete
AS 1012.3.1	2014	Determination of properties related to the consistency of concrete - Slump test
AS 1012.4.2	2014	Determination of air content of freshly mixed concrete - Measuring reduction in air pressure in chamber above concrete
AS 1012.8.1	2014	Method for making and curing concrete - Compression and indirect tensile test specimens
AS 1012.8.4	2015	Method for making and curing concrete - Drying shrinkage specimens prepared in the field or in the laboratory
AS 1012.9	2014	Compressive strength tests - Concrete, mortar and grout specimens

AS 1012.13	2015	Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory
AS 1012.14	2018	Method for securing and testing cores from hardened concrete for compressive strength
AS 1141		Methods for sampling and testing aggregates
AS 1141.11.1	2009	Particle size distribution - Sieving method
AS 1141.14	2007	Particle shape, by proportional caliper
AS 1141.18	1996	Crushed particles in coarse aggregate derived from gravel
AS 1141.21	2007	Aggregate crushing value
AS 1141.22	2008	Wet/dry strength variation
AS 1141.23	2009	Los Angeles value
AS 1141.24	2018	Aggregate soundness - Evaluation by exposure to sodium sulphate solution
AS 1289		Methods of testing soils for engineering purposes
AS 1289.4.2.1	1997	Soil chemical tests - Determination of the sulphate content of a natural soil and the sulphate content of the groundwater - Normal method
AS 1379	2007	Specification and supply of concrete
AS 1478		Chemical admixtures for concrete, mortar and grout
AS 1478.1	2000	Admixtures for concrete
AS/NZS 1554		Structural steel welding
AS/NZS 1554.3	2014	Welding of reinforcing steel
AS/NZS 2425	2015	Bar chairs in reinforced concrete - Product requirements and test methods
AS 2550		Cranes, hoists and winches - Safe use
AS 2550.1	2011	General requirements
AS 2758		Aggregates and rock for engineering purposes
AS 2758.1	2014	Concrete aggregates
AS 2870	2011	Residential slabs and footings
AS/NZS 3582		Supplementary cementitious materials
AS/NZS 3582.1	2016	Fly ash
AS 3582.2	2016	Slag - Ground granulated blast-furnace
AS/NZS 3582.3	2016	Amorphous silica
AS 3583		Methods of test for supplementary cementitious materials for use with Portland cement
AS 3583.13	1991	Determination of chloride ion content
AS 3600	2018	Concrete structures
AS 3610		Formwork for concrete
AS 3610.1	2018	Specifications
AS 3735	2001	Concrete structures retaining liquids
AS 3799	1998	Liquid membrane-forming curing compounds for concrete
AS 3850		Prefabricated concrete elements
AS 3850.1	2015	General requirements
AS 3850.2	2015	Building construction
AS 3972	2010	General purpose and blended cements
AS/NZS 4671	2001	Steel reinforcing materials
AS/NZS 4680	2006	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 5131	2016	Structural steelwork - Fabrication and erection
AS 5216	2018	Design of post-installed and cast-in fastenings in concrete
AS 6669	2016	Plywood - Formwork
ASCC	2008	National Code of Practice for Precast, Tilt-up and Concrete Elements in Building Construction
CIA CPN35	2003	Fibres in concrete
EN 14889		Fibres for concrete
EN 14889-1	2006	Steel fibres. Definitions, specifications and conformity

1101 TRAFFIC MANAGEMENT

1 GENERAL

1.1 RESPONSIBILITIES

General

Traffic management: Provide management for the safe movement of traffic and the protection of persons or property through and/or around the work site. Construct the Works with the least possible obstruction to traffic.

Authority requirements: This work-section does not override any applicable State or Local Government legislation and is to be read in conjunction with AS 1742.3 and the applicable State Road Authority traffic management specification.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1102 Control of erosion and sedimentation (Construction)*.
- *1111 Clearing and grubbing*.
- *1112 Earthworks (Road reserve)*.
- *1121 Open drains* .
- *1141 Flexible pavement base and subbase.*
- *1143 Sprayed bituminous surfacing.*
- *1144 Asphalt (Roadways).*
- *1195 Rigid road safety barrier systems*.
- *1194 Non-rigid road safety barrier systems*.
- *1351 Stormwater drainage (Construction)*.
- *1352 Pipe drainage*.
- *1354 Drainage structures*.

1.3 STANDARDS

General

Traffic control: To AS 1742.3 for works on or adjacent to roads.

1.4 INTERPRETATION

Definitions

General: For the purposes of this work-section the following definitions apply:

- Competent person: A person who has, through a combination of training, qualification and experience, acquired knowledge and skills enabling that person to correctly perform a specified task.
- Road safety barrier system: A physical barrier separating the work area and the travelled path, designed to resist penetration by an out of control vehicle and as far as reasonably practicable, to redirect out of control vehicles back into the travelled path.
- Traffic control plan (TCP): A drawing showing signs and devices arranged to warn traffic and to guide it around, past or, if necessary, through a work site or temporary hazard.
- Traffic controller: A person whose duty is to control traffic at a work site.

- Traffic management plan (TMP): A set of procedures, which may include drawings, showing how traffic is to be managed during construction. The plan describes the proposed work activities, their impact on the roadway and road users, and how these impacts are being addressed.
- Vehicle movement plan (VMP): A drawing showing the preferred travel paths for vehicles associated with a work site entering, leaving or crossing the through traffic stream.

1.5 SUBMISSIONS

Authority approvals

Requirement: Submit details of all authority approvals before commencing the works for which the approval is granted, including the following:

- Plan(s): Submit evidence of approvals from Councils and other authorities for temporary traffic arrangements.

Temporary speed zoning: Submit evidence of approval of temporary speed zoning requirements from the Local Traffic Committee and/or State road authority.

Execution details

Plan(s): Submit the plan(s) as required in **ANNEXURE – PROJECT PLAN REQUIREMENTS** conforming to the following:

- Plan requirements: Conform to **PRE-CONSTRUCTION PLANNING**, as appropriate.
- Access: Include proposal of alternative access to roads and properties for vehicles and pedestrians for work affecting side roads and existing accesses.
- Construction under traffic: If required, include traffic arrangements details and methods for traffic control.

Records

Traffic controllers: Submit names of proposed traffic control personnel with a signed declaration that they are appropriately trained in the traffic control duties to AS 1742.3 clause 4.10.6.

1.6 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Temporary roadways and detours: Completed stormwater drainage, wearing surface and linemarkings, and street lighting.
- Traffic control signs and devices: Completed installation including signals, safety barriers and containment fences.
- Plant delineation: If plant encroaches on traffic travel paths, completed installation of warning devices.
- Access: Completed alternative access for vehicles and pedestrians.
- Opening temporary roadways and detours to traffic: Completed roadway/detour and associated control measures.
- Opening completed work: Reinstatement of the area affected by the Works.

2 PRE-CONSTRUCTION PLANNING

2.1 TRAFFIC MANAGEMENT

Traffic management plan (TMP)

Plan components: Prepare a TMP with the following:

- Traffic staging plan: If required, include details of the traffic staging arrangement and the time periods when each stage is in operation.
- Identify level of management provisions.

- Risk assessment: Identify and address risks associated with road safety, traffic management and road network issues specific to the site.
- Traffic control plan(s).
- Vehicle movement plan(s) showing travel paths for vehicles including for delivery, personnel and contractor's vehicles.
- Provisions for access to adjoining properties affected by the Works.
- Safe passage measures for workers/personnel, pedestrians and cyclists.
- Temporary speed zoning changes.
- Design drawings for temporary roadways and detours, including alignment and surface levels, pavement width and cross section, wearing surface and drainage details.
- Names and contact details of personnel responsible for the maintenance of traffic control devices and temporary roadways outside normal working hours. Include evidence that these details have been provided to the local police.

Plan preparation: Use a competent person to prepare the TMP.

Site copy: Keep a copy of the approved TMP on-site at all times. Use the plan for maintaining traffic control devices and to check traffic arrangement.

Level of management provisions

Requirement: Conform to one of the following levels of provisions to AS 1742.3 clause 2.2.1:

- Short term and mobile works not involving full or part road closure.
- Works involving relatively simple part-roadway closures.
- Works involving complex traffic arrangements or staged works or both.

Traffic control plan (TCP)

Requirement: Prepare a TCP showing the following, as appropriate:

- Types and locations of permanent regulatory and advisory signs.
- Types and locations of temporary signs, including advance warning signs and speed zone signs.
- Pavement marking details, including types of delineation required, turning arrows, stop/holding lines and other road markings, types and positions of raised pavement markers and other delineation devices.
- Locations of permanent and temporary traffic signals.
- Locations and lengths of tapers and buffer zones.
- Locations of traffic controllers.
- Locations of entry and exit gates to the working areas, individually numbered and signposted.
- Pedestrian and cyclist paths.
- Details of side roads and access for adjoining properties and parking.
- Locations of safety barriers, barrier systems and end terminals.
- Locations of temporary lighting.

Road Authority delegation: Ensure that persons preparing or approving a TCP have Road Authority delegation.

Signage

Signage application/function: In the TCP, provide signs for the following:

- Protection of workers.
- To adequately warn of changes in surface condition and the presence of personnel or plant engaged in work on the road.
- For safely guiding road users through, around or past the work site.

Safety barriers

Location: To AS 1742.3 clauses 2.4.5 and 3.10.3, and at temporary embankments where the vertical height between the edge of the shoulder and the intersection of the embankment slope and natural surface exceeds 2 m.

Temporary embankment barriers: Corrugated steel or precast concrete safety barriers.

Road safety audit

Safety audits: If required, arrange for a commencement meeting, with the road safety auditor present, before implementing any traffic control measure to determine inspection points for auditing.

Audit report: After auditing of the TMP/TCP and receipt of the audit report, obtain directions for amending the plan documents. If amendment is required, obtain approval of revised documents before implementing control measures.

2.2 TEMPORARY ROADWAY DESIGN

Design standards

Requirement: If temporary roadways and detours or adjustments to existing lane configurations are required, design roadways conforming to the following:

- Design parameters: To **ANNEXURE** – **TEMPORARY ROADWAYS** and the recommendations of Austroads AGRD03 for alignment and grading.
- Intersections, interchanges and crossings: To the recommendations of Austroads AGTM06.

Stormwater drainage

Design frequency: Provide drainage system to prevent run-off water overflowing on the road surface in any storm of intensity less than 1 in 5 year occurrence. Make sure the drainage system does not cause water ponding at any point.

Pavement drainage: Provide pavements with wearing surface and/or shoulders which will not pond water. Make sure temporary formations do not dam water.

Wearing surface

Wearing surface properties: Firm, even and skid resistant under all weather conditions and remain structurally sound during use.

Jointing to existing work: Extend wearing surface to the connecting roadway so that the finish is flush with existing roadway.

Design drawings

Requirement: Prepare drawings showing the following:

- Alignment and grading at a horizontal scale of 1:2000 for rural roads and 1:500 for urban roads, extending 100 m beyond the limits of the temporary roadway/detour.
- A sight distance diagram if opposing traffic is to use a single carriageway.
- Intersections, and other locations where traffic may be required to make turning, merging or diverging movements, at a scale of 1:500.
- Pavement type, including wearing surface, base and subbase details.
- Details of pavement markings, signposting, safety barrier and traffic control devices at a scale of 1:500.
- Sufficient cross-sections to indicate the feasibility of making connections between various parts of the Works.
- Sufficient dimensions, especially lane widths, showing clearly the geometry and clearances of the Works.
- Roadside furniture.

- Stormwater drainage, including culverts and pits.
- Street lighting details, as appropriate.

3 MATERIALS

3.1 SIGNS

Standards

Sign selection: To AS 1742.3.

Manufacturing of signs: To AS 1743.

Details of each letter: To the figures in AS 1744.

Retroreflective materials: Class 1 material conforming to AS/NZS 1906.1.

Sign size: To AS 1742.3 Tables 3.1 to 3.12, the figures in AS 1743 and **ANNEXURE – SUPPLEMENTARY TEMPORARY WARNING SIGNS**.

Signs for night work: If work area is outside of the car headlight beams, provide floodlighting to AS 1742.3 clause 2.4.3.

Flashing arrow signs: To AS 4192 and installed to AS 1742.3 clause 3.12.

Dynamic message and road weather information: To SA TS 5719.

Other work site approach/departure signs

Signs supplementary (ST/SW) to those in AS 1742.3 and AS 1743: To **ANNEXURE – SUPPLEMENTARY TEMPORARY WARNING SIGNS**.

Application: Provide warning signs as follows:

- Heavy machinery crossing: SW5-22.
- Cycle hazard grooved road: ST1-10 and T1-10 to AS 1743 if the road is grooved and is a hazard to cyclists.
- Tar spraying possible short delay: T3-11 to AS 1743 for bituminous surfacing works.
- Changed traffic conditions ahead: T1-1, T1-6, T1-23, T2-6 and T2-23 to 25 to AS 1743 on long term works, side tracks and detours.

3.2 BARRIERS AND FENCING

Barrier boards

Size, placement, material/colour: To AS 1742.3 clause 3.8.3(a).

Trestle supports:

- Material: Timber, metal or other suitable material.
- Colour: Yellow.
- Stability: Keep trestle in place with concrete blocks or sandbags.
- Bases: Keep the bases of trestles within the ends of the barrier boards.

Warning lamps: Provide barrier boards or trestles which allow for the mounting of traffic warning lamps.

High visibility flexible mesh fencing

Plastic mesh fencing: To AS 1742.3 clause 3.10.1(b).

Application: fencing for pedestrian containment or containment of workers.

Support: Fastened to steel star pickets/posts with cable ties or drawstring.

Location: As documented in the TCP.

Safety barriers
Road safety barrier systems: To AS/NZS 3845.1.

Temporary delineators
Material and erection: To AS 1742.3 clause 3.9.2 and 2.5.2.

Location: Erect parallel to and in close proximity to traffic, as documented.

Boom barriers
Type and location: As documented.

Cones and bollards
Requirement: To AS 1742.3 clause 3.9.1.

Spacing: To AS 1742.3 Table 3.7.

Conditions of use: Unless cones are firmly fixed in position, use only while work is in progress or in locations where an employee is present to re-instate cones dislodged by traffic. Otherwise, use bollards or barriers.

Cones and bollards used under night conditions: Provide cones and bollards with retroreflective bands conforming to AS 1742.3.

3.3 LINEMARKINGS

General
Existing linemarking: To AS 1742.3 clause 3.9.4 (a) and (b) for the period of work.

Temporary linemarking: To AS 1742.3 clause 3.9.4 (c), (d) and (e).

Superseded raised pavement markers: Remove immediately.

Edge lining: Where the adjoining roadway is edge lined, edge line temporary roadway to match.

Temporary linemarking
Type: If temporary marking is required on the final wearing surface, use pavement marking tape.

Maintenance:

- Generally: If the pavement linemarking is deemed ineffective, re-mark within 48 hours.
- Raised pavement markers: If markers are deemed ineffective, replace within 24 hours.

Arrows
Single carriageway: If opened adjacent to or is used in lieu of an existing dual carriageway length, place pavement arrows showing the direction of traffic flow spaced at 500 m maximum.

Remove arrows: Remove arrows when the section is reincorporated as a dual carriageway.

3.4 TRAFFIC SIGNALS

Portable traffic signals
Signal system: To AS 4191.

Application, installation and operation: To AS 1742.3 clause 4.11.

Temporary fixed traffic signals
Design and installation of signal system: To AS 1742.14.

Application: Longer term shuttle operations or for non-shuttle control of intersecting traffic flows.

Traffic warning lamps
Application: To AS 1742.3 clause 3.11.

Lamp maintenance: Clean lamps and make sure they are in good working order, and correctly aligned and positioned for the direction of traffic flow each night, before leaving the site.

4 EXECUTION

4.1 GENERAL

Traffic management
Requirement: Provide the following, as documented:

- Personnel, plant and traffic control devices.
- Temporary roadways and detours.
- Arrangement for traffic.

Safety: Provide traffic control measures with minimal safety risk and inconvenience to the workers and road users at all times, including pedestrians and cyclists.

Road safety audits
Construction phase auditing: If safety audits are required, obtain agreement for inspections and arrange for a road safety auditor to inspect the traffic control measures during daytime and night time conditions at the inspections points. If the measures are ineffective, revise the TMP and implement the appropriate measure.

Auditing procedures: To Austroads AGRS06.

Revisions to the TMP: Obtain agreement for amendments/decisions, and document and implement the amendments.

4.2 SIDE ROADS AND PROPERTY ACCESSES

Access
Requirement: Provide safe and convenient passage for vehicles, pedestrians and stock to and from side roads and property accesses connecting to the roadway.

Notice to property owners
Vehicular access: Where access is required, due to particular construction activities, conform to the following:

- Obtain approval.
- Advise the property owners with a letter drop at least 24 hours before the interruption.
- Repeat this advice verbally to the property owner in a courteous manner.
- Keep interruptions to a minimum.

4.3 PERSONNEL

Traffic controllers
Application, equipment and position: To AS 1742.3 clause 4.10.

Recognition marks: Controllers to wear a distinguishing mark on their outer garment indicating their authority.

Location of traffic controllers: Place to AS 1742.3 and as follows:

- One traffic controller at the head of each traffic queue whilst it is halted.
- An additional traffic controller at the tail end of the queue where there is restricted sight distance and the possibility of approaching traffic colliding with the tail of the queue.

Where both ends of the work are not intervisible: Provide the traffic controller at each end with a two-way radio. Where this is not possible, station an intermediate traffic controller at a location where the extremities of the work are visible to provide cues to both controllers.

Night work control: In conjunction with a STOP/SLOW hand bat, use an illuminated red cone wand (torch) with a minimum capacity of 30,000 candela.

Night time lighting of traffic controller and work area: If floodlighting of the traffic controller and the work area adjacent is required, position floodlights above the work area, directed downwards and inclined slightly to illuminate the face of the STOP/SLOW bat.

- Floodlighting and glare: Make sure lights do not create glare for approaching drivers.
- Effects on neighbouring properties: Make sure high lighting levels do not adversely affect neighbouring residential property.

Approved clothing for work personnel

Clothing and use: To AS 1742.3 clause 3.16.4.

Potentially flammable clothing: Do not wear close to work likely to generate flame or hot splatter/molten metal.

4.4 PLANT AND CONTROL DEVICES

Plant delineation

Plant and equipment: Where plant and equipment encroach on traffic travel paths, direct traffic around encroachment as follows:

- In daylight conditions: Attach a fluorescent red flag to the outer end of the projection.
- In night or poor light conditions: Provide an additional traffic controller with an illuminated red wand.

Night time clearance: If traffic is permitted to use the whole or part of the existing road, remove all plant items and similar obstructions from the normal vehicle path to provide minimum 6 m lateral clearance where practicable, with minimum 1.2 m clearance of other dimensions.

Warning lamps: Light plant and equipment within 6 m of the normal vehicle path with minimum two yellow steady lamps suspended vertically from the point of obstruction nearest to a traffic lane, and one lamp at each end of the obstruction on the side furthest away from the traffic lane.

Traffic control signs and devices

Arrangement and placement of traffic control devices: To the approved Traffic control plan.

Signs no longer required: Cover and/or remove temporary control devices no longer required without delay to maintain unambiguous safe guidance to traffic.

Control device maintenance: Maintain control devices so that they are in good working order and in the correct positions day and night. Maintain signs so that they are neat, clean, clear and legible.

Non-conforming signs and devices: Repair or replace to AS 1742.3 clause 2.6.3.

Sign installation: To AS 1742.3 clause 2.1 (i) to (vii) and clause 4.7.5.

Temporary speed zoning

Requirement: If temporary speed limit has been approved by the Local Council Traffic Committee or State Road Authority, provide temporary speed zoning signs complete with posts and fittings.

Speed limit: To AS 1742.3 Table 4.7 and the applicable State Road Authority specification.

Temporary speed zoning signs: Erect signs, cover the signs when the speed zone is not in use, and remove the signs when the speed zone is no longer required.

Operation diary: Keep a diary recording operation times of the speed zone.

4.5 TEMPORARY ROADWAYS AND DETOURS

Stormwater drainage

Requirement: Construct drainage system, as appropriate for the approved temporary roadway design, conforming to the following work-sections:

- *1121 Open drains*.
- *1351 Stormwater drainage (Construction)*.
- *1352 Pipe drainage*.
- *1354 Drainage structures*.

Temporary roadways

Requirement: Construct temporary roadways conforming to the following work-sections:

- *1102 Control of erosion and sedimentation (Construction)*.
- *1111 Clearing and grubbing*.
- *1112 Earthworks (Road reserve)*.
- *1141 Flexible pavement base and subbase.*

Temporary kerbing: If required for long term works as temporary medians, traffic islands or pavement edges, provide kerbing conforming to the following:

- Height: Maximum 150 mm.
- Securely fastened to the pavement.
- Clearly delineated.
- As seen by the approaching traffic is a 150 mm wide continuous line.
- **KERB AND CHANNEL (GUTTER)** in *1121 Open drains*.

Wearing surface

Requirement: Construct surfacing, as appropriate for the approved temporary roadway design, conforming to one of the following:

- *1143 Sprayed bituminous surfacing.*
- *1144 Asphalt (Roadways).*

Width of the wearing surface: As documented or the width of the traffic lanes plus the width of each shoulder.

Road safety barrier

Location: As documented on the TCP.

Corrugated steel or precast concrete safety barriers: If required, install conforming to the following work-sections, as appropriate:

- *1195 Rigid road safety barrier systems*.
- *1194 Non-rigid road safety barrier systems*.

Water-filled plastic barriers: Use in locations where rigid barriers are not allowed, such as at corners or intersections.

- Buffer zone: Provide the manufacturer's recommended buffer zone on the approach side of water-filled barriers.

- Water level: Maintain the required level for all water ballasted safety barriers at all times.

Opening temporary roadways and detours to traffic

Requirement: Complete all signposting, pavement marking, safety barriers and portable or temporary traffic signals before opening the temporary roadways to traffic.

Traffic switch: Traffic switch to a temporary roadway or detour is only permitted if the usual workforce will be on site for two days minimum thereafter.

Retaining existing roadway: Arrange the opening of temporary roadways so that sections of the existing roadway being replaced are not disturbed for minimum 48 hours so that traffic can be redirected back onto the existing roadway in the event of temporary roadway failure.

Approval to open roadway: Do not open temporary roadways and detours (including portable or temporary traffic signals sites) to traffic without written approval.

Maintenance during construction: Maintain road surface of temporary roadways and detours and any local roads used by the construction traffic so that it is safe for traffic, including:

- Maintaining existing pavement linemarkings, kerb and gutters, road shoulders and verges, drainage, signage and vegetation.
- Repairing potholes, surface drainage blockages or other failures without delay.
- Removing debris without delay.

Removal and restoration: Upon completion of the Works, remove the temporary roadways and/or detour arrangement and restore the area affected by the Works to a condition equivalent to that before commencement.

4.6 CONSTRUCTION UNDER TRAFFIC

Arrangement for traffic

Permission to construct under traffic: If a temporary roadway or a detour is not provided or available, construction under traffic may be permitted, if the following is provided:

- Through traffic on a two-lane roadway: Minimum 3.5 m lane width.
- Multilane roads: Minimum 3.5 m lane width in both directions.

Notification: Give minimum 5 working days' notice before carrying out work.

Carriageway restoration: Restore carriageway to a safe and trafficable state for through traffic before ceasing work each day.

4.7 OPENING TO TRAFFIC

Opening completed work

Notice: Provide at least 10 working days' written notice of the date of opening the Works to traffic. Obtain agreement for the procedure for opening including with the local Police.

Permanent signs and markings: Complete all permanent signposting, pavement markings, safety barriers and traffic signals required to complete the Works before opening to traffic.

Removal of temporary traffic control devices: Remove all temporary control devices no longer required for the safety of traffic, when part or all of the Works are opened to traffic.

Restoration: Restore the area to a condition equivalent to that at commencement.

5 ANNEXURES

5.1 ANNEXURE – PROJECT PLAN REQUIREMENTS

Plan type	**Required?***	
Traffic management plan (TMP)	Yes □	No □
Traffic control plan (TCP)	Yes □	No □
Traffic staging plan	Yes □	No □
Road safety audit of TMP/TCP	Yes □	No □
Vehicle movement plan (VMP)	Yes □	No □
*Check the box applicable for the project.		

5.2 ANNEXURE – TEMPORARY ROADWAYS

Roadways design parameters schedule

Property	**Minimum value/required?***	
Design travel speed (km/hr)		
Traffic lane width (m)		
Shoulder width (m)		
Shoulder seal	Yes* □	No* □
*Check the box applicable for the project.		

Roadways materials schedule

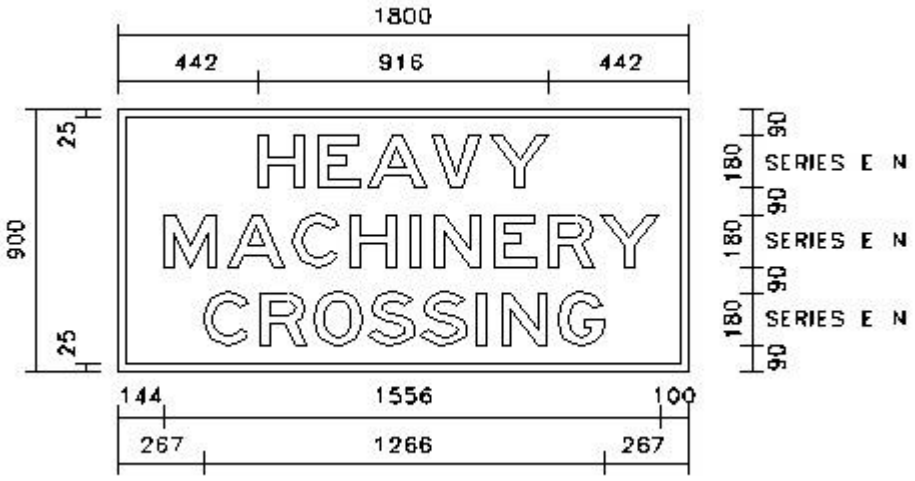
Pavement layer	**Type/material**	**Minimum thickness (mm)**
Wearing surface		
Base		
Subbase		

5.3 ANNEXURE – SUPPLEMENTARY TEMPORARY WARNING SIGNS

Sign SW5-22

Dimensions: In mm.

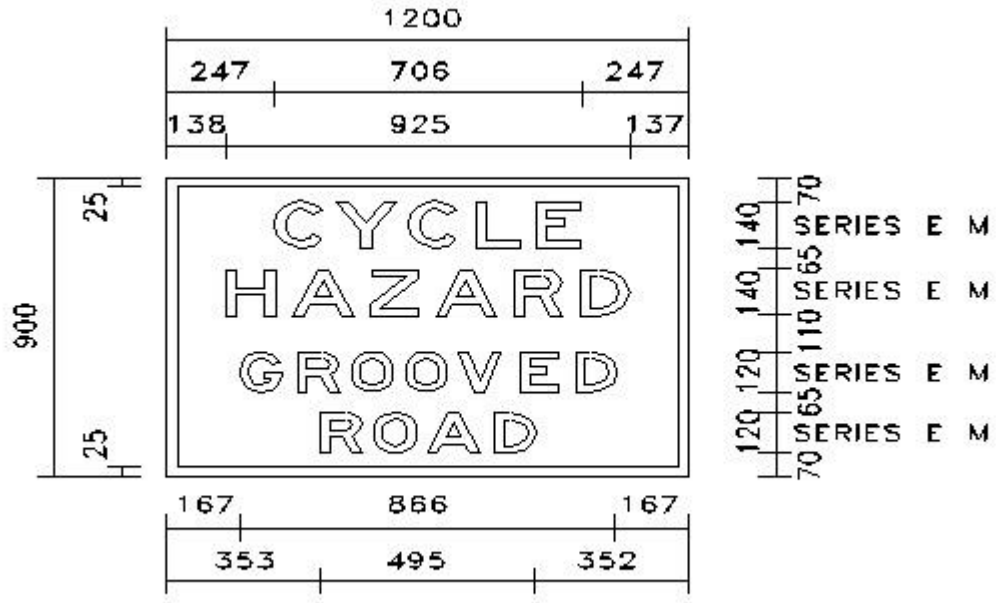
Colours: Black letters and border on yellow retroreflective background.



Sign ST1-10

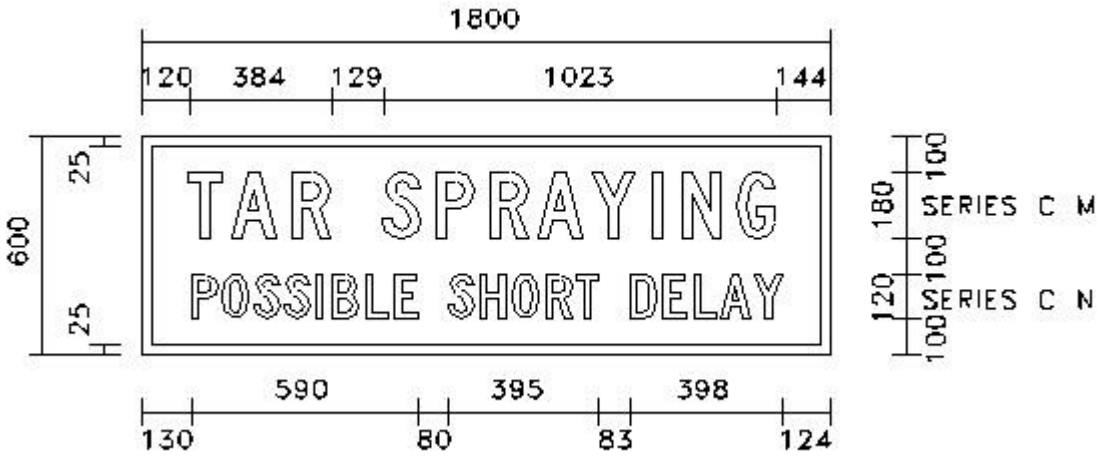
Dimensions: In mm.

Colours: Black letters and border on yellow retroreflective background.



Sign ST3-1
Dimensions: In mm.

Colours: Black letters and border on yellow retroreflective background.



5.4 ANNEXURE – SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Execution details Plan(s)	H	Plans and documents of the TMP.	2 weeks if pavement/ drainage works is not required. 4 weeks if pavement/ drainage works is required.	Commencement.
SUBMISSIONS, Authority approvals Plan(s)	H	Evidence of approvals for temporary traffic arrangements.	4 weeks before commencement	Commencement.
SUBMISSIONS, Authority approvals Temporary speed zoning	H	Evidence of approvals for changes to speed zoning.	5 weeks before implementation.	Implementation of speed zoning.
INSPECTIONS, Notice Temporary roadways and detours	W	Completed roadway/detour construction.	3 days before installing control signs and devices	-
INSPECTIONS, Notice Traffic control signs and devices	W	Completed installation of signs and devices.	1 day before opening to traffic	-

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
INSPECTIONS, Notice Access	W	Completed alternative access.	1 day before opening to traffic	-
INSPECTIONS, Notice Plant delineation	W	Completed warning devices installation.	1 day before opening to traffic	-
INSPECTIONS, Notice Temporary roadways and detours	H	Completed roadway/detour.	3 days before opening to traffic	Opening to traffic
INSPECTIONS, Notice Opening completed work	H	Reinstated area affected by the Works.	2 days before switching traffic	Opening of completed work to traffic
*H = Hold Point, W = Witness Point				

5.5 ANNEXURE – PAY ITEMS

Pay items	Unit of measurement	Schedule rate inclusions
1101.1 Traffic management	Lump sum item	All costs associated with the documentation and approvals of: - The design of temporary roadways and detours, traffic switching operations, the provision of traffic controllers, signposting, roadmarkings, raised pavement markers, lights, barriers. - Other traffic control devices required for the safe movement of traffic and the protection of persons and property. Progress payments work done under this item is to be made on a pro-rata basis, as appropriate for the duration of the Contract.
Temporary roadways and detours – Drainage		To the following work-sections: - *1121 Open drains*. - *1351 Stormwater drainage (Construction)*. - *1352 Pipe drainage*. - *1354 Drainage structures*.

Pay items	Unit of measurement	Schedule rate inclusions
Temporary roadways and detours – Temporary roadways		To the following work-sections: - *1102 Control of erosion and sedimentation (Construction)*. - *1111 Clearing and grubbing*. - *1112 Earthworks (Road reserve)*. - *1141 Flexible pavement base and subbase.*
Temporary roadways and detours – Wearing surface	Per m^2 for bitumen seal	To one of the following work-sections: - 1143 Sprayed bituminous surfacing. - 1144 Asphalt (Roadways).
Temporary roadways and detours – Road safety barriers	Refer to the work-sections	To the following work-sections: - *1195 Rigid road safety barrier systems*. - *1194 Non-rigid road safety barrier systems*.

5.6 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1742		Manual of uniform traffic control devices
AS 1742.3	2009	Traffic control for works on roads
AS 1742.14	2014	Traffic signals
AS 1743	2018	Road signs - Specifications
AS 1744	2015	Standard alphabets for road signs
AS 1906		Retroreflective materials and devices for road traffic control purposes
AS/NZS 1906.1	2017	Retroreflective sheeting
AS/NZS 3845		Road safety barrier systems and devices
AS/NZS 3845.1	2015	Road safety barrier systems
AS 4191	2015	Portable traffic signal systems
AS 4192	2006	Illuminated flashing arrow signs
Austroads AGRD		Guide to road design
Austroads AGRD03	2016	Geometric design
Austroads AGRS		Guide to road safety
Austroads AGRS06	2009	Road safety audit
Austroads AGTM		Guide to traffic management
Austroads AGTM06	2017	Intersections, interchanges and crossings
SA TS 5719	2017	Communications protocol for dynamic message signs and road weather information systems

1102 CONTROL OF EROSION AND SEDIMENTATION (CONSTRUCTION)

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide temporary and permanent measures to control erosion and sedimentation to the requirements of Erosion and sedimentation control plan in *0022 Control of erosion and sedimentation (Design)* and, as documented.

ESCP prepared by the contractor

Implementation: To control plans documented in **PRE-CONSTRUCTION PLANNING**.

Erosion and sedimentation control measures by principal/consultant

Implementation: To control measures documented in **EXECUTION**.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0022 Control of erosion and sedimentation (Design)*.
- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *0173 Environmental management (AUS-SPEC)*.
- *0257 Landscape - road reserve and street trees*.
- *1101 Traffic management*.
- *1111 Clearing and grubbing*.
- *1112 Earthworks (Road reserve)*.
- *1121 Open drains* .

1.3 STANDARDS

General

Standards: To IECA IECA Principles , IECA Book 5 and IECA Book 6.

Turf installation To AS 5181.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviations apply:

- ARI: Average Recurrence Interval.
- ESCP: Erosion and sediment control plan.
- NTU: Nephelometric Turbidity Units.

Definitions

General: For the purposes of this work-section the following definitions apply:

- Erosion: The wearing away of land by the action of rainfall, running water, wind, moving ice or gravitational creep. Soil detachment (erosion) occurs when the erosive forces exceed the soil's resistance, causing the soil particles to move.
- NTU: A measure of water turbidity or the optical clarity of a liquid.
- Sediment: Sediment is the result of erosion, and consists of small detached soil particles. Sedimentation occurs when the transportation of detached soil particles ceases or slows and the soil particles then settle or fall out of suspension.

- Site sections: The site divided into sections based on the catchment area draining to each permanent drainage structure in the works, including the following:
  . Access and haulage tracks.
  . Borrow pits and stockpile areas.
  . Compound areas, including Contractor's facilities and concrete batching areas.
- Waterway Works Licence: This licence is required for:
  . Construction, alteration, operation, removal or decommissioning of any works on a waterway or groundwater bore.
  . Works to deviate a waterway or private dam, and covers all domestic and stock dams that are built on waterways. This approval is not required for farm dams that are not on a waterway.
- Waterway: Include the bed and banks of the following:
  . A river, creek, stream or other natural channel in which water flows (continuously or intermittently);
  . The stormwater system;
  . A lake, pond, lagoon or marsh in which water collects (continuously or intermittently).

1.5 SUBMISSIONS

ESCP prepared by the contractor

Design documentation: Submit the following documents, if control plans are prepared or revised by the contractor:

- Erosion and Soil Sedimentation control plan (ESCP).
- Survey of embankments.
- Waterway Works Licence, if required.

Calculations: Submit calculations and references supporting the design and maintenance requirements.

Execution details

Section plans: Before disturbing the natural surface of a particular site section, submit an ESCP only for that site section consistent with the previously approved ESCP.

Personnel: Submit staff names and contact details for installation, monitoring, upkeep and removal.

Working in a waterways and floodplains: Submit a reinstatement plan if work in a stream is planned or the structure of a waterway will be altered including a copy of a Waterway Works Licence.

Drop inlet sediment control: Submit details of proposed alternative methods.

Reports

Work method statement: Submit detailed Environmental Work Method Statements.

1.6 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- General: Initial installation of sediment controls.
- Stockpile sites: Stockpiles are protected by approved erosion and contamination measures in the ESCP.
- Access and exit areas: Decontamination of vehicles.
- Areas not approved for clearing: Fencing and protection of areas.
- Diversion and catch drains: Construction and lining.
- Temporary sediment control: Temporary sediment traps and batter protection.
- Removal: Removal of temporary erosion and sedimentation works.

- Cleaning: Completion of cleaning.

2 PRE-CONSTRUCTION PLANNING

2.1 ESCP PREPARED BY THE CONTRACTOR

General

Requirement: To the *0022 Control of erosion and sedimentation (Design)* work-section.

Schedules

Content requirement: Conform to the following:

- Work schedules for multiple contractors co-ordinated to avoid delays so that disturbed land does not remain un-stabilised.
- Schedules for the construction of structures and the implementation of measures to control erosion and sedimentation programmed where possible to avoid seasonal intense rain storms.
- A work sequence with construction and stabilisation of culverts and surface drainage works at the earliest practical stage.

3 EXECUTION

3.1 SITE CONTROL AND PROTECTION

Dewatering

Requirement: Make sure that dewatering operations do not result in turbid water entering natural waterways and conform to the following:

- Treat contaminated water if turbidity exceeds 30 NTU.
- Only pump water into natural waterways if it is under safe limits to the regulatory water quality standards.
- Pump water to vegetated areas of sufficient width to remove suspended soil, or to sediment control structures.
- If discharge is to a natural waterway or a drainage system discharging to a natural waterway, monitor turbidity hourly.

Dust control

Requirement: Install measures for minimising health risk or loss of amenity due to emission of dust to the environment. and incorporate the following, if required:

- Suppression of dust by watering.
- Installation of wind fences.

Management of stockpiles and batters

Requirement: Manage soil stockpiles to minimise dust and sediment in run-off and conform to the following:

- Minimise the number and area of stockpiles and the time stockpiles are exposed.
- Keep topsoil and underburden stockpiles separate.
- Construct other protective measures including upstream diversion works and downstream sediment trapping devices.
- Height:< 2.5 m.
- Stockpiles and batters slopes: No steeper than 2H:1V.
- Stockpiles and batters bare for more than 28 days: Stabilise by covering with mulch, anchored fabrics or seeding with sterile grass.
- Install sediment controls around unstabilised stockpiles and batters.
- Suppress dust on stockpiles and batters, as required.
- Stockpile protection: Install the following at the end of each working day:

  - . Sandbags: Placed on downslope of stockpile to prevent movement:
  - . Waterproof cover: Placed over stockpile material.
  - . Sandbags, filter bags or fibre sausages: Locate to divert upslope flow of stormwater into grassed areas of the site and away from stockpiled material.
- Exclude timber and rubbish from stockpiles.

Access and exit areas

Decontamination measure: Decontaminate vehicles entering/exiting the site using shake-down or other approved methods.

Working in waterways and floodplains

Requirement: Minimise stress on aquatic communities and do not increase sediment load when working in waterways. Conform to the following:

- Plan in-stream works to minimise contact time.
- Establish special practices to minimise impacts on the waterway and disturbance of the banks.
- Stabilise the banks and the in-stream structures.
- Maintain minimum flows to make sure the viability of aquatic communities and do not limit the passage of fish up and downstream.
- Construct in-stream crossing during low flows, that are stable under expected vehicle loads and flow regimes.

3.2 EROSION AND SEDIMENTATION CONTROL MEASURES

General

Initial installation of sediment control: Prepare and present the works for inspection.

Control measures

Land clearance: Minimise in areas with highly erodible soils and steep slopes liable to water and wind erosion.

Runoff: Decontaminate in conformance with safe limits of regulatory waterway standards before dispersing. Disperse clean runoff to stable areas or natural watercourses

Drainage lines: Provide drainage to convey water through the works to minimise erosion generation. Identify drainage lines and install measures to control predicted stormwater and sediment loads generated in the mini catchment.

Limiting areas or erodible material exposed at any time: Limit to areas being actively worked.

Protection of areas not approved for clearing or disturbance: Clearly mark and fence off.

Clearing and grubbing: To the *1111 Clearing and grubbing* work-section.

Control measures: Install and maintain for the duration of the contract, control measures including the following:

- Permanent drainage structures: Install before the removal of topsoil and commencement of earthworks within the catchment area of each structure.
- Permanent and temporary drainage works: Complete promptly to minimise exposure period of disturbed areas.
- Diversion and catch drains: Construct to prevent uncontaminated runoff from passing through the site and mixing with contaminated water. Construct and line catch drains before the adjacent ground is disturbed and before excavation.
- Contour and diversion drains: Install across exposed areas before, during and immediately after the clearing. Re-establish and maintain these drains during soil removal and earthworks operations.
- Cut off or intercept drains: Establish cut-off or intercept drains to redirect stormwater away from cleared areas, and sloping to stable (vegetated) areas or effective treatment installations.

- Sediment filtering or sediment traps: Install before and in conjunction with earthworks operations, to prevent contaminated water leaving the site.
- Berms: Construct along the edge of the formation leading to temporary batter flumes and short term sediment traps, to minimise loss of sediment during construction of embankments during fill placement.
- Progressive revegetation of site: To the *0257 Landscape - road reserve and street trees* work-section as each site section is complete.

Maintenance

Maintenance of controls: Make sure each disturbed area has adequate means of containment of contaminated water. Restore and replace control measures as required.

Access areas: Provide and maintain access from within the road reserve, or from other acceptable locations, for cleaning out sedimentation control works.

Monitoring site performance

General: Maintain slopes, crowns and drains on all excavations and embankments, and make sure there is satisfactory drainage at all times. Do not allow water to pond on the works, unless ponding is part of an approved ESCP.

Ripped material remaining in cuttings and material placed on embankments: Seal off by adequate compaction to a smooth, tight finish.

Inspection: Inspect all erosion and sedimentation control measure as follows:

- At least daily when rain is occurring on site.
- At least weekly (even if work is not occurring on site).
- Within 24 hours prior to expected rainfall.
- Within 18 hours of a rainfall event of sufficient intensity and duration to cause on site runoff.

Rectification: Immediately rectify any defects revealed during inspection and revise ESCP, if required.

3.3 TEMPORARY EROSION AND SEDIMENTATION CONTROL MEASURES

General

Requirement: Install temporary erosion and sedimentation control measures to areas where the natural surface is disturbed by construction, including roads, depot and stockpile sites.

Temporary drainage control

Temporary drains: Control runoff from exposed areas with temporary contour drains and/or temporary diversion drains. Progressively implement and, if required, alter as the work progresses.

Contour drains: Construct across the natural slope at approximately the same elevation as follows:

- Timing: Immediately after site is cleared, intercept and divert runoff from the site to nearby stable areas at non-erosive velocities.
- Form: Channel with a ridge on the lower side.
- Grade: 1% to 1.5%.
- Spacing intervals: 20 m to 50 m, depending on the erodibility of the exposed soil, as documented.

Diversion drains: Construct diversion drains across haul roads and access tracks when there is an erosion risk, due to steepness, soil erodibility or potential for concentrating runoff flow, as follows:

- Form: Channel with a ridge on the lower side to intercept and divert runoff from the road or track to stable outlets.
- Spacing: Not greater than that required to maintain runoff at non-erosive velocities.

Temporary sediment control

Temporary sediment traps: Construct devices to remove sediment from sediment-laden runoff flowing from areas of 0.5 ha or more before the runoff enters the stormwater drainage systems, natural watercourses or adjacent land.

Waste barriers: Construct and maintain to prevent debris from entering natural watercourses.

Batter protection: Minimise scour of newly formed fill batters during and after embankment construction by diverting runoff from the formation away from the batter until vegetation is established.

Drop inlet sediment control

General: Construct drop inlet sediment traps and inlet control banks on completion of gully pits, as documented.

Functional requirement: Construct the inlet control banks, as required, to prevent the surface flows bypassing gully pits. Make sure the sediment traps remove sediment from the surface flow before it enters the drainage system.

Sediment traps and control banks: Conform to the following:

- Construct the drop inlet sediment traps and associated inlet control banks consisting of at least two courses of sandbags, containing a 10:1 sand/cement mix, as documented.
- Key the bags at least 25 mm into the surface, dampen and make sure cement is sufficiently hydrated, and tamp lightly to achieve a mechanical interlock between adjacent bags.

Removal

General: Remove all measures when revegetation is established on formerly exposed areas. Remove from the site, and dispose of, all materials and components used for the temporary erosion and sedimentation control works, as documented and in conformance with regulatory authorities' requirements.

3.4 PERMANENT EROSION AND SEDIMENT CONTROL MEASURES - EARTHWORKS

Erosion and sedimentation control basins

Planned levels: Construct earthworks for permanent erosion and sedimentation control basins to the documented levels and dimensions.

Site preparation: Clear the entire storage and embankment foundation area of permanent erosion and sedimentation control basins in conformance with the *1111 Clearing and grubbing* work-section. Strip topsoil and any unsuitable material under embankments in conformance with the *1112 Earthworks (Road reserve)* work-section.

Embankments: To the *1112 Earthworks (Road reserve)* work-section.

3.5 PERMANENT INLETS, SPILLWAYS AND LOW FLOW OUTLETS

Sedimentation control basins and sediment traps

Rock mattresses: Construct inlets and spillways using rock filled woven galvanized steel mattresses and geotextile. Install the rock filled mattresses to the *1121 Open drains* and *0294 Gabion walls and rock filled mattresses* work-sections.

Plastic pipe outlet: Install a 150 mm diameter plastic pipe low flow outlet in locations, as documented.

3.6 CLEANING

Sedimentation control structures

Progressive cleaning: Clean out, when accumulated sediment reduces the structure capacity of the control measure to 50% or less, or when sediment has built up to a point where it is less than 300 mm below the spillway crest and conform to the following:

- Removal of accumulated sediment: Use methods which will not damage the structures.

- Sediment disposal: Remove sediment to a nominated soil stockpile site or dispose in locations that sediments will not be conveyed back into the construction areas or into watercourses.
- Access: Maintain suitable access to allow cleaning out in all weather conditions.

Completion

Requirement: Clean, before Practical Completion of the Works.

Reinstatement: Reinstate surfaces including areas previously occupied by stockpiles and conform to the following:

- Within areas of permanent works: As documented.
- Areas outside permanent works: Reinstate to condition at commencement of contract.

4 ANNEXURES

4.1 ANNEXURE – SELECTIONS

Property	**Details/Required?***	
Contact details: - Installation - Monitoring - Upkeep - Removal		
Site hazard/risk assessment: - Low - General risk site - High risk site		
Site water quality monitoring (high risk site)	Yes ☐	No ☐
Drainage control measures		
Erosion control measures		
Sediment control measures		
*Check the box applicable for the project.		

4.2 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	**Type***	**Submission/Inspection**	**Submission/Notice details**	**Process held**
SUBMISSIONS ESCP prepared by the contractor Design documentation	H	Erosion and sedimentation control plan (ESCP)	3 days before disturbance of natural surface	Disturbance of natural surface
SUBMISSIONS ESCP prepared by the contractor Design documentation	H	Survey of embankments	7 days before disturbance of natural surface	Disturbance of natural surface
SUBMISSIONS ESCP prepared by the contractor	H	Waterway works licence Approval letter with conditions from	7 days before disturbance of waterway if applicable.	Statutory approval for works in a waterway and/or floodplain.

Clause and description	Type*	Submission/Inspection	Submission/Notice details	Process held
Design documentation		statutory organisation controlling access to a waterway		
SUBMISSIONS Execution details Section plans	H	Scale diagrams showing the following: - Features of the site including contours and drainage paths. - Relevant construction details of all erosion and sedimentation control structures. - All permanent and temporary erosion and sedimentation control measures, including the control measure to be implemented in advance of, or in conjunction with clearing and grubbing operations	7 days before disturbance of natural surface	Disturbance of natural surface
SUBMISSIONS Execution details Working in waterways and floodplains	H	Reinstatement plan for works in a stream including a copy of Waterway Works Licence	7 days before works in waterways and flood plains	Work in waterways and flood plains. Reinstatement plan.
INSPECTIONS Notice General	H	Initial installation of sediment controls	3 days before commencement of bulk earthworks	Commencement of bulk earthworks
INSPECTIONS Notice Stockpile sites	W	Approved protection measures are in place	2 days	-
INSPECTIONS Notice Access and exit areas	W	Decontamination of vehicles	2 days before site disturbance	-
INSPECTIONS Notice	W	Fencing and protection of areas	3 days	-

Clause and description	Type*	Submission/Inspection	Submission/Notice details	Process held
Areas not approved for clearing				
INSPECTIONS Notice Diversion and catch drains	W	Construction and lining	2 days before site disturbance	-
INSPECTIONS Notice Temporary sediment control	W	Temporary sediment traps and batter protection	2 days before site disturbance	-
INSPECTIONS Notice Removal	W	Removal of temporary erosion and sedimentation works	3 days	-
INSPECTIONS Notice Cleaning	W	Completion of cleaning	2 days	-
*H = Hold Point W = Witness Point				

4.3 ANNEXURE – PAY ITEMS

Pay items	Unit of measurement	Schedule rate inclusions
1102.1 Temporary erosion and sedimentation control measures	Lump sum	All costs associated with the installation, maintenance, inspection and removal of the temporary erosion and sedimentation control measures in conformance with **TEMPORARY EROSION AND SEDIMENTATION CONTROL MEASURES**. All costs associated with Drop inlet sediment control, including inlet control bank constructed in conformance with **Drop inlet sediment control**.
1102.2 Permanent erosion and sediment control - Earthworks	m^3. The volume will be determined by calculation using the end area method.	All costs associated with compacted embankment constructed in conformance with **PERMANENT EROSION SEDIMENTATION CONTROL MEASURES - EARTHWORKS**, **erosion and sedimentation control basins**. The schedule rate to cover the excavation of material from within the sedimentation control basin and embankment construction required under **erosion and sedimentation control** basins

Pay items	Unit of measurement	Schedule rate inclusions
		and will be an average rate for all types of materials. The cost of excavating and transporting material for embankment construction and obtained from within cuttings or from borrow will be included in the schedule rate for General earthworks in *1112 Earthworks (Road reserve)*.
1102.3 Permanent inlets, spillways and low flow outlets	m^2 of horizontal surface area	All costs associated with the rock filled mattress constructed in conformance with **PERMANENTINLETS, SPILLWAYS AND LOW FLOW OUTLETS**, **Sedimentation control basins and sediment traps**.
1102.4 Cleaning	m^3 of in-place sediment	All costs associated with sediment removal from the structure in conformance with **CLEANING**, **Sedimentation control structures**. The volume of sediment removed will be determined by survey The schedule quantity is a provisional quantity.
Clearing and grubbing		To *1111 Clearing and grubbing*.
Landscaping		To *0257 Landscape - road reserve and street trees*.
Topsoil stripping and placement in storage stockpile	m^3 solid bank	To *1112 Earthworks (Road reserve)*.
Topsoil replacement from storage stockpiles to restore grassed areas	m^3 solid bank	To *1112 Earthworks (Road reserve)*.

4.4 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 5181	2017	Use and installation of turf as an erosion, nutrient and sediment control measure
IECA Principles	2012	Principles of construction site erosion and sediment control - A training tool for the construction industry
IECA Book 5	2012	Best practice erosion and sediment control - A field guide for construction site managers
IECA Book 6	2010	Best practice erosion and sediment control - Standard drawings

1111 CLEARING AND GRUBBING

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide clearing, grubbing and removal of vegetation, debris and minor built structures for site works, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *0257 Landscape - road reserve and street trees*.
- *1101 Traffic management*.
- *1102 Control of erosion and sedimentation (Construction)*.

1.3 STANDARDS

General

Pruning of amenity trees: To AS 4373.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviation applies:

- CTPO: Council's Tree Preservation Officer.

Definitions

General: For the purposes of this work-section the following definitions apply:

- Dripline: The most outer reach of a tree's branches.
- Weed: An invasive plant that degrades natural areas, reduces the sustainability or affects the health of people and animals.

1.5 SUBMISSIONS

Design documentation

Survey: Submit a survey plan with area proposed for clearing.

Execution details

Clearing and grubbing plan: Submit a clearing and grubbing plan in conformance to **PRE-CONSTRUCTION PLANNING, CLEARING AND GRUBBING PLAN**.

Weed management plan: Submit a Weed management plan in conformance to **PRE-CONSTRUCTION PLANNING, WEED MANAGEMENT PLAN, Weed control.**

Establishment: Submit a method statement in conformance to **PRE-CONSTRUCTION PLANNING, ESTABLISHMENT, Method statement**.

Areas to be cleared outside the limits: If proposed, state the purpose for clearing and submit plan for approval.

Weed control: Submit herbicide operator's licence for personnel engaged in herbicide spraying.

Unsound trees in road reserve: Submit a proposal to clear unsound trees remaining within the road reserve, but outside the limits of clearing.

Disposal of material: If burning is proposed, submit for approval.

Records

Owners consent: Submit a copy of the owner's written consent to enter property to remove timber for disposal, or for fallen timber to remain on private property.

Reports

Clearing report: Before clearing, submit a clearing report in conformance to **PRE-CONSTRUCTION PLANNING, WEED MANAGEMENT PLAN, Clearing report**.

Variations

Trees within proposed embankment areas: Submit details if a tree marked for preservation is located within an area proposed for embankment construction.

1.6 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Weed control: Determine if additional areas require weed control.
- Trees within proposed embankment areas: Trees to be protected.
- Tagging: Tagging of protected trees.
- Limits of clearing: Peg out area for clearing.
- Unsound trees in road reserve: Trees marked outside the limits of clearing.

2 PRE-CONSTRUCTION PLANNING

2.1 CLEARING AND GRUBBING PLAN

General

Requirement: Prepare a clearing and grubbing plan including the following details:

- Areas to be cleared and grubbed.
- Areas of weed removal.
- Threatened flora species and trees marked for preservation.

2.2 WEED MANAGEMENT PLAN

Weed control

Requirement: Prepare a weed management plan including the following details:

- Identification of weeds and infestation zones within the work site and investigation date.
- Method of cleaning vehicles and machinery, and cleaning date.
- Cleaning bay location and treatment date.
- Contaminated fill stockpile, treatment type and treatment date.

Clearing report

General: Prepare a clearing report including the following:

- Statement from an ecologist identifying species and location of any weeds in the areas to be cleared and grubbed.
- Locations of threatened flora species and trees identified for preservation.
- List of any trees outside limits of clearing which are unsound and likely to fall on roadways or into neighbouring property.

2.3 ESTABLISHMENT

Survey

Requirement: Survey the proposed area for clearing and prepare site plans showing the clearing perimeters.

Pegging: Peg out the site area including recovery pegs.

Erosion control

Rivers, creeks and watercourses: Retain existing trees and ground cover within 15 m of rivers, creeks and watercourses and in drainage lines until directly before construction begins to minimise erosion.

Method statement

Requirement: Document the proposed methods, equipment and materials to be used for works within the exclusion zone, including the following:

- Protection methods.
- Excavation methods.
- Cutting of tree roots more than 50 mm diameter.
- Proposal for elevated platforms for earthwork machinery.
- Rehabilitation of damaged areas.
- If proposed, work within the dripline of trees within the exclusion zone.

Planning and programming

Requirement: Progressively carry out clearing with only the minimum area of land being disturbed at any time. Make sure that the absolute minimum area for construction is cleared.

3 EXECUTION

3.1 LIMITS OF CLEARING

General

Extent of clearing: As documented and areas occupied by the following:

- The completed Works.
- Erosion and sedimentation measures.
- Stockpile sites and borrow areas.
- If the natural fall of the ground is towards the roadway, a clearance zone of 4 m beyond tops of cuts and toes of embankments.
- If the natural fall of the ground either slopes away from the roadway or is level, a clearance zone of 2 m beyond the tops of cuts and toes of embankments.

3.2 AREAS TO BE CLEARED OUTSIDE THE LIMITS

General

Extent: If areas outside the limits are proposed to be cleared, clear the area to the extent defined in approved plans.

Requirement: Avoid danger to personnel, traffic, other trees, shrubs and structures.

Natural landscape features: Protect natural rock outcrops, natural vegetation, soil and water courses against disturbance.

3.3 WEED CONTROL

Procedures

Requirement: Tag areas documented in the **WEED MANAGEMENT PLAN**.

Implementation: Do not spread weeds during the clearing operations and remove all identified weeds as a separate operation.

Qualification: Use personnel with current pesticide operators' licence issued by the local authority.

3.4 VEGETATION PRESERVATION

Tagging

Requirement: Mark all trees documented for preservation or transplanting with ribbon markers.

Signage

Warning sign: Display a sign in a prominent position at each entrance to the site, warning that trees and other plants are to be protected during the contract.

Lettering: Road sign type sans serif letters, 100 mm high, in red on a white background, to AS 1744.

Work near trees noted for protection

Exclusion zone: Do not carry out the following activities within 4 m of the trunks of protected trees: Erection of structures.

- Filling.
- Changes to soil profiles.
- Stockpiling of spoil.
- Storage of other materials.
- Driving or parking of any vehicle or machinery.

Dripline: Conform to the following:

- Area within dripline: Free of sheds and paths, construction material and debris.
- Bulk materials: Do not place bulk material and harmful materials under or near trees.
- Spoil: Do not place spoil from excavations against tree trunks.
- Wind-blown material: Prevent wind-blown materials such as cement from harming trees and plants.

Tree enclosures

General: Provide temporary protective enclosures consisting of wire, mesh or chain-wire material.

Size: 10 times the trunk diameter measured at 1500 mm above ground, as a radius from the trunk.

Wire enclosures: Four strands of fencing wire, or plastic mesh barrier, supported on plastic capped star pickets spaced at not more than 4 m.

Mesh enclosures: SL 62 to AS/NZS 4671 reinforcing mesh 1800 mm high wired to 2400 mm long star pickets, driven 600 mm into the ground, spaced 1800 mm apart at a minimum distance of 1 m from the tree trunk.

Chain wire enclosures: 1800 mm high chain-wire panels fixed to 40 mm diameter galvanized steel posts.

Tree protection

Program: Install protection measures before starting clearing.

Trunk protection: If space is not available for tree enclosures, construct trunk protection comprising 2000 mm long planks of 100 mm x 50 hardwood stacked vertically around the trunk and secured with 10-gauge wire over hessian protective padding.

Sheeting to excavations: If excavating near trees, provide continuous 900 mm high corrugated galvanized steel sheeting, bedded 150 mm into the ground, and wired to the enclosure.

Damage: Prevent damage to tree bark and root system. Do not attach stays and guys to trees.

Tree removal: Minimise damage to protected trees by felling trees towards the centre of the area to be cleared. Cut tree in sections from top downward.

Roots: If tree roots less than 50 mm are cut, use cutting method that does not unduly disturb the remaining root system. Water the tree and apply a liquid rooting hormone immediately after cutting to stimulate the growth of new roots.

Compacted ground: Do not compact the ground or use skid-steel vehicles within the dripline.

Compaction protection: If earthwork machinery is required to operate within the dripline install an elevated platform.

Mulching: Spread 100 mm thick organic mulch to the whole of the area within the dripline of all protected trees.

Transplanting of trees

Method: Lift and temporarily store the documented vegetation for transplanting to **TRANSPLANTING STREET TREES** in the *0257 Landscape - road reserve and street trees* work-section.

Protection of other vegetation

Existing shrubs, native grasses and ground covers: Protect areas by temporary fencing.

3.5 CLEARING OPERATIONS

General

Requirement: Remove items including vegetation both living and dead, minor structures, redundant kerbs and gutters, bitumen surfacing, footpaths and driveways, rubbish and any other materials located within the limits of clearing.

Excavation near tree trunks

Open excavations: Minimise the time period an excavation is left open under tree canopies.

Topsoil: Do not remove or add topsoil to the area within the dripline.

Clearing machines: Fit machines used for pushing and heaping operations with appropriate attachments and operate to limit the amount of soil removed and heaped with the cleared vegetative material.

Working near tree roots

Hand excavation methods: If excavation is required within the dripline, use hand methods to preserve root systems intact and undamaged. Use hand methods to locate, expose and cleanly cut the roots on the line of the excavation.

Backfill material: A mixture of three parts by volume of topsoil and one part of well-rotted compost with a neutral pH value and free from weed growth and harmful materials.

Maximum backfill depth: 300 mm.

Compaction of backfill: Place layers of backfill and compact to a dry density similar to the original or surrounding soil.

Backfill height: Do not backfill around tree trunks to a height greater than 200 mm above the original ground surface.

Watering: Water trees as required, including where roots are exposed, at ambient temperature greater than 35°C. Thoroughly water the root zone immediately after backfilling.

Damage

Restoration: Rectify damage to vegetation, landforms, fauna habitat, and fencing that occurs during the clearing operations. Restore all damage to pre-construction conditions in the shortest period of time using the following methods:

- Deep ripping or hand scarifying and raking of wheel tracks and compacted soil.
- Reinstatement of rocks or stones.
- Planting of seeds or seedlings together with subsequent nurturing.
- Repairs to foliage or root systems of trees and shrubs and reinstatement of fauna habitat.

Unsound trees in road reserve

Marking of unsound trees: Tag unsound trees outside the limits of clearing.

Pruning: To AS 4373.

Disposal: Dispose of any unsound trees and overhanging branches to **TREATMENT OF CLEARED VEGETATION**.

Timber falling on private property: Prevent timber from falling on private property at all times.

3.6 GRUBBING

General

Extent: All trees and stumps on, or within the limits of clearing which cannot be felled and removed.

Depth of grubbing: Carry out grubbing operations to a depth of 0.5 m below the natural surface or 1.5 m below the top of the selected material zone.

Backfill

Holes and depressions: Immediately backfill holes or depressions remaining after grubbing trees and stumps to prevent the infiltration and ponding of water. Fill with soil material similar to the adjacent ground and compact the backfill material to at least the relative compaction of the material existing in the adjacent ground.

Areas outside the limits of clearing: Final backfill with 50 mm topsoil and vegetate within 7 days of removal of stump.

3.7 TREATMENT OF CLEARED VEGETATION

Milling

Timber species documented for milling: Trim branches and stack in neat manageable stockpiles in approved locations.

Fauna habitat

Large tree trunks: Cut into transportable logs not less than 3.4 m in length any tree trunks nominated for salvage as fauna habitat logs and stockpile clear of construction.

Woodchip mulch

Prepare: Cut or split to a size to facilitate chipping or incorporation into the existing topsoil, as documented. All remaining timber that is not for milling, use as fauna habitat logs or for disposal offsite.

Woodchip mulch: Produce a woodchip mulch from crowns of shrubs and maximum 100 mm diameter branches of trees cleared under this work-section.

Dimensions of woodchip mulch: Two orthogonal dimensions less than 75 mm and 50 mm.

Timing: Chip cleared vegetation within 7 days of clearing to avoid excessive drying out of the vegetation and loss of seed stock.

Stockpiling of chipped vegetation

Landscaping: Stockpile the woodchip mulch for subsequent use in landscaping to the **Management of stockpiles and batters** in the *0257 Landscape - road reserve and street trees* work-section or for use at other locations if required.

Mixing: Mix the chipped vegetation into the existing topsoil during topsoil operations, as documented.

Avoid degradation: Carry out stockpiling operations so that chipped vegetation is suitable for use in the revegetation works.

Avoid contamination: Provide vegetation stockpiles free from stones, soil, rubbish and other materials and make sure stockpiles are not contaminated with matter toxic to plant growth.

Shape of stockpile: 5 m bottom width, 1.5 m high, batter 1H:1.5V.

Weed free: Keep vegetation stockpile sites free of weeds for the duration of the stockpiling period. Treat as necessary to control the weed species in conformance with requirements of local council.

Location: Locate stockpile sites away from drainage lines and position to allow ease of transport of materials at any time. Make sure stockpiles do not influence driver's sight lines or affect road safety.

Rehabilitation: Rehabilitate stockpile sites to **Grassing** in the *0257 Landscape - road reserve and street trees* work-section.

3.8 DISPOSAL OF MATERIALS

General

Re-use: Wherever possible re-use material.

Removal from site: Remove from site any material that cannot be re-used, in conformance with the Waste management plan.

Hazard minimisation: If burning is permitted by relevant authorities, conform to the following:

- Apply for relevant permits.
- Prevent damage to protected trees or trees outside the limits of clearing.
- Make sure that smoke resulting from such burning off does not cause a traffic hazard.
- Give notice of the intention to burn to neighbours and to the Fire Warden of the Fire Brigade.

3.9 COMPLETION

General

Requirement: At completion of clearing and grubbing, do not drive machinery or equipment over or disturb areas where there is no construction works proposed.

Warning signs on protected trees: Remove all tags.

4 ANNEXURES

4.1 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Design documentation Survey	H	Submit a survey plan showing the proposed area for clearing to confirm the clearing perimeters	7 days before commencement of clearing	Commencement of clearing

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Execution details Clearing and grubbing plan	H	Submit a clearing and grubbing plan	7 days before commencement of clearing	Commencement of clearing
SUBMISSIONS, Report Clearing report	H	Clearing report	7 days before commencement of clearing	Commencement of clearing
SUBMISSIONS, Execution details Establishment	H	Submit a method statement including proposed methods, equipment and materials	7 days before commencement of clearing	Commencement of clearing
INSPECTION, Notice Limits of clearing	H	Peg out area for clearing	7 days before commencement of clearing	Commencement of clearing
INSPECTIONS, Notice Tagging	W	Trees marked for preservation and transplanting are tagged	7 days before commencement of clearing	-
INSPECTIONS, Notice Trees within proposed embankment areas	H	Trees to be protected	7 days before commencement of clearing	Commencement of clearing
INSPECTIONS, Notice Unsound trees in road reserve	W	Marking of trees outside the limits of clearing	3 days before site clearing	-
INSPECTIONS, Notice Weed control	W	Identify any additional areas that require weed control	1 day after tagging of areas to be weed controlled	-
SUBMISSIONS, Execution details Work within exclusion zone and dripline	H	Submit a method statement	7 days before work within exclusion zone and dripline	Work within exclusion zone and dripline
*H = Hold Point, W = Witness Point				

4.2 ANNEXURE - PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope inclusions
1111.1 Clearing and grubbing	Hectare	All costs associated with documentation, survey, clearing and grubbing.
1111.2 Removal of trees outside limits of clearing	Each tree	All costs associated with removal of trees outside the area bounded by the limits of clearing in **LIMITS OF CLEARING**. The schedule quantity is a provisional quantity.
1111.3 Wood chipping and stockpiling	m^3 in stockpile.	All costs associated with wood-chipping and stock piling. The schedule quantity is a provisional quantity.
Traffic management	Lump sum	To the *1101 Traffic management* work-section.
Control of erosion and sedimentation	Lump sum	To the *1102 Control of erosion and sedimentation (Construction)* work-section.
Boundary fencing	Lin.m	To the *1196 Boundary fencing for road reserves* work-section.

4.3 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1744	2015	Standard alphabets for road signs
AS 4373	2007	Pruning of amenity trees
AS/NZS 4671	2001	Steel reinforcing materials

1112 EARTHWORKS (ROAD RESERVE)

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide earthworks for road reserve, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *0173 Environmental management (AUS-SPEC)*.
- *0257 Landscape - road reserve and street trees*.
- *1101 Traffic management*.
- *1102 Control of erosion and sedimentation (Construction)*.
- *1111 Clearing and grubbing*.
- *1113 Stabilisation*.
- *1351 Stormwater drainage (Construction)*.
- *1352 Pipe drainage*.
- *1353 Precast box culverts*.
- *1354 Drainage structures*.
- *1171 Subsurface drainage (Construction)*.
- *1172 Subsoil and formation drains (Construction).*

1.3 STANDARDS

General

Soil testing: To AS 1289 (Various).

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviation applies:

- CBR: California Bearing Ratio.

Definitions

General: For the purposes of this work-section the following definitions apply:

- Open drains: All drains other than pipe and box culverts and include catch drains, channels (gutters) and kerbs and channels (gutters).
- Rock (AUS-SPEC): Monolithic material with volume greater than 0.5 m^3 in sites which cannot be removed until broken up by explosives, rippers or percussion tools. For support purposes material hardness on the Mohr scale not less than 3 and not deteriorate on exposure to the atmosphere.
- Selected material zone: The top part of the upper zone of formation in which material of a specified higher quality is required.
- Shallow embankments: Embankments less than 1.5 metres depth from the top of pavement to natural surface.
- Spoil: Surplus excavated material.
- Unsuitable material: Material not suitable for support of pavement or layer of fill including:

. Material showing deformation, rutting, softness, yielding, distress or instability under proof-rolling or the loading from construction machinery.
. Topsoil, peat or any organic material.
. Soluble material, e.g. gypsum or salt rock.
. Susceptible to scouring or classified as Emerson Class number 1 or 2.

1.5 TOLERANCES

General

Measurement: At right angles to the slope line.

(+): Means toward the roadway surface.

(-): Means away from the roadway surface.

Batter slopes

Excavation: Conform to the following:

- At toe of batter and level of table drain:
  . ≤ 1:1 slope: + 0 mm, - 150 mm from the documented slope line.
  . > 1:1 slope: + 0 mm, - 200 mm from the documented slope line.
- ≥ 2 m above table drain:
  . ≤ 1:1 slope: ± 300 mm.
  . > 1:1 slope: 300 mm, - 600 mm.

Embankment: Conform to the following:

- 1 m below shoulder: ± 150 mm.
- > 1 m below shoulder: ± 300 mm.

Median areas: Conform to the following:

- ≤ 2 m measured horizontally from edge of shoulder: ± 35 mm from documented slope line, measured at right angles to the slope line within 24 hrs of compaction.
- > 2 m measured horizontally from edge of shoulder: ± 75 mm from documented slope line, measured at right angles to the slope line within 24 hrs of compaction.

Floors

Floor of cutting: To **ANNEXURE - EARTHWORKS INFORMATION**.

Tops of embankments

At completion of embankment construction: Conform to the following:

- Parallel to the designed grade line.
- + 10 mm or - 40 mm of the levels specified.

Selected material

Completed layer: To **ANNEXURE - EARTHWORKS INFORMATION**

Selected backfill

Plasticity Index: > 2, < 12 adjacent to structures.

1.6 SUBMISSIONS

Authority approvals

Requirement: Submit details of all authority approvals before commencing the works for which the approval is granted, including the following:

- Spoil and borrow:

. Planning approval.
. Permits for access to locations.

Calculations

- Survey records.
- Cut and fill calculations.

Design documentation

General: Submit the following:

- Survey: Submit site survey verifying existing ground profile within 14 days of site possession.

Execution details

Survey system: Submit details of the proposed survey system for approval. within 14 days of possession of site before commencement of clearing and grubbing or earthworks.

Ground model discrepancies: If discrepancies in the model are identified, submit plans 7 days, before commencement of Works and state the maximum dimensions of the proposed stockpile.

Unsuitable material: Submit details of any areas of the foundation or layer which ruts excessively, yield or shows signs of instability.

Cuttings in rock: Submit detailed procedures to maintain accurate dimensions and uniform batters in rock.

Excavation method statement: Submit including details of excavation procedures based on geotechnical information, as documented.

Excavation beyond batter line: Submit details of alternative corrective measures.

Embankment treatment type: If either loosen and compact, bridging layer, working platform, geotextile/geogrid layer, drainage layer or other treatment is proposed, submit details.

Contaminated material: Notify and submit details of proposed method and disposal location, 24 hours before disposal.

Records

Drawings: Work-as-executed drawings. One design file in accordance with the ADAC specification, which is available on Council's website.

Tests

Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

1.7 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Unsuitable material: Material deemed unsuitable for embankment or pavement support in its present position.
- Unsuitable material: Determine that sufficient depth of unsuitable material has been removed.
- Cuttings in rock: Stability of batter.
- Ripping floors of cuttings: Ripped or loosened material.
- Compacting floors of cuttings: Completed cutting floor.
- Transition from cut to fill: Position of intersection line between cutting and embankment.
- Bridging layer treatment: Seepage water causing movement under roll test. Remove wet material to spoil or construct subsoil drainage or both based on site conditions.

- Foundations: Embankment foundation area following removal of topsoil.
- Trimming tops of embankment: Trimmed and compacted embankment.
- Selected material zone: Completed surface before placing any subsequent pavement layers over the completed select material zone surface.
- Deflection monitoring and proof rolling: Any visible deformation, rutting, yielding and or showing signs of distress or instability.

2 PRE-CONSTRUCTION PLANNING

2.1 GENERAL

Planning approval

Spoil haulage disposal: If handling of spoil is involved.

Borrow: If proposed, obtain approval and any permits required for entry on land.

Program

Timing: Program the work so that material conforming to **PLACING FILL FOR EMBANKMENT CONSTRUCTION** and **SELECTED MATERIAL ZONE** for the upper zones of the formation, is available when required.

Rock supply: Adjust working methods and program the work to obtain hard and durable rock to the documented dimensions, as required.

2.2 SURVEY

Ground models

Verification: The contractor may receive ground models before commencement of Contract, in the form of computer-generated road design data files in the format of the approved software.

Verification alternative: The Contractor may verify the accuracy of the model by field surveys.

Shallow embankments: Survey and calculate the area of shallow embankments after removal of topsoil.

3 MATERIALS

3.1 MATERIAL CHARACTERISTICS

Items to be clarified on site

Quality and quantity: Confirm the following factors for determining material quality and quantity:

- Nature and types of the materials encountered in excavations.
- The bulking and compaction characteristics of materials incorporated in embankments.
- The estimated quantity for general earthworks at any cutting includes all types of materials which may be encountered in the cutting.

Embankment material

Source: Obtain the material for embankment construction from the cuttings within the Works conforming to **CUTTINGS, Cuttings in rock**, supplement by borrow in conformance with **BORROW**.

Description: Free of tree stumps and roots, clay, topsoil, steel, organic material and other contaminants and suitable for compaction to **COMPACTION AND MOISTURE REQUIREMENTS**.

Excavated material: Use for constructing embankments if it conforms to documented requirements.

Deficient embankment material: Rectify deficiency conforming to **Benching in cuttings**.

Drainage layer material properties table

Property	Requirement
Maximum dimension	125 mm
Percentage passing: - 19.0 AS sieve - 1.18 AS sieve - 75 µm AS sieve	 0-15% 0-5% < 0.5%
Percentage of + 19.0 mm fraction with $Is_{(50)}$	Maximum 10%
Wet/dry strength variation	**ANNEXURE - EARTHWORKS INFORMATION**
$Is_{(50)}$ = Point lead strength	

4 EXECUTION

4.1 ESTABLISHMENT

Protection of earthworks

Erosion and sedimentation control: Install erosion and sedimentation control measures to the *1102 Control of erosion and sedimentation (Construction)* work-section before commencing earthworks and maintain measures for the duration of the contract.

Drainage of working areas: Maintain drainage of all working areas throughout the construction period, so that there is no ponding of runoff, except where ponding forms part of an approved erosion and sedimentation control system.

Salinity prevention: In salt affected areas, take precautions to minimise ingress of surface water into the groundwater table.

Wet weather precautions: If rain is likely or no work is proposed in a working area on the following day, take precautions to minimise ingress of excess water into earthworks material.

Loose material: Seal off ripped material remaining in cuttings and material placed on embankments by compaction to provide a smooth tight surface.

Wet material: If in-situ or stockpiled material becomes excessively wet as a result of inadequate protection of earthworks, replace and/or dry out the material to minimise any subsequent delays to the operations.

Setting out of earthworks

Timing: Establish batter indicator boards and pegs before earthworks operations commence and after survey controls are in place.

Indicators: Locate indicators as follows:

- Horizontal: Generally 25 m intervals.
- Verified interval: Not more than 5 m height.

Information on the indicator and pegs: Clearly mark the chainage/station, offset from control line and slope distance to the finished surface level.

Retention and removal of pegs: Maintain all pegs and batter indicators in their correct positions. Remove them on completion of the contract or separable part.

Additional pegs: Place additional pegs and indicators as required to suit. Do not paint these the same colours as setting out pegs and stakes.

Transitions cuttings/embankments: Mark the position and extent of all transitions from cuttings to embankments and foundations for shallow embankments with clearly labelled stakes.

4.2 REMOVAL OF TOPSOIL

Program

Timing: Remove topsoil only after implementation of erosion and sedimentation controls and completion of clearing, grubbing and disposal of materials for that section of the Works.

Extent of work

General: Remove topsoil throughout the length of the Work and stockpile separately clear of the work. Avoid contamination by other materials.

Cuttings: Remove topsoil to a depth documented in **ANNEXURE - EARTHWORKS INFORMATION**.

Embankments: Remove topsoil over the base of embankments to the depth below the natural surface documented in **ANNEXURE - EARTHWORKS INFORMATION**.

Shallow embankments: If the height of embankment from natural surface to underside of pavement is less than 2 m, remove topsoil which is deeper than the depth documented in **ANNEXURE - EARTHWORKS INFORMATION** to its full depth.

Erosion control

Stabilisation: Track roll or stabilise stockpile batters to minimise erosion.

Seeding of stockpiles: If required to encourage vegetation, conform to **Grassing** in the *0257 Landscape - road reserve and street trees* work-section.

4.3 UNSUITABLE MATERIAL

General

Requirement: Identify unsuitable materials conforming to AS 3798 clause 4.3. Excavate, remove and replace unsuitable material.

Removal: Dispose of unsuitable material as permitted by local authorities.

Replacement material

Material property: Replace unsuitable material with material from cuttings, or with material borrowed in conformance with **EMBANKMENTS, Embankment material** or **BORROW**.

Compaction: Before replacing material, compact the excavated surface to conform to **Compaction and moisture requirements**.

Placing: Replacement material is deemed to form part of embankment construction. Conform to **PLACING FILL FOR EMBANKMENT CONSTRUCTION** and to **COMPACTION AND MOISTURE REQUIREMENTS**.

Resultant unsuitable material: Rework or replace any unsuitable material resulting from inappropriate construction activities.

4.4 CUTTINGS

General

Requirement: Excavate material including benching, treatment of cutting floors and transition from cut to fill, as documented.

Excavated materials: Loosen and break down material excavated from cuttings to conform to **EMBANKMENTS**, **Embankment construction** and **Embankment material**.

Cleaning: Clean cut batters in rock with slopes of 1H:1V or steeper with compressed air until loose rock and soil is removed. Do not used water jets or air-water jets.

Benching in cuttings

Benches: Bench cut batters at locations and widths, as documented, to provide drainage and erosion control to **BATTERS**, **Excavation tolerances for batters table.**

Bench maintenance: Remove loose stones and boulders regularly throughout the Contract period.

Variable material

Excavation methods: If material of variable quality or moisture content is found after removal of topsoil, adjust excavation methods to allow blending of the materials and to obtain material in conformance with **EMBANKMENTS, Embankment material**.

Tops of cuttings

General: Neatly rounded, as documented.

Floors of cuttings

Excavation level: Excavate the floors of cuttings, parallel to the designed grade line, to a designed floor level at the underside of the selected material zone, or where there is no selected material zone, to the underside of the pavement subbase.

Trimming: Trim the floors to documented tolerance.

CBR testing: Before ripping the cutting floor, determine the CBR of the various materials which may exist in the cutting floor.

Ripping floors of cuttings: Rip material in the floor to a minimum depth of 150 mm below the designed floor level for the width of the selected material zone (or subbase layer, where no selected material zone).

Particles in the ripped or loosened zones: Maximum 150 mm.

Compacting floors of cuttings

Compaction: Re-compact ripped or loosened material to conform to **COMPACTION AND MOISTURE REQUIREMENTS.**

Maximum compacted material particle dimension: 200 mm.

After re-compaction: Re-trim the floors of cuttings parallel with the finished wearing surface.

Tolerances: Conform to **ANNEXURE - EARTHWORKS INFORMATION**.

Batter slopes

Profile: Construct batter slopes, as documented.

Tops of cuttings: Neatly round tops of cutting to the documented dimensions and, re-setout, remove additional material and re-trim, if required.

Batters for cuttings: Even and without undulations in the general plane of the batter except that batters may require progressive flattening at the ends of cuttings due to the presence of less stable material.

Unstable material: Clean cut faces of loose or unstable material progressively as the excavation proceeds.

Excavation beyond batter line

Minor over excavation: Minor change in the general slope of the batter, beyond slope line and the tolerance applicable may be approved, however, this does not constitute a variation for batter slopes.

Alternative corrective measures: Provide details of the material and/or methods proposed to restore the required slope and stability of the batter.

Batters steeper than 1H:1V: If any section of the batter, up to a height of 3 m above the table drain level, has been over excavated beyond the tolerance limit documented, restore batter to the average batter slope using randomly mortared stone.

Restoration material: Conform to the following:

- Stone: Similar to sound rock in the cutting.
- Mortar: Coloured to match the rock.

4.5 TRANSITION FROM CUT TO FILL

Intersection line

Survey: After removing the topsoil and before excavating any cutting, mark the position of the intersection line between cutting and embankment occurring at the underside of the selected material zone or pavement subbase.

Terrace construction

General: Following excavation to the cutting floor, excavate a terrace for the width of the selected material zone (or subbase layer, where no selected material zone) to a depth of 900 mm below and parallel to the cutting floor, as shown in **ANNEXURE - TRANSITION FROM CUT TO FILL**.

Extent of terrace: Extend the cut to the point where the cutting floor is 900 mm below the original stripped surface, or a distance of 20 metres, whichever is the lesser.

Excavated material: Incorporate the material excavated into the embankments or dispose of as permitted by local authorities.

Material placed above the terrace: Conform to **EMBANKMENTS, Embankment material** and compact to **COMPACTION AND MOISTURE REQUIREMENTS**.

Free drainage: Provide 1% minimum grade towards the nearest exit of the cutting or install a subsurface drain at the lower end.

4.6 EMBANKMENTS

Foundations

Unsuitable material: If any underlying material is determined unsuitable, remove and replace the material conforming to **UNSUITABLE MATERIAL**.

Preparation for shallow embankments: Loosen material exposed by the removal of topsoil and unsuitable material to a depth of 150 mm, adjust moisture content of loosened material and compact to **COMPACTION AND MOISTURE REQUIREMENTS**.

Preparation for other embankments: Grade and level to general area, adjust the moisture content and compact the top 200 mm to **COMPACTION AND MOISTURE REQUIREMENTS**.

Foundation damage: Use suitable equipment and techniques to minimise surface heaving or other foundation damage.

Bridging layer treatment

Ground water seepage: A bridging layer may be used with approval, if ground water seepage is encountered in foundation area or it is demonstrated that it is impracticable to achieve compaction of the foundation to **COMPACTION AND MOISTURE REQUIREMENTS**. A bridging layer is unacceptable where the proximity of the bridging layer to the pavement is likely to affect the pavement design.

Material: Free-draining granular material with strong mechanical interlock and low sensitivity to moisture.

Method: End-dump the granular material and spread in a single layer, in sufficient depth to allow the passage of earthmoving equipment with minimal surface heaving. The compaction requirements of C**OMPACTION AND MOISTURE REQUIREMENTS** do not apply to the bridging layer.

Working platform treatment

An alternative to a bridging layer: A working platform created by the chemical stabilisation of in-situ material conforming to the 1113 Stabilisation work-section.

Geotextile/geogrid layer

Requirement: If approved, to **MATERIALS**, **GEOTEXTILE** in the 1171 Subsurface drainage work-section and **EXECUTION, GEOTEXTILE** in the 1172 Subsoil and formation drains work-section.

Drainage layer treatment

General: Install drainage layer of rock enclosed with geotextile over embankment foundations.

Drainage: Shape and trim embankment foundation to provide drainage of the embankment. After, construction, maintain a clear drainage path, especially at the outer edges of the embankment.

Hillside embankments

Requirement: If embankments are constructed on or against any natural slopes or the batters of existing embankments, and if the existing slope or batter is steeper than 10H:1V in any direction, cut horizontal terraces as follows:

- Step the existing slope or batter in successive terraces, minimum 1 m in width, and cut terraces progressively as the embankment is placed.
- Depth: Conform to the following:
  - Minimum 300 mm at the steps.
  - If existing slope is 4H:1V: Minimum 600 mm at the steps.
- To coincide with natural discontinuities wherever possible.
- Provide subsoil drainage, if required.
- Compact excavated material as part of the new embankment material.

Batter slopes

Design criteria: The batter slopes, as documented represent the estimated requirements for the expected types of materials.

Redetermination: Batter slopes may be changed following further assessment of the materials found on site.

Average planes of embankment batter: As documented when completed.

Slope undulations: Avoid undulations in the general plane of the batter.

Batter slope for median areas

Free draining: Grade medians so there is no ponding.

Rock facing of embankments

Requirement: Provide a facing of clean, hard, durable rock to embankment batters, including embankments at bridge abutments.

Location: As documented.

Rock placement: Exercise extreme caution whilst placing the rock facing as follows:

- Where embankment material is placed above other roads in use, place the outer rock layer to prevent movement down the batter or onto the roadway.
- Make sure that, no rock can be dislodged and roll onto any adjacent roadway or track in use.

Mechanical interlock: Build up the rock facing in layers before each layer of filling. Place rock by hand or plant so that its least dimension is vertical and mechanical interlock between the larger stones occurs.

Excess fine material: Remove excess fine material surrounding rock. Replace rocks, if required.

Graded filter: Fill space between larger batter rocks with progressively smaller rocks to form a graded filter which prevents the leaching out of fines from the fill material but does not overfill the voids between larger rocks, or cause the larger rocks to lose contact with one another. Remove fine material from the outside of the rocks on the face of the batter.

Geotextile: Use an appropriate geotextile for embankment construction to prevent the leaching out of fines from the fill material, as documented.

4.7 PLACING FILL FOR EMBANKMENT CONSTRUCTION

General

Uniformity of material: Use methods for excavation, transport, depositing and spreading of fill material so that placed material is uniformly mixed.

Embankment stability: Construct the embankment and stabilise by compaction of the fine material, embedding the large rock pieces rather than mechanical interlock of the rock pieces. Compact fine material in conformance with **COMPACTION AND MOISTURE REQUIREMENTS**.

Placing: Place fill in layers parallel to the grade line and compact in conformance with **COMPACTION AND MOISTURE REQUIREMENTS**.

Layer thickness

Requirement: Uniform, compacted layers not more than 200 mm thickness.

Large rock: If more than 25% by volume of the filling consists of rock with any dimension larger than 150 mm, seek approval to increase thickness to 300 mm. Relative compaction to conform to **COMPACTION AND MOISTURE REQUIREMENTS**.

Maximum layer thickness and material properties of rock in earth fill embankments table

Maximum layer thickness (mm)	Minimum quantity rock (by volume)	Maximum rock size (mm)	% Passing 37.5 mm AS Sieve (by mass)
300	–	200	> 60%
500	25% > 200 mm	300	> 60%

Rock pieces

Grading of fill material: Break down rock material and evenly distribute it through the fill material, and place sufficient fine material around the larger material as it is deposited to fill voids and produce a dense, compact embankment.

Insufficient fine material: If there is insufficient fine material to fill the voids, obtain additional fine material from other places in the work or change the method of winning fill material.

Stony patches: Rework stony patches having insufficient fine material, with additional fine material to achieve a dense, compact layer.

Equipment

General: Use suitable equipment and techniques to avoid surface heaving or other damage to the foundations and underlying embankment layers.

CBR value

Requirement: CBR of compacted embankment material below selected material zone (or subbase layer, where no selected material zone) to **ANNEXURE - EARTHWORKS INFORMATION**.

Trimming tops of embankments

Top of embankments: Trim parallel to the design grade line at levels equal to the finished surface level, less the thicknesses of pavement courses and the selected material zone, if applicable.

Compaction: Compact the tops of embankments in conformance with **COMPACTION AND MOISTURE REQUIREMENTS**.

4.8 SELECTED MATERIAL ZONE AND VERGES

Site won selected material

Requirement: Conform to the following:

- Stone size: Maximum 100 mm and have no less than 50% passing the 19 mm sieve.
- CBR value: To **ANNEXURE - EARTHWORKS INFORMATION**.
- Maximum Plasticity Index: 15.

Site won verge material

Requirement: Conform to the following:

- Size: Maximum 50 mm and no less than 50% passing the 19 mm sieve.
- Have a CBR value not less than specified in **ANNEXURE -**
- **EARTHWORKS INFORMATION**.
- Maximum Plasticity Index: 15.

Spill through bridge abutment fill material

Material at waterway crossings and at overbridges: Conform to the following:

- Grading: 100% passing the 53 mm AS Sieve.
- Waterway crossings:
- CBR value: To **ANNEXURE - EARTHWORKS INFORMATION**.
- Plasticity Index: 6 to 15.
- Overbridges:
  . CBR value: To **ANNEXURE - EARTHWORKS INFORMATION**.
  . Maximum Plasticity Index: 25.

Stabilisation: If chemical stabilisation is required, the requirements of this clause apply to the selected material immediately before incorporating the stabilising agent.

Winning material: Obtain the selected material from cuttings excavated under the Contract or from borrow areas in conformance with **BORROW**.

Work methods: If required, use work methods to yield material by breaking down oversize rock, including processing through a crusher so that resulting material conforms to documented requirements.

Conservation of material

Stockpiles: If the material is not placed directly in the selected material zone, stockpile it at approved locations for future use until sufficient material is reserved to complete the selected material zone over the whole work and make sure stockpiles do not exceed 4000 tonnes.

Extra material: If suitable available material has not been conserved, provide material of equivalent quality.

Placing and compaction

Layers: Place and compact in layers in conformance with **COMPACTION AND MOISTURE REQUIREMENTS**.

Compacted layer thickness: < 150 mm.

Composition of layers: Homogeneous and free from patches containing segregated stone or excess fines.

Non- conforming material: Exclude all non-complying material from all areas.

Top of the selected material zone: Compact and trim parallel with the design grade line at a level equal to the finished surface level minus the thickness of pavement layers adopted. The tolerances for the trimmed levels are given in **ANNEXURE - EARTHWORKS INFORMATION**.

4.9 FILL ADJACENT TO STRUCTURES

General

Structure types: Structures include bridges, precast and cast-in-place box culverts and retaining walls.

Fill adjacent to other culverts and drainage structures: Conform to **BEDDING AND SUPPORT MATERIAL** and **BEDDING AND BACKFILLING** in the *1351 Stormwater drainage (Construction)* work-section.

Time of placement: Do not place fill against structures, headwalls or wing walls within 21 days after placing of the concrete, unless the walls are effectively supported by struts as approved or it can be demonstrated that 85% of the design strength of the concrete has been achieved.

Treatment at weepholes

Gravel: Provide drainage adjacent to weepholes by a layer of broken stone or river gravel consisting of clean, hard, durable particles graded from 50 mm to 10 mm as follows:

- Particle dimension: < 50 mm.
- < 5 % mass to pass the 9.5 mm AS sieve.

Extent: Extend broken stone or river gravel continuously in the line of the weepholes, at least 300 mm horizontally into the fill and from 200 below to at least 450 mm vertically above the level of the weepholes.

Geotextile membrane: Alternatively, provide a geotextile membrane of equivalent drainage characteristics. Store and install to the manufacturer's recommendations.

Backfill

Location: Place backfill adjacent to structures, as documented.

Backfill material: Conform to the following:

- Granular material.
- Size: < 50 mm.
- Plasticity Index: Between 2 and 12.

Placement: Place backfill in layers, with a maximum compacted thickness of 150 mm simultaneously on both sides of box culverts and other drainage structures to avoid differential loading. Start compaction at the wall and proceed away from it, in conformance with **COMPACTION AND MOISTURE REQUIREMENTS**.

Horizontal terraces: Cut the existing embankment slope behind the structure in the form of successive horizontal terraces, minimum 1 m wide, and place backfill to **PLACING FILL FOR EMBANKMENT CONSTRUCTION**.

Spill through abutments: Do not dump rocks against columns or retaining walls, build up evenly around or against structures.

Framed structures: For embankments at both ends of the structure, bring up backfill at both ends simultaneously, keeping the difference between the levels of the embankments less than 500 mm.

Backfill width and height table

Structure type	**Backfill**	
	Width	**Height**
Bridge abutments	2 m	H
Cast-in-place box culverts	H/3	H + 300 mm
Corrugated steel pipes and arches	0.5 m	H + 500 mm
Retaining walls	H/3	H
Note: H = Height of structure		

4.10 SPOIL

Non-contaminated materials

Embankments: If flatter batter slopes are required on embankments or if excess material is to be used in the uniform widening of embankments, shape the surface to provide a tidy appearance and effective drainage.

Surplus material: Spread and compact the surplus material in conformance with, **PLACING FILL FOR EMBANKMENT CONSTRUCTION** and **COMPACTION AND MOISTURE REQUIREMENTS** for material in embankments.

Disposal: Dispose of spoil at approved locations. Compact spoil in conformance with **COMPACTION AND MOISTURE REQUIREMENTS** for material in embankments.

Contaminated material

Requirement: Stockpile and/or remove from the site in an approved manner and location.

Method: Excavate and dispose of all contaminated material in an environmentally responsible manner including the following:

- Test material uncovered on-site before disposal. If putrescibles wastes are included, analyse leachate and landfill gases.
- Excavate material without creating off-site environmental problems.
- Seal remaining contaminated material or wastes, where only part of the tip has been excavated, so there is no off-site effect now or in the future.
- Transport odorous wastes in covered vehicles.
- Dispose of contaminated material in a landfill licensed to take the type of contaminated material or wastes uncovered.

4.11 BORROW

General

Criteria: Unless provided by the Contract, borrow will only be authorised for the following:

- Constructing cuttings and embankments to the batter slopes.
- Providing materials of the quality specified.

- When there is an overall deficiency in either the quantity or the quality of material required to complete the works.

Wastage: Borrow will not be authorised for excess widening of embankments or wastage of quality material by the Contractor.

Material: Conform to **EMBANKMENTS, Embankment material** and **Rock facing of embankments**, or **FILL ADJACENT TO STRUCTURES**.

Authorities: Conform to the requirements of the Local Council, land owners, and the State and Territory environmental planning legislation, livestock protection boards and soil conservation services, as appropriate.

Borrow sites

Location: Make sure the edges are no closer than 3 m from any fence line, road reserve boundary or edge of excavation or embankment and provide adequate clearance for the construction of catch drains.

Borrow site location: As approved.

Drainage: Provide drainage outlets, as documented.

Batter slopes: Conform to the following:

- Not steeper than 4H:1V.
- To be left in a tidy and safe condition.

Site preparation and restoration: For borrow within the defined working area for the Works, prepare site in conformance with the *1111 Clearing and grubbing* work-section and **REMOVAL OF TOPSOIL**.

Widening of cutting: If borrow material is obtained by uniformly widening a cutting, conform to **CUTTINGS**, **BATTERS**, for the redetermination of batter slopes, compaction of floors of cuttings respectively and the trimming of batters.

4.12 COMPACTION AND MOISTURE REQUIREMENTS

Trimming and compaction

Requirement: Compact all layers uniformly, as documented before the next layer is commenced.

Trimming: Trim each layer of material before and during compaction to avoid bridging over low areas and to present a smooth surface at the top of each layer.

95% compaction

Requirements: Compact the following areas to provide a relative compaction, not less than 95% for standard compactive effort:

- Each layer of material replacing unsuitable material, as documented in **UNSUITABLE MATERIAL**.
- Each layer of material placed in embankments, up to 0.3 m up to the underside of the pavement.
- Fill placed adjacent to structures up to 0.3 m from the top of pavement.
- Material in unsealed verges and within medians up to the level at which topsoil is placed.
- Spoil (excluding unsuitable material).
- All other areas except those where higher relative compaction is documented.

Unsuitable material: Stockpile as documented and compact by track rolling.

97% compaction

Requirements: Compact the following areas to provide a relative compaction of not less than 97% as for modified compactive effort:

- Foundations for shallow embankments.
- The whole area on the floor of cuttings.
- Each layer of the embankment within 0.3 m up to the underside of the pavement.
- Each layer of the selected material zone, as documented in **SELECTED MATERIAL ZONE**.
- Any areas of material of documented quality behind kerbs and/or gutters or adjacent to rigid pavements, as documented.
- The fill material placed adjacent to structures as documented in **FILL ADJACENT TO STRUCTURES, Backfill** in each layer within 0.3 m from the top of the pavement.

Shallow cutting

Floor of shallow cutting: To **CUTTINGS, Floors of cuttings** and **TRANSITION FROM CUT TO FILL** and compact to provide a relative compaction of not less than 97% for a depth of 300 mm for modified compactive effort.

Cut-fill transition

Requirement: If shallow cutting conditions occur, the requirements of **TRANSITION FROM CUT TO FILL** may be modified so that the depth of terrace excavation at the transition from cut to fill is reduced from 900 mm to 250 mm.

Proof rolling

General: Conform to, **ANNEXURE – MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Requirement: Proof roll, if required to **ANNEXURE - EARTHWORKS INFORMATION** and where ripping or loosening of the cutting floor is not required.

Moisture content

Compaction timing: Adjust the moisture content of the material at the time of compaction to allow the required compaction to be attained, at a moisture content which is within the range set out in **ANNEXURE - EARTHWORKS INFORMATION** and as follows:

- Wet material: Do not compact material that has become wet after placement until it has dried out so that the moisture content is within this range.
- Aeration: The drying process may be assisted by aeration or by the use of hydrated or quick lime.
- Drying: Alternatively, transport the wet material to a stockpile site for drying out and later use as fill material.
- Dry material: If the material is too dry for required compaction, add water. Apply water uniformly and thoroughly, mix with the material until a homogeneous mixture is obtained.

Compaction

Extent: Compact the material to obtain the required relative compaction for the full depth of each layer in embankments and for the full width of the formation over the entire length of the work.

Rain damage: Complete compaction promptly to minimise the possibility of rain damage and conform to the following:

- If material that has achieved relative compaction becomes wet and moisture content is greater than the optimum level, determined by AS 1289.5.1.1, dry out and uniformly recompact to the required relative compaction before next layer is placed. Alternatively, remove wet layer of material to a stockpile site for future use.

Repair: Loosen, recondition and recompact rain damaged surfaces before placing another layer of material.

4.13 FURNITURE AND SERVICES

Widening of formation

General: Widen road shoulders and formation to accommodate footpaths, guard fence, streetlight plinths, emergency telephone bays and vehicle standing areas, as documented.

Testing

4.14 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Deflection monitoring or proof rolling tests

Preparation: Present the work available in lots, to carry out deflection monitoring or proof rolling.

Minimum Lot size: 300 m continuous length of formation, or lesser length as approved, and a single carriageway width with homogeneous material and appearance.

Boundaries: Identify the boundaries of each lot with clearly labelled stakes.

Timing: Test within 3 days of compaction. Following completion of the formation to the underside of the selected material zone and completion of the selected material zone.

Compaction and moisture tests

Preparation: Prepare the area at sampling locations for required compaction and moisture tests.

Moisture content: Before testing, work the lot, make sure moisture content and compaction of all material is uniform within the lot.

Test representation: Test/s taken are considered to represent the total volume of material placed within the lot.

Further testing: Undertake further testing if the material which is present has not achieved required uniformity to **PLACING FILL FOR EMBANKMENT CONSTRUCTION**. Nominate the area to be represented by the additional testing.

Non-conforming material: If such testing confirms non-conformance, perform remedial work as necessary to achieve conformance to **COMPACTION AND MOISTURE REQUIREMENTS**.

Deflection monitoring or proof rolling test results: Conform to the following:

- If required characteristic deflection is less than 1.2 mm, make sure the standard deviation of the lot does not exceed 0.2 mm.
- If required characteristic deflection exceeds 1.2 mm, make sure the coefficient of variation of the lot does not exceed 25%.

Further proof rolling: If required, at a later date, re-condition the layer so that the moisture content conforms to **COMPACTION AND MOISTURE REQUIREMENTS**. Pass the roller no less than 8 times.

4.15 COMPLETION

Temporary works at completion

Tree enclosures: Remove temporary tree enclosures.

Tree marking: Remove temporary marks and tags.

Temporary supports: Remove temporary supports to adjacent structures.

Site restoration

Requirement: Where variation of existing ground surfaces is not required as part of the works, restore surfaces to the condition existing at the commencement of the contract or to the *0257 Landscape - road reserve and street trees* work-section.

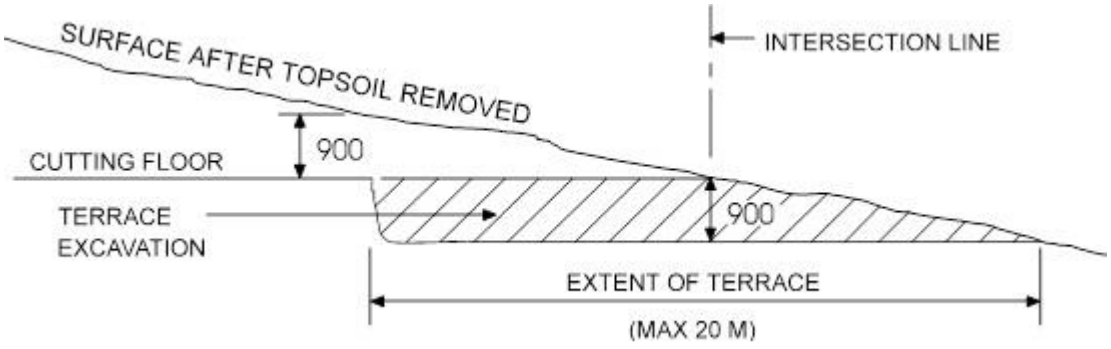
5 ANNEXURES

5.1 ANNEXURE - EARTHWORKS INFORMATION

Work-section clause/subclause	Description				Value
Removal of topsoil/Extent of work	The depth below natural surface up to which the removal and measurement of top soil shall apply:				
	- Cutting areas (mm)				
	- Embankment areas (mm)				
Cuttings/Floors of cuttings	Minimum CBR value in cutting floors used for design of pavement (%)				
Cuttings/Compacting floors of cuttings	Construction tolerances, of the designated grade and crossfall, for floors of cuttings after recompaction (mm)				
Embankments/Foundations for embankments	Requirements of material in foundations for shallow embankments:				
	- Moisture content range (% of optimum)				
Selected Material/Site won material	Upper Zones of Formation & Selected Material Zone				
	Location	Minimum CBR Value	Depth	Nominated Soaking Period (Days)	
	Selected Material Zone	<			
	Material below Selected Material Zone to 1.5 m from top of pavement.	<			
	'Spill through' bridge abutment fill material: - Waterway crossing - Overbridges	<			
Selected material zone/ Placing and compaction	Construction tolerances for Selected Material Zone are: - Designed grade and - Crossfall				
	Shallow cuttings:				

Work-section clause/subclause	Description	Value
Compaction and moisture requirements/Proof rolling	Sections of work nominated to be in shallow cutting:	
	- Ripping or loosening in shallow cutting	Required/Not required
	- Proof rolling of subgrade [is / is not] required.	Required/Not required
	- Monitor deflection at underside and top of selected material zone with Benkelman Beam	Yes/No
Compaction and moisture requirements/Moisture content	Moisture content range of material placed in embankments:	
	- Material in upper zones of formation: (% of optimum)	
	- All other embankment material: (% of optimum)	

5.2 ANNEXURE - TRANSITION FROM CUT TO FILL



5.3 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

Clause/Description	Type	Submission/Inspection	Submission/Notice details	Process held
INSPECTIONS Notice Unsuitable material	W	Material deemed unsuitable for embankment or pavement support in its present position.	3 days before replacement of unsuitable material	Replacement of unsuitable material
INSPECTIONS Notice Unsuitable material	H	Determine sufficient depth of unsuitable material has been removed	3 days before backfilling with replacement material	Backfilling with replacement material
INSPECTIONS Bridging layer treatment identified by roll test.	H	Subgrade or pavement movement observed under roll test	Wet material removed and subsoil treatment applied.	Subgrade or pavement layer acceptance prior to further pavement construction.
INSPECTIONS Notice	H	Stability of batter	3 days before excavation	Excavation below bench level for

Clause/Description	Type	Submission/Inspection	Submission/Notice details	Process held
Cuttings in rock				slopes of 1H:1V or steeper
INSPECTIONS Notice Ripping floors of cuttings	H	Ripped or loosened material	3 days before re-compaction	Re-compaction
CUTTINGS, Compacting floors of cuttings	H	Compacted cut floor	3 days before placing subsequent layers	Placing subsequent layers
INSPECTIONS Notice Transition from cut to fill	W	Position of intersection line between cutting and embankment.	3 days before excavation cutting	Excavation cutting
INSPECTIONS Notice Foundations	H	Embankment foundation area following removal of topsoil.	3 days before treatment of each Lot of embankment foundation	Treatment of each Lot of embankment foundation
SUBMISSIONS Execution details Embankment treatment type	H	If either loosen and compact, bridging layer, working platform, geotextile/geogrid layer, drainage layer or other treatment is proposed, submit details.	3 days before additional treatments	Additional treatments; loosen and compact, bridging layer, working platform or geotextile/geogrid layer, drainage layer
INSPECTIONS Notice Trimming tops of embankment	H	Trimmed and compacted embankment	3 days before placing any subsequent pavement layers	Placing any subsequent pavement layers
INSPECTIONS Notice Selected material zone	H	Completed surface	3 days before placing any subsequent pavement layers	Placing any subsequent pavement layers
INSPECTIONS Notice Deflection monitoring and proof rolling	W	Any visible deformation, rutting, yielding and or showing signs of distress or instability.	3 days before completion	Completion

5.4 ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Stripping topsoil	Surface levels	10,000 m²	1 cross section per 25 m	Survey
Excavation	Geometry	10,000 m²	1 cross section per 25 m	Survey
Floor of cuttings	Cuttings and placing fill for embankment construction: - CBR test	5,000 m²	1 per 1,000 m² *	AS 1289.6.1.1
	Compaction	10,000 m²	1 per 500 m²	AS 1289.5.4.1
Foundation for Embankments	Compaction	5,000 m²	1 per 500 m²	AS 1289.5.4.1
Embankments - General	Geometry	1 layer 10,000 m²	1 cross section per 25 m	Survey
	Material quality: - CBR	1 layer 5,000 m²	1 per 800 m³	AS 1289.6.1.1
	Compaction/moisture content/optimum moisture content	1 layer 5,000 m²	1 per 250 m³	AS 1289.5.1.1 AS 1289.5.4.1
Embankments - Select zone	Geometry	1 layer 10,000 m²	1 cross section per 25 m	Survey
	Material quality: - Particle size distribution - CBR	10,000 m² 10,000 m²	1 per 1,000 m³ * 1 per 500 m³ *	AS 1289.6.1.1
	Compaction/moisture content/optimum moisture content	1 layer 5,000 m²	1 per 250 m³ *	AS 1289.5.1.1 AS 1289.5.4.1
Selected material zone and fill adjacent to bridges, wingwalls, retaining walls and culverts	Material quality: - Particle size distribution - Plasticity index	1 Structure 1 Structure	1 per 200 m³ * 1 per 200 m³ *	AS 1289.3.3.1
	Compaction/moisture content	1 Structure	1 per layer	AS 1289.5.1.1 AS 1289.5.4.1
Compaction and moisture tests	Proof rolling	1 layer 5,000 m²	1 per lot	RMS T198
	Deflection monitoring: - Benkelman beam method	1 layer 5,000 m²	1 per lot	RMS T199
Subgrade			1 test per 50 lineal metres of road, or minimum one test per 250m2	
* Note: or part thereof, per lot. Lot size: A continuous length of formation at least 300 m, or lesser length, and a single carriageway width with homogeneous material and appearance.				

5.5 ANNEXURE – PAY ITEMS

Pay items	Unit of measurement	Schedule rate inclusions
1112.1 Removal and stockpiling of topsoil	m^3 measured as bank volume. The volume to be the sum of: - The volume removed from cuttings calculated by multiplying the area of cutting to be stripped as calculated from the plans of natural surface or accepted ground model by the depth of topsoil required to be removed plus; - The volume removed from under embankments calculated by multiplying the area to be stripped as calculated from the plans of natural surface or accepted ground model by the depth of topsoil stripping as nominated in **ANNEXURE - EARTHWORKS INFORMATION** plus; - The additional volume of topsoil removed from shallow embankments below the depth nominated in **ANNEXURE - EARTHWORKS INFORMATION** and calculated on the basis of plan area multiplied by the documented depth of excavation.	- Costs associated with all activities associated with stripping topsoil, carting and placing into stockpile, then stabilising and trimming the stockpiles.
1112.2 General earthworks	m^3 measured as bank volume. The volume of earthworks in cuttings to be determined by the surface to surface triangulation method, calculating the volume between the plans of natural surface or accepted Ground Model, the designed batter lines and the base of the excavation; from which is deducted the volume of topsoil as calculated under **Pay item 1112.1**. No account to be taken of the allowable batter tolerances or stepping of batters for topsoiling.	The schedule rate for this **Pay Item** to be an average rate to cover all types of material encountered during excavation and placed in embankments or spoil stockpiles, including both earth and rock. All costs associated with all documentation, approvals, survey and all activities associated with the excavation of material and the construction of embankments, stockpiling of spoil, the haulage of material and any pre-treatment such as breaking down or blending material or drying out material containing excess moisture, except that: - removal of unsuitable material to spoil to be paid under **Pay item 1112.3**;

Pay items	Unit of measurement	Schedule rate inclusions
		- extra costs in processing selected material to be paid under **Pay item 1112.4**; - overhaul of spoil or borrow to be paid under **Pay items 1112.5** and **1112.6** respectively. The base of the excavation to be the designed floor level in accordance with **Floors of cuttings** and no account to be taken of level tolerances. Where unsuitable material from the foundations of shallow cuttings or material from cut to fill transitions is excavated and placed into embankments the volume to be calculated from joint surveys carried out immediately prior to, and after subsequent removal of the unsuitable material.
1112.3 Unsuitable material to spoil	m^3 measured as bank volume of excavation	If the volume of excavation cannot be measured, propose a method to determine the conversion factors to be applied to the loose volumes measured in haulage units or to the measured stockpile volumes. All costs associated with all operations involved in the excavation, haulage, drying out, compaction or other activity required under **UNSUITABLE MATERIAL** for disposal as spoil in conformance with **SPOIL**. If this **Pay item** provides for ranges of provisional quantities, the rates are to be applied successively, but not cumulatively, as the volume of unsuitable material increases from one provisional quantity range to the next higher range. Apply each rate as the sole payment due for all unsuitable material removed within each quantity range, irrespective of the nature or quantity of the material removed.
1112.4 Selected material	m^3 measured as embankment volume in place in the selected material zone.	All costs associated with extra costs involved in stockpiling, processing, placing, compaction and trimming of material,

Pay items	Unit of measurement	Schedule rate inclusions
	Determine the volume by multiplying the theoretical plan area of the top of the selected material zone with its nominated thickness.	including surface preparation for deflection monitoring in the selected material zone over and above those costs allowed for under **Pay item 1112.2**. The width and depth to be taken as documented. No account is to be taken of level tolerances.
1112.5 Haulage of spoil	Per bank m^3 for each km or part thereof in excess of five km. m^3 measured using a weighbridge.	Where an approved location for spoil disposal is more than 5 km by road from the point of excavation of material being spoiled, make payment for haulage at the rate nominated in **ANNEXURE - EARTHWORKS INFORMATION** and include all costs associated with this activity. All costs associated with disposal of contaminated material.
1112.6 Haulage of borrow	Per bank m^3 for each km or part thereof in excess of 5 km.	Where an authorised borrow site that was not nominated in the Contract, is more than 5 km by road from the point of delivery of borrow material to the Works, make payment for haulage at the rate nominated in **ANNEXURE - EARTHWORKS INFORMATION** and include all costs associated with this activity.
Seeding and restoration of stockpile sites and borrow areas	m^2	To the *0257 Landscape – road reserve and street trees*.
Traffic management	Lump sum	To the *1101 Traffic management* work-section.
Control measures for erosion and sedimentation	Lump sum	To the *1102 Control of erosion and sedimentation (Construction)* work-section.
Clearing and grubbing of stockpile sites and borrow areas	Hectare	To the *1111 Clearing and grubbing* work-section.
Seeding and restoration of stockpile sites and borrow areas	m^2	To the *0257 Landscape - road reserve and street trees* work-section.
Working platforms created by chemical stabilisation		To the *1113 Stabilisation* work-section.
Fill adjacent to culverts, other than box culvers	m^3	To the *1351 Stormwater drainage (Construction)* work-section.
Drainage structures		To the *1352 Pipe drainage* work-section.

Pay items	Unit of measurement	Schedule rate inclusions
Selected backfilling to box culverts	m^3	To the *1353 Precast box culverts* work-section.

5.6 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1289		Methods of testing soils for engineering purposes
AS 1289.3.3.1	2009	Soil classification tests - Calculation of the plasticity index of a soil
AS 1289.5.1.1	2017	Soil compaction and density tests- Determination of dry density/moisture content relation of a soil using standard compactive effort
AS 1289.5.4.1	2007	Soil compaction and density tests - Compaction control test - Dry density ratio, moisture variation and moisture ratio
AS 1289.6.1.1	2014	Soil strength and consolidation tests - Determination of the California Bearing Ratio of a soil - Standard laboratory method for a remoulded specimen
AS 3798	2007	Guidelines on earthworks for commercial and residential developments
RMS T198	2013	Proof rolling test
RMS T199	2014	Deflection monitoring test

1113 STABILISATION

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide stabilisation of subgrade and pavement courses, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.
- *1112 Earthworks (Road reserve)*.
- *1141 Flexible pavement base and subbase*.

1.3 STANDARDS

General

Standard: To Austroads AGPT04D.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviations apply:

- DPP: Dry powdered polymer.
- CBR: California bearing ratio.
- OMC: Optimum moisture content.
- TIPES: Transport infrastructure product evaluation scheme.
- UCS: Unconfined compressive strength.
- PI: Plasticity index.

Definitions

General: For the purposes of this work-section the following definitions apply:

- Allowable working time: Measured from the commencement of incorporating/mixing the first application of the supplementary stabilisation binder into the un-stabilised pavement materials to the completion of trimming.
- Bitumen emulsion stabilising: The mixing of bitumen emulsion into the upper pavement layer to increase pavement strength.
- Bulking: The increase in volume of a layer designated for stabilisation resulting from preliminary pulverisation and/or incorporation of secondary or primary stabilisation binder.
- Foamed bitumen: The mixing of atomised water with hot bitumen at 180 to 190^{0}C with a foaming agent for use for use in stabilising granular materials.
- Expansion ratio: The ratio of the maximum volume of the bitumen in its foamed state to the volume of the bitumen once the foaming is completely subsided.
- Half-life: The time taken for the volume of the foamed bitumen to settle to half of the maximum volume achieved.
- Pozzolan: A siliceous or aluminous siliceous material, which in itself possesses little or no cementitious value but which in finely divided form may be mixed with lime or Portland cement to form a cementitious material.

- Residual bitumen: Residual bitumen is the net bitumen in the stabilised material remaining after the water has evaporated.
- Stabilent: A stabilent is any material mixed/ added to the pavement for improvement in pavement qualities.
- Stabilisation: The process by which the intrinsic properties of a pavement material are altered by the addition of a stabilisation binder and/or granular material to meet performance expectations in its operating, geological and climatic environment.
- Stabilisation binders: Materials that are used for the purpose of improving the properties of a subgrade or pavement. They are categorised in terms of their main constituents.
- Stabilised material: Any material which has been stabilised.
- Stabiliser: A specialised plant/machine with a centrally mounted mixing chamber, that can be connected to a watercart for moisture control and allows uniformity of mixing and depth control during the stabilisation process.

1.5 TOLERANCES

Cementitious blends

Mass of components of the nominated cementitious blend: ± 3% from the blend percentages in the nominated mix.

Application of stabilisation binder in a stationary mixing plant

Application rate tolerances: ± 10% from nominated rate.

In-situ application of stabilisation binder

Spread rate tolerances: ± 10% from nominated rate.

Width

Minimum width measured at any point of the stabilised layer: Not less than the documented width by more than 50 mm.

Levels

Surface levels: Conform to the following:

- Subgrade: ± 20 mm.
- Subbase: ± 15 mm.
- Base: – 5 mm, + 10 mm of design levels.

Surface quality

Maximum deviation from a 3 m straightedge: - 10 mm, after secondary trimming and immediately before sealing.

Layer thickness

Subbase: ± 10 mm of the documented layer thickness.

Base: Within 0 and + 20 mm of the documented layer thickness.

1.6 SUBMISSIONS

Certification

Stabilisation mix(es): Submit details and certification from a registered testing authority as evidence of conformity of the mix and its constituent materials to the nominated mix design.

- Materials proposed Submit details of source and certificates of compliance from a registered testing authority as evidence that the materials conform to documented requirements.

Execution details

Proposal for construction: Submit details of proposed method, equipment and procedures.

Trial section: Submit documentation demonstrating conformity of the trial section including:

- Record data of actual spread rate (in-situ) or incorporation rate (mixing plant) to verify conformance to the nominal rates.
- Compaction test results from a registered testing authority verifying the required relative compaction has been achieved for the trial section.
- Depth check records showing compacted thickness of stabilised layer for in-situ stabilisation.
- Survey report of compacted thickness for stationary plant mixed pavements.
- Survey report of finished levels.
- Record data of straightedge test.

Joints: Submit details of location and types of construction joints.

Records

Stationary mixing plant – application of stabilisation binder:

- Application rate: Submit record data for incorporation of stabilisation binder.

In-situ application of stabilisation binder:

- Spread rate: Submit record data from tray/mat tests or on-board load cells for spread of stabilisation binder.

In-situ application of bituminous binders:

- Foaming test: Submit the following:
  . Record data confirming all bitumen foaming nozzles are operating.
  . Record data of expansion ratio and half-life.
- Application rate: Submit record data for application of bituminous binder for each run.
- Daily record sheet.

In-situ mixing:

- Stabilised layer depth: Submit record data of stabilised layer depth.

Trimming:

- Survey report of finished levels.
- Survey report of compacted thickness for stationary plant mixed pavements.

Completion:

- Surface quality: Submit record data of straight edge test.

Tests

Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

Other tests:

- Lime demand test: To RMS T144 or VicRoads RC 131.01.
- Minimum pH: 12.4.

Variations

Nominated mix design: Submit details if the source, nature or type of any constituent material, or the proportion of any constituent materials is varied from the nominated mix design for correction or adjustment.

1.7 INSPECTIONS

Notice

Give notice so that inspection may be made of the following:

- Trial section: Location, materials, methods, equipment, procedures and joint construction.

2 MATERIALS

2.1 CEMENT

General

Standard: To AS 3972.

Storage and transport

Storage period: Re-test cement that has been stored for a period in excess of three months from the time of manufacture.

Transport: Transport cement in watertight packaging and protect from moisture until used. Do not use caked or lumpy cement.

2.2 QUICKLIME

General

Standard: To AS 1672.1.

Properties

Available lime - calcium oxide: Not less than 85%.

Active slaking time: Not greater than twenty minutes.

Temperature rise on slaking: Not less than 40°C in six minutes.

Particle size distribution of quicklime table

AS sieve size (mm)	% passing
13.2	100
9.5	96–100
4.75	70–100
2.36	0–90

2.3 HYDRATED LIME

General

Standard: To AS 1672.1.

Properties

Available lime - calcium hydroxide: Not less than 80%.

Form: Dry powder.

Residue on a 300 µm sieve: Not more than 2%.

2.4 GROUND GRANULATED BLAST FURNACE SLAG

General

Standard: To AS 3582.2.

2.5 FLYASH

General

Standard: To AS/NZS 3582.1.

2.6 CEMENTITIOUS BLENDS

General

Requirement: Conform to the blend proportion and constituents in the nominated mix design in the **ANNEXURE – STABILISATION SCHEDULES.**

Handling and storage

Requirements: Conform to the supplier's handling and storage recommendations.

2.7 CATIONIC OR ANIONIC BITUMEN EMULSION

General

Standard: To AS 1160.

Grade: Use slow setting grades.

Materials for Cationic or Anionic Emulsion Stabilisation

Standard: To AS 1160 for bitumen emulsions classes depending on the materials being stabilised. Conform to the following:

- Use either cationic or anionic slow setting grades to AS 1160.
- Conduct mix design testing to check the suitability emulsion grade which provides best retained strength modulus for the candidate materials.
- Add cement with in-situ stabilisation to achieve early strength increase and breaking of the emulsion.

Dust Laying with bitumen emulsions directly on an existing surface

Application rates: Conform to the following:

- Application rate for diluted emulsion is about 1.0 litres per square metre.
- Reduce the rate of application if surface runoff occurs.
- Use lower application rates and higher concentrations of emulsions on impermeable hard surfaces.
- Use higher application rates and lower concentration mixtures on softer and more permeable surfaces.

Operations:

- Shape and sweep the surface to remove excessive dust and loose material.
- Dampen the surface with watercart to increase effectiveness and reduce intervals between applications of emulsion.
- Use diluted emulsions.
- Check compatibility of water before diluting emulsion add the water to the emulsion and not the other way around. Heat the diluted emulsion to 60ºC before spraying to facilitate quick breaking of the emulsion.
- Close the road until the emulsion is fully broken and the surface is dry. This is usually 2 to 3 hours.

Life expectancy:

- Follow up the initial dust laying treatment with a second application after 2 to 3 days, and a 3rd application after 3 to 4 weeks.
- Effective service can range from several weeks to 6 months or more.

Dust laying with bitumen emulsion using soil stabilisation techniques

General: Do not use stabilisation with surface scarification and bitumen emulsion for fine grained soils and materials with high PI.

Preparation: Scarify and incorporate water into the existing surface gravel by tyning surface with a grader, or by using a stabiliser machine.

Optimum Moisture Content (OMC):

- If soil is dry add water with a water cart connected to the stabiliser so that the in-situ moisture of the material with the emulsion is at OMC.
- Use a calibrated pressurised sprayer to apply the emulsion on the scarified material from preparation.
- Before carrying out final compaction spray a diluted emulsion on the upper surface to form an enriched surface.

Application rates: Vary from 1% to 3% of binder without dilution compared to the mass of soil being stabilised. Lower rates are used with well graded granular soil; high rates for sandy soil.

2.8 FOAMED BITUMEN

General

Standard: To AS 2008.

Materials for Foam Bitumen Stabilisation

General: Use foamed bitumen stabilisation for gravels with high fines and high plasticity.

Requirement: The following are required:

- Bitumen, Class 170 is commonly used and usually between 3 and 4%.
- A bitumen foaming agent additive (Teric 311 or equivalent), to ensure suitable foaming.
- A secondary binder such as hydrated lime and/or GP cement.
- Potable water.

Supplementary binder:

- Hydrated lime: Conform to **HYDRATED LIME**. Use hydrated lime if the PI is above 7.
- Quicklime: Conform to **QUICKLIME**.
- Cement: Conform to **CEMENT**.

Supplementary binder limit: ≤ 2%.

Foaming agent if required: ≤ 2% of bitumen by mass.

Properties

- Expansion ratio: ≥ 10.
- Half-life: ≥ 20 seconds.

2.9 CHEMICAL BINDERS

General

Certification of non-traditional binders: Certificate of registration from ARRB TIPES.

Insoluble dry powdered polymer (DPP)

Grade: High.

Dry powdered polymer: Blended with hydrated lime or dry fine ground lime:

- Hydrated lime: To AS 1672.1.
- Available lime – calcium hydroxide: Not less than 80%.
- Testing for suitability: To test suitability of DPP for stabilisation test for plasticity index, Atterberg gradings, maximum dry density and optimum moisture content. Test for waterproofing as per AS 1141.53 absorption, swell and capillary rise (treated and untreated comparison). Test to assess CBR strengths, soaked, and elastic modulus RLT test (treated and untreated comparison)

Design pavement thickness with dry powdered polymer

Design ESA's	Standard pavement and subgrade conditions	Floodways, expansive subgrades
Low to moderate traffic ≤ 5 x 10^6	150 mm to 200 mm	200 mm to 250 mm

Design ESA's	Standard pavement and subgrade conditions	Floodways, expansive subgrades
Moderate to high traffic ≥ 5 x 10^6 and ≤ 9 x 10^7	200 mm to 300 mm	250 mm to 300 mm
Source: AustStab Pavement Recycling and Stabilisation Guide		

2.10 DUST SUPPRESSION ADDITIVES AND TREATMENTS

Dust suppression additives for unsealed roads

General: Select an appropriate dust suppressant option based on the site conditions:

2.11 GRANULAR MATERIAL ADDITIVE

General

Additional granular material: To **ANNEXURE – STABILISATION SCHEDULES, Granular stabilisation.**

Granular stabilised material: To **Unbound base and subbase materials** in *1141 Flexible pavement base and subbase*.

2.12 WATER

General

Requirement: Use clean water, free from harmful amounts of materials such as oil, salt, acid, alkali and organic or vegetable matter. Potable water will not require testing for conformity.

Content: Provide water with less than the following:

- 600 parts per million of chloride ion.
- 400 parts per million of sulphate ion.
- 1% by mass of undissolved solids.

2.13 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

3 EXECUTION

3.1 GENERAL

Weather conditions

Moisture content: Do not proceed with the stabilisation of pavement materials during wet weather or if rain is likely to occur during any stage of the stabilisation process so as to change the resultant moisture content and its uniformity in the mix.

Wind: Do not proceed with spreading during windy conditions which may cause loss of stabilisation binder, or cause nuisance or danger to people or property.

Stabilisation with foamed bitumen: Do not carry out stabilisation when the temperature measured at a depth of 50 mm in the pavement is below 10°C.

3.2 ALLOWANCE WORKING TIME

General

Requirement: Incorporate/mix the stabilisation binder into the subgrade or pavement material to be stabilised, trim and shape the surface to level and fully compact the layer to the required density ratio within the maximum allowable working time, as documented.

Maximum allowance working time table

Binder	Maximum allowable working time (hours)
Slow setting	
Hydrated lime and quicklime Slag/lime blends Foamed bitumen	10 10 10
Medium setting	
Type GB Cements Cementitious blends[1]	4 As documented
Rapid setting	
Type GP Cement[2]	2
Notes: 1. Cementitious blends allowable working time: Conform to **ANNEXURE – STABILISATION SCHEDULES.**	

3.3 TRIAL SECTION

General

Trial section: If required, construct 50 m long trial section for the width of the proposed works and incorporate in the finished works.

Materials and methods: Construct the trial stabilisation using the materials, equipment and methods for placing and finishing the same as would be used for the entire stabilisation works.

Binder application rate in a stationary mixing plant: To **ANNEXURE – STABILISATION SCHEDULES**.

In-situ application rate of stabilising agent: **To ANNEXURE – STABILISATION SCHEDULES**.

Compaction requirement: To **COMPACTION**.

Width, level, shape and layer thickness requirement: To **TOLERANCES, Width/Level/Shape/Layer thickness.**

Joints: Demonstrate the methods proposed for the construction of joints to conform the documented requirements.

Non-conformance: Assess the non-conforming trial section for fitness for purpose and determine appropriate disposition.

3.4 STATIONARY MIXING PLANT

General

Type: Purpose-made for the process of mixing road making materials.

Plant capability: Able to process at least 100 tonnes/hr.

Plant calibration: Calibrate the mixing plant to determine the rate of addition of the stabilising binder at various plant speeds.

Plant maintenance: Maintain and calibrate all equipment to provide a uniformly mixed product without segregation of the aggregate material.

3.5 STATIONARY MIXING PLANT – APPLICATION OF STABILISATION BINDER

Cement, hydrated lime, cementitious blends and dry powdered polymer

Incorporation of constituent materials: Mix into the approved plant at a steady continuous rate.

Application rate: Incorporate binder at the nominated application rate.

Spillage: Remove any spillage of the stabilising binder as soon as practicable within the same work shift that the spillage occurred.

3.6 STATIONARY MIXING PLANT - MIXING

Cement or cementitious blends

Water: Control and meter the addition of water into the mix.

Mixing: Add mix constituents to the plant at a steady continuous rate. Mix for a minimum of 30 seconds after all constituents have entered the plant, until stabilising binder has been evenly distributed.

Requirement: Uniform mixture to design requirements.

Moisture content of the mix delivered on site: 60% and 90% of the OMC as determined for the nominated mix. Cover the load during transport to minimise moisture loss.

Placing of pavement materials produced in a stationary mixing plant

General: Transfer and spread in a concurrent operation. Place without visual signs of any significant segregation.

Placing: Conform to **PLACING** of *1141 Flexible pavement base and subbase*.

3.7 IN-SITU STABILISATION – INITIAL SURFACE PREPARATION

Subgrade stabilisation

Initial shaping: Trim the surface to the required alignment, levels and shape necessary to produce the required final compacted thickness of stabilised material.

Pavement stabilisation

Pre-milling: If asphalt will be placed as a wearing course and the finished surface levels are to match existing kerb and gutter, pre-mill using a profiler. If asphalt patches are in the existing pavement, pre-mill and cross blend and remove excess material or material not suitable for stabilisation from site.

Material not suitable for stabilisation: Remove and dispose of material not suitable for stabilisation including asphalt patches where the total asphalt thickness is greater than 50 mm.

Pavements with asphalt and cement treated patches: If preliminary sampling and pavement design allow for the incorporation of asphalt and cement treated patches, incorporate in the pavement by pre-milling and cross blending materials uniformly across the full pavement.

Pre-pulverisation of existing material: Pulverise the material to be stabilised with an approved stabiliser or profiler to 50 mm less than the design depth of the stabilised layer. Control the depth of cut during the initial pulverising pass so that this thin layer of the existing material remains for recycling in the second stabilising pass. Add water so that the material can be compacted, and levels cut to provide the stabiliser with the correct surface shape for the second stabilising pass.

- Timing of pre-pulverisation:
  - . After the removal and replacement of material identified as material not suitable for stabilisation.
  - . Before the addition of shape correction material, if required.
  - . Before the application of binder.
  - . Before the application of supplementary binder, if required in stabilisation using foamed bitumen.
- Any additional material not suitable for stabilisation that is identified during pre-pulverisation: Remove or pulverise lumps which would otherwise be retained in a 53 mm sieve. Replace the volume of any large size material removed from the site with an equivalent volume of suitable granular material.

Additional granular material: Supply and spread to improve existing pavement material or to correct pavement levels as required.

Surface condition before in-situ application of stabilisation binder: Shape, compact and trim the existing surface to facilitate stabilisation, compaction and trimming to the documented alignment, levels and shape.

3.8 IN-SITU APPLICATION OF STABILISATION BINDERS

General

Construction traffic restrictions: Do not allow construction traffic or equipment, except for the centrally mounted mixer and watercart, to pass over the spread binder until incorporated into the pavement.

Quicklime, cement, cementitious blends or dry powdered polymer

Spreading: Use an approved load calibrated mechanical spreader from a rear or centrally calibrated drop chute capable of recording the output rate at which the binder is applied. Do not use agricultural or tipper-style spreaders.

Spread rate: Spread stabilisation binder at the nominated spread rate.

Record: Document the spread rate.

In-situ lime slaking

Timing: If quicklime is used, commence slaking within 30 minutes after spreading, before mixing.

Hydration: Apply water uniformly to produce a material at least 80% hydrated. Do not concentrate water into ruts or hollows, or over water to produce a wet hydrate.

Fully slake quicklime: Use either of the following methods to verify slaking:

- A thermometer to assess the maximum rise in temperature as calcium oxide is converted to calcium hydroxide.
- A visual observation of the change from a granular material to a fine powder. Assess by rubbing the lime between the thumb and finger and confirming the lime is no longer gritty. Use appropriate protective equipment when handling quicklime.

Safety equipment: Use appropriate personal protective equipment during in-situ lime slaking.

Equipment for Cationic or Anionic Emulsion Stabilisation

Emulsion stabilisation: Used with low fines and low plasticity (PI) gravels.

Plant and equipment: Use a reclaimer/stabiliser conforming to the following:

- Centrally mounted mixer.
- Minimum power capability: 300 kW (400 hp) for adequate mixing of materials.
- Two separate pumping/injection systems regulated by ground speed of the reclaimer/stabiliser for metering the bitumen and water.
- Fitted with a controlled device that calibrates the application rate in litres/m^2 of residual bitumen.

Equipment for Foam bitumen stabilisation

Requirement: Provide the following equipment:

- Suitable bitumen foaming equipment capable of manufacturing foamed bitumen with an appropriate expansion ratio and half-life as defined in AGPT/T301.
- A metal discharge container for checking the foamed bitumen discharge timer.
- Mechanical mixing equipment, e.g. pugmill capable of ensuring a uniform distribution of foamed bitumen and hence a homogeneous mixture. The mixing equipment should be designed so that foamed bitumen is shielded from the operator when it is discharged into the mixing chamber.

Bituminous binders

Plant and equipment: Use a reclaimer/stabiliser conforming to the following:

- Centrally mounted mixer.
- Minimum power capability: 300 kW (400 hp) for adequate mixing of materials.

- Two separate pumping/injection systems regulated by ground speed of the reclaimer/stabiliser for metering the bitumen and water.
- Fitted with a controlled device that calibrates the application rate in litres/m^2 of residual bitumen.

Additional plant requirements for foamed bitumen stabilisation:

- An inspection or test jet fitted to allow the flow of bitumen and the required expansion and half-life qualities of the bitumen.
- Self-cleansing bitumen jets.
- Appropriate pressure rating and temperature rating of bitumen lines for safety reasons.
- Mixing chamber for variable widths of binder to be incorporated into the pavement material.

Application rate: Incorporate bituminous binder at the nominated application rate.

3.9 IN-SITU ROAD MIXING

General

Rate of work: Complete lane by lane or full width of carriageway in the one-day operation.

Continuity: Start stabilisation from any end of the work and continue without gap to completion.

Pavement bulking: Take into account the degree of bulking to meet documented pavement thickness and finished levels.

Minimum mixing passes: 2.

Minimum mixing pass for unsealed pavements: 1.

Additional mixing: If required, carry out additional passes by the mixing equipment to improve visual uniformity of the mix and/or the moisture content.

Stabilised layer: Uniform over the full depth without lenses, pockets, lumps or granules of stabilisation binder.

Quicklime, cement, cementitious blends or dry powdered polymer

Mixing equipment: Conform to the following:

- Centrally mounted mixer with moisture control.
- Capable of mixing to the documented depth for the layer to be stabilised.
- Capable of mixing the stabilising agent uniformly through the full depth and over the whole area of the layer to be stabilised.
- Capable of supplying a calibrated amount of water to the area being agitated by the mixer to provide a uniformly moist mix to the documented moisture content.
- As mixing blades or tynes wear, replace to maintain mixing efficiency consistent with that demonstrated during the trial section.

Mixing procedure: Conform to the following:

- In the first pass, mix the binder into the material to 90% of the documented pavement depth.
- Carry out mixing of the second or final pass to the full documented pavement depth.
- Add water after mixing to shape, compact and trim within the allowable working time.

Bituminous binders

Mixing supplementary binders:

- Start mixing after spreading of supplementary binder.
- Mix binder into material to 90% of documented pavement depth.
- Add water to achieve the required moisture level.
- If the supplementary binder is quicklime, carry out slaking before mixing.

Foamed bitumen mixing: To AGPT/T302 procedure for adding foam bitumen to a granular material to produce foamed bitumen stabilised material (100% granular material passing the 37.5mm sieve)

- Bitumen temperature: Incorporate bitumen at a temperature between 180°C and 190°C.
- Add water only through the mixing chamber.
- Carry out mixing to the documented thickness in one or more passes.
- If bitumen streaks, blotches or masses form within the mix, cease mixing.

Moisture content immediately after mixing: 80% to 100% of the documented moisture content.

Record: Document the mixing in a Daily record sheet and include details of materials applied.

3.10 COMPACTION

General

Requirement: Compact the stabilised layer over the entire area and depth not less than as detailed in the following:

- Subgrade stabilisation: To *1112 Earthworks (Road reserve)*.
- Pavement stabilisation: To *1141 Flexible pavement base and subbase*.

Compaction equipment for unsealed roads:

- Vibrating smooth drum roller:
  - Compacting thickness up to 200 mm: Minimum mass of 15 tonnes.
  - Multi-tyre roller: Minimum mass of 12 tonnes.

Timing:

- Start compaction after mixing.
- Complete compaction within the allowable working time.
- Carry out compaction and trimming in a continuous method.

Compacted surface: Keep compacted layer moist, free from contamination and in good condition, until an overlying layer is constructed.

Compaction - bituminous binders

Compaction equipment for foamed bitumen stabilisation: Conform to the following:

- Vibrating padfoot roller:
  - Compacting thickness up to 200 mm: Minimum mass of 18 tonnes.
  - Compacting thickness up to 300 mm: Minimum mass of 21 tonnes.
- Vibrating smooth drum roller:
  - Compacting thickness up to 200 mm: Minimum mass of 18 tonnes.
  - Compacting thickness up to 300 mm: Minimum mass of 21 tonnes.
- Multi-tyre roller: Minimum mass of 12 tonnes.

Compaction - dry powdered polymers

Moisture content of material for compaction: 2 to 3% dry of OMC.

Test: To AGPT/T303 procedure for compacting cylindrical test specimens suitable for use in the determination of physical properties.

3.11 TRIMMING

General

Primary trimming: After mixing, trim and compact the layer conforming to *1141 Flexible pavement base and subbase* to produce a tight dense surface parallel with the finished wearing surface levels.

Secondary trimming: Trim the layer to meet shape and level requirements in preparation for the primer seal. Do not use surface slurrying or methods which lead to laminations in the pavement.

Trimmed material: Use trimmed material cut to waste as fill or spoil.

Surface quality: Provide finished surface as follows:

- True to line and level without any loose pockets, holes, bumps and flakes.
- Crowned pavements adjacent to gutter: Straight uniform profile from the crown of the pavement to the lip of the gutter.
- Stabilised road shoulders only: Finished profile that is straight and uniform in crossfall from the edge of the existing pavement to the outer edge of the new pavement.

Levels and thickness control methods

General: Provide controls so that the pavement layer thickness is not reduced during secondary trimming and that the pavement levels are within the documented tolerance.

Level and thickness control methods during construction: Determine levels using either survey or stringline measurements from survey pegs taken at close intervals to reduce longitudinal roughness.

Levels after trimming: Survey finished levels for conformity to the documented tolerances.

Layer thickness after trimming: Check layer thickness for conformity using the following methods:

- Stationary plant mixed pavements: Survey layer after secondary trimming.
- In-situ stabilisation: Measure the stabilised layer depth from a cutting adjacent to the stabilised pavement in at least two locations within the lot.

Straightedge test

General: Undertake immediately before sealing or before the agreed practical completion of any work component.

3.12 JOINTS

General

Requirement: Conform to the following:

- Form all joints by cutting back into the previously stabilised and compacted sections.
- Remove cut off material and keep joint area clean.
- Maintain cut face of the previous run in a damp condition.
- When compacting the fresh mix, support the roller partly on the previously compacted run.
- Level and shape of the joints: Within the documented limits.

Longitudinal joints

General: Minimise the need for longitudinal joints. If required, demonstrate that joints are unavoidable. If compaction of adjoining runs cannot be achieved within two hours of incorporating stabilisation binder, form a longitudinal joint between runs.

- Locate along lane marking line or midway between lane marking lines.
- Minimum longitudinal overlap of mixing runs: 100 mm.

Transverse joints

General: Form joints under the following circumstances:

- Before start of the day's stabilising process.
- After any delay in excess of 2 hours in the continuity of the stabilisation process.
- Minimum overlap of transverse joints: 1.5 m.
- Remix the material disturbed during cutting back at full depth and incorporate into the new work.

Joints - bituminous binders

General: Conform to the following:

- Undertake mixing in lanes. Work from one side of pavement to the other and do not interfere with lanes of unmixed material.
- Overlap: 100-200 mm.
- Completed joints: Keep area within 300 mm of joints uncompacted until adjacent material is mixed.
- Longitudinal joints: Avoid longitudinal joints by finishing a full carriageway width each day. If required, locate at a lane line or in the centre of carriageway.
- Transverse joints: Conform to the following:
  . Location: At works halted at the end of each day.
  . If joints are not made within 4 hours, cut back the adjoining stabilised surface to at least 1.5 m.

3.13 CURING

General

Traffic: Protect from heavy traffic until cured or the next pavement layer is laid.

Drainage: Maintain drainage for water run-off.

Curing method

Requirement: Cure stabilised material using one of the following methods:

- Water curing: Protect the stabilised work against rapid drying out by keeping it continuously wet or damp during the period before the provision of a subsequent layer or the application of a prime or primer-seal. Provide frequent light uniform spray that does not produce significant run off or flooding on sections of the area. Avoid slurrying of the surface or leaching of the stabilising agent.
- Bituminous surfacing.
- Constructing the next layer.

Bitumen stabilised pavements: Curing by wetting the surface is not required.

Curing period: As documented.

3.14 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Site tests

Stabilised materials mixed in a stationary mixing plant:

- Strength test: Confirm performance by monitoring the unconfined compressive strength of production, to AS 5101.4.

In-situ spread rate testing: Test spread rate using either of the following methods:

- Weigh the contents of a suitable 4-sided tray placed on the pavement and between the wheels of the mechanical spreader. Calculate the rate of stabilising agent spread by dividing the mass collected (kg) by the area of the tray (m^2).
- If spreading vehicles are fitted with load cells, ascertain the average spreading rate of the stabilising agent by dividing the mass of the stabilising agent spread per run by the area of the run.

In-situ mixing: Measure stabilised layer depth using either of the following methods:

- By measuring the depth of cutting adjacent to an existing pavement in two areas within the lot and measure to nearest 5 mm. Use a stringline to assess the depth of stabilised layer as the difference between finish surface level and the bottom of stabilised layer.
- Survey.

Compaction tests: Conform to the following:

- Test method: Sample and test the lots for true relative compaction assessments within the nominated allowable working time.
- Laboratory density:
  . Unbound and modified layers: Test samples to determine maximum dry density (modified compactive effort) in a laboratory to AS 1289.5.2.1.
  . Bound layers: Test samples to determine the maximum dry density (modified compactive effort) to RMS T130 within two hours of adding stabilisation binder to the mix.
- Field density testing: Use either of the following methods:
  . Sand replacement method: Test the compacted material to AS 1289.5.3.1 or AS 1289.5.3.2 or AS 1289.5.3.5.
  . Nuclear density meter: Test compacted material to AS 1289.5.8.1.
- Relative compaction: To AS 1289.5.7.1.

Site tests, Bituminous binders

- Foaming test: Confirm that all bitumen foaming nozzles are operating by conducting a foaming test adjacent to the site. Do not incorporate this material in the works.
- In-situ application rate of bituminous binders: Verify through dipping the tanker at the start and finish of each run.

Completion tests

Straight edge test: Take measurements with a 3 metre straightedge at a minimum of 10 randomly selected stations so as to represent each 200 metre lane length or part thereof.

4 ANNEXURES

4.1 ANNEXURE - STABILISATION SCHEDULES

General

Requirement: Include the appropriate schedule(s) required for the works.

Stationery plant mixed pavements using cement or cementitious blends schedule

Property	A	B	C
Nominated granular material (type)			
Source of granular material			
Type of stabilisation binder			
Blend constituent no. 1:			
Blend constituent no. 2:			
Blend constituent no. 3:			
Nominated stabilisation binder content (% by mass)			
Minimum unconfined compressive strength of stabilised material (MPa)			
Allowable working time (hours)			
Curing method			
Curing period			
Trial section			

In-situ stabilised subgrades using quicklime or hydrated lime schedule

Property	A	B	C
Target depth (mm)			
Type of stabilisation binder			
Nominated stabilisation binder content (% by mass)			
Nominated spread rate (kg/m²)			
Allowable working time (hours)			
Lime Demand Test (pH > 12.4)			
Trial section			

In-situ stabilised pavements using quicklime, cement, cementitious blends or dry powdered polymer schedule

Property	A	B	C
Target depth (mm)			
Type of stabilisation binder			
Blend constituent no. 1:			
Blend constituent no. 2:			
Blend constituent no. 3:			
Nominated stabilisation binder content (% by mass)			
Nominated spread rate (kg/m²)			
Lime Demand Test (pH > 12.4)			
Minimum unconfined compressive strength of stabilised material (MPa)			
Allowable working time (hours)			
Curing method			
Curing period			
Trial section			

Stationery plant mixed pavements using anionic or cationic emulsion blending

Property	A	B	C
Nominated granular material (type)			
Source of granular material			
Type of emulsion binder			

Property	A	B	C
Nominated emulsion binder content (% by mass)			
Minimum unconfined compressive strength of stabilised material (MPa)			
Allowable working time (hours)			
Curing method			
Curing period			
Trial section			

In-situ stabilised pavements using foamed bitumen schedule

Property	A	B	C
Target depth (mm)			
Nominated bituminous stabilisation binder content (% by mass)			
Nominated application rate of bituminous stabilisation binder (kg/m^2)			
Nominated supplementary binder			
Nominated supplementary stabilisation binder content (%, by mass)			
Nominated spread rate of supplementary stabilisation binder (kg/m^2)			
Minimum unconfined compressive strength of stabilised material (MPa)			
Allowable working time (hours)			
Curing period			
Trial section			

Granular stabilisation schedule

Material type	Mix proportions (%)	Sieve size (mm) and % passing by mass							
		0.075	0.425	2.36	4.75	9.5	13.2	19	25
Grading A									
Grading B									
Combination									

4.2 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection	Submission/Notice details	Process held
SUBMISSIONS, Certification, Stabilisation mix(es) and its constituents	H	Details and certification of stabilisation mix(es) and its constituents	14 working days before commencement of works	Stabilisation mix design
SUBMISSIONS, Certification, Materials proposed	H	Evidence of material conformance	14 working days before commencement of works	Ordering of materials
SUBMISSIONS, Variations, Nominated mix design	H	Details and certification of new stabilisation mix(es) and its constituents.	14 working days before commencement of works	Stabilisation mix design
SUBMISSIONS, Execution details, Trial section	H	- Record data of actual spread rate (in-situ) or application rate (mixing plant). - Compaction test results from a registered testing authority. - Survey report of finished levels. Depth check records showing compacted thickness of stabilised layer for in-situ stabilisation. - Survey report of compacted thickness for stationary plant mixed pavements. - Record data of straightedge test.	2 working days before commencement of remaining stabilisation works	Commencement of remaining stabilisation works
SUBMISSIONS, Execution details, Joints	H	Details of location and types	2 working days before construction of joints.	Construction of joints.
SUBMISSIONS, Execution details Compaction	H	Test results from a registered testing authority	2 working days before placement of subsequent layers or bituminous surfacing	Placement of subsequent layer; Bituminous surfacing
SUBMISSIONS, Execution details	H	- Survey report of finished levels.	2 working days before placement	Placement of subsequent layer;

Clause and description	Type*	Submission/Inspection	Submission/Notice details	Process held
Trimming		Depth check records showing compacted thickness of stabilised layer for in-situ stabilisation. - Survey report of compacted thickness for stationary plant mixed pavements. - Record data of straightedge test.	of subsequent layers or bituminous surfacing.	Bituminous surfacing.
INSPECTIONS, Notice Trial Section	H	Location, materials, equipment, methods and joint construction	2 working days before construction of trial section.	Construction of trial section.
*H = Hold Point W = Witness Point				

4.3 ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Stabilisation table

Activity	Key quality verification requirements		Maximum lot size	Minimum test frequency	Test method
Material supply	Material quality – Supplier's documentary evidence and certification of:				
	- Cement		1 contract	1 per 100 t	AS 3972 and AS 2350 (various)
	- Quicklime		1 contract	1 per 100t	AGPT/T303
		Available lime (CaO content)	1 contract	1 per 100 t	AS 4489.6.1
		Slaking rate	1 contract	1 per 100 t	RMS T432
		Particle size distribution	1 contract	1 per contract	AS 1141.11.1
	- Hydrated lime				
		Available lime ($Ca(OH)_2$)	1 contract	1 per 100 t	AS 4489.6.1
		Residue on sieving	1 contract	1 per contract	AS 4489.2.1
	- Ground blast furnace slag		1 contract	1 per month	AS 3582.2
	- Fly ash		1 contract	1 per month	AS 3582.1
	- Cementitious blends		1 contract	1 per 100 t	RMS 3211 part of R75/M

Activity	Key quality verification requirements		Maximum lot size	Minimum test frequency	Test method
		Blend proportion	1 contract	1 per mix	RMS 3211 part of R75/M
	Foamed bitumen		1 contract	1 test per mix	AGPT/T301, AGPT/T302 AGPT/T303 AGPT/T305
		Expansion ratio	1 contract	1 per tanker load supplied	RMS T153
		Half life	1 contract	1 per tanker load supplied	RMS T153
	- Water				
		Chloride ion content Maximum 600 parts per million	1 contract	1 per contract per source of water	AS 3583.13 and RMS T1004 RMS R75
		Sulphate ion content Maximum 400 parts per million	1 contract	1 per contract per source of water	AS 1289.4.2.1 and RMS T1014 RMS R75
		Undissolved solids Maximum 1% by mass	1 contract	1 per contract per source of water	AS3550.4 and RMS R75
Lime Demand Test	Lime	pH equals 12.4	1 contract	1 per contract	Test method Q133 (TMR)
Mix design	Certification of registered testing authority– Supplier's documentary evidence and certification		1 mix	1 per mix	As provided by the suppliers selected.
Stationary mixing plant	Application rate of stabilising agent		1 day's production	1 per 100 t	
	Unconfined compressive strength (UCS) of product		1 day's production	1 per 100 t	AS 5101.4
In-situ spreading	Spread rate		1 layer 1,000 m²	1 per lot or 1 per 500 m²	
	Mix uniformity		1 layer 1,000 m²	1 per 500 m²	Visual
In-situ emulsion binder	Cationic per square metre		1 layer per 1000 m^2	1 per 500 m^2	
	Anionic per square metre				
In-situ application –	Foaming test		1 day's production	1 per tanker load supplied	

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
bituminous binders	Application rate	1 layer 1,000 m²	1 per lot or 1 per 500 m²	
Mixing	Stabilised depth	1 layer 2,000 m², max. 1 day's placement	1 per lot	
Trimming and compaction	Finished levels	1 layer 2,000 m², max. 1 day's placement	One cross section per 25 m	Survey
	Surface quality	1 layer 2,000 m², max. 1 day's placement	10 per 200 m lane length *	3 m straight edge
	Average layer thickness	1 layer 2000 m², max. 1 day's placement	1 per lot	Survey (Stationary plant mixed pavements). Measure (In-situ stabilisation).
	Average width	1 layer 2,000 m², max. 1 day's placement	1 per lot	Measure/survey
	Relative compaction/moisture content	1 layer 2,000 m², max. 1 day's placement	3 per lot	AS 1289.5.7.1 AS 1289.5.8.1 AS 1289.5.3.1 AS 1289.5.3.2 AS 1289.5.3.5

* Note: or part thereof, per lot.

4.4 ANNEXURE - PAY ITEMS

Stabilisation with either of the following binders: cement, cementitious blends, quicklime, hydrated lime, dry powdered polymer table

Pay items	Unit of measurement	Schedule rate scope
1113.1 In-situ stabilisation	m^2 Determine the area by the length and width of work as documented on the drawings. Depth of stabilisation to be documented on the drawings.	All costs associated with in-situ stabilisation to the documented requirements of this work-section and pre-pulverisation where required.
1113.2 Stationary plant mixed pavements	m^2 Determine the area by the length and width of work as documented on the drawings. Thickness of stabilised layer to be shown on drawings.	All costs associated with the manufacture, delivery and placing of stabilised materials produced from stationary mixing plant, incorporation of water to achieve required moisture content, compaction, trimming, disposal of excess material, curing and testing.

Foamed bitumen stabilisation table

Pay items	Unit of measurement	Schedule rate scope
1113.3 Test to determine the foaming characteristics of the bitumen as per AGPT/T301	Per test into 20 litre drum on site for water and hot bitumen mix and associated test measures.	All costs for incorporating water and hot bitumen calibrated into a drum receptacle
1113.4 Test to the mixing of hot bitumen and water into granular material to produce sample product of foamed bitumen as per AGPT/T302	Per test into a mixing pugmill to incorporate water, hot bitumen, and granular material as a trial mix on site.	All costs associated with the trial mix.
1113.5 Preparation, and field compaction of test cylinder moulds for laboratory testing.	Per cylinder sample preparation	Unit cost
1113.6 Laboratory testing to determine resilient modulus using repeated load indirect tensile techniques	**Per cylinder**	
1113.7 Pre-pulverisation of existing material	m^2	All costs associated with pre-pulverisation of existing material including asphalt areas of maximum 50 mm thickness
1113.8 Supply and spread of additional granular material	Tonne Calculate by multiplying documented width by documented length by documented depth of layer and by nominated dry density	All costs associated with supply and spread of additional granular material
1113.9 Supply and delivery of supplementary binder	Tonne Calculate by multiplying documented width by documented length by the application rate	All costs associated with supply and delivery of supplementary binder
1113.10 Supply bitumen and additives	Tonne Calculate by multiplying documented width by documented length by the application rate	All costs associated with supply of bitumen and additives
1113.11 Spread and mix supplementary binder, and mix incorporate bitumen	m^2	All costs associated with spreading and mixing bitumen and supplementary binder to the documented thickness with a purpose-built mixer
1113.12 Compacting, trimming and jointing	m^2	All costs associated with compacting and trimming to specified levels of density and strength. All costs associated with jointing is also included.
1113.13 Density testing	Lump sum	All costs associated with collection of samples, delivery, laboratory testing and submitting results
1113.14 Rise and fall cost of bitumen	Tonne	If costs of bitumen vary from the tender date, submit rise and fall

Pay items	Unit of measurement	Schedule rate scope
		documentation from bitumen supplier
Traffic management		To the *1101 Traffic management* work-section

4.5 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1141		Methods for sampling and testing aggregates
AS 1141.53	1996	Methods for sampling and testing aggregates - Absorption, swell and capillary rise of compacted materials
AS 1160	1996	Bitumen emulsions for construction and maintenance of pavements
AS 1289		Methods of testing soils for engineering purposes
AS 1289.4.2.1	1997	Determination of the sulfate content of a natural soil and the sulfate content of the groundwater - Normal method
AS 1289.5.2.1	2017	Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using modified compactive effort
AS 1289.5.3.1	2004	Soil compaction and density tests - Sand replacement method using a sand-cone pouring apparatus
AS 1289.5.3.2	2004	Soil compaction and density tests - Sand replacement method using a sand pouring can, with or without a volume displacer
AS 1289.5.3.5	1997	Soil compaction and density tests- Determination of the field dry density of a soil - Water replacement method
AS 1289.5.7.1	2006	Soil compaction and density tests- Compaction control test - Hilf density ratio and Hilf moisture variation (rapid method)
AS 1289.5.8.1	2007	Soil compaction and density tests - Determination of field density and field moisture content of a soil using a nuclear surface moisture-density gauge - Direct transmission mode
AS 1672		Limes and limestones
AS 1672.1	1997	Limes for building
AS 2008	2013	Bitumen for pavements
AS 3350		Waters Determination of solids
AS 3350.4	1990	Gravimetric method
AS/NZS 3582		Supplementary cementitious materials
AS/NZS 3582.1	2016	Fly ash
AS 3582.2	2016	Slag - Ground granulated blast-furnace
AS 3583		Methods of test for supplementary cementitious materials for use with Portland cement
AS 3583.13	1991	Determination of chloride ion content
AS 3972	2010	General purpose and blended cements
AS 5101		Methods for preparation and testing of stabilized materials
AS 5101.4	2008	Unconfined compressive strength of compacted materials
Austroads AGPT		Guide to pavement technology
Austroads AGPT04D	2006	Stabilised materials
Austroads AGPT/T301	2017	Determining the foaming characteristics of bitumen
Austroads AGPT/T302	2017	Mixing of foamed bitumen stabilised materials
Austroads AGPT/T303	2017	Compaction of test cylinders of foamed bitumen stabilised materials Part 1: Dynamic compaction using marshall drop hammer
Austroads AGPT/T305	2017	Resilient modulus of foamed bitumen stabilised materials
RMS 3211	2018	Cements, binders and fillers
RMS R75	2015	In-situ pavement stabilisation using slow setting binders

RMS T130	2012	Dry density/moisture relationship of road construction materials (blended in the laboratory with cementitious binders)
RMS T144	2012	Hydrated lime for road construction materials (Lime demand test)
RMS T1004	2012	Quantitative determination of chloride ion in water
RMS T1014	2012	Quantitative determination of sulphate ion in water

1121 OPEN DRAINS

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide open drains, including unlined and lined open drains, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *0257 Landscape - road reserve and street trees*.
- *0294 Gabion walls and rock filled mattresses*.
- *0319 Auxiliary concrete works*.
- *1101 Traffic management*.
- *1102 Control of erosion and sedimentation (Construction)*.
- *1111 Clearing and grubbing*.
- *1112 Earthworks (Road reserve)*.
- *1352 Pipe drainage*.
- *1354 Drainage structures*.

1.3 INTERPRETATION

Definitions

General: For the purposes of this work-section the following definitions apply:

- Open drains: All drains other than pipe and box culverts and include catch drains, channels (gutters) and kerbs and channels (gutters).

1.4 SUBMISSIONS

Authority approvals

Road opening permit: Submit an application to the relevant Council for approval for works to road or footpath, including the following:

- Location of services.
- Opening and compaction specifications: To the *1151 Road openings and restoration* work-section.

Execution details

Survey: Submit set-out survey of drainage system.

Set-out of open drains: Submit details of any proposed changes to the location, length and design levels to suit construction procedures.

Temporary drainage: Submit details of procedures/devices to maintain effective drainage of the works area during construction.

Trees and rock outcrops: Submit a diversion proposal, if trees marked for preservation or rock outcrops occur in the line of the open drain.

Products and materials

Proprietary products: Submit the manufacturer’s technical data.

Samples
Joint fillers and sealants: Submit a sample of the proposed preformed joint filler.

Wire mattresses: Submit a sample of the proposed type of mattress and a schedule of locations.

Geotextile: Submit a sample of the proposed geotextile material and the manufacturer's recommendations for installation.

Tests
Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

1.5 INSPECTIONS

Notice
General: Give notice so that inspection may be made of the following:

- Set-out of open drains: Set-out.
- Salinity prevention: Location of open drains after set-out.
- Excavation:
  . Grade to open drains.
  . Backfill of excavation below the level of the natural channel.
  . Surplus material disposal.
- Catch drains: Location of drains.
- Table drains: Location of drains, swales and depressed medians after completing earthworks.
- Concrete lining: Location of weepholes.
- Stone pitching: Bedding material.
- Wire mattresses: Completed installation.

2 MATERIALS

2.1 CONCRETE

General
Concrete properties and delivery, placing, compaction, finishing, curing and protection: To the *0319 Auxiliary concrete works* work-section.

2.2 PROPRIETARY PRODUCTS

General
Requirement: Conform to the manufacturer's recommendations.

2.3 WIRE MATTRESSES

General
Requirement: Provide wire mattresses to the *0294 Gabion walls and rock filled mattresses* work-section.

2.4 BATTER DRAINS

General
Material: Half round steel pipes or precast nestable concrete units, as documented.

2.5 GEOTEXTILE

General
Type: Non-woven geotextile conforming to Austroads AGPT04G.

Geotextile strength and filtration requirements table

Application	Geotextile strength class (1)	EOS and flow rate requirements for $D_{15} \leq 75$ µm(3) (predominantly low permeability soils including clays and silts)	EOS and flow rate requirements for $D_{15} > 75$ µm(3) (predominantly pervious granular soils)	Filtration class
Drainage and separation behind retaining structures, including rock filled mattresses and joints of pipes and arches.	C	EOS ≤ 120 µm (2) $Q_{100} \geq 30$ L/s/m^2 (3) $\psi \geq 0.3$ s^{-1}	EOS ≤ 250 µm (2) $Q_{100} \geq 50$ L/s/m^2 (3) $\psi \geq 0.5$ s^{-1}	2

Source: RMS R63.

(1) Geotextile strength class for survivability for the given application. Geotextile survivability refers to the ability of the geotextile to withstand the installation stresses during construction. It is related to the construction method, subgrade condition, backfill material including stone size, and other factors.

(2) Equivalent opening size (EOS), defined as O_{95}, taken to be the mean value of the test results in conformance with AS 3706.1 and AS 3706.7. It is recognised that wet sieving generally results in lower EOS values than dry sieving.

(3) Q_{100}, the flow rate under 100 mm constant head and permittivity (ψ) determined in conformance with AS 3706.9.

Delivery and storage

Delivery: Deliver to site in the manufacturer's original packing, at least 14 days prior to before commencement of installation and legibly marked to show type and batch number.

Storage: Store above ground, under protective cover or wrapped in waterproof, opaque UV protective sheeting to the manufacturer's recommendations.

2.6 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Quality verification: If material/product quality verification can be obtained from the supplier, documented tests need not be repeated.

3 EXECUTION

3.1 ESTABLISHMENT

General

Survey control: Provide for the following:

- Mapping and pegging the drainage system.
- Locating components.

Survey data: Provide data for the set-out of gradients, open drains and construction to tolerances.

Set-out of open drains

Requirement: Identify and set out the location and levels of the open drains.

Temporary drainage during construction

Dams and diversions: Do not, temporarily or permanently, dam or divert existing watercourses.

Material and equipment: Locate material and equipment clear of watercourses or secure to prevent danger or damage due to large runoff flows.

Swales and buffer strips: Protect during construction or make use of the swale as a temporary measure. Provide geotextile with 50 mm topsoil and instant turf laid perpendicular to the flow path.

Stabilisation of topsoil areas: If required, stabilise the topsoil with hydroseed immediately after earthworks to the *0257 Landscape - road reserve and street trees* work-section.

Trees and rock outcrops

General: If trees marked for preservation or rock outcrops occur in the line of the drain, give notice.

3.2 OPEN DRAINS

General

Clearing: To the *1111 Clearing and grubbing* work-section.

Removal of topsoil and unsuitable material: To the *1112 Earthworks (Road reserve)* work-section.

Salinity prevention: Locate open drains to minimise ingress of surface water into the groundwater table and to prevent salinity degradation of adjacent land.

Discharge: Extend open drains to natural drainage depressions, culverts, or pits connected to underground drainage systems. Follow existing watercourses and depressions in the natural surface.

Waterways outside the site: Do not disturb.

Excavation

Profile: V-shaped or trapezoidal with a minimum depth of 300 mm and minimum waterway area 0.2 m^2 or as documented.

Grade: Minimum 0.5% or as documented.

Trimming: To a uniform surface free of irregularities.

Compaction of foundation material: Not less than 95% for standard compactive effort to AS 1289.5.4.1.

Excavation below the level of the natural channel: Backfill with suitable material and compact to a density equal to and compatible with that existing naturally.

Surplus material: Place excavated material to form embankments to lower side of drains or remove to spoil stockpiles as documented.

Construction

Embankments: Form in layers maximum 200 mm in depth and compact in layers of maximum depth of 150 mm.

Batter slope: Not steeper than 2H:1V.

Compaction of excavated material: Not less than 95% for standard compactive effort to AS 1289.5.4.1.

Revegetation: Vegetate the embankment after its completion to the *0257 Landscape - road reserve and street trees* work-section.

3.3 UNLINED OPEN DRAIN TYPES

Catch drains

General: Provide catch drains before construction of the adjacent roadway above the tops of cuttings and along the toes of embankments, as documented.

Position: Locate as follows:

- Minimum: More than 2 m above the tops of cuttings or below the toes of embankments.
- Maximum: To maintain the fall of the drain.

Minor diversion and contour drains

General: Provide minor diversion and catch drains as documented and with the same capacity as the nearest pipe culvert on the line of the drain.

Table drains

General: Provide table drains, swales and depressed medians, as part of earthworks to the line and level, as documented.

Channels

Requirement: Excavate inlet, outlet and diversion channels to the full width of the open drain, as documented and, extend to join the existing stream bed, avoiding disturbance in stream flow.

Existing stream bed: Preserve outside the limits of the excavation.

3.4 LINED OPEN DRAIN TYPES

General

Timing: Line within 5 days of shaping and compacting the foundation.

Organic fibre mat and vegetation lining

Requirement: Provide to lined open drains with a longitudinal grade between 1% and 5% for the completed drain.

Installation: To **OPEN DRAINS**, **Surface protection** in the *0257 Landscape - road reserve and street trees* work-section.

Concrete lining

Requirement: Provide to lined open drains with a longitudinal grade of less than 1% or greater than 5% for the completed drain.

Minimum compacted thickness: 100 mm, measured at right angles to the surface of the concrete lining.

Colour: To match that of the surrounding materials or as documented.

Installation: Cast in-situ or sprayed concrete to the *0319 Auxiliary concrete works* work-section.

Weepholes: Provide weepholes at 2 m spacing in non-horizontal elements or as documented.

Top of finished lining: True to line and of uniform width, free from humps, sags or other irregularities.

Tolerances: Conform to the following limits:

- Finished levels of lining surface: ± 10 mm of design levels.
- Surface deviation: Not more than 5 mm from a 3 m straightedge parallel to the direction of flow.

Contraction joints: Construct as follows or as documented:

- Width: 5 mm minimum.
- Depth: Minimum 50% of cross-sectional area. Tool joint to minimum 20 mm depth to form groove.

- Intervals: 3 m maximum.

Expansion joints: Construct as follows or as documented:

- Width: 15 mm.
- Depth: Full thickness of the concrete lining.
- Intervals: 15 m maximum.
- Material: Preformed jointing material of bituminous fibreboard or as documented.

Stone pitching

Material: Sound durable rock not less than 100 mm thick, bedded on loam or sand and mortared to present a uniform surface.

Exposed surface of each stone or block: Approximately flat and not less than 0.05 m^2 in area.

Spaces between adjacent stones or blocks: 20 mm maximum width.

Wire mattresses

Installation: To the *0294 Gabion walls and rock filled mattresses* work-section.

Batter drains

Installation: Install drains as follows:

- Backfill over-excavation and undulations in the batter line.
- Compact both sides of the drain to form a firm shoulder against the top edge of the batter drain.
- Lay the units in a template controlled excavated trench to form an even top edge to the batter drain.
- Tolerance from the batter line at the underside of topsoil: +0 mm, - 50 mm.

Topsoil: Taper over a width of 1 m to zero thickness at the top edge of the drain.

Turfing: To the *0257 Landscape - road reserve and street trees* work-section.

- Extent: To both sides of the drain for a minimum width of 600 mm.

3.5 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

4 ANNEXURE

4.1 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS Authority approvals Road opening permit	H	Approval of application	10 days before site commencement	Site commencement
SUBMISSIONS Execution details Set-out of open drains	H	Details of any proposed changes to designed system	5 days before proceeding	Site set-out of drainage
SUBMISSIONS Execution details	H	Details of procedures/devices	10 days before site commencement	Temporary drainage

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
Temporary drainage				
SUBMISSIONS Execution details Tree and rock outcrops	H	Proposal for diversion	1 day before set-out	Site set-out of drainage
INSPECTION Notice Set-out of open drains	W	Set-out	3 days	-
INSPECTION Notice Salinity prevention	W	Location of open drains for salinity prevention	1 day before set-out	-
INSPECTION Notice Excavation	W	Grade of open drains	Progressive	-
INSPECTION Notice Excavation	W	Backfill of excavation below the level of the natural channel	Progressive	-
INSPECTION Notice Excavation	W	Surplus material disposal	Progressive	-
INSPECTION Notice Catch drains	W	Location of catch drains	Progressive	-
INSPECTION Notice Table drains	W	Location of table drains, swales and depressed medians	Progressive	-
INSPECTION Notice Concrete lining	W	Location of weepholes	1 day before concreting	-
INSPECTION Notice Stone pitching	W	Bedding material	1 day before placing	-
INSPECTION Notice Wire mattresses	W	Completed installation	3 days	-
*H = Hold point W = Witness point				

4.2 ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Siting and excavation	Geometry	1 drainage line	1 per drainage line	Survey
Foundation	Compaction	1 drainage line	1 per 20 Lin. m *	AS 1289.5.4.1
Bedding	Material quality: Particle size distribution	1 contract	1 per 200 m^3 *	AS 1141.11.1
	Material quality: Compaction/moisture content	1 drainage line	1 per layer, per 20 Lin. m	AS 1289.5.4.1 AS 1289.5.7.1
Concrete lining	Geometry		1 cross section per 25 m	Survey and 3 m straightedge
Selected backfill	Material quality: - Maximum particle size - Plasticity index - Compaction/moisture content	 1 contract 1 contract 1 drainage line	 1 per 100 m^3 * 1 per 100 m^3 * 1 per 2 layers per 50 m^2	 AS 1289.3.3.1 AS 1289.5.4.1 AS 1289.5.7.1
* Note: or part thereof, per lot				

4.3 ANNEXURE - PAY ITEMS

Pay items	Unit of measurement	Schedule rate inclusions
1121.1 Excavation—catch, contour and minor diversion drains	Lin. m measured along the invert of the drain	All costs associated with: - Excavation of all material types - Do not include separate rates for earth and rock - Placement and compaction of material excavated from the drains on the lower sides of the drains to form banks in the excavation rates - Temporary measures for the control of stormwater runoff
1121.2 Excavation—inlet, outlet and diversion channels	m^3 measured from cross sections on the drawings using the end area method, or as 'each' where minor work is involved	All costs associated with: - Excavation of all material types - Do not include separate rates for earth and rock - Disposal of surplus material - Temporary measures for the control of stormwater runoff
1121.3 Concrete lining of open drains	m^2 of concrete in place	All costs associated with: - Surface preparation, supply and placing of concrete, jointing and curing

Pay items	Unit of measurement	Schedule rate inclusions
1121.4 Stone pitching of open drains	m^2 of stone pitching in place	All costs associated with: - Surface preparation, supply of stone, placing, final trimming and mortar jointing
1121.5 Batter drains	Lin. m along the length of the drain formed by batter drain units	All costs associated with: - Supply of the units, excavation, installation, backfilling and compaction
Traffic management	Lump sum	To the *1101 Traffic management* work-section
Erosion and sedimentation control		To the *1102 Control of erosion and sedimentation (Construction)* work-section
Vegetation of open drains		To the *0257 Landscape - road reserve and street trees* work-section
Concrete lining		To the *0319 Auxiliary concrete works* work-section

4.4 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1141		Methods for sampling and testing aggregates
AS 1141.11.1	2009	Particle size distribution - Sieving method
AS 1289		Methods of testing soils for engineering purposes
AS 1289.3.3.1	2009	Soil classification tests - Calculation of the plasticity index of a soil
AS 1289.5.4.1	2007	Soil compaction and density tests - Compaction control test - Dry density ratio, moisture variation and moisture ratio
AS 1289.5.7.1	2006	Soil compaction and density tests- Compaction control test - Hilf density ratio and Hilf moisture variation (rapid method)
AS 3706		Geotextiles - Methods of test
AS 3706.1	2012	General requirements, sampling, conditioning, basic physical properties and statistical analysis
AS 3706.7	2014	Determination of pore-size distribution - Dry sieving method
AS 3706.9	2012	Determination of permittivity, permeability and flow rate
Austroads AGPT		Guide to pavement technology
Austroads AGPT04G	2009	Geotextiles and geogrids
RMS R63	2017	Geotextiles (separation and filtration)

1132 LEAN MIX CONCRETE SUBBASE

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide lean mix concrete subbase and associated components, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.
- *0319 Auxiliary concrete works*.
- *1102 Control of erosion and sedimentation (Construction)*.
- *1112 Earthworks (Road reserve)*.
- *1133 Plain and reinforced concrete base*.
- *1143 Sprayed bituminous surfacing*.

1.3 STANDARDS

General

Standards: To AS 1379, AS 3600, Austroads AGPT08 and Austroads AGPT04C.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviations apply:

- CRCP: Continuously reinforced concrete pavement.
- JRCP: Jointed reinforced concrete pavement.
- PCP: Plain concrete pavement.
- SFCP: Steel fibre reinforced concrete pavement.

Definitions

General: For the purposes of this work-section the following definitions apply:

- Batch and load: Varies according to mixer types as follows:
  - . Central batch mixers: For mixers discharging into a tipper truck, a load may comprise more than one batch.
  - . Mobile batch mixers: A batch is deemed to be a load; a load must not comprise more than one batch.
  - . Continuous mixers: A batch is a load produced in a single discrete operation.
- Control line: A line generally at or near the centreline of a road on which the design is based and from which measurements for setting out may

- Efficiency index: The effectiveness of a curing compound in retaining moisture, assessed as a percentage of water retained in the test specimens relative to the uncoated specimens.
- Load: A single truckload of concrete comprising one or more batches.
- Mix: The proportions of component materials in a quantity of concrete.
- Nominated mix: The designed mix submitted for approval.

- Plan area: The Works area.
- Trial no fines concrete mix: Trialling of the nominated mix to demonstrate that the mix design conforms to the documented requirements.
- Vebe testing: A flow test on a vibrating table, used as a measure of workability in a stiff mix.

1.5 TOLERANCES

Concrete consistency

Maximum permissible difference in slump:

- Slipformed concrete: ± 10 mm.
- Manually placed concrete: ± 15 mm.

Concrete production tolerances table

Description	Tolerance (% by mass)
Particle size distribution (AS sieve):	
37.50 mm	± 5
19.00 mm	± 10
13.20 mm	± 10
4.75 mm	± 10
1.18 mm	± 5
600 µm	± 5
150 µm	± 2
Binder content	± 3

1.6 SUBMISSIONS

Certification

Certificate of calibration: Submit certification, from a registered testing authority, as evidence of accuracy of scales before handling and batching of material.

Execution details

Work method statement: Submit details of the proposed work method including the following:

- Handling, storing and batching of materials for concrete.
- Monitoring and measuring of constituent materials for concrete.
- Mixing and transporting of concrete.
- Placing and finishing of concrete, including a paving plan showing paving widths, sequence and estimated daily outputs.
- Plant and equipment to be used, including evidence of conformance to AS 1379.

Non-conforming trial section: Submit details of changes proposed for constructing the new trial section including the equipment, materials, mix, plant or rate of paving, to rectify non-conformance.

Non-conforming subbase thickness: If the subbase level exceeds the low-level tolerance, submit proposals for rectification.

Removal and replacement of subbase: Submit details of proposed work method for the removal and replacement of non-conforming subbase, including control measures for preventing damage to the adjoining subbase.

Products and materials

Nominated mix: Submit details of the following:

- Constituent materials:
  . Cement: Brand and source.

  - . Fly ash: Powerhouse source.
  - . Water: Source.
  - . Admixtures: Proprietary source, type, name, dosage recommended by the manufacturer and evidence of conformance to AS 1478.1.
  - . Aggregates: Source, geological type, moisture condition, blend proportions and grading for each type of aggregate.
  - . Soluble salt content.
- Mix design:
  - . Constituent quantities per m3 of concrete.
  - . Nominated particle size distribution of aggregates, including fine, coarse and combined particle size distribution.
  - . Forming time for each nominated.
- Trial mix test results: For each nominated mix, determined at the nominated slump, showing conformity for the following, as appropriate:
  - . Content of cement content, flyash and content of cementitious material per yielded m3 of concrete.
  - . Compressive strength at 28 days.
  - . Vebe reading.
  - . Drying shrinkage after 21 days air drying.
  - . Air content, if air entraining agent is used.

Steel reinforcement: Submit evidence of conformance with AS/NZS 4671.

Curing and surface debonding compounds: Submit evidence that the efficiency index conforms to **CURING AND DEBONDING COMPOUNDS**, **General** and test results confirming the non-volatile content.

Records

Subgrade survey: Submit a work-as-executed survey of the completed subgrade conforming to **SITE ESTABLISHMENT**, **Subgrade survey**.

Alignment and surface tolerances: Submit survey to verify that subbase alignment, surface levels, joints and edges conform to the requirements of this work-section.

Samples

Curing and surface debonding compounds: Submit reference sample for testing.

Tests

Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

Variations

Approved nominated mix: If change to the mix is proposed, submit details of the alternative mix, including its production method and source of constituent materials.

1.7 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Trial mix: Mixing of the trial mix.
- Trial section construction: Completed trial concrete subbase.
- Non-conforming trial section: If the original trial section is deemed non-conforming, completed new trial section.
- Excavation: Completed excavation for subgrade beams.

- Steel reinforcement: Steel reinforcement for subgrade beams in place before placing concrete.
- Repairing core holes: Completed restoration of cored areas where testing specimens were extracted.
- Non-conforming subbase thickness: Completed remedial work for subbase with non-conforming thickness.
- Removal and replacement of subbase: Completed replacement of non-conforming subbase.

2 MATERIALS

2.1 GENERAL

Nominated mix

Variations to the nominated mix: Any change without approval is subject to removal from the Works.

Storage and handling

Cement more than 3 months old (from date of manufacture): If required, retest to verify that the cement conforms to AS 3972 before using.

Transportation: Transport cement in watertight packaging, protected from moisture.

Storage and handling facilities: Prevent the aggregates becoming intermixed, mixed with foreign materials or segregated.

Storage area flooring: Concrete.

Non-conforming storage and handling facilities of concrete mix: If found, stop concrete production and delivery of materials until condition is rectified.

Storing cement bags: Under cover and clear of the ground.

2.2 CEMENT

General

General purpose and blended cement: To AS 3972.

Caked or lumpy cement: Do not use.

2.3 FLY ASH

General

Requirement: Fine grade fly ash to AS/NZS 3582.1.

2.4 WATER

General

Mixing water: To AS 1379 clause 2.4.

Water properties: Clean potable water, free from any material which may be harmful to the concrete or reinforcement including oil, acid, alkali, organic or vegetable matter.

Limits of impurities in mixing water: To AS 1379 Table 2.2 and the following:

- Chloride ion: Maximum 500 parts per million to AS 1289.4.2.1.
- Sulphate ion: Maximum 400 parts per million To AS 1289.4.2.1 or APHA 4500-CL.

2.5 ADMIXTURES

General

Chemical admixtures: To AS 1478.1.

Requirement: Free of calcium chloride, calcium formate, or triethanolamine or any other accelerators.

Chemical admixture dosage: To the manufacturer's recommendations for the air temperature and setting time.

Combining admixtures: Do not combine without verification from the admixtures manufacturers that they are compatible.

Types of admixtures

Warm season retarder: From October to March, use a lignin or lignin-based set-retarding admixture, Type Re or Type WRRe, for controlling slump within the limits in **CONCRETE PROPERTIES**, **Consistency**.

Cool season retarder: From April to September, use a lignin or lignin-based set-retarding admixture containing maximum 6% reducing sugars, Type WRRe conforming to AS 1478.1.

Mixes with less than 50% flyash: Make sure total alkali contribution from all admixtures does not exceed 0.20 kg/m^3.

Air-entraining agent: If used, conform to **CONCRETE PROPERTIES**, **Air content**.

Other admixtures which may be used: Superplasticisers and high range water reducers, Type HR, WR, Re.

2.6 AGGREGATES

General

Properties: To AS 2758.1 and the following:

- Clean, durable materials sourced from natural gravel, crushed stone, air-cooled iron blast furnace slag and sand. Do not use steel-plant slag.
- Chloride ion contents: Less than 0.8 kg/m3.
- Sulphate ion contents: Less than 5%.

Soluble salt content: Assess maximum 12 months before closing of tenders.

Samples for testing: Take from dedicated stockpiles or from materials delivered to site.

Blending of aggregates: If blending two or more fine aggregates or two or more coarse aggregates, make sure the aggregate from each source conforms to the **Fine aggregate properties table** or **Coarse aggregate properties table**, as appropriate.

Fine aggregates

Manufactured fine aggregate: Crushed from rock conforming to the **Coarse aggregate properties table** and non-plastic tested to the AS 1289.3 series, as appropriate.

Aggregate size: Less than AS 4.75 mm sieve.

- Permissible deviations: To AS 2758.1 Table 2.

Fine aggregate properties table

Property	Requirement	Test method
Bulk density(1)	Minimum 1200 kg/m^3	AS 1141.4
Water absorption	5.0% maximum, except slag aggregate: 6.0%	AS 1141.5 and AS 1141.6.1
Material finer than 75 µm	Maximum 10.0%	AS 1141.12
Material finer than 2 µm	Maximum 1.0%	AS 1141.13
Soundness	12 % max weighted average loss	AS 1141.24
Organic impurities	Maximum 0.5%	AS 1289.4.1.1
Sugar content	Less than 1 part in 10,000	AS 1141.35
Notes:		

Property	Requirement	Test method
(1) Bulk density in AS 2758.1 means the same as unit mass in AS 1141.4.		

Sodium sulphate soundness limits
Percentage of loss by mass: 6%.

Coarse aggregate properties table

Property	Requirement	Test method
Bulk density(1)	Minimum 1200 kg/m^3	AS 1141.4
Water absorption	Slag: Maximum 6% Other: Maximum 5%	AS 1141.6.1
Material finer than 75 µm	Maximum 2.0%	AS 1141.12
Material finer than 2 µm	Maximum 1.0%	AS 1141.13
Particle shape, 2:1 and 3:1 ratios	Maximum 35% and 10%	AS 1141.14
Wet strength	Minimum 50 kN	AS 1141.22
Wet/dry strength variation	Maximum 35%	AS 1141.22
Notes: (1) Bulk density in AS 2758.1 means the same as unit mass in AS 1141.4.		

Coarse aggregate grading
Testing: To AS 1141.11.1 and AS 1141.11.2.

Aggregate size: Less than AS 26.50 mm sieve.

- Permissible deviations: To AS 2758.1 Table 1.

Recycled concrete aggregate
Coarse aggregates from demolition concrete: To the recommendations of Austroads AGPT04E.

2.7 CURING AND SURFACE DEBONDING COMPOUNDS

General
Compounds for curing and debonding: To Austroads AGPT04C clause 6 and the following:

Bituminous emulsions: To AS 1160.

Liquid curing compounds: To AS 3799.

Compound types: Use one of the following:

- Wax emulsion: Class A, Type 2 to AS 3799.
  . Stability: Rate of separation in 7 days is not more than 4% tested to AS 1160.
- Hydrocarbon resin: Class B, Type 1-D to AS 3799.
- Waterborne hydrocarbon resin or styrene butadiene resin (SBR): Class Z, Type 1-D or Type 2 to AS 3799.
- Bitumen emulsion: Grade CRS/170. Cut back bitumen with up to 3% cutter oil.

Sprayed bituminous seal aggregates: Free of dust or treated with a bitumen base precoat and minimum nominal size of 5 mm.

Aggregate: To **AGGREGATE** in *1143 Sprayed bituminous surfacing*.

Water retention efficiency index: Minimum 90% tested to AS 3799 Appendix B.

Reference sample testing: To AS 3799. Test for conformity to the following tolerances in AS 3799:

- Non-volatile content.
- Efficiency index.
- Density.
- Drying time.
- Viscosity.
- Infrared spectrum.

2.8 STEEL REINFORCEMENT

General

Steel reinforcing materials: To AS 3600 clause 17.2.

Grade, type and size: As documented. Make sure this can be readily identified on the reinforcement.

Surface condition: Free from loose mill scale, rust, grease, tar, paint, oil, mud, mortar or any other material which may reduce the bond between the reinforcement and the concrete. Do not bring surface to a smooth polished condition.

Bar chairs: Plastic bar chairs or plastic tipped wire to AS/NZS 2425 and chairs capable of withstanding a load of 200 kg mass on the chair for one hour at 23 ± 5°C without malfunction.

Galvanized bars: Hot-dip to AS/NZS 4680.

2.9 COATING PROPERTIES

Compressive strength

Minimum compressive strength:

- At 7 days: 4 MPa.
- At 28 days: 5 MPa for flyash blended cement.

Maximum compressive strength:

- At 28 days: 15 MPa.

Sampling and testing: Conform to **TESTING**.

Drying shrinkage

Maximum drying shrinkage after 21 days air drying: Conform to the following:

- Maximum aggregate size > 20 mm: 450 με.
- Maximum aggregate size ≤ 20 mm: 550 με.

Preparation of test specimen: To AS 1012.8.4.

Consistency

Requirement: As required to allow the production of a dense, non-segregated mass with bleeding limited to prevent bleed water flowing over the slab edge under the conditions of pavement. Make sure the slab edge maintains its shape and does not sag or tear.

- Bleed water flowing over the edge: Stop paving until mix is adjusted or redesigned and approved.

Slump range:

- For slipformed concrete: 20 mm to 40 mm.
- For hand placed concrete: 55 mm to 65 mm.

Slipform concrete mix: Vebe reading of the trial mix to AS 1012.3.3.

Air content

Air content of fresh concrete: 3 to 7%.

2.10 CONCRETE FOR SUBGRADE BEAMS

General

Concrete: Conform to the *0319 Auxiliary concrete works* work-section.

Minimum compressive strength at 28 days: 32 MPa normal class to AS 1379.

Maximum nominal aggregate size: 20 mm.

Slump at the point of placement: 50 to 80 mm.

2.11 BINDER CONTENT FOR LEAN MIX CONCRETE

Cementitious binder content

Mix category	Flyash (kg/m^3)$^{(1)}$	Cement (kg/m^3)$^{(1)}$	Total binder (kg/m^3)$^{(1)}$
Subbase	100 minimum	90 minimum	250 minimum
$^{(1)}$ per yielded m^3 of concrete			

2.12 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Quality verification: If material/product quality verification can be obtained from the supplier, documented tests need not be repeated.

3 EXECUTION

3.1 NOMINATED MIX

Trial mix

Requirement: Before starting production of each mix, mix a trial batch of each nominated mix for testing as follows:

- Sampling: To AS 1012.1.
- Preparation of cylinders: Inspected, capped and crushed to AS 1012.9.
- Unit mass: Determine to AS 1012.12.1 or AS 1012.12.2 after dressing of voids in the specimen.

Compressive strength testing: Use 3 specimens conforming to the following:

- Cylinders: 28 days old concrete.
- Size: 100 mm nominal diameter.
- Sampling: From the same concrete.
- Specimens more than 28 days old: Adjust the age to the **TESTING**, **Concrete age conversion factors table**.

Testing: To the **Ready-mixed concrete production and supply table** in the **ANNEXURES**.

Date of testing: Maximum 18 months before starting paving.

3.2 PRODUCTION, TRANSPORT AND DELIVERY OF CONCRETE

Standard

Handling, storing and batching of materials, mixing, transport and consistency of concrete: To AS 1379 Section 4 and Appendix A.

Mixers: To AS 1379 clause 3.5.

Storage and handling

Aggregate moisture content: Determine at least twice daily immediately before batching and make corrections to quantities of aggregate and water, as appropriate.

Cementitious material: Weigh separately with an individual hopper, weighing the cement first.

Continuous type mixer: If used, measure using a continuous weighing method, except for liquids which may be measured by volume or flow rate meter.

Volumetric batching of water: Measure with a device calibrated in one litre increments.

Concrete for manually placed concrete: Deliver concrete in agitator vehicles.

Mixing and batching

Split drum mixer producing centrally mixed concrete: If used, discharge the whole batch into the tray of a moving vehicle for performing mixer uniformity tests to AS 1379 Appendix A.

Truck-mixed concrete: If required, add water to AS 1379, within 10 minutes of completing batching and 200 m from batching facilities.

Mixing time: Conform to the following:

- Stationary batch mixers: Minimum 54 seconds + 6 sec/m^3.
- Mobile batch mixers: Complete the full period of mixing at either the testing station or the point of placement. Ignore all other mixing and agitation for the purpose of assessing the actual mixing time for the batch.

Size of batching in an agitator: Do not exceed the manufacturer's rated capacity or exceed 80% of the mixer drum gross volume.

Maximum mixing time: Conform to the following:

- Generally: 10 minutes.
- Split mixer drums: 5 minutes.

Retempering

Addition of water: To AS 1379 clause 4.2.3.

Adding admixture

Requirement: Separately predilute in the mixing water before adding to other materials. Incorporate using a method that does not cause adverse interaction, as recommended by the admixture manufacturer.

Production and transport

Transport and production equipment: Use equipment which:

- Prevents segregation or loss of materials.
- Supplies a homogenous product.
- Provides concrete workability compatible with the capacity of the paving equipment to achieve the required compaction and nominal finish, and requires only nominal manual finishing.

Transport capacity for slipform paving: Use transportation with sufficient capacity for continuous paving at a speed of at least 1 m/minute.

Consistency

Testing: Slump test for consistency within the times measured from completion of batching, as appropriate for the concrete temperature, as follows:

- Temperatures ≤ 25°C: 40 minutes.
- Temperatures > 25°C: 30 minutes.

Concrete temperature: Measure at start of discharge of batch at intervals not exceeding 60 minutes throughout the paving operation.

Forming time

Maximum forming time: Determine time required for each mix to achieve the required concrete workability, taking into consideration prevailing weather conditions and concrete temperature.

Monitoring: Monitor and record forming time for any batch exceeding the following:

- Air temperature < 30°C: 90 minutes.
- Air temperature ≥ 30°C: 45 minutes.

Conformity of batch: Determined conditional on the compressive strength of the cores from that batch.

Concrete delivery

Delivery information: For each batch of mix, keep a record of the following:

- Batch number: Issued sequentially with the batching order.
- Supplier name and location.
- Volume of material supplied, including amount of water.
- Product identification.
- Completion of batching time and date.

Segregated or non-uniform mix: Do not deliver.

3.3 CONSTRUCTION PLANT AND EQUIPMENT

Paver machine

Mechanical paver: Use pavers conforming to the following:

- With an automatic control system, including a sensing device for controlling line and level to the documented tolerances.
- With internal vibrators capable of compacting the full depth of the concrete.
- With adjustable extrusion screed and/or conforming plate for forming the slab profile and producing the required finish on all surfaces.
- Capable of paving the documented slab widths or a combination of slab widths and slab depths.
- Able to spread the mix uniformly and regulate the flow of mix to the vibrators without segregation of components, to produce a dense and homogenous slab with a smooth uniform finish, requiring minimal hand finishing.

Gross operating mass: Use a self-propelling machine with mass not less than 4 tonnes/linear metre of paved width.

Paving speed: 1 m/minute or less, as required to enable the continuous operation of paver and obtain the required degree of compaction.

3.4 SITE ESTABLISHMENT

Subgrade survey

Measuring subbase invert levels: If spray sealing is required for the underlying layer, take levels on the top of the seal after removal of foreign or loose material such as aggregate.

Survey method: Survey on a 5.0 m grid or a plan area, reporting levels to the nearest mm.

Completion of subgrade: Submit a work-as-executed survey of the subgrade for the full extent of works. Highlight any locations where the actual level is higher than the design levels.

Non-conforming levels: Adjust pavement levels locally, this may include trimming and adjusting the paving layer.

3.5 CONCRETE SUBBASE PAVING TRIAL

Trial section construction

Requirement: Before starting normal concrete subbase paving, construct a trial section of the lean mix concrete subbase on the carriageway as follows:

- So that it may be incorporated in the finished work.
- Construct separate trial sections, for each subbase type, in a continuous operation without intermediate construction joints.
- Length:
  - 50 m to 100 m for mechanical placing in one continuous operation.
  - 15 m to 50 m for manual placement with a 20 m^3 minimum volume.
- Width: Same as that documented for the Works.

Materials and methods: Use the nominated materials, concrete mix, equipment and methods.

Non-conforming trial section

Requirement: If the trial concrete subbase is deemed non-conforming, remove the non-conforming subbase, rectify any damage caused by the removal, and construct the new trial subbase in conformance with **REMOVAL AND REPLACEMENT OF SUBBASE**.

3.6 SUBGRADE BEAMS

General

Location: Provide below the subbase at expansion joints and isolation joints in the concrete base, as documented. Construct subgrade beams before the subbase.

Extent: Extend beam the full length of joints or as documented on drawings.

Construction time: Construct beam before placing subbase.

Excavation

Dimensions and levels: Excavate to the documented dimensions. Finish the top surface of the subgrade beam level with the top of the subgrade.

Finishing: Trim the vertical faces to neat lines and remove all loose material. Re-compact the bottom of the trench, as required, to match the degree of consolidation of adjacent undisturbed material.

Steel reinforcement

Requirement: Conform to **INSTALLATION OF STEEL REINFORCEMENT** in the *1133 Plain and reinforced concrete base* work-section.

Reinforcement: Conform to the following:

- Form to documented shapes and sizes.
- Bend to an internal bend radius at least twice the diameter of the bar.
- Do not bend or straighten so that it will damage the material.
- Do not use with kinks or bends which is not documented.

Bending: Bend without impact or damage to the bar.

- Bend procedure: To AS 3600 clause 17.2.3.1 using one the following:
  - Cold bending around pins.
  - Applying uniform heat not exceeding 450°C to the portion to be bent.

Lapped splices

Requirement: Weld or securely tie together in at least 2 places the ends of bars forming a lapped splice.

Minimum length of lapped splices: To AS 3600 clause 13.2.

Splices in reinforcing fabrics: To AS 3600 clause 13.2.3 so that the two outermost transverse wires of one sheet overlap the two outermost transverse wires of the lapping sheet.

- Orientation of sheets: Make sure sheets mechanically engage each other.
- Sheet overlap: Not less than the pitch of the transverse wires plus 25 mm.

Construction and protection

Concrete compressive strength: Determine at 7 days for one specimen of concrete per subgrade beam pour.

- Minimum concrete strength: 20 MPa.

Concrete placing and finishing: To **CONCRETE PLACING AND FINISHING**.

- Loose subgrade material: Remove or recompact to the correct level. Where removal is required, fill voids with mortar or concrete and screed to provide a surface flush with the top of the subgrade beam.
- Finish: Steel float to produce a smooth surface, free of any texture.

Protection: Protect from damage by plant, motor vehicles and the paving operation. Rectify any damage.

- Vehicular traffic: Do not load beam until the concrete cylinder, stored adjacent to the beam, has achieved 20 MPa compressive strength.

Curing: Cure the top surface of the subgrade beam before placing the subbase in conformance with **CURING AND DEBONDING**.

Bond breaker: Apply to top surface of the subgrade beam, consisting of a further application of curing compound, 24 to 72 hours before placing subbase concrete.

3.7 CONCRETE PLACING AND FINISHING

Ambient conditions

Concrete placing: Do not place if:

- Rain appears imminent or during rain.
- Air temperature in the shade is below 5°C or above 36°C.
- Concrete temperature at the point of discharge is less than 10°C or more than 32°C.

Air temperature: If the air temperature in the shade is below 10°C or above 30°C, protect the concrete from cold or hot weather. Provide detailed proposals for protection of concrete in cold or hot weather.

Diurnal temperature changes ≥ 20°C: Make sure the upper limit of the concrete temperature is not more than 30°C before placing.

Surface temperature: Monitor the concrete surface temperature for the first 24 hours after placement, make sure it does not fall below 5°C.

- Measurement: Using a purpose-made thermometer, measure at 2 or more locations within each day's paving.

Records: Measure and record concrete air temperature in the shade and wind velocity at the point of concrete placement throughout the course of the Works.

- Air temperature measurement: Measure at an outdoor location, remote from artificial influences such as machinery.

Ground surface conditions

Requirement: Place concrete on a surface which is damp at the time of placement, clean, compacted and free of loose or foreign matter including sealing aggregate.

At time of placement: Make sure there is no ponded water on the surface.

Evaporation and moisture loss

Evaporation limit: If the rate of evaporation exceeds 0.50 kg/m^2/hr, determined from **ANNEXURE – RATE OF EVAPORATION**, perform approved measures to prevent excessive moisture loss or cease work.

Evaporation retarder: If used to prevent excessive moisture loss, apply by fine uniform spray after all finishing operations have been completed, except minor manual bull-floating. If re-application is required, carry out after level floating and so as not to incorporate the retarder into the surface mortar.

Monitoring and inspection: Regularly inspect plastic concrete to monitor the effectiveness of the procedures.

Paving generally

Requirement: Place, pave and finish concrete as follows:

- Prevent segregation or loss of materials.
- Prevent premature stiffening.
- Produce a uniform, dense, homogenous slab throughout the pavement.
- Expel entrapped air and make sure reinforcement and embedments are closely surrounded.
- Produce the documented thickness and surface finish.

Subbase surface after paving: Uniform, dense and compacted finish.

Surface finish: Conform to the following:

- Generally: Steel screed or float finish.
- For asphaltic base or concrete base with bitumen seal: Hessian dragged finish.
  . Mean texture depth: Maximum 0.6 mm measured to RMS T192.
- For concrete base without bitumen seal: Smooth surface without dimpling, ridges or recesses. Rectify non-conforming surface so that it is smooth before base paving.

Base slab anchors: If required, make provisions for base slab anchors during construction of the subbase at the documented locations.

Disruptions: If disruptions occur, form a construction joint before restarting the paving operations.

Mechanical (slipform) paving

Requirement: Spread, compact, screed and finish freshly placed concrete to form a dense, homogenous slab with a smooth uniform finish requiring minimal hand finishing.

Slab edge produced: Be able to maintain its shape without sagging or tearing. If excessive bleed water occurs, by flowing over the slab edge, stop paving until the mix consistency has been adjusted to prevent the flow.

Supplementary manual vibration: If mechanical paving is unable to fully compact and finish the concrete, such as at transverse construction joints, use manual vibration.

Paving continuity: Make sure the supply of concrete and concrete paving operations is continuous so that the mechanical paver does not require stopping once spreading commences.

Supporting surface: Provide a smooth and firm supporting surface for the tracks of the paver, curing machine and any other equipment in the paving and curing train.

Hand paving

Application: Use hand placement in areas where mechanical placement is not practical.

Formwork: Construct formwork conforming to the following:

- Construct so that it can be removed without damaging the concrete.

- True to line and grade.
- Braced sufficiently to support wet concrete.
- Mortar tight.
- Debonded to prevent adhesion of concrete to the forms.
- Set to tolerances equivalent to that required for the finished subbase finish.

Placing in forms: Deliver concrete in agitator trucks and deposit uniformly in the forms without segregation and by means other than vibration.

Compaction: Compact the concrete using poker vibrators and by two passes only of a hand-guided vibratory screed traversing the full width of the slab on each pass.

Build-up: Prevent any build-up of concrete between the forms and vibratory screed.

Poker vibrators: Use at systematic spacings and duration required to produce a homogenous slab with uniform compaction.

Number of working internal vibrators: Not less than 1 for each 10 m^3 of concrete placed per hour. For paving widths greater than 2.5 m, use minimum 2 vibrators.

Standby vibrators: ¼ of the vibrator number in use, with a minimum of 1 vibrator.

Alignment and surface tolerances

Alignment and surface levels: Within 4 days of placing, survey the alignment and surface levels, and inspect each joint for conformity.

Outer edge: Construct outer edges of the subbase conforming to the following:

- 50 ± 25 mm wider than the plan position of the overlying concrete base.
- 25 ± 25 mm wider than the plan position of other overlying base types.
- Square to the finished top surface of the subbase with a tolerance of ± 10°.

Conformity with straightedge profile: Start with the trial paving, test at random locations at the following minimum frequencies for each longitudinal and transverse alignment:

- One test of longitudinal and transverse surface profile per 10 m per paving run until 5 conforming results are recorded.
- After recording 5 conforming results, one test of longitudinal and transverse surface profile per 100 m per paving run.
- If non-conformity is discovered, retest from the beginning.

Longitudinal construction joint: If an edge of a slab is to form a longitudinal construction joint line, conform to **JOINT**, Longitudinal construction joints for horizontal alignment tolerances.

Assessment of subbase thickness

Subbase survey: Survey level runs, for the full extent of works, after subbase placement, taken on a 5 m grid. Round off measurements to the nearest 5 mm.

- Timing of survey: Within 4 days of placing.

Subbase thickness determination: Assess subbase thickness by comparing the subbase survey to the subgrade survey within each lot. Highlight locations which do not conform to **TOLERANCES**, **Finished subbase**.

Lot conformity: A lot is deemed conforming in thickness if:

- The mean thickness is not less than the documented thickness.
- No individual result is 15 mm or more below the documented thickness.

Non-conforming subbase thickness

Non-conforming thickness: Remove subbase if its thickness is more than 20 mm below the design thickness.

Remedial works: Remove concrete found to be above the design level. If the concrete is below the level tolerance, increase the thickness of the base course.

Protection of work

Traffic restrictions: Do not allow traffic or construction equipment, other than those associated with testing, on the subbase until the strength of the subbase has reached at least 4.0 MPa. Following this, only allow construction equipment with gross mass less than 1.5 tonnes on the subbase if they are associated with the following operations:

- Debonding treatment and spall treatment.
- Base paving at a distance of up to 300 m immediately ahead of the paver.

Rain protection: Do not expose concrete to rain within the period from tipping to application of curing compound. If the concrete is exposed, it will be deemed non-conforming. Beyond this period, acceptance of conformity will be assessed based on the surface finish.

Damage: Rectify any damage caused to the subbase.

3.8 JOINTS

Transverse construction joints

Requirement: Provide joints in conformance with the following:

- Need not be scabbled.
- Provide only at discontinuities in the placement of concrete determined by the paving operations.
- Be continuous over the paving width without steps or offsets in any axis. The line of joint is not more than 20 mm from a 3 m straightedge nor more than 10 mm from a 0.3 m straightedge.
- Constructed 90° ± 5° to the longitudinal joints with the joint face corrugated and square to the finished top surface of the subbase, to the documented dimension.
- Top surface of joint: 3 mm maximum deviation from a 0.3 m straightedge placed along the joint.
- Smooth across the joint.

Longitudinal construction joints

Requirement: Provide joints in conformance with the following:

- Do not scabble.
- Do not form within 100 mm of the base longitudinal joints and as documented.
- Maximum deviation from the planned or documented position: 20 ± 0.15 mm.
- Maximum deviation from a 3 m straightedge: 10 mm with allowances for any planned curvature.
- Smooth across the joint.
- Perpendicular to the subgrade surface.
- Under flexible bases:
  - Square of ± 5° to the finished top surface of the subbase.
  - Top surface of longitudinal construction joints: 3 mm maximum deviation from a 0.3 m straightedge placed along the joint.

3.9 CURING AND DEBONDING

Curing and debonding treatments table

Base type	**Recommended treatments**	
	Curing treatment	**Debonding treatment**
Plain concrete (PCP) base:		

Base type	Recommended treatments	
	Curing treatment	**Debonding treatment**
- -Bituminous interlayer debonding treatment applied before placing base - -Other situations	- Wax emulsion, hydrocarbon resin, waterborne hydrocarbon resin or styrene butadiene (SBR) compounds - Wax emulsion	- Sprayed bituminous seal, bitumen emulsion or wax emulsion - Sprayed bituminous seal
Joint reinforced dowelled concrete (JRCP) base	Wax emulsion, hydrocarbon resin, bitumen emulsion	Sprayed bituminous seal or bitumen emulsion
Continuously reinforced concrete (CRCP) base	Wax emulsion	Sprayed bituminous seal
Steel fibre reinforced concrete (SFCP) base	Wax emulsion	Sprayed bituminous seal, bitumen emulsion or wax emulsion
Asphalt base	Bitumen emulsion	Sprayed bituminous seal
Granular flexible base	Hydrocarbon resin, waterborne hydrocarbon resin or bitumen emulsion	Sprayed bituminous seal

Application of curing compound

Application method: Fine spray immediately following the surface finishing, when the surface is free of bleed water as follows:

- Paving < 2.5 m wide: By hand with single or multiple nozzles.
- Paving ≥ 2.5 m wide: By spray bar or hand lance fitted with minimum 3 nozzles spaced to give uniform cover over a minimum 1 m width in a single pass.
- Slipformed paving > 4.5 m: By mechanical sprayer fitted with a spray bar with multiple nozzles spaced to give uniform cover for the full paving width in a single pass.

Spray bars and lances: Fit with protective hoods to minimise drift of curing compounds to workers and roadside areas.

Sprayer features: Incorporate a device for continuous agitation and compound mixing in its container during spraying and nozzles which do not drip after shut-off.

Minimum application rate: As recommended by the manufacturer or at the following rates, whichever rate is greater.

- Generally: 0.2 L/m^2.
- Bitumen emulsion: 0.5 L/m^2.
- Hand lance application: 25% higher than that recommended by the manufacturer.
  . Application areas: Faces of formed joints and sections of slipformed edges which were supported by temporary forms at the time of initial spraying.

Calculations of application rate: Calculate the amount of curing compound applied to a measured area as follows:

- Calculate the average application rate from the total measured quantity of compound applied over each paving run.
- Local application rate: Test the local amount of curing compound measured on test mats placed on the pavement. Calculate the mean local rates falling on 3 test mats, each approximately 0.25 m^2, placed randomly within an area of 100 m^2 on the surface to be treated. Carry out testing at minimum frequency of once per 2000 m^2.

- Edge of slab sprayed by mechanical means: Calculate local application rate at minimum frequency of once per 3000 m^2 of upper surface paving. Randomly place 3 mats within a total edge length of 20 linear metres.

Conforming application rates: The application rate in a test area is deemed conforming if the average rate and the mean local rate is equal to or exceeds the required rate and if no single rate is more than 5% below the required rate.

Non-conforming application rates: Respray, within 6 hours of testing, at an application rate not less than twice the deficiency in the original application. Test resprayed application as for the first application.

Curing period: Maintain the curing membrane intact, in a continuous and unbroken film, for 7 days after placing the concrete.

Damage to curing membrane: Repair affected areas by hand spraying.

Adjoining hardened concrete: Respray hardened concrete less than 7 days old, at commencement of paving run, with a single application for a minimum distance of 7 m and extend to areas trafficked by people during placement at the construction joint.

Application of bond breaker

Preparation: Immediately before the application, clean the subbase surface, removing all loose, foreign and deleterious material. Treat spalled areas conforming to **Treatment of spalling** before applying bond breaker or asphaltic concrete.

Debonding treatment application: Apply to the top surface of the subbase and as an additional treatment to the curing treatment.

Application method: Conform to **Application of curing compound**.

Application rate: Minimum 0.2 L/m^2.

Application timing: Apply debonding treatment conforming to the following:

- After the curing compound is has been applied.
- Do not apply until the subbase has achieved a strength of 4.0 MPa.
- Do not apply until the subbase level schedules have been submitted and disposition of non-conformity is completed.
- Within 14 days of achieving the required strength.
- Minimum 72 hours before placement of the base.

Wax emulsion curing compound: If used, use the same wax emulsion as bond breaker.

3.10 CONCRETE CRACKING

Typical subbase cracks

Description: Full-depth transverse cracks continuous for the full width of the paving at approximately 3 to 15 m centres.

Subbase more than 6 m wide placed in a single pass: Longitudinal full-depth cracks at 4 m spacing in continuous lengths exceeding 4 m.

Remedial work: Not required.

Plastic shrinkage cracks

Description: Discrete cracks less than 300 mm long and with a depth less than 50% of the slab thickness, that does not intersect a formed edge.

Remedial work: Conform to **Corrective action**.

Other longitudinal and transverse cracks
Description: Cracks with cumulative length greater than 2 m in any 25 m^2 area of subbase.

Remedial work: If a bond breaker has been applied, conform to **Corrective action**.

Corrective action
Strain alleviating membrane strip: Apply 300 mm minimum wide geotextile backed polymer modified bitumen strip over the crack before placing the first asphalt base layer or concrete base.

Installation: To recommendations of the manufacturer and Austroads AGPT04G.

Wax emulsion: Apply two coats of 300 mm wide wax emulsion along the crack when a concrete base is required.

Non-conforming concrete for replacement
Replacement: Remove and replace subbase if one or more of the following occurs:

- Transverse cracks: Over 300 mm in length, at average spacing of less than 2 m over a length of 5 m.
- Longitudinal cracks: Continuous length exceeding 5 m.
- Cracks over 300 mm long: Within a distance of 1.5 m from a construction joint, isolation joint or free edge.

Treatment of spalling
Spalled areas greater than 10 mm deep and 15 mm wide: Infill with low-shrink rapid-hardening cement mortar or a mixture of aggregate and bitumen and screed the surface flush with the surrounding subbase concrete.

Full-depth cracks spalled more than 10 mm deep and 15 mm wide: Infill with an appropriate sealant or a mixture of sand bitumen so that the surface is flush with the surrounding subbase.

Spalling repair time: Complete treatment no earlier than five working days before applying bond breaker.

3.11 TESTING

Quality
Requirement: Test for all characteristics in conformance with **ANNEXURE – MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Test authority: A registered laboratory.

Sampling, curing and testing of fresh concrete
Sampling method: To AS 1012.1.

Sampling: Take samples from the delivery vehicles or from rolled concrete deposited ready for placement.

Frequency of sampling: To AS 1379 and the following:

- At least one sample for the concrete being placed at one time.
- At least one sample for each lot.

Test specimens: Mould at least two test specimens from each sample to AS 1012.8.1. Supply the number of moulds required for the documented frequency of testing. Inspect, cap and mark specimens before sending to testing laboratory.

- Initial curing: Carry out initial on-site (field) curing between 18 to 36 hours to AS 1012.8.1 clause 9.
- Transportation: Transport cylinders only after initial on-site curing.

Testing for compressive strength

Compressive strength testing: To AS 1012.9.

Compressive strength of each sample: Average compressive strength of the two specimens taken from the sample, tested at the same age.

Age of specimens: 7 and 28 days.

Adjustment due to age: If specimens are tested at more than 28 days after moulding, obtain the equivalent 28-day compressive strength by dividing the test compressive strength by the factor shown in the **Concrete age correction factors table**.

Concrete age correction factors table

Age of specimen at time of test (days)	**Correction factor (AF)**					
	Cylinders			**Cores**		
	Flyash content (%)[1]					
	< 10	10 – 25	> 25	< 10	10 – 25	> 25
28	1.00	1.00	1.00	1.00	1.00	1.00
35	1.02	1.03	1.03	1.00	1.00	1.00
42	1.04	1.06	1.06	1.00	1.00	1.00
49	1.06	1.09	1.09	1.02	1.03	1.09
56	1.08	1.12	1.12	1.04	1.06	1.17
70	1.10	1.15	1.15	1.06	1.09	1.35
84	1.12	1.18	1.18	1.07	1.11	1.54
112	1.14	1.21	1.21	1.10	1.14	1.75
140	1.16	1.24	1.24	1.11	1.16	1.95
168	1.18	1.27	1.27	1.13	1.18	2.04
196	1.20	1.30	1.30	1.14	1.20	2.14
224	1.22	1.33	1.33	1.14	1.21	2.17
308	1.24	1.36	1.36	1.15	1.22	2.21
365 or greater	1.25	1.38	1.38	1.15	1.23	2.23
Notes: (1) Relative to the total cementitious binder content. (2) For intermediate ages factor, determine on a prorata basis rounded to the nearest second decimal place.						

Acceptance criteria

Assessment process of test results: To AS 1379 Section 6.

Reports and records of test results: To the AS 1012 series. Submit test results and keep copies on-site.

Average compressive strength of samples representing the lot: Conform to **CONCRETE PROPERTIES**, **Compressive strength**.

Non-conforming concrete: Conform to **Testing by specimens cut from the work**.

Under-strength results from a lot: If the compressive strength of test cylinder is less than the required strength, remove and replace the lot represented by the test cylinder in conformance with **REMOVAL AND REPLACEMENT OF SUBBASE**.

Testing by specimens cut from the work

Requirement: If the subbase concrete strength is non-conforming, obtain approval to core the in-situ subbase for testing and provide specimens conforming to the following:

- Shape: Cylindrical cores.
- Preferred dimension of cores: 100 mm diameter.
- Minimum dimension of cores: 75 mm diameter or 2½ times the nominal size of the coarse aggregate, whichever is the greater.
- Tolerance in uncapped state: 5 mm.
- Minimum length: Same as the core diameter.

Before coring: Make sure the concrete has hardened enough to permit removal without disturbing the bond between the mortar and the coarse aggregate.

Frequency of coring: One core for each lot or one core for the area of subbase placed between any two consecutive construction joints, whichever is the lesser. Nominate the lot represented by each core at the time of sampling and record before testing.

Curing of cores: Despatch cores to arrive at the testing laboratory within 24 hours of cutting from the subbase. Start wet curing within 24 hours of receipt of the cores.

Test method: To AS 1012.14 and the following:

- Adjust the test strength by a factor conforming to the **Shape correction** factor table and the **Concrete age conversion factors table**.
- Core strength: [Test strength x SF factor] ÷ AF factor.
- Only use wet conditioning.

Shape correction factor (SF) table

Length/diameter ratio of core	Correction factor (SF)
2.00	1.00
1.75	0.98
1.50	0.96
1.25	0.93
1.00	0.87

Repair of core holes

Restoration method: Clean and restore all core holes in the subbase with non-shrink cementitious concrete, with compressive strength not less than the subbase and aggregate size of 10 mm nominal maximum.

Acceptance criteria for cored concrete

Equivalent 28 days compressive strength of the specimens cut from work: Conform to **CONCRETE PROPERTIES**, **Compressive strength**.

Non-conforming concrete: Conform to **REMOVAL AND REPLACEMENT OF SUBBASE**.

Corrected core strength of specimens cut from the subbase: 5 MPa for in-situ compressive strength.

3.12 REMOVAL AND REPLACEMENT OF SUBBASE

Subbase sawcuts

Transverse sawcut: Make sawcuts in conformance with the following:

- Cut the full depth of the subbase layer at each end of the section to be removed.
- Cut in a straight line, continuous between adjacent longitudinal joints, edges or proposed sawcuts.
- Cut normal to the control line at not less than 84° to the longitudinal construction joint.
- Do not oversaw into the adjoining base or underlying sub base.

Longitudinal sawcuts: Make sawcuts in conformance with the following:

- Cut 150 to 300 mm offset from planned longitudinal contraction joints in the overlying base.

- Do not to extend more than 150 mm past the transverse sawcut at each end of the section to be removed.
- So that the exposed face conforms to **Longitudinal construction joints**.

Oversawing: Do not oversaw on any additional internal sawcuts made to aid the removal of the subbase.

Removal and replacement of subbase

Removal of concrete: Remove to an existing longitudinal joint/edge or a newly sawn longitudinal joint conforming to the following:

- Slab width: Width of replacement slab and width of residual slab (the slab remaining after removal) is not less than 0.3 m, measured 90° to the control line.
- Slab length: Length of replacement slab and length of residual slab (the slab remaining after removal) is not less than 0.6 m, measured parallel to the control line.
- Corner angles resulting from removal and replacement of the slab is not more acute than 84°.

Disposal of removed subbase: Remove from site.

Damage to adjoining pavement: Remove and replace pavement adjacent to the original area of rejected subbase damaged by the operations.

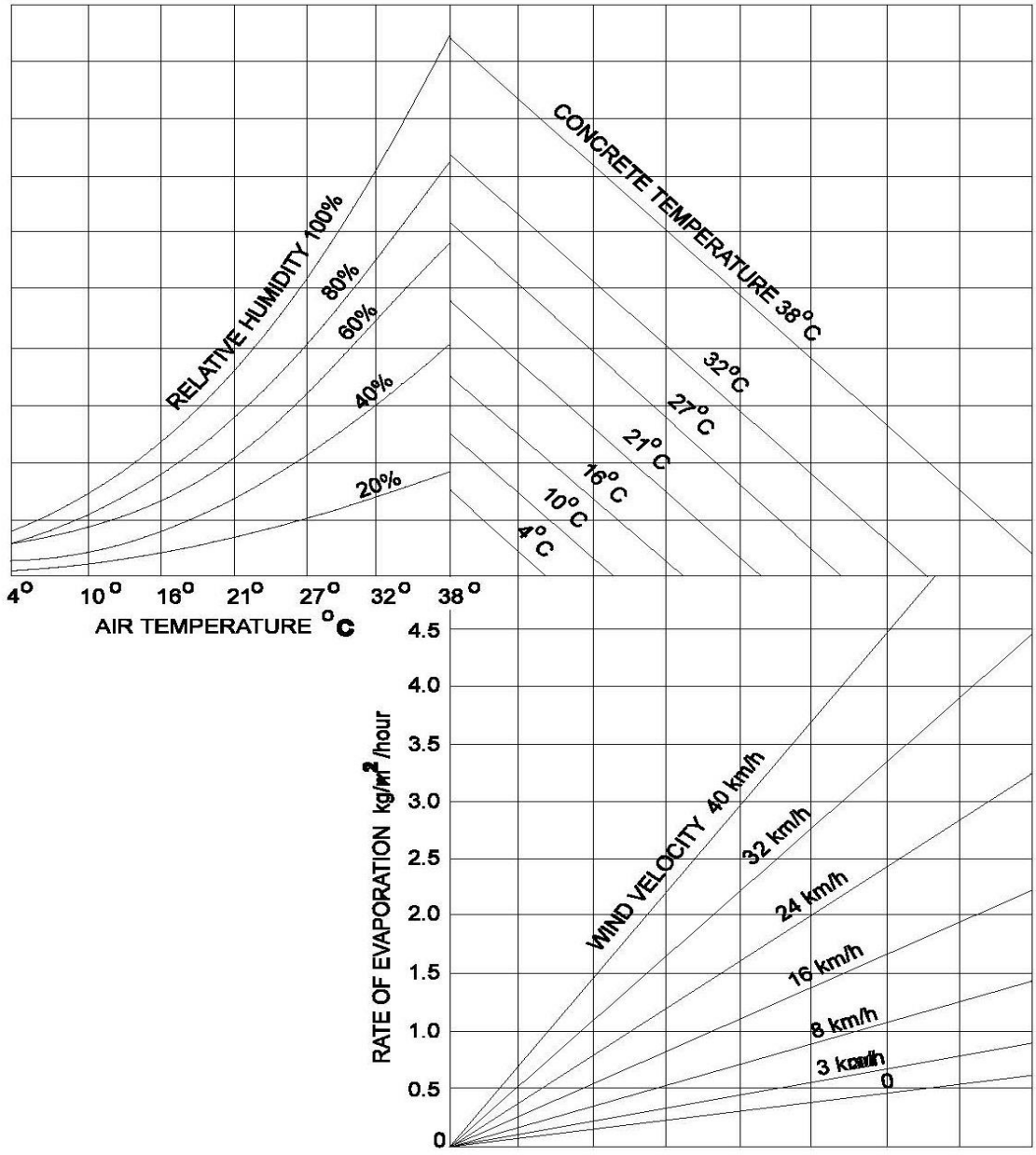
Non-conforming subbase more than 25 long: Replace by mechanical means unless the slabs are odd-shaped or mismatched.

Application of bond breaker: After completion of the replacement subbase, prepare and debond the pavement in conformance with **Application of bond breaker**.

4 ANNEXURES

4.1 ANNEXURE - RATE OF EVAPORATION

Rate of evaporation graph



Using the Rate of evaporation graph

Information: The graph shows the effects of air temperature, humidity, concrete temperature and wind velocity on the rate of evaporation of water from freshly placed and unprotected concrete.

Example: To determine the evaporation rate from the graph using air temperature at 27°C, relative humidity at 40%, concrete temperature at 27°C and a wind velocity of 26 km/h:

- Enter the graph at the air temperature of 27°C.
- Move vertically to intersect the curve for relative humidity encountered 40%.
- Move horizontally to the respective line for concrete temperature of 27°C.
- Move vertically down to the respective wind velocity curve and interpolate for 26 km/hour.

- Then move horizontally to the left to intersect the scale for the rate of evaporation.
- The rate of evaporation would be 1.6 kg/m^2/hour in this example.

4.2 ANNEXURE – SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Execution details Work method statement	H	Details of proposed work method.	4 weeks before commencement	Commencement
INSPECTIONS, Notice Trial mix	W	Mixing of trial mix.	2 days before mixing	Production of each concrete mix
SUBMISSIONS, Products and materials Nominated mix	H	Details of constituent materials, mix design and trial batch test results.	3 weeks before ordering materials	Ordering and delivery of material
SUBMISSIONS, Variations Approved nominated mix	H	Details of alternative mix.	3 weeks before implementing change	Ordering and delivery of material
SUBMISSIONS, Records Subgrade survey	H	Work-as-executed subgrade survey.	2 days before paving/trial paving	Paving/trial section
INSPECTIONS, Notice Trial section construction	H	Completed trial subbase.	5 days before paving	Trial section acceptance
SUBMISSIONS, Execution details Non-conforming trail section	H	Details of proposed changes to the trial section.	1 day after non-conformance has been identified	Paving
INSPECTIONS, Notice Non-conforming trail section	H	Completed new trial section.	1 day before the inspection	Paving
INSPECTIONS, Notice Excavation	W	Excavation for subgrade beam.	2 days before placing concrete	-
INSPECTIONS, Notice Steel reinforcement	W	Steel reinforcement of subgrade beam in place.	2 days before placing concrete	-

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Records Alignment and surface tolerances	H	Survey of subbase surface levels and alignment.	2 days after paving	Subbase acceptance or rectification
INSPECTIONS, Notice Repair of core holes	W	Completed restoration of cored areas.	1 day before the inspection	-
INSPECTIONS, Notice Non-conforming subbase thickness	W	Completed remedial work for subbases with non-conforming thicknesses.	1 day before the inspection	-
SUBMISSIONS, Execution details Removal and replacement of subbase	H	Details of proposed work method for removing and replacing non-conforming subbase.	5 days before removal	Removal and replacement of subbase
INSPECTIONS, Notice Removal and replacement of subbase	W	Completed replacement of subbase.	1 day before the inspection	-
*H = Hold point, W = Witness point				

4.3 ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Placement of lean mix concrete subbase table

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Steel supply	Steel reinforcement	1 contract	1 per contract	AS/NZS 4671
Concrete supply	To the **Ready-mixed concrete production and supply table**.			
	Concrete/air temperature	50 m³	1 per 50 m³	Measure
	Air content	50 m³	1 per 50 m³	AS 1012.4.2
	Consistency – slump	50 m³	1 per load	AS 1012.3.1
	Compressive strength (7 and 28 days)	50 m³	1 per pour	AS 1012.9
Curing	Material quality – supplier's documentary evidence	1 contract	1 per production batch	AS 3799 Section 3 AS 2341 series
	Application rate	1 day's work	1 per 1000 m²	

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Joints	Geometry	50 m³	All joints	Survey

Ready-mixed concrete production and supply table

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Raw materials supply	Material quality – supplier's documentary evidence of:			
	Cement	1 month's production	1 per week	AS 3972 Table 2
	Fly ash	1 month's production	1 per month	AS/NZS 3582.1
	Water	1 contract	1 per contract	AS 1289.4.2.1 or APHA 4500-CL
	Admixtures	1 month's production	1 per month	AS 1478.1
	Fine aggregates			
	- Grading	1 week's production	1 per 200 m³ concrete*	AS 1141.11.1
	- Moisture content	N/A	1 per day	
	- Sodium sulphate soundness	1 contract	1 per contract	AS 1141.24
	- Bulk density	1 contract	1 per contract	AS 1141.4
	- Unit mass (particle density)	1 contract	1 per contract	AS 2758.1
	- Water absorption	1 contract	1 per contract	AS 2758.1
	- Material finer 2 µm	1 contract	1 per contract	AS 1141.13
	- Deleterious material (impurities/reactive)	1 contract	1 per contract	AS 2758.1
	Coarse aggregates:			
	- Grading	1 week's production	1 per 200 m³ concrete*	AS 1141.11.1
	- Moisture content	N/A	1 per day	
	- Wet strength	1 contract	1 per contract	AS 1141.22
	- Wet/dry strength variation	1 contract	1 per contract	AS 1141.22
	- Sodium sulphate soundness	1 contract	1 per contract	AS 1141.24
	- Particle shape	1 contract	1 per contract	AS 1141.14
	- Fractured faces	1 contract	1 per contract	AS 1141.18

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
	- Bulk density	1 contract	1 per contract	AS 1141.4
	- Unit mass (particle density)	1 contract	1 per contract	AS 2758.1
	- Water absorption	1 contract	1 per contract	AS 2758.1
	- Material finer 75 µm	1 contract	1 per contract	AS 1141.12
	- Weak particles	1 contract	1 per contract	AS 2758.1
	- Light particles	1 contract	1 per contract	AS 2758.1
	- Deleterious materials (impurities/reactive)	1 contract	1 per contract	AS 2758.1
	- Iron unsoundness	1 contract	1 per contract	AS 2758.1
	- Falling/dusting unsoundness	1 contract	1 per contract	AS 2758.1
Mix design	Compressive strength	1 contract mix	1 per mix per contract	AS 1012.9
	Aggregate moisture content	1 contract mix	1 per mix per contract	RMS T262
	Consistency – slump	1 contract mix	1 per mix per load	AS 1012.3.1
	Air content	1 contract mix	1 per mix per contract	AS 1012.4.2 Method 2
	Drying shrinkage	1 contract mix	1 per mix per contract	AS 1012.13
* Note: or part thereof, per lot.				

4.4 ANNEXURE – PAY ITEMS

Pay items	Unit of measurement	Schedule rate inclusions
1132.1 Supply and place concrete in subbase	m^3 of concrete in place. Volume calculated from width, length and depth, as documented.	All costs associated with all documentation and approvals and the supply and placing of concrete subbase in place, including construction joints.
1132.2 Finish and cure subbase	m^2 of subbase. Area calculated from width, length and depth, as documented. Do not include sides of slabs in area calculation.	All costs associated with the finishing and curing of the subbase.
1132.3 Crack treatment by stress alleviating membrane strip (for asphalt base)	Linear metre of strip. Length is actual length measured on site.	All costs associated with the supply and installation of membrane strip.
1132.4 Bond breaker	m^2 of bond breaker. Area based on actual length, measured on site and design width, as documented. Do not account for tolerances.	All costs associated with the supply and installation of bond breaker.

Pay items	Unit of measurement	Schedule rate inclusions
1132.5 Subgrade beams	m^3 of concrete. Volume determined from width, length, and depth, as documented.	All costs associated with the supply, placing and installation of concrete and reinforcing steel for subgrade beams.
Traffic management		To the *1101 Traffic management* work-section.
Erosion and sedimentation control		To the *1102 Control of erosion and sedimentation (Construction)* work-section.
Base slab anchors		To the *1133 Plain and reinforced concrete base* work-section.

4.5 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1012		Methods of testing concrete
AS 1012.1	2014	Sampling of concrete
AS 1012.3.1	2014	Determination of properties related to the consistency of concrete - Slump test
AS 1012.3.3	1998	Determination of properties related to the consistency of concrete - Vebe test
AS 1012.4.2	2014	Determination of air content of freshly mixed concrete - Measuring reduction in air pressure in chamber above concrete
AS 1012.8.1	2014	Method for making and curing concrete - Compression and indirect tensile test specimens
AS 1012.8.4	2015	Method for making and curing concrete - Drying shrinkage specimens prepared in the field or laboratory
AS 1012.9	2014	Compressive strength tests - Concrete, mortar and grout specimens
AS 1012.12		Determination of mass per unit volume of hardened concrete
AS 1012.12.1	1998	Determination of mass per unit volume of hardened concrete - Rapid measuring method
AS 1012.12.2	1998	Determination of mass per unit volume of hardened concrete - Water displacement method
AS 1012.13	2015	Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory
AS 1012.14	2018	Method for securing and testing cores from hardened concrete for compressive strength and mass per unit volume
AS 1141		Methods for sampling and testing aggregates
AS 1141.4	2000	Bulk density of aggregate
AS 1141.5	2000	Particle density and water absorption of fine aggregate
AS 1141.6.1	2000	Particle density and water absorption of coarse aggregate - Weighing-in-water method
AS 1141.11.1	2009	Particle size distribution - Sieving method
AS 1141.11.2	2008	Particle size distribution for vision sizing systems
AS 1141.12	2015	Materials finer than 75 µm in aggregates (by washing)
AS 1141.13	2007	Material finer than 2 micrometer
AS 1141.14	2007	Particle shape, by proportional caliper
AS 1141.18	1996	Crushed particles in coarse aggregate derived from gravel
AS 1141.22	2008	Wet/dry strength variation
AS 1141.24	2018	Aggregate soundness - Evaluation by exposure to sodium sulphate solution
AS 1141.35	2007	Sugar
AS 1160	1996	Bitumen emulsions for construction and maintenance of pavements

AS 1289		Methods of testing soils for engineering purposes
AS 1289.3		Soil classification tests
AS 1289.4.1.1	1997	Soil chemical tests - Determination of the organic matter content of a soil - Normal method
AS 1289.4.2.1	1997	Soil chemical tests - Determination of the sulphate content of a natural soil and the sulphate content of the groundwater - Normal method
AS 1379	2007	Specification and supply of concrete
AS 1478		Chemical admixtures for concrete, mortar and grout
AS 1478.1	2000	Admixtures for concrete
AS 2341		Methods of testing bitumen and related roadmaking products
AS/NZS 2425	2015	Bar chairs in reinforced concrete - Product requirements and test methods
AS 2758		Aggregates and rock for engineering purposes
AS 2758.1	2014	Concrete aggregates
AS/NZS 3582		Supplementary cementitious materials
AS/NZS 3582.1	2016	Fly ash
AS 3600	2018	Concrete structures
AS 3799	1998	Liquid membrane-forming curing compounds for concrete
AS 3972	2010	General purpose and blended cements
AS/NZS 4671	2001	Steel reinforcing materials
AS/NZS 4680	2006	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
Austroads AGPT		Guide to pavement technology
Austroads AGPT04C	2017	Materials for concrete road pavements
Austroads AGPT04E	2009	Recycled materials
Austroads AGPT04G	2009	Geotextiles and geogrids
Austroads AGPT08	2009	Pavement Construction
RMS T192	2012	Determination of the Texture Depth of Road Surfacing by the TRL Mini Texture Meter
RMS T262	2012	Determination of moisture content of aggregates (Standard method)
APHA 4500-CL	1992	Standard Methods for the Examination of Water and Wastewater

1133 PLAIN AND REINFORCED CONCRETE BASE

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide plain or reinforced concrete base, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.
- *1102 Control of erosion and sedimentation (Construction)*.
- *1111 Clearing and grubbing*.
- *1112 Earthworks (Road reserve)*.
- *1121 Open drains*.
- *1132 Lean mix concrete subbase*.
- 1172 Subsoil and formation drains.

1.3 STANDARDS

General

Standard: To AS 1379, AS 3600, Austroads AGPT08 and Austroads AGPT04C.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviations apply:

- PCP: Plain concrete pavement.
- SCM: Supplementary cementitious material.

Definitions

General: For the purposes of this work-section the following definitions apply:

- Batch and load: Varies according to mixer types as follows:
  - . Central batch mixers: For mixers discharging into a tipper truck, a load may comprise more than one batch.
  - . Mobile batch mixers: A batch is deemed to be a load; a load must not comprise more than one batch.
  - . Continuous mixers: A batch is a load produced in a single discrete operation.
- Control line: A line generally at or near the centreline of a road on which the design is based and from which measurements for setting out may
- Efficiency index: The effectiveness of a curing compound in retaining moisture, assessed as a percentage of water retained in the test specimens relative to the uncoated specimens.
- Load: A single truckload of concrete comprising one or more batches.
- Mix: The proportions of component materials in a quantity of concrete.
- Nominated mix: The designed mix submitted for approval.
- Plan area: The Works area.

- Relative compaction: The ratio between the field bulk density and the bulk density of the job mix when compacted in the laboratory.

Slab

A portion of concrete base bounded by joints or free edges.

- Slab, odd-shaped: A slab is considered odd-shaped if:
  - The ratio of the longer dimension to the shorter dimension exceeds 1.6 or if the joint pattern produces an angle of less than 80° between two adjacent sides.
  - It contains blockouts, for example, for drainage structure.
- Slab, mismatched: Where any joint meets a slab and is not continued across that slab.
- Transition zones: Hand paved concrete which is cast in otherwise mechanically paved concrete, such as at transverse construction joints in mechanically paved work.
- Trial no fines concrete mix: Trialling of the nominated mix to demonstrate that the mix design conforms to the documented requirements.
- Vebe testing: A flow test on a vibrating table, used as a measure of workability in a stiff mix.

1.5 TOLERANCES

Alignment and surface tolerances

Horizontal tolerances at outer edges: ± 30 mm.

Thickness: - 0 mm and + 10 mm maximum.

Surface levels: Conform to the following:

- Maximum deviation from the design levels: + 10 mm/ - 0 mm.
- Maximum deviation from a 3 m straightedge, laid in any direction: 5 mm.

Concrete consistency

Maximum permissible difference in slump, tested within 40 minutes of completing batching:

- Mechanically placed concrete: ± 10 mm.
- Hand placed concrete: ± 15 mm.

Nominated slump: ± 5 mm of the slump measured in the trial mix.

Joints

Maximum deviation from the documented position: 10 mm.

Maximum deviation from a 3 m straightedge: 10 mm.

Concrete production tolerances table

Description	Tolerance (% by mass)
Particle size distribution (AS sieve):	
19.00 mm	± 2
13.20 mm	± 5
9.50 mm	± 5
4.75 mm	± 3
2.36 mm	± 5
1.18 mm	± 5
600 µm	± 5
300 µm	± 5
150 µm	± 2
75 µm	± 0.5

Description	Tolerance (% by mass)
Cement	± 2.0
SCM	± 4.0
Water	± 15.0

1.6 SUBMISSIONS

Execution details

Work method statement: Submit details of the proposed work method including the following:

- Handling, storing and batching of materials for concrete.
- Monitoring and measuring of constituent materials for concrete.
- Mixing and transporting of concrete.
- Placing and finishing of concrete base, including a paving plan showing paving widths, sequence and estimated daily outputs.
- Concrete texturing: Details of texturing device and method of achieving the required texture.

Non-conforming trial section: Submit details of changes proposed for constructing the new trial section including the equipment, materials, mix, plant or rate of paving, to rectify non-conformance.

Removal and replacement of base: Submit details of proposed work method for the removal and replacement of non-conforming base, including control measures for preventing damage to the adjoining base and underlying subbase.

Products and materials

Nominated mix: Submit details of the following:

- Constituent materials:
  - Cement: Brand and source.
  - Fly ash: Powerhouse source.
  - Water: Source.
  - Admixtures: Proprietary source, type, name, dosage recommended by the manufacturer and evidence of conformance to AS 1478.1.
  - Aggregates: Source, geological type, moisture condition, blend proportions and grading for each type of aggregate.
  - Soluble salt content.
- Mix design:
  - Constituent quantities per m^3 of concrete.
  - Nominated particle size distribution of aggregates, including fine, coarse and combined particle size distribution.
  - Forming time for each nominated mix.
- Trial mix test results: For each nominated mix, determined at the nominated slump, showing conformity for the following, as appropriate:
  - Content of cement, fly ash and content of cementitious material per yielded m^3 of concrete.
  - Compressive strength at 28 days.
  - Vebe reading.
  - Drying shrinkage after 21 days air drying.
  - Air content, if air entraining agent is used.

Sealants: Submit details, from the manufacturer, of the proposed sealing method, testing results, evidence that the sealant is compatible with the materials to be sealed and suitable for the documented joint dimensions.

Steel reinforcement: Submit evidence of conformance with AS/NZS 4671.

Records

Subbase survey: Submit a work-as-executed survey of the subbase to **SITE ESTABLISHMENT**, **Subbase survey**.

Alignment and surface tolerances: Submit survey to verify that the base alignment, surface levels, joints and edges conforms to the requirements of this work-section.

Samples

Curing compounds: Submit reference sample for testing.

Tests

Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

Requirement: Submit results, as follows:

- Uniformity testing: Evidence of conformity.
- Trial concrete base paving: To demonstrate conformance for compressive strength, compaction and thickness.

Variations

Approved nominated mix: If change to the mix is proposed, submit details of the alternative mix, including its production method and source of constituent materials.

1.7 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Trial mix: Mixing of the trial mix.
- Trial section construction: Completed trial concrete base.
- Non-conforming trial section: If the original trial section is deemed non-conforming, completed new trial section.
- Placing steel reinforcement: Steel reinforcement and embedment in place before placing concrete.
- Repairing core holes: Completed restoration of cored areas where testing specimens were extracted.
- Base sawcuts: Completed removal of non-conforming base before replacing with new base.
- Replacement of base: Completion of remedial work for non-conforming base thickness.

2 MATERIALS

2.1 GENERAL

Nominated mix

Variations to the nominated mix: Any change without approval is subject to removal from the Works.

Storage and handling

Cement more than 3 months old (from date of manufacture): If required, retest to verify cement conforms to AS 3972 before using.

Transportation: Transport cement in watertight packaging, protected from moisture.

Storage and handling facilities: Prevent the aggregates becoming intermixed, mixed with foreign materials or segregated.

Non-conforming storage and handling facilities of concrete mix: If found, stop concrete production and delivery of materials until condition is rectified.

Storing cement bags: Under cover and clear of the ground.

- Cement storage area flooring: Concrete.

2.2 CEMENT

General

General purpose and blended cement: To AS 3972.

Caked or lumpy cement: Do not use.

Minimum cement content: 300 kg/m^3 of concrete yielded.

2.3 FLY ASH

General

Requirement: Fine grade fly ash to AS/NZS 3582.1.

2.4 WATER

General

Mixing water: To AS 1379 clause 2.4.

Requirement: Clean potable water, free from any material which may be harmful to the concrete or reinforcement including oil, acid, alkali, organic or vegetable matter.

Limits of impurities in mixing water: To AS 1379 Table 2.2 and the following:

- Chloride ion: Maximum 500 parts per million to AS 1289.4.2.1.
- Sulphate ion: Maximum 400 parts per million to AS 1289.4.2.1 or APHA 4500-CL.

2.5 ADMIXTURES

General

Chemical admixtures: To AS 1478.1.

Requirement: Free of calcium chloride, calcium formate, or triethanolamine or any other accelerators.

Chemical admixture dosage: To the manufacturer's recommendations for the air temperature and setting time.

Combining admixtures: Do not combine without verification from the admixtures manufacturers that they are compatible.

Mixes with less than 50% fly ash: Make sure total alkali contribution from all admixtures does not exceed 0.20 kg/m^3.

Superplasticisers and high range water reducers Type HWRRe: May be used in non-paving applications including anchors and subgrade beams.

2.6 AGGREGATES

General

Properties: To AS 2758.1 and the following:

- Clean, durable materials sourced from natural gravel, crushed stone, air-cooled iron blast furnace slag and sand. Do not use steel-plant slag.

Samples for testing: Take from dedicated stockpiles or from materials delivered to site.

Combined aggregate: Make sure the particle size conforms to the **Combined aggregate grading table**.

Blending of aggregates: If blending two or more fine aggregates or two or more coarse aggregates, make sure the aggregate from each source conforms to the **Fine aggregate properties table** or **Coarse aggregate properties table**, as appropriate.

Combined aggregate grading table

AS sieve	**% passing by mass**
19.00 mm	95 – 100
13.20 mm	75 – 95
9.50 mm	55 – 75
4.75 mm	36 – 50
2.36 mm	30 – 42
1.18 mm	22 – 34
600 µm	16 – 30
300 µm	5 – 15
150 µm	0 – 7
75 µm(1)	0 – 4(2)
2 µm(2)	0 – 1.0(2)
Note: The aggregate grading is based on materials of equal particle densities in a saturated surface dry condition. If particle densities vary by more than 20%, adjust the grading accordingly. (1) Determine to AS 1141.12 (calculated washed blend). (2) Assess conformance to **Fine aggregate**.	

Fine aggregate

Requirement: Clean, hard, tough, durable, uniform, uncoated grains. Conform to AS 2758.1 for bulk density, water absorption, materials finer than 2 µm, impurities and reactive materials.

Size: 4.75 mm maximum.

- Permissible deviations: To AS 2758.1 Table 2.

Fine aggregates properties table

Property	**Test: Individual or Total fine(1)**	**Requirement**	**Test method**
Bulk density (compacted)	Individual	1200 kg/m^3 minimum	AS 1141.4 Procedure 7.2
Water absorption	Individual	5.0% maximum	AS 1141.5
Soundness (sodium sulphate)	Individual	6.0% maximum weighted average loss	AS 1141.24
Organic impurities	Total fine	Pass/fail (AS 1141) and 0.5% maximum (AS 1289) (2)	AS 1141.34 and AS 1289.4.1.1(2)
Sugar content	Total fine	< 1 part in 10,000	AS 1141.35
Acidic insoluble residue(4)	Total fine	60% minimum(4)	Texas DOT test Tex-612-J

Property	Test: Individual or Total fine[1]	Requirement	Test method
Micro-decal loss[4]	Total fine	15% maximum[4]	ASTM D7428
Fine cone time[3]	Total fine	27 seconds maximum	RMS T279
Glass content	Total fine	15% maximum[4]	RMS T279 and AS 1141.5

NOTE:
[1] Total fine: Calculate based on Individual component results with proportioning as per the nominated mix or test the mixed total fine aggregate blend.
[2] Test initially to AS 1141.34. If organic impurities are present, test to AS 1289.4.1.1.
[3] Fine cone testing is not mandatory if the manufactured fine aggregates are less than 20% (by mass) of the total fine aggregate.
[4] As a proportion of the total fine aggregate component.

Coarse aggregate

Requirements: Clean, crushed, hard durable rock, metallurgical furnace slag or gravel. If required, wash coarse aggregates.

Aggregate size: Less than AS 26.50 mm sieve.

- Permissible deviations: To AS 2758.1 Table 1.

Alkali-aggregate reactivity (AAR): Determine the AAR to RMS T363 and conform to the following for the appropriate classification:

- Non-reactive: No action required.
- Slowly reactive: Limit alkalis in the mix to 2.1 kg/m^3.
- Reactive: Using the nominated supplementary cementitious materials (SCM) and aggregates, test to AS 1012 to demonstrate that they are non-reactive.

Coarse aggregate properties table

Property	Requirement	Test method
Bulk density	≥ 1200 kg/m^3	AS 1141.4
Particle density	≥ 2100 kg/m^3	AS 1141.6.1, SSD[1] method
Water absorption	≤ 2.5%	AS 1141.6.1
Material finer than 75 µm	≤ 1%	AS 1141.12
Material > 9.50 mm: Particle shape, 2:1 and 3:1 ratios	≤ 25% and 10%	AS 1141.14
Material ≤ 9.50 mm: Ratio AGD/ALD[2] for all fractions 2 - 9 mm	≤ 2.25	AS 1141.20.1 and AS 1141.20.2
Wet strength	≥ 80 kN	AS 1141.22
Wet/dry strength variation	≤ 35%	AS 1141.22
Weak particles	≤ 0.3%	AS 1141.32
Light particles	≤ 1.0%	AS 1141.31
Fractured faces (2 or more)	≥ 80%	AS 1141.18
Foreign matter contents	≤ 0.1%	RMS T276

Notes:
[1] SSD = Saturated surface dry
[2] Ratio AGD/ALD = Ratio of Average Greatest Dimension to Average Least Dimension

Recycled concrete aggregate
Coarse aggregates from demolition concrete: To the recommendations of Austroads AGPT04E.

2.7 STEEL REINFORCEMENT

General
Steel reinforcing materials: To AS 3600 clause 17.2 and Austroads AGPT04C clause 5.

Grade, type, shape, dimensions and lapped splices: As documented. Make sure grade, type and size can be readily identified on the reinforcement.

Surface condition: Free from loose mill scale, rust, grease, tar, paint, oil, mud, mortar or any other material which may reduce the bond between the reinforcement and the concrete. Do not bring surface to a smooth polished condition.

Bar chairs: Plastic bar chairs or plastic tipped wire chairs to AS/NZS 2425 and capable of withstanding a load of 200 kg mass on the chair for one hour at 23 ± 5°C without malfunction.

Galvanized bars: Hot-dip to AS/NZS 4680.

Cold-worked reinforcing bars: Do not use.

Tie wire: Annealed iron wire with minimum 1.25 mm diameter.

Tie bar minimum lengths: 1.0 m with drill ties minimum 0.75 m long.

Dowels
Fabrication and mechanical properties: To AS/NZS 3679.1.

Condition: Straight and free of irregularities, including burrs and protrusions which may hinder their movement.

Length: 450 mm.

2.8 SEALANTS

Silicone joint sealant requirements table

Attribute	Requirements	Test method
Specific gravity	1.1 to 1.55	ASTM D792 (Method A)
Extrusion rate	90 to 250 g/minute	ASTM C603
Tack free time	Track free at 5 hours	ASTM C679
Durometer hardness	≤ 25 at -29°C ≤ 30 at +23°C	ASTM C661
Adhesion to concrete	Extension to 70%, compression to 50%. After 500 cycles, note more than 10% failure over the cross-sectional area.	RMS T1192
Accelerated ageing	Condition of specimen after one ageing cycle.	RMS T1193
Adhesion to concrete	Minimum 35 N average peel strength	ASTM C794
Accelerated weathering	No surface crazing, hardening, chalking or bond loss at 5000 hours	ASTM C793

Attribute	Requirements	Test method
Colour	Grey, compatible with pavement concrete	N.A.

2.9 CURING COMPOUNDS

General

Compounds for curing: To Austroads AGPT04C clause 6 and the following:

- Bituminous emulsions: To AS 1160.
- Liquid curing compounds: To AS 3799.

Water retention efficiency index: Minimum 90% when tested to AS 3799 Appendix B.

Reference sample testing: To AS 3799 Test for conformity to the following tolerances in AS 3799:

- Non-volatile content.
- Efficiency index.
- Density.
- Drying time.
- Viscosity.
- Infrared spectrum.

Curing compound properties table

Compound type	Class to AS 3799	Use limitations
Hydrocarbon resin (HCR)	Class B with ≥ 30% NV resin content	Do not use where a bitumen seal or asphalt will be placed
Waterborne hydrocarbon resin (WHCR)	Class B with ≥ 30% NV resin content	Do not use where a bitumen seal or asphalt will be placed
Styrene butadiene resin (SBR)	Class B	Do not use where a bitumen seal or asphalt will be placed
Blended bitumen and waterborne hydrocarbon resin (B-HCR)	Class Z with ≥ 40% bitumen	Make sure it is compatible with the primer that will be applied later
Wax emulsion (WE)	Class A with ≥ 30% NV resin content	Do not use on the top surface. Use only for debonding joints.

2.10 CONCRETE PROPERTIES

General

Properties: To AS 3600 Section 3.

Compressive strength

Sampling and testing: To **TESTING** and **Trial mixes**.

Minimum concrete strengths table

Description		Compressive strength (MPa)	Flexural strength[1] (MPa)
Non-SCM mixes[2]	In the trial mix	45.0	5.0
	In the Works	40.0	4.8
SCM mixes[2]	In the trial mix	40.0	4.8
	In the Works	35.0	4.5

Description	Compressive strength (MPa)	Flexural strength[1] (MPa)
Test specimen size	100 mm diameter cylinder	100 x 100 x 350 mm beam
Notes: [1] Applicable to base pavement mixes only. Not applicable to non-pavement mixes such as anchors and kerbs. [2] SCM: Mixes containing supplementary cementitious materials.		

Drying shrinkage

Testing: To AS 1012.13 and the following:

- Testing time: In the trial mix.

Preparation of test specimen: To AS 1012.8.4.

Assessment of conformity: The specimen is only required to conform for shrinkage at one age, either after 21 or 56 days drying period. If the test results do not conform at 21 days, extend testing to 56 days.

Maximum shrinkage strain table

Mix type	Shrinkage strain (με)	
	21 days drying period	56 days drying period
GGBFS mixes[1]	580	680
Other mixes	450	580
Notes: [1] GGBFS: Having minimum 40% ground granulated iron blast-furnace slag by mass.		

Consistency

Requirement: As required to allow the production of a dense, non-segregated mass with bleeding limited to prevent bleed water flowing over the slab edge under the conditions of pavement. Make sure the slab edge will maintain its shape and not sag or tear.

- Bleed water flowing over the edge: Stop paving until the mix is adjusted or redesigned to approval.

Testing time: Check consistency within 30 minutes of adding cement to aggregate. If actual haul time exceeds 45 minutes, check consistency immediately before discharging.

Slump range:

- For mechanically placed concrete, except at transitions: 15 to 50 mm.
- For hand placed concrete: 50 to 70 mm.
- Paving in transition zones: 15 to 70 mm.

Non-conforming concrete: Do not incorporate into work.

Air content

Content: 3 to 6% when discharged from the transport vehicle ready for placement.

Non-conformance: If air content is not within the required limits, repeat testing immediately from another portion of the sample.

Compaction

Testing: Conform to **TESTING**, **Relative compaction of pavement**.

Minimum relative compaction: 98%.

Other concrete attributes
Chloride ion content: Maximum 0.8 kg/m^3 of concrete.

Sulphate ion content: Maximum 5% relative to cement mass, excluding supplementary cementitious materials such as fly ash and slag.

Bleeding: Maximum 3%, tested in the trial mix.

2.11 TESTING

Quality
Requirement: Test for all characteristics in conformance with **ANNEXURE – MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Quality verification: If material/product quality verification can be obtained from the supplier, documented tests need not be repeated.

3 EXECUTION

3.1 NOMINATED MIX

Trial mix
Requirement: Before starting production of each mix, mix a trial batch of each nominated mix for testing as follows:

- Sampling: To AS 1012.1.
- Preparation of cylinders: Inspected, capped and crushed to AS 1012.9.
- Unit mass: Determine to AS 1012.12.1 or AS 1012.12.2 after dressing of voids in the specimen.

Compressive strength testing: Use 3 specimens conforming to the following:

- Cylinders: 28 days old concrete.
- Size: 100 mm nominal diameter.
- Sampling: From the same concrete.
- Specimens more than 28 days old: Adjust the age to the **TESTING**, **Concrete age conversion factors table**.

Testing: To the **Ready-mixed concrete production and supply table** in the **ANNEXURES**.

Date of testing: Maximum 18 months before starting paving.

3.2 PRODUCTION, TRANSPORT AND DELIVERY OF CONCRETE

Standard
Handling, storing and batching of materials, mixing, transport and consistency of concrete: To AS 1379 Section 4 and Appendix A.

Mixers: To AS 1379 clause 3.5.

Storage and handling
Aggregate stockpiling: Stockpile on clear, even, well-drained, firm ground or constructed floor, separate from each other so that there is no cross contamination or segregation.

- Lots: Organise separate stockpile for each lot.
- Signposting: Identify lot number, aggregate type and quantity of material.

Aggregate moisture content: Determine at least twice daily immediately before batching and make corrections to quantities of aggregate and water, as appropriate.

Cementitious material: Weigh separately with an individual hopper, weighing the cement first.

Continuous type mixer: If used, measure using a continuous weighing method, except for liquids which may be measured by volume or flow rate meter.

Volumetric batching of water: Measure with a device calibrated in one litre increments.

Concrete for manually placed concrete: Deliver concrete in agitator vehicles.

Steel reinforcement: Protect from the weather with a waterproof cover and store above the ground.

Mixing and batching

Split drum mixer producing centrally mixed concrete: If used, discharge the whole batch into the tray of a moving vehicle for the purpose of performing mixer uniformity tests to AS 1379 Appendix A.

- Mixer uniformity tests sampling points: Approximately 15% and 85% along the length of vehicle tray.

Truck-mixed concrete: Water may be added, to AS 1379 within 10 minutes of completion of batching and 200 m of batching facilities.

Size of batching in an agitator: Do not exceed the manufacturer's rated capacity or exceed 80% of the mixer drum gross volume.

Continuous type mixer: If used, do not run plant at a greater rate than the manufacturer's recommended rated capacity. Reduce production rate if the quality of concrete produced shows a longer mixing time is required.

Mixing time – stationary batch mixers: Measured from when at least 90% of the total water content and all other ingredients are in the mixing drum, until mixing stops or after the required revolutions. Up to 10% of the total water may be added after the defined mixing time if:

- Split drum mixers: There is minimum 30 seconds of mixing after final addition of water.
- Twin shaft mixers: There is minimum 15 seconds of mixing after final addition of water.

Mixing time – mobile mixers: Measured as from when all the ingredients are in the mixing drum, until mixing stops or after the required revolutions. If additional water is required, conform to **Retempering**.

Minimum mixing time: Conform to the following:

- Twin shaft mixers: Mixing time after charging not less than 30 seconds + 5 sec/m^3.
- All other stationary batch mixers: Mixing time after charging not less than 54 seconds + 6 sec/m^3.
- Mobile batch mixers: Mixing time not less than that shown on the mixer identification plate or 3.0 minutes, whichever is the greater.

Maximum mixing time: Conform to the following:

- Generally: 10 minutes.
- Split drums and twin shaft mixers: 5 minutes.

Retempering

Addition of water: To AS 1379 clause 4.2.3.

Adding admixture

Requirement: Separately predilute with mixing water before adding to other materials. Incorporate using a method that does not cause adverse interaction, as recommended by the admixture manufacturer.

Adding to mix water: Use one of the following methods:

- Add into water weigh hopper.

- Direct add into water feed line during water batching.

Adding to a mobile mixer after completion of batching: Immediately after adding, remix adjusted batch for minimum 55 revolutions at minimum mixing speed of 30 revolutions, as required to re-establish mix uniformity.

Production and transport

Transport and production equipment: Use equipment which:

- Prevents segregation or loss of materials.
- Supplies a homogenous product.
- Provides concrete workability compatible with the capacity of the paving equipment to achieve the required compaction and nominal finish and requires only nominal manual finishing.

Equipment capacity for slipform paving: Use mixing, agitation and transportation equipment with sufficient capacity for continuous paving at the required speed.

Forming time

Maximum forming time: Determine time required for each mix to achieve the required concrete workability, taking into consideration prevailing weather conditions and concrete temperature.

Monitoring: Monitor and record forming time for any batch exceeding the following:

- Air temperature < 30°C: 90 minutes.
- Air temperature ≥ 30°C: 60 minutes.

Conformity of batch: Determined conditional on the compressive strength of the cores from that batch.

Uniformity testing

Uniformity tests: To AS 1379 Appendix A.

Uniformity conformance: The mixer is deemed to conform if:

- Central batch and continuous mixers:
  - Testing of batches result in 3 consecutive passes.
  - In each batch, the highest and lowest value does not exceed those in AS 1379 Table A1.
  - No slump value is outside the required range.
  - Coefficient of variation for compressive strength (CoV_C): Less than 4.5%.
  - Coefficient of variation for mass unit volume (CoV_{MUV}): Less than 1.0%.
- Mobile batch mixers: To AS 1379 Table A1.

Concrete delivery

Delivery information: For each batch of mix, keep a record of the following:

- Batch number: Issued sequentially with the batching order.
- Supplier name and location.
- Volume of material supplied, including amount of water.
- Product identification.
- Dispatch time and date.

Segregated or non-uniform mix: Do not deliver.

3.3 CONSTRUCTION PLANT AND EQUIPMENT

Paver machine

Mechanical paver: Use pavers conforming to the following:

- With an automatic control system, including a sensing device for controlling line and level to the documented tolerances.
- With internal vibrators capable of compacting the full depth of the concrete.
- With adjustable extrusion screed and/or conforming plate for forming the slab profile and producing the required finish on all surfaces.
- Capable of paving the documented slab widths or a combination of slab widths and slab depths.
- Able to spread the mix uniformly and regulate the flow of mix to the vibrators without segregation of components, to produce a dense and homogenous slab with a smooth uniform finish, requiring minimal hand finishing.

Spreading device

Requirement: Use before using mechanical paver as follows:

- To transport and spread concrete uniformly over the full pavement width.
- Without disturbing the reinforcement or its supports.
- Without segregating or adversely affecting the concrete.

3.4 SITE ESTABLISHMENT

Subbase survey

Measuring base invert levels: If spray sealing is required for the underlying layer, take levels on the top of the seal after removal of foreign or loose material such as aggregate.

Survey method: Survey on a 5.0 m grid or a plan area, reporting levels to the nearest mm.

Assessment of subbase: Submit a work-as-executed survey of the subbase for the full extent of works. Highlight any locations where the actual level is higher than the design levels.

Non-conforming levels: Adjust pavement levels locally, this may include trimming and adjusting the paving layer.

3.5 CONCRETE BASE PAVING TRIAL

Trial section construction

Requirement: Before starting normal concrete base paving, construct a trial section of the concrete base on the carriageway as follows:

- So that it may be incorporated in the finished work.
- Construct separate trial sections, for each concrete base type, in a continuous operation without intermediate construction joints.
- Length:
  - 50 to 100 m for mechanical placing in one continuous operation.
  - 15 to 50 m for manual placement with a 20 m^3 minimum volume.
- Width: Same as that documented for the Works.
- Demonstrate methods proposed for applying curing compound, construction and sawing of joints, and the placement of tie bars and dowels.

Materials and methods: Use the same materials, concrete mix, equipment and methods for the entire works.

Non-conforming trial section

Requirement: If the trial concrete base is deemed non-conforming, remove the non-conforming base, rectify any damage caused by the removal, and construct the new trial base in conformance with **REMOVAL AND REPLACEMENT OF BASE**.

3.6 SLAB ANCHORS

General

Location: Construct anchors normal to the control line, extending over the full width of the base, to the documented dimensions and locations.

Associated transverse expansion joint spacing: Minimum 2 m from other transverse joints.

Excavation

General: Remove all loose material, trim the vertical faces to neat lines and recompact the bottom of the trenches, where required, to match the degree of consolidation of the adjacent undisturbed material.

Excavated material: Dispose off-site.

Adjacent to flexible pavement: If a slab anchor is required at the junction of an existing flexible pavement, sawcut straight the full depth of the asphaltic concrete or bituminous seal in the flexible pavement along the joint line.

Remediation: Rectify any disturbance or damage to the flexible pavement.

Subsoil drains: Provide a subsoil drain at the bottom of the trench conforming to 1172 Subsoil and formation drains.

Construction

Anchor types: Construct anchors as follows:

Bridge approaches: Use Type 12 or 18.

Flexible pavement transverse interfaces: Use Type 6 or 12.

On steep grades: Use Type 12 at documented locations.

Method: Produce, transport and place concrete to **CONCRETE PLACING AND FINISHING, Hand paving**.

Sequence: Cast anchors minimum 24 hours before constructing the overlying base. Pour slab anchors separately from the base slabs up to the top surface of the subbase.

Transverse isolation joint: Provide on the downhill side of the slab anchor.

Steel reinforcement: Conform to **STEEL REINFORCEMENT** and as documented on drawings.

Concrete: Use concrete with the following properties:

- Strength grade: N32.
- Aggregate: 20 mm.
- Slump: 40 to 80 mm at the point of placement.

Concrete placement: Place concrete and compact using internal vibration conforming to **Hand paving**.

Anchor stirrups: Lap to the base reinforcement.

At junctions with an existing flexible pavement: Make a straight sawcut for the full depth of any asphalt in the flexible pavement, along the joint line. Excavate trench without disturbing or damaging the existing pavement. Rectify any damage or disturbance.

3.7 INSTALLATION OF STEEL REINFORCEMENT

General

Construction requirements of reinforcing steel: AS 3600 clause 17.2.

Reinforcement: Do not carry out the following:

- Bend or straighten so that it will damage the material.
- Use with kinks or bends which are not documented.

Tack welding: To AS/NZS 1554.3. If required, obtain approval for locations.

Placing steel reinforcement

Placing and securing: Secure the reinforcement in position by blocking from the forms, by supporting on bar chairs or metal hangers and by tying together with annealed tie wire.

- Perimeter enclosing bar chair: Provide minimum 25% voids.
- Gap in chair below the reinforcement: Minimum 1.5 times the maximum nominal size aggregate in the concrete mix.
- Order: Place longitudinal steel on top of the transverse steel.

Supports: Concrete, plastic or wire chairs. Do not use the following:

- Wooden supports, pieces of aggregate or metal supports which extend to any surface of the concrete.
- Support chairs likely to impede compaction of the enveloping concrete.

Support loading: Make sure layout and spacing of chairs provide proper support with permanent deflection or displacement of the reinforcement no more than 2 mm during placing and compaction of the concrete.

Bearing at chair base: Sufficient to prevent overturning.

Mass loading without distortion: Capable of supporting a 200 kg mass without permanent distortion more than 2 mm.

Mass of reinforcing steel supported by one bar chair: Maximum 10 kg.

Support layout: In a maximum 0.9 m regular grid.

Ends of bars: Securely wire together bars forming a lapped splice in minimum two places.

Steel mesh reinforcement: Place mesh as follows:

- Within 80 ± 20 mm of the finished top surface of the base slab.
- 80 ± 20 mm clear of all joints and edges.

Concrete cover

Minimum bottom cover: 50 mm to the nearest concrete surface or as documented.

Minimum top cover: 70 mm ± 10 mm.

Tie bars

Method of inserting tie bars: Place bars in conformance with the following:

- So that they remain in their required location after concrete placement.
- So that there is no disturbance to the finished concrete surface.
- Do not place tie bars through the finished upper surface of the pavement.

- Place either manually before placement of concrete, by a bar vibrator into the edge of the joint or by an automatic tie bar inserter on the mechanical paver.
- For fixed form paving, vibrate tie bars in their final position by either internal vibration or by vibrating screed board.
- So that bars extending from any face of base concrete or gutter is anchored to develop 85% of the yield strength of the bar in tension.

Longitudinal tied joints: Place tie bars conforming to the following:

- Not closer than 300 mm to a transverse untied joint, contraction or isolation joint.
- Not closer than 200 mm to a transverse tied joint.
- Within the central third of the slab depth but with minimum clearance of 30 mm to any crack inducer or sawcut.
- At documented spacing ± 20 mm on spacing of individual bars.

Transverse joints: Place bars not closer than 300 mm to a longitudinal joint or slab edge.

Dowels

Before installing: Coat one end of the dowel with a tough, durable debonding agent as follows:

- Coating thickness: 0.75 ± 0.25 mm.
- Coating length: Minimum 275 mm.
- Sanding: Sand coated ends, as required, to allow free movement of the concrete base slab when the temperature varies.
- At formed joints: Debond within the second placed slab.

Dowelled joints: Install dowels before paving. Conform to the following:

- Place at mid-depth ± 20 mm, parallel to the pavement surface and normal to the line of the joint, as documented.
- Use a dowel support assembly. Make sure no part of the assembly, except the dowel, crosses the joint.
- At expansion joints: Debond end to provide a clearance for movement equal to the width of the joint plus 15 ± 5 mm.
- Equally position about the line of the intended joint within a tolerance of ± 25 mm.
- Do not place closer than 150 mm to a longitudinal joint or slab corner.
- Average bonding stress: Maximum 0.15 MPa.

Alignment tolerance of individual dowel location:

- In the dowel assemble: ± 2 mm.
- In the finished slab: ± 2 mm.

Bending

Requirement: Bend without impact or damage to the bar.

Bend procedure: To AS 3600 clause 17.2.3.1 using one the following:

- Cold bending around pins.
- Applying uniform heat not exceeding 450°C to the portion to be bent.

Internal diameter of reinforcement bend and hooks table

Type of bar	**Minimum internal diameter of bend**
(a) Normal bends:	
- Fitments: Bar grade 250 and wire grade 450	3 db
- -Fitments: Bar grade 500	4 db

Type of bar	Minimum internal diameter of bend
- -Mesh and bars other than (b) and (c)	5 db
(b) Bends designed to be straightened or re-bent subsequently:	
- -db < 28 mm	5 db
- -db ≥ 28 mm	6 db
(c) Bends in reinforcement epoxy coated or galvanized before or after bending:	
- -db ≤ 16 mm	5 db
- -db ≥ 20 mm	8 db
Note: db = Nominal diameter of a bar or wire.	

Lapped splices

Requirement: Weld or securely tie together in at least 2 places the ends of bars forming a lapped splice.

Minimum length of lapped splices: To AS 3600 clause 13.2.

Splices in reinforcing fabrics: To AS 3600 clause 13.2.3 so that the two outermost transverse wires of one sheet overlap the two outermost transverse wires of the lapping sheet.

- Orientation of sheets: Make sure sheets mechanically engage each other.
- Sheet overlap: Not less than the pitch of the transverse wires plus 25 mm.

Splice lengths

Bar type	Bar diameter (mm)	Splice lengths (mm)
Deformed	12	360
	16	525
	20	600
	24	900
	28	1050
	32 and 36	1200
Plain (fitment)	db < 13 mm	50 db or 30 mm, whichever is greater
Note: db = Nominal diameter of a bar or wire.		

Odd-shaped and mismatched slabs

Reinforcement: Minimum SL 82 reinforcing fabric at top layer or as documented. Place fabric clear of all transverse and longitudinal joints by 50 to 100 mm.

Minimum cover: 50 to 60 mm to the surface of the base.

3.8 CONCRETE PLACING AND FINISHING

Subbase

Subbase surface condition, at time of base paving: Clean and free of loose or foreign matter, including sealing aggregate, and does not hold pond water.

Subbase treatment: Conform to the following, as appropriate for the subbase material:

- Lean mix concrete subbase: Treat with a debonding agent conforming to **CURING AND DEBONDING** in the *1132 Lean mix concrete subbase* work-section.
- Asphalt subbase: Make sure the surface condition, at time of base paving, minimises mortar and water absorption from the base concrete.
- Other subbase: Seal with a bituminous spray or bituminous emulsion.

Ambient conditions

Concrete placing: Do not place if:

- Rain appears imminent or during rain.
- Air temperature in the shade is below 5°C or above 35°C.
- Concrete temperature at the point of discharge is less than 10°C or more than 32°C.

Concrete temperature: Measure and record the concrete temperature at the point of placement.

Diurnal temperature changes ≥ 20°C: Make sure the upper limit of the concrete temperature is not more than 30°C before placing.

Surface temperature: Monitor the concrete surface temperature for the first 24 hours after placement, make sure it does not fall below 5°C.

- Measurement: Using a purpose-made thermometer, measure at 2 or more locations within each day's paving.

Evaporation and moisture loss

Evaporation limit: If the rate of evaporation exceeds 0.50 kg/m^2/hr, when determined from **ANNEXURE – RATE OF EVAPORATION**, prevent excessive moisture loss using approved measures or cease work.

Evaporation retarder: If required to prevent excessive moisture loss, apply by fine uniform spray after all finishing operations have been completed, except minor manual bull-floating. If re-application is required, carry out after level floating without incorporating the retarder into the surface mortar.

Monitoring and inspection: Regularly inspect plastic concrete to monitor the effectiveness of the procedures.

Paving generally

Requirement: Place, pave and finish concrete as follows:

- Prevent segregation or loss of materials.
- Prevent premature stiffening.
- Produce a uniform, dense, homogenous slab throughout the pavement.
- Expel entrapped air and make sure reinforcement and embedments are closely surrounded.
- Produce the documented thickness and surface finish.

Disruptions: If disruptions occur, form a construction joint before the restart of paving operations.

Non-monolithic concrete: If subsequent testing at the location of an interruption indicates the presence of non-monolithic concrete, remove and replace concrete to **REMOVAL AND REPLACEMENT OF BASE**.

Ponding: Not acceptable.

Mechanical (slipform) paving

Requirement: Spread, compact, screed and finish freshly placed concrete to form a dense, homogenous slab with a smooth uniform finish requiring minimal hand finishing.

Slab edge produced: Able to maintain its shape without sagging or tearing. If excessive bleed water occurs, by flowing over the slab edge, stop paving until the mix consistency has been adjusted to prevent the flow.

Supplementary manual vibration: If mechanical paving is unable to fully compact and finish the concrete, such as at transverse construction joints, use manual vibration.

Paving continuity: Make sure the supply of concrete and concrete paving operations is continuous so that the mechanical paver does not require stopping once spreading commences.

Supporting surface: Provide a smooth and firm supporting surface for the tracks of the paver, curing machine and any other equipment in the paving and curing train.

Hand paving

Application: Use hand placement in areas where mechanical placement is not practical.

Formwork: Construct formwork conforming to the following:

- So that it can be removed without damaging the concrete.
- True to line and grade.
- Braced sufficiently to support wet concrete.
- Mortar tight.
- Debonded to prevent adhesion of concrete to the forms.
- Set to tolerances equivalent to that required for the finished subbase finish.

Placing in forms: Deliver concrete in agitator trucks and deposit uniformly in the forms without segregation.

Build-up: Prevent any build-up of concrete between the forms and vibratory screed.

Standby vibrators: ¼ of the vibrator number in use, with a minimum of 1 vibrator.

Internal vibration: Compact concrete using internal vibrators to operating parameters suitable for site conditions. Use systematic spacing and duration for producing a homogenous slab with uniform and thorough compaction conforming to **TESTING**, **Relative compaction of pavement**.

Internal vibrators: Use vibrators with the following operating parameters:

- Minimum diameter: 50 mm.
- Operating frequency: 8000 to 12000 vibrations/minute (130 to 200 Hz).
- Method of vibration: Vibrate using either the drip, drag or modified drag method.

Following internal vibration: Compact and finish the concrete by minimum two passes of a hand-guided vibratory screed conforming to the following:

- Traversing the full width of the slab on each pass.
- Screed length: Compatible with the slab width under construction.
- Construction: Tubular steel trusses or rigid metal and/or timber.
- Operating frequency: 3000 to 6000 vibrations/minute (50 to 100 Hz) and minimum amplitude of 0.3 mm.

Concrete head in front of the screed: Maintain a suitable head over the whole screed length to allow uniform transmission of vibration into the slab.

Concrete surface disturbance: If there is a significant disturbance, such as walking in the mix, provide at least two passes of the screed.

Power trowelling: Do not use on the surface.

Terminal slabs

Placement location: Construct at adjoining bridge approach slabs and where there is a change from a rigid pavement to a flexible pavement, as documented.

Surface texture

Requirement: Texture the concrete surface by hessian drag and tining except where:

- Tining is not required beneath bituminous or asphalt surfacing.
- Light brooming is required instead of hessian drag.

Hessian drag and brooming (initial texturing): Adjust drag length or broom type, as required, to produce the documented finish. Maintain or replace, as appropriate, to produce a uniform consistent texture.

Tining: As soon as possible after placing concrete or initial texturing, apply additional texture to the concrete surface with a mechanical device for grooving plastic concrete. Conform to the following:

- Paving less than 2.5 m wide: A manual tining comb may be used for transverse tining.
- Texturing equipment: With rectangular shaped tines of flat spring steel, approximately 0.6 mm thick, 3 mm wide and minimum 200 mm free length.

Transverse tining: Conform to the following:

- Spacing of tines: Randomly spaced between 10 and 21 mm, with average spacing of 13 to 14 mm.
- Texturing brush or comb width: Minimum 750 mm.
- Texture direction: 90º to the direction of linemarking.
- Machine tining: If used, make provisions for downward adjustment to compensate for tine wear.

Longitudinal tining: Conform to the following:

- Tine spacing: Uniformly space 15 ± 3 mm.
- Texture direction: Parallel with the linemarking.
- Tining method: Tine with a machine. Make provisions for vertical adjustment to compensate for tine wear.

Machine texture: Use a machine spanning the concrete slab and guided for level and direction, by the rails (for fixed form construction) or paver guide wires (for slipform construction).

Asphalt surfacing: If required over the concrete base, texture the surface with a fine broom or hessian-drag.

Remedial grooving: For areas with less than the allowable average texture depth, transversely sawcut grooves conforming to the following:

- Width: 3 mm.
- Depth: 3 mm.
- Groove spacing: Randomly spaced between 10 mm and 18 mm, with an average spacing of 12 to 15 mm.
- Texture alignment: Parallel with the tining.
- Procedure: Remove grooving residue from pavement and do not allow residue to travel into the drainage system or across public lanes.

Average texture depth: Conform to the following, tested to RMS T192:

- Longitudinal: 0.65 ± 0.15 mm.
- Transverse: 0.60 ± 0.10 mm.
- Hessian drag with no tining or grooving: 0.40 ± 0.05 mm.

Texture depth testing: For tining and grooving, test orthogonal to the direction of texturing for minimum 7 m long.

Assessment of base thickness

Base survey: Survey runs, for the full extent of works, to the nearest 5 mm, taken on a 5 m grid and compare with the subbase survey conforming to **SITE ESTABLISHMENT**, **Subbase survey**.

Alternative methods:

- Concrete cores.
- Measurement at the pavement edge.
- Audit checks: Using a suitable probe whilst the concrete is being placed measured to the nearest 5 mm.

Non-conforming base thickness

Non-conforming thickness: If thickness is 10 mm or more below the documented thickness, remove and replace base in conformance with **REMOVAL AND REPLACEMENT OF BASE**.

Thickness 10 mm or less below: If the thickness is 10 mm or less below the documented thickness and represents isolated sections within a lot, comprising less than 5% of the area of the lot, conform to **ANNEXURE– DEDUCTIONS**.

Protection of work

Traffic restrictions: Do not allow traffic or construction equipment, other than those associated with testing, sawcutting, groove cleaning or joint sealing, heavier than 0.5 tonne, on the finished base until the joints have been permanently sealed and the concrete has reached a compressive strength of at least 20 MPa.

Trafficking after the concrete reaches 20 MPa strength: The following limits apply:

- Axle group loads: Single 5.0 T, tandem 8.0 T and triaxle 9.0 T.
- Tracked vehicles: 15 T/m^2 pressure over the track area, with the concrete protected from damage.

Compaction of granular verge material against edge of base: Do not allow until the concrete has reached a compressive strength of at least 20 MPa.

Steel implements: Do not allow implements such as grader blades and loader buckets to impact joints or edges of base.

Rain protection: Do not expose concrete to rain within the period from tipping to application of curing compound. If the concrete is exposed, it will be deemed non-conforming. Beyond this period, acceptance of conformity will be assessed based on the surface finish.

3.9 JOINTS

General

Location: As documented.

Scabbing: If required, expose coarse aggregate over a large portion of the scabbled face, avoid the documented arrises, to achieve a rough surface with indentations 4 to 6 mm deep.

- Scabbled joints: Subsequently debond but do not debond joints in anchors.

Joint sealant: Handle and install to the manufacturer's recommendations.

- Asphalt surfacing placed over the base: Use a silicone sealant confirmed by the manufacturer suitable for the application.

Transverse construction joints

Location: Conform to the following:

- Provide at discontinuities in placement of concrete, determined by the paving operations.
- Do not place closer than 1.5 m to a transverse contraction joint.
- Construct 90 ± 6° to the longitudinal joint line, with joint face corrugated and square to the finished top surface of the base.
- Smooth across the joint before texturing. Construct joint continuous over the paved width without steps or offsets in any axis so that the line of the joint does not deviate by more than 20 mm from a 3 m straightedge.
- Odd-shaped slabs: Align joints so that the skew angle is not increased.

In joint bases: Install tie bars conforming to **INSTALLATION OF STEEL REINFORCEMENT**. If ties are installed by drilling and fixing in hardened concrete, an epoxy mortar may be used to give minimum anchorage strength of 85% of the yield strength of the bar.

Initially non-conforming or damaged joints: Reinstate or repair before placing adjoining concrete. Do not place repair material integrally with the adjoining concrete.

Face of joint: Debond, for new and existing concrete pavement, to prevent intimate microtexture bond.

First-placed slab face condition: Dense, fully compacted, and free of honeycombing and re-entrant angles. If non-conforming or edge is damaged, reinstate or repair before placing adjoining concrete.

Scabbling adjoining edge before placing concrete: Roughen the surface to expose coarse aggregate. Wash clean the roughened surface and the projecting reinforcement and remove all excess water and loose material.

Curing compound application: Respray first-placed face with a wax emulsion and a single spray application at a minimum rate of 0.20 L/m^2, maximum 10 days before placing adjoining concrete, conforming to **CURING**.

- Reinforcement: Do not spray wax or bitumen compounds on the reinforcement.
- Coating: Intact and effective at time of subsequent concrete placement.

Transverse contraction joints

Requirement: Continuous across the full width of the base without steps or offsets in any axis so that the line of the joint does not deviate by more than 10 mm from a 3 m straightedge.

Location: Normal to the control line, as documented. If required, the joint may be skewed to maximum 1:10 to accommodate construction joints and slab anchors.

Joint formation: Saw using either a two-cut or single-cut operation.

Deflection angle: If documented, saw so that alignments do not extend beyond the intended limit defined by intersecting joints such as longitudinal joints.

Plastic joint: If the concrete base is to be overlaid with an asphalt wearing course, the joint may be formed with an appropriate plastic joint inducing system.

Sealing: Provide preliminary and/or temporary and permanent seal to all formed edges, including vertical faces. Maintain joint free of incompressible foreign materials. Also seal any underlying induced cracks.

Sawcutting

Two-cut operation: Saw joints as follows:

- Initial cut: 3 mm wide for the full depth of the base slab.
- Second cut: A widening sawcut.

Timing: Between 6 and 24 hours after initial paving to prevent excessive ravelling of aggregate adjacent to the cut and cracking of the base concrete other than the bottom of the 3 mm wide sawcut.

Equipment: Use equipment and type of blade suited to the hardness of the concrete being sawn. Have standby equipment available on-site to maintain continuity of sawing.

Ravelling: Conform to the following:

- Surface of transverse contraction joint edge ravelling: 10 mm maximum for vertical or horizontal edges.
- Length of edge ravelling greater than 3 mm: 300 mm maximum in any 3 m length of joint on each edge.
- Vertical face at edge of slab: Does not show ravelling greater than 20 mm in any axis at any point of intersection with the sawn joint.
- Wash saw debris from the joint and pavement immediately after sawing.

Non-conforming sawcuts: Rectify or repair.

Cleaning

Cleaning sawcuts: Immediately after any sawing, clean sawcut to remove debris before residue dries or hardens.

Method: Use a pressurised liquid or liquid/air oil-free jet conforming to the following:

- Do not damage sawcut or arrises.
- With sufficiently high pressure to maintain dust-free faces when dry.
- Do not gravity feed cleaning liquid from tanks.
- Does not leave any substance deleterious to the concrete or to adhesion of joint sealant.
- Removes all sawing residue without it entering the joint.

Preliminary sealing

Requirement: Within 2 hours of cleaning the initial sawcut, seal joint to prevent drying and contamination by installing a continuous closed-cell polyethylene backer rod, including to the vertical faces of the slab at the end of the sawcuts.

Top of seal position: Not higher than the concrete surface or more than 5 mm below it.

Seal condition: Maintain in a sound and effective condition at the top of the seal until joint is temporarily or permanently sealed.

- Damaged rods or rods removed for sealing: Replace within one day.

Two-cut operations: Maintain preliminary seal in place until start of widening sawcut. At start of widening, push to the bottom of the initial sawcut so that it is effective in preventing sawcut residue entering the underlying joint.

Single-cut operations: Maintain preliminary seal in place until permanent sealing.

Temporary sealing

Sealing after widening sawcut: Within 2 hours of cleaning, seal joint to prevent drying and contamination by installing a continuous closed-cell polyethylene backer rod, including to the vertical faces of the slab at the end of the sawcuts.

Top of sealant position: Not higher than the concrete surface or more than is 5 mm below it and passing over any longitudinal joint seal already in place.

Before grooving: Provide temporary joint seal robust enough to prevent the applied stresses.

Rod diameter: As required to prevent sawcut residue entering the underlying joint.

Seal condition: Maintain in a sound and effective condition at the top of the seal until joint is temporarily or permanently sealed.

- Damaged rods or rods removed for sealing: Replace within one day.

Permanent sealing

Requirement: Install an in-situ cast silicone sealant, stored and installed to the manufacturer's recommendations.

Extent of seal: Install at slab edges and formed joints, extending down the vertical faces of joints and any underlying cracks.

Installation timing: Place seal 7 to 14 days after initial sawing, unless grooving is proposed, or immediately after removal of temporary sealant.

Before sealing: Make sure the joint faces are clean and surface dry. Do not place sealant within 24 hours of the concrete surface having been wet.

Preparation: Before placing silicone sealant, carry out the following:

- Backer rod: Install to **Preliminary sealing** and/or **Temporary sealing**.
- Cleaning: Clean out groove to remove foreign or disturbed material from the joint and from the top of the backer rod by dry air jet. Do not use grit blasting.
- Forming backer rod: Depress the backer rod so that the bottom of the silicone sealant is at the required location and of the correct shape. If the backer rod is damaged in any way, replace for the full length of the joint.
- Installing sealant: If recommended by the sealant manufacturer, use a joint primer. Tool sealant to the required shape before surface skin forms.

Before asphalt overlay: If asphaltic surfacing over the concrete base is required, provide initial 3 mm wide sawcut only and fill with silicone joint sealant.

Isolation and expansion joints

Location: As documented ± 25 mm.

Construction: Continuous across the full width of the base, without steps or offsets in any axis so that the line of the joint does not deviate by more than 20 mm from a 3 m straightedge.

- Joint faces: ± 5° to the finished top surface of the base.
- Spacing: 2.0 m minimum to other transverse joints.

Joint filler: Jointing material conforming to the **Silicone joint sealant requirements table**.

Installation: To the manufacturer's recommendations and as documented.

Seal condition: Maintain joint so that it is free of incompressible and foreign materials and as follows:

- At free edges: Extend permanent seal down the vertical face of the joint.
- Other edges: The filler prevents ingress of concrete and other foreign materials to the joint space during subsequent works.

Joint faces not constructed by sawing: Prepare joint cavity for permanent sealant using one of the following methods:

- Sawing: Clean and provide second cut as for a two-cut operation to **Cleaning** and **Sawcutting**.
- Wire brushing: Clean the full joint face area with a mechanised rotary wire brush or similar abrasive contact equipment. Remove residue and arris spalling to **Sawcutting**.

Longitudinal joints generally

Requirement: Continuous over the full length of the base without steps or offsets in any axis so that the line of the joint does not deviate by more than 20 mm from a 3 m straightedge.

Formed joints: Conform to the following:

- Joint face: 90 ± 6° to the finished top surface of the base and corrugated.
- Debonding: Debond joint face to prevent intimate microtexture bond.
- Non-conforming or damaged joints: Reinstate or repair before placing adjoining concrete. Place repair material integrally with adjoining concrete.

Longitudinal tied joints

Location: As documented, parallel to the control line.

Method: Form or induce by sawing or by machine insertion of a crack inducer ribbon.

Tie bars: Conform to the following:

- 12 mm diameter deformed steel bars Grade 500N, 1 m long, inserted to **INSTALLATION OF STEEL REINFORCEMENT**, **Tie bars**.
- Location and spacing: Where asphalt surfacing is required and as documented, with all parts of bar lying within 50 mm of the required position.
- Tie bars within 500 mm of a transverse joint: Omit.
- Installing in existing concrete: Use a hydrophilic epoxy resin with the required setting system to develop anchorage strength at least 85% of the yield strength of the bar.

Corrugated joint face: If joint is formed or slipformed, corrugate joint face as documented.

Asphalt surfacing over sawn longitudinal tied joints: Depress sealant 10 mm minimum below concrete surface. After thorough cleaning, seal joint flush with the concrete surface with bituminous rubber compound compatible with the narrow groove.

Sawn-induced longitudinal tied joints

Location and dimensions: As documented.

Sawcutting: To Sawcutting.

Joint surface condition: Conform to the following:

- Horizontal and vertical edge ravelling: Not more than 10 mm wide.
- Cumulative length of ravelling more than 3 mm wide: Maximum 300 mm in any 3 m length of joint edge.

Joint cleaning and preparation: Remove all debris within 24 hours of sawing and insert a closed-cell polyethylene backer rod, as documented.

Sealant insertion: Conform to the following:

- Permanently seal the vertical face at the ends of sawcuts.
- Coat sealant with an approved lubricant-adhesive compound, coloured to match the pavement.
- Insert the sealant into the groove using equipment which will not damage the sealant.
- Maximum increase in sealant length after installation: 10% of the original length.

Joints in sealant: Minimise and cement together using an adhesive to the manufacturer's recommendations.

Top of sealant: Between 5 mm above and 7 mm below the surface of the base, except where the sealant is depressed to lie under the transverse joint sealant.

Longitudinal joint with kerb and/or channel (gutter)

Application: Kerbs and/or gutters constructed within the shoulder of a concrete base, formed directly onto the concrete subbase, and cast integrally with the concrete base or separately.

Location: Parallel to the control line (parallel to the centreline for ramps) and, as documented.

Joint construction: To **Isolation and expansion joints**.

Face of joint: Do not scabble the face and do not seal the joint.

- First placed joint face: If initially non-conforming or damaged, reinstate or repair before placing adjoining concrete. Do not place repair material integrally with the adjoining concrete.

Tied joints: If constructed separately, tie kerbs and/or gutters to the concrete base using 12 mm diameter deformed steel tie bars Grade 250N or 500N, 1000 mm long at 1 m centres. Insert the tie bars, as documented, conforming to **INSTALLATION OF STEEL REINFORCEMENT**, **Tie bars**.

Untied joints: Seal as documented.

Kerb and/or channel (gutter) construction: Conform to the *1121 Open drains* work-section, with concrete strength greater than 35 MPa.

- SA, SB, SC, SE, SO and SL kerb types: If these kerb types are required beside the concrete, do not extrude. Conform to this work-section or AS 1379 for normal class concrete with strength grade N32 and 20 mm aggregate.
- Rounding of kerb or gutter lip: Maximum 5 mm.

Inlet pits: Separate from adjoining base concrete with a Type 15 isolation joint (unbeamed), as documented.

Re-entrant angles

Requirement: Reinforce re-entrant angles exceeding 190° with SL82 reinforcing fabric.

3.10 CURING

Application

Application method: Apply curing compound to form a continuous film with two uniform fine sprays as follows:

Generally: Apply as follows:

- First application: Within 15 minutes of the surface reaching the low-sheen bleed water condition.
- Second application: 10 to 30 minutes after the first application.
- Fixed form surfaces: Apply as follows:
  - First application: Within 30 minutes of stripping.
  - Second application: 10 to 30 minutes after the first application.

Spraying equipment: Spray curing compound transversely and longitudinally with a mechanical sprayer with the following:

- A spray broom fitted with nozzles spaced to give uniform coverage for the full paving width in a single pass.
- Device for continuous agitation and mixing of compound in its container during spraying.
- Spray nozzles that prevent compounds dripping on the concrete surface after shutting off.

Minimum application rate: Conform to the following rates at each pass:

- For paving wider than 4.5 m: Using a mechanical sprayer with multi-nozzled spray bar:
  - On tined texture: 0.30 L/m^2.

. On hessian drag or light broom texture: 0.25 L/m^2.

- For paving less than 4.5 m wide: 0.30 L/m^2 using a hand lance or spray bar, regardless of texture. This is also applicable to faces of formed joints and sections of slipform edges supported by temporary forms.

Calculation of application rate: Calculate and check the amount of curing compound falling on three felt mats per test, each approximately 0.25 m^2 placed within an area of 50 m^2 of the testing surface.

Hand spraying: Spray with a hand lance in small areas where mechanical spraying cannot be used and sides of formed slabs.

- Rate: 25% higher than that used on the main base.

Spraying area: In addition to the paving run, respray any hardened concrete less than 7 days old adjoining concrete, for minimum 7 m from the start of the paving run, with a single application.

Curing membrane: Conform to the following:

- Maintain membrane intact and unbroken for 7 days after placing concrete or until concrete strength of 25 MPa is achieved.
- Rectify any damage to the curing membrane by hand spraying affected areas.

Equipment and materials for curing operations: Keep on-site at all times during concrete placement and curing.

Inoperable mechanical sprayer: Cease concrete paving by mechanical means and do not restart until sprayer becomes fully operable again.

Curing of other structural concrete

Requirement: Cure all structural concrete members, including anchors, kerbs and gutters, for minimum 7 days after placing.

Plastic covers: Cover the full concrete area to form a continuous barrier and secure around all edges to maintain a moist environment.

3.11 CONCRETE CRACKING

Planned cracks

Description:

- Plastic shrinkage cracks: Discrete cracks less than 500 mm long and with a depth less than 50% of the slab thickness and does not intersect a longitudinal or formed edge.

Remedial work: Not required, if slabs contain only:

- Plastic shrinkage cracks with a cumulative length of 1 m maximum.
- Plastic shrinkage cracks with a cumulative length of 1 m maximum and drying shrinkage cracks.

Unplanned structural cracks

Description: All cracks other than plastic shrinkage, including drying shrinkage in unreinforced slabs.

- Drying shrinkage cracks in mesh-reinforced slabs: Occurring in the central part of the slab, extending the full depth and continuous between joints and/or edges.

Treatment: If unplanned structural cracking occurs, remove and replace concrete base in conformance with **REMOVAL AND REPLACEMENT OF BASE**.

3.12 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE – MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Test authority: A registered testing authority.

Assessment process of test results: To AS 1379.

Reports and records of test results: To the AS 1012 series. Submit test results and keep copies on-site.

Sampling, curing and testing of fresh concrete

Sampling method: To AS 1012.1.

Sampling: Take samples from the delivery vehicles or from rolled concrete deposited ready for placement.

Frequency of sampling: To AS 1379 and the following:

- At least one sample for the concrete being placed at one time.
- At least one sample for each lot.

Test specimens: Mould at least two test specimens from each sample to AS 1012.8.1. Supply the number of moulds required for the documented frequency of testing. Inspect, cap and mark specimens before sending to testing laboratory.

- Initial curing: Carry out initial on-site (field) curing between 18 to 36 hours to AS 1012.8.1 clause 9.
- Transportation: Transport cylinders only after initial on-site curing.

Testing for compressive strength

Testing of specimens: Test each specimen for compressive strength to AS 1012.9.

Compressive strength of each sample: Average compressive strength of the two specimens taken from the sample, tested at the same age.

Age of specimens: 7 and 28 days.

Adjustment due to age: If specimens are tested at more than 28 days after moulding, obtain the equivalent 28 day compressive strength by dividing the test compressive strength by the factor shown in the Concrete age **correction factors table**.

Concrete age correction factors table

Age of specimen at time of test (days)	**Correction factor (AF)**			
	Cylinders		**Cores**	
	SCM content (%)[1]			
	0	**≥ 15**	**0**	**≥ 15**
28	1.00	1.00	0.90	0.90
35	1.02	1.03	0.93	0.94
42	1.04	1.06	0.96	0.98
49	1.06	1.09	0.98	1.01
56	1.08	1.12	1.00	1.04
70	1.10	1.15	1.02	1.07
84	1.12	1.18	1.03	1.09
112	1.14	1.21	1.06	1.12
140	1.16	1.24	1.07	1.14
168	1.18	1.27	1.08	1.16
196	1.20	1.30	1.09	1.18
224	1.22	1.33	1.0.9	1.19

Age of specimen at time of test (days)	Correction factor (AF)			
	Cylinders		Cores	
	SCM content (%)[1]			
	0	≥ 15	0	≥ 15
308	1.24	1.36	1.10	1.20
365 or greater	1.25	1.38	1.10	1.21
Notes: [1] Relative to the total cementitious binder content.				

Acceptance criteria for compressive strength

Average compressive strength of samples representing the lot: Conform to **CONCRETE PROPERTIES**, **Compressive strength**.

Non-conforming concrete: Perform coring test to **Testing by specimens cut from the work**.

Testing by specimens cut from the work

General: If the base concrete strength is non-conforming, obtain approval to core the in-situ base for testing and provide specimens conforming to the following:

- Shape: Cylindrical cores.
- Preferred dimension of cores: 100 mm diameter.
- Minimum dimension of cores: 75 mm diameter or 2½ times the nominal size of the coarse aggregate, whichever is the greater.
- Tolerance in uncapped state: 5 mm.
- Minimum length: Same as the core diameter.

Coring: Do not core until the concrete has hardened enough to allow removal without disturbing the bond between the mortar and the coarse aggregate.

Frequency of coring: One core for each lot or one core for the area of concrete base placed between any two consecutive construction joints, whichever is the lesser. Nominate the lot represented by each core at the time of sampling and record before testing.

Coring location: Select location so that joints, steel reinforcement and tie bars are excluded from the core.

Hand placed concrete: Provide 2 cores to represent a section of work, confined between construction joints.

Storing cores: Place immediately in a tank of lime saturated water or in an individual plastic bag, sealed to prevent water loss. Keep cores stored in plastic bags in the shade.

Temperature control: Until delivered to the laboratory, do not subject cores to temperatures above the ambient temperature or 23°C, whichever is the greater, and temperatures lower than 10°C.

Curing of cores: Despatch cores to arrive at the testing laboratory within 24 hours of cutting from the subbase. Start wet curing within 24 hours of receipt of the cores.

Test method: To AS 1012.14 and the following:

- Adjust the test strength by a factor conforming to the **Shape correction**
- **factor table** and the **Concrete age conversion factors table**.
- Core strength: [Test strength x SF factor] ÷ AF factor.
- Only use wet conditioning.

Shape correction factor (SF) table

Length/diameter ratio	Correction factor (SF)
2.00	1.00
1.75	0.98
1.50	0.96
1.25	0.93
1.00	0.87

Acceptance criteria for cored concrete

Equivalent 28 days compressive strength of the specimens cut from work: Conform to **CONCRETE PROPERTIES**, **Compressive strength**.

Non-conforming concrete: Conform to **REMOVAL AND REPLACEMENT OF BASE**.

Relative compaction of pavement

Calculation of relative compaction: To RMS T381 clause 5.2(a).

Mass per Unit Volume (MUV): Determine to AS 1012.12.1 or AS 1012.12.2, as appropriate.

Representative cylinder unit mass (RCUM): Determine the mean of 28 day cylinders and round test result to the nearest 5 kg/m^3 as follows:

- Paving trial: The mean of 2 cylinders.
- The Works: The mean of up to 5 consecutive pairs of cylinders for each lot.

Test core specimens: Extract and prepare specimens to AS 1012.14.

Acceptance criteria for compaction

Fixed form paving: The base is deemed conforming if:

- It has been vibrated to **Hand paving**.
- Vibration procedure used limits lateral spreading of the mix.
- Disturbed areas in the compacted mix has been reinstated to **Hand paving**.
- The relative compaction is at least 98%.

Slipform paving: The base is deemed conforming if:

- It has vibrated in conformance with **Paver machine** and **Mechanical (slipform) paving**.
- Vibration procedure used limits lateral spreading of the mix.
- The relative compaction is at least 98%.

Under-strength slabs: If a slab conforms for all criteria other than relative compaction, carry out the following:

- Relative compaction is 97 to 98%: Take cores and test to **Testing by specimens cut from the work** on the basis of a 28 days core compressive strength.
- Relative strength less than 97%: Remove and replace to **REMOVAL AND REPLACEMENT OF BASE**.

Repair of core holes

Restoration method: Clean and restore all core holes taken in the base and fill with non-shrink cementitious concrete, with compressive strength of not less than that in the base and aggregate size of 10 mm nominal maximum.

Surface condition of restored hole: To match the surrounding surface texture and colour.

Chloride and sulphate

Requirement: Test using one of the following methods:

- Testing concrete constituents.
- Testing hardened concrete.

Testing concrete constituents: Conform to the following:

- Chloride ion testing:
  - . Aggregates: To AS 1012.20.1.
  - . Water and admixtures dissolved in water: To AS 1478.1 Appendix C and then calculate the total content in the mix.
- Sulphate ion testing:
  - . Aggregates: To AS 1012.20.1.
  - . Water and admixtures dissolved in water: To AS 1289.4.2.1.
  - . Cementitious materials: To AS 2350.2 and then calculate the total content, as a percentage, in the mix.

Testing hardened concrete: Conform to the following:

- Test method: To AS 1012.20.1.
- Water: From the same source as the mixing water to be used in the Works.

3.13 REMOVAL AND REPLACEMENT OF BASE

General

Non-conforming base: Replace base in conformance with the following:

- Non-conforming section extending more than 25 m longitudinally: Replace by mechanical means unless the slabs are odd shaped or mismatched.
- Replace full slab widths between longitudinal joints and/or external edges.

Base adjoining removed slab: If damaged from the removal process, remove and replace.

Disposal of removed base: Remove from site.

Base sawcuts

Transverse sawcuts: Make sawcuts conforming to the following:

- At each end of the section of base to be removed, for the full depth of the base layer.
- Normal to the control line and not closer than 1.5 m to a transverse contraction joint in the base.
- Cut in a straight line, continuous between adjacent longitudinal joints, at an angle 90 ± 6° to the longitudinal joint.

Longitudinal sawcuts: Make sawcuts conforming to the following:

- Along existing longitudinal joints to define the edges of the base section for removal.
- Not extending more than 250 mm past the transverse sawcut at each end of the section to be removed.

Oversawing: Do not oversaw into the adjoining base or underlying subbase.

Additional internal sawcuts: If required for the removal process, make sawcuts without oversawing into the underlying subbase.

Further damage to adjoining slab: Remove and replace in conformance with this clause.

Replacement of base

Subbase preparation: Before construction of the replacement base, prepare and debond the subbase in conformance with **CURING AND DEBONDING** in the *1132 Lean mix concrete subbase* work-section.

Replacement requirements: Conform to this work-section and the following:

- Joint faces on the adjoining slab at the transverse sawcuts: Deeply scabble, leaving the top 25 mm smooth.
- Seal all joints and cracks which become exposed with silicone sealant to prevent ingress of mortar and other incompressible materials.
- Tie bars: Provide to form a transverse construction joint conforming to **JOINTS, Transverse construction joints**.
- Transverse contraction joints: Continuous across the full width of the base containing the replaced section. Seal the length of the joint across the full width of the base with silicone sealant the **Silicone joint sealant requirements table**.
- Longitudinal joint faces: Deeply scabble the lower two thirds of the joint face and remove loose concrete. Attach a crack inducer ribbon to the surface of any formed longitudinal joint in the replacement base and provide tie bars to form a longitudinal tied joint to **JOINTS, Longitudinal tied joints**.
- Tie bars placed into hardened concrete: Set using a hydrophilic epoxy resin, using the required setting system to develop anchorage strength at least 85% of the yield strength of the bar.

Traffic restrictions: Conform to **PLACING AND FINISHING, Protection of work**.

Rectification of finished surface and rideability non-conformance

Requirement: Grind areas requiring surface rectification with a purpose-built diamond grinder. Do not use impact methods such as milling or profiling.

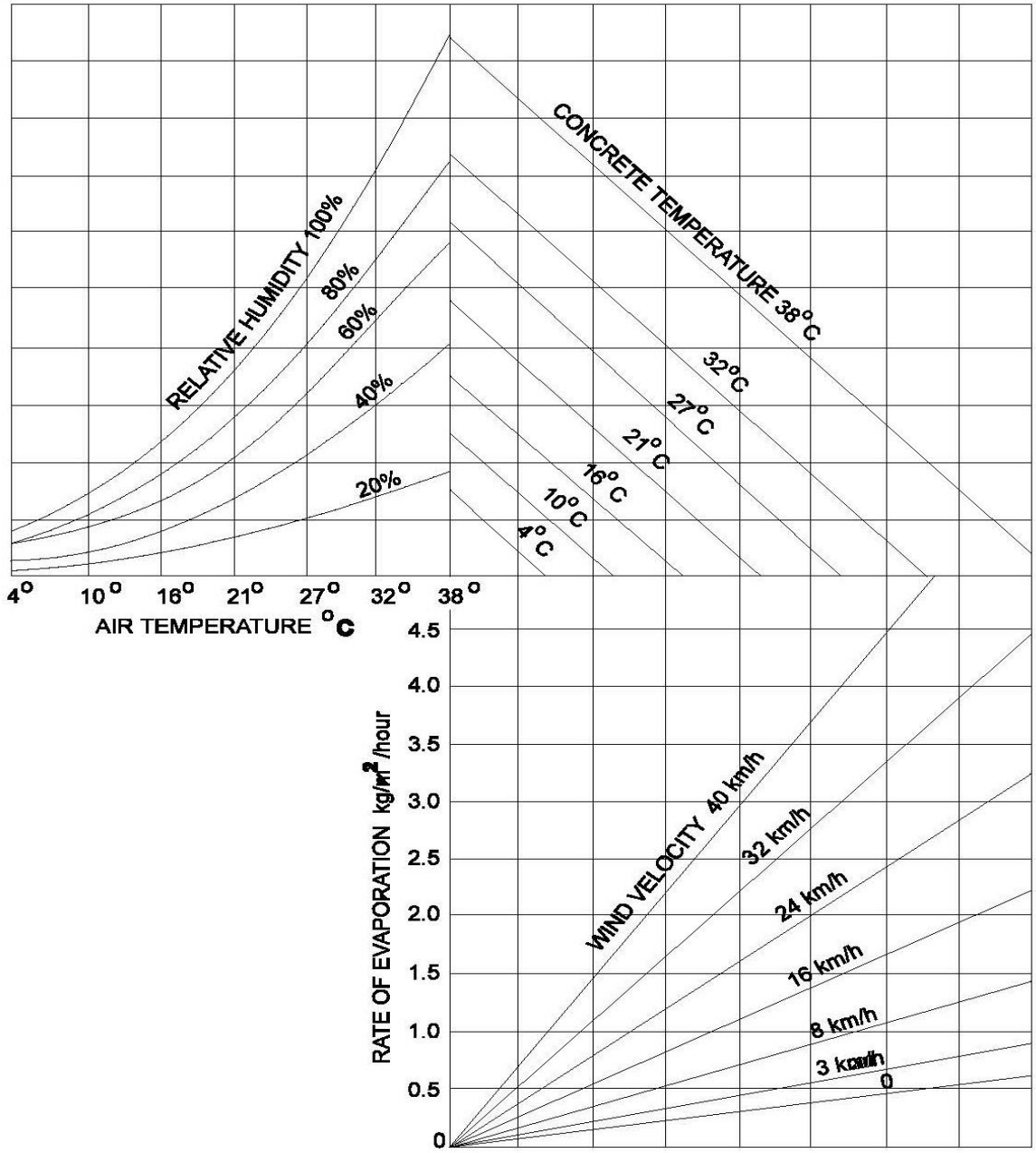
- Grinding equipment: Use equipment which creates longitudinal texture as follows:
  - Grooves: Uniformly spaced using a 3.2 mm wide blade separated by a 2.5 mm wide blade spacer.
  - Minimum average texture: To **CONCRETE PLACING, Surface texture**.

Timing: Do not carry out grinding until all slab replacements have been completed.

4 ANNEXURES

4.1 ANNEXURE - RATE OF EVAPORATION

Rate of evaporation graph



Using the Rate of evaporation graph

Information: The graph shows the effects of air temperature, humidity, concrete temperature and wind velocity on the rate of evaporation of water from freshly placed and unprotected concrete.

Example: To determine the evaporation rate from the graph using air temperature at 27°C, relative humidity at 40%, concrete temperature at 27°C and a wind velocity of 26 km/h:

- Enter the graph at the air temperature of 27°C.
- Move vertically to intersect the curve for relative humidity encountered 40%.

- Move horizontally to the respective line for concrete temperature of 27°C.
- Move vertically down to the respective wind velocity curve and interpolate for 26 km/hour.
- Then move horizontally to the left to intersect the scale for the rate of evaporation.
- The rate of evaporation would be 1.6 kg/m^2/hour.

4.2 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Execution details Work method statement	H	Details of proposed work method.	4 weeks before commencement	Commencement
SUBMISSIONS, Products and materials Nominated mix	H	Details of constituent materials, mix design and trial batch test results.	3 weeks before ordering materials	Ordering and delivery of material
INSPECTIONS, Notice Trial mix	W	Mixing of the trial mix.	2 days before mixing	Production of each concrete mix
SUBMISSIONS, Variations Approved nominated mix	H	Details of alternative mix.	3 weeks before implementing change	Ordering and delivery of material
SUBMISSIONS, Tests Uniformity testing	H	Evidence of conformity.	2 days before trial section paving	Trial section paving
SUBMISSIONS, Records Subbase survey	H	Work-as-executed subbase survey.	2 days before paving/trial paving	Paving/trial section
INSPECTIONS, Notice Trial section construction	H	Completed trial base.	5 days before paving	Trial section acceptance
SUBMISSIONS, Execution details Non-conforming trial section	H	Details of proposed changes to the trial section.	1 day after non-conformance has been identified	Paving
INSPECTIONS, Notice Non-conforming trial section	H	Completed new trial section.	1 day before the inspection	Paving
INSPECTIONS, Notice	W	Steel reinforcement and embedment in place.	2 days before placing concrete	-

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
Placing steel reinforcement				
SUBMISSIONS, Records Alignment and surface tolerances	H	Survey of base surface levels and alignment.	2 days after paving	Base acceptance or rectification
INSPECTIONS, Notice Repair of core holes	W	Completed restoration of cored areas.	1 day before the inspection	-
SUBMISSIONS, Execution details Removal and replacement of base	H	Details of proposed work method for removing and replacing non-conforming base.	5 days before removal	Removal and replacement of base
INSPECTIONS, Notice Base sawcuts	W	Completed removal of non-conforming base.	1 day before the inspection	-
INSPECTIONS, Notice Replacement of base	W	Completed replacement of base.	1 day before the inspection	-
*H = Hold point, W = Witness point				

4.3 ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Placement of plain and reinforced concrete base

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Concrete supply	To **Ready-mixed concrete production and supply**.			
	Concrete/air temperature	50 m³	1 per 50 m³	Measure
	Air content	50 m³	1 per 50 m³	AS 1012.4.2 Method 2
	Consistency – slump	50 m³	1 per load	AS 1012.3.1
	Compressive strength (7 and 28 days)	50 m³	1 per pour	AS 1012.9
Placement	Relative compaction			
	Machine placed	50 m³	1 per 50 m³*	To **TESTING**, **Relative**

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
				compaction of pavement.
	Hand placed	Area between 2 consecutive construction joints or 50 m³ (whichever is the lesser)	2 per lot	To **TESTING**, **Relative compaction of pavement**.
Ride quality	Profile factor	1000 m²	10/lane/lot	3 m straightedge
Surface texture	Texture depth	1000 m²	2 per lot	Survey
Curing	Material quality – supplier's documentary evidence	1 contract	1 per production batch	AS 3799 Section 3 AS 2341 series
	Application rate	1 day's work	1 per 1000 m²*	
Joints	Sealant material quality supplier's documentary evidence and certification	1 contract	1 per production batch	
	Geometry	50 m³	All joints	Survey
* Note: or part thereof, per lot.				

Ready-mixed concrete production and supply

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Raw materials supply	Material quality – supplier's documentary evidence of:			
	Cement	1 month's production	1 per week	AS 3972 Table 2
	Fly ash	1 month's production	1 per month	AS 3582.1
	Water	1 contract	1 per contract	AS 1289.4.2.1 or APHA 4500
	Admixtures	1 month's production	1 per month	AS 1478.1
	Fine aggregates			
	- Grading	1 week's production	1 per 200 m³ concrete*	AS 1141.11.1
	- Moisture content	N/A	1 per day	
	- Sodium sulphate soundness	1 contract	1 per contract	AS 1141.24

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
	- Bulk density	1 contract	1 per contract	AS 1141.4
	- Unit mass (Particle density)	1 contract	1 per contract	AS 2758.1
	- Water absorption	1 contract	1 per contract	AS 2758.1
	- Material finer 2 µm	1 contract	1 per contract	AS 1141.13
	- Deleterious material (impurities/reactive)	1 contract	1 per contract	AS 2758.1
	Coarse aggregates:			
	- Grading	1 week's production	1 per 200 m^3 concrete*	AS 1141.11.1
	- Moisture content	N/A	1 per day	
	- Wet strength	1 contract	1 per contract	AS 1141.22
	- Wet/dry strength variation	1 contract	1 per contract	AS 1141.22
	- Sodium sulphate soundness	1 contract	1 per contract	AS 1141.24
	- Particle shape	1 contract	1 per contract	AS 1141.14
	- Fractured faces	1 contract	1 per contract	AS 1141.18
	- Bulk density	1 contract	1 per contract	AS 1141.4
	- Unit mass (Particle density)	1 contract	1 per contract	AS 2758.1
	- Water absorption	1 contract	1 per contract	AS 2758.1
	- Material finer 75 µm	1 contract	1 per contract	AS 1141.12
	- Weak particles	1 contract	1 per contract	AS 2758.1
	- Light particles	1 contract	1 per contract	AS 2758.1
	- Deleterious materials (impurities/reactive)	1 contract	1 per contract	AS 2758.1
	- Iron unsoundness	1 contract	1 per contract	AS 2758.1
	- Falling/dusting unsoundness	1 contract	1 per contract	AS 2758.1
Mix design	Compressive strength	1 contract mix	1 per mix per contract	AS 1012.9
	Aggregate moisture content	1 contract mix	1 per mix per contract	
	Consistency – slump	1 contract mix	1 per mix per contract	AS 1012.3.1
	Air content	1 contract mix	1 per mix per contract	AS 1012.4.2 Method 2

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
	Shrinkage	1 contract mix	1 per mix per load	AS 1012.13
* Note: or part thereof, per lot.				

4.4 ANNEXURE - PAY ITEMS

Pay items	Unit of measurement	Schedule rate inclusions
1133.1 Supply and place concrete in base	m^3 - The documented width and length, including odd-shaped and mismatched slabs. - The depth is the depth documented across each section. - Do not account for the allowable tolerances.	All costs associated with all documentation and approvals and the supply and placing of concrete base, including all costs of providing transverse construction joints and longitudinal tied joints in association with kerbs and/or gutters.
1133.2 Finish, cure and texture base	m^2 - The documented width and length, including odd-shaped and mismatched slabs. - Do not account for the allowable tolerances. - The sides of slabs are not included in the measurement of surface area.	All costs associated with finishing, curing and texturing the base.
1133.3 Supply and place wire reinforcing fabric	m^2 of wire reinforcing fabric placed. - The documented width and length, including odd-shaped and mismatched slabs. - Do not account for the allowable tolerances or of any laps.	All costs associated with supplying and placing all wire reinforcing fabric.
1133.4 Supply and install steel bar reinforcement	Tonne of steel reinforcement. - The mass is to be determined from the unit masses given in AS/NZS 4671 and the actual length of bar measured in place. - Do not account for laps and splices.	All costs associated with supplying and installing reinforcement, except dowels and tie bars.
1133.5 Transverse contraction joints	Linear metre. Measure the distance along the line of the joint.	All costs associated with the provision of transverse contraction joints.
1133.6 Transverse expansion and isolation joints	Linear metre. Measure the distance along the line of the joint.	All costs associated with the provision of transverse expansion and isolation joints.

Pay items	Unit of measurement	Schedule rate inclusions
1133.7 Longitudinal tied joints	Linear metre. Measure the distance along the line of the joint.	All costs associated with the provision of longitudinal tied joints including provision of tie bars.
1133.8 Longitudinal isolation joints	Linear metre. Measure the distance along the line of the joint.	All costs associated with provision of longitudinal isolation joints including the provision of dowels, as documented.
1133.9 Slab anchors	m^3 The documented volume with adjustments for any authorised variation. Measure the depth from the top of the subbase.	All costs associated with the construction of slab anchors including excavation, disposal of material, supply and placing of reinforcement and the subsoil drain
1133.10 Bridge approach slabs	m^3 - The width, depth and length are as documented. - Do not account for the allowable tolerances.	All costs associated with the construction of a bridge approach slab, including provision of a transverse expansion joint at the bridge abutment, but excluding the supply and fixing of steel which is to be paid for at the schedule rate for **Pay item 1133.4**.
Traffic management		To *1101 Traffic management*.
Erosion and sedimentation control		To *1102 Control of erosion and sedimentation*.
Kerb and gutter		To *1121 Open drains*.
Subsoil drains at slab anchors		To *1172 Subsoil and foundation drains* work-section

Deductions

Requirement: Conform to the following:

- Concrete with compressive strength of 33 to 35 MPa at 28 days: Subject to a deduction of 4% of the applicable schedule rate for Pay Item 1133.1 for the lot represented, for each 0.5 MPa or part that, deficiency in strength.
  . Acceptance of this concrete is conditional of it representing isolated sections and such sections comprising less than 5% of the total area of the base.
- Concrete base which is 10 mm or less below the specified thickness: May be accepted, subject to a deduction to the schedule rate for Pay Item 1133.1, for the lot represented:
  . 24% for areas with thickness 5 mm below the documented thickness.
  . 60% for areas with thickness 5 to 10 mm below the documented thickness.

4.5 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1012		Methods of testing concrete
AS 1012.1	2014	Sampling of concrete

AS 1012.3.1	2014	Determination of properties related to the consistency of concrete - Slump test
AS 1012.4.2	2014	Determination of air content of freshly mixed concrete - Measuring reduction in air pressure in chamber above concrete
AS 1012.8.1	2014	Method for making and curing concrete - Compression and indirect tensile test specimens
AS 1012.8.4	2015	Method for making and curing concrete - Drying shrinkage specimens prepared in the field or laboratory
AS 1012.9	2014	Compressive strength tests - Concrete, mortar and grout specimens
AS 1012.12		Determination of mass per unit volume of hardened concrete
AS 1012.12.1	1998	Determination of mass per unit volume of hardened concrete - Rapid measuring method
AS 1012.12.2	1998	Determination of mass per unit volume of hardened concrete - Water displacement method
AS 1012.13	2015	Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory
AS 1012.14	2018	Method for securing and testing cores from hardened concrete for compressive strength and mass per unit volume
AS 1012.20.1	2016	Determination of chloride and sulphate in hardened concrete and concrete aggregates
AS 1141		Methods for sampling and testing aggregates
AS 1141.4	2000	Bulk density of aggregate
AS 1141.5	2000	Particle density and water absorption of fine aggregate
AS 1141.6.1	2000	Particle density and water absorption of coarse aggregate - Weighing-in-water method
AS 1141.11.1	2009	Particle size distribution - Sieving method
AS 1141.12	2015	Materials finer than 75 µm in aggregates (by washing)
AS 1141.13	2007	Material finer than 2 micrometer
AS 1141.14	2007	Particle shape, by proportional caliper
AS 1141.18	1996	Crushed particles in coarse aggregate derived from gravel
AS 1141.20.1	2000	Average least dimension - Direct measurement (nominal 10 mm and greater)
AS 1141.20.2	2000	Average least dimension - Direct measurement (nominal sizes 5 mm and 7 mm)
AS 1141.22	2008	Wet/dry strength variation
AS 1141.24	2018	Aggregate soundness - Evaluation by exposure to sodium sulphate solution
AS 1141.31	2015	Light particles
AS 1141.32	2008	Weak particles (including clay lumps, soft and friable particles) in coarse aggregates
AS 1141.34	2007	Organic impurities other than sugar
AS 1141.35	2007	Sugar
AS 1160	1996	Bitumen emulsions for construction and maintenance of pavements
AS 1289		Methods of testing soils for engineering purposes
AS 1289.4.1.1	1997	Soil chemical tests - Determination of the organic matter content of a soil - Normal method
AS 1289.4.2.1	1997	Soil chemical tests - Determination of the sulphate content of a natural soil and the sulphate content of the groundwater - Normal method
AS 1379	2007	Specification and supply of concrete
AS 1478		Chemical admixtures for concrete, mortar and grout
AS 1478.1	2000	Admixtures for concrete
AS/NZS 1554		Structural steel welding
AS/NZS 1554.3	2014	Welding of reinforcing steel

AS 2341		Methods of testing bitumen and related roadmaking products
AS 2350		Methods of testing Portland, blended and masonry cements
AS 2350.2	2006	Chemical composition
AS/NZS 2425	2015	Bar chairs in reinforced concrete - Product requirements and test methods
AS 2758		Aggregates and rock for engineering purposes
AS 2758.1	2014	Concrete aggregates
AS/NZS 3582		Supplementary cementitious materials
AS/NZS 3582.1	2016	Fly ash
AS 3600	2018	Concrete structures
AS/NZS 3679		Structural steel
AS/NZS 3679.1	2016	Hot-rolled bars and sections
AS 3799	1998	Liquid membrane-forming curing compounds for concrete
AS 3972	2010	General purpose and blended cements
AS/NZS 4671	2001	Steel reinforcing materials
AS/NZS 4680	2006	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
Austroads AGPT		Guide to pavement technology
Austroads AGPT04C	2017	Materials for concrete road pavements
Austroads AGPT04E	2009	Recycled materials
Austroads AGPT08	2009	Pavement Construction
RMS T192	2012	Determination of the Texture Depth of Road Surfacing by the TRL Mini Texture Meter
RMS T262	2012	Determination of moisture content of aggregates (Standard method)
RMS T276	2012	Foreign materials content of recycled crushed concrete
RMS T279	2012	Flow time and voids content of fine aggregate by flow cone
RMS T363	2012	Accelerated mortar bar test for the assessment of alkali-reactivity of aggregate
RMS T381	2014	Relative compaction of pavement concrete
RMS T1192	2012	Adhesion of sealant
RMS T1193	2012	Accelerated aging of cured sealant
APHA 4500-CL	1992	Standard Methods for the Examination of Water and Wastewater
ASTM C603	2014	Standard Test Method for Extrusion Rate and Application Life of Elastomeric Sealants
ASTM C661	2015	Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer
ASTM C679	2015	Standard Test Method for Tack-Free Time of Elastomeric Sealants
ASTM C793	2017	Standard test method for effects of laboratory accelerated weathering on elastomeric joint sealants
ASTM C794	2018	Standard test method for adhesion-in-peel of elastomeric joint sealants
ASTM D792	2013	Standard test methods for density and specific gravity (relative density) of plastics by displacement
ASTM D7428	2015	Standard Test Method for Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
Tex-612-J	2000	Acid insoluble residue for fine aggregate

1141 FLEXIBLE PAVEMENT BASE AND SUBBASE

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide flexible pavement base and subbase, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.
- *1113 Stabilisation*.
- *1143 Sprayed bituminous surfacing*.

1.3 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviations apply:

- CBR: California bearing ratio.
- CRB: Crushed rock base.
- CRS: Crushed rock subbase.
- DGB: Dense graded base.
- DGS: Dense gravel subbase.
- OMC: Optimum moisture content.
- CCB: Crushed concrete base.
- CCS: Crushed concrete subbase.
- RCMB: Recycled material base.
- RCMS: Recycled material subbase.
- UCS: Unconfined compressive strength.

Definitions

General: For the purposes of this work-section the definitions in Austroads AP-C87 and the following apply:

- Base/based course: One or more layers of material forming the uppermost structural element of a pavement and on which the surfacing may be placed. It may be composed of fine crushed rock, natural gravel, broken stone, stabilised material, asphalt or Portland cement concrete.
- Blended material: A material formed by the combination and mixing of materials obtained from different sources or rock types or recycled materials, in order to obtain a product with improved properties.
- Bound material: A granular or subgrade material to which a binder has been added to improve structural stiffness.
- Flexible pavement: A pavement which obtains its load-spreading properties from intergranular pressure, mechanical interlock and cohesion between the particles of the pavement material.
- Modified material: Granular materials to which small amounts of stabilising agent have been added to improve their performance (e.g. adjusting plasticity) without causing a significant increase in structural stiffness.
- Pozzolan: A siliceous or alumino siliceous material, which in itself possesses little or no cementitious value but which in finely divided form may be mixed with lime or Portland cement to form a cementitious material.

- Recycled materials: Materials manufactured from recycled material such as crushed concrete, bricks, terracotta tiles or glass or reclaimed asphalt pavement (RAP).
- Subbase: Material laid on the subgrade below the base either for the purpose of making up additional pavement thickness required, to prevent intrusion of the subgrade into the base, or to provide a working platform.
- Unbound base: A base comprised of granular or mechanically stabilised materials and without the capacity to resist significant tensile stresses.
- Unbound material: Materials that are natural, manufactured or recycled mineral blends of graded particles which have not been modified or bound.
- Windrows: A shallow ridge of material formed by the action of a grader (or other) blade during in-situ cutting or mixing operations.
- Working time: The duration at which the contractor has to mix a binder, compact and trim stabilised material before the material loses its intended strength. An unconfined compressive strength (UCS) test is used for the establishment of working time.

1.4 TOLERANCES

Layer width

Width of pavement: - 50 mm to + 300 mm of design dimension when the horizontal dimension measured from the design centre line to the edge of the constructed pavement base/subbase layer. Conform to the following, measured from the centreline to the edge of the pavement:

- Base: 0 to +100 mm, with maximum 50 mm each side.
- Subbase: 0 to +150 mm, with maximum 75 mm each side.

Subbase layer

Level: 0 mm to - 10 mm from design level.

Thickness: ± 10 mm from design thickness.

Base layer

Level: 0 mm to + 10 mm from design level.

Level adjacent to kerb and channel: + 5 to - 0 mm.

Thickness: 0 mm to + 20 mm from design thickness.

Shape: Less than 5 mm deviation from a 3 m straightedge laid in any direction after trimming and immediately before sealing.

1.5 SUBMISSIONS

Execution details

Trial section verification: Submit the following:

- Compaction test results: From a NATA accredited laboratory confirming the required relative compaction has been achieved.
- Survey reports: Covering line, level and thickness.
- Record data of straightedge test.

Delivery: Submit the following:

- Delivery vehicles not fitted with fabric covers: If proposed for the delivery of modified or bound materials, details of vehicle.
- Bound materials: Delivery dockets for each truck load of bound materials, indicating the time and date of mixing, and registration or fleet number of the delivery truck.

Alternative stockpile sites: If proposed, submit details of locations not documented on drawings.

Placing: Submit placing details if the following are proposed or required:

- Placing and compacting pavement layers outside the required layer thickness range.

- Placing bound materials outside the required ambient air temperature range.

Trimming, compaction and curing: Submit details of hand operated compaction plant required where self-propelling compaction plant is not practical.

Products and materials

Unbound base and subbase materials: Submit details for each proposed constituent material including the following:

- Source of supply.
- Blend proportions for blended materials.
- Test results for proposed base and subbase materials.

Test results for a sample of the proposed recycled constituent material to verify the limits of undesirable material to **Base/Subbase material properties and test methods tables**.

- Test results from a NATA accredited laboratory.

Alternative unbound base and subbase materials: If proposed, submit details of the following:

- Test results from a NATA accredited laboratory.
- Evidence of conformance to the **Shear strength table**.

Records

Survey of completed pavement layer: Submit survey reports covering line, level and thickness for each layer before placing the next layer.

Record of roll tests for observation of any movement of each layer tested with the 3 point dead weight roller.

Tests

Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

Variations

Variation to approved materials: Submit details of proposed changes to the approved base and subbase materials or source of supply. Obtain the approval of the variation prior to any material being delivered to site

1.6 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Materials at delivery: Subbase, base, modified and bound materials upon their delivery to the site.
- Underlying layer properties: Assess layer condition properties, including required moisture content before placing base and subbase material.
- Trial section construction: Completed trial base and subbase section.
- Non-conforming trial section: If the original trial section is deemed non-conforming, completed new trial section.
- Non-conforming lot: Completed base or subbase removal before replacement.
- Lot package closure certificate confirming works completed as specified.
- Wearing surface: Prepared base surface before applying prime or initial seal.

Roll test inspections: Roll test for subgrade, base, subbase. and wearing course is to be witnessed and approved by the Superintendent as specified in the Councils development works standards. The Superintendent shall select the line of the roller and walk behind or beside the roller to detect any movement of the pavement by observation

- The roll test shall use 3 point, 7.5 tonne dead weight roller or as agreed by the Superintendent as guided by Councils specified standards.

2 MATERIALS

General: Council to accept RMS compliant material at their discretion.

2.1 UNBOUND BASE AND SUBBASE MATERIALS

Granular material properties and production

Material properties: Provide unbound granular materials, including blends of two or more different materials, which develops structural stability and are uniform in grading and physical properties when compacted.

Material production: Materials produced by crushing plant or naturally occurring granular materials.

Moisture content of base/subbase materials: 60 to 90% of laboratory OMC to AS 1289.5.2.1, after spreading and before compaction.

Traffic loading and material selection

Design traffic: As documented on drawings.

Pavement materials: Select base and subbase material based on the traffic category in the **Traffic loading and pavement materials table**.

Traffic loading and pavement materials table

Traffic classification	Design traffic ESA (N)	Acceptable base material	Acceptable subbase material
Medium (M)	$10^6 \leq N < 4 \times 10^6$	CRB20-1	CRS20, CRS40
Light (L)	$N \leq 10^6$	CRB20-1, CRB20-2, CCB20-1, CCS20-2, DGB20	CRS20, CRS40, CCS20, DGS20, DGS40

Classes of crushed rock

Material: Provide from the following classes:

- Class 1: Pavement base material with a minimum plasticity index for unbound pavements requiring a very high standard of surface preparation for a sprayed sealed or thin asphalt surfacing.
- Class 2: Pavement base material with no minimum plasticity index for unbound pavements which may not requiring a very high standard of surface preparation. Use of recycled material is permitted.
- Class 3: Pavement subbase material requiring minimum permeability to provide positive drainage to the subsurface drains for medium traffic. Pavement base material for light traffic pavements provided the material produces sufficient cohesive fines during compaction. Use of recycled material is permitted.
- Class 4: Subbase material for unbound flexible pavements. Use of recycled material is permitted.

Crushed rock

Crushed rock materials: Select from the following based on the **Base/Subbase material properties and test methods tables**:

- CRB20-1: 20 mm nominal crushed rock base.
- CRB20-2: 20 mm nominal crushed rock base.
- CRS20-3: 20 mm nominal crushed rock subbase.
- CRS40-4: 40 mm nominal crushed rock subbase.

Crushed concrete

Crushed rock materials: Select from the following based on the **Base/Subbase material properties and test methods tables**:

- CCB20-1:20 mm crushed concrete base.
- CCB20-2: 20 mm crushed concrete base.
- CCS20: 20 mm crushed concrete subbase.

Recycled materials

Requirements: Select individual recycled or manufactured material and blend with virgin materials or other recycled materials to the **Limits on use of recycled and manufactured materials as constituents table**. Properties for RCMB and RCMS are based on the **Base/Subbase material properties and test methods tables**.

- RCMB: Recycled material base.
- RCMS: Recycled material subbase.

Limits on use of recycled and manufactured materials as constituent materials table

Recycled material	Unbound or modified base and subbase	Bound base and subbase
Iron & steel slag	100%	100%
Crushed concrete(1)	100%	100%
Brick	20%	10%
RAP	40%	40%
Fly ash(2)	10%	10%
Furnace bottom ash	10%	10%
Crushed glass fines(3)	10%	10%
Notes:		
1. For pavements using high percentages of crushed concrete, take into account the amount of available cement which will rehydrate when subjected to moisture to create rigid or semi-rigid pavement and result in subsequent shrinkage cracking. 2. For pavements using fly ash, take into account the possibility of hydration and binding when subject to moisture to create rigid or semi-rigid pavement and result in subsequent shrinkage cracking. 3. Crushed glass fines refer to clean glass, which has been processed to produce an aggregate product for which an exemption has been issued.		

Natural gravel

Unbound natural gravel materials: Select from the following based on the **Base/subbase material properties and test methods tables**:

- DGB20: 20 mm dense gravel base.
- DGS20: 20 mm natural gravel subbase.
- DGS40: 40 mm natural gravel subbase.

Base material properties and test methods table

Property and test method	Differentiating criteria	Material requirements					
		CRB20-1	CRB20-2	CCB20-1	CCB20-2	RCMB	DGB20
Particle size distribution or grading (% passing through sieve) AS 1289.3.6.1	**Sieve size (mm)**	—	—	—	—		—
	26.5	100	100	100	100	100	100
	19.0	95 - 100	95 - 100	95 - 100	95 - 100	95-100	93 - 100
	13.2	77 - 93	77 - 93	78 - 92	78 - 92	70-90	—
	9.5	63 - 83	63 - 83	63 - 83	63 - 83	60-80	71 - 87
	4.75	44 - 64	44 - 64	44 - 64	44 - 64	40-65	47 - 70
	2.36	29 - 49	29 - 49	30 - 48	30 - 48	35-55	35 - 56
	0.425	13 - 23	13 - 23	13 - 21	13 - 21	10-30	14 - 32
	0.075	5 - 11	5 - 11	5 - 9	5 - 9	5-15	6 - 20
Liquid limit (w_L) to AS 1289.3.1.1	—	max 25%	max 25%	max 30%	max 30%	max 27%	max 25%
Plasticity index (I_P) to	**Rainfall**	—	—	—	—		—
	All areas	min 2%	—	min 2%	—		—

Property and test method	**Differentiating criteria**	**Material requirements**					
		CRB20-1	**CRB20-2**	**CCB20-1**	**CCB20-2**	**RCMB**	**DGB20**
AS 1289.3.3.1							
	Areas with annual rainfall > 500 mm	max 6%	max 6%	max 6%	max 6%	max 6%	max 6%
	Areas with annual rainfall < 500 mm	max 10%	max 10%	max 10%	max 10%	max 10%	max 10%
Linear shrinkage (*LS*) to AS 1289.3.4.1	**Rainfall**	—	—	—	—		—
	All areas	min 0.7%	—	min 0.7%	—		—
	Areas with annual rainfall > 500 mm	max 2.0%	max 2.0%	max 2.0%	max 2.0%	max 2.0%	max 2.0%
	Areas with annual rainfall < 500 mm	max 4.0%	max 4.0%	max 4.0%	max 4.0%	max 4.0%	max 4.0%
Undesirable constituent materials (% retained on a 4.75 mm sieve) to RMS T276	**Material type**	—	—	—	—		—
	Type I - Metal, glass, stone, ceramics and slag	—	—	max 2.0	max 2.0	max 2.0	—
	Type II - Plaster, clay lumps and other friable material	—	—	max 0.5	max 0.5	max 0.5	—
	Type III - Rubber, plastic, paper, cloth, paint, wood and other vegetable matter	—	—	max 0.1	max 0.1	max 0.1	—
For materials with plasticity index less than 1: Maximum dry compressive strength on fraction passing 19 mm sieve to AS 1141.52	—	min 1.7 MPa	min 1.7 MPa	min 1.7 MPa	min 1.7 MPa	min 1.7 MPa	min 1.7 MPa
Particle shape by proportional caliper (% misshapen for 2:1 caliper ratio) to AS 1141.14	—	max 35%	max 35%	max 35%	max 35%	max 35%	—
Aggregate wet strength* to AS 1141.22	—	min 100 kN	min 80 kN	min 100 kN	min 80 kN	Min 70kN	—
Wet/dry strength variation* (dry - wet)/dry to AS 1141.22	—	max 35%	max 35%	max 35%	max 35%	max 35%	—
Los Angeles value (% loss or abrasion) to AS 1141.23	—	max 35%	max 35%	max 40%	max 40%	max 40%	—

Property and test method	Differentiating criteria	Material requirements					
		CRB20-1	**CRB20-2**	**CCB20-1**	**CCB20-2**	**RCMB**	**DGB20**
4 day soaked CBR (98% modified compaction) to AS 1289.6.1.1	—	min 80%	min 80%	min 80%	min 80%	—	min 80%
Unconfined compressive strength to AS 5101.4	—	max 1.0 MPa	max 1.0 MPa	max 1.0 MPa	max 1.0 MPa	max 1.0 MPa	—
NOTES: * Use the fraction with the highest wet/dry strength variation as the value for determining conformance. Test the fraction 19.0 to 9.5 mm. For blended materials, also test the fraction 9.5 to 4.75 mm. Test any other fraction where there is risk of failing.							

Subbase material properties and test methods table

Property and test method	Differentiating criteria		Material requirements				
		CRS20-3	**CRS40-4**	**CCS20**	**RCMS**	**DGS20**	**DGS40**
Particle size distribution or grading (% passing through sieve) to AS 1289.3.6.1	**Sieve size (mm)**	—	—	—		—	—
	53.0 mm	—	100	—		—	100
	37.5	—	90 - 100	—		—	95 - 100
	26.5	100	74 - 96	100	100	100	80 - 97
	19.0	90 - 100	62 - 86	95 - 100	85-100	96 - 100	—
	13.2	74 - 96	—	75 - 95	70-90	—	—
	9.5	61 - 85	42 - 66	60 - 90	60-80	65 - 89	48 - 85
	4.75	42 - 66	28 - 50	42 - 76	40-65	47 - 80	35 - 73
	2.36	28 - 50	20 - 39	28 - 60	30-55	32 - 67	25 - 58
	0.425	11 - 27	8 - 21	10 - 28	10-30	14 - 42	10 - 33
	0.075	4 - 14	3 - 11	2 - 10	5-15	6 - 26	3 - 21
Liquid limit (w_L) to AS 1289.3.1.1	—	max 25%	max 25%	max 30%	max 27%	max 25%	max 25%
Plasticity index (I_P) to AS 1289.3.3.1	**Rainfall**	—	—	—		—	—
	Areas with annual rainfall > 500 mm	max 12%	max 12%	max 12%	max 6%	max 12%	max 12%
	Areas with annual rainfall < 500 mm	max 12%	max 12%	max 12%	max 12%	max 12%	max 12%
Linear shrinkage (*LS*) to AS 1289.3.4.1	**Rainfall**	—	—	—		—	—
	Areas with annual rainfall > 500 mm	max 4.5%	max 4.5%	max 4.5%	max 4.5%	max 4.5%	max 4.5%
	Areas with annual rainfall < 500 mm	max 6.0%	max 6.0%	max 6.0%	max 6.0%	max 6.0%	max 6.0%
Undesirable constituent materials (% retained on the 4.75 mm sieve) to RMS T276	Type I - Metal, glass, stone, ceramics and slag	—	—	max 3.0	max 3.0		—
	Type II - Plaster, clay lumps and other friable material	—	—	max 0.2	max 0.2		—

Property and test method	Differentiating criteria		Material requirements				
		CRS20-3	CRS40-4	CCS20	RCMS	DGS20	DGS40
	Type III - Rubber, plastic, paper, cloth, paint, wood and other vegetable matter	—	—	max 0.2	max 0.2		—
Maximum dry compressive strength on fraction passing 19 mm sieve (only applies if plasticity index is less than 1) to AS 1141.52	—	min 1.0 MPa	min 1.0 MPa	min 1.0 MPa	min 1.0 MPa	min 1.0 MPa	min 1.0 MPa
Particle shape by proportional calliper - % misshapen (2:1) to AS 1141.14	—	max 35%	max 35%	max 35%	max 35%	—	—
Aggregate wet strength* to AS 1141.22	—	min 50 kN	min 50 kN	min 50 kN	min 70 kN	—	—
Wet/dry strength variation* (dry - wet)/dry to AS 1141.22	—	max 40%	max 40%	max 40%	max 40%	—	—
Los Angeles value to AS 1141.23	—	max 40%	max 40%	max 40%	max 40%	—	—
4 day soaked CBR (98% modified compaction) to AS 1289.6.1.1	—	min 30%	min 30%	min 30%	min 60%	min 30%	min 30%
NOTES: * Use the fraction with the highest wet/dry strength variation as the value for determining conformance. Test the fraction 19.0 to 9.5 mm. For blended materials, also test the fraction 9.5 to 4.75 mm. Test any other fraction where there is risk of failing.							

2.2 ALTERNATIVE UNBOUND BASE AND SUBBASE MATERIALS

Shear strength

Requirement: If proposed materials conform to the **Base/subbase material and test method table** except for particle size distribution (grading), conform to **Shear strength table**.

Shear strength table

Material layer	Modified Texas Triaxial Classification number (Test method T171)
Base	Maximum 2.5
Subbase	Maximum 3.2

2.3 STABILISED MATERIALS

Material properties and production

Stabilised materials: Conform to *1113 Stabilisation* for:

- Modified base and subbase.
- Bound base and subbase.

Material production: To *1113 Stabilisation* using one of following stabilisation method, as appropriate:

- Stationary mixing plant.
- In-situ stabilisation.

2.4 MODIFIED BASE AND SUBBASE MATERIALS

Material properties

Materials after stabilisation: Conform to **UNBOUND BASE AND SUBBASE MATERIALS**.

CRB20 material before stabilisation: Conform to the requirements for CRS20 in the **Subbase material properties and test methods table** and the following:

- Aggregate wet strength: > 80 kN.

CRB20 material after stabilisation:

- CBR: ≥ 80.
- UCS: < 1.0 MPa.

Testing period: Sample within 24 hours of adding stabilisation binder and test after 7 days accelerated curing.

2.5 BOUND BASE AND SUBBASE MATERIALS

Material type

Requirement: Lightly bound or bound.

Properties

Material UCS after bound stabilisation:

- Lightly bound material: 1 to 2 MPa.
- Bound material: > 2 MPa.

Testing period: Sample within 1 hour of adding stabilisation binder and test after 7 days accelerated curing.

2.6 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Quality verification: If material/product quality verification can be obtained from the supplier, documented tests need not be repeated.

3 EXECUTION

3.1 DELIVERY

Material transportation from a pugmill mixer

Delivery vehicles: Use delivery trucks with tipping bodies including semi-trailers and dog trailers. Cover the body to prevent moisture loss during transit.

Material condition at delivery: Handle materials as little as possible to minimise segregation, moisture loss and loss of fines during transit.

Material moisture content at delivery: Uniformly distributed and within - 2% and 0% of the OMC.

Modified or bound materials

Allowable working time: Allow for mixing, delivery and incorporation into the works, including trimming and compaction, to the **Maximum allowable working time table** in *1113 Stabilisation*.

3.2 STOCKPILING UNBOUND MATERIALS

Stockpile locations

Locations: Locate each stockpile on a firm level ground, as shown on drawings.

Clearances: Allow adequate clearance between machinery and overhead power lines.

Stockpile site preparation: Clear sites of all vegetation and extraneous matter, and shape to form a crown so that the area drains freely. Compact the area to 95% minimum relative compaction, tested to AS 1289.5.4.1.

Stockpile and maintenance

Stockpiled material: Sample to AS 1141.3.1 within 3 days of delivery.

Stockpile height: < 3 m.

Stockpile shape and slopes: Uniform shape with side slopes not steeper than 1.5H:1V or flatter than 3H:1V.

Stockpile material moisture content: Maintain at a level sufficient to prevent loss of fines. Spray the stockpile with waterproofing material to prevent wet weather damage to the gravel.

Contamination of materials: Make sure stockpile materials do not become intermixed, segregated or contaminated with foreign material.

Surplus materials: At completion of the Works, clear stockpile sites of all surplus material and leave in a clean and tidy condition.

3.3 BASE AND SUBBASE PAVING TRIAL

Trial section

Extent: Construct trial section as follows:

- So that it may be incorporated in the finished work.
- Length: 50 m.
- Width: Same as that required for the pavement.

Materials and methods: Use the same materials, equipment and methods as that required for the pavement works.

Compaction requirements: To **TRIMMING, COMPACTION AND CURING** and **ACCEPTANCE OF COMPACTION.**

Line, level and thickness: To **TOLERANCES**.

Non-conforming trial section

Requirement: If the trial concrete subbase is deemed non-conforming remove the non-conforming subbase, rectify any damage caused by the removal, and construct the new trial subbase in conformance with REMOVAL AND REPLACEMENT OF NON-CONFORMING LOT.

3.4 UNDERLYING LAYER

Layer condition

Compaction, shape and levels: Before constructing unbound granular pavement, compact the underlying layer so that there are:

- No soft spots that can cause premature failure of the pavement.
- No significant high spots that can reduce the pavement below the required thickness.

Layer preparation before constructing pavement

Subgrade: Prepare layer in conformance with *1112 Earthworks (Road reserve)*.

Subbase: Prepare layer to the following:

- **UNBOUND BASE AND SUBBASE MATERIALS** and this subsection.
- Moisture content: Less than 80% of the OMC.
- Layer condition: Free from rutting and foreign matter.

3.5 PLACING

Spreading

Plant: Use the following for the placing of base and subbase:

- Grader.
- Mechanical spreader.

Ambient air temperature for spreading bound materials: 5 to 35°C in the shade.

Levels adjacent to kerb and channel: Where pavement is to be constructed to the lip level of kerb and channel, construct flush with the lip of the channel.

Grader-placed layers

Placing: Place base or subbase in stages as follows:

- Dumping: Upon delivery, tip the material into uniform windrows across the pavement.
- Amount of material dumped: Not more than that which can be placed and compacted in one day.
- Spreading: Provide an even distribution of material over the whole pavement, as follows:
- Windrows: Respread across the formation or subbase in a continuous cycle and at a speed that allows for proper control.
- Spread material: To the required depth, crossfall and grade ready for compaction.
- Mixing and watering: Undertake concurrently with spreading.
- Low spots: Cut to fill without lensing or laminating occurring.
- Moisture content: If necessary, add water or remix material to achieve the required moisture content.
- Mixing passes: 3 to 6.

Turning over of materials: Minimise turning by grader to avoid segregation.

Mechanical spreaders

Spreader: Use self-propelling spreader with automated level control.

Rate of material delivery: Allow for the spreader to operate in continuous process, so that surface irregularities do not occur from spreader stop-start action.

Layer thickness: Set screed to the required layer thickness so that the compactive effort is even throughout.

Joints

Number of joints: Minimise.

Transverse joints: Locate at minimum 2 m offset from any joint in the layer below.

Longitudinal joints: Locate along lane linemarkings or midway between linemarkings. Offset minimum 100 mm from any joint in the layer below.

Bound materials work boundaries: Provide vertical faces for transverse and longitudinal joints.

3.6 TRIMMING, COMPACTION AND CURING

Plant

Compaction: Use self-propelling compaction plant where practical.

Plant movement restrictions: Do not stand watering and compaction plant on the pavement being compacted.

Compaction procedure

Process: Uniformly compact the entire area to **ACCEPTANCE OF COMPACTION**. Trim compacted layer to the required thickness.

One-way crossfall sections: Compact from the low to the high side.

Crowned sections: Compact from edge to crown on each side of the pavement.

Rolling: Pass rollers parallel to the centreline of the pavement and uniformly overlap each preceding pass.

Compacting sides: Allow minimum 2 additional passes of roller to the outer 1 m width on both sides of the pavement.

Subsequent layers

Placing subsequent layers: Do not place until testing has been completed and the test results for each layer has been approved.

Excessive moisture content

Wetted layers: If an unbound layer becomes wet after completing compaction, allow to dry out. If required, uniformly re-compact and trim to the required density and level tolerances.

Unstable areas

Rejection criteria: Any area that becomes unstable during rolling or is identified by proof rolling.

Replacement: Open up, dry back and re-compact. If dry back is not possible, remove the full depth of the layer and replace with fresh material to **REMOVAL AND REPLACEMENT OF NON-CONFORMING COURSES**.

Curing of bound materials

Curing time: Start curing the surface layer of a lot immediately after completing compaction.

Water curing: Before placing subsequent layer or applying a prime or initial seal, keep stabilised work continuously wet or damp during the curing period to prevent rapid drying out.

Water curing procedure: Provide frequent light uniform water spray without significant run-off or flooding. Avoid slurrying of the surface or leaching of the stabilising agent.

3.7 ACCEPTANCE OF COMPACTION

Acceptance criteria for lots

Acceptance of work: Based on density testing of the work in lots.

Lots: Nominate lots as follows:

- Extent generally: A single layer of work, constructed under uniform conditions in continuous operation, not crossing any transverse construction joint.
- Extent for unbound materials: A day's output using the same material.

Lot dimensions and levels: To **TOLERANCES**.

Lot acceptance criteria for compaction of unbound layers table

Traffic classification	Characteristic value of density ratio (%)		Mean value[1] of density ratio (%)		Assessment
	Base	Subbase	Base	Subbase	
Medium (M)	≥ 98	≥ 97	-	-	Accept lot
Light (L)	-	-	≥ 100	≥ 98	Accept lot
Note: 1. Allow for minimum 3 tests per lot.					

Lot acceptance criteria for compaction of bound layers

Requirement: Any zones with relative compaction of 93 to 97% (modified compactive effort) may be accepted if there is evidence that the zone forms less than 5% of the lot.

Layers thicker than 250 mm: Conform to the following relative compaction requirement:

- Top 150 mm: 93 to 97% (modified).
- Below 150 mm from the top: ≥ 92% (modified).

Relative compaction determination

Calculation: Calculate the relative compaction of pavement material, at each location tested for field dry density, as follows:

- Relative compaction % = [(Field dry density*)/(Laboratory maximum dry density)] x 100.

*Field dry density: Calculate to AS 1289.5.4.1.

3.8 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE – MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES.**

Moisture content testing

Underlying layer site testing: To AS 1289.5.2.1.

Density testing

Laboratory density: Test as follows:

- Unbound layers: Test to AS 1289.5.2.1.
- Bound layers: Test to RMS T130 within two hours of adding stabilisation binder to the mix.

Field dry density testing: The following methods can be used:

- Sand replacement method: Test the compacted material to AS 1289.5.3.1, AS 1289.5.3.2 or AS 1289.5.3.5.
- Nuclear density meter: Test compacted material to AS 1289.5.8.1.

3.9 NON-CONFORMANCE

Unbound

Density and compaction: If lot or area has been assessed as non-conforming, rework the area and allow for compaction reassessment.

Width, shape and level tolerance: If the lot can be corrected by further trimming, obtain approval for trimming.

- Trimming: Trim layer to produce a uniform, hard surface by cutting without filling, with corrected surface conforming to **TOLERANCES.**

Removal and replacement: If lot or area has become degraded, segregated or reduced in quality from reworking, remove and replace layer/course with fresh material to **REMOVAL AND REPLACEMENT OF NON-CONFORMING LOT** before placing next layer.

Bound materials

Subbase course is lower than the design level: Increase the base course thickness to make up the thickness deficiency.

Subbase course is above the design level: Obtain approval for regrading, to increase the base course level by maximum 20 mm above the original design level without decreasing the base course thickness.

Base course is above the design level: Obtain approval to regrade the base course level.

Corrective regrading of base course level: Approval may be granted for regrading subject to the following:

- The rate of change of grade from the original finished design surface level is less than 3 mm/m.
- Regrading will not interfere with the proper functioning of the drainage system.
- Regrading will not affect levels at property boundaries and will not increase or decrease the footpath or footpath crossover levels and the levels are within the Council's allowable design limits.

Removal and replacement: Lots that cannot be corrected by trimming or regrading.

3.10 REMOVAL AND REPLACEMENT OF NON-CONFORMING LOT

Extent of removal

Extent: Non-conforming material over the full length and width of the lot with the following exceptions:

- Exceptions from removing full length of lot: If the minimum length of pavement layer to be removed is 50 m and the cause of non-conformance can be isolated.
- Exception from removing full width of lot: If the cause of non-conformance can be isolated transversely and the new longitudinal cold joint is formed along the centreline of the road pavement.

Replacement of base/subbase

Replacement material: Replace with fresh material. Make sure material used, and the subsequent spreading, compaction, trimming, curing and testing of the replacement materials, conforms to the requirements of this work-section.

Damage to abutting or underlying layers or structures: Rectify to match existing.

3.11 MAINTENANCE BEFORE COMPLETION OF WEARING SURFACE

Surface condition and protection

Prepared surface: Maintain the approved condition of the base course until the initial seal is completed.

Pavement surfacing: Within 7 days of lot approval, cover the full width of base course with prime or initial seal to *1143 Sprayed bituminous surfacing*.

Pavement condition before pavement surfacing

Dry back: Allow material to dry to 60 to 80% of the OMC before applying the prime, initial seal or wearing surface.

Embedment test: Before starting any spray seal surface treatments, perform embedment test as follows:

- Method: To Austroads Austroads AG:PT/T251.
- Timing of test: Within 48 hours before applying sprayed seal.
- Embedment value allowance: Maximum 3 mm.

Deteriorated pavement condition

Requirement: If the base condition deteriorates before applying the prime or initial seal, and approval to proceed with bitumen surfacing work is withdrawn, re-prepare the base.

Surface drainage

Ponded water: Maintain adequate drainage of the pavement before completion of the wearing surface. Remove any ponded water within 12 hours if free drainage is not achievable.

Restrictions on movement

Bound pavements: Prevent construction plant and vehicles not involved in current construction or testing activities from using the pavement before applying the initial seal and within 7 days of placing the base course.

Unbound pavements: Prevent construction plant and vehicles not involved in current construction or testing activities from using the pavement before applying the initial seal.

Opening to traffic

Traffic restriction: Do not permit traffic on bound pavements within 7 days after completing the full pavement depth and initial seal.

4 ANNEXURES

4.1 ANNEXURE - SCHEDULES

Authority requirements schedule

Property/Requirement	A	B	C

4.2 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection	Submission/Notice details	Process held
SUBMISSIONS, Products and materials Unbound base and subbase materials	H	Test results from NATA accredited laboratory as evidence of material conformance	Minimum 10 days before material delivery	Material delivery
SUBMISSIONS, Products and materials Alternative unbound base and subbase materials	H	Test results from a NATA accredited laboratory as evidence of material conformance	Minimum 10 days before material delivery	Material delivery
SUBMISSIONS, Variations Variations to approved materials	H	Details of any changes to the approved base and subbase or source of supply.	Minimum 10 days before material delivery	Material delivery
SUBMISSIONS, Execution details Trial section	H	Compaction test results from a NATA accredited laboratory for the subbase and base layer of trial section.	Minimum 2 days before commencement of remaining pavement works.	Commencement of remaining pavement works.

Clause and description	Type*	Submission/Inspection	Submission/Notice details	Process held
		Survey report covering line, level and thickness for the subbase and base layer of trial section. Record data of straightedge test.		
SUBMISSIONS, Execution details Delivery vehicles	H	Use of vehicles not fitted with fabric covers for the delivery of modified or bound materials.	Minimum 2 days before delivery.	Material delivery.
SUBMISSION, Execution details Delivery of bound materials	W	Delivery dockets of bound materials indicating time and date of mixing and registration or fleet number of delivery truck.	Upon delivery	-
SUBMISSION, Execution details Placing outside temperature range	H	Proposal to place bound materials when temperatures are outside the required ambient air temperature.	Minimum 2 days before spreading.	Spreading of bound materials.
SUBMISSIONS, Execution details Placing outside layer thickness range	H	Proposal to place and compact layer outside the required thickness range.	Minimum 2 days before spreading.	Spreading of pavement materials.
SUBMISSIONS, Execution details Trimming, compaction and curing	H	Details of any hand operated compaction plant as to where and why hand equipment is to be used.	Minimum 2 days before use of hand operated compaction plant.	Use of hand operated compaction plant.
SUBMISSIONS, Execution details Trimming, compaction and curing Record of roll test for each layer of pavement.	H	Compaction test results from a NATA accredited laboratory authority for the completed pavement layer. Survey report covering line, level and thickness for the completed pavement layer. Record data of straightedge test. Records of roll tests for identification of any movement under 3 point 7.5 tonne roller by visual observation by Council Superintendent.	Minimum 2 days before placement of next layer.	Placement of next layer.
SUBMISSIONS, Execution details	H	Disposition of non-conforming lot. .	Minimum 5 days before corrective	Corrective action or removal and replacement.

Clause and description	Type*	Submission/Inspection	Submission/Notice details	Process held
Non-conformance			action or removal and replacement.	
INSPECTIONS, Notice Materials	W	Unbound, modified and bound materials.	Upon delivery.	-
INSPECTIONS, Notice Underlying layer	H	Quality of underlying layer including assessment of required moisture content.	Minimum 2 days before placing.	Placing.
INSPECTIONS, Notice Removal and replacement of non-conforming lot	H	Inspection of completion of removal of non-conforming base or subbase.	Minimum 1 day before inspection.	Replacement of non-conforming lot.
INSPECTIONS, Notice Maintenance before completion of wearing surface	H	Inspection of the condition of prepared base course. Submission by the contractor of the lot closure certificates confirming the pavement works have been completed and prepared for seal as specified.	Minimum 2 days before prime or initial seal.	Prime or initial seal.
*H = Hold Point W = Witness Point				

4.3 ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Flexible pavement base and subbase table

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Base and subbase supply	Material quality – Supplier's documentary evidence and certification	1 contract		
	- Particle size distribution		1 per 1,000 t	AS 1289.3.6.1
	- Liquid limit		1 per 1,000 t	AS 1289.3.1.1
	- Plasticity index		1 per 1,000 t	AS 1289.3.3.1
	- Linear shrinkage		1 per 1,000 t	AS 1289.3.4.1
	- Undesirable constituent material		1 per 1000 t	RMS T276

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
	- Maximum dry compressive strength		1 per 5,000 t	AS 1141.52
	- Particle shape		1 per 1,000 t	AS 1141.14
	- Aggregate wet strength		1 per 5,000 t	AS 1141.22
	- Wet/dry strength variation		1 per 5,000 t	AS 1141.22
	- Los Angeles value		1 per 1,000 t	AS 1141.23
	- CBR		1 per 5,000 t	AS 1289.6.1.1
	- Modified Texas Triaxial Class		1 per contract	RMS T171
	- Unconfined compressive strength		1 per 5,000 t	AS 5101.4
	- Unconfined compressive strength (bound)	1 Contract	1 per mix design	AS 5101.4
Placement	Geometry: Alignment and level - Width and surface trim	One layer 2,000 m² or max. 1 day's placement	1 cross section per 15 m 10 per selected 200 lin. m	Survey Measure and deviation from a 3 m straightedge
	Compaction/moisture content/ dry density testing of Subgrade		1 test per 50 lineal metres of road, or minimum one test per 250m2	RMS T130 AS 1289.5.2.1 AS 1289.5.3.1 AS 1289.5.3.2 AS 1289.5.3.5 AS 1289.5.4.1 AS 1289.5.8.1
	Compaction/moisture content/ dry density testing of Sub base		1 test per 50 lineal metres of road, or minimum one test per 250m2	
	Compaction/moisture content/ dry density testing of Base Course		1 test per 50 lineal metres of road, or minimum one test per 250m2	

4.4 ANNEXURE - PAY ITEMS

Pay items	Unit of measurement	Schedule rate inclusions
1141.1 Supply, place and compact subbase course	m^3 volume compacted - Determine quantity by the length and width of work for total relevant thickness.	Do not account for allowable tolerances. All costs associated with all documentation and approvals and: - Supplying, placing, compaction, trimming, jointing, and testing of the subbase course, and curing of bound material.

Pay items	Unit of measurement	Schedule rate inclusions
1141.2 Supply, place and compact base course	m^3 volume compacted - Determine quantity by the length and width of work for total relevant thickness.	Do not account of allowable tolerances. All costs associated with: - Supplying, placing, compaction, trimming, jointing, and testing of the base course, and curing of bound material.
Traffic management	Lump sum.	To *1101 Traffic management*.

4.5 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1141		Methods for sampling and testing aggregates
AS 1141.14	2007	Particle shape, by proportional caliper
AS 1141.22	2008	Wet/dry strength variation
AS 1141.23	2009	Los Angeles value
AS 1141.3.1	2012	Sampling - Aggregates
AS 1141.52	2008	Unconfined cohesion of compacted pavement materials
AS 1289		Methods of testing soils for engineering purposes
AS 1289.3.1.1	2009	Soil classification tests - Determination of the liquid limit of a soil - Four point Casagrande method
AS 1289.3.3.1	2009	Soil classification tests - Calculation of the plasticity index of a soil
AS 1289.3.4.1	2008	Soil classification tests - Determination of the linear shrinkage of a soil - Standard method
AS 1289.3.6.1	2009	Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving
AS 1289.5.2.1	2017	Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using modified compactive effort
AS 1289.5.3.1	2004	Soil compaction and density tests - Sand replacement method using a sand-cone pouring apparatus
AS 1289.5.3.2	2004	Soil compaction and density tests - Sand replacement method using a sand pouring can, with or without a volume displacer
AS 1289.5.3.5	1997	Soil compaction and density tests- Determination of the field dry density of a soil - Water replacement method
AS 1289.5.4.1	2007	Soil compaction and density tests - Compaction control test - Dry density ratio, moisture variation and moisture ratio
AS 1289.5.8.1	2007	Soil compaction and density tests - Determination of field density and field moisture content of a soil using a nuclear surface moisture-density gauge - Direct transmission mode
AS 1289.6.1.1	2014	Soil strength and consolidation tests - Determination of the California Bearing Ratio of a soil - Standard laboratory method for a remoulded specimen
AS 5101		Methods for preparation and testing of stabilized materials
AS 5101.4	2008	Unconfined compressive strength of compacted materials
Austroads AG:PT/T251	2010	Ball penetration test
RMS T130	2012	Dry density/moisture relationship of road construction materials (blended in the laboratory with cementitious binders)
RMS T171	2012	Modified Texas triaxial compression test for pavement materials
RMS T276	2012	Foreign materials content of recycled crushed concrete

1143 SPRAYED BITUMINOUS SURFACING

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide sprayed bituminous surfacing for roads and related applications, as documented.

1.2 PRECEDENCE

General

Schedule of job details: If there are conflicts between the requirements of this work-section and the **ANNEXURE – SCHEDULE OF JOB DETAILS**, the requirements of the **ANNEXURE – SCHEDULE OF JOB DETAILS** apply.

1.3 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.
- *1141r Flexible pavement base and subbase*.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviations apply:

- ALD: Average least dimension.
- PMB: Polymer modified bitumen.
- v/l/d: Vehicle/lane/day.

Definitions

General: For the purposes of this work-section the definitions in Austroads AP-C87 and those given below apply:

- Adhesion agent: A substance for promoting adhesion between binder and aggregates, normally in the presence of water.
- Average least dimension: The average height of the aggregate particles when they are spread as a single layer with their dimensions vertical.
- Binder: A bituminous material used for waterproofing the surface and holding an aggregate layer to the base.
- Cutter: A light petroleum distillate (e.g. kerosene) added to bitumen to temporarily reduce its viscosity (cutback bitumen).
- Cutback bitumen: Bitumen to which cutter oil (kerosene) has been added to achieve a temporary reduction in viscosity.
- Double/double seal (D/D): A seal consisting of two successive applications of binder each followed by an application of aggregate.
- Flux oil: A petroleum distillate (e.g. diesel) added to bitumen to produce a long-term reduction in viscosity.

- Flaky aggregate is defined as an aggregate particle with a least dimension (thickness) less than 0.6 of the mean of the smallest sieve size through which the particle passes and the largest sieve size on which the particle is retained.
- The flakiness index is defined as the percentage by mass of stones in an aggregate having an ALD of less than 0.6 times their average dimension.
- Geotextile reinforced seal (GRS): An application of a bituminous binder into which both aggregate and geotextile are incorporated to provide a durable wearing surface. A layer of binder is applied first, followed by a layer of geotextile fabric, then a second coat of binder, followed by the aggregate.
- High stress seal or reseal (HSS): A bituminous seal or reseal treatment which may be a single/single or double/double seal, but with a polymer modified binder (PMB) to improve seal performance in areas of high traffic loading and stress.
- Initial seal: An application of a sprayed seal to a prepared basecourse which has not been primed. It is intended to adhere to the base, whilst providing a temporary wearing course for traffic.
- Initial treatment: An application of a prime (prime coat) or initial seal to a prepared basecourse.
- Prime: An application of a primer to a prepared base, without cover aggregate, to provide penetration of the surface, temporary waterproofing and to obtain a bond between the pavement and the subsequent seal or asphalt. It is a preliminary treatment to a more permanent bituminous surfacing.
- Primer (AUS-SPEC): A bituminous material of low viscosity and low surface tension used in priming.
- Primer-seals: A material, more viscous than a primer, and required to act both as a primer and binder, and used in initial sealing.
- Reseal: A sprayed seal applied to an existing sealed, or asphalt surface.
- Residual binder: A binder that remains in services after any volatiles have evaporated.
- Retreatment: An application of a sprayed bituminous treatment on an existing bituminous surfacing.
- Secondary treatment: An application of a sprayed bituminous treatment on an initial treatment.
- Seal: A thin surface layer of bituminous binder into which aggregate is incorporated. A sprayed seal may incorporate more than one application of binder and aggregate and may also be combined with a layer of geotextile fabric.
- Single/double seal: A seal consisting of a single application of binder followed by a double application of aggregate.
- Single/single seal (S/S): A seal consisting of a single application of binder followed by a single application of aggregate.
- Strain alleviating membrane (SAM): A sprayed seal with the binder containing a relatively large concentration of rubber or polymer modifier. It is used to absorb strains that occur in a road pavement and thereby reduce reflection cracking.
- Strain alleviating membrane interlayer (SAMI): The application of a polymer modified binder into which aggregate is incorporated. A SAMI is used as an interlayer between an asphalt wearing course and underlying layers to provide alleviation from tensile strains developed beneath it.

1.5 SUBMISSIONS

Execution details

Sprayed seal design: Submit evidence that the seal design conforms to Austroads AGPT04K clause 4 for the following:

- Seal type and grade selection.
- Binder application rates and aggregate spread rate for the required seal treatment type.

Products and materials

Mix design: Submit details of the following:

- Type and source of constituent materials: Including for aggregates and binders.
- Proportions of constituent materials used: Including binders, bituminous emulsion content, adhesion agents and additives).
- The combined aggregate particle size distribution as a single grading (not a range).

- Nominal size of the design mix.
- Application rate litres/m^2 of sealed road surface at minimum 15 ˚C.
- Test certificates: Submit evidence of conformance from a NATA accredited laboratory (for the required test method) for each constituent material (aggregates/mineral fillers/binders/additives) including any previous documented conformance and performance and including the following:
  . Aggregates: Quality and grading.
  . Blended aggregates: Proportions of the various sizes, including coarse aggregates.
- Trial mix testing results for review and approval.

Sprayed seal treatment type: Submit evidence of conformance to **ANNEXURE – SCHEDULE OF JOB DETAILS** or drawings.

Bituminous materials: Submit evidence of conformance to **MATERIALS**.

- Evidence of previous satisfactory performance, if applicable.

Aggregates: Submit details of material source and evidence of conformance to AS 2758.2.

Bitumen binder: Submit of cutter oil content required.

Records

Machinery and equipment: Submit evidence that spray machinery and other road plants are registered and insured.

Ambient condition before spraying: Submit record of temperature and weather conditions during the course of the work.

Drawings: Submit work-as-executed drawings and other documents with details of the extent and condition of final works. One design file in accordance with the ADAC specification, which is available on Council's website.

Spraying details: Submit the following:

- Sprayer certificate.
- Binder spraying temperature.
- Work record for each sprayer run.

Tests

Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES.**

1.6 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Surface preparation: Completed surface preparation, including repair of surface defects.
- Surfacing trial: Completed trial section.
- Non-conforming trial section: If the original trial section is deemed non-conforming, completed new trial section.
- Completed new trial section.
- Spraying rate.
- Spreading: Completed surfacing.
- Non-conforming sections: Completed replacement and rectification of non-conforming sections.

2 PRE-CONSTRUCTION PLANNING

2.1 GENERAL

Sealing treatment

General: To the **Categorisation of sealing treatments table**.

Initial treatment	Secondary treatment
Prime S/S S/D D/D HSS Graded Seal	S/S S/D D/D HSS SAM SAMI Inverted seal Coloured Surface Treatment High Friction Surface Treatments (HFST)[1] Multiple Layer Applications (bleeding in wheel tracks) Aggregate Retention Seal Fibre Reinforced Seals Geotextile Reinforced Seal Surface rejuvenation[2] Surface enrichment[2]
Source: Austroads AP-T310. Notes: 1. For High friction surface treatment refer to *ARRB High friction surface guide to good practice.* 2. For surface rejuvenation and surface enrichment, refer to *1147 Sprayed preservation surfacing* work-section and *NATSPEC GEN 025* for preservation surfacing treatments.	

Design of sprayed seals

Seal design: To Austroads AP-T310 or Austroads AGPT04K Section 5 and 6.

Plant

Registration and insurance: Register and insure all plant for use on a public road, as appropriate.

Operation: Conform to statutory environmental regulations.

2.2 ENVIRONMENTAL RISK

Risk assessment

Requirement: Assess and manage the risk of environmental damage from primer or primer-seals being washed into adjacent drains and open watercourses from rain on uncured materials.

Priming and initial seal risk assessment table

Weather conditions (Note 2)	**Risk of wash-off in the event of rain within the stipulated periods after spraying (Note 1)**			
	0 – 12 hours	**12 – 24 hours**	**24 – 48 hours**	**Over 48 hours**
(a) Cutback bitumen				
Fine, sunny, warm/hot	Moderate	Moderate	Low	Low
Fine, overcast, cool/warm	High	Moderate	Low	Low
Damp, overcast, warm	High	High	Moderate	Moderate
Damp, overcast, cool	Unacceptable	High	High	Moderate
Wet, overcast, warm	Unacceptable	Unacceptable	High	High
Wet, overcast, cool	Unacceptable	Unacceptable	Unacceptable	Unacceptable
(b) Bitumen emulsions				

Weather conditions (Note 2)	Risk of wash-off in the event of rain within the stipulated periods after spraying (Note 1)			
	0 – 12 hours	**12 – 24 hours**	**24 – 48 hours**	**Over 48 hours**
Fine, sunny, warm/hot	Moderate	Low	Low	Low
Fine, overcast, cool/warm	Moderate	Low	Low	Low
Damp, overcast, warm	High	Moderate	Low	Low
Damp, overcast, cool	High	Moderate	Moderate	Moderate
Wet, overcast, warm	Unacceptable	High	High	Moderate
Wet, overcast, cool	Unacceptable	Unacceptable	Unacceptable	High

Notes:
1. The risk levels reflect the likelihood of a wash-off from granular pavements on moderate grades with typical crossfall. For roads on steep grades, or with abnormal crossfall, or with low porosity base course, the risk of wash-off is higher than that documented.
2. Typical temperatures associated with different weather conditions are: Hot = 25°C, Warm = 15 to 25°C, Cool = 15°C.
3. If risk is classified as unacceptable, delay application until conditions improve.
4. If risk is classified as high, delay application or supervise application and curing continuously until dry. Precautionary measures include blocking of stormwater entry points, placing of spill response equipment, regular weather checks and frequent inspections.
5. If risk is classified as moderate, inspections must be frequent enough to respond to rain events. Stormwater entry points should be blocked and spill response equipment available on site.
6. If risk is classified as low, inspections may be less frequent, but weather should be monitored to make sure prompt response to rain events.

3 MATERIALS

3.1 BITUMINOUS SURFACING

Types

Requirement: Use the following types of sprayed bituminous surfacing:

- Prime.
- Initial seal.
- Seal.

3.2 BITUMINOUS MATERIALS

Bitumen

Classification and properties and testing of bitumen and bituminous binders: To AS 2008 and Austroads AGPT04F Section 4.6.

Multigrade bitumen: To AS 2008.

Cutback bitumen

Standard grades of cutback bitumen: To AS 2157, Austroads AGPT04F section 5 and AGPT04K.

Field preparation: If required, prepare cutback bitumen by blending bitumen and cutter oil in proportions for the particular application.

Proprietary grades of cutback bitumen: To the manufacturer's specification.

Polymer modified binders

Binder properties, classification and testing: To Austroads AG:PT/T190 and Austroads AGPT04F section 6 and AGPT04K section 4.6.3.

Bitumen emulsion

Standard: To AS 1160.

Type, grade and testing: To Austroads AGPT04F section 7 and AGPT04K section 4.6.4

Proprietary grades of bitumen emulsion: To the manufacturer's specification.

Adhesion agent

Addition to bituminous binder or aggregate precoating material: Provide agent type and proportion depending on the following:

- Previous documented conformance and performance with the proposed combination of binder, aggregate source and precoating material based on trials or previous use.
- Materials selected are approved by the road authority.

Cutter oil and flux oil

Standard: To AS 3568.

Aggregate precoating materials

Materials: Flux oil, flux oil and bitumen mixture, cutback bitumen, proprietary bitumen emulsion or other proprietary products. Proprietary products may be used subject to previous satisfactory field performance as an aggregate precoating material.

Approved adhesion agent content in precoating material: Minimum 1%.

Rejuvenation and enrichment treatment

Materials: To *1147 Sprayed preservation surfacing*.

3.3 AGGREGATES

Properties

Source: Use aggregates from a nominated location.

Aggregates: To AS 2758.2 and the following:

- Conformance to **ANNEXURE – SCHEDULE OF JOB DETAILS** for aggregate class, polishing resistance, method of determination of aggregate shape, and combination of hardness and durability test measures.
- Apply only one method of aggregate shape determination and one combination of hardness and durability.
- If no aggregate details are documented in **ANNEXURE –SCHEDULE OF JOB DETAILS**, select the aggregate class, polishing resistance and test methods combination based on the service conditions and customary test procedures used in the state where the works are located.

Aggregate size

Selection of aggregate size: Select the appropriate aggregate size based on traffic, pavement life expectancy and climate conditions To AGPT04K Table 4.3.

- For lower traffic volume roads: Provide 7mm aggregate.
- For higher traffic volume: Provide 10mm or 14mm aggregate.

Selection of aggregate size combinations

For single/single seals: Conform to the following:

- Provide 7 mm aggregate for low traffic applications.
- Provide 10mm aggregates for higher traffic applications. Do not use for high-stress traffic movements, extreme heat, or predominantly wet conditions.
- Do not use 14 mm aggregates for single/single initial seals and for light traffic applications. Use only when high viscosity binder is required to retain the aggregate and provide adequate bonding with the binder.

For double/double initial seals:

- Double/ double initial seals, or single/single initial seals: Conform to the following:

- Incorporate scatter coat, for high traffic and high stress sites.
- Use aggregate size combinations with double/double seals such as 10/5, 10/7, and 14/7 mm.

Aggregate dimensions (ALD)

For double/double or single/single seals: Provide ALD for second application to be half the ALD of the aggregate in the first application.

Sampling and testing: Apply appropriate sampling techniques and testing procedures for ALD to ensure correct aggregate design spread rates and accurate design binder application rates.

Flaky aggregate

Flakiness index: To AS 1141.15.

3.4 SELECTING A SPRAYED SEAL

General

Sprayed seal selection: Select sprayed seal to Austroads AGPT04K Table 4.7, based on the design traffic (v/l/day), equivalent heavy vehicles, air and road temperatures, stress locations such as sharp corners, roundabouts, turning lanes, intersections and steep grades. Cracked pavements will require special treatments. Obtain specialist advice to manage variations based on local experience.

3.5 DESIGN OF A SPRAYED SEAL

Design of single/single seals

Design principles: To Austroads AGPT04K Section 5.1.

Design traffic

General: Details for traffic design, traffic data and distribution of traffic to Austroads AGPT04K Section 5.2.

Procedure for determining design traffic.

Single carriageway - two-way road: Apportion traffic to each lane for single carriageway in rural areas and estimate design traffic to AGPT04K Table 5.1.

Dual carriageway - one-way road: Apportion half the traffic count to each lane and estimate design traffic to Austroads AGPT04K Table 5.2.

Equivalent heavy vehicles (EHV %): For the effects of heavy vehicles and for adjustments to the basic voids factor to cater for this extra loading factor to AGPT04K Clause 5.2.5.

Short term traffic variations: Make provisions for events such as grain harvests, show days, seasonal tourists, school holidays especially if they coincide with seasonal wet weather events.

Access roads to sites such as quarries and mining locations: To Austroads AGPT04K Section 5.2.7.

Design of a double/double seal

General: For double/double seal design to AGPT04K Figure 5.3 and Section 5.5.2.

Surface texture allowance: If the second seal is delayed about 3 months and up to 24 months then assess the surface texture allowance to **Double/double seal design surface texture allowance and time between seals table.**

Double/double seal design surface texture allowance and time between seals table

Time between seal applications	Surface texture allowance – as a percentage of the standard allowance
Less than 3 months	30%
Between 3 and 6 months	30 to 50%
Between 6 and 12 months	50 to 75%
12 months to 24 months	75 to 100%

Austroads Part 4K Table 5.3

Initial treatment

General: Design of primes To **Guide to grades and application rates for primer table**.

Grades and application rates of primer table

Pavement types	Grade AS 2157	Primer application rates
Tightly bonded (impervious)	AMC 00	0.6 to 1.1
Medium porosity	AMC 0	0.8 to 1.1
Porous	AMC 1	0.9 to 1.3
Very porous (limestone and sandstone)	AMC 1	2 application rates: 1st@ 0.7 to 0.9 2nd@ 0.5 to 0.7
Hill gravels, granitic sands	AMC 0	0.8 to 1.1
Stabilised	AMC 00(1)	0.5 to 0.8
Concrete	AMC 00(1)	0.2 to 0.4
1. Can also consider using proprietary materials, or additional cutter in these cases.		

Trials: Conduct small scale trials on pavement materials in-situ test and compare the appropriateness of the prime grade and the application rate.

Design of Initial Seals

Initial seals: For the design of initial seals conform to the following:

- Determine binder application rate.
- Adjust the application rate and apply allowances for:
  - . Surface texture.
  - . Binder absorption.
  - . Aggregate embedment To AGPT04K Section 5.5.

Other seals

SAMI treatments: Conform to the following:

- Use highly modified binders applied at a high rate of application.
- Overlay with asphalt within 1 day after construction.
- For effective crack sealing performance provide 1.8 L/ m^2 minimum design binder rate.

Geotextile reinforced seals

General: To Austroads AGPT04K and Austroads AP-T37 and to the **Geotextile reinforced seals table**.

Type: Non-woven, needle punched fabrics with a melting point of 165˚C and a minimum fabric mass of 130 g/m^2

Fibre reinforced seals (FRS)

General: Conform to AGPT04K Section 5.5 and the following:

- Design of FRS based on single/single design procedures.
- Include allowances for polymer and bitumen emulsion and coating glass fibres.
- Use a scatter coat of 5 or 7 mm aggregate over a 14mm seal and 5mm aggregate on a 10mm seal.

3.6 SEAL DESIGN INPUT PARAMETERS

Basic voids factor Vf

Basic voids factor Vf for single/single seals: To AGPT04K Figure 6.1 and 6.2.

Basic voids factor Vf for double/double seals: To AGPT04K Figure 6.3 and 6.4.

Adjustments to voids factor Va and Vt: To AGPT04K Table 6.1 for aggregate shape (Va) and Table 6.2 for traffic effects (Vt).

Design voids factor VF

Design voids factor: Determine by using the following:

VF =Vf + Va +Vt

Where Vf = basic voids factor

- Va = adjustment for aggregate shape
- Vt = adjustment for traffic effects

Basic binder application rate (Bb)

Binder application rate Bb: Determine the binder application rate for the proposed seal by using the formula:

- Bb =VF x ALD(L/m^2) where VF is the design voids factor and ALD is the average least dimension of aggregate.

Allowances applied to the basic binder application rate

General: Make allowances for:

- Surface texture of existing surface to AGPT04K Table 6.3 and Section 6.2.2 for asphalt, microsurfacing, concrete, timber and primed surfaces.
- Potential aggregate embedment into the existing surface.
- Embedment of aggregate in initial treatments over a soft base or primed surfaces to AGPT04K Figure 6.5.
- Potential binder absorption allowance into the existing pavement to AGPT04K section 6.2.4 for:
  - Initial seals for each type of pavements, granular unbound, cementitious binders, bitumen stabilised, with chemical binders ranging from -0.1 to +0.2 L/m^2 allowance factor.
  - Reseals will seldom be a problem unless the surface is visibly open and porous.
- Potential binder absorption into the sealing aggregate for porous e.g. sandstone or rhyolite, or vesicular e.g. scoria and slags.

Binder factors

Binder factors for single/single seals: To AGPT04K Table 6.4.

Binder factors for double/double seals: To AGPT04K Table 6.5.

Design binder application rate (Bd)

General: Determine to AGPT04K Section 6.4 and Section 6.2.2.

- Design binder application rate, Bd = Bbm + allowances.
- Where Bbm = modified basic binder application rate (rounded to the nearest L/m^2)
- Allowances = any applicable allowances.

Geotextile reinforced seals (GRS)

General: Use a minimum fabric mass of 130g/m^2 and 10mm aggregate maximum size to reduce potential to puncture the fabric.

Binder fabric retention allowance: To the **Geotextile reinforced seals table.**

Geotextile reinforced seals table

Geotextile grade	Application	Retention allowance (L/m^2)
130 – 140 g/m^2	Resealing	0.9 to 1.0

Geotextile grade	Application	Retention allowance (L/m^2)
175 – 200 g/m^2	Initial seal on low quality base material	1.1 to 1.3

Bond coat

Application of bond coat: Conform to the following:

- Apply the bond coat to the existing surface as a proportion of the binder fabric retention allowance. Add the balance of the fabric retention allowance to the seal coat on top of the fabric.
- Make sure the bond coat is sufficient to hold the fabric in place, without bleeding through the fabric and adhering to the tyres of the fabric spreading and rolling equipment.
- Bond coat application rate: 0.4 - 0.8 L/m$^{2.}$

Fibre reinforced seals (FRS)

Binder application rate: Use similar procedures as for conventional sprayed seals.

Binder allowance for glass fibres: To AGPT04K Table 6.7.

Aggregate spread rate

General: The aggregate spread rate is influenced by ALD and traffic.

- Make sure the binder application rate fills the voids in the aggregate to a depth of about two-thirds up the aggregate.
- The aggregate spread rate for low traffic roads (less than 200 v/l/d) is 5% heavier than that that for heavier trafficked roads.
- When ordering aggregate for works, make allowance for stockpile wastage and order additional 5 - 10% over the required quantity.

Single/single seals aggregate spread rates

Aggregate spread rates: To the **Aggregates rates for single/single seals table.**

Aggregates rates to the single/single seals table

Binder	Aggregate spread rate (m^2/m^3)
C170, C240, C320, Multigrade bitumen, PMB	900/ALD
Emulsion, AMC4 and AMC5 cutback binders	800/ALD
Application	
Scatter coat	400
SAMI	1000/ALD to 1100/ALD

Double/double seals aggregate spread rates

Aggregate spread rates for first application: To the **Aggregates rates for double/double seal first application table**.

Aggregates rates for double/double seal first application table

Binder	Aggregate spread rate (m^2/m^3)
C170, C240, C320, Multigrade bitumen, PMB	950/ALD
Emulsion, AMC4 and AMC5 cutback binders	850/ALD

Aggregate spread rates for first application: To the **Aggregates rates for double/double seal second application table**. If the second application for the double/double seal is delayed use **Aggregates rates to the single/single seals table** to determine aggregate spread rates.

Aggregates rates for double/double seal second application table.

Binder	**Aggregate size mm**	**Aggregate spread rate (m^2/m^3)**
All binder types	10, 7	900/ALD
	5 (No ALD)	225
Note: For the second aggregate application the design spread rate is 20% less than for single/single seal design based on the spread rate of the first application.		

4 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE – MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Pavement surface preparation: To the ball penetration test AGPT/T251.

5 EXECUTION

5.1 STORAGE AND HANDLING OF RAW MATERIALS

Aggregates

Aggregate stockpile: Arrange and manage as follows:

- Lot size: Not more than 250 m^3 (approximately 350 tonnes).
- Stockpile location: Locate each stockpile on firm levelled ground that sheds water away from the stockpile. Separate stockpiles to prevent cross-contamination and interfering with loading and/or precoating operations.
- Stockpiles clearances: Allow adequate clearance between machinery and overhead power lines.
- Stockpile management: Prevent environmental damage from dust or bituminous material run-off.
- Signpost: Show stockpile quantity and material type at all times.
- Contamination prevention: If necessary, cover stockpiles to reduce contamination by dust or water.
- Recovery from stockpiles: Avoid contaminating aggregates.
- Contamination: Observe effect of weathering and dust causing a reduction in effectiveness of precoat of aggregates in stockpiles: Rectify or replace stockpile.

Binder.

Heating of binder at time of application: Conform to the following:

- Heating temperature: ≤ 200°C and to the manufacturer's recommendations.
- Do not use overheated bituminous material.
- If there are no manufacturer’s recommendations, adopt the temperature guidelines in AAPA Advisory Note 7.

Storage and handling: Store and handle binder to Austroads AGPT08 Section 8.2.2 and as follows:

- Time and temperature: To the manufacturer’s recommendation.
- Procedures: Flush binders with liquids or other materials to prevent segregation and contamination.

- Straining devices: Use at all times for transferring binders into sprayers to eliminate hardened bituminous material particles or other contaminants that may block spraying jets.

5.2 PAVEMENT SURFACE CONDITION FOR SPRAYING

Surface condition assessment.

Flexible pavement base and subbase: Assess for conformance to the *1141 Flexible pavement base and subbase* work-section. Obtain all as-constructed granular pavement results including moisture content, dryback and compaction before spraying.

Pavement surface hardness: Before any spray seal surface treatments, perform embedment test as follows:

- Method: To Austroads AG:PT/T251.
- Time of testing: Within 48 hours before application of sprayed seal.
- Embedment value allowance: Not more than 3 mm.

Defective pavement surface

Rectification: Do not start sprayed sealing work until defects in the pavement surface have been rectified.

Defects requiring rectification: Before starting sprayed sealing work, inspect for pavement defects that may adversely affect the quality of the finished work including the following:

- Excessive moisture in unbound granular base requiring priming or initial sealing.
- Loose, poorly bonded, or inadequately compacted materials in the surface of unbound granular base requiring priming or initial seal.
- Poorly shaped unbound granular base requiring priming or initial seal.
- Soft, fatty or bleeding patches in pavements requiring resealing.
- Uncured patching materials, crack sealing.
- Porous patches in surface requiring resealing.
- Significant variations in surface texture requiring corrective treatment before resealing.
- Inadequate repair of weak or cracked pavements.
- Inadequate curing of primed surfaces before sealing.
- Inadequate curing of initial seal pavements before resealing. Generally, allow minimum 12 months curing for cutback bitumen primer-seals.

Preparation of pavement surface

Surface preparation: Conform to the following:

- Before the application of primer, primer-seals or binder, sweep pavement surface with a rotary road broom or suction broom to provide a uniformly clean surface.
- If necessary, carry out further sweeping by hand, using stiff brooms.
- Extend sweeping at least 300 mm beyond the edge of each spraying area.
- If sealing work is carried out on localised areas and/or half pavement widths, remove any remaining loose material from the pavement surface immediately adjacent to the swept areas.
- Remove adherent patches of foreign material from the surface of the pavement.
- Remove raised pavement markers and replace with temporary markers.

Pavement temperature and weather conditions

Measure and record pavement temperatures: At regular intervals during the course of the work, using appropriate equipment and measurement procedures.

Pavement is partly in sun and partly in shade: Record the temperatures for both conditions. Use the lower recorded temperature as a basis for spraying and selection of cutter oil proportions requirements.

Primers, primer-seals and binders: Spray only if the pavement temperature, one hour before start of spraying and during the spraying period, conforms To **Pavement temperature table .**

Ambient temperatures: Do not spray below that recommended unless the risk of poor bitumen adhesion can be adequately managed through suitable type and proportion of cutter oil, traffic control, speed of aggregate covering, rolling and aftercare of completed work.

Pavement temperature table

Binder type	**Minimum pavement temperature (ºC)**	
	with cutter oil	**without cutter oil**
Hot bitumen	15	35
Polymer modified binder (1)	20	45(2)
Crumb rubber bitumen	20	45(2)
Bitumen emulsion	-	5
1 Does not apply to SAMI seals. 2 This will vary by binder type and could be as high as 65ºC in some cases.		

Selecting binders for maximum permissible vertical road gradients

Selection of binders: To the **Recommended maximum permissible gradients for various binders table**.

Recommended maximum permissible gradients for various binders table

Surfacing Binder Type	**Maximum gradient (%) (1)**
Hot bitumen	12
Hot cutback bitumen	10
Polymer modified binder	>12 (2)
Bitumen emulsion	8 (3)
Multigrade (M500)	12
1 The gradient will also depend to some extent on the existing surface texture and surface temperatures. 2 Depends on the PMB type and concentration. 3 Depends on the percentage of residual bitumen content, with higher residual bitumen content or polymer modified emulsions preferred for steeper grades.	

Surface condition

Wet pavement: Do not carry out spraying on a wet pavement, if rain appears imminent or during strong winds or dust storms.

Surfaces for priming: Surface dry, and no more than damp to the depth of pavement penetration.

Surfaces for initial sealing: Damp, but not wet. If necessary, lightly water the pavement surface shortly before applying the primer binder.

Surfaces for sealing: Dry and clean.

5.3 PREPARATION OF AGGREGATES

Precoating of aggregate

Requirement: Precoat aggregate to provide a complete, light, uniform, effective cover of all aggregate particles at the time of spreading.

Precoating for stockpile: Precoat at the quarry, or on site as follows:

- Bitumen based materials: Use a bitumen, flux oil/cutter oil and adhesion agent mixture or bitumen emulsion formulated for precoating aggregate materials so that a thin film of bitumen adheres to the aggregate.
- Curing period for bitumen/flux oil mixtures: One week before use.
- Precoated aggregates stockpiled for more than one month: Re-assess precoating effectiveness and determine if rejuvenation is required before use.
- Protection of stockpiles: Cover stockpiles to prevent dust settlement, moisture penetration or drying out of aggregate precoating.

Precoating for immediate use: Precoat on site as follows:

- Use bitumen/flux oil mixture, flux oil, flux oil/cutter oil mixture, cutter oil or bitumen emulsion specifically formulated for use as aggregate precoating material.
- Adhesion agent: Add 1% (by volume) of agent to oil based precoating materials if aggregates are damp or when the weather conditions are unfavourable, humid conditions or if rain is imminent.
- Field precoating of aggregates for immediate use: Do not carry out when rain is imminent. If aggregates have been precoated and rain appears imminent, adequately cover the aggregates to prevent the fresh precoating material being washed from the aggregate particles.

Application rate of precoating agent: Conform to the following:

- Application rate: Determine rate based on the **Typical precoating rates table**.
- Porous aggregates: Increase rates by up to 2 L/m^3 from the values in the **Typical precoating rates table**.
- Smooth, hard aggregates: Reduce by up to 2 L/m^3 from the values in the **Typical precoating rates table**.

Typical precoating rates table

Aggregate condition	**Precoating material (L/m^3)**	
	Bitumen based, including bitumen emulsions	Oil based
Clean	6 to 12	4 to 10
Dirty	8 to 14	6 to 12

5.4 PREPARATION OF BITUMEN BINDER

Adding cutter oil

Requirement: If cutter oil is required, add to binder in conformance with the following:

- Oil content:
  - Class 170 or 320 bitumen, multigrade binder: To the **Basic cutting practice for**
  - **Class 170 bitumen and multigrade binder table**.
  - Polymer modified binders: To the **Guide to cutting practice for PMBs for SAM and HSS applications table**.
- Temperature of binder when adding cutter oil: To the **Binder temperature table**.
- Moisture contamination: Make sure materials added to hot binder are free of moisture. Check materials considered at risk from moisture contamination, with a water-finding paste before use, for example, drummed materials stored in the open.
- Standard bitumen binders: Place the cutter oil into a sprayer that has not been previously heated, followed by the hot bitumen.
- Polymer modified bitumen binders, including crumb rubber binders: Place hot binder into the sprayer followed by the cutter oil.
- Circulating sprayer load: Circulate the sprayer load of cutback bitumen at a rate of not less than 700 litres/min (approximately 350 rpm) for minimum 20 minutes before spraying.

Returned cutback bitumen: If part of a sprayer load is not used on the day of mixing and needs to be returned to the heater tanks, place it in a tank reserved for that purpose. Do not add bitumen or cutter oil to the returned bitumen unless the tank is fitted with an effective circulation system. When the

returned bitumen is subsequently used as part of a sprayer load, make allowance for the cutter oil contained in the returned cutback bitumen mix to be used the next day.

Spraying temperature: To the **Cutback bitumen spraying temperature table.** Interpolate spraying temperatures for proportions of cutter oil between those shown in the table.

Basic cutting practice for Class 170 bitumen and multigrade binder table
(Parts by volume of cutter oil to be added to bitumen measured at 15°C).

	Aggregates of 10 mm nominal size or larger			**Aggregates of 7 mm nominal size or smaller**		
Pavement temperature (°C)	**Traffic (vehicles/lane/day)**			**Traffic (vehicles/lane/day)**		
	< 100	**100 – 1500**	**> 1500**	**< 100**	**100 – 1500**	**> 1500**
15 – 19	10	8	6	12	10	8
20 – 25	8	6	4	10	8	6
26 – 32	6	4	2	8	6	4
33 – 38	4	2	0	6	4	2
39 – 45	2	0	0	4	2	0
> 45	0	0	0	2	0	0

Notes:
1. Rates are based on fine, stable weather conditions and active, freshly applied or partially dried oil or bitumen precoating.
2. For dry or inactive precoating, add 2 parts except for heavy traffic and high pavement temperatures.
3. For damp aggregates, add 2 parts, except for heavy traffic and high pavement temperatures.
4. For periods of falling temperatures, add 2 parts or up to 4 parts if very cold overnight temperatures are expected to follow.
5. Add a further 2 parts of cutter oil for pavement temperatures below 15°C, provided that sprayed sealing work should not be carried out at temperatures below 10°C.
6. Subtract 5°C from measured pavement temperature for wind chill and fresh breeze. Cease spraying in strong winds.
7. In double/double seals, where the second application is to be applied the same day, or without any significant period of trafficking, it is undesirable to include any cutter oil in the first binder application. If cutter oil is considered necessary, it should be a maximum of 2 parts.
8. If cutter proportions are added as percentage of total binder, the proportions shown here as parts per 100 parts of bitumen may be taken as a reasonable approximation of percentage by volume.
9. If pavements are not intended to carry normal design traffic for a period of time after sealing, the proportion of cutter oil may be varied to reflect the conditions likely to prevail at the time of opening to traffic.
10. Traffic volume.

Guide to cutting practice for PMBs used in for SAM and HSS applications [1, 2] table

(Parts by volume of cutter oil to be added to 100 parts by volume of PMB-measured at 15°C)[4]

Pavement temperature[5] (°C)	**Traffic**	**Class of PMB (1)**			
		S15E (2)	**S20E (2) S25E**	**S35E (2)**	**S45R (2) S15RF[6,7]**
20 to 25	< 1000 ≥ 1000	6 - 8 6	8 6 - 8	6 4	10 8
26 to 32	< 1000 ≥ 1000	4 - 6 4	6 4 - 6	4 2	8 - 10 6 - 8
33 to 38	< 1000 ≥ 1000	4 2	4 - 5 3 - 4	2 2	6 - 8 6

Pavement temperature[5] (°C)	**Traffic**	**Class of PMB [(1)]**			
		S15E [(2)]	**S20E [(2)] S25E**	**S35E [(2)]**	**S45R [(2)] S15RF[6,7]**
39 to 45	< 1000 ≥ 1000	Min 2	Min 3	0 - 2	4 - 6 4 - 6
> 45	All	Min 2	Min 3	0 - 2	Min 4

Notes:
1. Sealing grade of PMB to Austroads AGPT04F Table 6.1.
2. In SAMI applications, if the seal is to be covered by asphalt within a short period, it is undesirable to include any cutter oil. If cutter oil is considered necessary, include a maximum of 2 parts of cutter oil to 100 parts of PMB. Similar provisions apply to the first binder application of a double/double seal if the second application is to follow the same day, or within a short period.
3. In aggregate retention applications using lower levels of polymer modification, i.e. S10E, and some proprietary blends of PBD, cut back binder as per normal Class 170 bitumen.
4. If cutter proportions are added as percentage of total binder, take the proportions documented as parts per 100 parts of PMB as a reasonable approximation of percentage by volume.
5. Base pavement temperature on the worst condition, i.e. shaded areas.
6. Pre-blended crumb rubber grades can contain process oil used in their manufacture. This oil will reduce the viscosity compared to field blended grades, and allow a small reduction, say 2 parts, in added cutter oil compared to field produced grades.
7. At high rates of application of binder (e.g. higher than 2 L/m^2) the proportion of cutter oil can be reduced by 2 parts.

Binder temperature table

Binder type	**Temperatures for adding cutter oil (°C)**
Bitumen Class 170, Multigrade 600/170	160 - 180
Bitumen Class 320	170 - 190
PMB	Within a range of 10°C below the maximum recommended application temperature.

Cutback bitumen spraying temperature table

AS grade (if applicable)	**Viscosity at 60°C (Pa.s)**	**Equivalent cutter oil content (%)**	**Temperature range (°C)**
AMC 00	0.008-0.016	56	ambient
AMC 0	0.025-0.05	44	35 – 55
AMC 1	0.06-0.12	34	60 – 80
AMC 2	0.22-0.44	27	75 – 100
AMC 3	0.55-1.1	21	95 – 115
AMC 4	2.0-4.0	16	110 – 135
AMC 5	5.5-11	11	120 – 150
		9	130 – 155
AMC 6	13.0-26.0	7	135 – 160
		5	145 – 170
AMC 7	43.0-86.0	3	155 – 180
		2	150 – 175

Adding flux oil

Requirement: If flux oil is required, add oil to binder in conformance with the following:

- Moisture content: Make sure flux oil added to hot binder is free of moisture.
- Circulating sprayer load: Add flux oil to the bitumen in the sprayer and circulate the mixture at a rate not less than 700 litres/min for 20 minutes before spraying.

Adding bitumen adhesion agent

Requirement: If bitumen adhesion agent is required, add oil to bitumen in conformance with the following:

- Circulating sprayer load: Add adhesion agent to the bitumen in the sprayer after adding the last component. Circulate the mixture at a rate of not less than 700 litres/min for 20 minutes, before spraying.
- Bitumen containing adhesion agent: If not used within 8 hours of mixing agent with hot bitumen, disregard the active contribution of adhesion agent in subsequent use of the bitumen material. Make allowance for the oil component of the adhesion agent in the returned bitumen.

5.5 APPLICATION OF PRIMER, PRIMER-SEALS AND BINDER

Primer and primer-seals

Class and grade of primer and primer-seals: To **ANNEXURE – SCHEDULE OF JOB DETAILS**.

Application rate of primer-seals: To Austroads AGPT04K Table 4.3.

Temperature at mixing and spraying: Measure application rates and quantities of primer and primer-seals applied to the mixture at 15 degrees C, including cutter oil or water content of the bitumen emulsion.

Primer drying period: At least 72 hours after applying primer. If required, allow additional time for the primer to dry completely before applying binder for seals.

Traffic restrictions: Conform to the following:

- Keep all traffic off the primed surface.
- If limited traffic access is required to the primed surface, apply a light layer of grit on the surface to avoid pickup. Do not apply gritting until a substantial proportion of the primer has been absorbed into the pavement.

Binder

Class or type of bitumen: To the **ANNEXURE – SCHEDULE OF JOB DETAILS**, including for modified bitumen, cutback bitumen or bitumen emulsion.

Application rate and binder quantity: Allow as follows:

- Base rates on bitumen volume measured at 15 degrees C, not including adhesion agent, cutter oil or water content of emulsions.
- If flux oil has been added to the bitumen, include flux oil quantity as part of the binder.
- If adhesion agent and/or cutter oil has been added to the binder, adjust the binder application rate at 15 degrees C to suit the adhesion agent and oil content in the mixture.

Forward speed of bitumen sprayer: Determine speed based on either of the following:

- Hot application rate of total binder: Including adhesion agent and/or cutter oil.
- Temperature and adhesion agent and cutter oil content, measured at 15 degrees C.

Volume correction factors: Convert the volume of bituminous binders from 15°C to elevated temperatures, or from elevated temperatures back to 15 degrees C to the **Volume conversion for bitumen table** or **Volume conversion for bitumen emulsion table.**

Volume conversion for bitumen* table

Multiply by "A" to reduce volume at T°C to volume at 15°C Multiply by "B" to increase volume at 15°C to volume at T°C					
A	**Temp. (T °C)**	**B**	**A**	**Temp. (T °C)**	**B**
0.9856	38	1.0146	**0.9356**	**120**	**1.0688**
0.9844	**40**	**1.0158**	0.9344	122	1.0702
0.9831	42	1.0172	0.9332	124	1.0716
0.9819	44	1.0184	0.9320	126	1.0730
0.9806	46	1.0198	0.9308	128	1.0743
0.9794	48	1.0210	**0.9296**	**130**	**1.0757**
0.9782	**50**	**1.0223**	0.9284	132	1.0771
0.9769	52	1.0236	0.9272	134	1.0785
0.9757	54	1.0249	0.9260	136	1.0799
0.9745	56	1.0262	0.9249	138	1.0812
0.9732	58	1.0275	**0.9237**	**140**	**1.0826**
0.9720	**60**	**1.0288**	0.9225	142	1.0840
0.9708	62	1.0301	0.9213	144	1.0854
0.9695	64	1.0315	0.9201	146	1.0868
0.9683	66	1.0327	0.9189	148	1.0883
0.9671	68	1.0340	**0.9178**	**150**	**1.0896**
0.9659	**70**	**1.0353**	0.9166	152	1.0910
0.9646	72	1.0367	0.9154	154	1.0924
0.9634	74	1.0380	0.9142	156	1.0939
0.9622	76	1.0393	0.9130	158	1.0953
0.9610	78	1.0406	**0.9119**	**160**	**1.0966**
0.9597	**80**	**1.0420**	0.9107	162	1.0981
0.9585	82	1.0433	0.9095	164	1.0995
0.9573	84	1.0446	0.9084	166	1.1009
0.9561	86	1.0459	0.9072	168	1.1023
0.9549	88	1.0472	**0.9060**	**170**	**1.1038**
0.9537	**90**	**1.0486**	0.9049	172	1.1051
0.9524	92	1.0500	0.9037	174	1.1066
0.9512	94	1.0513	0.9025	176	1.1080
0.9500	96	1.0526	0.9014	178	1.1094
0.9488	98	1.0540	**0.9002**	**180**	**1.1109**
0.9476	**100**	**1.0553**	0.8990	182	1.1123
0.9464	102	1.0566	0.8979	184	1.1137
0.9452	104	1.0580	0.8967	186	1.1152
0.9440	106	1.0593	0.8956	188	1.1166
0.9428	108	1.0607	**0.8944**	**190**	**1.1181**
0.9416	**110**	**1.0620**	0.8933	192	1.1195
0.9404	112	1.0634	0.8921	194	1.1209
0.9392	114	1.0647	0.8909	196	1.1224
0.9380	116	1.0661	0.8898	198	1.1239
0.9368	118	1.0675	**0.8886**	**200**	**1.1253**
*Including for cutback bitumen					

Volume conversion for bitumen emulsion table.

Hot litres x A = Cold litres (at 15°C) Cold litres x B = Hot litres (T°C)								
60% bitumen emulsion			**70% bitumen emulsion**			**80% bitumen emulsion**		
A	**Temp. (T°C)**	**B**	**A**	**Temp. (T °C)**	**B**	**A**	**Temp. (T °C)**	**B**

Hot litres x A = Cold litres (at 15°C) **Cold litres x B = Hot litres (T°C)**								
1.0000 0.9998 0.9989 **0.9980**	15 16 18 **20**	1.0000 1.0002 1.0011 **1.0020**	1.0000 **0.9977** 0.9951 **0.9924**	15 **20** 25 **30**	1.0000 **1.0023** 1.0049 **1.0076**	1.0000 **0.9974** 0.9948 **0.9921**	15 **20** 25 **30**	1.0000 **1.0026** 1.0052 **1.0079**
0.9971 0.9962 0.9953 0.9944 **0.9935**	22 24 26 28 **30**	1.0029 1.0038 1.0047 1.0056 **1.0065**	0.9899 0.9872 0.9840 0.9830 **0.9819**	35 40 46 48 **50**	1.0102 1.0129 1.0162 1.0172 **1.0184**	0.9895 0.9868 0.9837 0.9826 **0.9816**	35 40 46 48 **50**	1.0106 1.0134 1.0166 1.0177 **1.0187**
0.9926 0.9917 0.9908 0.9899 **0.9890**	32 34 36 38 **40**	1.0074 1.0083 1.0092 1.0102 **1.0111**	0.9809 0.9798 0.9788 0.9777 **0.9767**	52 54 56 58 **60**	1.0194 1.0206 1.0216 1.0228 **1.0238**	0.9805 0.9794 0.9783 0.9773 **0.9762**	52 54 56 58 **60**	1.0199 1.0210 1.0222 1.0232 **1.0244**
0.9881 0.9872 0.9863 0.9854 **0.9845**	42 44 46 48 **50**	1.0120 1.0129 1.0138 1.0148 **1.0157**	0.9752 0.9746 0.9736 0.9725 **0.9715**	62 64 66 68 **70**	1.0254 1.0260 1.0271 1.0282 **1.0293**	0.9751 0.9740 0.9730 0.9719 **0.9709**	62 64 66 68 **70**	1.0255 1.0267 1.0277 1.0289 **1.0300**
0.9836 0.9827 0.9818 0.9809 **0.9800**	52 54 56 58 **60**	1.0166 1.0176 1.0185 1.0194 **1.0204**	0.9704 0.9693 0.9683 0.9672 **0.9662**	72 74 76 78 **80**	1.0305 1.0316 1.0327 1.0339 **1.0349**	0.9698 0.9687 0.9677 0.9667 **0.9656**	72 74 76 78 **80**	1.0311 1.0323 1.0334 1.0344 **1.0356**
0.9791 0.9782 0.9773 0.9764 **0.9755**	62 64 66 68 **70**	1.0213 1.0222 1.0232 1.0241 **1.0251**	0.9651 0.9640 0.9630 0.9619 **0.9608**	82 84 86 88 **90**	1.0361 1.0373 1.0384 1.0396 **1.0407**	0.9643 0.9630 0.9616 0.9603 **0.9590**	82 84 86 88 **90**	1.0370 1.0384 1.0399 1.0413 **1.0427**

5.6 APPLICATION OF SPRAYED BITUMINOUS SURFACING

Plant and equipment

Spraying: Use a mechanical sprayer to apply primer, primer-seals and binder.

- Use a mechanical sprayer to apply primer, primer-seals and binder.
- A current sprayer certificate issued by a registered testing authority.

Spray nozzles: Use nozzles which conform to the following:

- Make and type endorsed on the sprayer certificate.
- Nozzles types used on the spray bar of the sprayer: Compatible with the nature of the binder type to be sprayed and its application rate.
- Replace damaged, or unduly worn or defective nozzles.

Aggregate spreading equipment: Use mechanical spreader capable of achieving a uniform spread rate.

Rollers: Use rollers that conform to the following:

- Pneumatic tyred multi-wheel rollers: With a minimum mass of 7 tonnes mass, smooth tyres and a minimum tyre pressure of 550 kPa.
- Combination rollers: With a rubber coated, vibratory drum on one axle and pneumatic tyres on the other.

- Capable of achieving effective incorporation of incorporating aggregates into the binder without breaking breakdown or crushing of the cover aggregates.

Non-conforming plant: Remove plant or equipment not fully operational or not capable of carrying out the works in conformance with this work-section.

Spraying area

Extent of spray run: Limit the spraying area to that can be covered with aggregates within 15 minutes of spraying.

Adjacent longitudinal spray runs

Where overlap is not required: Use special type end nozzles or intermediate nozzles set with a jig as end nozzles.

Where an overlap is required: Provide the following overlaps between adjacent longitudinal runs:

- Overlap of spray between adjacent longitudinal runs: 50 mm.
- For special type end nozzles or jig set intermediate nozzles: 50 mm.
- Overlap of adjacent longitudinal sprays if for intermediate nozzles set in the normal manner: 300 mm.

Spraying operation

Procedure: Spray primer, primer-seals or binder onto surface as follows:

- Start of spraying: Start spraying for each sprayer run on a protective strip of heavy paper laid across and held securely to the pavement surface.
- Sprayer movement: Start moving the sprayer at a sufficient distance in advance of the protective strip to attain the road speed for correct application.
- Road speed: Maintain a constant road speed throughout the length of each sprayer run.
- End of sprayer run: Terminate each spraying run on protective paper laid across and held securely to the pavement surface beforehand.
- Hand spraying: If required, use hand spray equipment attached to the sprayer for small areas or areas of irregular shape.
- After each sprayer run: Check the quantity of binder sprayed against the area covered. If the actual application rate is not within the required limits, adjust to achieve the required target application rate in subsequent runs.

Defective equipment: Cease spraying immediately if any defect develops in the spraying equipment. Rectify the fault before further spraying.

Blockages: If any nozzle blockages occur, cease spraying immediately. Do not recommence spraying until the cause of the blockage is identified and rectified.

Non-conforming sprayed areas: Areas not within 5% of the required application rate.

Temperature

Bituminous material temperature: If the temperature is below the lower limits in the **Binder temperature table** or **Cutback bitumen spraying temperature table,** heat the bituminous material to Austroads AP-G41 Section 7.

Geotextile

Placing geotextile: If required in the **ANNEXURE – SCHEDULE OF JOB DETAILS**, place geotextile as follows:

- Use a purpose-built geotextile fabric spreading device.
- Fix the geotextile to the pavement smoothly and without wrinkles, using a tack coat of up to 0.8 L/m^2 (residual) of Class 170 bitumen.

- Rate of application of tack coat application rate: Included in, and not additional to, the overall design binder application rate for the geotextile reinforced seal (including allowances for surface texture and absorption by the fabric).

Joints: Overlap minimum 200 mm or butt joint to **ANNEXURE – SCHEDULE OF JOB DETAILS**.

Longitudinal joints: Do not place in wheel paths.

5.7 AGGREGATE SPREADING AND ROLLING

Spreading

Spreading time: Spread aggregates as soon as practicable after binder spraying has commenced and complete within 15 minutes of spraying.

Spreader calibration: Calibrate spreader as follows:

- To Austroads AG:PT/T537, with using aggregates from the stockpile to be used for the work.
- Calibrate off-road.
- Calibration site: With sufficient length to allow the aggregate spreader to reach normal operational speed before applying the aggregates.
- Calibrate the total width of the aggregate spreader.
- Spreading process: Spread aggregate as follows:
  - . Application: Apply the required sized aggregates at the required application rate.
  - . Aggregate quantity: Make sure there are sufficiently loaded trucks at the site to provide full cover for the sprayed area.
  - . Coverage: Spread the aggregates over the sprayed area uniformly with a mechanical spreader.
  - . Bare or insufficiently covered areas: Re-run with a mechanical spreader or cover by hand to provide uniform and complete coverage.
  - . Localised excess aggregates: Remove any local excess of aggregate before rolling.

Rolling

Rolling process: Roll areas covered with aggregates as follows:

- Rollers and rolling area: Supply sufficient pneumatic tyred multi-wheel rollers to cover the sprayed areas to the **Area that can be effectively rolled table**.
- Rolling time: Schedule rolling times Allow adequate time at the end of the day's work so that the last materials spread for each day receives the same amount of rolling as that placed earlier in the day.
- Initial rolling: Carry out after the aggregates are applied to each work section with one or more rollers. Continue initial rolling until the aggregates is are firmly adhered to the primer-seals or binder.
- Rolling period: Reduce the amount of rolling while the aggregate is wet, but resume normal rolling as soon as aggregate dries. Avoid trafficking during this period, or keep to a minimum speed, until aggregate has dried sufficiently adhered.
- Unevenly distributed aggregate: If the aggregates are not evenly distributed over the pavement surface, traverse the surface with a light drag broom after the initial rolling, without dislodging aggregate particles bedded in the primer-seals or binder.
- If drag brooming is not used: Substitute with light hand brooming.
- Carry out back rolling until the total sprayed area achieves the roller hours to the **Area that can be effectively rolled table**.
- After adhesion: After the aggregates have been evenly distributed and are adhered to the binder, remove any remaining loose aggregate particles from the pavement.

Area that can be effectively rolled table[2]

Aggregate size (mm)	**Traffic Volume (vehicles per lane per day)**		
	< 300 v/l/d (1)	**300 – 1200 v/l/d (1)**	**> 1200 v/l/d (1)**
	Rolling rate (m^2/roller hour)		
7 or smaller	4500 – 5000	5000 – 5500	5500 – 6000

Aggregate size (mm)	**Traffic Volume (vehicles per lane per day)**		
	< 300 v/l/d (1)	**300 – 1200 v/l/d (1)**	**> 1200 v/l/d (1)**
	Rolling rate (m^2/roller hour)		
10	3000 – 3500	3500 – 4000	4500 – 5000
14	2500 – 3000	3000 – 3500	3500 – 4000
Note: 1. Traffic volume. 2. Area that can be rolled, per hour, with each pneumatic tyred multi-wheel roller.			

Spreading and rolling variations for different seal types

Single/single seals: Apply a single application of aggregates on a single application of binder, roll the seal and, if required, light hand or drag broom.

Single/double seals: Apply the second application of aggregates after initial rolling of the first application, and before final rolling and trafficking.

Double/double seals:

- Binder and aggregates are applied on the same day: Complete the first application as a single/single seal. Reduce the aggregate application by 10% of that required for a single/single seal. Apply the second binder application of binder, followed by a second aggregate application, at a rate required to fill the voids. Roll and remove any remaining loose aggregates.
- Bitumen as the binder in the first application: Do not apply the second binder until the binder in the first coat is completely broken to form a stable seal.
- Trafficking the first application: Allow trafficking for a period not exceeding several weeks. Complete the first application as a single/single seal and reduce the aggregates in the second application by 30% to fill the voids from the first application.
- Second application applied after a significant period of trafficking: Complete both applications as single/single seals.
- Other occasionally trafficked facilities: Allow for an in-service follow-up rolling after 12 months in warm conditions.

5.8 PERFORMANCE

Bituminous surfaces

Completed surface: Make sure the complete surface conforms to Austroads AGPT04K and the following:

- Generally: The work has clean, straight edges and no obvious defects related to poorly constructed longitudinal or transverse joints, blocked spray nozzles or any other construction fault.
- Cured primes: Have a uniform appearance.
- Primer-seals and single/single seals with maximum 7 mm aggregates: Have a uniform surface and retains a matrix of aggregates.
- Single/single seals with minimum 10 mm aggregates: Have a uniform, single retained layer of aggregate.
- Single/double seals: Have a uniform layer of retained aggregate with both sizes fitting together to produce a uniform surface texture.
- Double/double seals: Have uniform double retained layers of aggregate with the second layer of aggregate fitting inside the texture of the aggregate used in the first layer.

5.9 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE – MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Laboratory testing

Requirements: Test the properties required by the work-section as follows:

- Perform in a NATA accredited laboratory (for the required test method) in conformance with procedures required by the relevant Austroads Test Method or Australian Standard.
- If there is no applicable Australian Standard or Austroads Test Method or if the Standard or Test Method provides a choice of procedures, adopt a procedure endorsed by the state road authority where the work is undertaken.

Exceptions: Requirements for NATA accredited laboratories do not apply to field tests such as surface texture measurements or aggregate spreader calibration. These may be completed by a competent, trained personnel.

5.10 REMOVAL OF LOOSE AGGREGATES

Loose aggregate particles removal

Surface of seals with minimum 10 mm aggregates: After final sweeping and before the removal of speed restriction and warning signs, make sure the number of loose aggregate particles remaining on the surface do not to exceed the values in the **Limits for loose stone particles remaining after sweeping table**.

Aggregate windrows: Remove any windrows on the sealed surface or shoulder that may be a traffic hazard. If required, remove all surplus aggregates.

Timing: Complete the removal from the trafficked pavement to the **Time limit for removal of loose aggregate table**.

Limits for loose stone particles remaining after sweeping table

Road type	**Maximum loose stones (particles/m^2)**
Urban areas	20
Other medium to high traffic (> 250 v/l/d)	30
Low traffic (< 250 v/l/d)	40

Time limit for removal of loose aggregates table

Traffic volume	**Maximum time limit**
> 2000 and all freeways	Within 8 hours of sealing
1000 to 2000	Within 24 hours of sealing
250 to 1000	Within 48 hours of sealing
< 250	Within 5 days of sealing

5.11 SAFETY AND PROTECTION

Newly completed surfacing

Warning signs: Provide signage to protect the public as follows:

- Provide signs and temporary raised pavement markers to warn the public of loose stones and absence of linemarkings.
- Maintain signs until loose aggregates have been removed and linemarkings are reinstated.

Services and fixtures adjacent to the surfacing area

Protection: Take precautions to prevent the primer, primer-seals, binder, aggregates or other materials used on the work from entering or adhering to gratings, hydrants, valve boxes, manhole covers, bridges, culvert decks and other road fixtures.

Cleaning: Immediately after spreading aggregates, clean off or remove any sprayed material on the services and/or road fixtures. Leave in a condition equivalent to that before spraying.

Defects liability period

Responsibility: Protect the new work and correct any defects occurring within the defects liability period with the exception of damage caused by accident and other events outside the control of the contractor.

5.12 REMOVAL OF SURPLUS AND WASTE MATERIALS

Final cleaning

Completion: Before leaving the work site, uncover and clean all services. Remove from site all waste from the sprayed sealing operations, including paper. Clean the stockpile sites and store any excess material in a tidy heap or remove, if required.

Disposal

Special requirements: For disposal of surplus aggregate at stockpile sites specify additional requirements or include in the **ANNEXURE - SCHEDULE OF JOB DETAILS**.

5.13 NON-CONFORMANCE

General

Non-conforming works: Provide remedial treatment as directed to provide the required level of service.
Annexures

6 ANNEXURES

6.1 ANNEXURE – PROJECT REQUIREMENTS

Definition of project requirements

Schedule of job: Take the following actions to prepare the **ANNEXURE - SCHEDULE OF JOB DETAILS** and schedule of rates:

- Define scope of work. In addition to a description of location, the limits of work should also be clearly marked on the road pavement.
- Define type of sprayed seal treatment.
- Define aggregate class and minimum PSV or PAFV, if required.
- Define binder type or grade.
- Include details of traffic for design purposes.
- Include any special design requirements, if applicable.
- Prepare and insert special clauses for submission of sprayed seal design details in advance of sprayed sealing work, if applicable.
- Prepare price schedule based on the scope of work and method of measurement and payment.
- Prepare a schedule for sites available for the stockpiling of aggregates, if applicable.
- Prepare and insert special clauses for removal of loose aggregate by suction broom, if applicable.
- Prepare and insert special clauses for reinstatement of line marking, if applicable.
- Prepare and insert clauses for any other special job requirements, if applicable.

6.2 ANNEXURE – SCHEDULE OF JOB DETAILS

Item	Road name	Location			Approx. length (m)	Approx. width (m)	Approx. area (m^2)	Treatment			Aggregate			Traffic		Estimated rates of application		Other requirements [11]
		Map ref. [1]	Chainage	Distance markers or ref. points				Type [2]	Description [3]	Application [4]	Size(s)	Min. class [5]	Min. PSV/PAFV [6]	v/l/d [7]	Heavy veh. (%) [8]	Binder (L/m^2) [9]	Aggregates (m^2/m^3) [10]	

Notes:
1. Map references: Nominate directory used.
2. Treatment type: Prime only (PO), Primer-seal (PS), Prime and seal (P&S), Reseal (R).
3. Treatment description: Strain alleviating membrane (SAM), Strain alleviating membrane interlayer (SAMI), Geotextile reinforced seal (GRS), Surface enrichment (SE).
4. Number of applications: Single/single (S/S), Single/double (S/D), Double/double (both immediate) $(D/D)_i$, Double/double (delayed second) $(D/D)_d$.
5. Aggregate Class: A, B or C (AS 2758.2).
6. Aggregates PSV or PAFV: Generally, 48 for Class A aggregates.
7. Vehicle/lane/day (v/l/d): Use design traffic calculation methods included in Austroads AGPT04K or Austroads AP-T310.
8. % Heavy vehicles: Percentage of AADT that are counted as heavy vehicles.
9. Estimated binder application rate: For tendering purposes only, actual rates to be determined after measuring surface and aggregate properties.
10. Estimated aggregate spread rate: For tendering purposes only, actual rates to be determined after measuring of aggregate ALD.
11. Other requirements: May include job specific requirements such as binder type or surface pre-treatment

6.3 ANNEXURE – SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Products and materials Mix design – Type and source of constituent materials; Test certificates	H	Documentation on material type, source and test certificates as evidence of conformance for each constituent.	3 weeks before commencement	Spray sealing
SUBMISSIONS, Execution details Sprayed seal design	H	Sprayed seal design details	2 weeks before commencement	Spray sealing
SUBMISSIONS, Records Plant and equipment	H	Evidence of plant and equipment registration and insurance	2 weeks before using plant	Spray sealing
INSPECTIONS, Notice Surface preparation	H W for dried back moisture	Completed preparation and rectification of pavement surface defects. Contractor supplied test certificates for died back moisture % prior to sealing.	2 days before spraying surfacing	Spraying of primer, primer-seals or binder
INSPECTIONS, Notice Primer/binder application	H	Completed sprayed surface	2 days before spreading aggregate	Aggregate spreading
INSPECTIONS, Notice Aggregate spreading and rolling	H	Completed rolled surface with linemarkings, services fixtures and warning signs cleaned and in place	1 day before inspection	Opening to traffic
INSPECTIONS, Notice Non-conforming sections	W	Completed remedial treatment of non-conforming sections.	1 day before the inspection	Linemarking application and opening to traffic
SUBMISSIONS, Records Work-as-executed documentation (WAE)	-	Drawings and documents of final completed works. Contractor to provide Schedule 6.2 Schedule of job details of WAE. One design file in accordance with the ADAC specification,	On completion	Materials actually used.

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
		which is available on Council's website.		
*H = Hold Point, W = Witness Point				

6.4 ANNEXURE – MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Sprayed bituminous surfacing table

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Materials supply	Material quality – Supplier's documentary evidence and certification of:			
	- Standard classes of bitumen	1 tanker load	1 per tanker load	AS 2008
	- Multigrade bitumen	1 tanker load	1 per tanker load	AS 2008
	- Polymer modified binder	1 tanker load	1 per tanker load	Austroads AG:PT/T190
	- Bitumen emulsion	1 tanker load	1 per tanker load	AS 1160
	- Cutback bitumen	1 tanker load	1 per tanker load	AS 2157
	- Adhesion agent	1 delivery	1 per delivery	
	- Cutter oil and flux oil	1 delivery/ tanker	1 per delivery/tanker	AS 3568
	- Aggregate precoating material	1 delivery/ tanker	1 per delivery/ tanker	
	- Aggregate	1 contract	1 per 400 m^3	AS 2758.2
	. Flakiness index			AS 1141.15
	. ALD for 5 mm and 7 mm aggregate			AS 1141.20.2
	. ALD for 10 mm or larger aggregate			AS 1141.20.1
	- Protective paper	1 contract	1 per sprayer run	
	- Geotextile	1 contract	1 per roll	Austroads AP-T37
Pavement surface hardness	Embedment value allowance	2,000 m^2	10 per 200 lin. m	Austroads AG:PT/T251
Application rates	Binder	1 day's operation	Calculate per spray run	

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
	Aggregates	1 day's operation	Calculate per spray run	
* Note: or part thereof, per lot				

6.5 ANNEXURE – PAY ITEMS

The two options of measurement by area or length or measurement of actual quantities are used.

Measurement by area or length table

Pay Items	Unit of measurement	Schedule rate scope
1143.1 Priming, primer-sealing or sealing	Area - m²	No deductions for openings not exceeding 1 m² each. All costs associated with priming, initial sealing or sealing.
1143.2 Removal and disposal of existing raised pavement markers	Measured by length in kilometres	
1143.3 Traffic management	Lump sum	To *1101 Traffic management*.

Measurement by quantity of material supplied table

Pay items	Unit of measurement	Schedule rate scope
1143.4 Supply and spray primer or primer binder (including preparation of surface) at 15°C	Litres Determine the quantities (in litres) by either: - Multiplying the target application rate of the combined primer or primer-seals mixture of primer or primer-seals (including any cutter or flux oil) at 15°C (in litres/m2) by the area of road surface sprayed for each sprayer run (in m²); or - Measurement of actual volume (at 15°C) of materials used.	All costs associated with the surface preparation and supply and spray of primer or primer-binder
1143.5 Supply and spray binder (including adhesion agent where required, and surface preparation at 15°C	Litres Determine the quantities (in litres) by either: - Multiplying the target application rate of the residual (excluding any cutter oil or flux oil) at 15°C (in litres/m^2) by the area of road surface sprayed for each sprayer run (in m2); or - Measurement of actual volume (at 15°C) of materials used.	All costs associated with the supply and spray of binder.
1143.6 Supply, incorporate and spray cutter oil, flux oil and adhesion agent in binder	Litre Determine the quantities from either:	All costs associated with the supply of cutter oil, flux oil and adhesion agent in the binder.

Pay items	Unit of measurement	Schedule rate scope
at ambient temperature or 15°C	- The target proportion of cutter, oil flux oil, or adhesion agent added to the binder; or - Measurement of actual volume of materials used.	
1143.7 Supply, precoat, apply aggregates	m^3 - Volume. - Determine the quantity of aggregates (in m^3) by dividing the area of road surface covered by each sprayer run (in m^2) by the target application rate (in m^2/m^3)	All costs associated with the supply, precoat and application of aggregates
1143.8 Roll and incorporate aggregates	m^2	All costs associated with the rolling of aggregates
1143.9 Supply and place geotextile	m^2 Pavement area covered - m^2	All costs associated with the supply and placement of geotextile to exclude laps and application of binder and aggregates.
1143.10 Sweeping	m^2	All costs associated with sweeping before and after sealing

Non-conformance

Requirement: Apply the following if the work or materials supplied are not within the documented requirements:

- Offset the reduced service life arising from the non-conformance by reducing payment for the non-conforming portion of work or material by the method defined in **ANNEXURE – SCHEDULE OF JOB DETAILS**.
- Any other remedial treatment that is expected to provide the required level of service.

6.6 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1141.15	1999	Methods for sampling and testing aggregates- Flakiness index
AS 1141.20.1	2000	Average least dimension - Direct measurement (nominal size 10mm and greater)
AS 1141.20.2	2000	Average least dimension - Direct measurement (nominal sizes 5mm and 7 mm)
AS 1160	1996	Bitumen emulsions for construction and maintenance of pavements
AS 2008	2013	Bitumen for pavements
AS 2157	1997	Cutback bitumen
AS 2758		Aggregates and rock for engineering purposes
AS 2758.2	2009	Aggregate for sprayed bituminous surfacing
AS 3568	1999	Oils for reducing the viscosity of residual bitumen for pavements
AAPA Advisory Note 7	2013	Guide to the heating and storage of binders for sprayed sealing
ARRB	2018	High friction surface guide to good practice.
Austroads AGPT		Guide to pavement technology
Austroads AGPT04F	2017	Bituminous binders
Austroads AGPT04K	2018	Selection and Design of Sprayed Seals

Austroads AGPT08	2009	Pavement Construction
Austroads AG:PT/T190	2014	Specification framework for polymer modified binders
Austroads AG:PT/T251	2010	Ball penetration test
Austroads AG:PT/T537	2005	Field spread rate of cover aggregate
Austroads AP-C87	2015	Austroads glossary of terms. 2015 edition.
Austroads AP-G41	2015	Bituminous materials safety guide
Austroads AP-T310	2016	Selection and design of initial treatments for sprayed seal surfacings
Austroads AP-T37	2005	Geotextile reinforced seals.
Austroads AP-T236	2013	Update of double/double design for Austroads sprayed seal design method
NATSPEC GEN 025	2017	Sprayed preservation surfacing treatments

1144 ASPHALT (ROADWAYS)

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide asphalt for roadways and related pavement applications, as documented.

1.2 PRECEDENCE

General

Schedule of job details: If there are conflicts between the requirements of this work-section and the **ANNEXURE - SCHEDULE OF JOB DETAILS**, the requirements of the **ANNEXURE - SCHEDULE OF JOB DETAILS** apply.

1.3 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.
- *1141 Flexible pavement base and subbase.*
- *1143 Sprayed bituminous surfacing.*

1.4 STANDARDS

General

Asphalt: To Austroads AGPT04B.

Flexible pavements: To Austroads AGPT02 clause 3.15.

Asphalt pavement surfacing: To Austroads AGPT03 Section 5.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the abbreviations given below apply:

- DGA: Dense graded asphalt.
- FGGA: Fine gap graded asphalt.
- ITP: Inspection test plan
- LTA: Light traffic asphalt.
- OGA: Open graded asphalt.
- PAFV: Polished aggregate friction value.
- PMB: Polymer modified binder.
- RAP: Reclaimed asphalt pavement.
- SMA: Stone mastic asphalt.
- UTA: Ultra-thin asphalt.

Definitions

General: For the purpose of this work-section the definitions in Austroads AP-C87 and the following definitions apply:

- Added filler: Mineral matter, suitable for use in asphalt – at least 75% of which is finer than 75 µm and all of which is finer that 600 µm – which is added to the combined aggregate of an asphalt mix.

Typical materials include hydrated lime, flyash, cement, cement works flue dust, ground limestone and rock dust other than that which occurs as a natural component of the combined aggregate.

- Anionic bitumen emulsion: A binder material in which the suspended particles are negatively charged.
- Cationic bitumen emulsion: A binder material in which the suspended particles are positively charged.
- Coarse aggregate: A general term for aggregates substantially retained on a sieve of specified size, commonly 4.75 mm.
- Fine aggregate: A general term for aggregate that substantially passes the 4.75 mm.
- Mineral filler: A fine material, the majority of which passes a 75 µm sieve, derived from aggregate or other similar granular material.
- Mix design: The designed portion of constituent materials comprising the type and source of components, target grading, binder content and volumetric properties of the mix.
- Production mix: Mix produced in the plant and delivered to the site in a workable condition suitable for stockpiling, spreading and compaction.

1.6 TOLERANCES

Level

Each course of asphalt: ± 10 mm.

Wearing course placed against kerb and channel: ≤ 5 mm above the lip of the channel.

Thickness

Average total compacted thickness of the combined asphalt courses: Not less than the documented thickness.

Average thickness of any individual course: Not less than the documented thickness by more than 10%.

Surface shape tolerance table

Layer	Deviations below 3 m straightedge (mm)			
	Heavy and very heavy traffic roads		Medium and light traffic roads	
Wearing course	5	7	7	10
Intermediate and base	8	12	12	16

1.7 SUBMISSIONS

Execution details

Spreading at low temperatures: If proposed, submit details of procedures.

Joints: Submit plans showing joints locations.

RAP management plan: Submit a plan with details of procedures for acceptance, processing and material testing.

Products and materials

Mix design: Submit details of the following for each asphalt mix:

- Type and source of constituent materials: Including for aggregates, fillers, binders and binders.
- Proportions of constituent materials used: Including binders, bituminous emulsion content, adhesion agents and additives.
- The combined aggregate particle size distribution as a single grading (not a range).
- Nominal size of the design mix.

- Test certificates: Submit evidence of conformance from a NATA accredited laboratory (for the required test method) for each constituent (aggregates/mineral fillers/binders/additives) including the following:
  . Aggregates: Quality and grading.
  . Blended aggregates: Proportions of the various sizes, including coarse aggregates.
- Trial mix testing results for review and approval.
- Mixes incorporating more than 30% RAP: Submit mix details including manufacturing plant, quality control procedures, and technical and performance data.
- Fine gap graded asphalt: If alternative particle size distribution is proposed, submit details for approval demonstrating conformance with the volumetric properties in **Design requirements for fine gap graded asphalt mixes table**.

Production mix test results: For each production batch or run of mix from the plant, submit evidence of conformity to the approved mix design and **MIX PROPERTIES** (for the appropriate asphalt type), including for:

- Grading.
- Binder content.
- Maximum density.
- Air voids.
- Laboratory compaction method used.

Records

Daily works record: Contractor to submit records for countersigning with the following:

- **ANNEXURE – ASPHALT WORK RECORD section 8.2**, completed each day of the work performed.
- Asphalt delivery dockets: Indicate the time and date of mixing, registration or delivery truck fleet number and mass of each truck load.
- After finishing each asphalt pavement course:
  . Provide survey certificate demonstrating compliance with surface level and thickness requirements.
  . Provide inspection record verifying compliance with surface finish, shape, alignment and width requirements.
  . Provide lot diagram updated to show bounds of lots.
  . Provide lot register updated to record: Lot numbers, Delivery docket numbers, Lot volumes and Number of tests required for lot and specified test compliance criteria.
- Review of test results:
  . Provide test certificates verifying compliance with specified compaction requirements.
- Lot package closures: Provide lot package closure certificates confirming for the work lots covered by this ITP:
  . Confirm all inspections have been completed.
  . Confirm all tests have been completed and the results recorded on the lot record.
  . Confirm all non-conformances have been notified.
  . Confirm that non-conformances that have not been closed are recorded in the defects register.
  . Confirm that all changes to design details have been reviewed and approved in accordance with requirements, and these have been recorded and certified on a marked up copy of the relevant drawings(interim as built drawings) with a reference to the applicable design change notice or survey certificate.
  . Confirm that the complete set of construction records and as built drawings are accessible on-line.
  . Confirm that the lot package has been closed.

Tests

Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES.**

Frequency of sampling: Submit proposal to vary frequency to correct non-conformance.

Variations

Approved mix design: Submit details, of proposed changes to the approved mix design, including its method of production, constituent material supply source, and alterations to RAP content, if applicable.

1.8 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Production plant and trucks: Asphalt production and delivery equipment before start of production mix and delivery to site.
- Sprayer calibration: Before start of spraying.
- Mobile equipment: Equipment condition before using.
- Surface preparation: Completed surface preparation, including repair of surface defects.
- Base gravel: Confirm that the base gravel has been prepared and approved for sealing.
- Spreading and compaction: Completed surfacing.
- Non-conforming sections: Completed replacement and rectification of non-conforming sections.

2 PRE-CONSTRUCTION PLANNING

2.1 ROAD OCCUPANCY

Road occupancy licensing

Requirement: Before commencement, obtain a road occupancy license for local roads for the area of work from the appropriate road/local government authority.

- Roads shared by the state road authority: Obtain occupancy from the state road authority.

2.2 PLANT AND EQUIPMENT

Plant

Operation: Conform to statutory environmental regulations.

3 MATERIALS

3.1 AGGREGATES

Properties and source

Properties and assessment: To Austroads AGPT04J.

Material source: Obtain each individual component of fine and coarse aggregates from the same sources as materials in the approved mix design.

Coarse aggregates

- Properties: To AS 2758.5 and the **Other coarse aggregate requirements table**.

Other coarse aggregate properties table

Test property	**Test value**	
	Heavy/very heavy traffic mix types	**Other mix types**
Shape testing: (See note 1) - Particle shape 2:1 ratio or - Flakiness Index	 25 25	 35 35

Test property	Test value	
	Heavy/very heavy traffic mix types	**Other mix types**
Weak particles (% maximum) (See note 2)	1	1
Water absorption (% maximum)	2.5	2.5
Polished stone value or polished aggregate friction value of wearing course asphalt	48 minimum	44 minimum
Notes: 1. Select only one type of shape test to be performed. 2. Weak particles test not required if unsound stone content is tested.		

Fine aggregates

Properties: Clean, hard, durable and free from lumps of clay and other aggregations of fine materials, organic material and other deleterious materials.

Soundness tested to AS 1141.24: ≤ 12% weighted loss.

Mineral fillers

Properties: Added filler consistent in mineral composition; dry; and free from lumps, clay, organic matter or other materials deleterious to asphalt.

Added filler materials table

Material	**Property**[(1)]
Hydrated lime	To AS 1672.1
Fly ash	To AS/NZS 3582.1
Cement kiln dust	Solid material extracted from the flue gases in the manufacture of Portland cement, with maximum water-soluble fraction of 20% (by mass) and conforms to the **Grading limits for ground limestone and cement kiln dust filler materials table**.
Slag	To AS 3582.2
Ground limestone	Rock dust derived from ground limestone conforming to the **Grading limits for ground limestone and cement kiln dust filler materials table**.
Cement	To AS 3972
Notes: 1. Provide test certificates verifying conformance, tested to the **Combined filler materials tests table**. 2. Rock dust not derived from the other aggregate components in the mixture: May be used as added filler if they are derived from materials that conform to **AGGREGATES**. 3. Where the AS indicates Loss on Ignition testing this is not required for fillers used in asphalt.	

Grading limits for ground limestone and cement kiln dust filler materials table

AS sieve size (mm)	**% passing sieve size (by mass)**
0.600	100
0.300	95 – 100
0.075	75 – 100

Combined filler material tests table

Filler type	**Test type**	**Test property**
All	Voids dry compacted filler	≥ 38%
All	Moisture content	Maximum 2%

3.2 BINDERS

Bitumen

Bituminous binders: To Austroads AGPT04F.

Classification and properties of bitumen: To AS 2008.

Other binders

Polymer modified binders: To Austroads AG:PT/T190 Table 5.2.

Additives

Type and proportion: To the manufacturer's recommendations.

Warm mix asphalt additives

Application: If required to reduce the asphalt manufacturing temperature and/or to improve workability during paving and compaction.

Rejuvenating agents

Mixes incorporating recycled asphalt: If rejuvenating agents are required, include an agent of with low volatility oil, capable of combining with bitumen to counteract hardening and to produce a binder with lower viscosity.

3.3 RECLAIMED ASPHALT PAVEMENT

Properties and manufacturing

Reclaimed asphalt pavement (RAP): Provide materials derived from milling or excavating existing asphalt with the following properties:

- Crushed and screened to provide the required grade and size.
- Maximum size: Not greater than the mix size being produced.
- Material texture: Well graded, free flowing, and consistent product as detailed in the manufacturer's RAP management plan.
- Contaminants: Free of foreign material such as unbound granular base, broken concrete, crumbed rubber or other contaminants.
- Asphalt containing tar: Do not use.

Stockpiling: Place in designated stockpiles before use.

3.4 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

3.5 MIX DESIGN - GENERAL

Asphalt mixes

Mix types: Select from the following mixes based on particle size distribution to **ANNEXURE - SCHEDULE OF JOB DETAILS**:

- Dense graded asphalt (DGA), also called asphaltic concrete (AC).
- Stone mastic asphalt (SMA).
- Open graded asphalt (OGA).
- Fine gap graded asphalt (FGGA).
- Light traffic asphalt (LTA).
- Ultra-thin asphalt (UTA).

Asphalt courses: Provide the following asphalt in the pavement structure:

- Wearing or surface course.

- Intermediate course.
- Base course.
- Regulating, levelling or corrective course.

Dense graded asphalt mixes: Provide mix appropriate to the pavement traffic classification required in **ANNEXURE - SCHEDULE OF JOB DETAILS**.

3.6 MIX DESIGN - AGGREGATE GRADING AND BINDER CONTENT

General

Combined aggregate grading (including filler) and binder content: To the limits appropriate for the wearing course and asphalt mix type.

Dense graded asphalt (DGA) - Medium, heavy and very heavy traffic wearing course and base course mix table

AS sieve size (mm)	**Mix designation**				
	DGA10(1)	**DGA14(1)**	**DGA20(1)**	**DGA28(1)**	**DGA40(1)**
	Percentage passing by mass				
53.0	–	–	–	–	100
37.5	–	–	–	100	90 – 100
26.5	–	–	100	90 – 100	72 – 87
19.0	–	100	90 – 100	73 – 88	58 – 76
13.2	100	90 – 100	71 – 86	58 – 76	–
9.5	90 – 100	72 – 83	58 – 83	47 – 67	38 – 58
6.7	68 – 82	54 – 71	46 – 64	37 – 58	–
4.75	50 – 70	43 – 61	37 – 55	30 – 50	27 – 43
2.36	32 – 51	28 – 45	24 – 42	20 – 37	16 – 33
1.18	22 – 40	19 – 35	15 – 32	13 – 28	11 – 26
0.600	15 – 30	13 – 27	10 – 24	9 – 22	7 – 20
0.300	10 – 22	9 – 20	7 – 17	6 – 16	5 – 14
0.150	6 – 14	6 – 13	4 – 12	4 – 10	4 – 10
0.075	4 – 7	4 – 7	3 – 6	3 – 6	3 – 6
Binder content (% by mass)(2)	5.2 – 6.5	4.8 – 6.0	4.5 – 5.8	4.3 – 5.5	4.0 – 5.0
Notes: 1. Mix designation: Nominal mix size. 2. Bitumen content: Expressed as a percentage of the total mix by mass. 3. For high fatigue base course mix types, increase the range of binder content by 0.5% to 1%.					

Dense graded asphalt (DGA) - Light traffic wearing course mix table

AS sieve size (mm)	**Mix designation**			
	DGA5(1)	**DGA7(1)**	**DGA10(1)**	**DGA14(1)**
	Percentage passing by mass			
19.0	–	–	–	100
13.2	–	–	100	90 – 100
9.5	100	100	90 – 100	72 – 89
6.7	98 – 100	85 – 100	68 – 87	54 – 79
4.75	85 – 100	70 – 87	50 – 76	43 – 69
2.36	55 – 75	44 – 65	32 – 57	28 – 53
1.18	38 – 57	29 – 48	22 – 42	19 – 40

AS sieve size (mm)	**Mix designation**			
	DGA5[1]	**DGA7**[1]	**DGA10**[1]	**DGA14**[1]
	Percentage passing by mass			
0.600	20 – 43	19 – 35	15 – 31	13 – 30
0.300	15 – 28	12 – 25	10 – 23	9 – 22
0.150	8 – 18	8 – 16	6 – 14	6 – 15
0.075	4 – 11	5 – 8	4 – 7	4 – 7
Binder content (% by mass)[2]	6.5 –7.5	6.0 –7.5	5.5 – 6.5	5.0 –6.0
Notes: 1. Mix designation: Nominal mix size. 2. Bitumen content: Expressed as a percentage of the total mix by mass.				

Open graded asphalt (OGA) mix table

AS sieve size (mm)	**Mix designation**	
	OGA10[1]	**OGA14**[1]
	Percentage passing by mass	
19.0	–	100
13.2	100	85 – 100
9.5	85 – 100	45 – 70
6.7	35 – 65	25 – 45
4.75	20 – 45	10 – 25
2.36	10 – 20	7 – 15
1.18	6 – 14	6 – 12
0.075	2 – 5	2 – 5
Binder content (% by mass)[2]	5.0 – 6.5	4.5 – 6.0
Notes: 1. Mix designation: Nominal mix size. 2. Bitumen content: Expressed as a percentage of the total mix by mass.		

Stone mastic asphalt (SMA) mix table

AS sieve size (mm)	**Mix designation**		
	SMA7[1]	**SMA10**[1]	**SMA14**[1]
	Percentage passing by mass		
19.0	–	–	100
13.2	–	100	90 – 100
9.5	100	90 – 100	30 – 55
6.7	85 – 100	30 – 55	20 – 35
4.75	30 – 62	20 – 40	18 – 30
2.36	20 – 35	15 – 28	15 – 28
1.18	16 – 28	13 – 24	13 – 24
0.600	14 – 24	12 – 21	12 – 21
0.300	12 – 20	10 – 18	10 – 18
0.150	10 – 16	9 – 14	9 – 14
0.075	8 – 12	8 – 12	8 – 12
Binder content (% by mass)[2]	6.0 – 7.3	6.0 – 7.0	5.8 – 6.8
Notes:			

AS sieve size (mm)	Mix designation		
	SMA7[1]	SMA10[1]	SMA14[1]
	Percentage passing by mass		
- Mix designation: Nominal mix size. - Bitumen content: Expressed as a percentage of the total mix by mass.			

Fine gap graded asphalt (FGGA) mix table

AS sieve size (mm)	Mix designation	
	FGG7[1]	FGG10[1]
	Percentage passing by mass	
13.2	–	100
9.5	100	85 – 100
6.7	85 – 100	60 – 86
4.75	65 – 85	55 – 74
2.36	55 – 72	50 – 70
1.18	45 – 65	45 – 65
0.600	30 – 60	30 – 60
0.300	18 – 40	18 – 40
0.150	8 – 18	8 – 18
0.075	6 – 12	5 – 11
Binder content (% by mass)[2]	6.0 – 7.0	6.0 – 7.0
Notes: 1. Mix designation: Nominal mix size. 2. Bitumen content: Expressed as a percentage of the total mix by mass. 3. Alternative particle size distribution: Do not use without approval.		

3.7 MIX PROPERTIES - GENERAL

Design criteria

Asphalt mix sampling and compaction: Use the gyratory compaction or the Marshall Method.

3.8 MIX PROPERTIES - DENSE GRADED ASPHALT

Mix design criteria

Volumetric design criteria: To either of the following:

- **Dense graded asphalt (DGA) mixes prepared using gyratory compaction table**.
- **Dense graded asphalt (DGA) mixes compacted by the Marshall Method (50 blow compaction) table**.

Voids mineral aggregate (VMA): To the **Voids mineral aggregate (VMA) table**.

Minimum effective binder film index:

- High fatigue base mix: 0.01 mm.
- All other mixes: 0.0075 mm.

Dense graded asphalt (DGA) mixes prepared using gyratory compaction table

Mix type		Laboratory compaction level (cycles)	Air voids (%)	Minimum air voids at 250 cycles (%)
Traffic classification	Application			
Light	Wearing and base	50	3.0 – 7.0	–
Medium	Wearing and base	80	3.0 – 7.0	–

Mix type		Laboratory compaction level (cycles)	Air voids (%)	Minimum air voids at 250 cycles (%)
Traffic classification	**Application**			
	High fatigue base	80	2.0 – 4.0	–
Heavy	Wearing and base	120	3.0 – 7.0	–
	High fatigue base	80	2.0 – 4.0	–
Very heavy	Wearing and base	120	3.0 – 7.0	2.0

Dense graded asphalt (DGA) mixes compacted by the Marshall Method (50 blow compaction(1)) table

Mix type		Air voids (%)	Minimum stability (kN)	Flow (mm)
Traffic classification	**Application**			
Light	Wearing and base	3.0 – 7.0	5.5	2 – 4
Medium	Wearing and base	4.0 – 7.0	6.5	2 – 4
	High fatigue base	2.0 – 4.0	6.5	2 – 4
Heavy	Wearing and base	3.0 – 7.0	6.5	2 – 4
	High fatigue base	2.0 – 4.0	6.5	2 – 4
Very heavy	Wearing and base	3.0 – 7.0	7.0	2 – 4

Notes:
1. Where 75 blow Marshall compaction is used, reduce the air voids range by 1% .
2. Where 35 blow Marshall compaction is used, increase the air voids range by 1% .

Voids mineral aggregate (VMA) table

Mix nominal size (mm)	VMA (% minimum)		
	Gyratory compaction	Marshall compaction (50 blow(1))	
		Heavy/very heavy traffic wearing course mixes	Other mix types<
7	16	–	16
10	16	16	16
14	15	15	15
20	14	–	14
28	13	–	13
40	12	–	12

Note:
1. Where 75 blow Marshall compaction is used, reduce the VMA by 1% .

3.9 MIX PROPERTIES - OPEN GRADED ASPHALT

Mix design criteria

Volumetric design criteria: To the **Level 1 open graded asphalt mixes table**.

Asphalt particle loss: To the **Asphalt particle loss table**.

OGA maximum binder drain-off test value at 160°C: 0.3% by mass. A lower test temperature may be applied if the temperature is unlikely to be exceeded during manufacture and transportation.

Level 1 Open graded asphalt (OGA) mix table

Mix type/Traffic classification	Laboratory compaction		Air voids (%)
	Gyratory (cycles)	Marshall (blows)	
OGA	80	50	20 – 25

Asphalt particle loss table

Mix type/Traffic classification	Maximum asphalt particle loss (%) to AGPT/T236	
	Unconditioned	Moisture conditioned
OGA	20	35

3.10 MIX PROPERTIES - STONE MASTIC ASPHALT

Mix design criteria

Volumetric design criteria: To the **Level 1 stone mastic asphalt mixes table**.

Minimum cellulose fibre content (by mass): 0.3% of cellulose fibre or not less than 0.5% of mineral fibre.

Binder drain-off test value at 170ºC: Not more than 0.3% by mass.

Polymer modified binder: Use A15E to eliminate the risk of flushing/bleeding in wheel paths.

Level 1 stone mastic asphalt mix table

Mix type		Laboratory compaction		Air voids to AS/NZS 2891.9.2(%)	Minimum VMA
Size (mm)	Traffic classification	Gyratory (cycles)	Marshall (blows)		
7	Light/Medium	120	50	3.0 – 5.0	18
10	Light/Medium	120	50	3.0 – 5.0	17
10	Heavy/Very heavy	120	50	3.0 – 5.0	16
14	Heavy/Very heavy	120	50	3.0 – 5.0	15

3.11 MIX PROPERTIES - FINE GAP GRADED ASPHALT

Mix design criteria

Volumetric design criteria: To the **Fine gap graded asphalt mixes table**.

Fine gap graded asphalt mixes table

Traffic classification	Laboratory compaction		Air voids (%)
	Gyratory (cycles)	Marshall (blows)	
Light	80	50	3.0 – 5.0

3.12 MIX PROPERTIES – LIGHT TRAFFIC ASPHALT

Mix design criteria

Volumetric design criteria: To the **Light traffic asphalt mix table**.

Light traffic asphalt mix table

Traffic classification	Laboratory compaction		Air voids (%)
	Gyratory (cycles)	Marshall (blows)	
Light	80	50	3.0 – 5.0

3.13 MIX PROPERTIES – ASPHALT MIXES INCORPORATING (RAP)

Mix design criteria

Mixes containing RAP: Design mixes in conformance with the following:

- Prepare separate mix designs for mixes containing RAP.
- Binder in RAP: Include as binder in the total mix.
- RAP content in dense graded asphalt mixes generally: Maximum 15% of the total mix by mass.
- 15% to 30% of RAP content: May be used in dense graded asphalt mixes except for heavy and very heavy-duty wearing course mixes, mixes containing polymer modified binder, or where not allowed in the **ANNEXURE - SCHEDULE OF JOB DETAILS**. If required, allow for bitumen binder one class lower than the required viscosity if there is an increase in binder stiffness from hardening of binder in the RAP.

4 EXECUTION

4.1 MIX DESIGN

Mix design requirements

Design limits: Design a mix that conforms to **MATERIALS** for approval.

Identification: Identify each mix design by a unique numbering system acceptable to the Principal.

Non-conforming mixes: Revise and retest mixes that do not conform to **MATERIALS**.

Previously designed mixes: These may be acceptable if it conforms to all the following requirements:

- **MATERIALS**.
- The work is undertaken within a two-year period of the date of testing in the mix design report.
- The type, quality and source of all constituent materials remain unchanged.
- The proportions of aggregates and filler do not vary by more than 20% of the proportion of that constituent material in the original mix design.

Mix design approval

Trial mix testing: Prepare minimum 6 samples for testing at the coarse and fine limits of the particle size distribution (PSD) in a laboratory.

Approval procedure: Provide mix design details to **SUBMISSION**, **Products and materials** and trial mix testing results demonstrating that the design mix conforms to the requirements of this work-section over the range of PSD and binder content limits.

Testing: By an accredited laboratory and test results presented in an endorsed test report.

Non-conforming mix design: Revise and retest.

Mix design currency

Period of mix currency: Mix designs may be current for a period of up to two years where no substantial change has occurred for the source and quality of the constituent materials.

4.2 PRODUCTION MIX

Sampling and testing of asphalt production

Production mix testing: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES.**

Sampling: Prepare samples from fresh production asphalt at the asphalt plant to AS/NZS 2891.1.1. Do not mix samples. Visually inspect each loaded truck on a random basis for segregation, uncoated particles, excess bitumen or overheating, before dispatch from the plant.

Sampling and testing frequency

Frequency of production asphalt testing: To the **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**

Process control

Process control measures: Develop, document and implement suitable measures for controlling the asphalt production process. Process control measures may include the following:

- The use of statistical process control charts for some or all of the tests required.
- Rules for determining the process is under statistical control and subject to reduced testing frequency.

Production tolerances on for aggregate grading and binder content table

AS sieve size (mm)/property	**Maximum permitted variations from the approved mix design (% by mass)**
Grading: Sieve size one size larger than nominal size	Nil
26.5 mm sieve or larger	± 7
4.75 to 19.0 mm sieve inclusive	± 7
1.18 to 2.36 mm sieve inclusive	± 5
0.300 to 0.600 mm sieve inclusive	± 4
0.150 mm sieve	± 2.5
0.075 mm sieve	± 1.5
Binder content: Percent by mass of total mix	± 0.3
Notes: 1. Source: AS 2150 Table 11.	

4.3 CONSTRUCTION PLANT AND EQUIPMENT

General

Plant operating condition: Make sure all plant and equipment used on the work is suitable, conforms to the contractor's submitted quality documentation and kept in good operating condition.

Operation: Conform to statutory environmental regulations.

Faulty plant or equipment: Do not use faulty plant or equipment that may affect the product quality or operational safety.

4.4 MANUFACTURE AND STORAGE

Asphalt manufacturing plant

Plant condition: Sound design and construction, capable of consistently producing the required asphalt mixes at a rate suitable for smooth, continuous asphalt placing.

Storage of raw materials

Storage: Store raw materials at the mixing site in sufficient quantities to allow continuous production, and effective sampling and testing before use.

Facilities for handling materials: Handle and store as follows:

- Aggregates: Prevent contamination and segregation. Allow for separate stockpiles of aggregates from different sources or of different sizes.
- Fillers: Keep dry and free flowing at all times. Separate fillers of different types.
- Additives, including cellulose or mineral fibres: Protect from moisture or contamination. Do not use wet materials.
- Binders: In thermostatically controlled binder tanks, each fitted with a thermometer that is located where it can be read conveniently and to allow for sampling of binders.

Heating binders: Do not heat bitumen binder to more than 185°C. Conform to the manufacturer's recommendations for temperature and time combinations for heating and storing multigrade and polymer modified binders.

Mixing temperature

Temperature of bitumen and aggregates: Not more than the temperature limits in the **Mixing temperatures table** at the mixing plant and when discharged from the plant.

Mixing temperatures table

Material	Maximum temperature (°C)
Class 170, Class 320 Bitumen delivered into mixer	165
Class 450, Class 600 Bitumen delivered into mixer	175
Asphalt at discharge from asphalt plant	175(1)
Note: 1. Maximum temperature of open graded asphalt: Not more than that determined from the asphalt binder drain-off test.	

Moisture content

Maximum moisture content: 0.5% after completion of mixing.

Storage of mixed asphalt

Asphalt storage before delivery: If required, conform to the following:

- Store the mix in insulated bins to minimise segregation and prevent localised cooling and overheating if heating is required to maintain a uniform temperature throughout the body of mix.
- Discharging: Use a method that minimises segregation. Discard any caked or segregated portions of mix.
- Asphalt with polymer modified binders: Do not store in plant silos for more than 8 hours and to the manufacturer's recommendations.
- Open graded asphalt and stone mastic asphalt: Do not store in plant silos for more than four hours.
- Total time of storage: Not more than 24 hours without approval.

Manufacture of stone mastic asphalt

Fillers systems: Design or modify to provide for the appropriate quantity of added filler. In drum mix plants, minimise loss of filler by feeding direct into the mixer alongside addition of binder.

Fibres: Add in a way that allows good dispersion and prevent loss through dust collection systems and damage from overheating.

Increase mixing times: Allow if required for adequate dispersal and mixing of fibres.

Asphalt mixes incorporating reclaimed asphalt pavement (RAP)

RAP materials: Use RAP from stockpiles that have been tested for grading and binder content and is consistent with the materials used in the approved mix design.

Batch mixing plants: Incorporate the RAP by one of the following methods:

- Meter into the asphalt plant after heating and drying of aggregates.
- Add directly to the weigh hopper with the other aggregate materials, for each batch.
- Weigh separately and add directly to the pugmill.

Batch mixing time: If necessary, increase mixing time to allow adequate heat transfer and dispersion of RAP.

Drum mix plants: Protect RAP from excessive temperatures at drum entry point and shield from direct flame contact.

4.5 DELIVERY

Transportation

Requirement: Transport asphalt as follows:

- Vehicle body: Keep the inside of vehicle bodies clean and coat with a thin film of an appropriate release agent to prevent asphalt sticking to the body. Remove surplus release agent before loading asphalt into the vehicle.
- Protection: After loading with asphalt, cover the vehicle body to prevent contamination and reduce the mix cooling rate.
- Vehicle insulation: Insulate vehicles if the haul length or weather condition may cause the asphalt temperature to drop below the required placing temperature, or where excessive local cooling of the mix may occur.
- Transportation operation: Program so that operations allow for continuous placing of asphalt.

Asphalt work records

Requirement: Record the details of the work performed each day. Include delivery dockets stating the mass of each truck load.

4.6 PLACING

Surface preparation

Requirement: Clear surface of deleterious material before tack coating and placing asphalt.

Protection of services and fixtures adjacent to surfacing area

Protection: Prevent tack coat, binder, aggregate, asphalt or other material used on the work from entering, adhering or obstructing gratings, hydrants, valve boxes, inspection pit covers, access chamber covers, bridges, or culvert decks, kerbs and other road fixtures.

Cleaning: Immediately after spreading the asphalt, clean off and remove any residual materials from services and road fixtures.

Priming

Requirement: If required, prime crushed rock and gravel pavements to *1143 Sprayed bituminous surfacing.*

Tack coating

Application: Apply tack coat to the cleaned surfacing area before placing asphalt as follows:

- Tack coat material: Use a bitumen emulsion that conforms to AS 1160, at a breaking rate suitable to for the climatic and surface conditions so that the coating surface is fully broken, free of surface water and intact before spreading asphalt.
- Application rate of residual binder: Apply at a uniform rate 0.20 to 0.30 L/m^2.
- Application method: Apply tack coat by spray bar fitted to a mechanical sprayer. Use hand spraying only in areas where it is impracticable to use a spray bar.
- Protection of adjacent works: Protect kerbs, channels, adjoining structures, traffic and parked vehicles from tack coat spray.

Tack coat omission: Coating may be omitted if spreading asphalt over clean, freshly placed asphalt, or over a clean primed surface.

Ultra-thin surfacing materials application rate: Nominate application rate of tack coat and modify the tack coating procedure to suit.

- Application rates more than 0.5 L/m^2: Apply through a spray bar mounted directly on the asphalt paver, immediately ahead of the spreading of asphalt.

Asphalt spreading temperatures (for DGA) table

Road surface temperature (°C) [1]	**Minimum mix temperature (°C)**[2]			**Range of mix temperature (°C)**[3]
	< 30 mm[4]	**30 – 40 mm**[4]	**41 – 100 mm**[4]	**> 100 mm**[4]
5 – 10	See note 5	See note 5	145	135 – 150
10 – 15	150	145	140	130 – 145
15 – 25	150	145	135	125 – 140
> 25	150	145	130	120 – 135

Notes:
1. Generally applicable to the coolest area of the pavements, e.g. shade areas.
2. Applicable to Classes 170, 320 and 450 bitumen binders. If using Class 600, multigrade, or PMBs, allow for temperatures 5 to 10°C higher than those shown.
3. Maximum temperatures apply when placing thick layers, to avoid excessive displacement under rolling.
4. Layer thickness.
5. If placing asphalt in thin layers under cool conditions is required, consider mix workability, asphalt temperature, compaction techniques and any other factor that may cause cooling from wind or moisture as this may adversely affect the ability to achieve proper compaction, joints and surface finish quality.
6. If placing of asphalt over a previous layer that has not cooled below about 65°C, adjust mix temperatures.
7. If warm mix asphalt (WMA) is used, the temperatures required can be reduced by 25°C to 30°C up to layer thicknesses of 100 mm. The minimum temperature of WMA for layer thicknesses of over 100 mm may be reduced by up to 15°C.

Spreading

Placing: Place asphalt with a self-propelling paving machine except where the use of a paver is impracticable.

Ambient conditions for placing: Place asphalt in the following conditions:

- Surfacing area: Dry and free from standing water.
- Surface temperature: Minimum 5°C.
- Pavement surface temperature for placing wearing course asphalt: Minimum 10°C. If placing at lower temperatures is required, obtain approval of procedures for compensating rapid cooling of asphalt materials.

Layer thickness: To the **Asphalt mix requirements table**.

Level control: To the **ANNEXURE - SCHEDULE OF JOB DETAILS**. If no method is documented, apply suitable automatic or manual screed level controls using an averaging beam or electronic device.

Spreading: Spread asphalt without tearing or segregation, in conformance with the following:

- Paving speed: Match the paving machine speed to the supply rate so that the number of paving stops is minimised.
- Paving stops: Do not leave the paving machine stationary for prolonged periods where the screed box is in contact with the previously placed asphalt or if there is loose asphalt in front of the screed.

Adjoining existing work

New work adjoining to existing work or structure: Align the horizontal location of any point on the pavement with the existing pavement structure.

Compaction

Timing: Uniformly compact asphalt as soon as the asphalt has cooled sufficiently to support the rollers without displacement.

Rollers: Use suitable sized steel wheeled or vibratory rollers and pneumatic tyred rollers to achieve compaction.

Open graded and stone mastic asphalt: Compact asphalt as follows:

- Do not use pneumatic tyred rollers.
- Use a methods that does not damage to the aggregates or draws binder to the surface of stone mastic asphalt.
- Apply maximum 2 vibratory passes using high frequency and low amplitude.

Joints

Joint location: Plan the joint locations before work commences and provide joints as follows:

- Longitudinal joints: Provide if the width of the pavement requires more than one paving run.
- Transverse joints:
- At the completion of each day's paving operations.
- Where a delay in paving operation may cause the asphalt to cool and adversely affect placing.
- If a break in a longitudinal run is required.
- Minimise the number of joints.
- Shape requirements: To the **Surface shape tolerance table**.

Longitudinal joints: Locate joints as follows:

- Align joints in the wearing course with traffic lane linemarkings.
- Offset joints from layer to layer by minimum 150 mm, provided that no joint is placed directly below a trafficked wheel path.

Transverse joints: Offset joints by minimum 2 m in adjoining paving runs and from layer to layer.

Hot joints: If placing asphalt against the edge of a preceding lane that has not cooled below 100°C, construct hot joints by leaving a 150 mm strip of asphalt unrolled along the free edge until the adjoining lane is placed. Compact the unrolled strip simultaneously with the material in the adjoining lane.

Warm joints: If placing asphalt against the edge of a preceding lane that has not cooled below 60°C, construct warm joints by rolling the full width of the first lane being placed, before placing the adjoining lane.

Cold joints: If placing asphalt against the edge of a preceding lane that has cooled below 60°C, construct cold joints by:

- Overlapping the previous edge by 25 to 50 mm.
- Pushing back the overlap using lutes, immediately after spreading, forming a slight ridge that is compacted with the steel wheel roller.

4.7 FINISHED PAVEMENT PROPERTIES

Dimensions and levels

Requirement: Provide finished pavement to level, alignment, thickness and shape to **TOLERANCES**.

Density assessment

Lot conformance: Assess the lot characteristic value of in-situ air voids.

Characteristic value of in-situ air voids: Calculate the upper (V_u) and lower (V_L) characteristic values of in-situ air voids of the lot as follows:

$V_L = \bar{a} - ks$

$V_u = \bar{a} + ks$

where:

$\bar{a}$ = arithmetic mean of the in-situ air voids expressed as percentage for the lot.

s = standard deviation of the air voids expressed as percentage for the lot.

k = factor that depends on the number of tests as documented in **Acceptance constant table**.

$$a = \left(\frac{MD - BD}{MD} \right) \times 100\%$$

and

MD = mean maximum density of the production lot to AS 2891.7.1 or AS/NZS 2891.7.3.

BD = bulk density of the lot to AS/NZS 2891.9.2 for cores or AS/NZS 2891.14.2 and AS/NZS 2891.14.3 for nuclear density gauge.

Characteristic value of in-situ air voids for wearing course asphalt table

Asphalt type and thickness (mm)	Upper limit characteristic value (%)	Lower limit characteristic value (%)
All heavy and very heavy traffic asphalt wearing courses	8	3
Medium traffic wearing course	8	3
Light traffic wearing course	7	3

Characteristic value of in-situ air voids for base asphalt table

Asphalt type and thickness (mm)	Upper limit characteristic value (%)	Lower limit characteristic value (%)
All heavy and very heavy traffic asphalt wearing courses	8	3
Medium traffic wearing course	8	3
Light traffic wearing course	7	3

Acceptance constant table

Number of tests or measurements	Acceptance constant (k)
3	0.52
4	0.62
5	0.67
6	0.72
7	0.75
8	0.78
9	0.81
10 - 14	0.83
15 - 19	0.90
20	0.95

Ride quality

Surface wearing course longitudinal profile: Maximum 40 to 50 NAASRA roughness counts or 1.6 to 2.0 International Roughness Index (IRI_S).

4.8 FIELD TESTING FOR PLACING AND FINISHED PAVEMENT

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Frequency of in-situ asphalt testing: To **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Dimensions and levels

Course position: Determine using the following method:

- Levels: Survey.
- Alignment: Survey.

Thickness: If confirmation of asphalt thickness is required, determine it by coring to a recognised random sampling plan.

- Coring of asphalt: To AS 2891.1.2. Determine layer thickness before trimming of cores. Do not trim cores by more than 5 mm.

Density testing

Timing: Perform testing as soon as practicable after completion of work.

Location: Choose the location of each in-situ density test by a method of random stratified sampling.
Layer thickness: Allow as follows:

- For core sample tests: The layer thickness is the mean thickness of the core samples.
- For nuclear and impedance density gauge tests: The layer thickness is the nominal thickness.

Core holes: Repair all holes using a method compatible with the pavement from which cores have been taken.

Restrictions: Do not perform density testing on the following:

- Lots less than 30 t.
- Layers with a nominal thickness equal to or less than 30 mm.
- Layers with a nominal thickness less than 2.5 times the nominal mix size, or open graded asphalt.

Bulk density: Determine from either of the following methods:

- Presaturation method: To AS/NZS 2891.9.2.
- Nuclear density measurement: To AS/NZS 2891.14.2 using the calibrated procedure described in AS/NZS 2891.14.3.

Maximum density: To AS 2891.7.1 or AS/NZS 2891.7.3.

Reference density: To AS/NZS 2891.14.5 calculate as the mean maximum density of the lot, for the purpose of in-situ air voids calculations.

Completion tests

Surface shape: Deviation from 3 m straightedge test.

5 ANNEXURES

5.1 ANNEXURE - SCHEDULE OF JOB DETAILS

Asphalt mix requirements table

Item	Layer/course	Asphalt mix type	Traffic classification	Binder class/type	Nominal mix size	Layer thickness

5.2 ANNEXURES - ASPHALT WORK RECORD

CLIENT:

Date: _____ Contract No:_____ Work location: _____km to: _____ km

Road name: _____ Supplier: _____ From: _____Towards: _____

(Crossroad or landmark)

Road no.: _____ Job no.: _____ PMS/MMS segment numbers: _____

Plan no.: _____ Mix type: _____ New surfacing Resurfacing Existing surface type: _____

Delivery								Paving									Remarks
Load no.	Time			Truck reg'd No.	Docket no.	Net mass (t)	Mix temp ex paver °C	Chainage		Paved width (m)	Direction with or against chainage	Dist. from left edge to centre of	Thickness (mm)	Layer			Sample no. & lot size (tonnes) if sampled	Weather work stoppages, start & finish etc.
	Depot plant	Arrive job	Depart job					From	To					1st	2nd	3rd		

Remarks: _____

Penciller: _____ Sampling by: _____ Superintendent's_____ Contractor's_____

Representative: (Signature) Representative: (Signature)

Affiliation: _____ Affiliation: _____

5.3 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Products and materials Mix design – Type and source of constituent materials; Test certificates	H	Documentation on material type, source and test certificates as evidence of conformance for each constituent.	10 days before starting production mix	Production of mix
SUBMISSIONS, Products and materials Mix design	H	Samples, documentation and test certificates verifying the mix design meets the project requirements.	10 days before starting production mix	Production of mix
SUBMISSIONS, Tests Production mix	H	Test certificates.	7 days before ordering materials	Ordering and delivery of material
INSPECTIONS, Notice Production plant and trucks	W	Asphalt production and delivery equipment condition	1 day before starting production mix	Asphalt production
INSPECTIONS, Notice Sprayer calibration	W	Spraying equipment condition	1 day before spreading	Primer spraying
INSPECTIONS, Notice Mobile equipment	W	Equipment condition	1 day before using equipment	Asphalt production and primer spraying
SUBMISSIONS, Records Daily work records	W	Completed **ANNEXURE – ASPHALT WORK RECORD**. Delivery dockets.	On the day of delivery	Asphalt supply
INSPECTIONS Asphalt delivery. Asphalt finishing. Asphalt tests	W	QA documentation of delivery, finishing, and testing	7 days before finishing processes such as linemarking and RPM's	**ASPHALT WORK RECORDS**
SUBMISSIONS, Execution details Spreading at low temperatures	H	If required, details of proposed procedures.	1 day before spreading	Placing/ spreading
SUBMISSIONS, Execution details Joints	H	Plan of joint locations.	7 day before placing	Placing/ spreading
INSPECTIONS, Notice Surface preparation	H	Completed surface preparation, including repair of surface defects.	7 days before placing	Placing/ spreading

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
		Confirm base gravel is approved for surfacing to commence		
INSPECTIONS, Notice Spreading and compaction	H	Completed surfacing.	2 days after compaction	The next lot or application of pavement marking
INSPECTIONS, Notice Non-conforming sections	W	Completed replacement and rectification of non-conforming sections.	1 day before the inspection	Linemarking application and opening to traffic
*H = Hold Point, W = Witness Point				

5.4 ANNEXURE – MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES TABLE

Frequency of sampling and testing of constituent materials

Activity	Material properties	Maximum lot size	Minimum test frequency	Test method/Conformance assessment
Material supply	Coarse and fine aggregates Grading	1 week's production	1 per week	AS 1141.11.1
	Coarse aggregates			
	Los Angeles Abrasion (where applicable)	1 contract	1 per contract or change in materials or 6 monthly	AS 1141.23
	Unsound and marginal stone content (where applicable)		or 6 monthly	AS 1141.30.1
	Wet strength (Where applicable)		or 6 monthly	
	Wet/dry variation (Where applicable)		or 6 monthly	
	Weak particles		or 6 monthly	AS 1141.32
	PAFV		or 12 monthly	AS 1141.40, AS 1141.41 or AS 1141.42
	Water absorption and density		or 6 monthly or change in materials	AS 1141.6.1 or AS 1141.6.2
	Shape testing of coarse aggregate - Particle shape 2:1 ratio		or 6 monthly or change in materials	AS 1141.14 or AS 1141.15

Activity	Material properties	Maximum lot size	Minimum test frequency	Test method/Conformance assessment
	- Flakiness Index			
	Fine aggregates			
	Soundness	1 contract	1 per contract or change in materials	AS 1141.24
	Combined filler			
	Voids in dry compacted filler	1 contract or 1 month's production	1 per contract or 1 per month	AS/NZS 1141.17
	Added mineral filler			
	Grading	Each production batch	1 per batch or 12 monthly	AS 1141.11.1
	Voids in dry compacted filler			AS/NZS 1141.17
	Moisture content			AS 4489.8.1
	Binder			
	Bitumen	Each production batch	AS 1160 Table A1	AS 1160 Table A1
	PMB		Austroads AG:PT/T190 Table 5.2	Austroads AG:PT/T190 Table 5.2
	RAP			
	Grading	1 stockpile	1 per stockpile	AS/NZS 2891.3.1, AS/NZS 2891.3.2 or AS/NZS 2891.3.3
	Binder content	1 contract	1 per contract or change in materials	
	Mix properties			
Mix design	Approval of mix and NATA endorsed certification – supplier's documentary evidence and certification	1 contract	1 per mix	**MATERIALS**

Frequency of sampling and testing of production of asphalt table

Activity	Key quality verification requirements	Normal minimum frequency	Test method
Asphalt production	Grading	One test per 300 t of asphalt plant production	AS/NZS 2891.3.1
	Binder content	One test per 300 t of asphalt plant production	AS/NZS 2891.3.1
	Binder film index	One test per 300 t of asphalt plant production	Austroads AG:PT/T237

Activity	Key quality verification requirements	Normal minimum frequency	Test method
	Temperature	Each loaded truck or as indicated on the plant control system	
Laboratory compacted dense graded asphalt (DGA) - Voids and VMA	Marshall stability and flow (50 blows)	One test per 300 t of asphalt plant production	AS/NZS 2891.5
	Voids in mix (50 blows)	One test per 300 t of asphalt plant production	AS/NZS 2891.8
	Gyropac (80 cycles)	One test per 300 t of asphalt plant production	AS/NZS 2891.2.2 AS 2891.7.1 or AS/NZS 2891.7.3 AS/NZS 2891.9.2 AS/NZS 2891.8
	Gyropac (120 cycles)	One test per 300 t of asphalt plant production	AS/NZS 2891.2.2 AS 2891.7.1 or AS/NZS 2891.7.3 AS/NZS 2891.9.2 AS/NZS 2891.8
	Gyropac (250 cycles)	One test per 300 t of asphalt plant production	AS/NZS 2891.2.2 AS 2891.7.1 or AS/NZS 2891.7.3 AS/NZS 2891.9.2 AS/NZS 2891.8
Laboratory compacted open graded asphalt (OGA)	Voids: Gyropac (80 cycles)	One test per 300 t of asphalt plant production	AS/NZS 2891.2.2 AS/NZS 2891.7.3 AS/NZS 2891.9.3 AS/NZS 2891.8
	Asphalt particle loss	One test per 300 t of asphalt plant production	Austroads AG:PT/T236
Laboratory compacted stone mastic asphalt (SMA)	Voids: Gyropac (120 cycles)	One test per 300 t of asphalt plant production	AS/NZS 2891.2.2 AS 2891.7.1 or AS/NZS 2891.7.3 AS/NZS 2891.9.2 AS/NZS 2891.8
Laboratory compacted fine gap graded asphalt (FGGA)	Voids in mix (50 blows)	One test per 300 t of asphalt plant production	AS/NZS 2891.8
	Voids: Gyropac (80 cycles)	One test per 300 t of asphalt plant production	AS/NZS 2891.2.2 AS/NZS 2891.7.3 AS/NZS 2891.8 AS/NZS 2891.9.3

Frequency of sampling and testing of finished asphalt properties table

Activity	Characteristics	Maximum lot size	Minimum test frequency	Test method/Conformance assessment
Placing and compaction	Course position	1 day's laying	One survey point per 25 m^2	Survey
	Compacted course thickness	1 day's laying	One core per 500 m^2 with minimum 5 per lot	Average thickness of coring to AS 2891.1.2
	In-situ air voids for DGA, FGG, SMA	1 day's laying	One core per 500 m^2 with minimum 5 per lot	AS/NZS 2891.9.2 or AS/NZS 2891.14.2
	Density ratio and percentage of air voids of in-situ compacted asphalt < 40 mm	1 day's laying	One core per 500 m^2 with minimum 5 per lot	AS/NZS 2891.14.5
	Surface shape	1 day's laying	10 per 200 m lane length or part thereof	3 m straightedge
	Ride quality	1 day's laying	10 per 200 m lane length or part thereof	RMS T188

5.5 ANNEXURE - PAY ITEMS

Separate pay items

Requirement: Separate pay items in the **Schedule of rates** for each nominal course thickness and each nominal size and type of asphalt required.

Method

Pay items: Determine by **Measurement by mass** or **Measurement by area** and thickness.

List any special job requirement as an additional separate payment items.

Standard method

Pay items	Unit of measurement	Schedule rate scope
1144.1 Mix design	Lump sum	All costs associated with mix design and control.

Measurement by mass

Pay items	Unit of measurement	Schedule rate scope
1144.2 Supply and install asphalt measured by mass unless otherwise specified in the **ANNEXURE - SCHEDULE OF JOB DETAILS**	Tonnes Determine the mass in tonnes from dockets supplied by the Contractor and issued at a certified weighing system by batch weights using certified scales approved by the Superintendent.	All costs associated with supply, install and finishing of asphalt.

Measurement by area and thickness

Pay items	Unit of measurement	Schedule rate scope
1144.3 Supply and install asphalt determined from measurement of area and thickness where specified in the **ANNEXURE - SCHEDULE OF JOB DETAILS**	Tonnes. Determine the mass in tonnes by multiplying the area and thickness determined from the dimensions on the plans or as specified for the work being measured by the density of asphalt in a lot taken as the arithmetic mean of the in-situ densities of the lot.	All costs associated with supply, install and finishing of asphalt.

Non-conformance

General: Any of the following may be required for non-conforming material:

- Offset the reduced service life arising from the non-conforming material by reducing payment for the non-conforming material by the method defined in the **ANNEXURE - SCHEDULE OF JOB DETAILS**.
- Remove the non-conforming material.
- Any other remedial treatment that is expected to provide the required level of service.

Deductions for non-conforming in-situ air voids

In-situ air voids outside of specified limits V_U by (%)	Deduction (% of lot value)
≤ 1.0	7.5
1.0 - 2.0	30
≥ 2.0	Reject

Deductions for ride quality

In-situ air voids outside of specified limits V_U by (%)	Deduction (% of lot value)
≤ 5	2
6 - 10	4
11 - 15	8
16 - 20	16

5.6 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1141		Methods for sampling and testing aggregates
AS 1141.6.1	2000	Particle density and water absorption of coarse aggregate - Weighing-in-water method
AS 1141.6.2	1996	Particle density and water absorption of coarse aggregate – Pycnometer
AS 1141.8	2014	Water soluble fraction of filler
AS 1141.11.1	2009	Particle size distribution - Sieving method
AS 1141.14	2007	Particle shape, by proportional caliper
AS 1141.15	1999	Flakiness index
AS/NZS 1141.17	2014	Voids in dry compacted filler
AS 1141.22	2008	Wet/dry strength variations
AS 1141.23	2009	Los Angeles value
AS 1141.30.1	2009	Coarse aggregate quality by visual comparison
AS 1141.32	2008	Weak particles (including clay lumps, soft and friable particles) in coarse aggregates
AS 1141.40	2017	Polished aggregate friction value - Vertical road-wheel machine
AS 1141.41	2017	Polished aggregate friction value - Horizontal bed machine

AS 1141.42	2017	Pendulum friction test
AS 1160	1996	Bitumen emulsions for construction and maintenance of pavements
AS 1672		Limes and limestones
AS 1672.1	1997	Limes for building
AS 2008	2013	Bitumen for pavements
AS 2150	2005	Hot mix asphalt - a guide to good practice
AS 2758		Aggregates and rock for engineering purposes
AS 2758.5	2009	Coarse asphalt aggregates
AS/NZS 2891		Methods of sampling and testing asphalt
AS/NZS 2891.1.1	2013	Sampling - Loose asphalt
AS 2891.1.2	2008	Sampling - Coring method
AS/NZS 2891.2.2	2014	Sample preparation - Compaction of asphalt test specimens using a gyratory compactor
AS/NZS 2891.3.1	2013	Bitumen content and aggregate grading - Reflux method
AS/NZS 2891.3.2	2013	Binder content and aggregate grading - Centrifugal extraction method
AS/NZS 2891.3.3	2013	Bitumen content and aggregate grading - Pressure filter method
AS/NZS 2891.5	2015	Compaction of asphalt by Marshall method and determination of stability and flow - Marshall procedure
AS 2891.7.1	2015	Determination of maximum density of asphalt - Water displacement method
AS/NZS 2891.7.3	2014	Determination of maximum density of asphalt - Methylated spirits displacement
AS/NZS 2891.8	2014	Voids and density relationships for compacted asphalt mixes
AS/NZS 2891.9.2	2014	Determination of bulk density of compacted asphalt – Presaturation method
AS/NZS 2891.9.3	2014	Determination of bulk density of compacted asphalt - Mensuration method
AS/NZS 2891.14.2	2013	Field density tests - Determination of field density of compacted asphalt using a nuclear thin-layer density gauge
AS/NZS 2891.14.3	2013	Calibration of nuclear thin-layer density gauge using standard blocks
AS/NZS 2891.14.5	2014	Field density tests - Density ratio and percentage air voids of compacted asphalt
AS/NZS 3582		Supplementary cementitious materials
AS/NZS 3582.1	2016	Fly ash
AS 3582.2	2016	Slag - Ground granulated blast-furnace
AS 3972	2010	General purpose and blended cements
AS 4489		Test methods for limes and limestones
AS 4489.8.1	1997	Free moisture - Convection oven
AAPA	2004	National Asphalt Specification
Austroads AGPT		Guide to pavement technology
Austroads AGPT02	2012	Pavement structural design
Austroads AGPT03	2009	Pavement surfacings
Austroads AGPT04B	2014	Asphalt
Austroads AGPT04E	2009	Recycled materials
Austroads AGPT04F	2017	Bituminous binders
Austroads AGPT04J	2008	Aggregates and source rock
Austroads AG:PT/T190	2014	Specification framework for polymer modified binders
Austroads AG:PT/T236	2005	Asphalt Particle Loss
Austroads AG:PT/T237	2005	Binder Film Index
Austroads AP-C87	2015	Austroads glossary of terms
Austroads AP-T41	2006	Specification framework for polymer modified binders and multigrade bitumens
RMS T188	2012	Project ride quality (Vehicular laser profilometer)

1145 SEGMENTAL PAVING

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide segmental paving, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.
- *1102 Control of erosion and sedimentation (Construction)*.
- *1112 Earthworks (Road reserve)*.
- *1113 Stabilisation.*
- *1122 Kerbs and channels (gutters)*.
- *1132 Lean mix concrete subbase*.
- *1133 Plain and reinforced concrete base*.
- *1141 Flexible pavement base and subbase.*
- *1171 Subsurface drainage.*

1.3 STANDARDS

General

Standards: To AS 3727.1.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviations apply:

- CBR: California bearing ratio.
- CMAA: Concrete Masonry Association of Australia.
- MDD: Maximum dry density.
- PICP: Permeable interlocking concrete pavement.

Definitions

General: For the purposes of this work-section the following definitions apply:

- Absolute level tolerance: Maximum deviation from design levels.
- Base: One or more layers of material, forming the uppermost structural element of a pavement and on which the surfacing may be placed.
- Clay segmental pavers: Manufactured from clay, shale or argillaceous materials which may be mixed with additives. Clay pavers may have square, bevelled (chamfered), rounded or rumbled edges. They are generally rectangular in shape, with the length twice the width, plus 2 mm.
- Concrete segmental pavers: Units of not more than 0.10 m^2 in gross plan area, manufactured from concrete, with top and bottom faces parallel, with or without chamfered edges and identified by the following shape types:
  - Shape Type A: Dentated chamfered units which key into each other on four sides, are capable of being laid in herringbone bond, and by plan geometry, when interlocked, resist the spread of joints parallel to both the longitudinal and transverse axes of the units.

  - Shape Type B: Dentated units which key into each other on two sides, are not (usually) laid in herringbone bond, and by plan geometry, when keyed together, resist the spread of joints parallel to the longitudinal axes of the units and rely on dimensional accuracy and accuracy of laying to interlock on the other faces.
  - Shape Type C: Units which do not key together rely on dimensional accuracy and accuracy of laying to develop interlock.
- Lippage: Height deviation between adjacent units.
- Permeable pavers: Segmental paving units designed and manufactured for PICP, to permit rapid infiltration of rainfall.
- Relative level tolerance: Maximum deviation from a 3 m straightedge laid on the surface.

1.5 TOLERANCES

Base course

Absolute: +10 mm, -0 mm.

Relative: 10 mm.

Finished surface after compaction of pavers

Absolute:

- Class 4 clay segmental pavers: ±6 mm.
- 80 mm thick concrete segmental pavers: ±6 mm.
- All other segmental pavers: ±8 mm.

Relative: 6 mm, except at grade changes.

Lippage: 2 mm or less.

Drainage inlets

Pavers level: + 5 mm to + 10 mm above adjacent inlets.

1.6 SUBMISSIONS

Operation and maintenance manuals

Requirement: Submit the manufacturer's maintenance manual.

Products and materials

Segmental paving materials: Submit details of proposed materials, including bedding and joint filling materials.

Proprietary products: Submit the manufacturer's technical data.

Samples

Requirement: Submit labelled samples of pavers, illustrating the range of variation in colour and finish.

Subcontractors

Requirement: Submit names and contact details of proposed installers of all paving materials.

Suppliers

Requirement: Submit names and contact details of proposed suppliers of all paving materials.

Tests

Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

Other tests: Submit results, as follows:

- Slip resistance site test of completed paving.

Variations
Requirement: Submit any proposed changes to approved drawings, materials or execution, 5 days before the related construction activity.

Warranties
Requirement: Submit the manufacturer's warranty.

1.7 INSPECTIONS

Notice
General: Give notice so that inspection may be made of the following:

- Subgrade preparation: Completed subgrade.
- Subbase preparation: Completed subbase.
- Base preparation: Completed base.
- Compaction of bedding course: Moisture content of trial section after screeding sand bedding course.

2 MATERIALS

2.1 MARKING

Identification
General: Deliver materials to the site in the manufacturer's original sealed packaging, legibly marked to show the following:

- Manufacturer's identification.
- Product brand name.
- Product type.
- Quantity.
- Product reference code and batch number.
- Date of manufacture.
- Material composition and characteristics such as volatility, flash point, light fastness, colour and pattern. Submit technical data sheets if not shown on labels.
- Handling and installation instructions.
- Safety data sheets.

2.2 CONCRETE AND CLAY SEGMENTAL PAVERS

General
Standard: To AS/NZS 4455.2.

Permeable interlocking concrete pavers: To the recommendations of CMAA PE01 Section 7.

Slip resistance classification: To AS 4586.

Proprietary product: Conform to the **ANNEXURE– PAVER SCHEDULE**.

2.3 SAND

General
Description: Well-graded, clean, hard sand, with uncoated grains of uniform quality and free of soluble salts or other contaminants which may cause efflorescence.

Storage: Protect from rain.

Cement: Do not use cement bound material.

Bedding sand

Grading: Obtain material from a single source or blend.

Fines: Do not use single-sized, gap-graded or excessive fine material.

Moisture content: 4 to 8% and uniform when spread.

Bedding sand grading table

AS sieve to AS 1152	% passing
9.52 mm	100
4.75 mm	95–100
2.36 mm	80–100
1.18 mm	50–85
600 µm	25–60
300 µm	10–30
150 µm	5–15
75 µm	0–10

Joint filling sand

Moisture content: Dry when spread.

Joint filling sand grading table

AS sieve to AS 1152	% passing
2.36 mm	100
1.18 mm	90–100
600 µm	60–90
300 µm	30–60
150 µm	15–30
75 µm	5–10

2.4 GRANULAR MATERIAL

Permeable pavement

Description: Well-graded, clean aggregate of uniform quality.

Grading: Bedding and jointing material to the recommendations of CMAA PE01 Table 2.

Bedding and jointing course material: 2 to 5 mm uniform size of aggregate.

Joint filling material grading table

AS sieve to AS 1152	% passing
9.5 mm	100
4.75 mm	85–100
2.36 mm	10–40
1.18 mm	0–10
0.3 mm	0–5

2.5 GEOTEXTILE AND LINER

Geotextile standards

Marking and labelling: To AS 3705.

Test methods: To AS 3706.1.

Properties and application: To Austroads AGPT04G.

Permeable pavement
Requirement: To the recommendations of CMAA PE01 Section 9.5.

Storage and handling
Requirement: Store under protective cover or wrapped with a waterproof, opaque UV protected sheeting, off the ground and unaffected by heat, dirt or damage and as recommended by the manufacturer.

Properties
Geotextile description: Non-woven needle punched continuous filament polyester or polypropylene geotextile. Free of flaws, stabilised against UV radiation, rot proof and chemically stable with low water absorbency. Filaments resistant to delamination and dimensionally stable.

Geotextile filtration: Conform to the following:

- Mass: Minimum 140 gsm.
- Wide strip tensile strength: Minimum 9.5 kN.
- Pore size: Maximum 110 µm.
- Flow rate: Minimum 200 L/m^2/s.

Impermeable liner protection: Conform to the following:

- Mass: Minimum 280 gsm.
- Wide strip tensile strength: Minimum 21 kN.
- CBR: Minimum 3600 N.

2.6 CONCRETE FOR EDGE RESTRAINTS

Properties
General: To AS 1379 clause 1.5.3.

Concrete strength: Unless documented otherwise, conform to the following minimum characteristic compressive strength at 28 days:

- For pavers on road pavements: 32 MPa.
- For pavers on medians, traffic islands and driveways: 25 MPa.

Slump: 60 mm.

2.7 TESTING

Quality
Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Quality verification: If material/product quality verification can be obtained from the supplier, documented tests need not be repeated.

3 EXECUTION

3.1 SUBGRADE

Subgrade preparation
Requirement: Form subgrade to the required depth below the finished surface level as documented and to the *1112 Earthworks (Road reserve)* work-section.

Permeable pavements
Requirement: To the recommendations of CMAA PE01 clause 7.1.2 and the following:

- Compaction: 92 to 96% standard MDD for trafficable areas.

- Cohesive subgrades: Install filter fabric under base course as documented.
- Contaminated, saline or expansive subgrade: Install an impermeable membrane and run up the sides of the pavement, as documented.

Subsurface drainage: If required, to 1171 Subsurface drainage as documented.

3.2 SUBBASE

Subbase preparation

Requirement: If required, construct a subbase or working platform, to the documented thickness, compaction and depth below the surface level and to the design grade and crossfalls of the finished surface.

Rigid pavements: To the *1132 Lean mix concrete subbase* work-section.

Flexible pavements: To the following work-sections as appropriate:

- *1113 Stabilisation*.
- *1141 Flexible pavement base and subbase*.

Permeable pavement

Construction: To the recommendations of CMAA PE01 clause 7.1.2 and the following:

- Unbound subbase: Compact to 95% modified MDD for trafficable areas.

3.3 BASE

Base preparation

Requirement: Construct base to the documented depth below the finished surface level.

Width: Extend the base course to at least the rear face of all new edge restraints.

Rigid pavement: To *1133 Plain and reinforced concrete base*.

Flexible pavement: To 1141 Flexible pavement base and subbase.

Remedial work: Do not use sand bedding material as a levelling material to compensate for base finishing outside the documented tolerances.

Finished surface of base: Drain free from ponding.

Permeable pavement

Construction: To the recommendations of CMAA PE01 clause 7.1.2 and the following for trafficable areas:

- Unbound base: Compact to 98% modified MDD.
- Cement-stabilised materials: Compact to 96% modified MDD.
- Construction vehicles trafficking mud onto the base course for permeable paving: If unavoidable, increase documented base thickness by 50 mm, scalp off and immediately discard before installing the bedding course.

3.4 EDGE RESTRAINTS

General

Requirement: Construct edge restraints along the perimeter of all segmental paving as documented, with the vertical face of edge restraints abutting the pavers.

Edge restraint support: On compacted base and/or subbase to AS 3727.1 Appendix D.

Joints

Contraction joints: 20 mm deep at 3 m maximum spacing.

Kerbs and/or gutters, and edge strips
Requirement: To AS 2876.

Construction: To the *1122 Kerbs and channels (gutters)* work-section.

Backfilling
Timing: Backfill at least 3 days after placing concrete.

Compaction: Backfill behind the edge restraint with earth, compacted in layers not greater than 150 mm thick, and complete with topsoil to finished design levels.

3.5 BEDDING COURSE

Geotextile
Position: Place fabric over prepared base course before laying the bedding course.

Requirement: Cover within 48 hours of being placed, rectify any punctures or tears prior to covering. Overlap 500 mm where deformations are expected.

Screeding
General: Spread the bedding course in a single uniform layer and screed in a loose condition to the nominated design profile and levels.

Sand bedding course thickness: 20 mm to 30 mm following final compaction of the paving.

Progressive screeding: Do not screed more than 2 m in advance of the laying face at the completion of work on any day.

Depressions: Before laying pavers, loosen, rake and re-screed any depressions exceeding 5 mm.

Remediation: If screeded sand left overnight is subject to rain, check for level and re-screed where necessary before placing pavers.

Permeable pavement
Granular bedding course thickness: 20 to 40 mm, following final compaction of the paving or as documented.

Sand: Do not use.

Drainage
Bedding course drainage: If water ponds at edge restraint, drain bedding course to existing subsurface drain or drainage pit using geotextile and 20 mm diameter PVC-U pipe.

Compaction of bedding course
Moisture content of sand bedding course: Prepare a trial section to establish the moisture content limits which will allow paver system compaction to be achieved.

Incorporation: Incorporate the trial section in the completed works.

Manual placing of pavers: Maintain the bedding at a uniform loose density.

Mechanised laying: Provide firm, uniform but not full compaction.

3.6 LAYING PAVERS

Placing and jointing
Placement: Uniformly place pavers on the screeded bedding to the documented laying pattern. Lay the pattern at either 90° or 45° to the line of edge restraints.

Joint width: Lay pavers with a joint range after bedding compaction and joint filling operations as follows:

- Pavers generally: 2 to 5 mm.
- Permeable type A pavers: 2 to 5 mm.
- Permeable type B pavers: 2 to 5 mm or less than 13 mm.
- Permeable type C pavers: Less than 13 mm.

Colour variation: Mix the pavers between pallets to evenly distribute colour variation over the whole paved area.

Sequence: Lay first row next to edge restraint or an established straight line.

Odd shapes: In each row, lay the full units first followed by cut closer units. Do not use cut pieces smaller than one quarter the size of a full block.

Cutting edge or closer units: Cut neatly using a paver scour or mechanical/hydraulic guillotine.

Laying around obstacles

Concrete surrounds: Finish public utility access pits, drainage pits and similar penetrations in the pavement with a concrete surround, conforming to the following:

- Minimum thickness between the utility pit and adjacent pavers: 100 mm.
- Strength grade: N32.
- Plan shape: Square or rectangular.

Pit covers: Adjust the levels of the pit covers before paving around them. Make sure the water drains away from closed pits.

Precast access chamber: Lay pavers to suit required dimensions of access chambers.

Patterns around obstacles: Continue to lay pavers along both sides of the obstacle, from the main or original laying face.

Control joints

Pavers over joints in underlying concrete base: If pavers are placed over an isolation, contraction or expansion joint, provide a control joint in the segmental paving.

Joint: 10 mm thick preformed bituminous fibreboard jointing material.

Protection

Foot or barrow traffic: Provide boards overlaying paving to prevent disturbance of pavers before compaction.

Other construction traffic: Do not allow on the pavement before compaction and joint filling.

3.7 BEDDING COMPACTION

Method

Requirement: Compact the bedding after laying the pavers with not less than two passes of a high frequency low amplitude plate compactor which covers at least 12 units.

Pavers damaged during compaction: Replace and re-compact the pavement for at least 1 m surrounding each replacement unit.

Progressive compaction: Arrange the paving operations as follows:

- Progressively compact behind the laying face.
- Complete compaction of laid paving at end of each day.
- Do not compact within 1 m of laying face except where next to edge restraint.

3.8 FILLING JOINTS

Timing

Joint filling: After bedding compaction and before the end of each day.

Method

Segmental pavement: Spread the joint filling dry sand over the pavement and fill the joints by brooming.

Permeable pavement: Fill the joints completely with granular jointing material. Sweep off excess aggregate.

Compaction: After filling joints, make one or more passes of a plate compactor and refill the joints. Repeat the process until the joints and drainage voids are completely filled.

3.9 COMPLETION

Protection

Traffic generally: Do not allow traffic to use the pavement until compaction and joint filling operations have been completed.

Exceptions: Foot and barrow traffic, wheeled trolleys, forklifts and cluster-clamp vehicles.

Opening to traffic

Excess material: Remove excess joint filling material before opening to traffic.

Construction traffic: Allow on pavement after completion of compaction and joint filling. Encourage traffic over the greatest possible area of pavement to assist in the development of lock-up.

Inspection

Joint filling: Inspect the pavement at regular intervals during the Defects Liability Period, make sure that all joints remain completely filled.

3.10 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Site tests

Slip resistance site test of completed paving: To AS 4663.

4 ANNEXURES

4.1 ANNEXURE – PAVER SCHEDULE

Property	A	B	C
Pavement application			
Paver material			
Paver shape type/shape name			
Permeable paver classification			
Paver size			
Paver colour			
Paver thickness			
Laying pattern			

Property	A	B	C
Direction of paver to line of edge restraint			
Minimum characteristic breaking load			
Dimensional deviation category			
Abrasion resistance			
Salt attack resistance grade			
Slip resistance classification			
Geotextile/liner type			
Product			

4.2 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Products and materials Segmental paving materials	H	Details of proposed materials, including bedding and joint filling materials	*2* weeks before commencement	Ordering material
INSPECTIONS, Notice Subgrade preparation	H	Completed subgrade	1 day before proceeding	Subbase preparation
INSPECTIONS, Notice Subsurface drainage	W	Installed system	1 day before proceeding	-
INSPECTIONS, Notice Subbase preparation	W	Completed subbase	1 day before proceeding	-
INSPECTIONS, Notice Base preparation	H	Completed base	2 days before proceeding	Edge restraint construction or bedding placement
INSPECTIONS, Notice Compaction of bedding course	H	Moisture content of trial section of paving after screeding sand bedding course	1 day before laying pavers	Laying pavers
**H = Hold Point, W = Witness Point				

4.3 ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Material supply	Suppliers documentary evidence and certification of:			
	Concrete/clay segmental paving units:			
	- Characteristic breaking load and flexural strength	1 contract	1 per contract	AS/NZS 4456.5
	- Dimensional deviations	1 contract	1 per contract	AS/NZS 4456.3
	- Abrasion resistance	1 contract	1 per contract	AS/NZS 4456.9
	- Salt attack resistance grade	1 contract	1 per contract	AS/NZS 4456.10
	- Slip resistance	1 contract	1 per contract	AS 4586
	Geotextile	1 contract	1 per contract or change in material	AS 3706
	Bedding:			
	- Sand grading	1 contract	1 per contract or change in material	AS 1141.11.1
	- Granular grading	1 contract	1 per contract or change in material	AS 1141.11.2
	Joint filling:			
	- Sand grading	1 contract	1 per contract or change in material	AS 1141.11.1
	- Granular grading	1 contract	1 per contract or change in material	AS 1141.11.2
Base	Geometry	1 layer 5000 m² or max 1 day's placement	1 cross section per 25 m	Survey
	Surface quality	1 layer 5000 m² or max 1 day's placement	10 per 200 m² or lot	3 m straightedge
Subgrade, subbase & base	Trafficked permeable pavement: Compaction/moisture content/dry density testing	1 layer 5000 m² or max 1 day's placement	10 per 5000 m^2 layer or 3 per lot, whichever is greater	AS 1289.5.4.2
Edge restraints	Ready mixed concrete material and supply	1 day's placement	1 per production batch	AS 1379
Laying paver units	Joint width	1 day's placement	All joints	Measure
	Geometry	1 day's placement	1 cross section per 15 m	Survey

4.4 ANNEXURE – PAY ITEMS

Pay items	Unit of measurement	Schedule rate inclusions
1145.1 Segmental paving - Road pavements	m^2 The surface area of segmental paving for road and driveway pavements calculated from the width and length as documented	All costs associated with the following: - Supply, laying and compaction of segmental paving units, bedding and joint filling material - Supply and installation of geotextile/liner - Cutting of units - Joints overlying concrete pavement joints - Concrete surrounds or aprons around surface penetrations
Kerb and channel (gutter)		To *1122 Kerbs and channels (gutters)*.
Subgrade		To *1112 Earthworks (Road reserve)*.
Subsurface drainage		To 1171 Subsurface drainage.
Subbase		Rigid pavements: To *1132 Lean mix concrete subbase* work-section. Flexible pavements: To the following work-sections as appropriate: - 1113 Stabilisation. - 1141 Flexible pavement base and subbase.
Base		Rigid pavement: To *1133 Plain and reinforced concrete base*. Flexible pavement: To *1141 Flexible pavement base and subbase*.

4.5 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1141		Methods for sampling and testing aggregates
AS 1141.11.1	2009	Particle size distribution - Sieving method
AS 1141.11.2	2008	Particle size distribution for vision sizing systems
AS 1289		Methods of testing soils for engineering purposes
AS 1289.5.4.2	2007	Soil compaction and density tests - Compaction control test - Assignment of maximum dry density and optimum moisture content values
AS 1379	2007	Specification and supply of concrete
AS 2876	2000	Concrete kerbs and channels (gutters) - Manually or machine placed
AS 3705	2012	Geotextiles - Identification, marking, and general data
AS 3706		Geotextiles - Methods of test
AS 3706.1	2012	General requirements, sampling, conditioning, basic physical properties and statistical analysis
AS 3727	2016	Pavements

AS 3727.1	2016	Residential
AS/NZS 4455		Masonry units, pavers, flags and segmental retaining wall units
AS/NZS 4455.2	2010	Pavers and flags
AS/NZS 4456		Masonry units and segmental pavers and flags - Methods of test
AS/NZS 4456.3	2003	Determining dimensions
AS/NZS 4456.5	2003	Determining the breaking load of segmental pavers and flags
AS/NZS 4456.9	2003	Determining abrasion resistance
AS/NZS 4456.10	2003	Determining resistance to salt attack
AS 4586	2013	Slip resistance classification of new pedestrian surface materials
AS 4663	2013	Slip resistance measurement of existing pedestrian surfaces
Austroads AGPT		Guide to pavement technology
Austroads AGPT04G	2009	Geotextiles and geogrids
CMAA PE01	2010	Permeable interlocking concrete pavements - Design and construction guide

1146 MICROSURFACING

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide microsurfacing treatment, as documented.

Mix design

Requirement: Provide mix design for microsurfacing treatment to **MATERIALS** and EXECUTION, **MIX DESIGN**.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.
- *1102 Control of erosion and sedimentation (Construction)*.

1.3 STANDARDS

General

Pavement surfacings: To Austroads AP-R569 and Austroads AGPT03.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviations apply:

- PAFV: Polished aggregate friction value.
- PSD: Particle size distribution.

Definitions

General: For the purposes of this work-section the definitions given in Austroads AP-C87 and the following apply:

- Bitumen emulsion: A system of fine droplets of bitumen with or without polymer, suspended in a mixture of water and emulsifier which begins to set upon contact with surfaces and when exposed to air.
- Microsurfacing: A bituminous slurry surfacing that contains polymer modified emulsion binder, which is capable of being spread in layers with variable thickness for rut-filling and correction courses, and for wearing course applications requiring good surface texture. Microsurfacing is cured using a chemically controlled curing process.
- Mix: The proportions of component materials in a quantity of slurry seal or microsurfacing treatment mixture.
  - Mix design: The designed proportion of component materials comprising the surfacing treatment mixture.
  - Production mix: Mix produced in the plant and delivered to the site in a workable condition suitable for stockpiling, spreading and compaction.
- Paving unit: A purpose-built continuous flow mixing unit capable of accurately metering each individual component material into a mixer which thoroughly blends these materials to form a homogeneous mixture and transfers the mix into a spreader box for application to the pavement surface.
- Polymer modified emulsion (PME): A bitumen emulsion containing a polymer modifier to assist in the development of early aggregate retention and enhanced performance during service. The

polymer modifier may be added prior to, during or post emulsion manufacture to achieve specific performance attributes.

- Polymer modified binder (PMB): Materials added to microsurfacing materials to provide enhanced performance for strength and flexibility properties of the final delivered surfacing. These materials may be such materials as fibres or emerging technologies, and their use and inclusion should be substantiated by laboratory testing for the desired attributes.
- Slurry seal: A thin layer of slurry, usually without a polymer modifier, consisting of a mixture of bitumen emulsion, aggregate, water and additives. Slurry seals are cured through a thermal process.

1.5 TOLERANCES

Finished surface

Finished level: ± 10 mm from design levels.

Finished level adjacent to kerb and/or gutters: 0, + 10 mm above design level.

Finished shape: 15 mm maximum deviation from the bottom of a 3 m straightedge placed anywhere on the surface in any direction, assessed within 24 hours of completion of work.

1.6 SUBMISSIONS

Execution details

Storage and handling: Submit the proposed method of material handling and storing including the following:

- Binders: Submit details for preventing contamination of binder by other materials.

Program: Submit a surfacing program including inspection and testing plans 7 days before surfacing.

Production plant control system: Submit details of the production control system to **PRODUCTION MIX**, **Plant production control**.

Plant and equipment: Submit details of plant and equipment proposed for use in the works.

Paving unit calibration: Submit evidence that the proposed equipment will perform the required work and that all metering devices are accurately calibrated, as follows:

- Individual calibration: Each component material at various settings for the paving unit's metering devices.

Non-conforming trial section: Submit details of changes proposed for the new trial section including the equipment, materials, mix and application rate to rectify non-conformance.

Product and materials

Mix design: Submit details of the following:

- Type and source of constituent materials: Including for aggregates, fillers and binders.
- Proportions of constituent materials used: Including binders, bituminous emulsion content and the residual binder content of the emulsion, adhesion agents and additives).
- The combined aggregate/mineral filler particle size distribution as a single grading (not a range).
- Nominal size of the mix design.
- Application rate (m^3 of mix/m^2 of road surface) and the corresponding layer thickness.
- Test certificates: Submit evidence of conformance in NATA endorsed reports from a NATA accredited facility for the required test method for each constituent (aggregates/mineral fillers/binders/additives) including the following:
- Aggregates: Quality and grading.
- Blended aggregates: Proportions of the various sizes, including coarse aggregates.
- Trial mix testing results for review and approval.

Tack coat emulsion: Submit a certificate of conformance and details of the storage tank batch.

Records

Daily record sheets: Submit details of the materials applied, at the completion of the works for each day.

Tests

Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES** and as follows:

- Mix design: To **SUBMISSIONS**, **Products and materials**.
- Production mix: Test certificates in NATA endorsed reports from a NATA accredited facility for the required test method verifying conformance to the **Maximum permitted variations from approved mix design table**.
- Texture depth: If required, submit test results after one month of opening up to traffic.

Variations

Approved mix design: Submit details, of proposed changes to the approved mix, including its method of production and constituent material supply source.

1.7 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Surface preparation: Completed surface preparation, including repair of surface defects.
- Surfacing trial: Completed trial section.
- Non-conforming trail section: If the original trial section is non-conforming, completed new trial section.
- Spreading: Completed surfacing.
- Non-conforming sections: Completed replacement and rectification of non-conforming sections.

2 MATERIALS

2.1 AGGREGATES

Aggregate properties

Mineral aggregates: To AS 2758.2 and AS 2758.5.

Components: Crushed rock or crushed gravel, or a mixture of either and natural sand.

Properties: Clean, dry, hard, angular, durable particles; with uniform grading; free from clay, dirt, organic material or other deleterious matter.

To ensure adequate physical strength and durability characteristics, the aggregate shall be derived from source rock that when crushed meets the requirements set out in **Aggregate properties table and the Particle size distribution table** following.

Aggregate properties table

Property	Limit	Test method
Degradation factor	50 minimum	AS 1141.25.12 and AS 1141.25.3
Los Angeles value: - - Slurry seal - -Microsurfacing	 35% maximum 30% maximum	AS 1141.23
Polished aggregate friction value (PAFV)	45 minimum or higher value	AS 1141.40 or AS 1141.41
Sand Equivalent (SE) - Slurry seal	 45% minimum 60% minimum	AS 1289.3.7.1

Property	Limit	Test method
- Microsurfacing		
Wet Strength	150 kN minimum	AS 1141.22
Wet / Dry Strength Variation	30%maximum	AS 1141.22

Particle size: When tested in accordance with AS 1141.11.1 and AS 1141.12 , the aggregate (including mineral filler) shall conform to the particle size distribution limits shown in

Particle size distribution limits for combined aggregate and filler table

AS sieve size (mm)[1]	Percent passing by mass	
	Size 4[2]	Size 7[2]
13.2	100	100
9.50	100	100
6.70	100	85 – 100
4.75	90 – 100	70 – 90
2.36	65 – 90	45 – 70
1.18	45 – 70	28 – 50
0.60	30 – 50	19 – 34
0.30	18 – 30	12 – 25
0.15	10 – 21	7 – 18
0.075	5 – 15	5 – 15

2.2 MINERAL FILLERS

Properties

Filler composition and materials: To AS 2150 clause 4.2.

Components: Hydrated lime, flyash, Portland cement.

Size: Mineral matter with minimum 85% passing a 0.075 mm sieve.

Properties: Dry and free from lumps, clay, organic matter and any deleterious material to asphalt.

Quantity of filler added to the mix: Do not vary by more than 1% (by mass) of the total filler content in the approved mix design.

2.3 BINDERS

Properties

Composition: To AS 1160 clause 6.1.

Bitumen: To AS 2008 (before emulsification).

Type: Emulsified polymer modified bitumen.

- Polymer content: Minimum 3% solids based on bitumen weight content.
- Softening point of bitumen: Minimum 57ºC. to AS 2341.18

Grade: Select a grade of binder appropriate for the bitumen emulsion required for slurry surfacing and with residual binder softening point higher than 57ºC (in accordance with the suppliers recommended method).

Tack coat binder
Type: Cationic rapid setting bitumen emulsion.

2.4 WATER

General
Properties: Compatible with the component materials as required to achieve the mix performance.

Requirement: Potable to AS/NZS 4020.

2.5 ADDITIVES

Quantity
Requirement: If required to control curing and flow characteristics of the mix, initially provide the quantity allowed in the approved mix design and adjust to suit changes in temperatures and moisture levels.

Higher performance additives
Requirement: Specify the range of additive levels in the mix design and provide supportive test data. Conform to the **Mix Properties Table** for wear loss, required traffic time, adhesion, and the required excess binder content. Do not use additives without approval.

2.6 TESTING

Sampling and testing of materials
Certificates and test results: Performed by a NATA accredited facility for the required test method within 24 months of use. Provide test of all tests, measurements, calibrations or inspections on NATA endorsed reports.

Quality
Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

3 MIX DESIGN AND PRODUCTION

3.1 MIX PERFORMANCE

Bituminous mix
Properties: Provide mix to the **Mix properties table** and as follows:

- That is easy to lay and provides a stable and durable finish.
- Provides asphalt emulsion mix, capable of carrying slow moving traffic (less than 40 km/h), within one hour of application without permanent damage such as rutting or ravelling.

Mix stability: Provide a mix with the following properties:

- Sufficiently stable to prevent premature breaking in the spreader box.
- Is homogenous during and following mixing and spreading.
- Free from excess water or bitumen emulsion to prevent segregation.

Mix properties table

Property	**Test method**	**Value**
		Microsurfacing
Wear loss	Austroads AG:PT/T272: - 1-hour soak - 6-day soak	 540 g/m^2 maximum(3) 800 g/m^2 maximum(1)
Traffic time	Austroads AG:PT/T271: - 30 minutes - 60 minutes	 12 kN.m minimum 20 kN.m minimum
Adhesion	To ISSA TB 114 wet stripping test	≥ 90%

Property	Test method	Value
		Microsurfacing
	or To ISSA TB144	or 11 grade points minimum (AAA, BAA)
Consistency	Austroads AG:PT/T270	20 mm
Excess binder content (for traffic volume > 3000 v/l/d)	Austroads AG:PT/T273	Not applicable
Notes: v/l/d: vehicles/lane/day. (1) Microsurfacing for traffic volume > 3000 v/l/d. (2) As for microsurfacing if applicable is for traffic volume > 3000 v/l/d. (3) Microsurfacing for traffic volume ≤ 3000 v/l/d.		

3.2 MIX DESIGN

Mix design requirements

General: Design a bituminous mix for the required application that conforms to **MATERIALS** and the following for approval:

- For the designed traffic volume.
- With the sufficient binder for the required mix performance.
- With sufficient workability.
- Meets performance required over the service life of the pavement.

Inclusions: In the design report/submission, determine the following:

- The required performance grade of binder identification.
- Aggregate stockpile selection suitable for use in the volumetric design.
- Binder selection.
- Optimum binder content determination: Through trial mix laboratory testing.

Previously designed mixes: These may be acceptable if conforming to the following requirements:

- **MATERIALS**.
- The work is undertaken within a two-year period from the date of testing in the mix design report.
- The type, quality and source of all constituent materials remain unchanged.
- The **Maximum permitted variations from approved mix design table**.

Mix design approval

Trial mix testing: Prepare samples for testing in a laboratory to EXECUTION, **TESTING**, **Sampling** to demonstrate conformance with **MATERIALS**.

Approval procedure: Provide mix design details to **SUBMISSIONS**, **Products and materials** and trial mix testing results, demonstrating that the mix design conforms to the requirements of this work-section.

Testing: By a NATA accredited facility for the required test method and test results presented in an endorsed test report.

Mix design currency

Period of mix currency: Mix designs may be current for a period of up to two years where no substantial change has occurred for the source and quality of the component materials.

Additives

Requirement: Only use if there is evidence that it has no detrimental effect on the mix performance. If required, include dose rates in the mix design.

3.3 PRODUCTION MIX

Mix properties

Properties: Make sure the mix conforms to the following:

- Can be placed and spread evenly on the road surface.
- Capable of being spread in layers of variable thicknesses for surface correction and for wearing surface applications.
- The sources and quality of the component materials remain unchanged from the approved mix design.
- The proportions of the component materials remain unchanged from the approved mix design.
- The mix continues to perform in service.

Maximum permitted variations from approved mix design table

AS sieve size (mm) [(1)]/ property	Maximum permitted variations from approved mix design (% by mass)	
	Size 4[(1)]	Size 7[(1)]
9.50 and larger	Nil	Nil
6.70	Nil	± 7
4.75	± 7	± 7
2.36 and 1.18	± 5	± 5
0.600	± 4	± 4
0.300	± 4	± 4
0.150	± 2.5	± 2.5
0.075	± 1.5	± 1.5
Residual binder content	– 0.5 + 1.0	– 0.5 + 1.0
Notes: 1. Nominal mix size		

Plant production control

Manufacturer's production control system: Maintain control system so that the surfacing mixture conforms to the required performance.

Production control system components: Establish, document and maintain a system consisting of the following:

- Operational techniques and measures for maintaining and controlling mix requirements.
- Inspection and test regime for incoming materials.
- Records system for product and test traceability, and evidence of compliance including changes to the source of supplies and changes to the proportions of a mix.
- Notification of changes.
- Handling and storage of incoming products and actions required if incoming products do not conform.
- Moisture control and particle grading limits and tolerances for incoming granular materials.
- Mix design methodologies, recording and numbering systems.

Subcontractors: If the constituent materials or the mix has been designed or tested by another supplier or is subcontracted, the manufacturer retains the overall responsibility of the mix.

4 EXECUTION

4.1 CONSTRUCTION PLANT AND EQUIPMENT

Equipment properties

Equipment condition: Maintain all plant and equipment in good working condition at all times.

Paving unit: Use paving units with the following properties:

- Self-propelling.
- Accurately proportioning and delivering constituent material to the mixer.
- Mixing capacity to continuously supply treatment mixture for the works required.
- Sufficient storage capacity for the extent of the works required.
- Capable of individual calibration for the component materials of the mix.

Spreader box: Use paving units with spreader box attached to or forming part of the mixing unit for uniform spread of the mix.

Ancillary equipment: Supply all required ancillary equipment in conformance with statutory requirements including for rotary road brooms, rollers, signs, lamps, barricades, hand squeegees, shovels and hand brooms.

Paving unit calibration

Individual calibration: Calibrate each paving unit with the component materials of the approved mix before the start of spreading.

4.2 SURFACING TRIAL

Trial section construction

Requirement: Before starting normal surfacing, conduct a test run to demonstrate surface texture:

- Length: Minimum 10 m.
- Width: Same as that documented for the Works.

Materials and methods: Use the approved materials, mix, equipment and methods.

Trial run

Requirement: Carry out the trial run to demonstrate performance and conformance of the following:

- Method of operation and efficiency of mobile plants.
- Emulsion content and rate of spread.
- The ability of surfacing to carry the required traffic load.
- Material and workmanship, including to the **Surface finish requirements for wearing courses table**.

Surface texture depth requirements for microsurfacing table[(1)]

Mix size (mm)	Minimum texture depth (mm)	Test method
Size 4	0.4	Austroads AG:PT/T250 or approved alternate method
Size 7	0.8	Austroads AG:PT/T250 or approved alternate method
Note: 1. A correction course is not considered to be a wearing course for the purposes of this requirement.		

Non-conforming trial section

Requirement: If the trial section is deemed non-conforming, rectify any damage caused by the removal, and construct a new trial section in conformance with **NON-CONFORMANCE**.

4.3 SURFACE PREPARATION

Set-out

Setting out: Set out works for the required size, thickness, and extent of surfacing.

Marking intervals: Place marks at maximum 10 m intervals on the line to be followed by the paving unit. Where the line is defined by a kerb or edge, marking is not required.

Edges and joints: Locate parallel to kerbs and shoulders and to prevent run-off of the treatment mixture. Keep lines at intersections straight, use masking if required.

Cleaning

Sweeping surfaces: Before applying mixture, make sure the surface is dry and clear of loose material, stones, dirt, dust and foreign matter. Sweep the surface beyond the edge of the surfacing area by at least 300 mm.

Contaminated areas: Clean areas affected by oil and other contamination.

Vegetative growth: Remove from surface and cracks before applying tack coat.

Existing bituminous surfaces: Remove loose or peeling bitumen.

Protection of services and fixtures adjacent to the surfacing area

Protection: Prevent microsurfacing mixture or other materials used in the surfacing operation from entering or adhering to kerbs, gutters, driveways, gratings, hydrants, valve boxes, manhole covers, bridges, culvert decks or other road fixtures.

Surface defects

Requirement: Repair surface defects including drainage problems, cracks, potholes repairs and failed pavement, if required minimum 3 months before spreading mix**.**

Minor repairs: Hand place mix to surfacing areas if the use of a paving unit is impracticable.

Cracks: Treat cracks wider than 6.5 mm in the pavement surface with an approved crack sealer before spreading.

Tack coat

Requirement: If surface to be covered is extremely oxidised, ravelled or comprises concrete or brick, apply a tack coat.

Application rate: 0.2 to 0.3 L/m^2 of residual binder at 15°C.

Break prior to microsurfacing: The tack coat emulsion will be permitted to break prior to microsurfacing.

Water fog coat

Fogging: If required, pre-wet surface ahead of the spreader box so that the entire surface is damp, with no apparent flowing water.

Application rate of fog spray: Adjust to suit the temperature, surface texture, humidity and dryness of the surface being covered.

4.4 SPREADING

Weather and surface conditions

Weather conditions: Do not apply the mix in the following conditions:

- During periods of rain, snow or sleet.
- When free water, frost, ice or snow is present on the surface.
- When the air/shade temperature is below 8ºC or below 10ºC on a falling thermometer or when the pavement surface temperature is below 8ºC.

- When the air temperature exceeds 40ºC.
- Permitted application conditions: Treatment mixture may be applied if both pavement and air temperatures are above 7°C and rising.

If rain is forecasted: Work may proceed but any microsurfacing damaged by rain is to be rectified without incurring extra costs.

Surface pavement condition: If dampening is required, slightly dampen surface by water fogging.

Mix consistency

Consistency: As required to produce a uniform coating when deposited in the spreader box.

Water: Only add minor amounts for overcoming temporary mix build-ups in the corners of the spreader box.

Mixing time and rate

Requirement: Adjust the mixing time and rate to produce a uniform coating and a mixture that can be fed into the moving spreader box at a rate required for maintaining supply across the full width of the strike-off.

Application rate

Requirement: Adjust the strike-off so that the application rate meets the required rate and completely fills the surface voids.

Rolling

Method: Generally rolling is not required for microsurfacing. If required, use self-propelling, pneumatic tyred, multi-wheel rollers to produce a dense, even, homogeneous compacted surface

Timing: Carry out rolling after the emulsion has broken, when the mix is sufficiently stable, and has been cured sufficiently to prevent pick-up on the roller tyres and prevent delamination.

Combination treatment

Seal construction: To Austroads AGPT04K and Austroads AGPT03.

Timing: Apply spray seal and slurry seal or microsurfacing on the same day.

Sprayed bituminous seal: To *1143 Sprayed bituminous surfacing*.

Protection from traffic: Prevent trafficking of the surface until the surfacing texture has cured.

Traffic time

Open to traffic: To avoid undue permanent damage such as rutting or ravelling open the road surface within 1 hour of spray application. Traffic time varies with temperature. Cooler weather , thicker layers or in shaded areas will extend time delay for traffic.

Surface texture

Properties: Uniform in appearance, and free of areas showing segregation or excessive/ insufficient binder.

Finished surface: Finish work so that the surface texture conforms to the **Surface finish requirements for wearing courses table**.

Surface finish

Unsatisfactory finish: Remove and replace any section of surfacing that is loose, broken or contaminated with dirt.

Texture testing: If surfacing is applied as a wearing course, test texture depth to EXECUTION, **TESTING**, **Completion tests**.

Surface shape

Finished surface or final wearing course: To **TOLERANCES**.

Joints

Longitudinal joints in the wearing course: Place joints straight and within 300 mm of the edge or the centre of a traffic lane. If required, lightly screed the edges and joints with a hand squeegee to achieve a smooth uniform appearance and to remove excess build-up of material.

- Maximum overlap: 200 mm.
- Tolerance: Maximum 6.5 mm elevation along a 3 mm straightedge.

Number of joints: Use spreading equipment that minimises the number of longitudinal joints required for the project.

4.5 REPAIR OF EXISTING BITUMINOUS SURFACING

Rut-filling

Wheel ruts deeper than 15 mm: Apply a rut-filling course before constructing the wearing course. Use a spreader box capable of laying the bituminous mix across the varying cross-sectional depth to fill ruts.

Multiple layers: Specify the number of layers of rut-filling or correction course along with the maximum thickness of microsurfacing to be applied in each layer. Specify the minimum time delay between each correction course in **Multiple Layer Applications**

Apply rut-filling courses in layers of 1.5 to 2.0 times the nominal aggregate size. Guidance on the use of varying size mixes for correction to the **Rut-filling and shape correction table**.

Shape correction

Requirement: Provide a correction course to produce a suitable and stable finish over ruts in excess of 10 mm deep. Apply correction courses using a stiff strike-off screed on a standard spreader box for shallow ruts and a purpose-built rut-filling spreader box for ruts in excess of 10mm deep. For ruts in excess of 40mm, use asphalt for shape correction.

Multiple layer applications

Multiple layers: Sufficient time is required to achieve final cure. Delay at least 1 hour between layers to permit moisture evaporation escape for low volume roads. For heavy traffic locations or deep rutting allow 24 hours between layers to achieve stronger surfacing and ensure moisture evaporation from the thicker layers.

Rut-filling and shape correction table

Nominal Size	Size 4 mm	Size 7 mm
Void filling e.g. Cape seals	√	
For rutting 10 to 15mm deep	√	√
For rutting 15 to 25mm deep		√ (see note below)
For rutting 25 to 40mm deep		√ (see note below)
Note: Apply correction in multiple layers is suggested where the depth of a rut exceeds 2 to 2.5 times the nominal maximum aggregate size of the mix		

Textured surface: To obtain an even and uniformly textured surface, overlay rut filling and correction courses by a wearing course. If this is not done, the coarser aggregate fractions can settle into the mix resulting in a low or uneven surface texture and an unsightly appearance due to fatty spots.

4.6 CLEANING

Completion of spreading

Requirement: After bituminous mix spreading, remove excess materials from kerbs, gutters, driveways, gratings, hydrants, valve boxes, access chamber covers and other road fixtures. Leave these areas in a clean condition.

4.7 NON-CONFORMANCE

Materials and finished surfacing

Rectification: Rectify non-conforming work including the following:

- Materials supplied.
- Sections of slurry seal and/or microsurfacing treatments
- Materials made defective by the method of operation adopted.
- Texture depth.

Non-conforming sections: Replace and restore any underlying or adjacent surface/ or structure.

4.8 TESTING

Sampling

Requirement: Prepare samples to Austroads AGPT/T221 for testing as follows:

- Drying: Before testing for residual binder content and aggregate gradation, dry the samples to a constant weight in an oven at 60°C for minimum 15 hours.
- Tack coat: Take two 2 L samples of bitumen emulsion from each bulk delivery.

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Completion tests

Texture depth: One month after opening the completed surfacing to traffic, test for texture depth follows:

- Visual assessment.
- If visual assessment is not conclusive, carry out sand patch testing to Austroads AG:PT/T250.

4.9 PROTECTION

Surface protection

Protection from traffic: Do not allow traffic on the new work until:

- The surface is stable and able to withstand traffic without damage.
- Sufficient rolling has taken place to prevent damaging the freshly applied surfacing treatment.

Roadwork signs: Leave in place until the surfacing application is complete and stable, and linemarkings reinstated.

5 ANNEXURES

5.1 ANNEXURE – SELECTIONS

Microsurfacing treatment requirements schedule

Course	Nominal size	Average layer thickness (mm)	Minimum PAFV
Wearing			
Rut-filling			
Regulating			
Other			

Skid resistance requirements

Mix size (mm)	Skid resistance	Test method[(1)]
Size 4		
Size 7		

Mix size (mm)	Skid resistance	Test method[(1)]
Note: 1. Allow for SCRIM or Grip Tester as appropriate for the project location.		

5.2 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Products and materials Mix design – Type and source of constituent materials; Test certificates	H	Documentation on material type, source and test certificates as evidence of conformance for each constituent.	10 days before starting production mix	Production of mix
SUBMISSIONS, Products and materials Mix design	H	Samples, documentation and test certificates verifying the mix design meets the project requirements.	10 days before starting production mix	Production of mix
SUBMISSIONS, Execution details Plant and equipment	H	Details of plant and equipment.	14 days before spreading/surfacing trial run	Spreading/trial section
INSPECTIONS, Notice Surface preparation	H	Completed surface preparation, including repair of surface defects.	7 days before spreading/surfacing trial run	Spreading/trial section
SUBMISSIONS, Execution details Paving unit calibration	H	Evidence of paving unit calibration.	1 day before spreading/surfacing trial run	Spreading/trial section
INSPECTIONS, Notice Surfacing trial	H	Completed trial section.	5 days before normal surfacing	Acceptance of trial run
SUBMISSIONS, Execution details Non-conforming trail section	H	Details of proposed changes to the trial section.	1 day after non-conformance has been identified	Spreading
INSPECTIONS, Notice Non-conforming trail section	H	Completed new trial section.	1 day before the inspection	Spreading
INSPECTIONS, Notice Spreading	H	Completed surfacing.	2 days after spreading	The next lot or application of pavement marking

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
INSPECTIONS, Notice Non-conforming sections	W	Completed replacement and rectification of non-conforming sections.	1 day before the inspection	Linemarking application and opening to traffic
*H = Hold Point, W = Witness Point				

5.3 ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Binders	Content	1 contract	1 per type	AS/NZS 2891.3.1
Aggregates	Grading	1 contract	1 per type	AS/NZS 2891.3.1
	Degradation factor	1 contract	1 per type	AS 1141.25.1
	Los Angeles value	1 contract	1 per type	AS 1141.23
	Wet strength	1 contract	1 per type	AS 1141.22
	Wet/dry strength variation	1 contract	1 per type	AS 1141.22
	Polished aggregate friction value	1 contract	1 per type	AS 1141.42
	Sand equivalent	1 contract	1 per type	AS 1289.3.7.1
	Grading limits	1 contract	1 per type	AS 1141.11.1 and AS 1141.12
Mineral filler	Portland cement	1 contract	1 per type	AS 2350 (various)
Tack coat	Residual binder content	1 contract	Each delivery of emulsion	AS 1160
	Bitumen emulsion samples for testing	1 contract	1 per type	AS 1160
Bituminous mix	Sampling	50 m³ or one days' production or smaller quantities considered as representative of the consistent production of the paving unit	Take 1.0 kg representative samples from each lot	Austroads AG:PT/T221
Completion tests	Texture depth	1 contract	4 tests per lot	Austroads AG:PT/T250

Activity	Material	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method/ Conformance assessment
Materials supply		Material quality – supplier's			

Activity	Material	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method/ Conformance assessment
		documentary evidence and certification of:			
	Bitumen	- Material properties before emulsion	1 contract	1 per contract or change in material	AS 2008
	Bitumen emulsion	- Residual binder content (residue from evaporation) -Softening point of residual binder	1 contract	2 per bulk delivery	AS/NZS 2891.3.1 AS 2341.18
	Mineral aggregates	- Degradation factor	1 contract	1 per contract or 6 month period	AS 1141.25.1
		- Los Angeles value	1 contract	1 per contract or 6 month period	AS 1141.23
		- Aggregate wet strength	1 contract	1 per contract or 6 month period	AS 1141.22
		- Wet/dry strength variation	1 contract	1 per contract or 6 month period	AS 1141.22
		- Polished aggregate friction value	1 contract	1 per contract or 6 month period	AS 1141.42
		- Sand equivalent	1 contract	1 per contract or 6 month period	AS 1289.3.7.1
		- Combined aggregate grading	1 contract	1 per contract or 6 month period	AS/NZS 2891.3.1
		- Grading limits	1 contract	1 per contract or 6 month period	AS 1141.11.1 and AS 1141.12
	Mineral filler	- Material properties	1 month's production	1 per contract or 6 month period	AS 3972, AS 1672.1 or AS/NZS 3582.1
Mix design	All constituent materials	Approval of mix and NATA endorsed certification – supplier's documentary evidence and certification	1 contract	1 per mix	**MATERIALS**
Mix properties	-	Wear loss	1 contract	1 per mix	Austroads AG:PT/T272
		Traffic time	1 contract	1 per mix	Austroads AG:PT/T271

Activity	Material	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method/ Conformance assessment
		Adhesion	1 contract	1 per mix	ISSA TB 114 or Shulz Breuer and Ruck test
		Consistency	1 contract	1 per mix	Austroads AG:PT/T270
Production mix	-	Grading	1 day's production or 50 m^3 (whichever is the lesser)	2 per 50 m^3 (1)	AS/NZS 2891.3.1
		Residual binder content		2 per 50 m^3 (1)	AS/NZS 2891.3.1
Spreading	Surface finish	Levels	1 layer, max. 200 m^3	1 cross section per 15 m	Survey
		Surface quality – texture depth		10 per 100 m lane length (1)	Visual assessment or Austroads Austroads AG:PT/T250
Note: 1. or part thereof per lot.					

5.4 ANNEXURE - PAY ITEMS

Pay items	Unit of measurement	Schedule rate inclusions
1146.1 Surface preparation and tack bitumen coat	- Per m^2 area including bitumen tack coat	All costs associated with surface preparation, set out, cleaning, protection of services, tack coat supply and spray, and other preparation items
1146.2 Correction of rutting prior to placement area	- Per m^3 volume of dry mineral aggregate combined with binder mix.	Calculate the volume based on the width and length of the rutting to be corrected and the average depth of the rutting taken as half of the maximum rut depth obtained from network data. Quantities calculated can be verified against quantities of aggregate and bitumen supplied to the job by the contractor.
1146.3 Size 4 surfacing mix microsurfacing	- M^3 volume of the combined mix as applied on the road surface. - The volume of the combined mix is the volume of the dry mineral aggregate (excluding filler) used in completing the works recorded by the paving unit.	All costs associated with preparation of the surface, mix design, all sampling and testing, supply of all materials to site, and loading, mixing and spreading the bituminous surfacing mix including finishing, joint treatment and clean-up.
1146.4 Size 7 surfacing mix microsurfacing	- M^3 volume of the combined mix as spread on the road surface. - The volume of the combined mix is the volume of the dry mineral aggregate (excluding filler) used in completing the	All costs associated with preparation of the surface, mix design, all sampling and testing, supply of all materials to site, and loading, mixing and spreading the bituminous surfacing mix including finishing, joint treatment and clean-up.

Pay items	Unit of measurement	Schedule rate inclusions
	works recorded by the paving unit.	
1146.5 Traffic management	Lump sum.	To *1101 Traffic management*.

5.5 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1141		Methods for sampling and testing aggregates
AS 1141.11.1	2009	Particle size distribution - Sieving method
AS 1141.12	2015	Materials finer than 75 µm in aggregates (by washing)
AS 1141.22	2008	Wet/dry strength variation
AS 1141.23	2009	Los Angeles value
AS 1141.25.2	2003	Degradation factor – Coarse aggregate
AS 1141.25. 3	2003	Degradation factor – Fine aggregate
AS 1141.3.1	2012	Sampling - aggregates
AS 1141.42	2017	Pendulum friction test
AS 1160	1996	Bitumen emulsions for construction and maintenance of pavements
AS 1289		Methods of testing soils for engineering purposes
AS 1289.3.7.1	2002	Soil classification tests - Determination of the sand equivalent of a soil using a power-operated shaker
AS 1672		Limes and limestones
AS 1672.1	1997	Limes for building
AS 2008	2013	Bitumen for pavements
AS 2150	2005	Hot mix asphalt - a guide to good practice
AS 2341		Methods of testing bituminous and related roadmaking products
AS 2341.18	1992	Determination of softening point (ring and ball method)
AS/NZS 2341.23	2002	Determination of residue from evaporation
AS 2350		Methods of testing Portland, blended and masonry cements
AS 2758		Aggregates and rock for engineering purposes
AS 2758.2	2009	Aggregate for sprayed bituminous surfacing
AS 2758.5	2009	Coarse asphalt aggregates
AS/NZS 2891		Methods of sampling and testing asphalt
AS/NZS 2891.3.1	2013	Bitumen content and aggregate grading - Reflux method
AS/NZS 3582		Supplementary cementitious materials
AS/NZS 3582.1	2016	Fly ash
AS 3972	2010	General purpose and blended cements
AS/NZS 4020	2005	Testing of products for use in contact with drinking water
Austroads AP-C87	2015	Austroads glossary of terms
Austroads AGPT		Guide to pavement technology
Austroads AGPT03	2009	Pavement surfacings
Austroads AGPT04K	2018	Selection and design of sprayed seals
Austroads AP-R569	2018	Guidelines and specifications for microsurfacing
Austroads AG:PT-T221	2018	Sampling of Bituminous Slurry
Austroads AG:PT-T250	2010	Modified surface texture depth (PESTLE METHOD)
Austroads AG:PT-T270	2018	Consistency of bituminous slurry
Austroads AG:PT-T271	2018	Determination of Set and Cure for Bituminous Slurry (Cohesion Test)
Austroads AG:PT-T272	2018	Determination of Abrasion loss of Bituminous Slurry (Wet Track Abrasion Test)
Austroads AG:PT-T273	2018	Determination of Excess Binder in Bituminous Slurry (Loaded Wheel Test)
ISSA TB 114	2017	Wet Stripping Test for Cured Slurry Seal Mix

1171 SUBSURFACE DRAINAGE (CONSTRUCTION)

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide subsurface drainage, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *0319 Auxiliary concrete works*.
- *1101 Traffic management*.
- *1102 Control of erosion and sedimentation (Construction)*.
- *1111 Clearing and grubbing*.
- *1112 Earthworks (Road reserve)*.
- *1174 Drainage blankets*.

1.3 STANDARDS

General

Subsurface drainage: To Austroads AGPT10.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviations apply:

- AAR: Alkali aggregate reactivity.
- CI: Cast iron.

Definitions

General: For the purposes of this work-section the following definitions apply:

- Cleanout: A subsurface drainage inlet at the surface of the pavement, shoulder or surrounding ground surface. Also known as flushout riser and inspection point.
- Mandrel: A short length of smooth pipe of internal diameter 20 mm - 30 mm greater than the external diameter of the slotted pipe being enclosed by filter fabric.
- No fines concrete: Material consisting graded coarse aggregate, typically to a single AS sieve size, bound together by a mixture of cement and water to supply sufficient strength. The result is an open textured cellular concrete with many voids and increased permeability.
- Retempering of concrete: Use of water or admixtures in the mixer to delay the setting of concrete.
- Nominated mix: The designed mix submitted for approval.
- Prefabricated geo-composite drain: A proprietary product typically consisting of a plastic core wrapped in geotextile material, functioning as a single or second stage filter. Also termed as geo-composite edge drain and strip filter drain. These drains can be installed in narrower trenches than traditional pipe drains.
- Geotextile filter: A fabric manufactured from synthetic fibres of long chained polymer such as polypropylene, polyester or similar material and stabilised against deterioration by ultraviolet light. A geotextile filter can be either non-woven or knitted fabric.
- Production filter mix: A mix produced by a supplier using a stationary screening plant to meet the documented filter requirements.

- Trial no fines concrete mix: Trialling of the nominated mix to demonstrate that the mix design conforms to the documented requirements.
- Pervious pipe system: Comprises drainage pipes perforated, slotted, porous pipes, or impervious pipes laid with open joints.
- Staged granular filters:
  - Single stage filter: A granular filter material placed in contact with the trench sides and surrounding the pervious pipe system.
  - First stage filter: A granular filter material or geotextile placed in contact with the trench sides and surrounding a second stage filter surrounding the pervious pipe system.
  - Second stage filter: A granular filter material or geotextile placed in contact with the pervious pipe system and surrounding a first stage filter.

1.5 TOLERANCES

General

The invert of pipe or drain: No more than 25 mm from the documented level and no more than 50 mm from the documented line.

No fines concrete production mix tolerance table

Attribute	Tolerance (% by mass)
Particle size distribution (AS sieve)	
-19.0 mm	± 2
-9.5 mm	± 5
Binder content	+ 3.0/-0

Prefabricated geo-composite drains

Tolerance: ± 40 mm from the documented line and grade.

1.6 SUBMISSIONS

Authorities consultation

Requirement: Submit details of all utility authority notifications before commencing the works including the following:

- Service utility authorities: Submit evidence of notifications including responses received from all utility authorities for excavation in the vicinity using *dial before you dig* notified utility services, a minimum of 14 days before execution of the contract commencement.

Execution details

Siting of work: Submit any changes proposed to the location, length, designed levels, condition of installation or cover required to accommodate the requests from all the service authorities.

No fines concrete: Submit details of the following:

- Handling, storing and batching of materials: Proposed method.
  - Method of charging the mixer, including proposed sequence of adding ingredients.
  - Proposed method of how admixtures will be incorporated.
- Identification certificate (delivery docket) for each batch or load. Include the following:
  - Pre-numbered.
  - Issued sequentially in accordance with order of batching.
  - Time of completion of batching.
- Retempering: Submit details of monitoring for compliance.
- Non-conformance: Submit details of any non-conformance.

Products and materials

General: Submit compliance certificates and test results from a registered testing authority for the following materials:

- Corrugated circular plastic pipe and fittings.
- Plain wall plastic pipe and fittings.
- Corrugated flat plastic pipe and fittings.
- Slotted thick-walled PVC-U pressure pipe.
- Prefabricated geo-composite drains.
- Filter material type: Check test certificates for granular filter materials to **Type A** and **Type B filter grading tables.**
- No fines concrete: Nominated mix, submit the following including evidence of conformance:
  . Cement: Brand and source.
  . Water: Source.
  . Admixtures: Proprietary source, type, name, dosage recommended by the manufacturer and evidence of conformance.
  . Aggregates: Source, geological type, moisture condition, blend proportions and grading for each type of aggregate.
  . Soluble salt content.
  . Mix design: Constituent quantities per m^3 of no fines concrete, water to cement ratio and nominated particle size distribution of aggregates.
  . Permeability.
- Geotextile: Check maximum stored exposure to sunlight no greater than 14 days.

Records

Work-as-executed drawings: Submit plans of the completed subsurface drainage systems showing clearance and relative levels to the finished road construction One design file in accordance with the ADAC specification, which is available on Council's website.

Information Sheets: Submit details of completed drain or drainage system, 5 days after completion of each drain or drainage system or as agreed with the superintendent.

No fines concrete: Submit at the end of each day, the total of individual masses of cement and aggregate used in the day's production.

Tests

Results: Submit results of testing to **ANNEXURE** – **MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

Variations

Other types of subsurface drainage pipes: If proposed submit details of the type of pipe, and evidence of conformance.

1.7 INSPECTIONS

Notice

Give notice so that inspection may be made of the following:

- No fines concrete: Retempering.
- Siting of works: Set-out location and levels.
- Trenches: Excavation to the documented line, grade, width and depth.
- Laying of pipes: Compacted bedding, and placement of pipes to documented line and level.
- Backfilling: Documented level and relative compaction.
- Geotextile: Placement of fabric and not exposed to sunlight more than 14 days in both the trench and preconstruction storage.
- Flush test: Clean-outs of subsoil drainage lines.
- Inspection points for flushing: Check locations of inspection points, flush out risers and outlets at low points.

2 MATERIALS

2.1 SELECTION OF SUBSURFACE DRAIN AND FILTER TYPE

Subsurface pavement drains type

Pavement drains: Select from the **Subsurface drain and filter type table**.

Subsurface drain and filter type table

Parent Soil	Permeability range(m/sec)	Type of pavement drain (1)	Filter material (2)
Homogenous clay with very low permeability	$<10^{-9}$	Type 3 or Type 4	Sand (Grade A1 to A3)
Silty or sandy clays and stratified clays with moderate low permeability	10^{-9} to 10^{-5}	Type 2,Type 3 or Type 4	Sand (Grade A4 to A6)
Clean sand or gravel with high permeability	$>10^{-5}$	Type 1 or Type 2	Aggregate (Grade B1 or B2)
Solid rock or clean broken rock with high permeability to permeable fissures	Not applicable	Type 1	Aggregate (Grade B3 or B4)
Notes: 1. Pavement drains Type1, Type 2, Type 3 and Type 4 to AGPT10 Figure 3.1. 2. Filter material properties to **Type A filter gradings table** and **Type B filter gradings table**. Source: Austroads AGPT10			

2.2 SUBSURFACE DRAINAGE PIPES

General

Fittings: Joints, couplings, elbows, tees and caps to the manufacturer's recommendations.

Corrugated circular plastic pipe and fittings

Standard: To AS 2439.1.

Pipe: Conform to the following:

- Size: 65 or 100 mm diameter.
- Clean-outs and outlets: 100 mm diameter unslotted pipe set into a suitable concrete surface access surrounded with access cap and associated location marker posts.
- Type: Type 1.
- Class: SN20.
- 65 mm diameter pipes in edge drains under kerbs and in no fines concrete: Class SN8 pipe or higher.

Plain wall plastic pipe and fittings

Standard: To AS 2439.1.

- Type: Type 2.
- Size: As documented.

Corrugated flat plastic pipe and fittings

Standard: To ASTM D2122.

Size: 170 or 300 mm high.

Clean-outs and outlets: 100 mm diameter unslotted pipe.

Slotted thick-walled PVC-U pressure pipe and fittings
Standard: To AS/NZS 1477.

Pipe: Conform to the following:

- Size: If not documented, conform to the following:
  . Nominal diameter: 58 mm.
  . Minimum wall thickness: 6.5 mm.
- Type: Slotted except where documented otherwise.
- Slot sizes and spacings: To **ANNEXURE - SLOTTING DETAILS FOR THICK-WALLED PVC-U PRESSURE PIPE**.

Joints: Square ends and butt jointed.

Prefabricated geo-composite drains and fittings
General: Conform to the following:

- Joints and fittings: Use manufactured joints and fittings.
- Damage: Show no signs of cracks, splits or indents.
  . Supply of coils or bundles: Make sure that if ties are used, they do not cause any damage to drain.

Rigid geo-composite drain: Conform to the following:

- Standard: To ASTM D7001-06.
- Type: Class B.
- Requirement: To the **Rigid geo-composite drains - Load bearing properties table**.
- Properties:
  . Elongated high density polyethylene.
  . Corrugated.
  . Perforated or non-perforated.
  . Location of perforations: Minimum 20 mm from the bottom of geo-composite drain.
  . Clear water opening (150 and 300 mm drain): 3.5%.

Rigid geo-composite drains - Stiffness properties table

Property	Test method	Requirement (150 and 300 mm drains)
Horizontal compressive strength at 20% deflection	ASTM D2412	Minimum 200 kPa
Change in core area	ASTM D6244	< 5% loss in internal core area

Flexible geo-composite drain: Conform to the following:

- Requirement: To the **Flexible geo-composite drains - Load bearing properties table**.
- Do not use flexible strip filter drains in pavement subsurface with traffic loading.
- Properties:
  . High density polyethylene with a geotextile wrapping.
  . Geotextile: Non-woven and strength class A. To the **Robustness classification of geotextiles table.**

Flexible geo-composite drains - Stiffness properties table

Horizontal loading	Geo-composite drain height		
	Up to 200 mm	200 to 400 mm	400 mm and above
Min force (kN) at 4 mm deflection	5.5	11	16.5

2.3 FILTER MATERIAL

Standard
General: AS 1141.11.1

General
Properties: Clean, hard, and durable particles.

Subsoil drains laid in or adjacent to planted areas: pH range of filter material 6 to 7.

Compatibility of Filters with soils and Pipes: To Austroads AGPT10 Section 5.6:

- Standard filter gradings: To **Type A Filters Table** and **Type B**
- **Filter Table**.
  . Type A filter: Use with natural soil, geotextile filters and pavement materials (A1 to A6)
  . Type B filter: Use as second stage filters to Type A, or with geotextiles. (B1 to B4)

Parent soil: Select filter(s) based on the parent soil to be drained.

Type A Filter gradings table
Single and first stage filters (including sands, uniformly graded fine aggregates and gravel)

Type A	**Percentage passing sieve**					
	A1	**A2**	**A3**	**A4**	**A5**	**A6**
Description of filter	Dune sand	Course washed sand		5 mm one size	6 – 8 mm one size	Sandy gravel
37.5 mm						100
26.5 mm						
19.0 mm					100	85 - 100
13.2 mm					90 - 100	
9.50 mm		100	100	100	70 - 100	65 - 100
4.75 mm		90 - 100	90 - 100	70 - 100	28 - 100	45 - 82
2.36 mm	100	75 - 100	70 - 100	0 - 50	0 - 28	30 - 60
1.18 mm	95 - 100	50 - 98	40 - 65	0 - 10	0 - 8	15 - 40
600 micron	70 - 98	30 - 80	12 - 40			5 - 25
300 micron	30 - 60	10 - 40	0 - 16	0 - 5	0 - 5	0 - 10
150 micron	0 - 12	0 - 7	0 - 4			0 - 5
75 micron	0	0 - 3	0 - 3	0 - 3	0 - 3	0 - 3
Parent soil	**Silt and friable clays**		**Sand silts**	**Fine to medium sands**	**Coarse sand**	**Sandy silts**
Maximum pipe slot width	0.4 mm	0.6 mm	1.5 mm	3.0 mm	3.3 mm	5.0 mm
Suitable second stage filter	**B1**	**B2**	**B3**	**B4**		**B3 or B4**

Type B filter gradings table

Second stage filters (uniformly graded aggregates)

Type B	**Percentage passing sieve**			
Direction of Filter	**B1**	**B2**	**B3**	**B4**
	5 mm one size	6 – 8 mm one size	10 mm one size	19 mm one size
37.5 mm				
26.5 mm				100
19.0 mm		100	100	70 - 100
13.2 mm		90 - 100	90 - 100	0 - 30
9.50 mm	100	70 - 100	40 - 70	0 - 10
4.75 mm	70 - 100	28 - 100	0 - 15	
2.36 mm	0 - 50	0 - 28	0 - 5	0 - 5
1.18 mm	0 -10	0 - 8		
600 micron				
300 micron	0 - 5	0 - 3		
150 micron				Oct 2
75 micron	0 - 3	0 - 3	0 - 3	0 - 3
Proposed use	**With type A1**	**With type A2**	**With types A3, A6**	**With types A4, A6**
Maximum pipe slot size	3.0 mm	3.3 mm	9.0 mm	15.0 mm

Robustness classification of geotextiles (G strength rating) table

Geotextile strength class	**Elongation** [1]	**Grab strength** [2] **(N)**	**Tearing strength(N)** [3]	**G rating** [4]
A	≥30	500	180	900
	<30	800	300	1350
B	≥30	700	250	1350
	<30	1100	400	2000
C	≥30	900	350	2000
	<30	1400	500	3000
D	≥30	1200	450	3000
	<30	1900	700	4500
E	≥30	1600	650	4500

Notes:
1. % elongation corresponding to max CBR burst strength determined in accordance with AS 3706.4.
2. Grab strength is the 80thpercentile characteristic value of the lot when tested in accordance with AS 3706.2.
3. Tearing strength is the 80th percentile characteristic value of the lot when tested in accordance with AS 3706.3 .

Geotextile strength class	Elongation (1)	Grab strength (2) (N)	Tearing strength(N) (3)	G rating (4)
4. G rating calculated on the 80th percentile values of CBR burst strength when tested in accordance with AS 3706.4 and drop height determined in accordance with AS 3706.5. Where the strain at failure during the CBR burst strength exceeds 80%, the CBR burst strength at 80% strain shall be used. 5. The number of tests shall be in accordance with AS 3706.1, but grab strength shall be determined on a 10 lot test. Source: Austroads AGPT04G.				

Geotextile filter properties table

Geotextile filter type (1)	Minimum robustness G (2)	EOS (3)(microns)	Minimum elongation(4) (%)
First stage filter	900 (moderately robust)	85 - 230	45
Second Stage Filter	600 - 900	125 – 350	20
Notes: 1. Geotextile filter type may vary in different states 2. G = Geotextile strength rating 3. EOS = Equivalent opening size using AS 3706.7. Determination of pore size distribution- dry sieving method. 4. Elongation at break as determined by AS 3706.2. Determination of tensile properties – wide strip method. Source: Austroads AGPT10. Storage of Geotextiles: Store geotextiles away from sunlight and not be exposed unnecessarily to sunlight during delivery and placement.			

2.4 NO FINES CONCRETE

Coarse aggregate

Properties: Clean and durable.

Standard: To AS 2758.1.

Coarse aggregate properties table

Test method	Property	Requirement
AS 1141.4	Bulk density	Minimum 1200 kg/m³
AS 1141.6.1	Particle density	Minimum 2100 kg/ m³
AS 1141.6.1	Water absorption	Maximum 2.5%
AS 1141.11.1	Particle size distribution	To the **Particle size distribution table**
AS 1141.14	Particle shape:	
	2.1 ratio	Maximum 35%
	3.1 ratio	Maximum 10%
AS 1141.22	Wet strength	Minimum 150 kN
RMS T239	Fracture faces: Two or more	Minimum 80%
AS 1141.22	Wet/dry variation	Minimum 35%
Notes: Bulk density is the same as unit mass.		

Particle size distribution table

AS sieve size (mm)	Percent passing by mass (%)
26.5	100
19.0	95-100
9.5	0-5

Cement

Standard: General purpose cement to AS 3972.

Admixtures

Standard: To AS 1478.1.

Properties: Free from calcium chloride, calcium formate, triethanolamine or any other accelerator.

Combining admixtures: Do not combine without verification from the admixtures manufacturers that they are compatible.

Warm season retarder: Use a lignin or lignin-based (ligpol) set-retarding admixture, Type Re or Type WRRe.

Cool season retarder: Use a lignin or lignin-based set-retarding admixture containing maximum 6% reducing sugars, Type WRRe.

Alkali contribution: The total alkali contribution (measured as Na_2O) from all admixtures used in any mix must not exceed 0.20 kg/m^3.

Other admixtures which may be used: Superplasticisers and high range sodium oxide water reducers, Type HR, WR, Re.

Water

Mixing water: To AS 1379 clause 2.4.

Water properties: Clean potable water, free from any material which may be harmful to the concrete or reinforcement including oil, acid, alkali, organic or vegetable matter.

Limits of impurities in mixing water: To AS 1379 Table 2.2 and the following:

- Chloride ion: Maximum 500 parts per million to AS 1289.4.2.1.
- Sulphate ion: Maximum 400 parts per million to AS 1289.4.2.1 or APHA 4500-CL.

Nominated mix

Variations to the nominated mix: Any change without approval is subject to removal from the Works.

Aggregate to cement and water to cement ratios table

Grade	Aggregate to cement ratio (by mass)	Water to cement ratio
NFC SD	6:1	0.35-0.45

2.5 GEOTEXTILE

Standard

General: To AS 3706.

Properties

Requirement: Conform to the following:

- Material: A woven, non-woven or knitted type manufactured from synthetic materials other than polyamide, except seamless tubular filter fabric.
- Type: Needle punched, chemically bonded or heat melded.
- Curtain drains material: Polyester, polypropylene or polyethylene.
- Bio-stable and resistant to attack by alkalis, acids, dry heat, steam, moisture, brine, mineral oil, petrol, diesel and detergents.
- Open air exposure: Remove to spoil any geotextile exposed to sunlight for more than 14 days.
- Selection of material for robustness and strength: To suit subgrade conditions for the relevant location/ or function.
- Minimum mass requirements: As documented.
- Rate of water flow: To Austroads AGPT04G Table 4.1, under 100 mm constant head.
- Needle punched, non-woven geotextile representative equivalent opening size: Between 75 and 150 µm.
- Free of imperfections in weave or yarn, abrasion resistant and weave stability qualities such that it does not form holes, ladder, de-weave, tear or unravel more than 5 mm from a cut end.

Identification, marking and storage

Standard: To AS 3705.

Protection: Cover each roll to protect the fabric against moisture and ultraviolet radiation.

Storage: Store under a protective cover and support off the ground. Protect from damage and conform to the manufacturer's recommendations.

Seamless tubular filter fabric

Material: Polypropylene or polyester seamless knitted tubular filter fabric.

Arrangement: Enclose slotted pipe of 65 mm or 100 mm diameter.

Representative large opening size: Between 200 and 500 µm.

Fitting: Conform to the requirements of **ANNEXURE - PROCEDURE FOR FITTING SEAMLESS TUBULAR FILTER FABRIC TO SLOTTED PIPE**.

Damaged filter fabric: Remove and replace filter fabric that is torn, excessively stretched or otherwise damaged during transportation, storage, fitting of the fabric or pipe laying. Replace filter fabric exposed for more than 14 days to sunlight.

2.6 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Quality verification: If material/product quality verification can be obtained from the supplier, documented tests need not be repeated.

Test authority: A registered laboratory.

Nominated mix aggregates testing: Date of testing less than 18 months from the time the nominated mix is proposed to be used.

No fines concrete: Coarse aggregate properties, conform to the following:

- Fractured faces: Each fractured face to be a signification proportion of the total surface area of the particle.
  . Aggregates derived from igneous rock: Test not required.
- RMS T239.

- AAR: For petrographic examination, eliminate without further testing aggregates containing reactive components, including the following:
  . Opaline material.
  . Unstable silica minerals including tridymite and cristobalite.
  . Sheared rock with stained quartz and microcrystalline quartz.
- Soluble salts content: Conform to the following:
  . Chloride ion: < 0.8 kg/m³ of concrete.
  . Sulphate ion: 5% of the cement content.

3 EXECUTION

3.1 GENERAL

Clearing and grubbing
Requirement: To *1111 Clearing and grubbing*.

Subsoil and formation drains
Requirement: To *1172 Subsoil and formation drains (Construction).*

Pavement drains
Requirement: To *1173 Pavement drains (Construction)*.

Drainage blankets
Requirement: To *1174 Drainage blankets*.

Timing: Construct formation drain after completion of clearing and grubbing operations, and before commencement of embankment construction.

3.2 NO FINES CONCRETE

Trial mix
Requirement: Before starting production of each mix, prepare a trial batch of each nominated mix for testing.

Mixing and consistency
Contaminated material: Do not use aggregates that have become intermixed or contaminated with foreign matter.

Cement: Weigh cement separately.

Measuring equipment: Conform to the following:

- Water: Use a calibrated device with one litre increments.
  . Accuracy: ± 2%.
- Admixtures accuracy: ± 5%.

Handling storage and batching
Standard: To AS 1379 Section 4 and Appendix A.

Mixing time: Conform to the following:

- For stationary batch mixers: Not less than 54 seconds plus 6 seconds for each m³.
- For mobile batch mixers: Full period of mixing required at either the testing station or the point of placement.
- Split drum mixers: Maximum 5 minutes.
- Measured from the time all ingredients are in the mixing drum.

Adding mixture

Admixtures: Separate and thoroughly pre-dilute in the mixing water before mixing with other materials. Mix in accordance with the manufacturer's recommendations.

Retempering

Requirement: Conform to the following:

- Designated mixing speed: Not less than 30 revolutions.
- If there is no evidence of original mixing conditions: Re-mix for 55 revolutions.
- Water: Record quantity on the identification certificate for each batch. Make sure it does not exceed the water to cement ratio of the mix.
  - . Addition of water after the commencement of discharge: Record the estimated remaining quantity of no fines concrete.
- Time: Retemper only within 40 minutes of completion of batching.
- Location: Either batch plant, testing stations or point of placement.

Production and transport

Transport and production equipment: Use equipment which:

- Prevent segregation or loss of materials.
- Supply a homogenous product.

Sampling

Requirement: Sample at the point of delivery within 45 minutes of completion of batching.

Material non-conformance

Requirement: Remove from the site and replace with conforming material.

3.3 TEMPORARY DRAINAGE DURING CONSTRUCTION

Temporary drainage during construction

Runoff overflows during construction: Allow for runoff to avoid damage or nuisance due to scour, sedimentation, soil erosion, flooding, diversion of flow, damming, undermining, seepage, slumping or other adverse effects to the Works or surrounding areas and structures.

Equipment and material: Locate clear of watercourses and secure in the event of large runoff flows.

3.4 ESTABLISHMENT

Siting of work

Set-out: To the type of subsurface drains, location and levels, as documented.

3.5 EXCAVATION

Safety

Stabilisation: If required, undertake shoring, sheet piling or other stabilisation of the sides of trench excavation.

Trenches

Method: Excavate trenches as follows:

- To the line, grade, width and depth as documented or as required.
- Minimum grade: 0.5%.
- Construct the bottom of the trench to avoid localised ponding.
- Remove all loose material.

Unsuitable material

Requirement: Rectify unsuitable material to **UNSUITABLE MATERIA**L in the *1112 Earthworks (Road reserve)* work-section and as follows:

- Remove and dispose of unsuitable material at the bottom of the trench or at foundation level.
- Replace with backfill material to conform to the requirements of this work-section.
- Trim the bottom of the excavated trench or foundation parallel with the documented level and slope of the work.

Laying of pipes

Joints: Minimise joints in the pipeline.

Joints in slotted pipe: To the manufacturer's recommendations.

Flushout points construction: Construct flushout points at the locations shown on the Drawings, complete with concrete covers and cover caps.

Bedding for pipes in the geotextile wrapped zone

- General: Place filter aggregate bedding for the pipework as documented.
- Minimum depth of the bedding: 50 mm.

Prefabricated geo-composite drains

Flow rate: Space out outlets more frequently than for standard drain pipes to achieve the same flow capacity or increase drainage grade.

Laying of drain: Conform to the following:

- Trenches: Minimum 500 mm depth and 150 mm width.
- Location: Position centrally within the trench and place vertically.
  . Other drainage pipes: If required, place alongside other drainage pipes in the same trench.
- Bedding: Not required and drain can be directly laid on the floor of the trench.

Joints: If geotextile is used to wrap sections of drain, use a minimum width of 450 mm.

Rigid geo-composite drains: Wrap pipe with non-woven geotextile strength class A encapsulating the drain and join the geotextile by heat or electrical weld to the **Robustness classification of geotextiles table.**

3.6 BACKFILLING

General

Prevent damage to pipes: Place, spread, compact the subbase by tamping around and over the pipe to avoid damage to the drain pipes.

No fines concrete: Do not mechanically tamp.

Compaction: Compact cohesionless material to a Density Index of 70%.

Staged construction

Stage 1: After constructing the underlying trench, protect the filter material placed from scour and/or contamination by overlapping the geotextile above the underlying trench and placing a sacrificial geotextile or plastic. Cover with a 50 mm thick plug/cap of select fill material with a maximum particle size of 25 mm.

Stage 2: Place and compact above the plug the selected fill material to a relative compaction of 95%.

Stage 3: Excavate, remove plug/cap, and any contaminated filter material and any selected material covering. Conform to the following:

- Do not disturb previously laid pipes, filter sock or geotextile.
- Extend height of the underlying trench to the underside of the pavement.
- Alignment and width of trench: Same as the underlying trench.

Stage 4: Replace with filter material and compact to 95% relative compaction and place any overlying pavement layers.

3.7 GEOTEXTILE

Location

Extent: As documented.

Requirement: Install at the interface between the filter material and adjoining materials.

Installation

Placement: Cover the bottom and sides of the trench with sufficient fabric to wrap around the completed drain. Conform to the shape of the trench with minimal wrinkles, folds or air voids between fabric and trench, but not stretched over the soil. Do not allow loose material from outside of the trench to enter the excavation.

Intersections: Minimum 200 mm laps.

Program: Less than 14 days between initial laying out and final cover of the geotextile with drainage backfill layer. Where possible, place geotextiles just ahead of construction works, and cover with materials within 48 hours.

Protection: Secure the geotextile to prevent movement by wind or by construction. Protect and avoid damage during installation and backfilling operations.

Removal and replacement: Remove damaged geotextile. Remove and replace if geotextile is exposed to sunlight for longer than 14 days.

3.8 OUTLET STRUCTURES

Discharge and salinity prevention

Subsurface drainage pipes: Connect discharge into gully pits or to outlet structures, as documented.

Salinity prevention: Discharge on the downhill side of the embankment or in the cut area, to avoid recharging the subsurface water table.

Outlets

Location intervals: 120 m maximum.

Rodent proofing method: Secure outlets, including those discharging into gully pits, with stainless steel or UPVC filter fitting to prevent access by rodents.

Erosion control

Method: Locate the outlet so that erosion of the adjacent areas does not occur and/or protect the outlet by the placement of selected stone.

Locations: Provide marker posts to indicate the location of pipe outlets and assist maintenance. **To Marking of drains and outlets.**

Outlet pipe

Type: Install unslotted outlet pipes from curtain drains.

Levels: Make sure no point in an outlet pipe is higher than the pipe at the end of the curtain drain.

Concrete

Requirement: To the *0319 Auxiliary concrete works* work-section.

Batters

Requirement: If connection to a trench drain or stormwater pit is not possible, install an outlet at the batter to discharge water beyond the edge of the road.

Pipe: Conform to the following:

- Type and size: Same as documented within the subsoil, formation or pavement drains.

- Length extending beyond the edge of the pavement: Non-perforated laid at the base of the trench.

Height: Taper height of the base of the trench of the connecting section of perforated pipe, from 0 to 100 mm, over a 2 m length.

Backfill: Backfill the section of pipe with selected material and conform to the following:

- Maximum particle size: 50 mm.
- Relative compaction: 95%.

3.9 CLEAN-OUTS

General

Requirement: Provide clean-outs and cast-iron caps, as documented.

Cleanout pit location: At the commencement start of each run of subsoil drain line.

Intervals: Approximately 100 – 140 m to cleanout risers and pits.

Flush out point: Provide the subsoil drain flush out point with a concrete cover of Class N32 concrete fitted with a removable cap to Austroads AGRD05A, Figure 8.4.

3.10 MARKING OF DRAINS AND OUTLETS

General

Marker Posts: Provide white powder coated galvanised steel post box sections with the following properties:

- Dimensions: 80 mm x 40 mm X 1200 mm high with welded steel cap on top of the posts.
- Drive posts:
  - Underground: 500 mm
  - Above ground: 700 mm.
- Stencil with black letters: SS DRAIN on the 80 mm face of the post facing the road.
  - Letters dimensions with height 60 mm and width 30 mm.

3.11 RECORDING

General

Work-as-executed plans: Record details of all subsurface drainage pipes and the completed subsurface drainage systems.

Information sheets: Include the following:

- Date of completion of drain construction.
- Drain number.
- Type of drain.
- Pipe size.
- Pipe type.
  - Seamless tubular filter fabric enclosure: If proposed.
- Filter type.
- Grade of drain and levels of the drain relevant to the finished edge of the road pavement or top of kerb.
- Locations of clean-outs.
- Locations of outlets: Include GPS coordinates.
- Geotextile type.
  - Seamless tubular filter fabric enclosure: If proposed.
- Response time: The time taken for water to travel from the inlet end of a drain or from a clean-out leading to a drain, to the outlet end of the drain.

3.12 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Site tests

- No fines concrete: Permeability greater than 20 mm/s.
- Geotextile exposed to sunlight in excess of 21 days: 60% retained strength.
- Flush test: After completion of backfilling, pump clean water into the clean-out at the commencement start of each run, until only clean water discharges at the outlet.
  . Minimum rate of flow of flushing water at the inlet: 100 l/min at the inlet.

4 ANNEXURES

4.1 ANNEXURE - SUBSURFACE DRAINAGE SCHEDULE

Drainage Run	Nominal Depth of Trench (mm)	Pipe			Filter type					Geo-composite Drain		
					Single or First Stage		Second Stage					
		Category	Diameter (mm)	Perforation Size (mm)	Granular	Geotextile	Granular	Geotextile	EOS of Geotextile (microns)	Type	Width (mm)	Granular Backfill

4.2 ANNEXURE - SLOTTING DETAILS FOR THICK-WALLED PVC-U PRESSURE PIPE

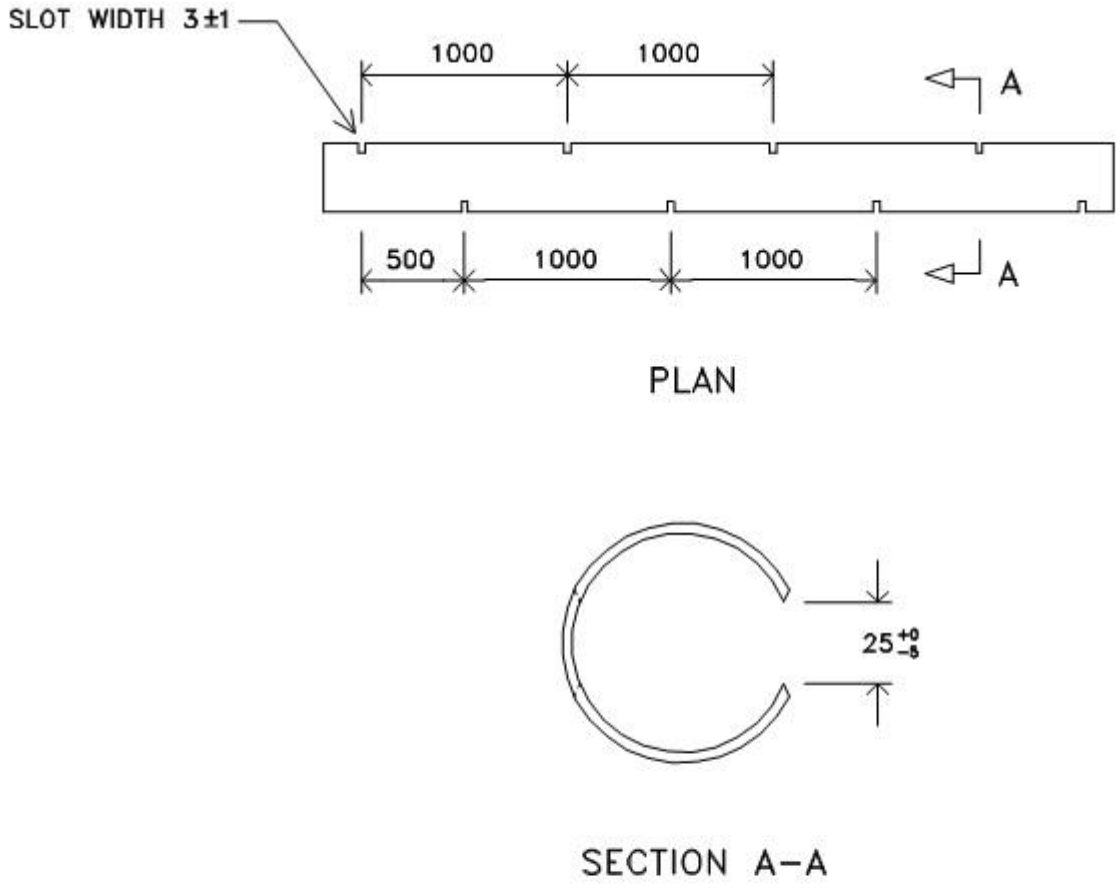


Diagram not to scale
Dimensions are in millimetres

4.3 ANNEXURE - PROCEDURE FOR FITTING SEAMLESS TUBULAR FILTER FABRIC TO SLOTTED PIPE

General

Installation: Fit filter fabric to the slotted pipe on site immediately before it is laid in its final position in the works.

Requirement: Conform to the following procedure:

- Pull the filter fabric over and onto the mandrel. Pass the slotted pipe through the mandrel.
- Clamp the filter fabric to the forward end of the slotted pipe, when the end of the slotted pipe emerges from the mandrel, so that it cannot slip back along the pipe.
- Pull the remaining slotted pipe through the mandrel, allowing the filter fabric to progressively slip and stretch fit over the slotted pipe as it emerges.

- Neatly cut the filter fabric, leaving an overhang off the end of the pipe, after the slotted pipe has passed through the mandrel. This allows for a fully covered join with an adjacent pipe when the pipes are installed in the drain.
- Clamp the filter fabric to the end of the slotted pipe, so that the filter fabric remains stretch-fitted onto the pipe when the pipe is positioned in the drain.

Precautions

Protection from damage: Do not drag the slotted pipe fitted with seamless tubular filter fabric over the ground. If carrying, lift off the ground, and protect from damage.

Damaged fabric: If the filter fabric is damaged and its filtering properties affected, remove it from the pipe and replace it with undamaged filter fabric.

Loose fabric: If the filter fabric becomes loose on the slotted pipe during installation, re-stretch it to the correct position. If re-stretching causes damage to the filter fabric, remove it and replace with undamaged filter fabric.

4.4 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS Service utility authorities consultation	H	Results of consultation with service authorities	14 days minimum before contract commencement	Commencement of work
SUBMISSIONS Products and materials Circular plastic pipe and fittings	H	Compliance certificates and test results	7 days before supply of pipes	Pipe and fittings supply (round plain wall pipes)
SUBMISSIONS Products and materials Corrugated flat plastic pipe and fittings	H	Compliance certificates and test results	7 days before supply of pipes	Pipe and fittings supply (corrugated pipes)
SUBMISSIONS Products and materials Slotted thick-walled PVC-U pressure pipe	H	Compliance certificates and test results	7 days before supply of pipes	Pipe and fittings supply (slotted thick-walled PVC-U pressure pipe)
SUBMISSIONS Products and materials Filter granular material	H	Type of filter material and grading Type A and B gradings	7 days before	Delivery of granular filter material
SUBMISSIONS	H	Nominated mix: Submit the following including	5 days before date of delivery	Delivery of no fines concrete

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
Products and materials No fines concrete		evidence of conformance: - Cement: Brand and source. - Water: Source. - Admixtures: Proprietary source, type, name, dosage recommended by the manufacturer and evidence of conformance. - Aggregates: Source, geological type, moisture condition, blend proportions and grading for each type of aggregate. - Soluble salt content. - Permeability.		
SUBMISSIONS Records of no fines concrete placed each day	H	Daily record of mass of no fines concrete placed	End of each day	Records
SUBMISSIONS Work- as – executed information sheets for completed subsoil drains	W	Show levels and clearance of the subsoil pipes to the finished road construction.	5 days after subsoil pipe completion.	Information sheets given to Superintendent.
SUBMISSIONS Products and materials Geotextile	H	Data sheets, compliance certificates and test results	14 days before supply of pipes	Geotextile supply
SUBMISSIONS Execution details Siting of work	H	Changes proposed to the length, location, designed levels, condition of installation or cover	7 days before commencement	Commencement
INSPECTIONS Notice No fines concrete	H	Retempering if required.	3 days before after retempering	Notice to Superintendent
INSPECTIONS, Notice Siting of works	H	Set-out of location and levels	7 days before pipe installation	Pipe installation
INSPECTIONS, Notice	H	Excavation to the documented line, grade, width and depth	1 days before pipe installation	Pipe installation

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
Trenches				
INSPECTIONS, Notice Laying of pipes	H	Compacted bedding, and Placement of pipes or geo-composite drains to documented line and level	1 day before backfilling	Backfilling
INSPECTIONS, Notice Backfilling	H	Documented level and relative compaction	1 day before covering with geotextile	Placement of geotextile
INSPECTIONS, Notice Geotextile	H	Placement of fabric	1 day before backfilling	Backfilling
INSPECTIONS, Notice Flush test	H	Clean-outs of subsoil drainage lines	3 days before completion	Completion
*H = Hold Point W = Witness Point				

4.5 ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Material supply	Material quality — Supplier's documentary evidence and certification of:			
	Circular plastic pipe and fittings	1 contract/size	1 per type/size	AS 2439.1
	Plain wall plastic pipe and fittings	1 contract/size	1 per type/size	AS 2439.1 and RMS T1507
	Corrugated flat plastic pipe and fixings	1 contract/size	1 per type/size	ASTM D2122
	Thick-walled PVC-U pressure pipe:	1 contract/size	1 per type/size	AS/NZS 1477
	- Transmissivity property	1 contract/size	1 per type/size	ASTM D6574/D6574M
	- Crush strength test	1 contract/size	1 per type/size	AS 2439
	Prefabricated geo-composite drains: Damage	1 contract/size	1 per type/size	RMS T1508, RMS T1509 and RMS T1510
	Rigid geo-composite drains:			
	- Horizontal compressive strength	1 contract/size	1 per type/size	ASTM D2412
	- Change in core area	1 contract/size	1 per type/size	ASTM D6244

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
	Flexible geo-composite drains:			
	- Stiffness	1 contract/size	1 per type/size	RMS T1507
	Filter material:			
	- Grading **Type A filter gradings table**	1 contract/size	1 per type	AS 1141.11.1
	- Grading for **Type B filter** - **gradings table**	1 contract/size	1 per type	AS 1141.11.1 and AS 1141.22
	- Compaction	1 contract/size	1 per type	AS 1289.5.6.1
	No fines concrete:			
	- Bulk density	1 contract	1 per type	AS 1141.4
	- Particle density	1 contract	1 per type	AS 1141.6.1
	- Water absorption	1 contract	1 per type	AS 1141.6.1
	- Particle size distribution	1 contract	1 per type	AS 1141.11.1
	- Particle shape: 2:1 ratio	1 contract	1 per type	AS 1141.14
	- Particle shape: 3:1 ratio	1 contract	1 per type	AS 1141.14
	- Petrographic examination	1 contract	1 per type	ASTM C295/C295M
	- Assessment and classification: Mortar bar test	1 contract	1 per type	RMS T363
	- Assessment and classification: Concrete prism test	1 contract	1 per type	RMS T364
	- Wet strength: Particle distribution interval	1 contract	1 per type	AS 1141.22
	- Fractured faces	1 contract	1 per type	RMS T239
	- Wet/dry variation	1 contract	1 per type	AS 1141.22
	- Chloride testing: Aggregates	1 contract	1 per type	AS 1012.20.1
	- Chloride testing: Water and admixtures dissolved in water	1 contract	1 per type	AS 1478.1

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
	- Sulphate testing: Aggregates	1 contract	1 per type	AS 1012.20.1
	- Sulphate testing: Water and admixtures	1 contract	1 per type	AS 1289.4.2.1
	- Sulphate testing: Cementitious material	1 contract	1 per type	AS 2350.2
	- Soluble salts: Hardened concrete	1 contract	1 per type	AS 1012.20.1
	- Permeability: Moulding and curing specimens	1 contract	1 per type	RMS T376
	Permeability test	1 contract	1 per type	RMS T377
	Geotextile:			
	- Identification and marking	1 contract	1 per type	AS 3705
	- General	1 contract	1 per type	AS 3706 (Various)
	- Rate of water flow: Perpendicular flow test	1 contract	1 per type	AS 3706.9
	- Exposure to sunlight in excess of 21 days	1 contract	1 per type	AS 3706.11
	- Seamless tubular filter fabric: Opening size	1 contract	1 per type	RMS T1524
	- Seamless tubular filter fabric: Laddering, unravelling or deweaving from a cut end	1 contract	1 per type	RMS T1521
	- Seamless tubular filter fabric: Abrasion resistance	1 contract	1 per type	RMS T1522
	- Seamless tubular filter fabric: Weave stability	1 contract	1 per type	RMS T1523
Excavation – Trench base	Line and grade	1 drainage line	1 per 200 lin. m	Survey
	Compaction	1 drainage line	1 per 200 lin. m*	AS 1289.5.4.1

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Bedding and backfill: - Filter material	Compaction	1 drainage line	1 per drainage line	AS 1289.5.4.1
- Selected backfill	Compaction	1 drainage line	1 per 200lin m*	AS 1289.5.4.1
- Earth backfill	Compaction	1 drainage line	1 per 200 lin. m*	AS 1289.5.4.1
- Cohesionless backfill	Compaction	1 drainage line	1 per 200 lin. m*	AS 1289.5.6.1
Staged construction	Temporary plug over filter material: Plasticity Index of fill material	1 contract	1 per type	AS 1289.3.3.1
* Note: or part thereof, per lot				

4.6 ANNEXURE - PAY ITEMS

Pay items	Unit of measurement	Schedule rate inclusions
1171.1 Subsoil drain pipe - Corrugated circular plastic pipe and fittings, plain wall plastic pipe, thick-walled PVC-U pressure pipe or prefabricated geo-composite drain	Linear Metres (Lin. M) - Measured along the length of the pipe.	All costs associated with: - Supply and laying of the subsoil pipe including connections, markers, fittings and seamless tubular filter fabric where documented. - The schedule quantity is a provisional quantity.
1171.2 Filter material Type A, backfill for single and first stage filters	- Compacted m^3 - Calculate the volume from the actual length and depth of the trench or blanket up to the level of the filter material multiplied by the design width of the trench.	- All costs associated with supply, placement and compaction of filter material and the capping of the trench where documented. - The schedule quantity is a provisional quantity.
1171.3 Filter material Type B backfill for second stage filters	- Compacted m^3 - Calculate the volume from the actual length and depth of the trench or blanket up to the level of the filter material multiplied by the design width of the trench or blanket.	- All costs associated with supply, placement and compaction of filter material and the capping of the trench where documented. - The schedule quantity is a provisional quantity.
1171.4 No fines concrete	- Compacted m^3	- All costs associated with supply, placement and compaction of no fines concrete.
1171.5 Outlet structures for subsurface drainage pipes	- Each outlet structure.	- Outlet structures in conformance with this work-section excluding outlets into pits. - All costs associated with the construction of the outlet

Pay items	Unit of measurement	Schedule rate inclusions
		including forming of the structure, supply of concrete and, the provision of erosion control measures. - The schedule quantity is a provisional quantity.
1171.6 Supply of geotextile	m² - Area covered by geotextile as measured on site.	All costs associated with: - Supply, placement and securing of the geotextile material. - No additional payment for additional geotextile used at intersections. - The schedule quantity is a provisional quantity.
1171.7 Establishment – Setting out	Lump Sum	All costs associated with setting out and associated survey work.
1171.8 Clean-out structures	Each - Clean-out structure constructed as documented.	All costs associated with the following: - Provision of clean-out structures - Supply and installation of lids - Recording of clean-out locations in accordance with *1171 Subsurface drainage (Construction)*. The schedule quantity is a provisional quantity.
Minor concrete		To the *0319 Auxiliary concrete works.*
Control of erosion and sedimentation		To *1102 Control of erosion and sedimentation (Construction)*.
Earthworks		To *1112 Earthworks (Road reserve).*
Traffic management	Lump sum	To *1101 Traffic management*.

4.7 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1012		Methods of testing concrete
AS 1012.20.1	2016	Determination of chloride and sulphate in hardened concrete and concrete aggregates
AS 1141		Methods for sampling and testing aggregates
AS 1141.4	2000	Bulk density of aggregate
AS 1141.6.1	2000	Particle density and water absorption of coarse aggregate - Weighing-in-water method
AS 1141.11.1	2009	Particle size distribution - Sieving method
AS 1141.14	2007	Particle shape, by proportional caliper
AS 1141.22	2008	Wet/dry strength variation
AS 1289		Methods of testing soils for engineering purposes
AS 1289.3.3.1	2009	Soil classification tests - Calculation of the plasticity index of a soil

AS 1289.4.2.1	1997	Soil chemical tests - Determination of the sulphate content of a natural soil and the sulphate content of the groundwater - Normal method
AS 1289.5.4.1	2007	Soil compaction and density tests - Compaction control test - Dry density ratio, moisture variation and moisture ratio
AS 1289.5.6.1	1998	Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material
AS 1379	2007	Specification and supply of concrete
AS/NZS 1477	2017	PVC pipes and fittings for pressure applications
AS 1478		Chemical admixtures for concrete, mortar and grout
AS 1478.1	2000	Admixtures for concrete
AS 2350		Methods of testing Portland, blended and masonry cements
AS 2350.2	2006	Chemical composition
AS 2439		Perforated plastics drainage and effluent pipe and fittings
AS 2439.1	2007	Perforated drainage pipe and associated fittings
AS 2758		Aggregates and rock for engineering purposes
AS 2758.1	2014	Concrete aggregates
AS 3705	2012	Geotextiles - Identification, marking, and general data
AS 3706		Geotextiles - Methods of test
AS 3706.1	2012	General requirements, sampling, conditioning, basic physical properties and statistical analysis
AS 3706.2	2012	Determination of tensile properties - Wide strip and grab method
AS 3706.3	2012	Determination of tearing strength - Trapezoidal method
AS 3706.4	2001	Determination of burst strength - California bearing ratio (CBR) - Plunger method
AS 3706.5	2000	Determination of puncture resistance - Drop cone method
AS 3706.7	2014	Determination of pore-size distribution - Dry sieving method
AS 3706.9	2012	Determination of permittivity, permeability and flow rate
AS 3706.11	2012	Determination of durability - Resistance to degradation by light, heat and moisture
AS 3972	2010	General purpose and blended cements
Austroads AGPT		Guide to pavement technology
Austroads AGPT04G	2009	Geotextiles and geogrids
Austroads AGPT10	2009	Subsurface drainage
Austroads AGRD		Guide to road design
Austroads AGRD05A	2013	Drainage – Road surface network, basins and subsurface
RMS T239	2012	Fractured faces of coarse aggregate
RMS T363	2012	Accelerated mortar bar test for the assessment of alkali-reactivity of aggregate
RMS T364	2012	Concrete prism test for AAR assessment
RMS T376	2016	Moulding of no fines concrete specimens
RMS T377	2016	Water permeability of no fines concrete (Falling head laboratory permeameter)
RMS T1507	2012	Determination of the compressive stiffness of strip filters
RMS T1508	2012	Determination of the low temperature resistance of strip filters during straightening
RMS T1509	2012	Determination of the high temperature impact resistance of strip filters
RMS T1510	2012	Determination of the low temperature impact resistance of strip filters
RMS T1521	2012	Laddering, unravelling of deweaving of a seamless knitted tubular filter fabric from a cut E
RMS T1522	2012	Abrasion resistance of seamless knitted tubular filter fabric
RMS T1523	2012	Weave stability of seamless knitted tubular filter fabric
RMS T1524	2012	Determination of opening size of seamless knitted tubular filter fabric
APHA 4500-CL	1992	Standard Methods for the Examination of Water and Wastewater

ASTM C295/C295M	2012	Standard guide petrographic examination of aggregates for concrete
ASTM D2122	2016	Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
ASTM D7001-06	2011	Standard specification for geo-composite for pavement edge drains and other high-flow applications
ASTM D2412	2018	Standard test method for determination of external loading characteristics of plastic pipe by parallel-plate loading
ASTM D6244	2018	Standard test method for vertical compression of geo-composite pavement panel drains
ASTM D6574/D6574M	2013	Test method determining the (in-plane) hydraulic transmissivity of geosynthetic by radial flow

1173 PAVEMENT DRAINS

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide sub-pavement drains, intra-pavement drains and edge drains, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.
- *1112 Earthworks (Road reserve)*.
- *1141 Flexible pavement base and subbase*.
- *1144 Asphalt (Roadways)*.
- *1171 Subsurface drainage (Construction)*.

1.3 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviations apply:

- CI: Cast iron.
- HDPE: High Density Polyethylene.

Definitions

General: For the purposes of this work-section the following definitions apply:

- Edge drains: Drainage of rigid pavements from the interface between the base and subbase.
- Intra-pavement drains: Drainage of pavement layers of a flexible pavement on steep grades and sag curves where water flows are likely to be more parallel than transverse to road alignment. The subbase material is a macadam crushed rock or open graded asphaltic concrete.
- Selected material zone: The top part of the upper zone of formation in which material of a specified higher quality is required.
- Sub-pavement drains: Drainage of the pavement layers where the subbase is not a macadam crushed rock.

1.4 SUBMISSIONS

Execution details

Intra-pavement drains: Conform to the following:

- Submit details of the proposed method and locations for installing transverse pavement drain pipes .
- Submit test results of the permeability of the base and subbase material based on the type of treatment selected from AGPT 10, Figure 3.2.
- Submit evidence of suitability of pipes selected to resist crushing damage if in the pavement compaction work zone.

Edge drains: Conform to the following:

- Excavation: If proposed, submit details of strip filters.
- Laying of pipe: Submit details of the proposed method of locating the pipes within the rigid flexible pavement without crushing of the pipes during subgrade compaction.

1.5 INSPECTIONS

Notice for inspections

Laying of pipes: Inspect compaction of pipe bedding and placement of pipes.

2 MATERIALS

2.1 GENERAL

Pipes and geotextiles

Requirement: To the **SUBSURFACE DRAINAGE PIPES** and **GEOTEXTILE** in *1171 Subsurface drainage (Construction)* work-section.

Sub-pavement drains: 100 mm diameter corrugated plastic piping or prefabricated geo-composite drain on the compacted bed, as documented.

Intra-pavement drains: Slotted thick-walled PVC-U pressure pipe.

Edge drains: Conform to the following:

- Corrugated circular plastic pipe: 65 mm diameter pipe enclosed in seamless tubular filter fabric to conform to **Corrugated plastic pipe and fittings**, and **Seamless tubular filter fabric** to *1171 Subsurface drainage (Construction)*.
- Rigid geo-composite drains: To **Prefabricated geo-composite drains and fittings** in *1171 Subsurface drainage (Construction)*.

Filter material

Requirement: Type A or Type B filter material to the **FILTER MATERIAL** in *1171 Subsurface drainage (Construction)*.

Edge drains: Install geotextile wrapping trench extremities. Backfill the pipe bedding and after the subsoil pipe laid in trench with Type A or B filter material to **FILTER MATERIAL** in *1171 Subsurface drainage (Construction)*.

3 EXECUTION

3.1 GENERAL

Documentation

Requirement: To *1171 Subsurface drainage (Construction)*.

Pipe

Continuous length without junction pit: Less than 100 to 150 m dependent on gradient.

3.2 ORDER OF CONSTRUCTION

Sub-pavement drains

Requirement: Construct sub-pavement drains immediately after road earthworks are completed in the area of the drains.

Stabilisation: If stabilisation of the subgrade is required, construct the sub-pavement drain after completion of stabilisation except where excessive ground water is encountered; construct sub-pavement drains before stabilisation of the subgrade.

Excessive groundwater: Where a Selected Material Zone is required and excessive ground water is encountered, sub-pavement drains may be installed in two stages as follows:

- Stage 1: Install standard sub-pavement drains below the base of the cutting before placement of select material in the selected material zone.
- Stage 2: Extend sub-pavement drain to top of the selected material zone after placement of selected material.

Intra-pavement drains

Requirement: Construct intra-pavement drains after construction of the road impervious subbase gravel and below the pervious base road pavement.

Edge drains

Requirement: Construct edge drains (geo-composite strip filters) after the construction of the rigid pavement and before the placement and compaction of verge table drain material.

3.3 SUB-PAVEMENT DRAINS

Excavation

Two stage construction: If two stage construction of the sub-pavement drain is required, for Stage 1 trim the trenches 300 mm wide to the required line and to a depth of 600 mm below the bottom of the subbase or below the base of the cutting and conform to the following:

- Carry out excavation for Stage 2 after placement and compaction of the Selected Material Zone.
- Excavate the Stage 2 trench to the same line and width as Stage 1 and maintain a clean, full contact with the filter material previously placed in Stage 1.

Laying of pipe

Bedding: Lay 50 mm thick compacted filter material to the documented line and grade.

Filter material type: As documented.

Joints: Minimise joints in the pipeline.

Backfilling

Filter material: Backfill the trench with filter material to the documented level.

Layers: Place and compact the filter material in layers with a maximum compacted thickness of 300 mm.

Pipe outlets: Conform to the following:

- Backfill the trench on the outlet section of pipes discharging through the fill batters with the selected filter material to a depth of 50 mm above the pipe.
- Backfill the balance of trench with earth backfill material of maximum particle size of 50 mm and compact for the full depth to a relative compaction of 95% (Standard compaction).
- Provide a paved area around the outlet to prevent scour, growth of grass and to make the outlet easy to find. Provide a marker post and a smooth bore unslotted pipe of sufficient crush strength to bear maintenance plant.

3.4 INTRA-PAVEMENT DRAINS

Excavation

Trench dimensions: Cut a ‘V’ shaped trench 75 mm deep to the documented line in the pavement layer immediately below the crushed rock macadam subbase pavement layer to AGPT 10 Figure 3.2.

Discharge pipe: If the pipe is to discharge through the fill batter, construct a trench on a grade suitable for the pipe to discharge its contents without scour. After laying the pipe, backfill the trench with fill material and compact for the full depth to a relative compaction of not less than 95% (Standard compaction).

Laying of pipe

Subbase: Conform to either of the following:

- Crushed rock subbases: Less than 10% of material passing the 9.5 mm AS sieve and with a layer thickness between 150 mm and 200 mm. Or
- Open graded asphalt subbases having layer thicknesses between 80 mm and 100 mm. Or

- No fines concrete: Lay the pipe on a bed of no fines concrete to the line and level, as documented. Where using pipes in concrete, the pipes will need pegging and tied down to prevent floating when the concrete is liquid and newly poured.

Suitability for subbases: If the subbase requires pavement drains, make sure that the proposed type of pavement drain has adequate crushing strength to cope with compaction equipment in the following locations:

- Pervious crushed rock subbase depth: 200 mm minimum.
- Open graded asphalt subbase depth: 100 mm minimum.

Outlet length: Install an unslotted outlet pipe from the outside edge of the free-draining subbase to an outlet structure in the embankment batter and seal the pipe joints in this length of pipe with suitable couplings or mastic.

Level and alignment: Lay the pipe to the documented line and level.

Joints: Minimise joints in the pipeline.

Pipe anchorage: Anchor the pipes by securing all pipes held to the layer under the free-draining subbase to prevent movement of the pipes during placement and compaction of the free-draining subbase.

Backfilling

Subbase: Spread subbase material, compact and trim, where appropriate, as follows:

- For crushed rock macadam subbase: To the **SPREADING** and **TRIMMING, COMPACTION AND CURING** in *1141 Flexible pavement base and subbase*.
- For open graded asphalt subbase: To *1144 Asphalt (Roadways)*.

Compaction: Place and compact the filter material in layers with a maximum compacted thickness of 300 mm. Tamp around and over the pipe to avoid damage or disturbance to the pipe.

No fines concrete: Backfill with no fines concrete, as documented.

3.5 EDGE DRAINS

Excavation

Trench dimensions: Trim the verge material to subgrade level and to the minimum width, as documented.

Discharge pipe: If the pipe is to discharge through the fill batter, excavate a suitable trench to the documented grade.

Strip filters: Do not use strip filters.

Laying of pipe

Pipe: If any part of a shoulder consists of material other than concrete, install slotted thick-walled PVC-U pressure pipe.

Securely hold in place: Secure all pipes held against the vertical face of the rigid pavement.

Bedding and alignment: Lay the pipe on a prepared bed of filter material or no fines concrete to the documented line and level.

Joints: Minimise joints in the pipeline.

Backfilling

Soaking of filter material: Mechanical compaction of this filter material is not required. After placement of the filter material, soak with water and add additional filter material, if required.

Material: Backfill filter material to **FILTER MATERIAL** in the *1171 Subsurface drainage* work-section or no fines concrete to **NO FINES CONCRETE**, in the *1171 Subsurface drainage* work-section and as required for verges.

Compaction: Relative compaction of not less than 95% (Standard compaction).

3.6 OUTLETS STRUCTURES

General

Requirements: Conform to *1171 Subsurface drainage (Construction)*.

Intra-pavement drain discharge: If discharge must be constructed, extend each pipe using a 60° bend. Unslotted pipe to discharge through the fill batter and construct an outlet structure on the discharge end, as documented.

Edge drain: If discharge must be constructed, install unslotted pipe with mastic sealed joint from the outlet section of a pipe at the vertical face of the rigid pavement to an outlet in the embankment batter.

3.7 CLEAN-OUTS

General

Outlet: Preformed riser fitting or pipe not less than 100 mm diameter.

Intervals: Maximum 120 m.

4 ANNEXURES

Duplicate and customise these Schedules, adding and deleting rows and columns, as required. Delete schedules if not required.

To be completed by the specifier.

4.1 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
INSPECTIONS, Notice Laying of pipes	H	Compacted bedding, and placement of pipes	1 day before backfilling over pipes	Backfilling
SUBMISSIONS, Execution details Intra-pavement drains	H	Submit details of securing pipes for holding down subsoil drains using no fines concrete.	7 days before laying of pipe.	Laying of subsoil pipe under pavement
SUBMISSIONS, Execution details Edge drains	H	Submit details of securing geo-composite drains	7 days before laying of edge drain.	Laying of subsoil geo-composite edge drain
*H = Hold Point, W = Witness Point				

4.2 ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Backfilling	Pipe outlets: Relative	1 contract	1 per type	AS 1289.5.4.1.

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
	compaction of fill material			
Backfilling of intra-pavement drains with no fines concrete	Ability of no fines concrete to be porous under road	1 contract	1 per type	
	- Water absorption			AS 1141.6.1
	- Permeability			RMS T376

4.3 ANNEXURE - PAY ITEMS

Pay items	Unit of measurement	Schedule rate inclusions
1173.1 Excavation	m³ - Calculated from the width, depth and length of trench. - Width: As documented. - Depth and length: As documented.	All costs associated with the following: - Excavation for all types of material. - Replacement for over excavation for any reason. - Disposal of excavation material The schedule quantity is a provisional quantity.
1173.2 Subsoil drain pipe	Lin. m - Length measured along the pipe including any slotted pipe required for outlets.	All costs associated with the following: - Laying and securing of the subsoil pipe, including connections, fittings and seamless tubular filter fabric where specified. - The schedule quantity is a provisional quantity.
Subsurface drainage		To *1171 Subsurface drainage (Construction)*
Flexible pavement		To *1141 Flexible pavement base and subbase*
Asphaltic (Roadways)		To *1144 Asphalt (Roadways)*
Earthworks		To *1112 Earthworks (Road reserve)*
Traffic management	Lump sum	To *1101 Traffic management*

4.4 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1141		Methods for sampling and testing aggregates
AS 1141.6.1	2000	Particle density and water absorption of coarse aggregate - Weighing-in-water method
AS 1289		Methods of testing soils for engineering purposes
AS 1289.5.4.1	2007	Soil compaction and density tests - Compaction control test - Dry density ratio, moisture variation and moisture ratio
Austroads AGPT		Guide to pavement technology

Austroads AGPT10	2009	Subsurface drainage
RMS T376	2016	Moulding of no fines concrete specimens

1174 DRAINAGE BLANKETS

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide geotextile and create drainage blankets, filter aggregates and filter slotted pipes, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.
- *1171 Subsurface drainage (Construction)*.
- *1173 Pavement drains (Construction)*.
-

1.3 INTERPRETATION

Definitions

General: For the purposes of this work-section the following definitions apply:

- Phreatic line or water table: The top flow line of a saturated soil mass below which seepage takes place, is called the Phreatic line. Hydrostatic pressure acts below the phreatic line whereas atmospheric pressure exists above the phreatic line. This line separates a saturated soil mass from an unsaturated soil mass. It is not an equipotential line, but a flow line.
- Type A blankets: Blankets constructed in fill road embankments where it is necessary to provide an open graded filter material to prevent upward flow of groundwater by capillary action into the road pavement material or a saturation weakening of the subgrade just below the pavement.
- Type B blankets: Blankets constructed to intercept water in road cuttings uplifting into pavements by capillary action from water charged aquifers underlying the road formation.

1.4 SUBMISSIONS

Tests

Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

1.5 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Installation of geotextile in trenches.
- Survey of road subgrade minus 300 mm for thickness of filter layer.
- Installation of bottom layer of geotextile on road subgrade minus 300 mm and overlapping trenches
- Installation of filter material over the base filter geotextile.
- Survey of constructed subgrade after placing of filter material.
- Installation of top layer of geotextile over top of filter material prior to subbase gravel.

2 MATERIALS

2.1 BLANKET COMPONENTS

General

Pressure pipes, geotextile, and filter material: To *1171 Subsurface drainage (Construction)* for grading requirements for granular filter materials.

Filter material

Type A blankets: Provide Type A blankets in road cuttings or in transition fill embankment zones to the **Type A filter grading table** for single and first stage filters A1 to A6 gradings as documented in *1171 Subsurface drainage (Construction)*.

Type B blankets: Provide Type B blankets in both cuttings and transition embankment fill adjacent to geotextile surrounded pipework and separated from local soils or road pavement gravels by geotextile material to the **Type B filter grading table** for second stage filters, type B1 to B4 gradings, limited graded aggregates as documented in *1171 Subsurface drainage (Construction)***.**

Pipes

General: Thick-walled PVC pressure pipe.

3 EXECUTION

3.1 ORDER OF CONSTRUCTION

General

Requirement: Conform to the following:

- Type A blankets: Place blankets after the site has been cleared and grubbed and before commencement of embankment construction.
- Type B blankets: Place blankets after completion of the subgrade construction minus 300 mm and before construction of the pavement.

3.2 TYPE A BLANKETS (IN FILL) GEOTEXTILE

Location

General: Provide Type A drainage blankets for transition from road cutting to low road fill embankment, as documented.

Extent: 2 m beyond the toes of embankments.

Clearing and grubbing

General: Conform to the following:

- Clear and grub the road footprint plus 5 m extra either side of the base of proposed fill.
- Strip topsoil 200 mm to selected heaps for reuse later for revegetation.

Compaction

Requirement: Trim and compact the parent local soil subgrade to a design level 300 mm below design subgrade of the road. Compact with a flat drum roller to allow an even surface for the geotextile.

Placement of geotextile

Requirement: Conform to the following:

- Place the lower geotextile layer of the proposed drainage blanket across the road and clear of the toe of embankment.
- Place the alternative Type A1 to A6 filter gravel material selected based on the parent soil to **Type A filter grading table** in *1171 Subsurface drainage (Construction)*.
- Trim and compact the top of the selected filter gravel layer to the design road subgrade level.

- Survey top of compacted filter layer to ensure level of subgrade is within tolerances for road design.
- Place the upper geotextile layer of the proposed drainage blanket on the subgrade across the road and 2 metres clear of the base of the embankment. Cover the overlapped geotextile with parent soil.

Additional requirements of geotextile

Special advice: Conform to the following:

- At rock embankments: Place an additional layer of geotextile at the base of any rock facing. Extend the additional layer of geotextile beyond the outside and inside faces of the bottom layer of rock.
- Intersections: Minimum 200 mm overlap.
- Timing: Less than 14 days between initial laying out and final cover of the geotextile with filter layer.
- Protection: Secure the geotextile to prevent movement by wind or by construction activities. Protect and avoid damage during construction of the drainage blanket.
- Removal to spoil and replacement: Remove and replace damaged geotextile and remove if geotextile is exposed for longer than 14 days.

Thickness of filter gravels: Conform to the following:

- Known expected consolidation of embankment: 300 mm minimum plus allowance for the expected total consolidation of the embankment.
- Check by survey that the top of compacted filter material is at design subgrade level for the road pavement.

Protective layer: After the approval of the subgrade survey information and the placement of the top geotextile layer of the blanket. Cover the extension of the top geotextile beyond the toe of the embankment with 300 mm filter material or parent soil.

Discharge

Outlets: Install as follows:

- Surface outlets: At the toes of embankments.
- Piped outlets: Connect to other drainage systems.

3.3 TYPE B BLANKETS IN CUTTINGS

Location

General: Provide Type B drainage blankets in cuttings to be integrated with side trench drains.

Clearing and grubbing

General: Conform to the following:

- Clear and grub the road footprint to about 5 m clear of the proposed top of road cutting.
- Strip topsoil 200 mm depth to selected heaps for later reuse.
- Trim and compact the parent local soil subgrade to a design level between 250 mm and 300 mm below design subgrade of the road. Compact with a flat drum roller.
- Trim the cutting embankment with extra width both sides for the proposed subsoil side drains plus some extra width as selected.
- Excavate subsoil drainage trenches to a selected design depth depending on assessed water table levels from the cuttings and surrounding land grades.

Placement of geotextile

Location: In cuttings, as documented.

Width: The full width of cuttings and overlapping the side drains and, for the road pavement width.

- Place the lower level geotextile across the road and lining trenches plus provision for overlap of geotextile for the top layer of geotextile.
- Compact the 50 mm pipe bedding of filter gravel then place subsoil drainage pipework with or without filter sock as determined by type of filter material selected either B1, B2, B3 or B4.

- Cover the subsoil drain with gravel filter material compacting in maximum 300 mm layers.
- When the side drains are filled to the bottom of the road filter level place and compact the filter material across the roadway and over the side drains and to the design level of the road subgrade.
- Survey top of compacted filter layer to ensure level of subgrade is within tolerances for road design.
- Place the upper level geotextile with overlapping of at least 200 mm for material from the side drains.
- Place and compact a 500 mm width layer of parent soil or clayey subbase gravel over both side drains 150 mm thick then place the subbase and base gravel layers over the central roadway.

Special treatment of geotextile

General: Install geotextile as follows:

- Geotextile under rock facing: Place an additional layer of geotextile at the base of any rock facing. Extend the additional layer of geotextile beyond the outside and inside faces of the bottom layer of rock.
- Intersections: Minimum 200 mm overlaps.
- Geotextile deterioration by ultraviolet light: Ensure that all geotextile is covered at least 14 days maximum after first sunlight exposure to prevent sunlight damage to the geotextile. Where possible, place geotextiles just ahead of construction works and cover with materials within 48 hours.
- Protection: Secure the geotextile to prevent movement by wind or by construction activities. Protect and avoid damage during construction by using only flat drum roller to provide a flat surface for placement of filter material over geotextile.
- Removal and geotextile replacement: If geotextile is exposed to sunlight for longer than 14 days or damaged by activity then remove and replace geotextile where affected.

Filter material

Compaction: Compact cohesionless material to a Density Index of 70%.

Thickness: As documented.

Layers: Install filter material in layers so that the thickness of each compacted layer is no greater than 250 mm maximum.

Discharge

Outlets: To *1171 Subsurface drainage (Construction)*.

Tolerance

Surface level to top of drainage blankets: + 0 and - 40 mm from designed finished level.

4 ANNEXURES

4.1 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
INSPECTION Notice Install geotextile in trenches.	H	Inspection of pipes, bedding and trench geotextile prior to filling trench with trench filter aggregates.	1 day before filling trenches	Compaction
INSPECTION Notice Survey of road subgrade	H	Survey of parent soil under road filter 300mm below road design subgrade.	1 day before placement of bottom geotextile layer.	Placement of filter material
INSPECTION Notice	W	Inspection of bottom geotextile layer and	1 day prior to placement of	Placement of filter material

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
Installation of bottom layer of geotextile.		trench geotextile prior to placement of Type A or Type B filter material	aggregate filter materials	
INSPECTIONS, Notice Installation of filter material over the base filter geotextile.	H	Filter gravel material Type A or Type B placement. Compaction with vibrating flat drum roller.	2 days before placing of top geotextile layer	Filter material placement and compaction of each layer
INSPECTION Notice Survey of constructed subgrade after placing of filter material	H	Survey of top of Type A or Type B of compacted filter material. Levels to road subgrade design.	1 day before placement of top geotextile filter layer	Placement of geotextile top layer
INSPECTIONS Notice Installation of top layer of geotextile over top of filter material prior to subbase gravel.	W	Geotextile for top layer properly overlaps side trench geotextile	1 day before placement of filter material	Placement of filter material at road subgrade level for top of drainage blanket completion
*H = Hold Point, W = Witness Point				

4.2 ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Parent soil below lower geotextile filter	Compaction density test soil below Filter material A or B	500 m^2	300 m^2	AS 1289.5.1.1
Compaction	Density Index for cohesionless material filter A and B	1 contract/size	1 per filter type	AS 1289.5.6.1

4.3 ANNEXURE - PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope inclusions
1174.1 Supply and installation of filter material Type A drainage blankets and side drainage where applicable	m^3 solid compacted Type A filter material	All costs associated with supply and placement of Type A filter material.

Pay items	Unit of measurement	Schedule rate scope inclusions
1174.2 Supply and installation of filter material Type B drainage blankets and side trenches.	m^3 solid compacted Type B filter material	All costs associated with supply and placement of Type B filter material.
1174.3 Supply and placement of geotextile	m^2 of area covered by the geotextile. Exclude laps.	- All costs associated with supply, placing and securing of the geotextile material. - The schedule quantity is a provisional quantity.
1174.4 Drainage blanket side trenches, supply and installation of subsoil pipe, flushing points and outlet filter, together with filter material supply up to subgrade level.	Lin. m. Measure the actual length along the centreline of the pipe including pipe leading to outlet structures.	- All costs associated with the supply and laying of the pipe. - The schedule quantity is a provisional quantity.
Traffic management	Lump sum	To *1101 Traffic management.*
Surface drainage	-	To *1171 Subsurface drainage (Construction).*
Pavement drains	-	To *1173 Pavement drains (Construction).*

4.4 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1289		Methods of testing soils for engineering purposes
AS 1289.5.1.1	2017	Soil compaction and density tests- Determination of dry density/moisture content relation of a soil using standard compactive effort
AS 1289.5.6.1	1998	Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material

1191 PAVEMENT MARKING

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide pavement markings, as documented.

Authority requirements: This work-section does not override any applicable State or Local Government legislation and is to be read in conjunction with AS 1742.3 and the applicable State Road Authority pavement marking specification.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.

1.3 STANDARDS

General

Pavement markings: To AS 1742.2.

1.4 INTERPRETATION

Definitions

General: For the purposes of this work-section the following definitions apply:

- Longitudinal linemarking: All lines that are generally parallel to the traffic flow, such as centre, lane, edge, turn, continuity and transition lines and outline markings.
- Other markings: All diagonal and chevron markings on the pavement including symbols, words, numerals and arrows, kerb markings and markings for parking.
- Paint (AUS-SPEC): In this work-section implies pavement marking paint.
- Pavement marking: All longitudinal linemarking, transverse lines, raised pavement markers and other markings placed on the road to control traffic movement or parking.
- Thermoplastic material: In this work-section implies thermoplastic pavement marking material.
- Transverse lines: All lines that are marked at right angles to the general traffic flow, such as Stop/Give way lines and pedestrian crosswalk lines.

1.5 TOLERANCES

Marking tolerances table

Marking type and dimension	New installation	Maintenance
Spotting		
All markings: Documented location	± 50 mm	-
Arrows, chevrons, painted medians, painted left turn islands and speed markings: Each dimension	± 50 mm	± 50 mm of existing marking
Longitudinal linemarkings		
Width	± 5 mm	Width of existing marking ± 10 mm

Marking type and dimension	New installation	Maintenance
Width of gap between adjacent lines	± 10 mm	± 10 mm
Length	± 50 mm	Length of existing marking ± 100 mm
Distance between centreline of new and existing	-	< 15 mm
Transverse lines and other markings		
Width	± 10 mm	Width of existing marking ± 10 mm
Length	± 10 mm	Width of existing marking ± 10 mm
Raised pavement markers		
Documented location: Transverse	± 25 mm	-
Documented location: Longitudinal	± 100 mm	
From other markers in the same line for a distance of 1.5 m	± 25 mm	-
Documented direction	± 4°	-

1.6 SUBMISSIONS

Execution details

Removal of redundant markings: Submit details of method for removing redundant pavement markings.

Products and materials

Material properties: Submit test reports from a registered laboratory verifying material property conformance, including for paint, glass beads, raised pavement markers and thermoplastic material.

- Test currency: Not older than 3 years.

Samples

Permanent pavement marking tape: If marking tape is required, submit samples and product details for approval.

Tests

Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

Warranties

Manufacturer's warranty: Submit the manufacturer's published product warranties for all materials and components.

1.7 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Setting out: Completion of pavement marking set-out.
- Surface preparation: Completes surface preparation, before applying pavement markings.
- Completion: Completed pavement marking.

2 MATERIALS

2.1 PAVEMENT MARKING PAINT

Type

Waterborne paint: To AS 4049.3.

Solvent-borne paint: Do not use.

2.2 ANTI-SKID PAVEMENT MARKINGS

Properties

Anti-skid materials: Angular, polishing resistant particles which provide skid resistance.

- Colour: Compatible with marking colour.

Particle size:

- For transverse lines and other markings: 0.4 to 0.7 mm.
- For longitudinal linemarking: 0 to 2.0 mm.

2.3 THERMOPLASTIC MATERIAL

Standard

Thermoplastic marking: To AS 4049.2.

Non-profile thermoplastic pavement marking material

Longitudinal linemarkings: Sprayed or extruded thermoplastics applied uniformly.

Transverse lines and other markings: Screeded or preformed thermoplastic.

2.4 TWO-PART COLD APPLIED PAVEMENT MARKING MATERIAL

Properties

Lead content: Not greater than 0.25% to ASTM D3335 .

No-pick-up time: Measured at 23°C and to AS 1580.401.8, as follows:

- For trowel or screed applied material (containing intermix glass beads): Maximum 20 minutes for 2.0 ± 0.25 mm applied film thickness.
- For spray material (not containing glass beads): Maximum 5 minutes for 0.200 ± 0.025 mm applied film thickness.

White road marking material luminance factor: Not less than 80% as delivered.

Abrasion resistance: Loss in mass not exceeding 0.3 g for 500 cycles to AS 4049.2 Appendix G.

Longitudinal linemarking: Sprayed material.

Transverse lines and other markings: Trowelled, screeded, sprayed or extruded material.

2.5 REFLECTIVE GLASS BEADS

Properties

Glass beads for pavement marking: To AS/NZS 2009.

Glass bead proportion: Incorporate glass beads in thermoplastic material as follows:

- In the proportion of a minimum 20% of the total mass.
- As part of the aggregate constituent and conforming to AS/NZS 2009.

Glass beads: Conform to the following:

- Bead type: B or D-HR.

- Type D-HR for use with thermoplastic applications: Provide with a proprietary adhesive coating and in clearly labelled packaging.

2.6 PAVEMENT MARKING TAPE

Type

Temporary markings: Strippable tape.

2.7 RAISED PAVEMENT MARKERS

Classification type

Markers: Reflective and non-reflective markers to AS/NZS 1906.3, to the documented dimensions.

Adhesive to wearing surface: Hot melt bitumen adhesive.

Tests

Sampling: To AS/NZS 1906.3.

Testing

2.8 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Quality verification: If material/product quality verification can be obtained from the supplier, documented tests need not be repeated.

3 EXECUTION

3.1 GENERAL

Protection of work

Protection of markings: Protect markings until the material has hardened sufficiently so that traffic will not cause damage.

Material application

Pavement marking paint: Provide in conformance with the following:

- Permanent markings: To all wearing surfaces.
- Temporary markings: To surfaces other than final wearing surfaces.

Thermoplastic pavement marking material: Install where permanent markings are required.

Pavement marking tape: Use where temporary markings on final wearing surfaces are required.

Reflective glass beads: Apply to all painted and thermoplastic markings.

Raised pavement markers: Install as permanent and temporary markings, as documented.

Cold applied plastics: Install to the manufacturer’s recommendations.

Pavement marking finish

Pavement marking appearance: Straight or with smooth, even curves, where applicable.

Edges: Clean, sharp cut off.

Faulty application beyond defined edge: Remove and leave a neat and smooth marking on the wearing surface of the pavement.

3.2 ESTABLISHMENT

Colour

All pavement marking materials: White Y35 to AS 2700 with a luminance factor not less than 80% to AS 4049.3.

Anti-skid materials: White, equivalent to or whiter than Y35, Off White to AS 2700.

Setting out

Locations: Place all markings as documented.

Surface preparation

Application surface: Apply to clean dry surfaces only. Clean the surface, make sure there is a satisfactory bond between the markings and wearing surface of the pavement.

Existing material: If the existing surface is flaking, chipping or in a condition where adhesion of new material to the road surface cannot be guaranteed for the required life of the marking, obtain approval for the proposed extent and method of surface preparation.

Curing compound applied to new rigid concrete pavement surface: Remove by physical abrasion such as grinding or blasting.

Wet weather: Do not carry out pavement marking during wet weather or if rain is likely to fall during the process.

Raised markers on concrete wearing surface: Lightly scabble the full area under each marker to remove fine mortar material (laitance).

Maintenance of pavement markings

Requirement: Maintain and replace, if necessary, all raised pavement markers and pavement marking during the contract period and the contract defects liability period.

3.3 PAINT MARKING

General

Glass bead application: Apply to a smooth surface.

Mixing of paint

Requirement: Thoroughly mix all paint in its original container before use to produce a smooth uniform product, consistent with the freshly manufactured product.

Application of paint and beads

Paint thickness excluding surface applied beads: Apply uniformly and at the following minimum dry film thickness:

- Type B beads for transverse lines and other markings: 0.20 mm.
- Type D-HR beads for longitudinal linemarkings: 0.30 mm.

Ambient conditions for applying paint with glass beads: For optimum performance and durability, incorporate glass beads under the following conditions:

- Air and pavement temperature: > 15°C.
- Relative humidity: > 70%.
- Air movement: 10 km/hr (reasonable air movement).
- Protection of markings from traffic during the drying process.

Hand spraying: Hand spraying with the use of templates to control the pattern and shape is permitted for transverse lines, symbols, legends, arrows and chevrons.

Longitudinal lines

Paint application: Spray lines in conformance with the following:

- With a self-propelling machine.
- Two sets of lines forming a one-way or two-way barrier line pattern: Spray concurrently.

Glass bead application rate: Conform to the following:

- Type D-HR beads: Apply to the surface of all longitudinal lines at a minimum application rate of 0.50 kg/m2 immediately after applying the paint.
- Actual application rate: Set to overcome any loss of beads between the bead dispenser and the sprayed line.

Other markings

Dimensions: Conform to local or state requirements for the following:

- Arrows.
- Chevrons.
- Painted medians.
- Painted left turn islands.
- Speed markings.

Thickness of non-profile markings: Maximum 6 mm.

Arrows and speed markings: Place square with the centreline of the traffic lane.

Glass bead application: Apply as for other paint markings at the following rate:

- Type B glass beads: Minimum 0.30 kg/m^2, immediately after applying paint.
- Type D-HR glass beads: Minimum 0.5 kg/m^2.

Field measurement of spherical glass bead application rate

Requirement: Measure spherical glass bead application rate onto wet paint or thermoplastic surfaces as follows:

- Turn off the paint or thermoplastic supply valves and operate the glass bead dispenser for 10 seconds, allowing glass beads to run into a plastic bag or tray.
- Pour the glass beads from the bag or tray into a suitable measuring cylinder calibrated in mL to measure the volume of glass beads collected. Level, but do not compact, the glass beads in the cylinder.
- Compare the volume of glass beads collected with that in **Volume of glass beads (mL) required in 10 seconds of operation table**.

Volume required for 0.50 kg/m^2: For the calibration of application rates to suit type D-HR beads, alter the **Volume of glass beads (mL) required in 10 seconds of operation table** to 0.50 kg/m^2.

Volume of glass beads (mL) required in 10 seconds of operation table

Road speed (km/h)	Line widths				
	80 mm	100 mm	120 mm	150 mm	200 mm
8	396	495	594	742	990
13	643	804	965	1207	1698
16	791	990	1188	1484	1484

Notes:
- These figures are calculated for an actual application rate of 0.34 kg/m^2 and are used for calibrating the machine because there is a loss of beads between the bead dispenser and the marked line and the volume is measured with beads not compacted.
- Tolerance of + 10% is permissible when measuring these volumes.
- If using two or more glass bead dispensers, check each dispenser separately to make up the required totals.
- Glass beads weigh approximately 1.53 g/mL.

Anti-skid material
Surface application: Apply anti-skid material before applying glass beads.

Anti-skid material application rates for transverse lines and other markings
Material stirred into paint before application: Minimum 500 g/L.

Material surface applied: Minimum 200 g/m².

3.4 THERMOPLASTIC (NON-PROFILE) MARKING

General
Arrows and speed markings: Place square with the centreline of the traffic lane.

Application of thermoplastic materials and beads: Uniformly apply the thermoplastic material.

Preparation of thermoplastic material on site
Heating: Immediately before application, uniformly heat the thermoplastic material in a suitable kettle to the temperature recommended by the manufacturer without overheating.

Molten pot life: Maximum 6 hours for hydrocarbon resins and 4 hours for wood and gum resins.

Discard: Over-heated resin and/or expired molten materials.

Tack coat
Requirement: Apply where wearing surface of the pavement is smooth or polished.

Application: To the thermoplastic and tack coat manufacturer's recommendations.

Timing: Immediately before applying the thermoplastic material.

Anti-skid materials and glass beads
Bead application: Apply materials conforming to the following:

- Generally: Uniformly apply after application of thermoplastic material to pavement, whilst material is molten.
- Longitudinal lines: Separate bead applications, use application methods which retains bead in the materials.
- Type B glass beads: For lines other than longitudinal lines, apply to screeded markings using an approved method.

Bead application rate: Conform to the following:

- Type B glass beads: Minimum 0.30 kg/m^2.
  . Rate retained in the surface for transverse lines and other markings: Minimum 0.30 kg/m^2.
- Type D-HR glass beads: Minimum 0.50 kg/m^2.
  . Rate retained in the surface for longitudinal lines: Minimum 0.40 kg/m2.

Anti-skid material application rate: Minimum 0.20 k/m^2.

Longitudinal lines
Applying thermoplastic material: Spray lines in conformance with the following:

- With a self-propelling machine.
- Two sets of lines forming a one-way or two-way barrier line: Spray concurrently.
- Application: Apply uniformly with minimum cold film thickness of 1.8 mm.

Bead application: Conform to the following:

- Type B glass beads: Apply by air propulsion or gravity feed to the surface of all lines immediately after application of thermoplastic material.

. Actual application rate: Set to overcome any loss of beads between the bead dispenser and the sprayed line.

- Application rate: Conform to Anti-skid materials and glass beads.

Transverse lines and other markings

Other marking dimensions: Conform to local or state requirements for the following:

- Arrows.
- Chevrons.
- Painted medians.
- Painted left turn islands.
- Speed markings.

Thickness: 3 mm ± 1 mm.

Screeded markings: If required, screed thermoplastic material using a mobile applicator and templates to control the pattern.

Field testing

Thermoplastic material: Verify the cold film thickness applied to the road pavement.

Test method: Use a vernier or suitable dry film thickness gauge to measure the thickness of thermoplastic material applied to a metal test plate. Take the mean of at least 6 readings distributed over the test area.

Field measurement of spherical glass bead application rate

Requirement: Measure to **PAINT MARKING**, **Field measurement of spherical glass bead application rate**.

3.5 TWO-PART COLD APPLIED PAVEMENT MARKING

General

Primer: Apply if the surface is concrete, smooth or polished, or where recommended by the manufacturer. Apply to the manufacturer's recommendations.

Anti-skid material and glass beads: Uniformly apply onto the two-part cold applied material while fluid and immediately after it has been applied to the pavement.

Longitudinal lines

Bead applications: Separate bead application. Use methods which retain beads in the material.

Application rates for two-part cold applied pavement materials and glass beads table

Material	**Longitudinal linemarking**	**Transverse lines and other markings**	
	Sprayed application	**Trowelled, screeded or extruded**	**Sprayed**
Cold applied material thickness (excluding surface applied beads)	0.5 ± 0.05 mm (wet)	2.0 ± 0.2 mm (dry)	1.00 ± 0.1 mm (wet)
Completed marking thickness	-	-	2.0 ± 0.2 mm
Surface applied glass beads*:			
- Type (AS/NZS 2009)	Type D-HR (adhesive coated)	Type B	Type B
- Rate retained in the painted surface	≥ 400 g/m^2	≥ 300 g/m^2	≥ 300 g/m^2
Anti-skid material	≥ 200 g/m^2	≥ 200 g/m^2	≥ 200 g/m^2

Material	Longitudinal linemarking	Transverse lines and other markings	
	Sprayed application	Trowelled, screeded or extruded	Sprayed
* Glass beads coated with a compatible coupling agent for an improved adhesive bond with thermoplastic or two-part cold applied road marking material.			

3.6 PAVEMENT MARKING TAPE

General

Application: To the manufacturer's recommendations.

Removal: If required, remove to the manufacturer's recommendations.

3.7 RAISED PAVEMENT MARKERS

Installation

Adhesive preparation: Freshly heat and mix the adhesive to the manufacturer's recommendations. Do not allow the adhesive to cool and do not reheat before use.

Application of adhesive: Spread the adhesive uniformly over the underside of the marker to a depth of approximately 10 mm.

Fixing marker to pavement: Conform to the following:

- Press marker onto the pavement surface in its correct position and rotate slightly until the adhesive is squeezed out around all edges of the marker.
- Do not disturb the marker until the adhesive has set.

Rough surfaces

Locations: Newly laid coarse sprayed bituminous seals.

Fixing marker to pavement: Conform to the following:

- Apply an initial pad of adhesive 20 mm larger than the diameter of the base of marker.
- Apply adhesive to fill irregularities in the pavement surface to produce a flat, smooth surface, flush with the upper stone level.
- Allow the adhesive pad to set.
- Apply additional adhesive to the pavement in conformance with **Installation** and press down marker onto the adhesive pad on the pavement surface. Make sure there is good adhesion.

3.8 REMOVAL OF REDUNDANT MARKINGS

Removal method

Redundant markings: Remove immediately before or after placement of new markings.

Requirement: Remove marking from wearing surface of pavement as follows:

- Without significant damage to the surface.
- Remove markings in blocks to avoid ghosted images.
- Black out markings only as a temporary measure.
- Complete removal within 48 hours.

3.9 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

4 ANNEXURES

4.1 ANNEXURE – SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Execution details Removal of redundant markings	H	Removal method of redundant markings.	24 hours before commencement	Removal of markings
SUBMISSIONS, Samples Permanent pavement marking tape	H	Samples and product details.	5 days before commencement	Material ordering and delivery
SUBMISSIONS, Products and materials Type tests, material properties	H	Tests reports verifying material properties.	5 days before commencement	Material ordering and delivery
INSPECTION, Notice Setting out	H	Pavement marking set-out.	5 days before marking application	Marking application
INSPECTION, Notice Surface preparation	H	Completed surface preparation.	1 day before marking application	Marking application
INSPECTION, Notice Completion	W	Completed marking.	1 day before inspection	-
*H = Hold Point, W = Witness Point				

4.2 ANNEXURE – MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Materials supply	Material quality – supplier's documentary evidence of:			
	Paint	1 contract	1 per contract or change in material	AS 4049.3
	Glass beads	1 contract	1 per contract or change in material	AS/NZS 2009
	-Thermoplastic material	1 contract	1 per contract or change in material	AS 4049.2

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
	-Raised pavement markers	1 contract	1 per contract or change in material	AS/NZS 1906.3
Paint application	Paint marking wet film thickness	1 contract	1 per site visit or change in pressure settings	AS/NZS 1580.107.3 Method B, comb gauge
	Application rate of glass beads	1 contract	1 per site visit or change in pressure settings	To **PAINT MARKING**, **Field measurement of spherical glass bead application rate**
Thermoplastic application	Cold film thickness	1 contract	1 per site visit or change in pressure settings	Measure by micrometer
	Unbeaded material thickness applied to road pavement	1 contract	1 per contract or change in material	RMS T841
	Application rate of glass beads	1 contract	1 per site visit or change in pressure settings	To **THERMOPLASTIC (NON-PROFILE) MARKING**, **Field testing**
Two-part cold applied material application	Lead content	1 contract	1 per contract or change in material	ASTM D3335
	No-pick-up time	1 contract	1 per contract or change in material	AS 1580.401.8
	Abrasion resistance	1 contract	1 per contract or change in material	AS 4049.2 Appendix G

4.3 ANNEXURE – PAY ITEMS

Pay items	Unit of measurement	Schedule rate inclusions
1191.1 Pavement marking paint – longitudinal lines	Line pattern km (including any gaps). Calculate the area from the specified width (excluding tolerances) and the actual application length measured along the centreline of the longitudinal line.	All costs associated with the setting out of the work, paint and beads and traffic control.
1191.2 Pavement marking paint – Transverse lines, symbols, legends, arrows, chevrons, traffic islands and kerbs		Determine the extent of the painted surface by directly measuring the applied markings. All costs associated with the setting out of the work, all material, supply and application and traffic control.
- 1191.2(1) Transverse lines	Linear metres	
- 1191.2(2) Arrow	Each	
- 1191.2(3) Symbols	Each	
- 1191.2(4) Chevrons	m^2	

Pay items	Unit of measurement	Schedule rate inclusions
- 1191.2(5) Kerbs	Linear metres	
- 1191.2(6) Traffic Islands	m²	
- 1191.2(7) Legends	Each or m²	
1191.3 Thermoplastic (or cold Applied Plastics) pavement marking material – longitudinal lines	Line pattern km (including any gaps). Calculate the area from the specified width (excluding tolerances) and the actual application length measured along the centre line of the longitudinal line.	All costs associated with the setting out of the work, tack coating, supply and application of thermoplastic material and beads and provision for traffic.
1191.4 Thermoplastic (or cold Applied Plastics) pavement marking material – transverse lines, symbols, legends and arrows		Determine the extent of the thermoplastic material applied by directly measuring the applied markings. All costs associated with the setting out of the work, tack coating, supply and installation of all material and the provision for traffic.
- 1191.4(1) Transverse lines	Linear metres	
- 1191.4(2) Arrow	Each	
- 1191.4(3) Symbols	Each	
- 1191.4(4) Chevrons	m²	
- 1191.4(5) Kerbs	Linear metres	
- 1191.4(6) Traffic Islands	m²	
- 1191.4(7) Legends	Each or m²	
1191.5 Raised pavement markers (all applications)	Each marker installed.	All costs associated with the setting out of the work, supply and installation of all material and provision for traffic.
1191.6 Removal of pavement markings	m²	All costs associated with removal and disposal.
Traffic management	Lump sum.	To the *1101 Traffic management* work-section.

4.4 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1580		Paints and related materials - Methods of test
AS/NZS 1580.107.3	1997	Determination of wet film thickness by gauge
AS 1580.401.8	1997	No-pick-up time of road marking paints
AS 1742		Manual of uniform traffic control devices
AS 1742.2	2009	Traffic control devices for general use
AS 1742.3	2009	Traffic control for works on roads
AS 1906		Retroreflective materials and devices for road traffic control purposes
AS/NZS 1906.3	2017	Raised pavement markers (retroreflective and non-reflective)
AS/NZS 2009	2006	Glass beads for pavement-marking materials
AS 2700	2011	Colour standards for general purposes
AS 4049		Paints and related materials - Pavement marking materials
AS 4049.2	2005	Thermoplastic pavement marking materials - For use with surface applied glass beads

AS 4049.3	2005	Waterborne paint - For use with surface applied glass beads
RMS T841	2001	Field measurement of wet film thickness of road marking paint
ASTM D3335	2014	Standard Test Method for Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy

1192 SIGNPOSTING

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide signs and support structures for regulatory, warning and guide signs, and proprietary street name and community facility name signs, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.

1.3 STANDARDS

General

Speed control signs: To AS 1742.4.

Street name and community facility name signs: To AS 1742.5.

Road signs: To AS 1743.

Letters and numerals for road signs: To AS 1744.

1.4 SUBMISSIONS

Execution details

Sign support structures: Submit proposed fabrication details.

Submission time: 2 weeks before fabrication.

Products and materials

Sign details: Submit details of sign materials and sign attachment systems before start of sign manufacture.

Evidence of conformance: Submit evidence that proposed materials and parts conform to the requirements of this work-section:

- Regulatory, warning and guide signs.
- Sign support structures.
- Steel reinforcement cages for sign support structures.

Retroreflective material for background and legend: Submit details of materials and evidence that materials for background and legend are compatible in application and durability.

Suppliers

Requirement: Submit details of the following:

- Name and details of proposed regulatory, warning and guide signs supplier.
- Name and details of proposed support structure supplier.
- Evidence of competency from these suppliers to carry out the work in conformance with this work-section.

Submission time: 1 week before engaging supplier.

Tests
Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

1.5 INSPECTIONS

Notice
General: Give notice so that inspection may be made of the following:

- Pre-delivery inspection: Completed fabrication of purpose-designed sign structures.
- Existing underground services: Protection of services before constructing sign structure footings.
- Clearing: Completed vegetation clearance after setting out.
- Set-out: Completed sign support structure set-out before placing footings.
- Excavation: Completed excavation before placing sign structure footings.
- Steel reinforcement: Reinforcement in place before placing concrete of sign structure footings.
- Sign damage: Completed sign damage repairs.
- Adjustment of existing signs: Completed adjustments, relocation or replacement of signs and/or support structures.

2 MATERIALS

2.1 GENERAL

Storage and handling
Sign support structures and reinforcement cages: Store until required to be incorporated into the Works.

Completed reinforcement cages: Store under a waterproof shelter, supported above the ground. Protect from exposure damage and deterioration.

2.2 STREET AND COMMUNITY FACILITY NAME SIGNS

Standards
Road name assignment: To AS/NZS 4819.

Proprietary sign requirements
Manufacture and installation: To AS 1742.5 and the **Proprietary sign requirements schedule**.

Signage system
Local authority requirements: Conform to the following:

- Council's signage system.
- Incorporate Council's supplied logo.

2.3 REGULATORY, WARNING AND GUIDE SIGNS

Standards
Sign and legend dimensions and details: To AS 1743.

Sign blanks
Aluminium quality: Free of cracks, tears and other surface blemishes, and with true and smooth edges.

Aluminium sheet alloy thickness: 1.6 mm.

Type and temper: Type 5251 or Type 5052 and Temper H38 or Temper H36 to AS 1743.

Sign blank tolerance: ± 1.5 mm of the documented dimensions.

Finished sign: Flat, within a maximum allowable bow of 0.5% of the maximum dimension of the sign blank in any direction.

One piece blanks: Provide one piece sign blanks unless sign size is larger than one full sheet of aluminium.

Multipiece sign: Construct as follows:

- Minimise the number of sheets, butt sheets together with 1 mm maximum gap at any point along the joint.
- Cover the full length of all joints with a 50 mm wide minimum backing strip of the same material and colour as that used for the sign blank.
- Fix the backing strip to each sheet with rivets, coloured to match, at 200 mm maximum spacing.

Aluminium extrusion as backing strips: The aluminium extrusion used for mounting may be used as the backing strip for horizontal joints if it conforms to the spacing requirements.

Face treatment: Chemically clean and etch or mechanically abrade the face of each sign blank. If sign blank is to receive a paint background, spray paint face with a compatible primer.

Back treatment: Uncoat the back of each sign blank and render the surface finish dull and non-reflective by mechanical or chemical means. Make sure surface is free of scratches and blemishes.

Mounting: Supply the signs with square holes or aluminium extrusion backing for mounting at the documented spacings.

Aluminium extrusion backing

Design section: Include special aluminium extruded sections for mounting, as documented.

Aluminium type: 6063-T5 to AS/NZS 1866.

Fixing: Fix aluminium extrusion at the documented spacings. Fix to sign blank with matching colour rivets at 200 mm maximum spacings.

Rivets

Type: With domed head, aluminium alloy shank with a steel mandrel which is discarded after securing the rivet.

Colour matching: If coating thickness does not restrict insertion of shank into the standard drilled hole for that rivet, paint head and shank with alkyd enamel over an etch primer before insertion.

Retroreflective material for background and legend

Retroreflective material: Class 2 materials to AS/NZS 1906.1.

Material colours: To AS 1743.

Application: Apply retroreflective material to the sign blank to the manufacturer's recommendations so that it adheres completely, without bubbles, cracks or blemishes.

Non-reflective background material – background paint

Paint properties: High adhesion, abrasion resistance, resistance to weathering and colour fastness under varying conditions of exposure, and compatible with etched primer used on sign blank.

Paint system:

- Standard: To AS/NZS 2311 clause 5.2.3(b).
- Primer: One coat of two-pack epoxy.
- Finishing coats: Two coats of two-pack polyurethane (B20) or acrylic polyurethane (B44).

Paint application: Use conventional compressed air spray application to give a uniform cover, free of blemishes.

Minimum dry film thickness: 38 µm when tested to AS 1580.108.2.

Colours: To AS 1743 from one of the following AS 2700 colours:

- Red: R13 Signal Red.
- Yellow: Y15 Sunflower.
- Brown: X65 Dark Brown.
- Blue: B23 Bright blue.
- Standard green: G12 Holly Green.
- Freeway green: G13 Emerald.

Background colours: From one of the following AS 2700 colours:

- White: N14 White, gloss.
- Green: G61 Dark Green, matt.
- Brown: X65 Dark Brown, matt.
- Grey: N64 Dark Grey, matt.

Colorimetric data: To AS 2700 Table 1.

Gloss levels:

- Matt coatings: 12% to 15% of gloss as determined by AS/NZS 1580.602.2, using a reflector geometry of 85°.
- Gloss coatings: 85% to 95% of gloss as determined by AS/NZS 1580.602.2, using a reflector geometry of 20°.

Non-reflective background material – background sheet material

Material properties: Adhesive cast vinyl sheet material of uniform density, compatible with the legend material in application and durability.

Alternative background material: Equivalent approved material may be used in place of background paint.

Colours and gloss: Uniform colour and gloss levels, conforming to **Non-reflective background material – background paint**.

Application: Apply sheet material to sign blank to the manufacturer's recommendations so that it adheres completely, without bubbles, cracks or blemishes.

Non-reflective material for legend – legend screening ink

Ink properties: Full gloss, non-fade, non-bleed and scratch resistant high quality screening ink, compatible with the material to which it is applied.

Durability: At least equal to the material to which the ink is applied.

Application: Apply screening ink legends to background material to the manufacturer's recommendations.

Non-reflective material for legend – legend sheet material

Material properties: Adhesive cast vinyl sheet material of uniform density, compatible with the background material in application and durability.

Alternative sheet material: Equivalent approved material can be provided in place of screening ink.

Application: Apply sheet material legends to background material to the manufacturer's recommendations so that it adheres completely, without bubbles, cracks or blemishes.

Non-reflective material for legend – colours and finish

Requirement: To **Non-reflective background material – background paint** with additional colours conforming to AS 2700.

Reference markings – identification codes

Code requirement: Clearly and permanently stamp or engrave all warning, regulatory and guide signs with an identification coding. Do not damage the front face.

Code cipher height: 6 to 10 mm.

Code location: At the bottom left hand corner of rectangular signs and on or below the horizontal centreline, to the left hand edge of other shaped signs, on the rear face of the sign.

Information required: Show the following coding information:

- Sign reference number.
- Manufacturer's name.
- Month and year of manufacture.
- Manufacturer and class of retroreflective material.

Proprietary signs: Reference markings are not required for proprietary street name or community facility name signs.

Protection of signs

Protection: Protect signs from damage during storage and transportation to site.

2.4 SIGN SUPPORT STRUCTURES

General

Requirement: Fabricate components and provide materials, sign support structure protection, anchor bolt assemblies, and footing reinforcement cages, as documented.

Support structure type: Use one of the following, as documented:

- Standard round galvanized steel posts with 50, 65 or 80 mm nominal bore, fitted with a cap for waterproofing.
- Purpose-designed steel structures manufactured to AS 4100.

Fabrication

Purpose-designed steel structures: Fabricate from steel sections which conform to AS/NZS 1163, AS/NZS 3678 and AS/NZS 3679.1.

Splices: Provide full penetration butt weld splices conforming to the following:

- Maximum splice number: One splice per member.
- Welding: As documented and to AS/NZS 1554.1 as follows:
  - Sign structure welds: Category SP.
  - Anchor bolt assemblies: Category GP.

Anchor bolts: Fabricate anchor bolt assemblies for purpose-designed structures, as documented.

Steelwork finish: Free from pitting, sharp corners and projections. Remove mill scale, loose rust and foreign particles by blast cleaning.

Protective treatment - galvanizing

Preparation for galvanizing: Conform to the following:

- Chemical clean: To AS 1627.1.
- Abrasive blast cleaning: To AS 1627.4.
- Grade: Sa 2½ to AS 1627.9.

Standard galvanized steel posts: Electrogalvanize.

All other steel components: Including for brackets and anchor bolt assemblies. Hot-dip galvanize after fabrication processes are completed. Hot-dip galvanizing: To AS/NZS 4680 to provide a bright finished surface free from white rust and stains with average minimum coating thickness of 85 µm.

- Bolts and nuts: To AS/NZS 1214.

Splices in galvanized posts: Paint with an organic zinc-rich primer or inorganic zinc silicate paint conforming to AS/NZS 4680 clause 8.

Attachment of signs – typical systems

Posts and other components: Provide with the required sign attachment holes or fittings to suit the typical attachment systems as documented.

Sign panels: Attach to each supporting member at each extrusion section or bolt hole in the sign panel.

2.5 FOOTING REINFORCEMENT

Steel reinforcement cages for sign support structures

Standards: To AS/NZS 4671.

Cleanliness: Provide reinforcement free from loose or thick rust, grease, tar, paint, oil, mud, millscale, mortar or any other coating but not smooth and polished.

Accuracy: Bend reinforcement to the documented dimensions and shapes. Do not heat reinforcement for bending unless Grade 400 deformed bar reinforcement is required.

Full bars: Provide reinforcement in the lengths as documented. Only use splice bars at approved locations using approved method.

Splicing of reinforcing fabric: Measured as the overlap between the outermost wire in each sheet of fabric transverse to the direction of splice. Make sure overlap is not less than the pitch of the transverse wires plus 25 mm.

Welded splices and tack welding of bars: To the AS/NZS 1554 series.

2.6 OFF-SITE REQUIREMENTS FOR SIGN STRUCTURES

Manufacturer's identification

Purpose-designed structure: For each structure, provide clear identification marking on the post column 1 m above the base plate, outreach arm, and sign support vertical.

Identification information: Show the following:

- Sign reference number.
- Manufacturer's name.
- Month and year of manufacture.
- Drawing number.

Marking: Legible, durable and applied by etching, stamping, engraving or welding.

Pre-delivery inspection certificate

Sign structure conformance: Do not install signs until a certificate listing particulars of the items inspected, verifying conformance, has been issued.

Non-conformance: Rectify non-conforming items included in the certificate.

2.7 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Quality verification: If material/product quality verification can be obtained from the supplier, documented tests need not be repeated.

3 EXECUTION

3.1 GENERAL

Provision for traffic

Minimise delays: Organise the work to avoid or minimise delays and inconvenience to vehicular and pedestrian traffic.

Premature sign exposure

Wrap sign: Where a sign is erected before it is intended for use by traffic and is visible to traffic, completely and securely wrap the face of the sign in porous cloth sheeting or other approved opaque covering material until the sign is operational.

Temporary signs

Requirement: Install signs for the control of traffic nominated in the *1101 Traffic management* work-section.

3.2 ESTABLISHMENT

Existing underground services

Services laid in close proximity to the signs: Locate and protect services from damage before placing footings and erecting signs.

Alignment

Angle of placement: Align signs in conformance with the following:

- Generally: At right angle to the direction of traffic they are intended to serve ± 5°.
- On curved alignments: Determine angle of placement by the course of approaching traffic rather than the orientation of the road at the point where the sign is located.

Set-out

Setting out: Set-out the work so that all signs and support structures are placed as documented.

Clearing

Clearing vegetation: Following set-out approval and advice from Council's Tree Preservation Officer, clear and remove any tree and undergrowth within 3 m of the sign support structure or along a driver's line of sight to the front of the sign.

3.3 SIGN STRUCTURE FOOTINGS

Construction

Requirement: Construct footings for simple pipe support or for each post of a purpose-designed sign support structure, as documented.

Excavation

Excavation and disposal: Neatly excavate footings to the documented depth and width. Do not excavate by machine within 1 m of existing underground services. Dispose of the excavation material from the site using approved methods.

Anchor bolt assemblies

Requirement: Provide in conformance with the following:

- Accurately place and provide firm support.
- With levelling nuts under the sign structure baseplates to allow adjustment of structure after installation.
- Protect all exposed bolt threads from damage or adhesion of concrete during footing construction.

Steel reinforcement

Requirement: Place reinforcement as documented.

Concrete properties

Concrete sign support structure footings:

- Minimum compressive strength:
  - Pipe support footings: 20 MPa at 28 days.
  - Purpose-designed support footings: 32 MPa at 28 days.
- Slump: 60 mm.

Ready mixed concrete: If used, mix and deliver to AS 1379.

3.4 ERECTION

Sign installation

Position and support: Accurately position and support all components during erection.

Top of post level: Conform to the following:

- Extend each pipe support post beyond the upper extrusion section or bolt holes on the sign panels to allow attachment of the signs.
- Finish the top of each post below the top edge of the sign panel.
- Multi-post installations: Finish the tops of the posts at the same level, unless required otherwise for the sign shape or sign panel arrangement .

Sign damage

Protection during erection: Support and brace sign panels and protect the sign face from damage.

Signs damaged during erection: Repair to a standard equivalent to the original sign or replace sign.

Repair of damaged galvanized coatings: Conform to the following:

- Scratched and slightly damaged purpose-designed support structures: For areas less than 2500 mm^2 on any one structure, repair with an organic zinc-rich primer or inorganic zinc silicate paint to AS/NZS 4680 clause 8.
- Totally-damaged coating: For areas exceeding 2500 mm^2, regalvanize.

3.5 EXISTING SIGNS AND SUPPORT STRUCTURES

Adjustment of existing signs

Requirement: If required, carry out the following as documented:

- Adjust sign panel and/or sign support structures.
- Dismantle signs and sign support structures.
- Relocate or replace sign support structures, including removing and providing footings and re-erection of signs.

3.6 SIGN STRUCTURE WARRANTY

Sign face material warranty table

Sign face material	Warranty from date of manufacture (years)	Sign face photometric value (% of new value retained[1])
Class 1X	10	80

Sign face material	Warranty from date of manufacture (years)	Sign face photometric value (% of new value retained[1])
Class 1X (white with EC[2] overlay film)	12	80
Class 1X	10	80
Class 1X	3	80
Class 1X	10	80
Class 1	12	80
Class 1 (white with EC[2] overlay film)	12	80
Class 1 screen printed	10	80
Class 2	7	50
Class 2 screen printed or white with EC[2] overlay film	7	50
Non-reflective[3] (sheeting or coating)	7	Not applicable
VHB joining strip	12	Not applicable
Notes: [1] To AS/NZS 1906.1. [2] EC = electronic cuttable. [3] Includes non-reflective parking signs.		

Sign structure

Warranty period: Equal to that warranted for the sign face material.

Warranty provisions: Cover the following in event of structure failure or defect:

- Remove any sign structure which has failed in service or is found defective.
- Rectify defect and re-erect the repaired/replaced unit at the original location.
- Process and return defective structures within 30 calendar days from the date of defect notification.

Warranty provision exclusions: Any structure which has failed as a result of a traffic accident, abuse or act of vandalism caused by a third party after delivery to the site.

Date of dispatch mark: To facilitate checking of warranty claims, legibly stamp, etch or engrave the date of manufacture on all separate items of the sign structure.

3.7 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

4 ANNEXURES

4.1 ANNEXURE – PROPRIETARY SIGN REQUIREMENTS SCHEDULE

Property	A	B	C
Material: Legend			
Material: Background			
Colour: Legend			

Property	A	B	C
Colour: Background			
Lettering and numerals: Font type			
Lettering and numerals: Font height			

4.2 ANNEXURE – SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Products and materials Sign details	H	Details of sign manufacturer, materials and attachment system.	2 weeks before fabrication	Sign fabrication
SUBMISSIONS, Products and materials Regulatory, warning and guide signs	H	Evidence that sign materials and parts conform to this work-section.	1 week before ordering	Sign fabrication
SUBMISSIONS, Products and materials Retroreflective material for background and legend	H	Details of materials and evidence that materials for background and legend are compatible.	1 week before ordering	Sign fabrication
SUBMISSIONS, Products and materials Sign support structure	H	Evidence that materials and parts conform to this work-section.	1 week before ordering	Sign support structure fabrication
SUBMISSIONS, Products and materials Steel reinforcement cages for sign support structures	H	Evidence that materials conform to this work-section.	1 week before fabrication	Sign support structure fabrication
INSPECTIONS, Notice Pre-delivery inspection	H	Fabricated purpose-designed sign structures.	2 days after fabrication	Sign structure delivery to site
INSPECTIONS, Notice	H	Services protection.	1 week before sign erection	Sign structure footing placement

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
Existing underground services				
INSPECTIONS, Notice Clearing	W	Cleared vegetation.	1 day after clearing	-
INSPECTIONS, Notice Set-out	H	Sign support structure set-out.	1 week before sign erection	Footing placement
INSPECTIONS, Notice Excavation	W	Completed excavation for footings.	1day before placing footings	-
INSPECTIONS, Notice Steel reinforcement	W	Footings steel reinforcement in place.	1day before placing	-
INSPECTIONS, Notice Sign damage	W	Repaired sign damage.	3 days before inspection	-
INSPECTIONS, Notice Adjustment of existing signs	W	Adjusted, relocated or replaced signs.	3 days before inspection	-
*H = Hold point, W = Witness point				

4.3 ANNEXURE – MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Materials supply	Material quality – supplier's documentary evidence of:			
	- Sign blanks	1 contract	1 per contract, or change in material	AS 1743
	- -Aluminium extrusion backing	1 contract	1 per contract, or change in material	AS/NZS 1866
	- -Retroreflective material	1 contract	1 per contract, or change in material	AS 1743
	- -Non-reflective paint	1 contract	1 per contract, or change in material	AS/NZS 2311
	- -Non-reflective sheet material	1 contract	1 per contract, or change in material	N.A.

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
	- -Steel sign support structures	1 contract	1 per contract, or change in material	To **SIGN SUPPORT STRUCTURES**
	- -Grade	1 contract	1 per contract, or change in material	AS 1627.9
	- -Protective treatment	1 contract	1 per contract, or change in material	AS/NZS 4680 and AS/NZS 1214

4.4 ANNEXURE – PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
1192.1 Supply and delivery of signs (area less than 1 m²)	Each.	All costs of mounting extrusions, fittings, labelling, packaging and delivery to site.
1192.2 Supply and delivery of signs (area between 1 m² and 3 m²)	Each.	All costs of mounting extrusions, fittings, labelling, packaging and delivery to site.
1192.3 Supply and delivery of signs (area greater than 3 m²)	m² of signs supplied.	The total face surface area of each sign supplied. All costs of mounting extrusions, fittings, labelling, packaging and delivery to site.
1192.4 Supply and delivery of sign support structures (standard round galvanized posts)	Each post.	All costs of fabrication, fittings, caps, packaging, storage for up to 2 months.
1192.5 Supply and delivery of sign support structures (purpose-designed)	Each sign support structure. Note: Where a purpose-designed sign support structure consists of more than one post, the unit of measurement (each) to include all posts required for that particular sign.	All costs of fabrication, hot-dip galvanising, fittings, packaging, storage for up to 2 months.
1192.6 Supply and delivery of anchor bolt assemblies **1192.6(1) Mk 1** **1192.6(2) Mk 2** **1192.6(3) Mk 3**	Each for the anchor bolt assemblies for each individual footing.	All costs of fabrication, hot-dip galvanizing, fittings, packaging, storage for up to 2 months.
1192.7 Supply and delivery of reinforcement cages **1192.7(1) (Size)** **1192.7(2) (Size)** **1192.7(3) (Size)**	Each for the complete reinforcement cage for each individual footing.	All costs of fabrication, packaging, storage for up to 2 months.
1192.8 Erection of sign structures (standard round galvanized posts)	Each post erected.	All costs of clearing, excavation, casting of concrete footings, erection and bracing.
1192.9 Erection of sign structures (purpose-designed)	Each sign support structure erected. Note: Where a purpose-designed sign support structure consists of more than one post	All costs of clearing, excavation, placement of reinforcement cages and anchor bolt assemblies, casting of concrete footings, erection and bracing.

Pay items	Unit of measurement	Schedule rate scope
	and footing, the unit of measurement (each) to include all posts and footings required for that particular sign.	
1192.10 Erection of signs (to standard round galvanized posts)	Each sign erected.	All costs of erection and attachment costs and any necessary temporary covering of signs with plastic or other approved opaque covering.
1192.11 Erection of signs (to purpose-designed structures)	m² of signs erected.	The total face surface area of the signs. All costs of erection and attachment costs and any necessary temporary covering of signs with plastic or other approved opaque covering.
1192.12 Adjustment of existing signs and support structures	m² of signs adjusted. Note: Separate pay items to be included for each adjustment required to re-erect existing signs and sign support structures and to cover all work required that is not covered by the other pay items under signposting.	The total face surface area of the signs adjusted. All costs of dismantling of signs and sign structure, relocation or replacement of sign structures including excavation, concrete footings, (including placement of reinforcement cages and anchor bolt assemblies where specified) and re-erection of signs including all fittings.
Traffic management		To the *1101 Traffic management* work-section.

4.5 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS/NZS 1163	2016	Cold-formed structural steel hollow sections
AS/NZS 1214	2016	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)
AS 1379	2007	Specification and supply of concrete
AS/NZS 1554		Structural steel welding
AS/NZS 1554.1	2014	Welding of steel structures
AS 1580		Paints and related materials - Methods of test
AS 1580.108.2	2004	Dry film thickness - Paint inspection gauge
AS/NZS 1580.602.2	1995	Measurement of specular gloss of non-metallic paint films at 20 degrees, 60 degrees and 85 degrees (ISO 2813:1994)
AS 1627		Metal finishing - Preparation and pre-treatment of surfaces
AS 1627.1	2003	Removal of oil, grease and related contamination
AS 1627.4	2005	Abrasive blast cleaning of steel
AS 1627.9	2002	Pictorial surface preparation standards for painting steel surfaces
AS 1742		Manual of uniform traffic control devices
AS 1742.4	2008	Speed controls
AS 1742.5	2017	Street name and community facility name signs
AS 1743	2018	Road signs - Specifications
AS 1744	2015	Standard alphabets for road signs
AS/NZS 1866	1997	Aluminium and aluminium alloys - Extruded rod, bar, solid and hollow shapes

AS 1906		Retroreflective materials and devices for road traffic control purposes
AS/NZS 1906.1	2017	Retroreflective sheeting
AS/NZS 2311	2017	Guide to the painting of buildings
AS 2700	2011	Colour standards for general purposes
AS/NZS 3678	2016	Structural steel - Hot-rolled plates, floorplates and slabs
AS/NZS 3679		Structural steel
AS/NZS 3679.1	2016	Hot-rolled bars and sections
AS 4100	1998	Steel structures
AS/NZS 4671	2001	Steel reinforcing materials
AS/NZS 4680	2006	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 4819	2011	Rural and urban addressing

1193 GUIDE POSTS

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide guide posts, delineators, and remove and dispose of existing posts, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.

1.3 INTERPRETATION

Definitions

General: For the purposes of this work-section the following definitions apply:

- Delineator: Small retroreflectors or panels of retroreflective sheeting attached to guide posts to provide a coherent pattern of delineation of carriageway edges as an aid to night driving.
- Flexible guide post: A guide post that when impacted by a vehicle, deflects and returns to the vertical position without maintenance intervention.

Guide post

Post used to mark the edge of the road carriageway. They assist the road user by indicating the alignment of the road ahead, especially at horizontal and vertical curves, and in some cases, provide a gauge with which to assess available sight distance.

- Rigid guide post: A guide post which when impacted by a vehicle, fails by fracturing or remains intact and straight, but not vertical.
- Semi-flexible guide post: A guide post which when impacted by a vehicle, fails by bending but can be straightened with maintenance intervention.

1.4 TOLERANCES

Maximum guide post installation tolerances

Verticality: 3 from the true vertical position.

Height: 25 mm of the uniform profile height.

Location (in plan): In relation to the control line of the road, conform to the following:

- 200 mm longitudinally of the documented spacing.
- 100 mm transversely of the documented position.

1.5 SUBMISSIONS

Design documentation

Set-out drawings: Submit set-out of post locations.

Execution details

Guide posts fixed to concrete pavements: Submit details of post fixing to the concrete.

Proprietary guide posts: Submit manufacturer’s instructions for anchorage.

Products and materials

Post product data: Submit details of the proposed guide post including the following:

- Type of material.
- Manufacturer's recommended installation procedures.
- Technical specifications.

Tests

Requirement: Submit results, as follows:

- Post strength.
- Flexibility.
- Impact and heat and cold resistance.
- Durability.

Warranties

Manufacturer's warranty: Submit the manufacturer's published product warranties.

1.6 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Location of guide posts: Completed post set-out.
- Installation of guide post:
  . Posts set in natural ground: After completion of backfilling for posts.
  . Posts set in concrete pavement: After completion of post fixings.
- Removal and disposal of existing guide posts: Completed reinstatement of surrounding material including backfilling.

2 MATERIALS

2.1 GENERAL

Guide post materials

Flexible guide posts: Plastic, rubber or similar.

Semi-flexible guide posts: Plastic, metal or other.

Rigid guide posts: Metal or non-timber material.

Guide post selection table

Post type	Traffic and road condition
Flexible guide posts	- Posts are likely to be struck by vehicles, e.g. tight curves and narrow shoulders. - Roads with high volumes of motor cycles or bicycles.
Guide posts hinged at ground level	
Timber or semi-flexible guide posts	- Posts unlikely to be struck by vehicles.

2.2 PROPRIETARY NON-TIMBER POSTS

General

Type and material: Metallic or flexible, driveable or non-driveable, posts.

Surface finish of posts: Durable gloss or semi-gloss opaque white which is smooth and easy to clean.

- Colour: Whiter than Y35 Off White of AS 2700.

Resistance to impact: Post is resistant to overturning, twisting and displacement from wind and impact forces when installed in the ground to the manufacturer's recommendations.

Dimensions
Minimum height above ground surface: 1000 ± 100 mm.

Minimum width of post above ground: One face of 100 ± 5 mm.

Thickness: 50 ± 5 mm.

Anchorage
Requirement: Resistant to bending, twisting and displacement by wind and/or impact forces.

Resistance to removal: Cannot be removed by persons other than personnel using recommended removal tools.

Markings
Traceability: Mark each post legibly and indelibly with the following:

- Name of the supplier.
- Month and year of manufacture.

Letter size: 5 to 10 mm high.

Marking placement: On at least one side and 500 mm from the top of the post.

Marking of ground level: Mark 1000 mm from the top of the post.

End treatment
Top cap: Fit posts manufactured from thin walled hollow sections or sheet material less than 10 mm thick with a cap on the top of the post.

Cap dimensions: Cover the whole top of the post.

- Minimum dimensions: 100 x 25 mm.

Cap type: Rounded with no sharp edges, and of the same colour and durability as the guide post.

Attachment: Attach cap so that it cannot be dislodged from the post by a force of 500 N pulling on the cap in a direction away from the post.

Top of plastic posts: Have rounded edges and corners.

Physical properties and performance
Durability: No deterioration of post material after minimum 720 hours under accelerated weatherometer testing.

2.3 NON-TIMBER POST TESTS

Physical properties after testing
Deflection tolerance: 50 mm maximum.

Acceptable physical condition of post: No fractures, cracks or splits.

Heat resistance – flexible guide posts
Heating: Condition posts at 60± 2°C for 2 hours in an oven.

Test procedure: Conform to the following:

- After conditioning, remove the post from the oven and clamp the base so that the post is vertical and protruding 1000 mm from the post top.

- Bend the conditioned post adjacent to the clamp in the direction of the adjacent traffic flow to form a 90° angle.
- Subject the post to 3 cycles of bending through 180° within 2 minutes of its removal from the oven so that the post is bent in a right angle. Release the post after the third cycle.
- Record the physical condition and horizontal deflection at the top of the post from a vertical line 30 seconds after release from the bent position.

Cold resistance – flexible and semi-flexible guide posts

Cooling: Condition post at 0 ± 2°C for 2 hours in an ice bath.

Test procedures for metallic and non-metallic posts: Conform to the following:

- After conditioning, remove post from the ice bath and clamp in a vertical position with the top of the post protruding 1000 mm.
- Bend the conditioned post adjacent to the clamp in the direction of the adjacent traffic flow to form a 90° angle within 30 seconds of its removal from the ice bath.
- Manually straighten semi-flexible posts.
- Release the post from the clamp 60 seconds after removing it from the ice bath and place in the ice bath for an additional 60 seconds.
- Repeat the bending and ice bath procedure three times and conform to the following:
  - Semi-flexible posts: Manually straighten.
  - Flexible posts: Release post from the bent position and record the horizontal deflection at the top of the post from a vertical line 60 seconds after release.

Non-metallic posts: After completing test procedures for metallic and non-metallic posts, conform to the following:

- Return the post to ice bath for 60 seconds minimum.
- Remove the post from ice bath and place in a horizontal position, securely clamped so that the minimum clear length between supports is 1000 mm.
- Drop a 1 kg steel ball for a distance of 1500 mm vertically through a low friction guide so that it impacts the centre face of the post displayed towards the traffic.
- Recondition post in ice bath for 60 seconds.
- Repeat ball dropping and reconditioning procedures. After the fifth ball drop, record the condition of the post.

Rigidity tests

Testing conditions: Conduct tests under the following conditions:

- Temperature: At 23 ± 2°C.
- Clamps: Shape jaws of clamps to suit post profile so that the post cannot rotate in the clamp.

Rigid guide post test procedures: Conform to the following:

- Securely clamp post to a bench in a horizontal position with the top of post unsupported and protruding 1000 mm.
- Apply a 10 kg mass to a point 50 mm from the top of the post, in the direction of adjacent traffic flow. Continue to add mass in 10 kg increments until post fractures.
- Record mass at which fracture occurs.

Flexible and semi-flexible guide post test procedures: Conform to the following:

- Securely clamp post to a bench in a horizontal position with the top of post unsupported and protruding 1000 mm.
- Bend the post adjacent to the clamp in the direction of adjacent traffic flow to 90° and straighten. Repeat this procedure 10 times with maximum 3 minute intervals between procedures.
- Apply a 0.9 kg mass to a point 50 mm from the top of the post, in the direction of adjacent traffic flow. Record the vertical deflection of post top from its original position.

- Remove mass and record the final deflection.

Alternative testing procedures for flexible and semi-flexible guide posts: Conduct testing as for standard testing procedures. Instead of applying a mass, conduct testing in a wind tunnel with a wind speed of 12.5 m/s applied in the direction of the adjacent traffic flow.

Maximum rigidity of flexible and semi-flexible guide posts test procedures: Conform to the following:

- Securely clamp post to a bench in a horizontal position with the top of post unsupported and protruding 1000 mm.
- Apply a 10 kg mass to a point 50 mm from the top of the post, in the direction of adjacent traffic flow.
- Record the vertical deflection of post top from its original position.

Rigidity test results table

Guide post type and test	Property	Acceptable range
Rigid	Applied mass when fracture occurs	30 to 100 kg
Flexible and semi-flexible: Maximum deflection	Minimum deflection when mass is applied	500 mm from original position
Flexible and semi-flexible	Maximum vertical deflection of post top when mass is applied	130 mm from original position
	Unassisted return of post to its original position when mass is removed	Within 10 minutes
	Final deflection when mass is removed	Maximum 10 mm from vertical position
Flexible and semi-flexible: When tested in a wind tunnel	Wind speed post is able to withstand	12.5 m/s
	Maximum horizontal deflection of post top when wind is applied	130 mm from original position
	Unassisted return of post to its original position when wind is removed	Return to 10 mm maximum from vertical position

2.4 TIMBER POSTS

Description

Cross section: Rectangular.

Structural properties: To AS/NZS 1748.1 and AS/NZS 1748.2.

Surfaces: Smooth and free from obvious saw marks.

Dimensions: 100 x 50 mm finished size x 1400 mm long.

Post top: Slope the 90 mm face 10 mm lower than the opposite edge.

Hardwood

Natural durability class of the species supplied: To AS 5604.

Preservative treatment: To AS 1604.1 Table H4.

Grade: Structural grade No.4 to AS 2082.

Softwood

Preservative treatment: To AS 1604.1 Table H4.

Grade: Structural grade No.5 to AS 2858.

Finish
Preparation: Stop holes, cracks and other imperfections with white putty after applying primer coat.

Paint coating system:

- Primer: One coat of latex wood primer to AS 3730.17.
  . Preservative treated posts: Apply solvent-borne primer followed by the latex primer.
- Undercoat: One coat of latex undercoat for exterior applications to AS 3730.18.
- Top coat: One coat of gloss latex for exterior applications to AS 3730.10.

Application: To AS/NZS 2311 Section 6.

Colour: White.

Extent of preservative treatment
Natural durability class 1 or 2 with less than 20% sapwood cross section: No treatment.

Natural durability class 1 or 2 with more than 20% sapwood cross section: Full treatment.

Natural durability class 3 or 4: Full treatment.

2.5 DELINEATORS

General
Properties: To AS/NZS 1906.2.

Type: Provide one of the following for each post:

- Corner-cubed: 80 to 85 mm diameter.
- Class 1A retroflective sheeting:
  . Minimum area: 0.01 m².
  . Minimum width: 50 mm.

Colour: To AS 1742.2 clause 4.2.5.2.

3 EXECUTION

3.1 ESTABLISHMENT

Safety
Precautions: Restrict site access to prevent people and stock from stepping into the post holes during the erection of posts.

Existing underground services
Services laid in close proximity to the guide posts: Locate before placement of footings and protect from damage.

Location of guide posts
Location: To AS 1742.2 and as documented.

Placement: Place posts at a uniform distance from the pavement edge and as follows:

- Shoulder adjacent to an embankment or at the surrounding natural surface level: Place post so that the inside edge is in line with the outside edge of the shoulder.
- Shoulder located in a cutting: Place post on the road pavement side of the table drain so that it does not impede water flow in the drain.

3.2 INSTALLATION OF GUIDE POSTS

Positioning
Requirement: Set posts vertically in the shoulder pavement as follows:

- Embedded depth:
  . Rigid and timber guide posts: 500 mm minimum.
  . Flexible and semi-flexible guide posts: 350 mm minimum.
- Shoulder irregularities: Vary embedded depth to provide uniform post height above ground level, with the tops evenly graded.
- Post position in relation to road: Install each post with 100 mm axis at right angles to the centre line of the road.

Vertical alignment

Post height allowance: To keep the posts within the range of the beam of vehicle headlights, allow for the effects of superelevation and other road geometry.

Posts installed in natural ground

Timber posts: Do not install by driving into ground.

Posts for which driving is not recommended: Erect inside excavated holes. Backfill and compact around post after erection.

Backfilling

Backfill material: Use the excavated material. If relative compaction cannot be achieved using the excavated material, use imported fill and remove excavated material from site.

Imported backfill properties: Similar to the shoulder material.

Backfilling and compacting: Backfill the posts firm in the ground as follows:

- Compact in layers not more than 150 mm for the full depth of the post up to ground level.
- Density of the compacted backfilling: Not less than that of the adjacent undisturbed ground.
- Relative compaction of the compacted backfill material: Not less than that of the adjacent shoulder material.

3.3 DELINEATORS

Fixing

Delineator position: Centrally locate delineators between the edges of the post, with the top of each delineator finishing 50 to 100 mm below the top of the post.

Fixings: Fix the delineators to the post so that they are weatherproof and vandal resistant, and can be replaced without damaging the post.

- Timber posts: Fix corner-cubed delineators to post with one-way, anti-theft screws.
- Proprietary posts: Glue or fasten so that delineators cannot be dislodged by vehicular impact.

Corner-cube delineators that can be damaged by vehicular impact: Do not use on flexible or semi-flexible guide posts.

Arrangement: Arrange the delineators so that drivers approaching from either direction will see only red delineators on their left side and white delineators on their right side.

Consistency: Provide the same type of delineator on each post for a minimum distance of 2 km. Do not change delineator type within this distance.

3.4 EXISTING GUIDE POSTS

Removal and disposal of existing guide posts

Removal: Extract and dispose of all posts and other in-ground components and materials, as documented.

Backfilling: Backfill all holes after removal of existing guide posts and compact to the relative compaction of the surrounding shoulder material in maximum 150 mm deep layers.

- Imported backfill material properties: Similar to the shoulder material.

Recycle: Existing posts manufactured from recyclable materials.

4 ANNEXURES

4.1 ANNEXURE – SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Products and materials Post product data	H	Details of proposed guide posts.	2 weeks before manufacturing	Material ordering and delivery
SUBMISSIONS, Design documentation Set-out drawings	H	Set-out drawings of post location.	5 days before installation	Post installation
SUBMISSIONS, Execution details Guide posts fixed to concrete pavement	H	Details of post fixing to the concrete.	5 days before installation	Post installation
INSPECTIONS, Notice Location of guide posts	H	Completed post set-out.	5 days before installation	Post installation
INSPECTIONS, Notice Installation of guide posts	W	Completed post installation.	1 day before inspection	-
INSPECTIONS, Notice Removal and disposal of existing guide posts	W	Completed reinstatement of surrounding materials.	1 day before inspection	-
*H = Hold Point, W = Witness Point				

4.2 ANNEXURE – PAY ITEMS

Pay items	Unit of measurement	Schedule rate inclusions
1193.1 Guide posts (Supply and erect)	Each guide post	All costs associated with the erection of each post, including supply of post, erection, painting (if applicable), and supply and fixing of corner-cubed delineators.
1193.2 Removal of existing guide posts	Each guide post	All cost associated with the supply, placement and compaction of backfill material

Pay items	Unit of measurement	Schedule rate inclusions
		for the reinstatement of post hole and the collection and disposal of the existing post.
Traffic management		To the *1101 Traffic management* work-section.

4.3 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1604		Specification for preservative treatment
AS 1604.1	2012	Sawn and round timber
AS 1742		Manual of uniform traffic control devices
AS 1742.2	2009	Traffic control devices for general use
AS/NZS 1748		Timber - Solid - Stress-graded for structural purposes
AS/NZS 1748.1	2011	General requirements
AS/NZS 1748.2	2011	Qualification of grading method
AS 1906		Retroreflective materials and devices for road traffic control purposes
AS/NZS 1906.2	2007	Retroreflective devices (non-pavement application)
AS 2082	2007	Timber - Hardwood - Visually stress-graded for structural purposes
AS/NZS 2311	2017	Guide to the painting of buildings
AS 2700	2011	Colour standards for general purposes
AS 2858	2008	Timber - Softwood - Visually stress-graded for structural purposes
AS 3730		Guide to the properties of paints for buildings
AS 3730.10	2006	Latex - Exterior - Gloss
AS 3730.17	2006	Primer - Wood - Latex - Interior/exterior
AS 3730.18	2006	Undercoat/sealer - Latex - Interior/exterior
AS 5604	2005	Timber - Natural durability ratings

1194 NON-RIGID ROAD SAFETY BARRIER SYSTEMS

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide non-rigid road safety barriers and terminals, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.
- *1195 Rigid road safety barrier systems*.

1.3 STANDARDS

General

Road safety barrier systems: To AS/NZS 3845.1.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviation applies:

- MELT: Modified eccentric loader terminal.

Definitions

General: For the purposes of this work-section the following definitions apply:

- Anchor: Restraint used to transmit impact forces into the ground.
- Clear zone: The area adjacent to the traffic lane to be kept clear of obstructions that could be hazardous to errant vehicles. It consists of the verge area and is measured from the nearside edge of the left-hand traffic lane. For divided roads, it is also measured from the offside edge of the right-hand traffic lane to the edge of the pavement for opposing traffic.
- End terminals: Devices that protect vehicle occupants from injury in an impact with the end of the safety barrier. Can be either leading or departure end treatment.
- Non-gating terminal: A road safety barrier terminal designed to allow an impacting vehicle to pass through the terminal and so compromise the safety barrier.
- Non-rigid road safety barrier system: A flexible barrier system where the barrier elements under an impact provide substantial movement, deformation and deflection.
- Rock catch fence: Fence to prevent rocks landing on roads.
- Safety barrier system: A longitudinal structure which restrains and/or redirects, in a controlled manner, vehicles which are out of control. A safety barrier system includes one or more safety barriers with associated end treatments and transitions.
- Safety bollard: A heavy duty post designed to prevent vehicular access into a pedestrian area.
- Security fence: A fence designed to prevent pedestrian entrance to unsafe areas
- Semi rigid barrier: A barrier with limited movement.
- Thrie beam: Triple corrugated beam component of a public domain non-rigid road safety barrier system.
- Transition: A type of interface used when less stiff longitudinal road safety barrier system is connected to a stiffer interface.

- W-beam: Double corrugated beam component of a public domain non-rigid road safety barrier system.
- Wildlife fence: Fence that prevents wildlife approaching a roadway and creating a hazard.
- Wire rope safety barrier: A road safety system consisting of wire rope cables under high tension that are supported on posts and anchored at the ends.

1.5 TOLERANCES

Concrete footings

Post foundations: To AS/NZS 3845.1 clause 3.2.13.

Post position

Line of the tops of posts: ± 20 mm of the documented height.

Steel posts

Ground movement: 3 mm maximum in any direction when force tested to AS/NZS 3845.1.

Steel components

Steel railing erection: To AS/NZS 3845.1 clause 3.2.11.

1.6 SUBMISSIONS

Execution details

Method statement: Before installation of road safety barrier system, submit description of the installation process.

- Submission time: 5 working days before erection.

Alternative methods of setting posts: If the documented depth cannot be achieved because of an underground obstruction, submit details of proposed alternative post setting method before carrying out the works.

Steel post driving details: Submit details of driving equipment, helmets and procedures for preventing damage to posts.

Wire rope safety barrier systems: If horizontal radius and/or vertical curvature is unsuitable, submit proposal for alternative barrier system to be installed.

Operation and maintenance manuals

Installation and maintenance manuals: On completion, submit manuals for all proprietary barrier and end treatment systems used in the works.

Products and materials

Evidence of conformance: Submit evidence that materials, components and systems including steel and timber components conform to the requirements of this work-section.

Galvanized steel components: Provide evidence from the manufacturer that zinc coating mass conforms to AS/NZS 4680.

Records

Work-as-executed drawings: Submit drawing design file with the following in accordance with the ADAC specification, which is available on Council's website.:

- Proprietary safety barrier systems or end treatments: Details of the system, name and post spacing.
- Non-proprietary end treatments: Details of the end treatment name and post types. If timber posts are used, details of the timber species and stress grade.

Tests

Tests: Submit results, as follows:

- Wire rope tension: Submit wire rope tension test certificate as evidence of conformity. Include the date, time, ambient air temperature, tension force and signature and name of the individual managing the work at the time.
  . Submission time: 5 working days after erection.

Warranties

Manufacturer's warranty: Submit the manufacturer's published product warranties.

1.7 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Location of barriers: Completed section set-out of safety barriers and terminal sections.
- Erection of barrier systems:
  . Posts set in natural ground: After completion of backfilling for posts.
  . Posts set in concrete pavement: After completion of post fixings.
  . Rectification of any damage to steel posts.
  . Completed barrier system erection, including posts, rails, end treatments and wire ropes.
- Removal of existing safety barrier systems: Completed removal and disposal of barriers, and reinstatement of surrounding material including backfilling.
- Rectification of ground/pavement: Completed rectification of disturbed ground/pavement surrounding posts.

2 MATERIALS

2.1 GENERAL

Storage and handling

Protection: Store all materials at least 200 mm above ground, including those fabricated, to prevent damage and corrosion.

Steel for rejection: Rusted, bent or damaged.

Timber posts/blockout blocks: Do not store on top of steel sections.

2.2 STEEL COMPONENTS

Properties

W-beam and thrie-beam elements: To AS/NZS 1594.

Steel components: To AS/NZS 3845.1 and as documented.

Flat washers: To AS 1237.1 and AS 1237.2.

Curving steel rail: Factory curved, as documented. Carry out curving without damaging the galvanizing.

Protective treatment

Treatment and galvanizing: After fabrication, treat surfaces of all ferrous metal components including posts, blockout pieces, rail elements, anchor plates, connectors and terminal pieces to AS 1627.4 or AS 1627.5 and hot-dip galvanize to AS/NZS 4680, unless recommended otherwise by the barrier system or device manufacturer.

Ferrous bolts, nuts, and washers: Galvanize to AS/NZS 1214.

- High strength bolts: To AS/NZS 1252.1.

2.3 TIMBER COMPONENTS

Properties

Application: Use timber posts only in W-beam terminal sections, as documented.

Surface: Smooth and free from obvious saw marks.

Finish

Preparation: Stop holes, cracks and other imperfections with white putty after applying primer coat.

Paint coating system:

- Undercoat: One coat of latex undercoat for exterior applications to AS 3730.18.
- Top coat: One coat of gloss latex for exterior applications to AS 3730.10.

Application: To AS/NZS 2311 Section 6.

Colour: Grey.

2.4 WIRE ROPE SAFETY BARRIER SYSTEMS

Proprietary item

Non-rigid road safety barrier systems with tensioned wire ropes: To AS/NZS 3845.1 clause 7.2.2 and as documented.

Wire rope for post and rail end treatments: To AS 3569.

2.5 PLASTIC COMPONENTS

General

Retroreflective materials: To AS/NZS 1906.1.

Delineators: To AS/NZS 1906.2.

Other plastic components: To the manufacturer's recommendations.

2.6 BACKFILL

Around steel posts: Clean, well-graded, granular material. Do not add cement.

Around other posts: Clean, well-graded, non-cementitious granular material or excavated material from post holes.

3 EXECUTION

3.1 GENERAL

Traffic safety

Material storage: Locate temporary stacks of new or surplus material associated with the Works clear of traffic flow and behind the line of barriers being removed or being erected.

Works program: Manage the construction sequence so that there are no traffic hazards or safety issues for road users, including exposed ends of barriers and partially completed works at the end of the day.

Installation

Requirement: Install to AS/NZS 3845.1 Section 6 and 7 except where explicit departures are documented.

Waste disposal: Remove all waste material from the site. Do not burn, bury or dispose of other waste material on-site.

Welding or flame cutting: Do not weld or flame cut any components on-site, carry out in factory conditions to the manufacturer's recommendations where documented.

Damage to surrounding pavement: Do not damage beyond 100 mm of the post, including any soil plates attached to the post.

3.2 ESTABLISHMENT

Existing underground services

Services laid in close proximity to the barrier system: Locate and protect services from damage before placing footings and installing barriers.

Sequence of construction

Requirement: Erect road safety barriers after constructing the base on concrete pavements and after placing the initial layer of asphaltic concrete or sprayed seal on a flexible pavement.

Set-out

Location of barriers: Locate road safety barriers and terminal sections as documented. Peg or paint mark the start and finish points, line of safety barrier, transitions and terminals including the line of flare if applicable.

Post accuracy: Position posts vertical and space so that no post movement is required to align holes.

3.3 ERECTION OF STEEL POSTS

Positioning of posts

Location: As documented.

Top of the posts: Position posts to form a smooth line both horizontally and vertically.

Level of posts: Level the posts on terminal ends to the extended crossfall of the main pavement or as documented.

Post depths: Set the posts to the full documented depth.

Foundation post installation

Steel posts erection: By driving or as documented.

Open section of posts: Point in the same direction as adjacent traffic.

Post holes: Compact bottom of holes to achieve the same density as the surrounding soil.

Backfilling around posts: Support the posts true to line and level whilst the holes are backfilled. Compact backfill to achieve the same density as the surrounding material tested to RMS T166.

Damage to posts

Acceptable condition: No obvious deformation as a result of driving.

Damage to galvanizing: Repair within 24 hours of damage to AS/NZS 4680 clause 8, using an organic zinc-rich primer.

Posts deemed excessively damaged: Replace.

3.4 ERECTION OF TIMBER POSTS

Positioning of posts

Requirement: To **ERECTION OF STEEL POSTS**, **Positioning of posts**.

Polystyrene foam

Requirement: Wrap the section of the posts to be cast into the reinforced concrete footing in 12 mm thick polystyrene foam sheeting before casting concrete.

Concrete footings
Minimum compressive strength at 28 days: 32 MPa.

Slump: 60 mm.

Footing size: 600 mm diameter.

Post foundations on natural ground: As documented.

Overbreak: Fill over-excavations and excessive depth with 32 MPa concrete.

Reinforcing fabric
Requirement: Wire fabric reinforcing, as documented.

3.5 ERECTION OF ROAD SAFETY BARRIER RAILS

Blockouts, rail laps and stiffening pieces
Steel blockout pieces: Erect with the open section or concave face pointing in the same direction as adjacent traffic.

Rail laps: Arrange in the same direction as adjacent traffic so that approach rail ends are not exposed to traffic.

Stiffening pieces: 300 mm long on intermediate posts.

Damages to galvanizing
Handling and erecting: Prevent damage to the galvanizing of road safety barrier rails and blockout pieces.

Repairs of galvanizing: Repair within 24 hours of damage to AS/NZS 4680 clause 8, using an organic zinc-rich primer.

Rail or blockout pieces deemed excessively damaged: Replace

Erection procedure
Rail attachment bolts and splice bolts: Initially tighten so that barriers can be erected.

Levelling rails: Make adjustments to rails using the slotted holes provided to produce a smooth regular line without any kinks or bumps.

Overall line of top of rails: Conform to the vertical alignment of the road pavement.

Splice bolt tightening: When vertically and horizontally aligned, fully tighten the splice bolts so that bolt head (not the shoulder) is in full bearing with the rail.

3.6 END TREATMENT OF ROAD SAFETY BARRIERS

Terminal sections
Leading and trailing terminals: Construct at both approach and departure ends of the road safety barrier, as documented.

Double sided road safety barriers: Construct terminal sections at the approach and departure ends, as documented.

MELT
Requirement: Locate as follows:

- At the approach end locations of road safety barriers as documented.
- If departure end of a road safety barrier is within the clear zone of opposing traffic, construct a MELT in place of a trailing terminal section.

Connections to rigid barriers

Requirement: Connect to rigid road safety barriers or bridge parapets as documented in conformance with the *1195 Rigid road safety barrier systems* work-section.

3.7 WIRE ROPE SAFETY BARRIER SYSTEMS INSTALLATION

General

Installation: To the manufacturer's recommendations.

Post installation: Install posts in concrete footings with appropriate sockets including covers to the sockets.

Intermediate blocks or tension bays: Install at the dimensions recommended by the manufacturer.

Footing installation: Install footing of uniform shape to the manufacturer's recommendations.

Wire rope tension testing: On completion of installation, test wire rope tension to verify it conform to the manufacturer's published requirements.

3.8 DELINEATORS

Fixing and location

Fixing: Fix delineators to road safety barriers with brackets.

Locations: As documented, starting at the first post.

Arrangement and colour: Arrange the delineators so that drivers approaching from either direction will see only red reflectors on their left side, and white reflectors on their right.

Delineators spacing table

Radius of curve (m)	Spacing of reflectors on barrier every
30 – 90	3rd post
90 – 180	5th post
180 – 275	8th post
275 – 365	11th post
Over 365 (including straight road)	16th post

3.9 EXISTING SAFETY BARRIER SYSTEMS

Removal of existing safety barrier systems

Removal and disposal: Conform to the following:

- Dismantle, extract and dispose of safety barriers and other components and materials including posts, transitions, end treatments, anchors and in-ground components, as documented.
- Remove and dispose of components and waste materials from site.
- Clean, backfill and mechanically compact excavations and holes formed by the extraction of posts, anchors and other in-ground components and materials.

Coordination and sequence of work: Minimise the exposure of incomplete safety barrier system to traffic. If practicable, start removal of barrier system from the departure end.

Backfilling and compaction of holes: In 150 mm layers using materials similar to existing surrounding layers. Compact backfill to not less than the density of the surrounding layers.

3.10 COMPLETION

Rectification of ground/pavement

Disturbed ground or pavement around post: Trim and compact to a dense, tight, smooth and sealed condition so that resistance to water penetration is similar to that of the adjacent surface.

4 ANNEXURES

4.1 ANNEXURE – SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection	Submission/Notice details	Process held
SUBMISSIONS, Products and materials Evidence of conformance	H	Evidence of material and component conformance.	5 days before erection	Material ordering and delivery
SUBMISSIONS, Products and materials Galvanized steel components	H	Evidence of zinc coating conforming to AS/ZS 4680.	5 days before erection	Material ordering and delivery
SUBMISSIONS, Execution details Wire rope safety barrier systems	H	Proposal for alternative barrier system if horizontal radius and/or vertical curvature is unsuitable.	5 days before erection	Barrier erection
INSPECTIONS, Notice Set-out	H	Set-out for safety barriers and terminal sections.	5 days before inspection	Barrier erection
SUBMISSIONS, Execution details Alternative methods of setting posts	H	Details of proposed alternative post setting method if required depth cannot be achieved.	5 days before erection	Setting of posts
SUBMISSIONS, Execution details Steel post driving details	H	Details for driving steel posts.	5 days before erection	Erection of steel posts
INSPECTIONS, Notice Erection of barrier systems	W	Completed post installation, rectification of damaged posts and completed barrier system.	3 days before inspection	-
INSPECTIONS, Notice Removal of existing safety barrier systems	W	Removal and disposal of barrier system and reinstated surrounding material.	3 days before removal of barrier system	-
INSPECTIONS, Notice Rectification of ground/pavement	W	Disturbed ground/pavement surround posts.	3 days before inspection	-
*H = Hold Point, W = Witness Point				

4.2 ANNEXURE – PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
1194.1 Single sided road safety barrier - 1194.1(1) Single W-beam. - 1194.1(2) Nested W-beam. - 1194.1(3) Single thrie-beam. - 1194.1(4) Nested thrie-beam. - 1194.1(5) Single modified blockout thrie-beam. - 1194.1(6) Nested modified blockout thrie-beam. - 1194.1(7) Single W/thrie-beam transition. - 1194.1(8) Nested W/thrie-beam transition.	Linear metre. - The distance measured along the centreline of the rail, centre to centre of posts, excluding terminal sections and connectors to rigid safety barriers or bridge parapets.	All costs associated with the supply of components, fixings and activities associated with the erection of each type of road safety barrier.
1194.2 Modified eccentric loader terminal (MELT)	Each MELT section supplied and erected.	All costs associated with supply and erection of MELTS as documented.
1194.3 Terminal section - 1194.3(1) Leading terminal - 1194.3(2) Trailing terminal	Each terminal section supplied and erected.	All costs associated with supply and erection of terminals as documented.
1194.4 Connectors to rigid road safety barriers (rsb) or bridge parapet - 1194.4(1) W-beam to RSB - 1194.4(2) W-beam to thrie-beam to RSB - 1194.4(3) Thrie-beam to RSB	Each connector supplied and erected.	All costs associated with supply and erection of RSB connectors as documented excluding the anchorage assemblies cast into the rigid road safety barrier or bridge parapet.
1194.5 Delineator brackets	Each.	All costs associated with S & E delineator brackets.
1194.6 Double sided road safety barrier - 1194.6(1) Single W-beam - 1194.6(2) Nested W-beam - 1194.6(3) Single thrie-beam - 1194.6(4) Nested thrie-beam - 1194.6(5) Single modified blockout thrie-beam - 1194.6(6) Nested modified blockout thrie-beam - 1194.6(7) Single W/thrie-beam transition - 1194.6(8) Nested W/thrie-beam transition	Linear metre. The distance measured along the centreline of the rails, centre to centre of posts, excluding terminal sections and connectors to rigid safety barriers or bridge parapets.	All costs associated with the supply of components, fixings and the erection of each type of road safety barrier.
1194.7 Double sided road safety barrier terminal section	Each terminal section supplied and erected.	All costs associated with the supply and erection of double sided road safety barrier terminal sections as documented.

Pay items	Unit of measurement	Schedule rate scope
1194.8 Concrete footings for posts	Each footing	All costs associated with the supply and installation of concrete footings as documented.
Traffic management		To the *1101 Traffic management* work-section.

4.3 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS/NZS 1214	2016	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)
AS 1237		Tolerances for fasteners - Washers for bolts, screws and nuts
AS 1237.1	2002	General plan
AS 1237.2	2016	Product grades A, C and F
AS/NZS 1252		High-strength steel fastener assemblies for structural engineering - Bolts, nuts and washers
AS/NZS 1252.1	2016	Technical requirements
AS/NZS 1594	2002	Hot-rolled steel flat products
AS 1627		Metal finishing - Preparation and pre-treatment of surfaces
AS 1627.4	2005	Abrasive blast cleaning of steel
AS 1627.5	2003	Pickling
AS 1906		Retroreflective materials and devices for road traffic control purposes
AS/NZS 1906.1	2017	Retroreflective sheeting
AS/NZS 1906.2	2007	Retroreflective devices (non-pavement application)
AS/NZS 2311	2017	Guide to the painting of buildings
AS 3569	2010	Steel wire ropes
AS 3730		Guide to the properties of paints for buildings
AS 3730.10	2006	Latex - Exterior - Gloss
AS 3730.18	2006	Undercoat/sealer - Latex - Interior/exterior
AS/NZS 3845		Road safety barrier systems and devices
AS/NZS 3845.1	2015	Road safety barrier systems
AS/NZS 4680	2006	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AP-T309-18	2018	Asset Management Strategy for Road -Related Assets (Safety Infrastructure)
RMS T166	2012	Relative compaction of road construction materials

1196 BOUNDARY FENCING FOR ROAD RESERVES

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide boundary fencing for road reserves, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *1101 Traffic management*.
- *1102 Control of erosion and sedimentation (Construction)*.
- *1111 Clearing and grubbing*.
- *1192 Signposting*.

1.3 STANDARDS

General

Steel wire fencing: To AS 2423.

Security fences and gates: To AS 1725.1.

1.4 INTERPRETATION

Definitions

General: For the purposes of this work-section the following definitions apply:

- Chain link fencing fabric: Diamond-pattern-woven fencing fabric manufactured from wire.
- Intermediate posts: Fence posts positioned at regular, equally spaced intervals between corner and/or end posts, to provide support for the fencing material.
- Post extension: An extension of the fence post above the normal height of chain-link fabric, which may be angled or vertical, to which barbed wire may be attached.
- Strainer posts: Fence posts at significant variations in levels and at intervals, as documented, with either bracing stays or bracing cables to achieve the required tension of support cables and chain-link fabric.
- Wire netting: Hexagonal-pattern-woven mesh manufactured from metallic-coated or uncoated (bare) wire.

1.5 SUBMISSIONS

Authority approvals

Requirement: Submit details of all authority approvals before commencing the works for which the approval is granted, including the following:

- Access to properties: Before starting work.
- Removal of existing tree: Within the clearing zone.

Execution details

Connections to existing fences: Submit details of proposed connection where new fencing intersects with existing fencing.

Post installation method: Submit details of proposed post type and installation method.

Products and materials
Material details: For each type of material, submit details of the source, manufacturer and type. Do not deliver or incorporate into the works until approved.

Tests
Requirement: Submit results, as follows:

- Stock grid compacted bedding index: To AS 1289.5.6.1.

Variations
Intermediate and strainer posts: If alternate sizes are proposed, submit details of proposed dimensions.

Warranties
Manufacturer's warranty: Submit the manufacturer's published product warranties.

1.6 INSPECTIONS

Notice
General: Give notice so that inspection may be made of the following:

- Set-out of fence lines: Completed fence section set-out.
- Small watercourse: Completed installation of erosion control measure.
- Removal of existing fencing for fence replacement: If removal is required, completed removal and disposal of existing fencing and reinstatement of the surrounding material including backfilling.
- Clearing and grubbing: Cleared work area before installation of fencing.
- Erection of fencing/gates:
  . Posts set in earth/rock: After completion of backfilling for posts.
  . Steel posts: Rectification of any damage to posts.
  . Installation: Completed fencing.
- Rectification of ground/pavement: Completed reinstatement of earth, rock or pavement surrounding posts.

2 MATERIALS

2.1 GENERAL

Storage and handling
Steel wire strand and rope: To AS 2759.

2.2 STEEL POSTS

Standards
Cold formed steel hollow sections: To AS/NZS 1163.

Posts for security fencing, pipe rail and post extensions for barbed wire attachment: To AS 1725.1.

Hot-dip galvanized coatings for steel tubes: To AS/NZS 4792.

Hot-dip galvanized coatings for star, strainer and intermediate posts: To AS/NZS 4680.

Steel tubes for strainer and intermediate posts: To AS 1074.

- Grade: Medium.

Steel tubes and posts generally
Steel tube grade to AS/NZS 1163: C250L0.

Pipe grade for chain link fencing posts to AS 1725.1: Medium quality.

Dimensions: As documented.

Splicing: If required, butt weld and set in concrete not less than 150 mm below ground level.

Welding: Clean and paint with a cold galvanizing compound, such as a zinc-rich paint.

Connections: If not welded and subject to movement, prevent connecting members from scratching to protect galvanized coatings.

Top caps: Fit each post with galvanized steel cap to prevent ingress of water.

Star posts (rural fencing)
Type: Star pattern (Y bar section) drilled to suit spacing of wires.

Finish: Black varnish or hot-dip galvanize.

Total weight: 320 posts each 1.65 m long not less than one tonne.

Pipe rail for pipe rail fencing
Dimension: Conform to the following, unless documented otherwise:

- Nominal diameter: 32 mm.

Joints: Only permitted for continuous top rail fencing longer than 6000 mm.

- Type: To AS 1725.1 clause 3.4.

Strainer posts
Minimum diameter: 150 mm.

Holes: Provide a set of 12 mm holes to suit the spacing of wires as documented.

Intermediate posts
Minimum diameter: 100 mm.

2.3 STEEL WIRE FENCING

General
Zinc coating: Uniform, continuous, free from imperfections, thoroughly adherent and applied to the wire before the mesh is woven.

Zinc coating mass: Minimum 290 g/m^2 of wire surface.

PVC coating: Coat in black PVC after galvanizing, if required.

Wire netting
Netting mesh: To AS 2423 Section 4.

Mesh/wire classification (dimensions): Unless documented otherwise, conform to the following:

- General use including rabbit-proof fencing: 105 x 4 x 1.4 (1065 mm wide, 38 mm mesh size, 1.40 mm diameter wire).
- At gullies and creek crossings: 90 x 5 x 1.6 (915 mm wide, 51 mm mesh size, 1.50 mm diameter wire).

Chain link fabric fencing
Chain link fencing fabric: To AS 2423 Section 5.

Product designation and dimensions to AS 2423: 10 m/1800 x 50 x 3.15/W10Z/HG/KK/HD (rolled length, width, pitch, wire diameter, metallic-coating grade, protective coating system code, selvedge type, service duty).

2.4 GATES

General

Material: To match adjoining fence.

Dimensions: Conform to the following:

- Vehicular access: 3.6 m wide x 1.5 m or 1.2 m high, to match height of adjoining fence.
- Pedestrian access: 0.9 x 1.5 m or 1.2 m high, to match height of adjoining fence.

Gate hardware: Substantial hinges, catch, drop bolts and locking chains or as documented.

Joints: Fully welded fillet welds, minimum 6 mm exposed surface width and cleaned.

Gates in rabbit-proof fencing: Minimum 900 mm above ground level with securely supported wire netting.

2.5 PRESTRESSED CONCRETE POSTS

Strainer and intermediate posts

Post loading: Designed to carry ultimate load of 3.5 kN for strainer posts and 7.5 kN for intermediate posts at the centre of the 1.5 m span. Take direction of the load perpendicular to the long axis of the post and parallel to the longer face.

Tendons: Minimum 2 high tensile tendons to AS/NZS 4672.1 tensioned as documented.

- Jointing: Do not join tendons.
- Diameter: 5 mm.

Minimum concrete compressive strength at 28 days: 32 MPa.

Minimum concrete cover: 20 mm except at post end faces.

Strainer posts

Grooves for wire: Minimum 5 mm deep and 5 mm wide at post surface, to suit wire spacing, as documented.

Intermediate posts

Grooves for wire, minimum concrete cover and concrete strength: Conform to **Strainer and intermediate posts**.

2.6 TREATED TIMBER POSTS AND BRACES

General

Hardwood: To AS 2082.

Sawn timber: To AS 2858 and Grade F5 to AS 1720.2.

Preservative treatment:

- Generally: To AS 1604.1 for hazard class H4.
- Timber rails, palings and other above ground items: To AS 1604.1 for hazard class H3.
- Treatment content: Containing no chromium and arsenic.

Strainer posts, intermediate posts and bracing dimensions and configuration: As documented.

2.7 WIRES

Metallic coating

Requirement: To AS 2423 clause 1.5.3.

Coating class: Minimum W02.

Coating type: Z or ZA.

Single strand wire
Fencing wires: To AS 2423 Section 2.

Tensile strength: Low tensile fencing to AS 2423 Table 2.4.

Diameter: As documented.

Tie wires: 2 mm diameter.

High tensile single strand wire
Fencing wires: To AS 2423 Section 2.

Tensile strength: High tensile fencing to AS 2423 Table 2.4.

Diameter: As documented.

PVC coated wire
Core wire: Conform to **Single strand wire** and **High tensile single strand wire**, as appropriate.

Coating: To AS 2423 clauses 1.5.4.1 to 1.5.4.4.

Barbed wire
Fencing wires: To AS 2423 Section 3.

Type: 2.5 mm diameter, galvanized, drawn annealed steel low tensile barbing wire to AS 2423 Table 2.4.

Alternative wire type: 1.6 mm diameter, high tensile barbed wire to AS 2423 Table 2.4.

Barb spacing: To AS 2423 clause 3.3.3.

Cable wire
Type: Three pairs of 2 x 3.15 mm galvanized steel wire tightly twisted around posts.

Location: As documented.

2.8 MISCELLANEOUS HARDWARE

General
Requirement: Conform to the following:

- Bolts and screws: To AS 1111.1 and AS 1111.2.
- Cup head bolts: To AS/NZS 1390.
- Hexagon nuts: To the AS 1112 series.
- Plain washers: To AS 1237.1 and AS 1237.2.
- Hot-dipped galvanized threaded fasteners: To AS/NZS 1214.

Type: Commercial grade bolts, nuts and washers.

2.9 CONCRETE

Concrete and mortar for backfilling of post holes
Minimum concrete compressive strength at 28 days: 20 MPa.

Slump: 60 mm.

3 EXECUTION

3.1 ESTABLISHMENT

Existing underground services

Services locations: Obtain locations of water, sewer, stormwater, gas, electricity and telephone services.

General

Access to properties: Liaise with property owners, Council and other relevant parties to obtain written approvals of access for clearing, fence construction, removal and disposal of materials.

Fencing

Finished fencing: Sound, strong and neat in appearance.

Minor irregularities in the ground levels: Do not vertically align fencing with these irregularities, align fencing to a uniform grade between definite changes in the natural slope of the ground.

Set-out of fence lines

Survey pegs: Make sure survey pegs remain undisturbed during the construction period. If required, adjust the post spacing slightly to avoid pegs.

Fence lines: Locate boundary fences on the boundary line between road reserve and private property.

Stock-proof: Secure fencing against movement of stock at all times, and take necessary precautions to prevent injury to people or stock from fencing activities.

Clearing and grubbing

Clearing zone: Clear one metre wide on either side of the fence line for the full length of the line.

Materials to remove: All logs, boulders, stumps, roots, undergrowth and waste, and dispose to the *1111 Clearing and grubbing* work-section.

Trees within the clearing zone: Do not remove trees without Council approval.

Survey marks: Protect during the clearing operations.

- Before clearing: For work in the vicinity of Permanent or State Survey Marks, obtain protection or relocation requirements from the Land Information Centre of the State Authority responsible for survey records.

Trees on fence line to be retained: Provide strainer posts on both sides of each tree. Do not strain wire around or against trees.

Trees and shrubs outside clearing zone: Do not damage.

Removal of existing fencing for fence replacement

Extent: Remove existing fencing as documented.

Existing posts set in rock: Obtain approval to neatly cut off at ground level and remove all traces of netting above and below ground level.

Backfilling of existing holes: Backfill all holes left after removal of existing fence and compact firmly in 150 mm maximum deep layers to the relative compaction of the surrounding ground materials.

Stock-proof fencing: Do not remove if there is risk of ingress or egress of stock.

Rabbit-proof fence: Conform to the following:

- If the bottom section of the fence netting to be replaced is buried, remove all traces of the old netting.

- Make sure that at night, weekends or other times when work is not being carried out, the whole of fence is maintained in a rabbit-proof condition.

3.2 ERECTION OF POSTS

General

Post alignment: Erect posts vertically except in unusually steep locations where posts may be erected perpendicular to the surface of the ground.

Concrete for footings and base strips: Crown the top surface at each post to shed water away from the post.

Damaged posts: Remove post if it becomes significantly damaged or cannot be driven vertically.

Post erection: Erect the same post, if undamaged, or a new post into neatly cut holes, backfill to the full depth with earth, if set in earth, or cement mortar or concrete if set in rock.

Posts set in earth: If post is not driven, make sure the diameter of hole is sufficient for compaction of backfill.

Backfilling and compact earthing: In layers of 150 mm deep maximum, for the full depth of the hole, to match the relative compaction of the original undisturbed ground.

Rock hole diameter: Sufficient for tight backfilling with cement mortar or concrete.

Post hole depth table

Type of post	**Depth (mm)**	
	Earth	**Rock**
Strainer posts	900	600
Intermediate posts	600	450
Other steel posts	450	450

Strainer posts

Locations: Provide as follows:

- Ends of fencing.
- Angles along the fence line.
- Abrupt changes in grade.
- Intersections with other fencing and gates.
- Intermediate points.

Distances between strainer posts:

- Generally: 120 m maximum.
- For cattle retention: 90 m maximum.

Bracing in one direction: At the ends of fencing and at gates.

Bracing in two direction: At angles in the fence line, abrupt changes of grade and intermediate points.

Other strainer post arrangements: As documented.

Bracing: Conform to the following:

- Timber posts: Round timber, as documented.
- Other than timber posts: Medium weight galvanized steel tube to documented dimensions.

After placing in position: Backfill to the full depth of the hole with earth, if post is set in earth, or with cement or concrete if post is set in rock.

Prestressed concrete posts

Erection: Erect in neatly cut holes sunk in earth or in rock, if encountered, or drive into the earth, using an appropriate post driver, to hold the post vertically in position during driving.

Protecting top of post during driving: Provide a steel cap with a 12 mm thick minimum plywood cushion.

Cutting concrete posts: Not permitted.

Posts set in rock: Provide posts manufactured in shorter lengths to suit the depth of sinking.

Steel posts

Posts not erected in rock: Drive steel posts with appropriate driving equipment, taking care not to damage the tops of the posts.

Damage to post protective coating: Repair using an organic zinc-rich primer conforming to AS/NZS 3750.9.

Posts erected in rock: Neatly cut holes, place in position and backfill to the full depth of the hole with cement mortar or concrete.

Treated timber posts

Erection: Erect in neatly cut holes sunk in earth or in rock, if encountered, or driven into the earth using a suitable post driver. Do not damage post during driving.

Stiff earth: Drive posts into drilled holes with diameters 50 mm less than the nominal maximum post diameter.

- Strainer posts: Drive small diameter end down.
- Other posts: Erect with butt end down.

3.3 ERECTION OF WIRES

Installation

Placement: Place wires as documented and by fixing them on the property owners' side of the posts.

Fastening and straining: Securely fasten and strain wires to strainer posts to the documented tension, measured using a wire strainer and gauge.

Wire fixing to posts: Fix wire as documented and to the following:

- Single strand and barbed wire to strainer posts: Wrap wire minimum 4 times around the tension side of the line, as documented.
- Barbed wire to prestressed concrete intermediate posts and steel posts: Tie top strand in position at the top of the posts.
- Single strand and barbed wire to timber intermediate posts: Fix each wire to the top of the post using a minimum 40 mm long galvanized staple.
- Single strand and barbed wire to steel intermediate posts: As documented or using proprietary galvanized fastening clips.
- Tie wire fixing to prestressed concrete intermediate posts: Tie wires securely so that they sit firmly in the grooves on the side of the posts.
- Fixing single strand and barbed wire to posts with tie wire: Stretch tie wire tight, fitted snugly against the side of the post to prevent wire movement. Wrap ends at least twice around the line wire and neatly cut off. Form all wire joints in figure-of-eight knots as documented.

Wire tensions table

Wire diameter (mm)	Type	Tension (kN)
4.0	Single strand wire	1.8
2.5	High tensile single strand wire	1.3

Wire diameter (mm)	Type	Tension (kN)
2.5	Barbed wire – Low tensile	1.3
1.6	Barbed wire – High tensile	1.3

3.4 ERECTION OF WIRE FENCING

Wire netting

Wire netting position: Erect on the same side of the fence as the line wire.

Type: As documented.

Fastening: Attach to the fence with tie wire or fixing clips. Twist each tie wire twice around the fence wire and neatly cut off the ends.

Straining netting: Loosely tie the netting to the fence wires then carefully strain without distorting or breaking the mesh, and immediately tie to the wires on each side of every post at 1.0 m maximum intervals.

Chain link fabric fencing

Location and extent: As documented.

Mesh position: Erect on the outside of the post, on the same side as the line wire.

Fastening: With two turns of the wire to each cable wire on both sides of each post and at 900 mm maximum intervals between posts and to each post midway between cable wires.

Rabbit-proof fencing

Erection: Conform to **Wire netting**.

Netting position: Erect netting on the side of the fence remote from the roadway.

Fixing of netting: With tie wire or fixing clips.

Straining and tying: Loosely tie netting to fence wires then carefully strain without disturbing or breaking the mesh, and immediately tie to the wires on each side of the post and at 1 m maximum intervals.

Bottom section of netting: Bury or lay flat on the ground, as documented and as follows:

- If existing net is buried: Excavate trench before running the netting.
- Replacing existing buried netting: Remove all traces of existing netting and replace with matching netting on the same alignment.
- Trenching: If required, place and compact with backfill material of similar properties to the surrounding material.

Lapping/trench: Erect the netting so there is a 200 mm lap laid on the ground surface or trenched 215 mm into the ground, as documented for the type of fencing erected.

At strainer post strut: Attach additional netting to the fence adjacent to the strainer post to the level of the top wire and 450 mm wide from the post, as documented.

3.5 GATES

Erection

Swing: Erect gates so that they swing away from the road.

Gate opening: Single gates.

Ground surface at gates: Make sure finished ground surface is levelled and horizontal for the full area of the gate opening arc.

Hanging: Hang gates and provide connections and fittings, as documented.

Rabbit-proof fencing: Install gates with minimum 25 mm gap underneath on each side.

Security gates: To AS 1725.1.

3.6 FLOOD GATES

General

At watercourses: Make appropriate provisions for the passage of flood waters through the fence.

Flood gate type: As documented.

Flood debris: Prevent accumulation of flood debris, while remaining stock-proof or rabbit-proof.

Small watercourses

Type: Provide flap gate and support frame as documented and as follows:

- In rural fencing: Provide gates which include netting or fabric.
- In rabbit-proof fencing: With maximum 25 mm gaps.

Opening of each gate: Provide waterway area at least twice that of the culvert opposite to which it is placed.

Width: Maximum 2.4 m.

Flap gate and frame:

- Provide a flap of hardwood frame with lapped corner joints, each secured by two M6 galvanized bolts.
- Cover the frame with a 1 mm galvanized sheet, secured to the frame by 25 x 2.8 mm galvanized clouts at 100 mm maximum centres.
- Swing the flap from a hardwood rail, connected to the strainer posts, located on each edge of the gully or creek with M12 galvanized cup head bolts.

Erosion control: Protect the lower edge of the opening from the effects of creek bed erosion by installing hardwood sheeting to a minimum depth of 300 mm below the existing ground level, as documented.

Gullies and creeks

Location: As documented.

Gate construction:

- Suspend a 9 mm galvanized steel wire rope over the gully in one span, thread through a strainer post on each edge of the gully and tie back to an anchor set in the footing of each adjacent intermediate post.
- End connections: Incorporate a thimble and wire rope grips.
- Turnbuckles: Provide at each end to tension the wire rope so that it lays horizontally. Suspend netting from the wire rope, fixed at 200 mm intervals, overlap and tie securely.
- Netting: Fix with sufficient length to lie on the ground for a distance of not less than 1.0 m on the downstream side.
  . Adjacent widths of netting: Overlap and securely tie together.

Netting ballast: 150 mm diameter treated timber securely fixed to the netting with 40 mm galvanized staples at the downstream end of the netting.

Trim: Trim the sides of the gully, as necessary, so that flood gate is stock-proof or rabbit-proof.

Flow of flood water: Make sure the suspended portion of the gate can move sufficiently under the flow of flood waters to prevent damage to the fence and the accumulation of debris against it.

Stay each strainer post: In three directions.

3.7 STOCK GRIDS

General

Location and extent: As documented.

Bedding: Evenly bed the grid base on a continuous layer of 50 mm thick compacted sand or other granular material with maximum particle size of 5 mm.

- Compact bedding material: To achieve density index of 90% minimum tested to RMS T166.

Raised abutments: Install grids on raised abutments with approach ramps.

- Alternative: Place grid over an excavated pit with adequate drainage.

Transition: Make a smooth transition from grid to ground.

Dispose: Dispose of any excavated material.

Single lane grids: No crossfall on grillage.

Two lane grids: Make sure each half of the grillage has a crossfall matching that of the approach road.

Advance signposting: To AS 1742.2 and the *1192 Signposting* work-section on each approach to the cattle grid.

3.8 COMPLETION

Rectification of ground/pavement

Requirement: Reinstate constructed ground surface layer material and associated foundation removed or damaged due to removal of existing fencing or installation of new fencing.

Removal and disposal of surplus material and waste

Requirement: Recycle, re-use or dispose of all surplus material, including off-cuts, timber logs, boulders, stumps, roots, undergrowth, waste and other debris from clearing and fencing erection.

Preservative-treated timber: Do not burn. Dispose to the treatment manufacturer's recommendations.

4 ANNEXURES

4.1 ANNEXURE – SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Authority approvals Requirement	H	Authority approvals of property access for the Works and removal of existing trees.	5 days before commencement	Commencement
SUBMISSIONS, Execution details Post installation method	H	Details of post type and installation method.	5 days before erecting posts	Erection of posts
SUBMISSIONS, Products and materials Material details	H	Details for each type of material.	5 days before ordering of material	Material ordering and delivery

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS, Variations Intermediate and strainer posts	H	Details of alternate sizes.	5 days before ordering of material	Material ordering and delivery/ erection of posts
INSPECTIONS, Notice Set-out of fence lines	H	Completed fence section set-out.	5 days before clearing	Clearing/removal of existing fencing
INSPECTIONS, Notice Small watercourses	H	Completed installation of erosion control measure.	5 days before erecting posts	Subsoil drainage
INSPECTIONS, Notice Removal of existing fencing for replacement	H	Completed removal and disposal of existing fencing and reinstatement of surrounding materials.	5 days before erecting posts	Erection of replacement fencing
INSPECTIONS, Notice Clearing and grubbing	W	Cleared work area for installation.	5 days before erecting posts	Erection of fencing
INSPECTIONS, Notice Erection of fences/gates	W	Completed backfill.	3 days before inspection	Erection of chain wire mesh, netting or gate.
INSPECTIONS, Notice Erection of fences/gates	W	Completed rectification of damage to steel posts.	3 days before inspection	Erection of chain wire mesh, netting or gate.
INSPECTIONS, Notice Erection of fences/gates	W	Completed fencing.	3 days before inspection	-
INSPECTIONS, Notice Rectification of ground/pavement	W	Completed reinstatement of earth/rock/pavement surrounding posts.	1 day after completing reinstatement	-
*H = Hold Point, W = Witness Point				

4.2 ANNEXURE – PAY ITEMS

Pay items	Unit of measurement	Schedule rate inclusions
1196.1 Supply and erection of boundary fencing	Linear metre of fencing, chain-link, stock-proof or rabbit-proof, measured on site.	Show separate pay for each type of fence required. All costs associated with the supply of materials; clearing of site, and all activities associated with the erection of fencing, including the levelling of mounds, if required, concreting; the provision of crossings for watercourses and depressions; flood gates and the connection of the new fencing to existing fencing removal and disposal of excavation material encountered (earth and rock), surplus material and rubbish.
1196.2 Supply and erection of boundary fence gates	Each gate erected.	All costs associated with the supply of materials and erection of each gate.
1196.3 Supply and installation of stock grid	Each cattle grid installed.	All costs associated with the supply and construction of the stock grid including excavation, bedding, approach ramps, wings, drainage, adjustment to fencing and the provision of signs.
1196.4 Removal of existing fence	Linear metre of fencing removed as measured on site.	All costs associated with the demolition and disposal of existing fencing.
Traffic management		To the *1101 Traffic management* work-section.
Clearing and grubbing		To the *1111 Clearing and grubbing* work-section.
Signposting		To the *1192 Signposting* work-section, except for stock grid signage.

4.3 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1074	1989	Steel tubes and tubulars for ordinary service
AS 1111		ISO metric hexagon bolts and screws - Product grade C
AS 1111.1	2015	Bolts
AS 1111.2	2015	Screws
AS 1112		ISO metric hexagon nuts
AS/NZS 1163	2016	Cold-formed structural steel hollow sections
AS/NZS 1214	2016	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)
AS 1237		Tolerances for fasteners - Washers for bolts, screws and nuts
AS 1237.1	2002	General plan
AS 1237.2	2016	Product grades A, C and F
AS 1289		Methods of testing soils for engineering purposes

AS 1289.5.6.1	1998	Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material
AS/NZS 1390	1997	Cup head bolts with ISO metric coarse pitch threads
AS 1604		Specification for preservative treatment
AS 1604.1	2012	Sawn and round timber
AS 1720		Timber structures
AS 1720.2	2006	Timber properties
AS 1725		Chain-link fabric fencing
AS 1725.1	2010	Security fences and gates - General requirements
AS 1742		Manual of uniform traffic control devices
AS 1742.2	2009	Traffic control devices for general use
AS 2082	2007	Timber - Hardwood - Visually stress-graded for structural purposes
AS 2423	2002	Coated steel wire fencing products for terrestrial, aquatic and general use
AS 2759	2004	Steel wire rope - Use, operation and maintenance
AS 2858	2008	Timber - Softwood - Visually stress-graded for structural purposes
AS/NZS 3750		Paints for steel structures
AS/NZS 3750.9	2009	Organic zinc-rich primer
AS/NZS 4672		Steel prestressing materials
AS/NZS 4672.1	2007	General requirements
AS/NZS 4680	2006	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 4792	2006	Hot-dip galvanized (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process
RMS T166	2012	Relative compaction of road construction materials

1351 STORMWATER DRAINAGE (CONSTRUCTION)

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide drainage works as a complete system for collecting and carrying stormwater from roadways, open spaces and built-up areas, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *0257 Landscape - road reserve and street trees*.
- *0319 Auxiliary concrete works*.
- *1101 Traffic management*.
- *1102 Control of erosion and sedimentation (Construction)*.
- *1112 Earthworks (Road reserve)*.
- *1121 Open drains*.
- *1151 Road openings and restoration*.
- *1352 Pipe drainage*.
- *1353 Precast box culverts*.
- *1354 Drainage structures*.
- *1859 CCTV inspection of drainage conduits*.

1.3 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviations apply:

- CCTV: Closed circuit television.
- NATA: National Association of Testing Authority.
- WSUD: Water Sensitive Urban Design.

Definitions

General: For the purposes of this work-section the following definitions apply:

- Inadequate foundation material: Material beneath or adjacent to the proposed drainage structures with insufficient strength to support the structure and loads on the structure, or material with characteristics that would adversely affect the performance or construction of the drainage structure.
- Select fill: Backfill material with known properties and grading placed and compacted in layers.

1.4 SUBMISSIONS

Authority approvals

Road opening permit: Submit an application to the relevant Council for approval for works to road or footpath, including the following:

- Location of services. Contact Dial Before You Dig.
- Opening and compaction specifications to the *1151 Road openings and restoration* work-section.

Certification

Construction traffic: If proposing to move heavy construction plant or vehicles over pipe or box culverts structures, submit certification by an NPER registered engineer of the protection measures.

Traffic Management Plan: Submit the traffic management plan for approval to the appropriate Road Authority.

Execution details

Survey: Submit set-out survey for drainage system.

Set-out of stormwater drainage system: Submit details of any proposed changes to the location, length, design levels, strength, conditions of installation or cover to suit construction procedures.

Temporary drainage during construction: Submit details of procedures/devices to maintain effective drainage of the works area.

Soil type: Give notice if the soil type on site is not consistent with the soil type used for design.

Subgrade before bedding: Check suitability of support material below culverts and compaction of subgrade.

Depth of bedding: Check level of base of trench to meet minimum bedding requirements before placing bedding material.

Products and materials

General: Submit product information for components of the stormwater system.

Product conformity: Submit current assessment of conformity as follows:

- Certificates for all pipes, culverts, precast concrete units, access covers, road grates or frames and all materials and components. Identify the item and record the inspection and test records that verify conformance to the specification.

Records

Work-as-executed drawings: Submit drawings including stormwater system information sheets and works. One design file in accordance with the ADAC specification, which is available on Council's website.

CCTV Reports

CCTV inspection results: If CCTV reports are required, submit inspection results to *1859 CCTV inspection of drainage conduits* within 5 working days of field CCTV inspection completion.

Samples

General: Submit the following:

- Components: Pipes and fittings.
- Samples: For conformity testing to relevant standards.
- Recycled materials.

Tests

Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

1.5 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Set-out of stormwater drainage system: Set-out of culverts and drainage system.
- Unsuitable foundation material: Area (including trench sides) containing material unsuitable to support drainage system.
- Rock foundation: Remove to spoil of any excavated rock, measure rock in heap loose, to pay.
- Backfilling:
  . Dimensions of corrugated metal structures after backfilling.

. Against in-situ concrete structures.
- Compaction adjacent to culverts or drainage structures: Rectification of damage due to compaction.
- Compaction of pipe drainage bedding: Cementitious stabilisation in the concrete pipe bedding and haunch zones.
- Protection to WSUD: Vegetated swales, buffer strips, and bioretention systems from construction traffic (Environmental protection).

2 MATERIALS

2.1 GENERAL

Materials and components

Pipe and culvert material: To Austroads AGRD05 Table B1.

Pipes: To the *1352 Pipe drainage* work-section.

Precast: To the *1353 Precast box culverts* work-section.

Structures: To the *1354 Drainage structures* work-section.

2.2 BEDDING AND SUPPORT MATERIAL

General

Recycled material: To IPWEA NSW Greenspec.

Concrete pipes

Fill material for bed and haunch zones: Select fill conforming to the following:

- Particle size distribution: To AS/NZS 3725 Table 6.
- Plasticity index: To AS 1289.3.3.1: Maximum 6.

Fill material for side and overlay zones of pipes, box culverts and adjacent to other drainage structures: Select fill conforming to the following:

- Maximum dimension: 75 mm.
- Plasticity index to AS 1289.3.3.1: 2 to 12.

Corrugated metal structures

Grading and plasticity: Select fill conforming to AS/NZS 2041.2 Table 2.4.1(B).

Flexible pipes

Embedment material: If using flexible pipes and the embedment method, provide embankment material to AS/NZS 2566.1 clause 3.3 or AS/NZS 2566.2 Appendix G.

Backfill material adjacent to weepholes

Requirement: Clean, graded, hard and durable stone or river gravel conforming to the following:

- Maximum particle dimension: < 50 mm.
- Minimum particle dimension: < 5% by mass passing the 9.5 mm AS sieve.

2.3 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Quality verification: If material/product quality verification can be obtained from the supplier, documented tests need not be repeated.

3 EXECUTION

3.1 ESTABLISHMENT

General

Survey control: Provide for the following:

- Mapping and pegging the drainage system.
- Locating components.

Survey data: Provide data for the set-out of gradients, culverts and drains and construction to tolerances.

Set-out of stormwater drainage systems

Requirement: Identify and set out the location and levels of the following:

- Outlets and inlets of pipes and box culvert structures. Include the lengths in the set out.
- Gully pits, junction boxes, energy dissipators and inlet and outlet structures.
- Ends of wingwalls and headwalls.
- Open drains.

Site conditions: If required by site conditions, amend the inlet and outlet locations, designed levels or the culvert length.

Temporary drainage during construction

Dams and diversions: Do not, temporarily or permanently, dam or divert existing watercourses.

Material and equipment: Locate material and equipment clear of watercourses or secure to prevent danger or damage due to large runoff flows.

Swales and buffer strips: Protect during construction or make use of the swale as a temporary measure. Provide geotextile with 50 mm topsoil and instant turf laid perpendicular to the flow path.

Stabilisation of topsoil areas: If required, stabilise the topsoil with hydroseed immediately after earthworks to the *0257 Landscape - road reserve and street trees* work-section.

Construction traffic

Requirement: If proposing to move heavy construction plant or vehicles over pipe or box culverts structures provide protection measures.

Existing structures

Existing redundant drainage structures: Demolish and remove existing redundant pipe culverts, head walls and pits as documented.

3.2 OPEN DRAINS

General

Requirement: Provide open drains, associated embankments and protective linings in conformance with the *1121 Open drains* work-section.

3.3 EXCAVATION FOR DRAINAGE SYSTEMS

General

Topsoil removal: To the *1112 Earthworks (Road reserve)* work-section and before excavation.

Trench support stabilisation: Provide shoring, sheet piling or other stabilisation to the sides of trench excavations.

Excavation level: Excavate to the design level for bedding or foundation. Remove all loose material.

Swales, batter slopes and bioretention trenches: Level beds as documented.

Soil type

Requirement: Confirm surrounding soil type conforms to the soil type used for the stormwater drainage system design.

Trenches and embankments

Concrete and flexible pipes: Minimum trench width as follows:

- Concrete pipes: To AS/NZS 3725 clause 9.
- Flexible pipes: To AS/NZS 2566.2 clause 4.4.

Embankment installation condition: Before placing bedding and laying pipes, place and compact embankment fill to the *1112 Earthworks (Road reserve)* work-section and to the following:

- Height above the top of the bed zone: At least 0.7 times the external diameter of the pipe.
- Minimum lateral distance outside each trench wall: 2.5 times the external diameter of the pipe.

Trench installation condition: Complete the embankment to the underside of the selected material zone before trenching.

Drainage structures other than pipes

Excavation: Provide a clear width between the structure wall and the face of the excavation of one third of the excavation face height or a minimum of 300 mm.

Inadequate foundation material

Requirement: Remove and dispose of inadequate foundation material to the *1112 Earthworks (Road reserve)* work-section and replace with material to **BEDDING AND SUPPORT MATERIAL**.

Rock foundation

Requirement: If rock is encountered at the foundation level, excavate to a depth required by the pipe type and backfill with compacted selected fill.

3.4 BEDDING AND BACKFILLING

Pipe bedding

Concrete and flexible pipes: Bedding depth as follows:

- Concrete pipes: To AS/NZS 3725 Table 5.
- Flexible pipes: To AS/NZS 2566.2 Table 4.2.

Corrugated metal structures: Provide minimum 75 mm thick uncompacted bedding material between the foundation and the outer surface of corrugations to AS/NZS 2041.2 clause 2.6.

Backfilling

Concrete pipes minimum cover: To AS/NZS 2566.2 Table 4.1.

Flexible pipes height of fill: To AS/NZS 3725 Table B1.

Corrugated metal structures: Place backfill as follows:

- Equally balanced on both sides, with minimum dimensions to AS/NZS 2041.2 Table 2.4.3 and Table 2.5.
- Monitor the shape during placement in conformance with AS/NZS 2041.2 clause 2.14.

In-situ concrete structures: Do not backfill against in-situ concrete drainage structures less than 14 days after placing concrete.

Trench backfill material: Backfill the remainder of the trench to the underside of the subgrade, or selected material zone in conformance with the *1112 Earthworks (Road reserve)* work-section.

Sequence: Start backfilling and compaction at the pipe or structure to confine future backfill material.

Compaction of pipe bedding, haunch, side and overlay to be to HS3 standard. HS3 stormwater material to be backfilled to subgrade level, within roads.

3.5 COMPACTION

Compaction of foundations, bedding and backfilling

Foundations, bedding (other than for pipe drainage) and backfilling: In accordance with the **Compaction table**, tested in conformance with AS 1289.5.4.1 for standard compactive effort.

Compaction table

Zone	Relative compaction
Foundations or trench base:	
- To a depth of 150 mm below foundation levels	95%
- Material replacing unsuitable material	95%
Bedding material	95%
Selected backfill and ordinary backfill material:	
- Below 1.5 m of finished surface	95%
- Within 1.5 m of finished surface	100%
Backfill material within the selected material zone	100%

Compaction layers thickness: Compact all material in layers not exceeding 150 mm compacted thickness and to the documented relative compaction before the next layer is commenced.

Moisture content range: At the time of compaction, adjust the moisture content (within the range 60% to 95% of the optimum moisture content) of the material to achieve the documented compaction as determined by AS 1289.5.7.1 (standard compaction).

Compaction adjacent to culverts or drainage structures

Method: If compacting adjacent to culverts or drainage structures, adopt compaction methods which do not cause damage or misalignment. Rectify any damage.

Compaction of pipe drainage bedding

Protection of the pipe from construction damage: If required, adjust the layer thickness to avoid damaging the pipe.

Concrete pipes bed and haunch zones:

- Compaction: To AS/NZS 3725 clause 8 and Table 5.
- Place and shape the top 0.1 times the external diameter of the pipe of the bedding and haunch material directly under the pipe to house the pipe after compaction achieved in the bed and haunch zone external to area of direct support.
- If the impermeability of the natural ground and the slope of the drainage line may result in erosion of bedding material, provide cementitious stabilisation.

Flexible pipe embedment: To AS/NZS 2566.2 clause 5.6 and Table 5.5.

3.6 CONCRETE WORK

General

Requirement: Supply and place normal class concrete, sprayed concrete, steel reinforcement, formwork and provide tolerances, construction joints, curing and protection to the *0319 Auxiliary concrete works* work-section and as documented.

3.7 WATER SENSITIVE URBAN DESIGN

Protection to WSUD

Vegetated swales, buffer strips and bioretention systems: Do not allow construction traffic access to areas of WSUD or infiltration systems. Provide fences if required to the *1196 Boundary fencing for road reserves* work-section.

Permanent protection: Install bollards, signposting or other street furniture, to protect the constructed vegetated areas from damage.

Vegetated swales and buffer strips

Details: As documented and to the following requirements if appropriate.

Ponding prevention: Provide a perforated pipe beneath the swale drain.

Geometry: Trapezoidal or parabolic shapes, side slopes no steeper than 3H:1V.

Longitudinal slope: If longitudinal slope is not within 1% to 4%, conform to the following:

- Slopes greater than 4%: Install check dams.
- Slopes less than 1%: Install under drains.

Maximum swale width: 2.5 m.

Maintenance:

- Buffer strips: Remove deposited sediment. Inspect vegetation regularly for reasonable condition.
- Swales: Vegetation height should be maintained so that it is not submerged.

Bioretention systems/rainwater gardens

Base or drainage layer:

- Depth: 150 to 200 mm.
- Material: Coarse sand (1 mm) or fine gravel (2 to 5 mm).
- Impermeable liner: If the surrounding soil is free draining, use an impermeable liner on the base and sides.

Transition layer:

- Minimum 100 to 150 mm thick layer of sand. A geotextile fabric may be used.

Filtration layer:

- Depth of filter media: 300 and 700 mm, as documented.
- Saturated hydraulic conductivity: 200 to 500 mm/hr.
- Perforated pipe capacity: Make sure the perforated pipe capacity is more than the infiltration capacity of the filter media.

Maintenance:

- Inspection: Inspect bioretention systems every fortnight between October to March and once a month between April to September.
- Litter: Remove litter and dead plant material from gardens.
- Density: Maintain the planting density of the garden.
- Herbicide: Do not use herbicides in bioretention systems/rainwater gardens.
- After rainfall of over 10 mm, within 2 days:
  - Remove surplus silt build up.
  - Replace washed away soil.
  - Replace gravel or mulch.
  - Remove litter.

Gross pollution treatment (GPTs) as part of a treatment system

General: Provide GPTs as documented.

Treatment objectives: To capture gross pollutants litter and vegetation larger than 5 mm and sediment particles larger than 0.125 mm.

Landscape and vegetation

Plant species selection: To the *0257 Landscape - road reserve and street trees* and street trees work-section.

Minimum depths of topsoil: Conform to the following:

- Turf areas: 150 mm.
- Ground covers and small shrubs: 300 mm.
- Large shrubs: 450 mm.
- Trees: 600 mm.

Stormwater re-use

Requirement: Provide stormwater re-use collection, storage, treatment and distribution.

3.8 TESTING

Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

3.9 COMPLETION

Inspection

Closed circuit television (CCTV) inspections: Inspect drainage structures to the *1859 CCTV inspection of drainage conduits* conduits work-section and as follows:

- On completion of all drainage structures and before commencement of pavement construction above the drainage structure to verify the works are within the specified tolerances and without visual signs of structural failure.
- No more than 14 days before completion to verify tolerances and to make sure there is no obstruction to the flow of water.

Cleaning

Flushing: On completion of the system, flush all pipes clean from end to end and leave in working order.

4 ANNEXURE

4.1 ANNEXURE – SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS Authority approvals	H	Dial Before You Dig investigation. Gain Service Authority Approval where conflicts exist.	10 days before site commencement	Site commencement
SUBMISSIONS Road opening permit from the Road Authority	H	Approval from Road Authority with appropriate approval certificate.	5 days before site commencement	Gain road opening permit with conditions
SUBMISSIONS Certification Construction traffic	H	Certification of protection measures	5 days before protection measures installation.	Protection measures
SUBMISSIONS Traffic Management	H	Traffic Management Plan submitted to Road Authority for Approval	10 days before commencement	Site Commencement

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS Execution details Set-out of stormwater drainage system	H	Details of any proposed changes to designed system	5 days before commencement	Construction setout
SUBMISSIONS Execution details Temporary bypass drainage during construction	H	Details of procedures/devices	10 days before site commencement	Temporary drainage proposal
SUBMISSIONS Execution details Soil type	H	Soil type confirmation	3 days before starting excavation	Excavation
SUBMISSIONS Tests Durability	H	Soil test results	5 days before proceeding	Site commencement
INSPECTIONS, Notice Set-out of stormwater drainage system	W	Set-out of location design levels and design cover	3 days	Set-out of stormwater drainage
INSPECTIONS, Notice Drainage structures other than pipes	W	Clear width of excavations	3 days	Temporary drainage during construction
INSPECTIONS Notice Unsuitable foundation material	W	Area containing material inadequate to support drainage system Identify unsuitable material and remove to spoil heap and pay loose heap measure.	Proceeding	Trench grade suitability
INSPECTIONS Notice Rock foundation	W	Compaction to fill for excavated rock Removal of rock to spoil to measure loose in heap.	Proceeding	Bedding depth over rock
INSPECTIONS Notice Culvert subgrade strength	W	Compaction and suitability of subgrade under culverts.	1 day before culvert foundation material	Subgrade before bedding material
INSPECTIONS Notice	W	Dimensions of corrugated metal	1 day	Backfilling

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
Backfilling		structures after backfilling		
INSPECTIONS Notice Backfilling	W	To in-situ concrete structures	2 days	Backfilling
INSPECTIONS Notice Compaction adjacent to culverts or drainage structures	W	Observation of compaction around culverts to check compliance.	Proceeding	Compaction of backfilling
INSPECTIONS Notice Compaction of pipe drainage bedding	W	Cementitious stabilisation in the concrete pipe bedding and haunch zones as specified	Proceeding	Compaction and stabilisation of backfilling and bedding
INSPECTIONS Notice Protection to WSUD	W	Vegetated swales, buffer strips, and bioretention systems from construction traffic	Proceeding	Restoration of any damaged WSUD
*H = Hold Point, W = Witness Point				

4.2 ANNEXURE – MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Siting and excavation	Geometry	1 drainage line/structure	1 per drainage line/structure	Survey
Foundation	Compaction	1 drainage line/structure	1 per 20 lin m *	AS 1289.5.4.1
Material surrounding steel structures	Material quality: - pH/Electrical resistivity	1 drainage line/structure	1 per material	AS 1289.4.3.1 AS 1289.4.4.1
Compaction of stormwater to HS3 standard. One test each for bedding, haunching, side and overlay	Material quality: - Particle size distribution - Compaction/moisture content	1 contract 1 drainage line/structure	1 Test per 50 lineal metres per line, and a minimum of one test per stormwater road crossing	AS 1141.11.1 AS 1289.5.4.1 AS 1289.5.7.1 AS1289.5.2.1
Concrete bedding or lining	Geometry		1 Cross section per 25 m	Survey and 3 m straight edge
Selected backfill	Material quality: - Maximum particle size - Plasticity index	 1 contract 1 contract 1 drainage line/structure	 1 per 100 m^3 * 1 per 100 m^3 * 1 per 2 layers per 50 m^2	AS 1289.3.3.1 AS 1289.5.4.1 AS 1289.5.7.1

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
	- Compaction/moisture content			
* Note: or part thereof, per lot				

4.3 ANNEXURE – PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
1351.1 Excavation and backfilling for stormwater drainage culverts and structures.	m^3 measured as volume excavated: **Box culverts:** - Plan area calculated from base slab dimensions plus 300 mm and wingwalls as documented. - Depth is average actual site measurement from the bottom of the specified bedding to the ground surface after stripping topsoil. **Other drainage structures:** - Plan area from outside dimensions as documented. - Depth is average actual site measurement from the bottom of the specified bedding to the ground surface after stripping topsoil. **Unsuitable material under culverts and drainage structures:** - Volume m^3 loose. - Actual plan area and average depth below bedding of material removed. - Provisional item for rock excavation per m^3 of rock .	The Schedule rate for this **Pay Item** to be an average rate to cover all types of material excavated including both earth and rock. All costs associated with all activities for the excavation of material and backfilling as specified including setting out and associated survey, replacement of unsuitable material, replacement of over-excavation, control of stormwater runoff, temporary drainage, erosion and sediment control, disposed of excess or unsuitable material.
1351.2 Excavation for pipe drainage, pipes, structures.	m^3 measured as volume of excavated material calculated for each component to **Excavation dimensions for PAY ITEM 1351.2schedule**.	The Schedule rate for this **Pay Item** to be an average rate to cover all types of material excavated including both earth and rock. All costs associated with all activities for the excavation of material, traffic control, erosion control.
1351.3 Inadequate foundation material under drainage structures and open drains.	m^3 measured as of excavated material (loose in tuck) or as measured in bank.	The Schedule rate for this **Pay Item** to be an average rate to cover all types of material excavated including both earth and rock. All costs associated with all activities for the excavation, removal, replacement and

Pay items	Unit of measurement	Schedule rate scope
		disposal of inadequate foundation material traffic control, erosion control.
Traffic management	Lump sum.	To the *1101 Traffic management* work-section.
Erosion and sedimentation control		To the *1102 Control of erosion and sedimentation (Construction)* work-section.
Topsoil removal and backfilling		To the *1112 Earthworks (Road reserve)* work-section
Open drain linings		To the *1121 Open drains* work-section
Concrete works		*0319 Auxiliary concrete works* work-section

Excavation dimensions for PAY ITEM 1351.2 schedule

Reinforced concrete and fibre reinforced cement pipes – Positive projection (if excavation required)		
Width	Single cell	External pipe diameter +1 m.
	Multi cell	Sum of external diameters + sum of spacings between pipes measured square to the line of the culvert + 1 m.
Depth	In natural ground	Average actual depth from topsoil stripped ground surface to underside of specified bedding.
	In embankment	Average actual depth or 500 mm above top of pipe to underside of specified bedding, whichever is lesser.
Length		Actual excavation length, centre to centre of pits or centre of pit to face of headwall.
Reinforced concrete and fibre reinforced cement pipes – Wide trench		
Width	Single cell:	External pipe diameter + 1 m.
	Multi cell:	Sum of external diameters + sum of spacings between pipes measured square to the line of the culvert + 1 m.
Depth	In natural ground	Average actual depth form topsoil stripped ground surface to underside of specified bedding.
	In embankment	Maximum 500 mm above top of pipe to underside of specified bedding.
Length		Actual excavation length, centre to centre of pits or centre of pit to face of headwall.
Reinforced concrete and fibre reinforced cement pipes – Normal trench		
Width		1.4 x external pipe diameter or + 300 mm on each side, whichever is the greater.
Depth	In natural ground	Average actual depth form topsoil stripped ground surface to underside of specified bedding.
	In embankment	Maximum 500 mm above top of pipe to underside of specified bedding.
Length		Actual excavation length, centre to centre of pits or centre of pit to face of headwall.

Reinforced concrete and fibre reinforced cement pipes – Positive projection (if excavation required)		
Steel pipes and pipe arches		
Width	Wide trench	External pipe diameter or span + 2 x external pipe diameter or span.
	Normal trench	External pipe diameter or span + 600 mm on each side.
Depth		As for RC and FRC pipes.
Flexible pipes		
Width	Pipe size	
	External diameter at collar ≥ 75 ≤ 150	External diameter of pipe + 200 mm
	External diameter at collar ≥ 150 ≤ 300	External diameter of pipe + 300 mm
	External diameter at collar ≥ 300 ≤ 450	External diameter of pipe + 400 mm
Depth		Average actual depth excavated.
Length		Actual excavation length, centre to centre of pits or centre of pit to face of headwall.

4.4 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1141		Methods for sampling and testing aggregates
AS 1141.11.1	2009	Particle size distribution - Sieving method
AS 1289		Methods of testing soils for engineering purposes
AS 1289.3.3.1	2009	Soil classification tests - Calculation of the plasticity index of a soil
AS 1289.4.3.1	1997	Soil chemical tests - Determination of the pH value of a soil - Electrometric method
AS 1289.4.4.1	2017	Soil chemical tests - Determination of the electrical resistivity of a soil - Method for sands and granular materials
AS 1289.5.4.1	2007	Soil compaction and density tests - Compaction control test - Dry density ratio, moisture variation and moisture ratio
AS 1289.5.7.1	2006	Soil compaction and density tests- Compaction control test - Hilf density ratio and Hilf moisture variation (rapid method)
AS/NZS 2041		Buried corrugated metal structures
AS/NZS 2041.2	2011	Installation
AS/NZS 2566		Buried flexible pipelines
AS/NZS 2566.1	1998	Structural design
AS/NZS 2566.2	2002	Installation
AS/NZS 3725	2007	Design for installation of buried concrete pipes
Austroads AGRD		Guide to road design
Austroads AGRD05	2013	Drainage – General and hydrology considerations
IPWEA NSW Greenspec	2010	Specification for the supply of recycled materials for pavements, earthworks (Roads and Transport Directorate)

1352 PIPE DRAINAGE

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide the pipework for the drainage system, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *0319 Auxiliary concrete works*
- *1101 Traffic management*.
- 1171 Subsurface drainage.
- *1351 Stormwater drainage (Construction)*.
- *1354 Drainage structures*.
- *1392 Trenchless conduit installation*.

1.3 INTERPRETATIONS

Definitions

General: For the purposes of this work-section the following definitions apply:

- Effective pipe length: The centre-line length dimension specified by the manufacturer and subject to permissible tolerances.

1.4 SUBMISSIONS

Execution

Invert protection to steel pipes: Submit cement slurry application procedure.

Products and materials

Product conformity: Submit manufacturer's certificate of conformance to the relevant standard for each batch of pipes before dispatch to site. Identify the item, source and record the inspection and test records that verify conformity.

Manufacturer's data and installation recommendations: Submit in conformance with AS/NZS 2041.4 Appendix A and AS/NZS 2041.6 Appendix A, AS/NZS 4058 Appendix B and AS 4139 Appendix A, as appropriate.

Samples

Components: Submit pipes and fittings.

Pre-treatment: If necessary, to represent the condition and grading when compacted and in service, pre-treat samples.

Tests

Other tests: Submit results, as follows:

- Concrete pipes joint tests.

1.5 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Additional protective coatings: Field cut and repairs to steel pipes.
- Damage: Repairs to damaged pipeline components.
- Joints for concrete pipes: Joint testing.
- Pipework installation: Each section of the installed and jointed pipework before commencement of trench backfilling.

2 MATERIALS

2.1 CONCRETE PIPES

Precast reinforced concrete pipes

Requirement: Provide precast reinforced non-pressure concrete pipes to AS/NZS 4058 and the following:

- Pipe class and size, as documented.
- Load classes: As documented.
- Jointing type: Provide as follows:
  . Spigot and socket joints: Flexible elastomeric seals to AS 1646.
  . Flush or butt joints: Use only for the first pipe if extending existing pipes.
- Clear cover to reinforcement: For normal environments to AS/NZS 4058 Table 3.1.

Marking: To AS/NZS 4058 clause 1.5.

Durability: Maximum concentration limit for chlorides, sulphates, aggressive CO2, and pH levels to AS/NZS 4058 Appendix E.

Fibre reinforced concrete pipes

Requirement: Provide fibre reinforced concrete pipes to AS 4139 and in conformance with the following:

- Pipe class and sizes: As documented.
- Load classes and installation conditions: As documented.
- Jointing type: Provide as follows:
  . Double V-ring joints: Flexible elastomeric seals to AS 1646.
  . Other joints: Jointing compound comprising plasticised butyl rubber and inert fillers, conforming to the manufacturer's recommendations.
  . Flush or butt joints: Use only for the first pipe if extending existing pipes.

Marking: To AS 4139 clause 12.

Durability: Maximum concentration limit for chlorides, sulphates, aggressive CO2, and pH levels to AS 4139 Appendix B.

2.2 CORRUGATED METAL PIPES AND STRUCTURES

Helical formed sinusoidal pipes

Requirement: Provide helical formed sinusoidal pipe to AS/NZS 2041.4 with pipe corrugation designation, size and base material, as documented.

Bolted plate structures

Requirement: Provide bolted plate structures to AS/NZS 2041.6 with pipe corrugation designation, size and base material, as documented.

Durability

Dissimilar metals: Prevent direct contact of dissimilar metals.

Additional protective coatings

Coatings for pipes and bolted plate structures: Bituminous coating to AASHTO M190 or to manufacturer's recommendations

Field cuts and repairs: Wire brush cut ends to remove any scale and apply two coats of zinc-rich organic primer to AS/NZS 3750.9.

2.3 PLASTIC FLEXIBLE PIPES

General

Requirement: Provide flexible pipes including fitting to AS/NZS 2566.1 with pipe class and size as documented.

Pressure polyethylene (PE): To AS/NZS 4130.

Polyethylene (PE) and Polypropylene (PP): To AS/NZS 5065.

PVC-U pipes: To AS/NZS 1260.

Pressure PVC-U: To AS/NZS 1477.

Joint sealant and type: To AS/NZS 2566.2 Appendix F.

Rubber rings for pipe joints: To AS 1646.

Electrofusion jointing for PE pressure pipe: To PIPA POP001.

Butt fusion jointing for PE pipe: To PIPA POP003.

Solvent cement jointing for PVC-U pipe: To PIPA POP102 .

3 EXECUTION

3.1 ESTABLISHMENT

General

Excavation: To the *1351 Stormwater drainage (Construction)* work-section.

Excavation drainage: Dewater the excavation to permit the compaction of the foundation, the bedding and backfilling, as documented.

Tolerances dimensions: Provide culverts within 10 mm of the grade line and within 10 mm of the horizontal alignment, as documented.

Subsurface drain location: At the discharge end of culverts terminating at pits and headwalls, provide a 3 m length of 100 mm diameter subsurface drain, as follows:

- Position in the trench 100 mm above the invert level of the pipe.
- Discharge through the wall of the pit or headwall.
- Seal the subsurface drainage pipe at the upstream end and enclose in a seamless tubular filter fabric to the 1171 Subsurface drainage work-section.

Damage

Pipeline components: Inspect all pipeline components for damage and flaws immediately before installation.

Damaged components: Repair damaged components in conformance with manufacture's requirements. Replace unit components, if unable to repair satisfactorily.

3.2 INSTALLATION

Concrete pipes

Standard: To AS/NZS 3725.

Positioning of pipes: Lay pipes as follows:

- Install with the socket end upstream.
- Install pipes with markings indicating the crown or invert in conformance with the markings.

Minimum pipe length: 1.2 m.

Stiffening of pipes: If required by the manufacturer, provide temporary stiffening struts to the interior before back filling.

Lifting holes: Before backfilling, seal lifting holes in all pipes with approved plastic preformed plugs or a 3:1 sand cement mortar.

Bulkhead locations: Construct bulkheads to the *1354 Drainage structures* work-section on all lines where the pipe gradient exceeds 5%.

Anchor blocks: Provide anchor blocks at a maximum spacing of 3 m and at bends or junctions for all stormwater pipes laid on a grade more than 20% and as documented.

Joints for concrete pipes

Joint testing: Test joints, as follows:

- Precast concrete pipes: To AS/NZS 4058 Appendix H.
- Fibre reinforced concrete pipes: To AS 4139 Appendix L.

Skid rings: To the manufacturer's recommendations, including the use of lubricants, if wedge shaped 'skid' rubber rings are required.

Flush or butt joints: Seal the joints with proprietary rubber sleeves to the manufacturer's recommendations.

Other joints: Provide direct side connections to other pipes, as documented.

Flexible plastic pipes

Standard: To AS/NZS 2566.2.

Positioning of pipes: Install pipes with markings indicating the crown or invert, or the direction of flow in conformance with the markings.

Bulkheads: If required, provide bulkheads or trench stops to AS/NZS 2566.2 Table 5.7 or as documented.

Flotation prevention: To AS/NZS 2566.2 clause 5.5.3.

Corrugated metal pipes and structures

Standard: To AS/NZS 2041.2.

Joints to helically formed sinusoidal pipes: Provide as follows:

- Re-roll both ends with 4 annular corrugations of pitch 68 mm.
- Semi-corrugated coupling bands
- Rubber ring joint seals, as documented.

Joint protection: Provide non-woven geotextile material to prevent loss of sand backfill or bedding into the pipe in to the requirements for geotextiles in the 1171 Subsurface drainage work-section and as follows:

- Extent: All joints or lap joints, except rubber ring joint coupling bands.
- Geotextile material: Minimum 250 mm wide and minimum 270 grams/m^2.

Bedding: Provide non-erodible poured concrete bedding to the bottom third of the pipe circumference to provide external protection of corrugations, as documented.

Invert protection for steel pipes

Surface preparation: Remove any foreign material and if corrosion has occurred, remove all loose scale.

Extent: Place sprayed concrete to a minimum thickness of 100 mm over the crest of the corrugations to cover the bottom third of the pipe circumference symmetrically about the invert centreline of the pipe, as documented.

Sprayed concrete: To the *0319 Auxiliary concrete works* work-section.

Reinforcement: Fabric of hard drawn steel wire 4 mm diameter with 200 mm square mesh, securely supported at a central location within the sprayed concrete by non-metallic supports on the pipe side of the fabric and as follows:

- Laps in fabric: 300 mm.
- Cover to the fabric: 50 mm.

Cement slurry application: Immediately after placement of the sprayed concrete, remove all free water and coat the surface with cement slurry.

Water flow: Prevent the flow of water over the surface of the sprayed concrete for 24 hours after the placement of sprayed concrete.

Bedding: Provide non-erodible poured concrete bedding to the bottom third of the pipe circumference to provide external protection of corrugations, as documented.

3.3 COMPLETION

Pipework installation

Progressive inspections: Inspect each section of installed and jointed pipework before commencement of trench backfilling.

4 ANNEXURE

4.1 ANNEXURE – SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS Products and materials Product conformity	H	Certificate of conformance of all pipes and fittings.	5 days before delivery	Delivery of pipes
SUBMISSIONS Samples Conformity of components	H	Samples of fittings	5 days before delivery	Delivery of pipes and fittings
INSPECTIONS, Notice Additional protective coatings	W	Field cut and repairs to steel pipes. Submit cement slurry procedures	3 days	Execution
INSPECTIONS, Notice	W	Repairs to damaged pipeline components	3 days	Inspections and notices.

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
Damage				
INSPECTIONS Notice Joints for concrete pipes	W	Joint testing Elastomeric seal. Check V ring joints	3 days	Precast concrete pipes
INSPECTIONS Notice Pipework installation	W	Each section of the installed and jointed pipework before commencement of trench backfilling	Progressive	Execution and installation
*H = Hold point W = Witness point				

4.2 ANNEXURE - PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
1352.1 Supply and install pipe drainage culverts, pipes, structures.	Linear m of pipe drainage culvert: - Measured on centreline of each type, class and size of stormwater drainage pipe culvert. - The plan length between centres of gully pits or faces of headwalls.	The Schedule rate for this **Pay Item** to be a rate for each type, class and size of pipe culvert. All costs associated with all activities including: - Supply. - Survey and setting out. - Bedding. - Jointing (including connections). - Subsoil drains at pits and headwalls. - Temporary bracing and strutting. - Anchoring system including anchor blocks. - Bituminous painting. - Sprayed concrete lining and other protective measures. - Selected material backfilling. - Embankment material trench backfilling. - Reinforcing fabric. - Disposal of excesses of - Unsuitable material.
Traffic management	Lump sum.	To the *1101 Traffic management* work-section.
Sprayed concrete		To the *0319 Auxiliary concrete works* work-section
Excavation, bedding, support and backfill material		To the *1351 Stormwater drainage (Construction)* work-section

Pay items	Unit of measurement	Schedule rate scope
Bulkheads		To the *1354 Drainage structures* work-section

4.3 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS/NZS 1260	2017	PVC-U pipes and fittings for drain, waste and vent application
AS/NZS 1477	2017	PVC pipes and fittings for pressure applications
AS 1646	2007	Elastomeric seals for waterworks purposes
AS/NZS 2041		Buried corrugated metal structures
AS/NZS 2041.2	2011	Installation
AS/NZS 2041.4	2010	Helically formed sinusoidal pipes
AS/NZS 2041.6	2010	Bolted plate structures
AS/NZS 2566		Buried flexible pipelines
AS/NZS 2566.1	1998	Structural design
AS/NZS 2566.2	2002	Installation
AS/NZS 3725	2007	Design for installation of buried concrete pipes
AS/NZS 3750		Paints for steel structures
AS/NZS 3750.9	2009	Organic zinc-rich primer
AS/NZS 4058	2007	Precast concrete pipes (pressure and non-pressure)
AS/NZS 4130	2009	Polyethylene (PE) pipes for pressure applications
AS 4139	2003	Fibre-reinforced concrete pipes and fittings
AS/NZS 5065	2005	Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications
Austroads AP-R575	2018	Design of buried flexible pipes
PIPA POP001	2017	Electrofusion jointing of PE pipe and fittings for pressure applications
PIPA POP003	2017	Butt fusion jointing of PE pipes and fittings - recommended parameters
PIPA POP102	2014	Solvent cement welding of PVC pipe
AASHTO M190	2004	Standard specification for bituminous-coated corrugated metal culvert pipe and pipe arches

1353 PRECAST BOX CULVERTS

1 GENERAL

1.1 RESPONSIBILITIES

General

General: Provide precast box culvert units including construction of base slabs, as documented.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *0319 Auxiliary concrete works*.
- *1101 Traffic management*.
- *1112 Earthworks (Road reserve)*.
- *1121 Open drains*.
- *1141 Flexible pavement base and subbase.*
- *1172 Subsoil and formation drains.*
- *1351 Stormwater drainage (Construction)*.
- *1354 Drainage structures*.

1.3 STANDARDS

General

Small culverts: To AS 1597.1.

Large culverts: To AS 1597.2.

1.4 INTERPRETATION

Definitions

General: For the purposes of this work-section the definitions given in AS 1597.1, AS 1597.2, as appropriate, and the following apply:

- Cofferdam: A structure, usually temporary, built to support the surrounding ground or to exclude water and soil sufficiently to permit work to proceed safely without excessive pumping.
- Large culvert unit: Culvert unit with a span exceeding 1200 mm up to 4200 mm and a height from 1200 mm up to 4200 mm.
- Small culvert unit: Culvert unit with a span up to 1200 mm and a height up to 1200 mm.

1.5 TOLERANCES

General

Inlet and outlet invert levels: ± 10 mm from documented levels.

Cast in-situ base slabs: Conform to the following:

- Invert levels: ± 10 mm.
- Grade: 1:500.
- Plan position: ± 50 mm.
- Surface irregularities: < 5 mm step in surface.
- Flatness: Maximum 8 mm deviations from a 3 m straightedge laid in any direction on a plane surface.

1.6 SUBMISSIONS

Execution details

Construction of cofferdams: Submit details of the coffer dam, formwork required, and proposed clearances.

Diversion and disposal of water: Submit details for managing water flows 1 week before starting diversion works.

Products and materials

Product conformity: Submit manufacturer's certificate of conformance to AS 1597.1 and AS 1597.2, as appropriate, for the box culverts before dispatch to site. Identify the item, source and record the inspection and test records that verify conformity.

Manufacturer's data and installation recommendations: Submit to AS 1597.1 Appendix A and AS 1597.2 Appendix A, as appropriate.

1.7 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Handling, delivery and storage: Precast box culvert on delivery to site.
- Removal of cofferdams: Timber and bracing and cofferdam removal.
- Diversion and disposal of water: Diversion works.
- Cast in-situ base slab: Completed bedding.
- Precast base slab: Completed bedding.
- Cast in-situ base slab: Minimum compressive strength.
- Placement precast units: Completed jointing between units.
- Side zones and overlay fill: Backfill sequence.

2 MATERIALS

2.1 PRECAST BOX CULVERTS

General

Requirement: Proprietary precast box culvert to the size and load class documented and conforming to AS 1597.1 and AS 1597.2, as appropriate.

Joint type: Butt joint.

Marking: Apply marking on each culvert, conforming to the following:

- Small culverts: To AS 1597.1.
- Large culverts: To AS 1597.2.

Handling, delivery and storage

Handling and storage: Handle and load store precast box culverts to prevent damage to the units.

Delivery inspection: Inspect batches of precast box culverts for dimensional accuracy and defects.

2.2 CEMENT MORTAR

Materials

Cement: To AS 3972.

Water: Clean and free from any deleterious matter.

Sand: Fine aggregate with a low clay content and free from efflorescing salts, selected for colour and grading.

Proportions (water : cement : sand): 0.4:1:3 by mass.

2.3 FILL MATERIAL

Material
General: To AS 1597.1 clause 1.4.2.7 and AS 1597.2 clause 1.4.2.7, as appropriate.

2.4 IN-SITU CONCRETE

General
In-situ concrete base slabs: To the *0319 Auxiliary concrete works* work-section.

2.5 DRAINAGE STRUCTURES

General
Requirement: To the *1354 Drainage structures* work-section.

3 EXECUTION

3.1 COFFERDAMS

General
Requirement: Construct a cofferdam as required by the site-specific conditions to allow dewatering of the construction area and diversion of the water course.

Construction of cofferdams
General: Construct cofferdams as follows:

- Sufficiently watertight to prevent damage to in-situ concrete structures, by percolation or seepage through the sides.
- Founded sufficiently below the culvert foundation level to prevent loosening of the foundation materials by water rising through the bottom of the excavation.
- Braced to prevent weakness or damage to the structure on removal of the cofferdam.

Clearances: Adjust cofferdams that have tilted or moved laterally to maintain the documented clearances.

3.2 ESTABLISHMENT

Diversion and disposal of water
Requirement: Divert and/or dispose of water from the construction area as required, without causing damage to any portion of the works or surrounding properties.

3.3 EXCAVATION

General
Requirement: To the *1351 Stormwater drainage (Construction)* work-section.

Trench width: As documented or the width of the base slab plus 150 mm minimum each side.

Line and level: Excavate earth and rock foundations to line and level of the underside of the bedding. Do not disturb material below this level.

Unsuitable material: Remove and dispose of inadequate foundation material and replace with ordinary fill.

Batter slopes: Evenly transitioned over 10 m length from the edge of the wingwall to match culvert wingwall slopes.

Rock foundations
Preparation: Thoroughly clean out all minor fissures and refill with concrete, mortar or grout. Remove all loose material.

Surface correction: Provide mass concrete to form a uniform bearing surface at least 50 mm above the highest points of rock to correct over-excavation or uneven surfaces.

Partial rock foundation: If rock is encountered over part of the foundation prepare as follows:

- Excavate the whole of the foundation to a depth of 300 mm below the level of the bottom of the base concrete slab.
- Replace and compact this additional excavation with ordinary fill to provide uniform bearing conditions.

Excavate existing stream bed

Joining: Excavate inlet and outlet channels as documented and extend to the existing stream bed to the *1121 Open drains* work-section.

3.4 BEDDING

Cast in-situ base slabs

General: Select bedding from the following alternatives:

- Mass concrete bedding.
- CRB20-2 bedding as follows:
  - CRB20-2 material: To *1141 Flexible pavement base and subbase*.
  - Lightly bound and compacted: To *1351 Stormwater drainage (Construction)*.
  - Place to the line and level of the underside of the base slab.
  - Level tolerance: ± 10 mm.
  - Finish: Screed to a smooth surface finish.

Precast base slabs

Foundation support as follows:

- Small culverts: Select backfill to AS 1597.1.
- Large culverts: Select backfill to AS 1597.2.
- Compacted depth: > 100 mm.

3.5 INSTALLATION

General

Inlet and outlet invert levels: As documented with a smooth, uniform gradient throughout each culvert length.

Installation: Conform to the following:

- Small culvert units: To AS 1597.1 Section 4.
- Large culvert units: To AS 1597.2 Section 6.

Cast in-situ base slabs

Requirement: Construct cast in-situ base slabs to the documented dimensions.

Traffic: Prevent construction or public traffic access over the base slab for 7 days after of placement.

Recesses: Form recesses to accommodate the walls of the precast crown units in the base slab to the documented dimensions.

Minimum comprehensive strength: 20 MPa before installation of precast crown units.

Placement of precast units

Temporary plug: If required, seal the ends of the culvert with a temporary plug to exclude water, sand or other deleterious materials.

Mortar bed in recess: Install precast crown units on a cement mortar bed in the base slab recess. Pack any gaps between the side walls and the sides of the recess with cement mortar.

Lifting holes and butt joints between the ends of units: Seal with cement mortar or grout of a consistency to make sure void is filled.

Slabs on U-shaped units or link slabs between crown units: Before placing slabs, clean the support bearing area and cover with a cement mortar bed, minimum 5 mm thick.

Lifting hooks: Cut lifting hooks and coat the exposed steel to prevent corrosion.

Multi-cell box culverts: Provide a 15 mm gap between adjacent cells. Fill gap with cement mortar or grout.

Curing of joints: Protect all mortar joints from the sun and cure for more than 48 hours before placing backfill.

Joint covering: Cover the external surfaces of joints between precast crown units, both laterally and longitudinally for the full length, with minimum 250 mm wide strips of non-woven geotextile of minimum mass 270 grams/m^2 to AUSTROADS AGPT04G.

3.6 BACKFILL

General

Removal of formwork: Remove all bracing and formwork before backfilling.

Subsoil drain: Provide a subsoil drain enclosed in a seamless tubular filter fabric at the outer walls of the precast crown sections and at wingwalls as documented and to the *1172 Subsoil and formation drains* work-section.

Horizontal terraces: If the sides of the excavation are steeper than 4H:1V, cut benches in the form of horizontal terraces at least 1 m in width before placing backfill.

Wingwalls: Do not backfill against wingwalls less than 21 days after placing concrete.

Side zones and overlay zone fill

Backfilling: Place select fill in the side zones of box culverts and wingwalls, and 300 mm deep in the overlay zone of box culverts.

Compaction: Compact in layers. with a maximum compacted thickness of 150 mm.

Sequence: Start backfilling and compaction at the box culvert wall. Place backfill equally balanced on both sides of the box culvert with a maximum 600 mm level difference.

Trench and embankment fill

Backfilling: Backfill the remainder of the excavation or embankment to the *1112 Earthworks (Road reserve)* work-section.

3.7 COMPLETION

General

Requirement: Remove and replace precast box culverts if required for any of the following reasons:

- Not within the tolerances.
- Settlement after installation.
- Damaged during backfilling, compaction or subsequent operations.

Flushing: Flush clean all culverts from end to end and maintain in working order until completion of the works.

Removal of cofferdams

Timber and bracing: Remove from the concrete and the backfill of the completed structure.

Cofferdams: Remove, including temporary piles, at least to the culvert invert level after completion of the structure. Prevent material associated with the cofferdam or dewatering from entering the culvert.

Construction loading on culverts

Requirement: Prevent the passage of construction vehicles and plant over the box culvert until 28 days after the placing the concrete base slab or until the compressive strength of the concrete base slab has reached 32 MPa.

Loading restrictions: To AS 1597.1 clause 4.7 and AS 1597.2 clause 5.7, as appropriate.

4 ANNEXURES

4.1 ANNEXURE – SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS Products and materials Product conformity	H	Certificate of conformance for dimensional accuracy and defects	5 days before delivery	Delivery of precast box culverts
SUBMISSIONS Execution details Construction of cofferdams	H	Details of proposed cofferdams and compliance with requirements	10 days before commencement.	Construction of cofferdam
INSPECTIONS Notice Handling, delivery and storage	W	Precast box culvert on delivery to site. Check dimensions and any defects	5 days before installation	Precast material supply
INSPECTION Notice Diversion and disposal of water	W	Diversion works	Proceeding	Cofferdam construction establishment
INSPECTIONS Notice Cast in-situ base slab	H	Completed bedding	5 days before installation of base slab	Installation of base slab
INSPECTIONS Notice Precast base slab	H	Completed bedding	5 days before installation of base slab	Installation of base slab
INSPECTIONS Notice Cast in-situ base slab	W	Minimum compressive strength	1 day	Cast in-situ base slab
INSPECTIONS Notice	W	Completed jointing between units	1 day	Precast base slabs

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
Placement precast units				
INSPECTIONS Notice Side zones and overlay fill	W	Backfill sequence	1 day	Backfill
INSPECTIONS Notice Removal of cofferdams	W	Timber and bracing and cofferdam removal	3 days	Cofferdams removal

4.2 ANNEXURE – PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
1353.1 In-situ base slab	m^3 of reinforced concrete in place. Volume to be calculated from length, width and depth of slab as documented or directed by the Superintendent	All cost associated with foundation preparation, bedding and all activities associated with the construction of the base slab. Including the following types: - -Lightly bound CRB20-2. - -Concrete, reinforcement, formwork.
1353.2 Precast base slab for small culverts	m^3 of reinforced concrete in place. Volume to be calculated from length, width and depth of slab as documented or directed by the Superintendent	All cost associated with the supply, delivery and installation of precast units.
1353.3 Precast concrete box culverts (supply and install)	Linear m of actual length installed for each size of box culvert as documented.	All costs associated with supply, installation and jointing of the precast units including selected backfilling and testing of the units.
Traffic management	Lump sum.	To the *1101 Traffic management* work-section.
Headwalls and wingwalls		To the *1354 Drainage structures* work-section
Excavation		To the *1351 Stormwater drainage (Construction)* work-section.
Excavation for inlet and outlet channels		To the *1121 Open drains* work-section.
Cast in-situ base slab		To the *0319 Auxiliary concrete works* work-section.
Subsoil drains		To the *1172 Subsoil and formation drains* work-section.
Trench and embankment fill		To the *1112 Earthworks (Road reserve)* work-section.

4.3 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1597		Precast reinforced concrete box culverts
AS 1597.1	2010	Small culverts (not exceeding 1200 mm width and 900 mm depth)
AS 1597.2	2013	Large culverts (exceeding 1200 mm span or 1200 mm height and up to and including 4200 mm span and 4200 mm height)
AS 3972	2010	General purpose and blended cements
Austroads AGPT		Guide to pavement technology
Austroads AGPT04G	2009	Geotextiles and geogrids

1354 DRAINAGE STRUCTURES

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide drainage structures as documented including headwalls, wingwalls, pits, gully pits, inspection pits, junction boxes/pits, drop structures, inlet and outlet structures, energy dissipaters, batter drains and other supplementary structures.

1.2 CROSS REFERENCES

General

Requirement: This work-section is not a self-contained specification. In addition to the requirements of this work-section, conform to the following:

- *0136 General requirements (Construction)*.
- *0152 Schedule of rates (Construction)*.
- *0161 Quality management (Construction)*.
- *0319 Auxiliary concrete works*.
- *1101 Traffic management*.
- *1172 Subsoil and formation drains.*
- *1351 Stormwater drainage (Construction)*.

1.3 INTERPRETATION

Definitions

General: For the purposes of this work-section the following definitions apply:

- Drainage structures: Devices to control stormwater flowing into and through a stormwater drainage system including culverts, inlet and outlet structures, junction boxes, gully pits, drop structures, headwalls, wingwalls, energy dissipaters and ancillary hardware such as grates, frames and step irons as well as subsurface drainage pipes at pits, headwalls and wingwalls.

1.4 TOLERANCES

General

Requirement:

- Horizontal position: ± 25 mm.
- Inlet and outlet invert levels: ± 10 mm of documented levels.
- Finished level of access cover: Flush with the finished level of the surrounding area ± 3 mm.

1.5 SUBMISSIONS

Materials

Product conformity: Submit manufacturer's certificate of conformance for the precast drainage structures before dispatch to site. Identify the item, source and record the inspection and test records that verify conformity.

Manufacturer's data and installation recommendations: Submit in conformance with AS 3996 Appendix B for access covers.

Execution details

Precast drainage structures: If proposing to substitute precast units for in-situ units, submit details of proposed proprietary items.

1.6 INSPECTIONS

Notice

General: Give notice so that inspection may be made of the following:

- Foundation:
  . At completion of excavation and compaction.
  . Rock foundation to wingwalls and headwalls. Excavation of rock to levels.
  . Rock foundation to gully pits and sumps. Excavation of rock for pits and sumps.
- Precast units: Installation of precast units.
- Backfilling: Before backfilling of in-situ concrete drainage structures.

2 MATERIALS

2.1 IN-SITU CONCRETE

General

In-situ concrete: To the *0319 Auxiliary concrete works* work-section for the concrete and reinforcement for in-situ drainage structures.

2.2 PRECAST DRAINAGE STRUCTURES

General

Requirement: Provide proprietary precast drainage structures as documented.

Handling, delivery and storage: Handle precast units to the manufacturer's recommendations.

Knockouts: Do not provide standard precast pit base units with thinned wall sections on all 4 sides. Provide base units and other riser units to suit the design configuration of the particular pit with preformed knockouts only where required.

Durability

Concrete cover: To AS 3600.

Marking

Identification marking: At the time of manufacture, clearly mark each precast unit with the following information:

- Date of manufacture.
- Manufacturer's name or registered mark and the location of manufacture.
- Maximum mass of unit in kg.
- Batch number.
- Inspection status.

Height of letters: 75 mm.

Location of marking: Easily visible but hidden once the unit is installed.

2.3 CEMENT MORTAR

Materials

Cement: To AS 3972.

Water: Clean and free from any deleterious matter.

Sand: Fine aggregate with a low clay content and free from efflorescing salts, selected for colour and grading.

Proportions (water: cement: sand): 0.4:1:3 by mass.

2.4 FILL MATERIAL

Material

General: To AS 1597.2 clause 1.4.2.7.

2.5 ACCESS COVERS AND FRAMES

Specification

Access covers and frames: To AS 3996 and as documented in the Access covers and frames schedule.

Proprietary items: To the manufacturer's recommendations.

3 EXECUTION

3.1 ESTABLISHMENT

Locating drainage structures

Alignment to road: Construct headwalls and pits parallel to the road centreline and wingwalls at 135° to the headwall or as documented.

Non-parallel culverts: If the culvert is not perpendicular to the road centreline, splay the wingwalls and headwalls so that the front edge of the wing bisects the angle between the centreline of the culvert and the headwall.

Dissipaters: Construct with centreline on axis to the culvert.

Preparation

Foundation: Dewater and wash clean of contaminants before placing concrete.

3.2 EXCAVATION

Foundation

Requirement: Excavate and compact the foundation to the *1351 Stormwater drainage (Construction)* work-section.

Wingwalls and headwalls: If rock is encountered at the bottom of excavations for wingwalls and headwalls, the documented depth of cut-off walls in uniform rock over the full width of the foundations may be reduced.

- Minimum depth of cut-off walls into sound rock: 150 mm.

Gully pits and sumps: If the full depth of the excavation is in sound rock, construct a neatly formed pit of the required dimensions and omit the concrete lining except to the wall adjacent and parallel to the road.

Subsoil drainage: Provide subsoil drains for the pits and headwalls to the *1172 Subsoil and formation drains* work-section.

Mass concrete bedding: Dampen the surface of the foundation and place a layer of concrete not less than 50 mm thick over the excavated surface and finish to a smooth, even surface.

3.3 INSTALLATION

General

Timing: Install drainage structures not later than 14 days after the installation of associated pipes, box culverts or open drains.

Trash racks: If documented, construct trash racks with access for machine removal of accumulated debris.

Joints and seals

Isolation joints: Provide joints where a drainage structures abut another structure or concrete pavements.

- Joint width: 10 mm wide
- Material: Preformed jointing filler to manufacturer's recommendations.

Sealing: Seal joints and connection points against the ingress of water and other kinds of material with cement mortar.

Rung ladders and step irons

Pits and junction boxes over 600 mm deep: Install an individual rung ladder or step iron on one internal wall for the full depth of the structure to AS 1657 and as follows:

- The top of the uppermost rung: ≤ 600 mm below the top of the pit.
- The top of the bottom rung: ≥ 300 mm and ≤ 500 mm above the invert of the pit.
- Rung spacings: 300 mm ± 50 mm.

Installation: Fix step irons using one of the following methods:

- Within the formwork before placing the concrete for the pit walls.
- Provide blockout formers to make recesses in the concrete to receive the arms of the step irons.
- Drill holes using a rotary masonry bit in the pit wall after placing concrete. Do not use percussion tools to drill holes.

Fixing into recesses or holes: Fix step irons using epoxy resin. Protect step irons from movement until the epoxy resin has reached the specified strength.

Bulkheads

Requirement: If the gradient of the stormwater drainage pipelines is more than 5%, construct concrete bulkheads to the documented spacings and details.

3.4 HEADWALLS AND WINGWALLS

General

Batter retention: Construct the wingwalls to retain the batters as documented.

Precast units

Requirement: Provide headwalls and wingwalls as documented.

Weepholes

Backfill material: To the *1351 Stormwater drainage (Construction)* work-section.

Location: Provide weepholes as documented and place backfill material as follows:

- Height: > 450 mm above the bottom of the weephole.
- Plan area: > 600 mm along the wall and 300 mm out from the wall located centrally about the weephole.
- Enclose the backfill material with geotextile filter fabric in conformance with Austroads AGPT04G.

Alternative to geotextile: Cover the face area of the structure with an equivalent area of geo-composite.

3.5 PITS AND JUNCTION BOXES

General

Existing pits: Modify existing pits only if modification documented.

Precast units

Requirement: Provide precast pit and junction boxes as documented.

In-situ concrete units

Requirement: Construct all new pits to accept access covers, gully grates and frames as documented and as follows:

- Concrete: Conform to the following:
  . Strength: > 32 MPa.

. Aggregate size: > 12 mm.

Inlet and outlet pipes: Cast ends of inlet and outlet pipes into the pit walls.

Access cover and pit: Locate so that removal of the cover is not obstructed by a wall, kerb or other fixed item.

Access covers and frames

Proprietary access covers: To manufacturer's recommendations, including any infill requirements for the covers.

Matching covers and frames: Do not switch covers and frames.

Cleaning: Remove excavated or other material from between cover and frame.

3.6 BACKFILLING AND COMPACTION

Backfilling

Requirement: Do not backfill against in-situ concrete drainage structures less than 14 days after placing concrete or before the compressive strength is more than 15 MPa.

Backfilling: Place selected fill against the full height of the vertical faces of structures for a horizontal distance equal to one-third the height of the structure, or as documented.

Sequence: Start backfilling and compaction at the drainage structure wall. Prevent excessive surcharge loading against vertical surfaces during the backfilling.

Balance: Backfill on both sides of the structure alternately in layers to avoid unbalanced forces on the structure.

Horizontal terraces: If the sides of the excavation are steeper than 4H:1V, cut benches in the form of horizontal terraces at least 600 mm in width, before placing backfill.

Compaction

Compaction: To the *1351 Stormwater drainage (Construction)* work-section.

3.7 COMPLETION

General

Requirement: Remove and replace drainage structures if required for any of the following reasons:

- Not within the tolerances.
- Settlement after installation.

4 ANNEXURE

4.1 ANNEXURE - SELECTIONS

Precast drainage structures schedule

Property	A1	A2	A3
Headwalls			
Wingwalls			
Gully pits			
Inspection pits			

Property	A1	A2	A3
Junction pits			
Drop structures			
Inlet and outlet structures			
Energy dissipaters			

Access covers and frames schedule

Property	A1	A2	A3
Cover number			
Load class			
Size			
Cover type			
Security			
Ventilation or sealing			
Cover orientation			
Handling			

4.2 ANNEXURE – SUMMARY OF HOLD AND WITNESS POINTS

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
SUBMISSIONS Products and materials Product conformity	H	Manufacturers certificates for conformance for precast units.	5 days before delivery	Delivery of drainage structures. Execution.
SUBMISSIONS Execution details Precast drainage structures	H	Substitution of precast units for in-situ units. Submit details of proprietary items.	5 days before commencing installation	Substitution of precast units. Precast drainage structures
INSPECTIONS Notice Foundation	H	Completed excavation and compaction of foundations	1 day	commencement of drainage structure and foundations
INSPECTIONS Notice	W	Rock foundation to wingwalls and headwalls	1 day	Excavation of rock for wingwalls and headwalls.

Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
Foundation				
INSPECTIONS Notice Foundation	W	Rock foundation to gully pits and sumps	1 day	Excavation of rock for pits and sumps.
INSPECTIONS Notice Precast units	W	Installation of precast units	5 days	Precast drainage structures
INSPECTIONS Notice Backfilling	W	Before backfilling of in-situ concrete drainage structures	1 day	Document and survey measure

4.3 ANNEXURE – PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
1354.1 Supply and place headwalls and wingwalls	m^3 of concrete in place. Volume calculated from the dimensions as documented	All costs associated with supply and placing of in-situ concrete including reinforcement in place including joints or backfilling.
1354.2 Supply and place pits, dissipaters, channel basins and other supplementary structures	Each completed structure as documented	All costs associated with the structures including cast in metal work, precast items frames, grates, lintels, lids, backfilling.
1354.3 Supply and place bulkhead structures	Each completed bulkhead as documented.	All costs associated with bulkhead structures including reinforcement and backfilling.
Traffic management	Lump sum.	To the *1101 Traffic management* work-section.
Concrete works		To the *0319 Auxiliary concrete works* work-section.
Excavation and compaction		To the *1351 Stormwater drainage (Construction)* work-section.

Alternatively use a single pay item.

Pay items	Unit of measurement	Schedule rate scope
1354.1 Supply and place drainage structures other than pipes and box culverts	Each completed structure as documented	All costs associated with supply and placing of in-situ concrete including reinforcement in place including joints or backfilling. All costs associated with the structures including cast in metal work, precast items frames, grates, lintels, lids, backfilling.
Traffic management	Lump sum.	To the *1101 Traffic management* work-section.

Pay items	Unit of measurement	Schedule rate scope
Concrete works		To the *0319 Auxiliary concrete works* work-section
Excavation and compaction		To the *1351 Stormwater drainage (Construction)* work-section

4.4 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this work-section by reference:

AS 1597		Precast reinforced concrete box culverts
AS 1597.2	2013	Large culverts (exceeding 1200 mm span or 1200 mm height and up to and including 4200 mm span and 4200 mm height)
AS 1657	2018	Fixed platforms, walkways, stairways and ladders - Design, construction and installation
AS 3600	2018	Concrete structures
AS 3972	2010	General purpose and blended cements
AS 3996	2006	Access covers and grates
Austroads AGPT		Guide to pavement technology
Austroads AGPT04G	2009	Geotextiles and geogrids

1859 CCTV INSPECTION OF DRAINAGE CONDUITS

1 GENERAL

1.1 RESPONSIBILITIES

General: Provide CCTV inspection and reporting of stormwater drainage and related maintenance structures, as documented and in conformance with **ANNEXURE** - **SCOPE OF CCTV INSPECTION**.

At the completion of all works, CCTV footage of all stormwater drainage infrastructure and an inspection report shall be undertaken and submitted to the Certifying Authority. Pipelines are to be clean and free of debris and silt. CCTV of dirty silted lines will not be accepted. The CCTV inspection shall be undertaken following stabilisation of the site and cleaning of the system. Where defects are identified, repairs shall be performed in accordance with the manufacturer's recommendations. Defects shall be notified to Council / PCA for approval of repair procedures prior to any repairs being made. Repairs are to be made to the satisfaction of the Council and revised CCTV footage and inspection report submitted to demonstrate rectification works have been completed. All repairs are to have certification of 100 years design life.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0135 General requirements (Services).*
- *0153 Schedules - period supply and service.*
- *1101 Control of traffic.*
- *1851 Clear open space and drains.*
- *1852 Clear open space drainage culverts.*
- *1853 Clear road reserve culverts and pits*

1.3 STANDARD

General

Code: To WSA 05.

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this work-section the following abbreviations apply:

- ADAC: Asset Design as Constructed.
- CCTV: Closed Circuit Television.
- FMP: Flow Management Plan.
- WHS: Work Health and Safety.

Definitions

General: For the purposes of this work-section the definitions given in WSA 05 apply.

1.5 SUBMISSIONS

Flow management plan

Requirement: Submit the FMP, in conformance with **FLOW MANAGEMENT**.

Submission time: A minimum of 5 working days before starting a CCTV inspection at any location.

Qualifications

Requirement: Submit evidence of operator's qualifications, in conformance with **OPERATOR TRAINING**.

Submission time: A minimum of 5 working days before starting CCTV inspection at any location.

Report

Inspection results: Submit inspection reports, in conformance with **Inspection report**.

Submission time: A maximum of 5 working days from completion of the first CCTV inspection and a maximum of 10 working days for subsequent inspections.

Urgent issues: Immediately after completion of the field investigation submit details of any defects nominated as requiring immediate notification, in conformance with **Immediate notification**. Provide the Principal with the option of a site visit whilst the camera is still on site.

Work health and safety plan
Requirement: Submit the WHS plan, in conformance with **WHS plan**.

Submission time: A minimum of 2 working days before starting a CCTV inspection at any location.

2 PRE-INSPECTION PLANNING

2.1 DRAINAGE NETWORK ASSET INFORMATION

General: For conduits and maintenance structures to be inspected the following information is provided:

- A plan/map of the network, to scale, including node and conduit locations, node numbers, street names and property boundaries.
- Size, material, class and flow direction of conduits.
- Coordinates, depth, surface and invert levels of nodes.
- Dates of construction - Age.
- Asset names or descriptors.
- Critical flow patterns and any pumped discharges.
- Any isolation or flow control measures relating to the network.

Access
Location: Confirm location of access maintenance structures based on the asset information obtained.

Traffic impact: Do not use access maintenance structures which are located under road surfacing or at heavy traffic junctions, if possible. Complete CCTV inspection from adjacent maintenance structures.

Notification: Provide minimum notice of 1 full working day of any required access locations which are inaccessible on Council property and a written notice to the owner/occupier before accessing any maintenance structures on private property, with the format and timeframe for such notice to be in conformance with relevant State legislation and local laws.

Identification: Always carry the Council/Municipality/Utility identification provided.

2.2 OPERATOR TRAINING

Qualifications
Requirement: Use operators trained and qualified with certified competence in conformance with WSA 05 clause 2.2.1 to conduct CCTV inspections, identify defects and report on condition of conduits and related maintenance structures. For stormwater assets the operators must also read the guidelines in IPWEA *Practice Note 5 – Stormwater drainage*.

2.3 CLEARING AND CLEANING

General
Requirement: If clearing or cleaning of the conduit and maintenance structures prior to inspection is requested, conform to *1851 Clear open space and drains*, *1852 Clear open space drainage culverts* or *1853 Clear road reserve culverts and pits* as appropriate.

Initial inspection: Perform an initial inspection using zoom cameras to identify any potential obstructions or blockages which may impede the successful completion of the detailed CCTV inspection.

2.4 WORK HEALTH AND SAFETY WHS PLAN

Requirement: Prepare a WHS plan for the CCTV inspection works including safe work method statements for each inspection location, in conformance with State regulatory requirements.

Confined spaces
General: Make sure all staff entering any confined space have completed the necessary confined space training, and are provided with the necessary safety equipment, required by State WHS regulation.

2.5 FLOW MANAGEMENT GENERAL

Timing: Where possible, plan to carry out CCTV inspections during dry weather for stormwater conduits and during periods of predicted low flow for sewerage conduits.

FMP: If it is anticipated that flows within the conduit will require management for a successful CCTV inspection, prepare an FMP detailing how normal dry weather and wet weather flows will be managed.

Flow storage
Upstream: Where storage of flows within the network can be safely achieved upstream of the inspection location, detail the following in the FMP:

- Management resources.
- Monitoring procedures of upstream storage/flow levels.
- Procedures to manage any sudden rises in storage/flow levels.
- Systems in place to make sure that, where plugs are used, they cannot be displaced in a situation where they deflate.

Flow diversion
By-pass pumping: If storage of flows within the network cannot be safely achieved, use by-pass pumping to divert flows past the area of inspection. Detail how the by-pass pumping will be installed, managed and operated in the FMP and include the following information:

- Proposed pumping access points.
- Identification of each point of inflow into the conduit to be inspected.
- Proposed equipment and provision of back-up equipment.
- Procedures for monitoring the equipment in operation.
- Control of noise and public safety.
- Anticipated duration of pumping activities.
- Procedures for dealing with any spillage/leakage which may occur.

3 EQUIPMENT

3.1 CCTV CAMERA

General
Standard: To WSA 05 clause 2.5.1.

Camera type: Use a camera to suit the specific conduit diameter and required picture quality.

Capability and quality
Requirement: Use cameras which conform to the following:

- Capability (Manoeuvrability): To WSA 05 clause 2.5.2.
- Picture quality: To WSA 05 clause 2.5.3.

4 EXECUTION

4.1 PROVISION FOR TRAFFIC

General
Requirement: Conform to *1101 Control of traffic*.

4.2 REQUIRED DOCUMENTATION

General
Requirement: The CCTV operator and inspection reporter/coder must have a copy of this specification and WSA 05 available at all times during inspection and coding.

4.3 CAMERA OPERATION

Camera position

Requirement: Position camera centrally within the conduit or maintenance structure in conformance with the tolerance requirements of WSA 05 clause 2.6.1.

Camera travel speed

Maximum: Manoeuvre the camera at no greater than the maximum speed documented in WSA 05 clause 2.6.2.

Camera pan

Restriction: Do not pan the camera whilst the camera is moving. At a defect or feature, stop the forward camera movement and then pan or rotate the camera, to conform to WSA 05 clause 2.6.2.

4.4 INSPECTION PROCEDURE

General

Asset data: Confirm that the conduit material and size conforms to any asset data obtained before starting the inspection. Identify and record any asset data which contradicts previous asset data obtained.

Inspection

Maintenance structures: Inspect, observe and record any features or defects of the maintenance structures at the start and end of the inspection. Also include any intermediate maintenance structures, not previously documented in the obtained asset data.

Start of conduit: Position camera at the face of the maintenance structure (conduit invert) and inspect the start of the conduit. Rotate the camera through 360º, paying particular attention to the 3, 6, 9 and 12 o'clock positions for the start of any longitudinal cracks or fractures. Record start node and water level codes to WSA 05.

End of conduit: Complete the same 360º inspection at the end of the conduit length. Record an inspection closing code to WSA 05.

Conduit joints: When defects are visible upon approach to a joint, complete the same 360º inspection at those joints.

Observation

Record: Record observed features or defects, which extend over a length greater than 1 m, as a continuous code. Define the continuous code by recording the start and finish linear measurement of the defect from the longitudinal reference point. Record defects or observations affecting less than 1 m of the conduit length as a non-continuous defect.

Camera vision

Clean lens: If the lens of the camera becomes obscured, preventing a clear view of the conduit and potential defects, pause the inspection and clean the lens. If the camera needs to be removed to clean the lens, the inspection can be resumed at the location where the inspection was paused. The video however must be a single video record.

Completion

Covers: Correctly reinstate all maintenance structure covers at the completion of the field CCTV inspection.

4.5 LINEAR MEASUREMENT

General

Standard: To WSA 05 clause 2.7.

Levels: Record all levels to Australian Height Datum (AHD). If a reference level is not available, record relative levels from the centre of the cover to the maintenance structure at which the inspection is to start.

Longitudinal reference point

Zero measurement: Set the longitudinal reference point as the centre of the maintenance structure at which the inspection is to start. The start linear measurement is the distance from the centre of the maintenance structure to the face of the maintenance structure.

Finish point: Finish the inspection at the corresponding reference point in the target maintenance structure, unless inspection has to be abandoned.

Alternative: If the centre of the maintenance structure cannot be accurately determined, set the longitudinal reference point in conformance with WSA 05 clause 3.5.4.5.

4.6 MAXIMUM DEPTH OF FLOW

In-service assets

General: Pause or terminate any inspection if the maximum depth of flow values stated in WSA 05 Table 2.1 are exceeded. Conform to the requirements of WSA 05 clause 2.11.

4.7 RECORDING WATER LEVEL

General

Water level: Record the water level of stagnant (ponding) water or water flowing at a constant depth at the start of the inspection. Do not record water flowing at fluctuating depths as a water level. Record water level and changes in water level to WSA 05 clause 3.7.8.3, Quantification 1.

Sagging

Sag: Record the water level to WSA 05 clause 3.7.8.3, Quantification 1, where the water level is increasing due to a sagging conduit. Terminate the inspection if the camera becomes submerged, unless the camera will become unsubmerged in a short distance.

5 REPORTING

5.1 GENERAL INSPECTION REPORT

Requirement: Prepare a report of the CCTV inspection in conformance with WSA 05 clause 2.12.1,

WSA 05 Appendix A and as follows:

Video record

Data display: During video playback, display data, superimposed on the image, to satisfy the requirements of WSA 05 clause 2.8. For conduits also include the following data:

- Direction of view (a dial, mimic or graphical indicator showing the camera's position with respect to the angle/circumferential direction of view). If camera does not have capability to record the direction of view, record the angle of view in conformance with WSA 05 clause 3.7.9.4.
- Conduit asset reference number.

Drawings

Requirement: Provide electronic format drawings, included in the inspection report, conforming to the ADAC methodology.

5.2 OBSERVATION CODING

Conduit inspection

Reporting: When describing and encoding all observations from the CCTV inspection, conform to the requirements and codes in WSA 05 Section 3.

Header information: Record the mandatory information required by WSA 05 clause 3.4.2.

Maintenance structure inspection

Reporting: When describing and encoding all observations from the CCTV inspection, conform to the requirements and codes in WSA 05 Section 4.

Header information: Record the mandatory information required by WSA 05 clause 4.4.2.

Immediate notification

Requirement: Upon completion of the field investigation, immediately notify the Principal of any observed defect that may warrant immediate investigation by the Principal, or if any of the following defect codes were observed:

Scoring of defects

General: Score each defect and grade the apparent condition of the asset, in conformance with the relevant WSA 05 Appendices, as follows:

- Appendix C – Sewers.
- Appendix D – Stormwater.
- Appendix E – Maintenance structures.

6 ANNEXURE - SCOPE OF CCTV INSPECTION

Inspection location:

- **Area:**_____
- **Start:** _____
- **End:** _____
- **Reason for inspection and scope of works:** _____

_____
_

The following defects/features can be excluded from the CCTV inspection reporting:

_____
_

_____
_

Existing asset information

Data on existing assets has been made available to Contractors in conformance with WSA 05 clause 2.3, clause 3.4.4 and clause 4.4.4:

☐ **Yes**

☐ **No**

(see below)

The following asset data is not available:

_____

_____

6.1 ANNEXURE - REFERENCED DOCUMENTS

Standards

General: The following document is incorporated into this work-section by reference:

Other publications

IPWEA - Institute of Public Works Engineering Australia

IPWEA PN 5-2015	Practice Note 5 - Conditions assessment and asset performance guidelines - *Stormwater drainage*

WSAA - Water Services Association of Australia

WSA 05 v3.1 – 2013	Conduit inspection reporting code of Australia